

Bioaccumulation of copper and zinc in *Oreochromis mossambicus* and *Clarias gariepinus*, from the Olifants River, Mpumalanga, South Africa

P Kotze*, HH du Preez and JHJ van Vuren

Department of Zoology, Rand Afrikaans University, PO Box 524, Auckland Park 2006, South Africa

Abstract

The upper and lower catchments of the Olifants River are characterised by many anthropogenic activities that adversely impact on the water quality of the river. The present study indicated that both Cu and Zn are present in elevated levels as reflected in the bioaccumulation of these metals in the fish. Bioaccumulation differences in the different age and gender groups were generally not significant ($P > 0.05$). This was due to the sampling of mostly adult fish and the exclusion of reproductive organs (gonads). Copper content in the organs and tissues indicated the following pattern: liver > gills > skin > muscle, but no specific pattern for Zn content was observed. The extent of accumulation differed in many cases between the two species, possibly due to differences in behaviour and feeding. Temporal variation in bioaccumulation occurred and generally indicated increased levels of bioaccumulation during periods of high flows. This phenomenon was ascribed to the influence of sediment-bound metals, being brought into contact with the fish at a higher intensity during these periods. Both Loskop Dam and Mamba Weir, the latter to a greater extent, are at present being exposed to levels of Cu and Zn which cause bioaccumulation. A more holistic biomonitoring approach is proposed for these impacted areas in an attempt to guide managers in a direction of improvement.

Introduction

As a result of mining, industrial and other anthropogenic activities in the catchment of the Olifants River over the past decade, this aquatic ecosystem has been degraded and increasingly contaminated by pollutants such as metals. This poses stress to aquatic organisms in particular and to the whole ecosystem in general. Copper and Zn are two of the metals occurring in elevated levels in the water of the Olifants River, Mpumalanga (Grobler et al., 1994; Seymore et al., 1994). This is of concern since they are tentatively classified as highly toxic metals by Hellowell (1986) and are also bioaccumulated by aquatic organisms (Alabaster and Lloyd, 1980; Latif et al., 1982; Villarreal-Treviño et al., 1986; Seymore et al., 1996). Due to the deleterious effects of metals on aquatic ecosystems, it is important to monitor the bioaccumulation of metals in an aquatic system. This will give an indication of the temporal and spatial extent of metal accumulation, as well as an assessment of the potential impact on human health (fish consumed) and organism health (if they have been exposed to elevated levels of a pollutant or if consumed by predators).

This study investigated levels of Cu and Zn in two species of fish, namely *Oreochromis mossambicus* and *Clarias gariepinus*, collected in the Olifants River, Mpumalanga (Fig. 1). The data will give some indication of the extent of metal contamination in these two fish species. The data from Loskop Dam are particularly important since this impoundment is commonly used for angling purposes. It is therefore important to determine the extent of the metal bioaccumulation of these two fish species as they are common angling species consumed by humans. Mamba Weir is situated inside the Kruger National Park (KNP) and it is the National Parks Board's view that water quality has to be

managed in order to maintain essential ecological processes. These ecological processes will preserve the genetic diversity and ensure sustainable utilisation of both species and ecosystems (Venter and Deacon, 1992). Monitoring of the metal pollution at this locality is thus important for the mentioned conservation objectives.

Materials and methods

Field sampling

Field surveys were undertaken seasonally at Loskop Dam and Mamba Weir (KNP) during the period February 1994 to May 1995 (Fig. 1). During the final survey (May 1995) Phalaborwa Barrage was also included so as to investigate the effect of the metal-polluted Selati River on the water quality of the Olifants River before it enters the KNP. Nhlanganini Dam was sampled as a control because its catchment lies within a relatively natural area (KNP). *Oreochromis mossambicus* (Mozambique tilapia) and *C. gariepinus* (Sharptooth catfish) were sampled with gill nets (70 to 120 mm stretched mesh size), cast nets and fishing rods. After capture the mass, length and gender of each fish were recorded. The fish were then killed by a blow on the head and a cut of the spinal cord behind the head. Fish were dissected on a polyethylene work-surface using stainless steel tools while taking care to prevent any contamination of the samples (Heit and Klusek, 1982). Muscle, gill, liver and skin tissues were removed from each fish and frozen until metal analyses could be performed.

Laboratory procedures

The samples were thawed in the laboratory and dried in an oven at 60°C for a period of 48 h. In order to calculate the moisture content of each sample, the dry and wet mass of each sample was recorded. Twenty ml of concentrated nitric acid (55%) and 10 ml

* To whom all correspondence should be addressed.

☎ (011) 489-2445; fax (011) 489-2286; e-mail pk@rau.ac.za

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