

Manganese, lead and strontium bioaccumulation in the tissues of the yellowfish, *Barbus marequensis* from the lower Olifants River, Eastern Transvaal

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Abstract

The bioaccumulation of manganese, lead and strontium in the freshwater fish (*Barbus marequensis*) from the lower Olifants River, E. Transvaal, was investigated. The highest concentrations of these metals were detected in the vertebrae and gills. The localities in the Kruger National Park did not differ significantly from each other and therefore no clear indication as to where the highest bioaccumulation had occurred, could be established. However, the highest manganese and strontium levels occurred in fish from the Selali River. For the future monitoring of manganese, lead and strontium levels in bony fish, it is suggested that bony tissues (e.g. vertebrae, opercular bone or scales), gills, liver and muscle tissue are used.

Introduction

Manganese, lead and strontium appear to be metabolised via calcium metabolic pathways (Hammond and Beliles, 1980) and, therefore, accumulate mainly in the skeletal tissues of fish (Paul and Pillai, 1983; Patterson and Settle, 1977; Bagenal et al., 1973). Manganese is an essential trace element and shows relatively low toxicity to aquatic biota. Lead is a non-essential metal and is known to be toxic to aquatic organisms, especially fish (Klein, 1962). The requirement of strontium by fish has not been established, but appears to be a non-essential metal, for although it is a bone-seeking element, strontium is not essential for bone formation (Sauer and Watabe, 1989).

In the natural freshwaters, manganese is rarely found at concentrations above 1 mg/l (Hellawell, 1986), while concentrations of soluble lead are generally less <3 µg/l (Forstner and Wittmann, 1979). Strontium values in South African surface waters typically range from 50 to several hundred µg/l (Kempster, 1994). The forms in which manganese and lead occur in freshwater are mainly particulate or complexed forms (Seenayya and Prahalad, 1987; Moore and Ramamoorthy, 1984), decreasing the bioavailability of these metals to the fish. As the pH of the water decreases, however, the ionic state of the metals becomes more prevalent and toxicity increases (Wang, 1987). Strontium, on the other hand, is found in water in solution rather than in particulate form (Carraca et al., 1990) and might, therefore, be more bioavailable to fish for uptake. Nevertheless, in calcium-rich waters calcium will compete with strontium in the uptake process, resulting in lower strontium accumulation by the fish (Phillips and Russo, 1978). Factors such as the water pH, water hardness, organic materials and other metals will, therefore, influence the toxicity of these metals, but there also seems to be a relation between the concentrations of these metals in the water and the accumulation thereof by freshwater fish (Bermane, 1969).

The manganese, lead and strontium concentrations in the water can increase to quite an extent due to the influence of industrial

wastes and mining effluents on the river. The combustion of oil and gasoline accounts for more than 50% of anthropogenic lead emissions and therefore atmospheric fall-out is usually the most important source of lead in freshwaters (Moore and Ramamoorthy, 1984). Fish can be affected sublethally when they are chronically exposed to lead concentrations ranging between 5 and 5 000 µg/l inorganic lead (Haux et al., 1986). Two distinctive characteristics of chronic lead poisoning in fish are black tails, also an early symptom of spinal deformities (Hodson et al., 1979), and a strong inhibition of the aminolevulinic acid dehydratase (ALA-D) activity in erythrocytes (Haux et al., 1986). The 96-h LC₅₀ value of total lead for freshwater fish varies from 0.5 to 482 mg/l Pb, depending on the water hardness and life stage of the fish (Moore and Ramamoorthy, 1984; Pickering and Henderson, 1966).

Manganese and strontium can also affect fish adversely at elevated levels, but limited research has been done in this field. Sublethal effects can occur at a manganese concentration of 0.278 g/l (Seymore, 1994), while the 96-h LC₅₀ value can vary from 1.723 to 3.230 g/l Mn (Nath and Kumar, 1987). For strontium the 96-h LC₅₀ value for fish has been determined to be greater than 92.8 mg/l Sr (Dwyer et al., 1992). The general order in which the relevant three metals can affect fish, is therefore: Pb > Mn > Sr. Associated factors, such as environmental conditions, should, however, be taken into consideration when assessing the toxicity of these metals to fish.

The objective of this study was to determine the extent of bioaccumulation (with respect to site, seasons, years, age, tissues) of manganese, lead and strontium in the yellow fish, *Barbus marequensis* from the lower Olifants River, E. Transvaal. The data were also used to establish which of the tissues contained the highest and lowest concentrations of these metals, respectively. The Olifants River was selected as study area because it is one of the most important rivers that flows through the Kruger National Park. Furthermore, anthropogenic activities in the catchment of this river may effect the quality of the water flowing through the Kruger National Park.

Materials and methods

Large-scaled yellowfish (*B. marequensis*) were sampled with gill nets (70 to 120 mm stretched mesh size) and standard cast nets

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