Shortcommunication

Note on the occurrence of selected trace metals and organic compounds in water, sediment and biota of the Crocodile River, Eastern Transvaal, South Africa

DJ Roux[1]*, JE Badenhorst[1], HH do Preez[2] and GJ Steyn[2]

[1] *Institute for Water Quality Studies, Department of Water Affairs and Forestry, Private Bag X313, Pretoria 0001, South Africa*

[2] *Research Unit for Aquatic and Terrestrial Ecosystems, Department of Zoology, Rand Afrikaans University, PO Box 524, Johannesburg 2000, South Africa*

Abstract

Samples of water, sedimenlandbiota (7 species of fish and 2 species of macrophytic plant) were collected at a number of sites on the Crocodile River, E. Transvaal. These samples were analysed for the trace metals arsenic (As), cadmium (Cd), copper (Cu), lead (Pb), mercury (Hg), selenium (Se), zinc (Zn), manganese (Mn), aluminium (Al) and iron (Fe), the pesticides DDT, DDE, DDD, Dieldrin, Heptachlor, Lindane and Endosulfan, as well as (he polychlorinated biphenyls Arochlor 1254 and Arochlor 1260. Acid-extraciable concentrations of the detected metals are reported. Concentrations of As, Cd, Cu, Hg and Se never exceeded their respective detection limits in watersamples. All the metals bui Cd, Pb and Hg were detected in the sediment samples, and all but Cu, Pb and Hg were delected in muscle tissue of fish. Arsenic, Cu. Zn, Mn, Al and Fe were detected in plant tissue. The detected metals always occurred at higher concentrations in the roots than in the leaves of the sampled plants. None of the selected pesticides was detected in the sediment samples and only *p,p-DDE* was found in muscle tissue offish.

Introduction

Pollution of South African waters by pesticides, mainly of agricultural origin, and by trace metals, mainty of industrial origin, is acause of increasing concern. This concern has escalated rapidly in recent years following major fish kills in certain parts of the country, e.g. the E, Transvaal and the Pretoria-Witwatersrand-Vereeniging (PWV) areas (Heath, 1992). Concern has also been expressed about the inadequacy of knowledge of, and data on, pesticide and metal concentrations in South African waters (DWA, 1986).

Birds, reptiles and mammats (including man) drink water and derive food from aquatic ecosystems, and are vulnerable to contaminant exposure and accumulation. The impact of pesticides and/or trace metals on aquatic organisms can be either dramatic (e.g. acute fish kills), or insidious due to gradual accumulation in the body tissues of organisms. Biotas are not only influenced by toxicant concentrations in the water or sediment, but due to the process of bioaccumulation, may be exposed to much higher amounts. Concentrations of many toxic substances in water are magnified as (hey are passed up through the food web, via phytoplankton, zoopiankton and forage fish, to piscivorous fish. This results in high contaminant concentrations in top predators (Swackhamer and Eisenreich, 1991).

Many of the organisms which live in, and feed from, aquatic systems are of ecological and economical value. Often the primary cause of toxification by organic and inorganic contaminants associated with the aquatic environment is consumption of fish or shellfish, rather than drinking *of* water (Mackay and Clark, 1991). Health risks associated with consumption of contaminated fish may be 20 to 40 times higher than those resulting from exposure to the same chemicals through drinking water (Foran, 1990). A hydrophobic chemical such as apolychlorinatedbiphenyl (PCB)or DDT may establish a concentration in fish 100 000 times that in water, implying a bioconcentration factor of 100 000 (Mackay and Clark, 1991). Because bioaccumulation may ultimately produce levels of contaminants in commercial species that may be toxic to humans, it is important to monitor key members of food chains (Chapman et al., 1982).

In order to allow detection of unacceptable contamination and of long-term trends, it is necessary to establish baseline levels nationally and to implement a statistically sound monitoring programme. A programme similar to the National Contaminant Biomonitoring Programme, where the US Fish and Wildlife Service periodically determines concentrations of organochlorine chemicals and selected trace metals in freshwater fish (Schmitt and Brumbaugh, 1990 and Schmitt et al., 1990), should provide useful information. The need for a national assessment of concentrations of persistent contaminants in the aquatic environment is certainly acknowledged. However, work in this field has in the past been hampered by the high costs involved and the limited availability of manpower. Currently the Department of Water Affairs and Forestry is investigating the feasibility of conducting bioaccumulation surveys in selected catchments.

Relatively few studies have been undertaken in South Africa dealing with levels of pesticides and trace metals in sediment or biota, and even fewer have incorporated the 3 main compartments of the aquatic environment, namely water, sediment and biota. For the rivers of the E. Transvaal, published data include levels of organochlorine pesticides in fish from the Letaba and Crocodile Rivers (Heath, 1992), pesticide concentrations in water, sediment and fish in the Olifants River (Grobler, 1991) and concentrations of selected trace metals in the tissues and organs of tigerfish *{Hydrocynus vittatus)* in the Olifants River (Du Preez and Steyn, 1992).

The Crocodile River catchment in the E. Transvaal supports the largest irrigation area in South Africa, with some 95 000 ha of a variety of crops being irrigated (Heath, 1992). Apart from its economic importance, the ecological significance of the Crocodile River is accentuated as it forms the southern boundary of the

* To whom all correspondence should be addressed.

Received 22 March 1994; accepted in revised form II July 1994.