Bull. Environ. Contam. Toxicol. (1994) 52:269–273

Environmental Contamination and Toxicology

Comparative Study of Lead Accumulation in Different Organs of Perch (*Perca fluviatilis*) and Its Intestinal Parasite *Acanthocephalus lucii*

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Received: 12 March 1993/Accepted: 20 June 1993

Lead is known as an important aquatic contaminant with different toxic effects on various organisms. Considerable data are available on lead in aquatic ecosystems including water, sediments, fishes (Biney and Beeko 1991) and invertebrates (Vranken and Heip 1986). Until now, no quantitative investigations have been published comparing the heavy metal (Pb, Cd, Hg) content in parasites with that in their final or intermediate hosts, although such parasites are very prevalent in many fish and invertebrate populations. Only Brown and Pascoe (1989) reported that the amphipod *Gammarus pulex* parasitized with the acanthocephalan *Pomphorhynchus laevis* was two or three times more sensitive to cadmium at low exposure concentrations (2.1 $\mu g\ l^{-1}$) than uninfected conspecifics.

The objective of the present study was to combine trace analytical and parasitological methods to investigate lead concentrations in different tissues (muscle, liver and intestine) of perch (*Perca fluviatilis*) and in the palaeacanthocephalan *Acanthocephalus lucii* parasitizing the intestine of these fishes. The fish were caught in the river Ruhr which drains the densely populated and industrialized Ruhr-district.

MATERIAL AND METHODS

Six perch, *Perca fluviatilis*, caught by a fish trap during January to March 1992 in the Ruhr-lake near Bochum were used for the study. The fish had a body weight between 100 and 350 g and a length between 20 and 29 cm. After being brought alive in river

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water to the laboratory, they were killed and dissected immediately. Samples of muscle, liver and intestine were taken with the aid of stainless steel scissors and forceps which had been previously cleaned with 1% ammonium-EDTA-solution and double-distilled water. The acanthocephalans were removed from the intestines using the same instruments. The number of *A. lucii* found in each intestine ranged between 4 to 29 individuals.

After homogenization of the tissues and parasites with a dispersing tool (Ultra-Turrax), the sample material was digested with 1 ml of a mixture of concentrated, "suprapure" nitric acid (2/3) and concentrated, "suprapure" perchloric acid (1/3; Merck, Darmstadt, FRG) for a sample weight of about 100 mg as described by Kruse (1980). The resulting white residue was redissolved in 1 ml of 1:1000 dilute nitric acid and analyzed for lead in a Perkin-Elmer Model Z-3030 atomic absorption spectrometer equipped with a HGA-600 atomizer and a Zeeman- effect background correction system. The accuracy of the analytical procedure was checked using standard reference material ZEBS nr. 999948 (Agricultural Research Centre, Finland). To determine the detection limit, analytical blanks were prepared in a similar manner without insert of a sample. The metal concentration in each sample was calculated from the corresponding regression lines (correlation factor ≥ 0.99) using the standard addition method for each fish tissue and the parasites. For statistical analysis Fisher's least significance test was applied.

RESULTS AND DISCUSSION

The lead concentrations in organs of perch and their parasites are summarized in Tables 1 and 2. The detection limit ($3 \times$ SD, N = 30) for lead was found to be 0.01 ppm; the average recovery

Table 1: Lead concentrations ($\mu g\ g^{-1}$ wet weight) in *A. lucii* and in different organs of *P. fluviatilis*

Perch no.	Muscle	Liver	Intestine	*A. lucii*
1	0.03	0.09	0.19	4
2	0.05	0.05	0.23	12
3	0.02	0.14	0.12	12
4	0.03	0.11	0.30	9
5	0.01	0.07	0.19	16
6	0.01	0.05	0.08	11

Table 2: Mean lead concentrations ($\mu g\ g^{-1}$ wet weight) in *A. lucii* and *P. fluviatilis*

Tissue	n	x	SD	Range
Muscle	6	0.03	0.02	0.01 - 0.05
Liver	6	0.09	0.04	0.05 - 0.14
Intestine	6	0.19	0.08	0.08 - 0.30
A. lucii	6	11	4	4 - 16

for spiked samples of muscle, liver, intestine and the parasites ranged between 88-92%

The results demonstrated that the intestine of the perch contained significantly higher ($p < 0.05$) concentrations of lead than that found in any other organs studied. This fact has never been described before as toxicological studies generally have dealt with muscle, liver, kidney, gill and blood (Tulasi et al. 1992). Thus kidney and liver have been considered to be the inner organs for lead accumulation in fish (Tulasi et al. 1992). The significantly lower concentration (0.03 $\mu g\ g^{-1}$) of lead in the muscle found here could be expected and was markedly below the German upper limiting value of 0.5 $\mu g\ g^{-1}$ for human consumption (see BGA 1979). In 1990, as well as in 1991, the average Pb concentration of the water of the river Ruhr near Bochum was 5 $\mu g\ l^{-1}$ (Umweltbundesamt 1992); a similar level during our sampling period in 1992 has been assumed. Based on these data the lead concentration of the water is 6 times lower than that of the muscle, 18 times lower than that of the liver and 38 times lower than that of the intestine.

The acanthocephalans found in the gut of the fish showed significantly higher ($p < 0.05$) concentrations of lead than the organs of the fish (Tables 1 & 2). In comparison to the muscle the accumulation factor in *A. lucii* was 370 : 1. Thus, *A. lucii* contained 2.2×10^3 times more lead than the water of the river Ruhr (based on the data provided by the environmental ministry of FRG).

Because of the enormous accumulation capacity of these acanthocephalans, *A. lucii* may serve as a very sensitive bioindicator for the presence of biologically available lead in aquatic ecosystems.

In comparison to other bioindicator organisms like the zebra mussel *Dreissena polymorpha* (ARGE 1991), *A. lucii* is a widely distributed parasite in perch (Scholz 1986 ; Kennedy and Moriarty 1987 ; Taraschewski 1988 ; Valtonen and Crompton 1990) which is also widely distributed. Brattey (1988) reported that a perch population in Scotland was parasitized by *A. lucii* throughout the year (prevalence rates 70 - 90%, 14 - 16 worms per fish, respectively). In addition to the infestation of perch, *A. lucii* also frequently occurs in several other fish species like *Gymnocephalus cernua, Anguilla anguilla, Esox lucius, Gasterosteus aculeatus* and *Lota lota* (Kennedy and Moriarty 1987 ; Køie 1988 ; Taraschewski 1988 ; Valtonen and Crompton 1990). Moreover, *Dreissena polymorpha* is a sessil animal (ARGE, 1991) and thus may provide data on locally confined lead contamination. *Acanthocephalus lucii* which parasitizes mobil hosts would indicate average lead concentrations in aquatic ecosystems.

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