Distribution of Selected Metals in Tissue Samples of Carp, *Cyprinus Carpio*

by ROBERT REHWOLDT
Environmental Science Program, Marist College, Poughkeepsie, New York
by DAVOUD KARIMIAN-TEHERANI, and HANS ALTMANN
Osterreichische Studiengesellschaft für Atomenergie GmbH Lenaugasse 10, A-1082 Wien, Austria

INTRODUCTION - The measurement of whole body concentration of metal ions in fish is important from the point of view of environmental protection. Of equal importance, however, is the distribution of these ions throughout the body of the animal itself. Much work has been done with mammals in this respect and the distribution patterns for many ions are known (BOWEN, 1966).

This work deals with the distribution of cobalt, chromium, iron, zinc, lanthium and scandium throughout biological sections of carp, Cyprinus carpio taken from the Danube River and Danube Canal from August 1973 to March 1974. Samples of gill, liver, kidney, bone and flesh were used for analysis, as well as homogenized samples to give Total Body Burden.

METHODS - Samples were dissected upon immediate return to the laboratory and freeze dried. Tissue samples weighing from 0.1-0.7 mg were placed in quartz ampules and irradiated for 24 hours in a neutron flux of $4\text{-}7.10^{13}$ n/cm^2, sec. After a waiting period of 7 days the samples were then counted on an Intertechnique pulse height analyzer connected to a 12 cm^3 Ge(Li) detector. Isotopes and energies measured were ^{60}Co 1333 KeV, ^{51}Cr 320 KeV, ^{59}Fe 1099 KeV, ^{65}Zn 1115 KeV, ^{140}La 487 KeV and ^{46}Sc 889 KeV.

RESULTS AND DISCUSSION - It should be mentioned that gill samples were taken to see how closely they resembled the suspended solid metal concentrations and were not included as part of the Total Body Burden. In the same manner alimentary tracts were also excluded from the measurement. The Total Body Burden refers to the concentration in homogenized samples after removal of head and digestive system.

The results of the analyses are presented as ug/g dry weight in Table 1 and as percentage distribution in the fish in Figure 1 and Table 2. The values listed in the table are mean values and they are presented with a Confidence Interval, C.I. = $\pm .95$ t x St. Dev. of mean.

As can be seen, the values for metal ions found in the gills resemble very closely, the values for suspended solids. This is to be expected since the gill system acts as a filter and most likely the high concentrations of metals were on particles imbedded on the gill surfaces and not in the tissue itself. (REHWOLDT et.al, 1972).

The distribution of the transition metals: Co, Cr, Fe and Zn in these carps follow closely the distribution for these metals in mammals (WACKER & VALLEE, 1959; UNDERWOOD, 1962).

They tend to concentrate in the liver and kidneys. Co accumulates somewhat in bone tissue; this has also been observed in mammals (PARR & TAYLOR, 1964).

Bulletin of Environmental Contamination & Toxicology,
Vol. 15, No. 3 © 1976 by Springer-Verlag New York Inc.

TABLE 1 Heavy metal content of samples ug/g dry wt.

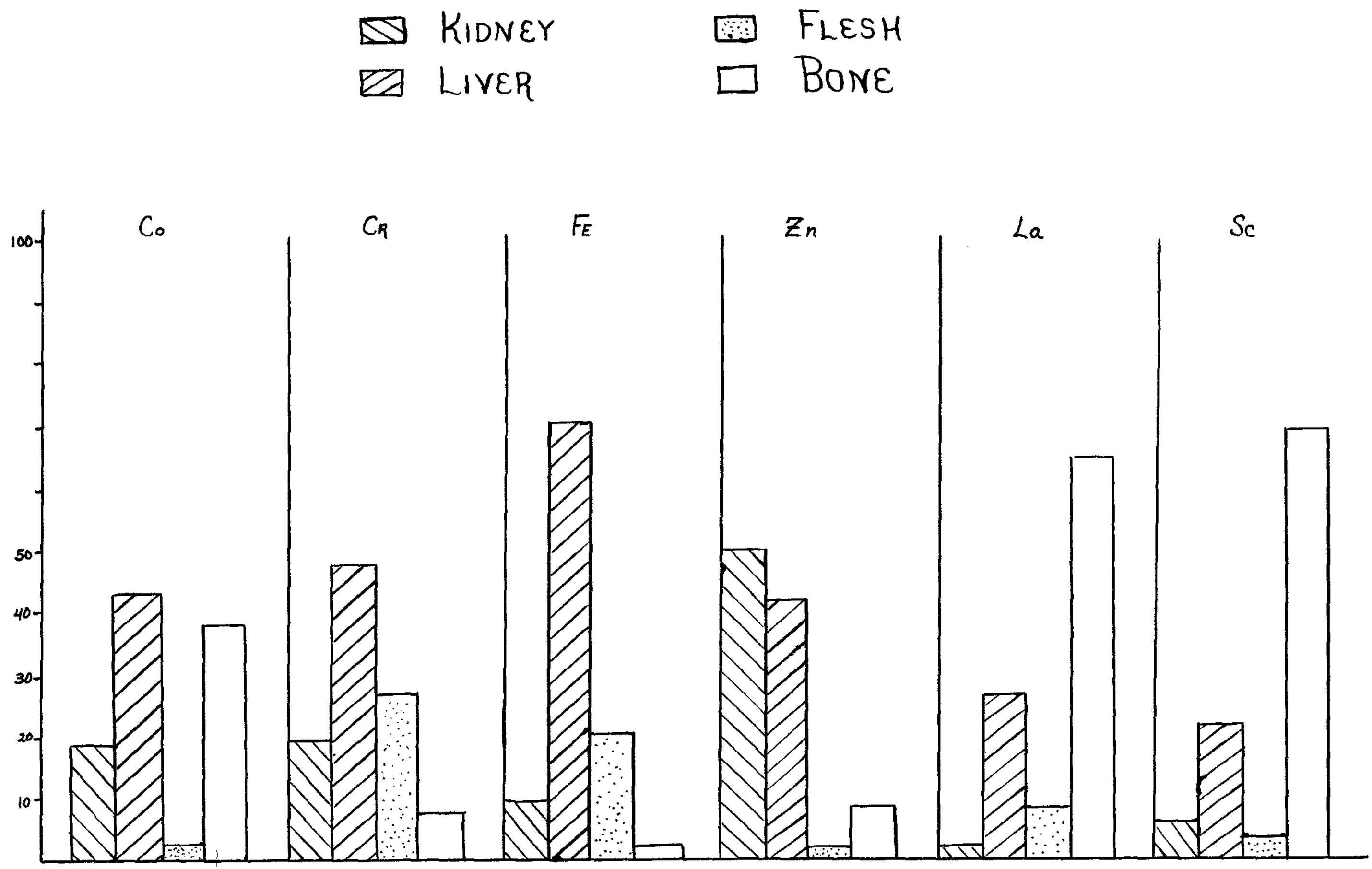
		Co	Cr	Fe	Zn	La	Sc
SUSPENDED SOLIDS	MEAN	2.61	67.31	11700	46.23	9.26	17.48
	C.I.	±0.21	±6.21	±7.10	±6.21	±2.61	±3.33
GILL	MEAN	2.00	53.17	14597	50.11	16.21	14.73
	C.I.	±0.99	±9.24	±9.07	±9.64	±9.62	±2.14
KIDNEY	MEAN	0.032	0.087	2.49	8.43	0.0346	0.0588
	C.I.	±0.012	±0.031	±0.92	±0.51	±0.012	±0.041
LIVER	MEAN	0.076	0.216	19.39	7.06	0.449	0.206
	C.I.	±0.041	±0.14	±3.1	±1.14	±0.19	±0.03
FLESH	MEAN	0.004	0.119	5.54	0.172	0.138	0.032
	C.I.	±0.002	±0.10	±1.01	±0.092	±0.72	±0.021
BONE	MEAN	0.067	0.032	0.277	1.37	1.107	0.676
	C.I.	±0.024	±0.01	±0.14	±0.92	±0.62	±0.022
*TOTAL BODY BURDEN	MEAN	0.18	0.45	27.70	17.03	1.73	0.97
(* see text)	C.I.	±0.08	±0.09	±2.14	±1.74	±0.89	±0.47

TABLE 2 Per Cent Distribution in Tissue Samples

		Co	Cr	Fe	Zn	La	Sc
KIDNEY	MEAN	17.9	19.2	9.0	49.5	2.0	6.0
	C.I.±	0.032	0.087	2.49	8.43	0.0346	0.0588
LIVER	MEAN	42.5	47.6	70.0	41.5	26.0	21.2
	C.I.±	0.076	0.216	19.39	7.06	0.449	0.206
FLESH	MEAN	2.2	26.2	20.0	1.0	8.0	3.3
	C.I.±	0.004	0.119	5.54	0.172	0.138	0.032
BONE	MEAN	37.4	7.0	1.0	8.0	64.0	69.5
	C.I.±	0.067	0.032	0.277	1.37	1.107	0.676

Figure 1

% Distribution of Metals in Tissues



MERLINI et. al. (1970) have done some work on the distribution of trace metals and of mercury in fresh water species and although in the trace metal study they divide their fish sample into just muscle, bone and scales, the distribution of Co, Fe and Zn are interesting for comparison. If one compares bone and flesh in this work to bone and muscle in the Merlini data one finds similarities and dissimilarities. The distribution of iron is the same in both cases, however, Merlini et. al. find cobalt to collect in muscle rather than bone, we find the opposite. In the cases of zinc, both laboratories have found that zinc concentrations in bone are somewhat higher than those in flesh or muscle. This laboratory, however, finds the zinc, bone/muscle ratio much higher than that found by Merlini. Obviously more work is needed in this area.

In contrast to the other metals examined, lanthium and scandium concentrate in the bone tissue. A possible explanation for lanthium bone concentration might be its ionic radius. The ionic radius La^{+2} is 1.39 A which is close to the radius of Ca^{+2}, 1.18 A. In fact much lanthium chemistry is similar to alkaline earth chemistry. Since the radius of Sc^{+3} is much smaller than that of the other normal bone concentrating elements, a simple ionic size explanation does not seem as adequate. (ANON. 1963).

These data seem to indicate that, for the metals studied, although the distribution in the fish is not uniform, unlike mercury, (CABELA et al, 1973) concentrate in the edible portions.

ACKNOWLEDGEMENT - The authors are indebted to Fr. Erika Greger for her help in the fish dissections and sample preparations. The authors are also indebted to Hr. Manfred Kehrer for his photographic help in the preparation of this manuscript.

ANON. Handbook of Chemistry and Physics, Chem. Rubber Publishing Co.Ohio, 1963.

BOWEN, H. Trace Elements in Biochemistry, Academic Press, London (1966).

CABELA, A.,D. TEHERANI & H. ALTMANN. Dimethylquecksilber I. Untersuchungen über die Verteilung und Ausscheidung in Ratten, SGAE2204, BL-66/73.

MERLINI,M., BIGLIOCCA,C., A.BERG, G.POZZI, F. GIRARDI. Proc. Symp. on Nuc. Tech. in Environ. Poll. 447 & 721, Salzburg (1970).

PARR, R. & J. TAYLOR. Biochem. J. 91, 424 (1964).

REHWOLDT, R.,L. MENAPACE, B. NERRIE, & D. ALESSANDRELLO. Bull. Environ. Contam. & Toxicol. 8, 91 (1972).

UNDERWOOD, E. Trace Elements in Human and Animal Nutrition. Academic Press, London. (1962).

WACKER, W. & V. VALLEE. J. Biol. Chem., 234,3257 (1959).