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Heavy Metal Concentrations in Tissues of Virginia River Otters

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River otters (Lutra canadensis) are an economically and esthetically important natural resource in Virginia where their range is the eastern portion of the state. Additionally, otters might be logical choices as monitors of environmental contaminants in the aquatic environment due to their position as primary carnivores at the top of the aquatic food chains. Presently, little research has been reported which investigated the effects of various contaminants on river otter reproduction, well-being, or behavior and only a few studies have been reported in which concentrations of environmental contaminants in river otters were determined. CUMBIE (1975) and SHEFFY (1977) determined tissue concentrations of mercury in otters from Georgia and Wisconsin, respectively. Concentrations of PCB's and DDT were determined in California river otters (AZEVEDO 1973) and in otters from Alabama (HILL & LOVETT 1975). CLARK et al. (1981) reported mercury concentrations in tissues from Georgia otters. Also, DDT, PCB's, mirex and dieldrin concentrations were determined in fat samples from these otters. Heavy metal concentrations in otter hair were reported in the appendix of the thesis by CLARK (1980).

The focus of the present report (a portion of a larger investigation on river otters) was to determine tissue concentrations of heavy metals in otters trapped in Virginia.

METHODS AND MATERIALS

Otter carcasses, obtained from trappers during the 1979-1980 and 1980-1981 trapping seasons, were dissected to acquire samples of liver, kidney and bone for heavy metal analyses. All the otters were trapped east of the Blue Ridge Mountains, with the majority being from the Tidewater region of the state. General procedures for sample preparation and atomic absorption spectrophotometry were those described by SCANLON et

al. (1980). Detection limits for the elements were as follows (ug/g dry weight of tissue): cadmium, 0.04; lead, 0.40; zinc, 0.08; and copper, 0.16.

Ages of otters were determined by analysis of cementum annuli with comfirmation by use of a baculum index in males and epiphyseal closure in both sexes (ANDERSON 1981).

RESULTS

Median, range, and mean (±S.E.) concentrations of lead, cadmium, zinc and copper in liver, kidney and bone samples of otter harvested during the 1979-1980 and 1980-1981 trapping seasons are reported in Table 1.

Correlations between metal concentrations and age for all three tissues were nonsignificant. Correlations among the concentrations of the four elements in liver and kidney samples were also nonsignificant for otter samples in both years. The highest correlation coefficient (0.47) was found between zinc and copper concentrations in liver samples from otters trapped during the 1979-1980 trapping season.

DISCUSSION

Median concentrations of lead and cadmium found in the otter tissues were considered to be well below toxic concentrations and mean lead concentrations were similar to those found in Canada geese (Branta canadensis) and mallards (Anas platyrhynchos) without evidence of ingested lead shot from Maryland near the Chesapeake Bay (SCANLON et al. 1980). The concentration of lead in bone is indicative of chronic exposure to lead since bone is the primary long-term storage site for lead. The highest concentrations of lead found in river otters were in the bone samples from 1980-1981 though median concentrations were relatively low. Mean concentrations of lead and cadmium were similar to mean concentrations found in whole body samples of small mammals trapped near roadways of low traffic densities but were higher than those in small mammals trapped in control areas (BLAIR 1979). As the present studies were done with liver, kidney and bones only this indicates that concentrations in these storage organs of otters were essentially quite low. Studies on the concentrations of lead, cadmium, or combinations of the two metals required to produce adverse physiological effects in

TABLE 1. Median, range and mean (± S.E.) heavy metal concentrations (mg/g dry weight of tissue) from river otters trapped in Virginia (1979-1980 and 1980-1981 seasons).

Tissue	Element	Median	Range	Mean (±S.E.)	N
			1979-1980		
Liver	Cd	0	(<0.04- 0.99)	0.09(± 0.01)	226
	Pb	0.39	(<0.40- 55.89)	1.40(± 0.62)	226
	Zn	56.59	(<0.08-235.78)	62.63(± 2.17)	226
	Cu	10.14	(<0.16-211.00)	13.92(± 1.48)	226
Kidney	Cd	0.15	(<0.04- 14.09)	0.61(± 0.09)	221
	Pb	0.51	(<0.40- 6.00)	0.81(± 0.07)	221
	Zn	65.00	(<0.08-564.34)	78.91(± 4.88)	221
	Cu	3.96	(<0.16- 80.15)	6.16(± 0.59)	221
Bone	Cd	0	(<0.04)	<0.04	198
	Pb	0	(<0.40- 35.16)	1.41(± 0.22)	198
	Zn	148.60	(<0.08-822.93)	179.13(± 9.49)	198
	Cu	0	(<0.16- 5.69)	0.13(± 0.04)	198
			1980-1981		
Liver	Cd	0	(<0.04- 1.58)	0.17(± 0.07)	131
	Pb	1.07	(<0.40- 16.97)	3.43(± 0.37)	131
	Zn	108.22	(<0.08-683.85)	154.38(±11.82)	131
	Cu	7.08	(<0.16-52.180)	9.96(± 0.78)	131
Kidney	Cd	0.12	(<0.04- 3.10)	0.37(± 0.04)	169
	Pb	0.75	(<0.40- 9.75)	1.68(± 0.15)	169
	Zn	139.73	(21.53-801.59)	176.23(± 9.93)	169
	Cu	2.34	(<0.16- 16.13)	3.22(± 0.23)	169
Bone	Cd	0	(<0.04- 0.27)	<0.04	78
	Pb	2.95	(<0.40- 18.13)	5.31(± 0.63)	78
	Zn	89.55	(<0.08-587.05)	138.71(±14.39)	78
	Cu	-		-	78

otters are lacking. Although cadmium and lead concentrations were low, interactions of low concentrations of these metals are worthy of consideration given that spermatogenesis was inhibited in laboratory rats by considerably lower combined doses of lead plus cadmium than separate doses of either metal (DER et al. 1976). River otters can possibly be adversely affected by the combined efforts of those concentrations of cadmium and lead present in fish species and in sediments which otters probably ingest with food. Median concentrations of lead and cadmium in sediment samples taken at three stations located relative to a heavily travelled highway on Back Creek (a tributary of the Roanoke River) near Roanoke, VA ranged from 4.9 to 8.1 ug/g dry weight and 0.02 to 0.04 ug/g dry weight, respectively (VAN HASSEL et al. 1980).

As primary carnivores at the top of the aquatic food chain, otters consume many types of food including fish, macro-invertebrates, reptiles, birds and amphibians. Examples of lead concentrations found in fish taken from Back Creek are reported by VAN HASSEL et al. (1980). Median lead concentrations ranged from 5.4 to 8.4 ug/g whole body, dry weight, in Bluehead chub (Nocomis leptocephalus), from 7.2 to 15.5 in Blacknose dace (Rhinichthys atratulus) and from 9.6 to 19.5 in Fantail darter (Etheostoma flabellare) with the highest concentrations being from fish taken at the furthest downstream location and the lowest concentrations being from fish taken at the furthest upstream location. Most food habits studies (summarized in ANDERSON 1981) show that fish makes up the greatest percentage of otter diets. However, a majority of these studies were based on analysis of digestive tract contents of otters trapped during the winter. Winter food habits of otters from Louisiana (CHABRECK et al. 1982) confirm that a broad range of other foods (birds, amphibians, mammals and invertebrates) are used and are as important as fish during the remainder of the year in most environments. The potential for otters to acquire relatively high concentrations of contaminants may be limited by the variety of their year-round diet and because of the otter's wide ranging behavior which is particularly manifest in males.

Median concentrations of lead and cadmium in tissues of fifteen species of waterfowl including diving species from the Chesapeake Bay region were, in general, higher than median concentrations in comparable tissues of the otters in this study (DIGIULIO 1982). Many of the otters used in this research were from the Chesapeake Bay Area. The higher

concentrations of lead and cadmium in waterfowl tissues could be explained by differences in the food habits between otters and the waterfowl species used in DIGIULIO's study. Most of the waterfowl fed on vegetation or clams, food items which otters rarely eat. Differences in accumulation rates of heavy metals between waterfowl and river otters might also explain the differences in heavy metal tissue concentrations. Nonetheless, the waterfowl concentrations of lead and cadmium are indicative of potential heavy metal concentrations available to river otters.

Copper and zinc are micronutrients and are normally present in animal tissues. The median and mean concentrations of copper and zinc found in the otter tissues are believed to be within normal ranges. Zinc and copper are co-factors in many enzymes. Cadmium, being very similar to zinc and copper, may exchange for these metals, especially zinc, and change the activity of enzymes (LUCKEY & VENUGOPAL 1979). High concentrations of zinc and copper in animals may act to decrease the toxicity of cadmium.

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