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Heavy Metal Concentrations in Livers and Kidneys of the Otter (*Lutra lutra*) from Central Europe

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The European otter (Lutra lutra) once a widespread species on the Eurasian continent declined in most parts of its former range in Western and Middle Europe (Foster-Turley et al. 1990). In contrast to the overall picture the otter expanded the area of occurrence in Austria and has now even become common on some southern tributaries of the Danube where the species was not present for decades (Kranz 1995). Otters show a regular occurrence in most parts of the Czech Republic northwest of Austria (Hlavac and Toman 1995). The Hungarian otter populations still represent the best strongholds of the species throughout the region (Kemenes 1991).

Contamination of aquatic environments with persistent pollutants is blamed to be the causative agent (Mason 1989) for the observed declines in European countries. Polychlorinated biphenyls (PCBs) are discussed to be the most important pollutant (Smit et al. 1994) but heavy metals may have additional negative effects at least at a regional scale (Mason 1989). Mercury poisoning has been reported for the American river otter Lutra canadensis (Wren 1985). Nothing is known on toxicological effects of low tissue levels of other heavy metals such as cadmium, lead, zinc or copper on otters particularly in combination with other contaminants. In this paper, we present concentrations of five metals in otter tissues from viable Central European populations.

MATERIALS AND METHODS

Otters found dead in Austria (Waldviertel, Lower Austria) were collected as part of a project to study causes of death in the Austrian otter population (Gutleb 1994). The otters from the Czech Republic were road victims and animals from Hungary were collected either as road victims or were killed with permission at fish ponds. Otters from the three countries were collected over the period 1989-94. All carcasses were stored deep-frozen prior to necropsy and tissue collection.
Dried tissue samples for analysis of cadmium, lead zinc, and copper were digested with 65 % HNO_3 using a microwave system A 301 (PROLABO, Paris). Wet tissue

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samples for the analysis of mercury concentrations were digested with a mixture of 65 % HNO_3 and 98 % H_2SO_4 (3:4) and H_2O_2 was added during the digestion process. Thereafter digested solutions were analysed with a Hitachi Z 8100 atomic absorption spectrophotometer (AAS) (HITACHI, Kyoto). Cadmium and lead were analysed using a graphite furnace atomiser. Zinc and copper were analysed by mean of a flame atomiser. Mercury was analysed using a hydrid formation system HF-2 (Hitachi, Kyoto). Details on the analytical conditions were published (Gutleb et al. 1992, Gutleb et al. in press). Detection limits were 0.01 µg g^{-1} dry weight for cadmium and lead, 0.03 µg g^{-1} dry weight for zinc and copper and 0.01 µg g^{-1} fresh weight for mercury. Recovery of a certified standard (MA-A-2, IAEA, Monaco) was 89-105 % for all elements, and the coefficient of variation on analysis of five replicates was < 10%.

RESULTS AND DISCUSSION

Mean (± SE) and range of cadmium, lead, zinc, copper, and mercury concentrations in liver and kidney samples of the otters are reported in Table 1 - Table 3.

Table 1. Cadmium and lead in liver and kidney samples (in µg g^{-1} dry weight)

		cadmium		lead	
		liver	kidney	liver	kidney
Austria	x	0.36	0.91	0.37	0.69
n= 15	± SE	0.30	1.13	0.36	0.23
	min-max	<0.01-0.87	0.03-4.6	0.01-1.17	0.15-3.7
Hungary	x	0.31	0.51	0.83	1.12
n = 7	± SE	0.17	0.3	0.65	0.93
	min-max	0.05-0.49	0.17-0.89	0.33-2.2	0.17-2.3
Czech	x	1.51	0.32*	0.39	0.23*
Republic	± SE	2.26		0.3	
n = 5	min-max	0.16-5.42	0.28-0.36	0.08-0.8	0.02-0.4

* n = 2

Cadmium levels were not exceeding 4.6 µg g^{-1} dry weight in kidneys. The highest level of 5.4 µg g^{-1} dry weight was found in the liver of an otter from the Czech Republic. No kidney sample was available for analysis from this animal. Similar mean concentrations were found in tissues of otters from other European countries (Broekhuizen 1987, Mason 1988, Mason and Reynolds 1988, Mason and O'Sullivan 1993, Skarén 1992). In general all these concentrations are considered to be of no concern for otters as a concentration of 100 µg g^{-1} fresh weight in kidneys was postulated to be critical for rats (Goyer et al. 1984) which was never reached or exceeded in otters samples analysed so far.

Lead concentrations in both liver and kidney tissues of our study were not exceeding 3.5 µg g^{-1}, with most concentrations not exceeding 1 µg g^{-1}. These concentrations were much lower than the proposed critical level for mammal tissues of 25 µg g^{-1} (Ma 1989). In otters from England and Wales liver concentrations up to 5.9 µg g^{-1} respectively 16 µg g^{-1} were found. Concentrations in otters from our Central European study area were in a similar range than those previously reported for otters from the Orkney Islands (Mason and Reynolds 1988), Ireland (Mason and O'Sullivan 1993), Spain (Hernandez et al. 1985) or France (Lafontaine et al 1990). None of the authors stated that these concentrations have negative effects on the population.

Zinc and copper are micronutrients and the uptake is depending on the animals demands. Only at very high levels in the diet tissue concentrations are expected to exceed critical levels. Zinc and copper concentrations reported here are not different from those previously found in otters from the Netherlands (Broekhuizen 1987), Ireland (Mason and O'Sullivan 1993) or Belorussia (Sidorovich et al. 1994) and are in a range where detrimental effects are unlikely to occur in mammals (Hapke 1988).

Table 2. Zinc and copper in liver and kidney samples (in µg g^{-1} dry weight)

		zinc		copper	
		liver	kidney	liver	kidney
Austria	x	92.6	138.2	38.7	14.2
n = 15	± SE	57.0	138.8	30.5	7.6
	min-max	23.6-244.3	37.7-557.3	8.4-128.3	3.8-33.4
Hungary	x	96.2	55.6	17.1	11.4
n = 7	± SE	39.6	25.6	6.3	3.2
	min-max	66.2-171.5	30.9-105.0	7.0-24.5	2.9-11.4
Czech	x	162.4	107.2*	23.1	17.6*
Republic	± SE	60.7		17.8	
n = 5	min-max	98.9-259.3	79.2-135.3	4.6-48.5	13.7-21.5

* n = 2

Special attention has been directed to possible effects of mercury on otters in the past. Mercury has been or is still released by natural weathering of rocks and soils as well as due to human activities such as mining, chlorine and paper production. Wren (1986) suggested that 4 µg g^{-1} in otter livers can be considered as background levels.

Tissue concentrations of mercury in livers and kidneys of otters from Austria and Hungary and in the kidneys of otters from the Czech Republic were low (Table 3) compared to the results reported from Sweden (4.1 - 30.7 µg g^{-1}, Olsson et al. 1981), Finland (0.05 - 31.0 µg g^{-1}, Skarén 1992), Orkney Islands (1.0 - 20.3 µg g^{-1}, Mason and Reynolds 1988), Spain (3.92 - 17.48 µg g^{-1}, Hernandez et al. 1985) or Ireland (0.15 - 17.03 µg g^{-1}, Mason and O'Sullivan 1993).

Table 3. Mercury in liver and kidney samples (in µg g^{-1} fresh weight)

		liver	kidney
Austria	x	1.01	0.68
n = 15	± SE	0.73	0.62
	min-max	<0.01-1.84	<0.01-2.1
Hungary	x	0.65	0.44
n = 7	± SE	1.01	0.32
	min-max	0.02-2.64	0.04-0.87
Czech Republic	x	14.43	0.32*
n = 5	± SE	23.89	
	min-max	<0.01-55.61	0.25-0.38

* n = 2

The concentrations of 15.2 µg g^{-1} and 55.6 µg g^{-1} in two livers of otters from the Czech Republic were much higher. Experimentally dosed American river otters died with symptoms of mercurialism and mean total mercury levels of 33.4 µg g^{-1} were found in the livers (O'Connor and Nielsen 1981). This concentration is exceeded at least in one animal from the Czech Republic. Wren (1985) reported on a river otter which was found near to a river known to be severely polluted with mercury. A concentration of 96 µg g^{-1} was found in the liver. The tracks indicated that the otter showed erratic behaviour such as travelling in circles, falling over and burrowing into the snow before dying. Two otters from the Shetland Islands with liver concentrations higher than 30 µg g^{-1} were found dying with similar symptoms (Kruuk and Conroy, 1991). As all animals from the Czech Republic were road victims no observations on the behaviour prior to death were made and it cannot be ruled out that the two animals showed symptoms of mercurialism. Mercury is likely to effect at least single individuals within the otter population in the Czech Republic.

When discussing the toxicological significance of heavy metal concentrations in otter tissues from our study the relative small sample size and the opportunistic sampling in the field have to be considered. The crucial point of such a procedure is the methodological approach. When dealing with rare and endangered species it is not possible to carefully design a field study as in most cases only a limited number of samples will become available for chemical analysis.

Mean concentrations of cadmium, lead, zinc, and copper in livers and kidneys of the otters included in our study are considered to be lower than toxic concentrations for otters and all values are within the range found in similar studies conducted in other areas from Europe (Mason 1988, Kruuk and Conroy 1991, Skarén, 1992). These results are strongly supported by own data on concentrations of the four metals in fish and scats from the same area (Gutleb,

1995) which were all lower than what is discussed to be critical for otter populations (Röchert 1989). The concentrations we found may therefore reflect background concentrations in otters.

Whereas mercury concentrations in otters from Austria and Hungary were low at least single animals in the Czech Republic are exposed to high mercury concentrations in their diet. The liver concentrations in two animals were in the range or even exceeding levels where behavioural alterations and mortality have been observed in animal experiments and free living otters. In the future more otter tissues and in addition fish samples from the Czech Republic should be analysed on their mercury concentrations to get insight where and to what extent otters are exposed to mercury. There is some evidence that mercury pose a problem at least on a local scale.

As the populations in the study area are increasing (Kranz 1995, Kemenes 1991) the concentrations of various environmental contaminants found in otter tissues from these areas may indicate that otters are not affected by contamination in their diet despite the fact that single animals seem to be exposed to high mercury levels. Anderson-Bledsoe and Scanlon (1983) stated that studies on the possible interactions of low concentrations of heavy metals on physiological parameters of otters are lacking. This question still remains unanswered and nothing is known on subtle long-term effects of low concentrations of heavy metals alone or in conjunction with other environmental contaminants.

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