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Mercury, Cadmium, and Lead in British Otters

C. F. Mason, N. I. Last, and S. M. Macdonald

Department of Biology, University of Essex,
Wivenhoe Park, Colchester CO4 3SQ, United Kingdom

Otters (subfamily Lutrinae), at the top of the food chain and feeding largely on fish, are likely to be especially vulnerable to the effects of bio-accumulating pollutants, while their aquatic habitat is often a sink for such chemicals derived from agricultural, industrial and domestic sources. The European otter (Lutra lutra) has shown substantial declines through much of its range over the past 30 years (Mason and Macdonald 1986), which have been attributed to pollution by organochlorines. Elevated levels of these compounds were recently reported from some individuals of a sample of British otters (Mason et al 1986). Other factors, such as habitat destruction, are undoubtedly also involved in the decline (Mason and Macdonald 1986).

There are few published data on metals in tissues of European otters and these refer only to mercury (Erlinge 1972, Olsson et al 1981). The present paper reports on burdens of mercury, cadmium and lead in tissues of a sample of British otters collected between 1982 and 1984.

MATERIALS AND METHODS

Tissues (hair, liver, kidney or muscle) were supplied by correspondents from a total of 36 otters between July 1982 and September 1985. Nineteen otters were traffic casualties, 6 were drowned in fish nets or lobster creels, 2 were live-trapped and released and 9 were found dead through causes unknown. Tissues were stored deep-frozen prior to preparation for analysis.

To remove superficial grease and metal contamination, hair samples were soaked in 'Pyroneg' for 30 min. They were then rinsed twice in double distilled water, washed twice in acetone and dried at room temperature in a dust-free atmosphere.

All samples (0.5-1.0 g), after weighing, were digested by the addition of 5 ml of a nitric/perchloric acid mixture (4:1 by volume, analytical grade reagents). Samples were left overnight at room temperature and digestion was then completed by heating to 40°C for 90 mins and 140° for a further 120 mins, until the evolution of fumes ceased. Samples were allowed to cool and then made up to a constant volume of 10 ml using double distilled water. Digests were stored in 25 ml polystyrene cell-counting pots at 4°C until analyzed. Three replicates of all samples were digested to allow the calculation of analytical and sample variability.

Analyses were performed by atomic absorption spectroscopy, either using flame (Varian AA-375) or graphite tube atomisation (Varian AA-1275 with GTA-95 Atomiser System). Total mercury was determined by flameless atomic absorption. Results are presented for hair as ppm (mg kg^{-1}) dry weight and for other tissues as ppm fresh weight. Detection limits for mercury were 0.01 ppm, for cadmium 0.001 ppm and for lead 0.02 ppm.

RESULTS AND DISCUSSION

Sites from which otters were obtained are shown in Fig. 1 and the concentrations of mercury, cadmium and lead are given in Table 1. Not all tissues were made available from each animal.

The mean concentration and range of mercury in the livers of British otters was lower than that recorded by Erlinge (1972) in Sweden (mean 16.5 ppm Hg, range 4.1-30.7 ppm), but levels in muscle from Britain were similar to those in a later sample from Sweden (mean 1.8 ppm Hg, range 0.45-9.6 ppm), both being higher than a sample from coastal Norway (mean 0.57 ppm Hg), where otters are still common (Olsson et al. 1981). On average, British otters had higher concentrations of mercury in tissues than Lutra canadensis from north-eastern U.S.A., Manitoba and Ontario (O'Connor and Neilsen 1981, Kucera 1983, Wren et al 1980). Levels of mercury in kidneys of otters from Wisconsin were higher on average than those from Britain, but levels in liver and hair were lower (Sheffy and St. Amant 1982). The mean levels of mercury in hair from British otters were similar to those of otters from Georgia (Cumbie 1975) and lower than from a Swedish sample (31.2 ppm Hg n = 11, unpublished data).

O'Connor and Neilsen (1981) dosed Lutra canadensis with mercury in the diet at concentrations of 2, 4 and 8 ppm

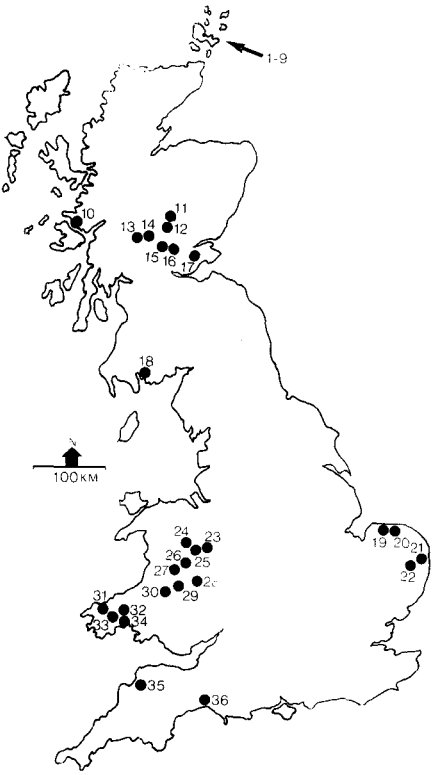

Figure 1. Origins in Britain of otters analyzed for heavy metals.

and all the otters developed advanced clinical signs of mercury poisoning. Tissue analysis revealed total mercury concentrations of 25.0-39.0 ppm in liver (c.f. 1.8-1.9 ppm in controls), 20.0-57.0 ppm in kidney (c.f. 1.6-2.6 ppm in controls) and 13.0-22.0 ppm in muscle (c.f. 0.07-1.2 ppm in controls). In a wild mink (Mustela vison), found dying of mercury poisoning, Wobeser and Swift (1976) recorded levels of 34.9 ppm Hg in hair, 58.2 ppm in liver and 31.9 ppm in kidney, while experimentally dosed mink, exhibiting acute mercury poisoning, had mean mercury levels of 24.3 ppm in liver, 23.1 ppm in kidney and 16.0 ppm in muscle (Wobeser et al 1975). Sublethal effects of mercury poisoning in wild animals must occur at tissue levels of mercury below those associated with acute mercurialism. In humans, hair concentrations in excess of 50 ppm Hg are associated with minor neurological disorders in some individuals, while the threshold value for pregnant women may be as low as 15-20 ppm (Piotrowski and Inskip 1981).

Two British otters exhibited mercury concentrations greater than 50 ppm in hair (no. 21 with 57.1 ppm, 29 with 85.1 ppm), while four otters (11, 16, 18, 32) had

Table 1. Concentrations (ppm) of mercury, cadmium and lead in tissues of British otters.

	Hair	Liver	Kidney	Muscle
Hg mean	18.75	5.37	2.27	1.66
S.E.	3.63	1.12	0.33	0.34
range	1.3-85.1	1.2-20.5	1.35-6.79	0.61-2.64
Cd mean	1.12	0.27	0.60	0.08
S.E.	0.64	0.04	0.13	0.04
range	ND-15.9	ND-0.54	0.08-2.18	ND-0.22
Pb mean	13.05	2.20	1.97	2.70
S.E.	4.16	0.43	0.25	0.76
range	ND-88.5	ND-5.86	ND-3.84	ND-5.33
n	25	19	16	6

levels greater than 20 ppm. Twenty-three out of 25 otters had mercury concentrations in hair greater than the 1-5 ppm background level suggested by Sheffy and St. Amant (1982). Background levels of mercury can be considered to be less than 5 ppm in liver and 3 ppm in kidney of otters (O'Connor and Neilsen 1981, Kucera 1983). Five of 19 British otters showed elevated levels of mercury in liver, with otter 3 (20.5 ppm) and 30 (12.4 ppm) being notable, but only one animal (30) showed elevated mercury in the kidneys. Wren (1984) has suggested that otters, some populations of which live in environments naturally high in mercury, may have a mechanism to detoxify mercury.

There are few data with which to compare cadmium concentrations in tissues of British otters. Levels in liver and kidney were similar to those recorded in L. canadensis from Virginia by Anderson-Bledsoe and Scanlon (1983) and higher than those from Ontario (Wren 1984). The only comparable mammalian data for cadmium in hair appears to be for children from Tennessee; the range of cadmium in hair of British otters is similar to that of a sample of urban children and higher than the range from rural children (Folio et al 1982). Tissue cadmium concentrations from this sample of British otters are unlikely to be toxicologically significant.

Mean levels of lead in liver and kidney of British otters were higher than in L. canadensis from Virginia (Anderson-Bledsoe and Scanlon 1983), though the range of concentrations in Virginia was greater. Levels of lead between 5 and 10 ppm in the liver are regarded as worthy of concern in mammals while levels greater than 10 ppm are diagnostic of lead poisoning (Diters and

Nielsen 1978). Three British otters out of 19 had liver concentrations between 5 and 6 ppm (nos. 8, 23 and 29). Mean levels in hair were similar to those reported for a population of children from rural Tennessee and lower than an urban population (Folio et al 1982), while one animal (36 with 88.5 ppm) had lead in hair above the permissible limit proposed for man.

The relationships between levels of metals in tissues were examined by Spearman rank correlations. There were no significant correlations ($P > 0.05$) between mercury, cadmium and lead in hair, liver or kidney. Concentrations of metals in hair were not significantly correlated with those in other tissues, but concentrations in liver and kidney were significantly correlated ($P < 0.05$) for mercury, cadmium and lead. The concentrations in soft tissues represent long-term exposure to metals, whereas levels in hair represent more recent exposure.

The results of this small study suggest that heavy metal contamination at present is not causing direct mortality of otters in Britain. Nevertheless some individuals do contain levels, particularly of mercury and lead, which approach concentrations known to produce sublethal effects in other mammals and so should give rise to concern. Similar conclusions were reached for mercury levels in L. canadensis from Georgia and Wisconsin by Cumbie (1975) and Sheffy and St. Amant (1982). Furthermore, individual otters may carry burdens of several pollutants which may act in combination; mercury levels in liver reported here were significantly correlated with levels of PCB and dieldrin (unpublished data). Any conservation measures for otters within Britain should therefore take account of accumulating pollutants in the ecosystem. As otter tissues are likely to be but rarely available, indirect methods of pollution assessment will be necessary, for example the determination of concentrations of metals in potential food (chiefly fish) and faeces of otter (Mason and Macdonald 1986).

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