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Metals in tissues of European otters (*Lutra lutra*) from Denmark, Great Britain and Ireland

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Abstract

Samples of livers of European otters from Denmark, Great Britain and Ireland were analyzed for manganese, chromium, zinc, copper, nickel and cobalt. Concentrations were generally significantly higher in samples from Great Britain. It was considered that this reflected the catchment geology from where the specimens originated. © 2001 Elsevier Science Ltd. All rights reserved.

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1. Introduction

The European otter (*Lutra lutra*) has declined substantially in numbers over much of Britain and Europe and indeed is now absent from many areas (Foster-Turley et al., 1990). This widespread decline was almost certainly caused by an environmental contaminant which reached critical levels during the late 1950s and 1960s, the evidence implicating organochlorines, and especially PCBs (Macdonald and Mason, 1994; Murk et al., 1998; Mason and Wren, 2001). Feeding primarily on fish, the otter is especially vulnerable to contaminants which accumulate along food chains.

Measurements of metals in otter tissues have concerned mainly mercury (see review in Mason and Wren, 2001). There are small number of analyses for cadmium, lead, zinc and copper in tissues of otters from several parts of Europe (Mason et al., 1986; Madsen and Mason, 1987; Kruuk and Conroy, 1991; Mason and O'Sullivan, 1993; Gutleb et al., 1998). We report here on concentrations of manganese, chromium, zinc, copper, nickel and cobalt in livers of otters from Denmark, Great Britain and Ireland.

2. Methods

There were 65 samples of otter livers from Denmark (mainly from northern Jutland), 51 samples from Great Britain (26 from southwest England, 13 from Scotland, six from Wales, six from East Anglia) and 39 samples from Ireland (mainly from County Cork). Samples were stored deep frozen prior to analysis.

Samples were dried and then crushed using a pestle and mortar. To 0.5 g of homogenized sample were added 10 ml of deionised water, 7.5 ml of concentrated hydrochloric acid and 2.5 ml of concentrated nitric acid. Samples were digested for 5 h at 130°C in a Gerhardt Kjeldatherm digestion block. After cooling to ambient temperature, samples were filtered into 50 ml grade-A volumetric flasks, diluted with deionised water and mixed. Sample blanks and samples of reference material (oyster tissue 1566a, National Institute of Standards

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and Methods, Washington, USA) were prepared in the same acid matrix as the samples. A quarter of the samples was selected randomly and prepared in duplicate. Samples were analyzed using inductively coupled plasma atomic emission spectroscopy (ICP AES: Varian Liberty 100).

3. Results and discussion

The results are given in Table 1. The majority of liver samples had concentrations of manganese, zinc and copper above detection limits. Great Britain had a greater percentage of samples above the detection level than Ireland or Denmark. There were significant differences between countries in mean concentrations of all metals but cobalt. Tukey–Kramer mean significant difference tests showed that these mean metal concentrations were all significantly higher in samples from Great Britain than in those from Denmark. There were also significantly higher concentrations of chromium, zinc and nickel in samples from Great Britain compared with Ireland, levels of chromium and nickel being more than 10 times higher. Danish samples had significantly higher concentrations of chromium than those from Ireland. The higher concentrations in otters from Great Britain may be explained by the fact that most animals originated from catchments draining metal rich geology, having been mined on a small scale since prehistoric times, so resulting in higher concentrations of metals in drainage waters.

Gutleb et al. (1998) measured concentrations of several metals in *L. lutra* from central Europe, including zinc and copper, with concentrations similar to those reported here (range: 26–259 mg kg^{-1} for zinc, 7–128 mg kg^{-1} for copper). There are no other comparable data on *L. lutra* for the metals considered here. There are more data for the North American river otter *Lontra canadensis*. Zinc (range: <0.08–683 mg kg^{-1} dry weight) and copper (range: <0.16–211 mg kg^{-1}) levels were similar in otters from Virginia (Anderson-Bledsoe and Scanlon, 1983). In various localities from lower British Columbia and Oregon mean levels of zinc (77–87 mg kg^{-1} dry weight) were slightly lower and copper (21–31 mg kg^{-1} dry weight) similar to those reported in *L. lutra* (Harding et al., 1998). Manganese (10–13 mg kg^{-1}), cobalt (<0.4–0.3 mg kg^{-1}) and chromium levels (<0.4–1.44 mg kg^{-1}) were higher in otters from British Columbia and Oregon than in *L. lutra* (Harding et al., 1998). Data on concentrations of nickel, manganese, copper and lead in otters from Ontario are presented as wet weights (Wren, 1984; Wren et al., 1988) and cannot be directly compared.

At the top of the food chain in aquatic habitats, otters are useful indicators of contamination with metals (Mason and Wren, 2001). The populations of otters from which the majority of animals originated in this study are currently thriving. The metal concentrations reported here are likely to represent background levels influenced by regional geology.

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Table 1
Mean concentrations[a] of metals in livers of European otter (*L. lutra*) from three countries

	Mn	Cr	Zn	Cu	Ni	Co
Great Britain ($n = 51$)						
Geometric mean	7.37	0.270	111.67	28.27	0.540	0.031
Range	1.5–19.0	[b]nd–4.4	61.1–531.9	7.1–78.5	nd–5.8	nd–1.9
% above detection limit	100.0	64.6	100.0	100.0	61.5	29.2
Ireland ($n = 39$)						
Geometric mean	4.91	0.024	83.80	23.77	0.035	0.015
Range	1.4–13.0	nd–1.0	49.5–276.0	2.5–63.2	nd–1.0	nd–1.0
% above detection limit	100.0	19.1	100.0	100.0	27.7	8.5
Denmark ($n = 65$)						
Geometric mean	3.53	0.081	92.13	21.10	0.047	0.018
Range	nd–33.1	nd–2.3	53.0–276.0	4.0–70.0	nd–1.5	nd–0.5
% above detection limit	93.0	41.9	100.0	100.0	32.6	11.6
$F_{2,152}$	5.87	13.79	7.77	3.49	30.57	2.99
P	<0.01	<0.001	<0.001	<0.05	<0.001	ns

[a] mg kg^{-1} dry weight, with range and percentage above detection level.
[b] Not determined.

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References

Anderson-Bledsoe, K.L., Scanlon, P.F., 1983. Heavy metal concentrations in tissues of Virginia river otters. Bull. Environ. Contam. Toxicol. 30, 442–447.

Foster-Turley, P., Macdonald, S., Mason, C., 1990. Otters: An Action Plan for their Conservation. IUCN, Gland, Switzerland.

Gutleb, A.C., Kranz, A., Nechay, G., Toman, A., 1998. Heavy metal concentrations in livers and kidneys of the otter (*Lutra lutra*) from Central Europe. Bull. Environ. Contam. Toxicol. 60, 273–279.

Harding, L.E., Harris, M.L., Elliott, J.E., 1998. Heavy and trace metals in wild mink (*Mustela vison*) and river otter (*Lontra canadensis*) captured on rivers receiving metals discharges. Bull. Environ. Contam. Toxicol. 61, 600–607.

Kruuk, H., Conroy, J.W.H., 1991. Mortality of otters (*Lutra lutra*) in Shetland. J. Appl. Ecol. 28, 83–94.

Macdonald, S.M., Mason, C.F., 1994. Status and Conservation Needs of the Otter (*Lutra lutra*) in the Western Palaearctic. Council of Europe, Strasbourg, France.

Madsen, A.B., Mason, C.F., 1987. Cadmium, lead and mercury in hair from Danish otters *Lutra lutra*. Natura Jutlandica 22, 81–84.

Mason, C.F., Last, N.I., Macdonald, S.M., 1986. Mercury, cadmium and lead in British otters. Bull. Environ. Contam. Toxicol. 37, 844–849.

Mason, C.F., O'Sullivan, W.M, 1993. Heavy metals in the livers of otters, *Lutra lutra*, from Ireland. J. Zool. Lond. 231, 675–678.

Mason, C.F., Wren, C.D., 2001. Carnivora. In: Shore, R.F., Rattner, B. (Eds.), Ecotoxicology of Wild Mammals. Wiley, Chichester, UK (in press).

Murk, A.J., Leonards, P.E.G., van Hattum, B., Luit, R., van der Weiden, M.E.J., Smit, M., 1998. Application of biomarkers for exposure and effect of polyhalogenated aromatic hydrocarbons in naturally exposed European otters (*Lutra lutra*). Environ. Toxicol. Pharmacol. 6, 91–102.

Wren, C.D., 1984. Distribution of metals in tissues of beaver, raccoon and otter from Ontario, Canada. Sci. Total Environ. 34, 177–184.

Wren, C.D., Fischer, K.L., Stokes, P.M., 1988. Levels of lead, cadmium and other elements in mink and otter from Ontario, Canada. Environ. Pollut. 52, 193–202.

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