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Organochlorine Pesticide Residues and PCBs in Otters (*Lutra lutra*) from Ireland

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The European otter (Lutra lutra) has declined substantially over much of its range in the last 30 years (Mason and Macdonald 1986). Of a variety of impacts on the species (habitat destruction, hunting, pollution, etc.), the factor most likely to have caused the widespread loss of range is contamination with organochlorines, pesticides and PCBs both having been implicated (Mason 1989a). Declines have been greatest in those European countries with greatest industrial output, or downwind of large centers of industry, indicating that air-borne contaminants, as well as those discharged directly to aquatic habitats, have been important (Macdonald in press). Otter populations are currently thriving along western seaboards (Norway, Scotland, Ireland, Portugal) where prevailing winds are from the Atlantic Ocean (Foster-Turley et al. 1990).

In Ireland otters are widespread over much of the country (Chapman and Chapman 1982). Environmental contamination of Irish wildlife with organochlorines is generally considered to be low (Eades 1976; Cabot 1985), though very few analyses of wildlife samples have been made. The present paper reports on the first analyses for organochlorine pesticides and PCBs in a sample of Irish otters.

MATERIALS AND METHODS

Otter carcases were collected over the period 1984-90. Weight and total length (nose to tail) were recorded. Tissues were stored deep-frozen (-20°C) prior to analysis. Samples were thinly sliced, weighed and homogenized in 10 mL acetone:hexane (35:10), the filtrate being collected into a separatory funnel containing 25 mL phosphoric acid / NaCl solution (11.7 g NaCl in 1L 0.1 M orthophosphoric acid). The sediment was resuspended in two further 10 mL aliquots of hexane:dithyl ether (9:1) and decanted after 5 min. The separatory funnel was shaken and the aqueous phase was decanted and re-extracted

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in hexane. The solvent phase extracts were evaporated to dryness at 50°C in the air-flow of a fume cupboard and the weight determined. The extract was re-dissolved in hexane and cleaned up in a column of sodium sulphate and alumina. Organochlorine concentrations were determined with a Varian 3300 gas chromatograph, with a tritium electron capture detector and using a 25-m capillary column. The column temperature was 280° C, the injector 300°C and the detector 310°C. PCB concentrations were determined against an Aroclor 1260 standard. Blanks were run every 20 samples and standards, with or without added lard, every 4 to 9 samples. Recovery rates were always greater than 80% and the detection level was 0.01 mg kg^{-1}

Correlations were made between organochlorine contaminant concentrations in the sample of 33 otters.

RESULTS AND DISCUSSION

Of the 33 otters analyzed, 23 were road casualties, 4 were drowned in fishing nets, 2 were killed by dogs and 4 were found dead or dying of unknown causes. Eleven were females and 22 males. Fig 1 shows the localities from which otters were obtained; most were from county Cork in the south of the country.

Livers were analyzed from 30 animals, but for three rural specimens only muscle tissue was available. Mason (1989b) showed that concentrations of PCBs were equivalent in muscle and liver of otters, but dieldrin and DDT were lower in muscle than liver, while concentrations of lindane were higher.

Dieldrin, p,p-DDE and total PCBs were detected in all samples, while lindane was detected in all but one. Generally small amounts of o,p-DDD and o,p-DDT were also recorded in many animals. The means and ranges of organochlorines in otter tissues are given in Table 1. A sample of five animals from within the city of Cork are treated separately from the remainder; Ireland, with its generally thriving population of otters is unusual in that some animals live within city boundaries, presumably because of population pressures in the wider countryside.

Concentrations of lindane within the rural and urban samples were similar, but the urban sample showed markedly higher mean concentrations of dieldrin, DDE and PCBs. Indeed the minimum concentrations of DDE and PCBs in the urban sample were greater than the mean concentrations from the rural sample. Mean concentrations of dieldrin and DDE from the rural sample were considerably lower than the means from Great Britain (Mason 1989a), reflecting the generally low past and current use of these chemicals in Irish agriculture (Cabot 1985).

PCBs are generally considered the greatest contaminant threat to otters, for reproductive failure in mink Mustela vison, given dietary doses of PCBs in laboratory experiments, was

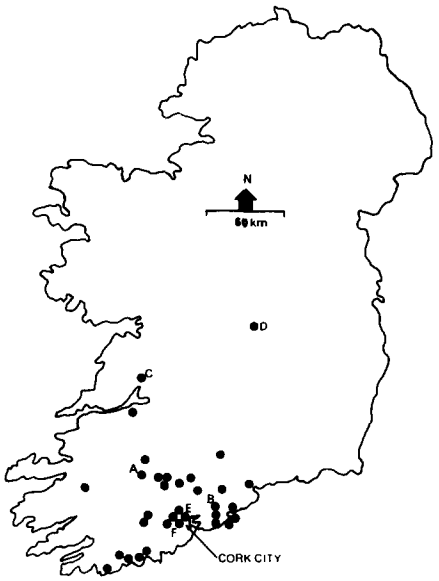

Figure 1. Study area (52°N, 9°W in Ireland showing localities from which otters were obtained (A-F indicate otters with elevated PCB concentrations, see text).

reported when tissue concentrations exceeded 50 mg kg^{-1} fat (Jensen et al. 1977; Olsson et al. 1981). The mean concentration of PCBs in the rural sample of Irish otters was similar to those from coastal Norway and Scotland (Olsson et al. 1981; Mason 1989a), both of which countries support thriving otter populations. Only two animals from rural Ireland had PCB concentrations exceeding 50 mg kg^{-1} fat, whereas two of the five animals from urban Cork had concentrations exceeding this value.

Further information can be provided for those otters with the highest PCB loads (A-F in Fig. 1). Four of the otters (A,D,E,F) were found alive but showing signs of disorientation. Such behavior was not reported in any of the other specimens. Specimen A (adult male, PCB 40.4 mg kg^{-1}, total organochlorine (OC) i.e. sum of pesticide and PCB residues, 57.2 mg kg^{-1}) was wandering in a disoriented fashion on the outskirts of a small town. On the following day it entered a house and sought refuge under a bed, being found dead beside the river on the third day. Specimen D (young female, PCB 58.7 mg kg^{-1}, total OC 109.14 mg kg^{-1}, of which 22.8 mg kg^{-1} was o,p-DDT), died within a few hours of being found in a disoriented state. It came from an area of extensive peat-milling and peat-fueled electricity generating stations. Specimen E (adult male, PCB 454.9 mg kg^{-1}, total OC 1136 mg kg^{-1} including 370 mg kg^{-1}

Table 1. Concentrations (means and ranges) of organochlorine pesticide residues and PCBs (mg kg^{-1}) in tissues of otters (n=33)

	Rural otters		Cork City otters	
compound	mean	range	mean	range
n	28		5	
Weight (kg)	6.13	3.21-11.60	6.58	4.00-10.80
Total Length (mm)	1042	823-1210	1074	926-1220
Body condition	1.20	0.82-1.87	1.27	1.00-1.74
Lindane	0.96	nd-8.04	0.70	0.15-1.60
Dieldrin	1.62	0.08-16.01	77.07	1.16-370.0
p,p-DDE	3.96	0.05-25.70	42.90	4.53-190.4
Total DDT	5.76	0.07-44.47	69.04	5.53-309.4
Total PCBs	15.17	0.18-123.24	118.16	15.56-454.9

dieldrin, 190 mg kg^{-1} DDE and 112 mg kg^{-1} o,p-DDT) was wandering disorientated and apparently blind along a main throughfare within Cork city and died the following day. Specimen F (adult female, PCB 83.7 mg kg^{-1}, total OC 99.4 mg kg^{-1}) was found in a disoriented state before it was hit and killed by a car. Specimen B (juvenile male, PCB 45.4 mg kg^{-1}, total OC 58.3) was killed by a vehicle with no unusual circumstances. Specimen C (male, PCB 123.2 mg kg^{-1}, total OC 170.82) was also killed by a car, but close to a municipal landfill site (adjacent to a river) which is known to flood regularly after heavy rain and at high tides.

From the same general locality of specimen C, two otters were found during 1986-87 in a disoriented state and apparently blind, but we did not receive tissues. Similarly during 1989-90 three otters were found wandering in a disoriented manner in Cork city. One entered a busy riverside shop. None were made available for analysis. Several similar cases of otter disorientation have been reported from the City of Limerick, western Ireland. These behavioral abnormalities are consistent with organochlorine poisoning (Blackmore 1963), though other factors may also have been responsible. For example, heavy metals, such as mercury, may produce similar symptoms, but metal concentrations were low in this sample of Irish otters (authors' unpublished data). Cork city (population c. 215,000) and its adjacent harbor area is very industrialized compared with the rest of Ireland, and it has seen considerable

expansion in recent years. For example one third of the country's chemical plants are based in the harbor area. The city's wastes, which are untreated, are discharged to the river within the town, while there are many other discharges within the estuary. There are thus likely to be many possible sources of organochlorine contamination within the city and harbor areas. Concentrations of PCBs, dieldrin, and DDE in mussel Mytilus edulis are higher than in other Irish Sea localities based on preliminary samples (Environmental Research Unit 1989).

Lindane showed no significant correlation ($P>0.05$) with other organochlorines, indicative of its comparatively rapid breakdown within tissues. DDE concentrations were highly correlated ($P<0.001$) with dieldrin ($r^2=0.98$) and PCB ($r^2=0.96$) concentrations, while dieldrin and PCB concentrations were also highly correlated ($r^2=0.90$). Excluding the five urban samples, correlations were still highly significant ($P<0.001$) between DDE and dieldrin ($r^2=0.62$) and PCB ($r^2=0.76$), but the relationship between dieldrin and PCB was weak ($r^2=0.22$, $P<0.05$). Similar relationships between PCB and DDT have been reported from marine mammals (e.g. Reijnders 1988), but there were no correlations between organochlorines in a small sample of coastal otters from the Orkney Islands, northern Scotland (Mason and Reynolds 1988).

It has been suggested that the reporting of organochlorine concentrations in terms of tissue fat weight, as opposed to wet weight, may give a false indication of the significance of contamination, because as an animal utilizes its fat, contaminants become concentrated in the remaining fat. The alternative view is that, as an animal loses weight, persistant organochlorine contaminants are mobilized and transferred to more sensitive tissues, such as skeletal muscles or the central nervous system, resulting in loss of co-ordination and death (see review in McEwan and Stephenson 1979). If organochlorines are merely concentrated as fat is mobilized then negative correlations between organochlorine concentrations and body condition should be expected. Body condition (weight as a function of total body length) was calculated for all otters in this study using the formulae for males and females given in Kruuk et al. (1987) - see also Mason and Madsen (1990). Correlation coefficients (r^2) between body condition (Table 1) and organochlorines were :- for lindane 0.10, for DDE 0.01, for dieldrin 0.008 and for PCBs -0.004. None were significant ($P>0.05$). A similar absence of correlation between PCB concentrations in kidneys and body weight of polecats (Mustela putorius) was reported by Mason and Weber (1990).

In conclusion the otter population of Ireland is considered of international importance because of widespread losses in much of the rest of the species' range (Foster-Turley et al. 1990), so that considerable attention should be given to the conservation of Irish otters. The present study shows that, overall, contamination with organochlorines is unlikely to pose a significant threat to these populations. Nevertheless, some

of the results give cause for concern and several otters had PCB concentrations high enough to potentially impair reproduction (Olsson et al. 1981). In view of the sensitivity of otters to organochlorine contamination, every effort should be made to minimize the contamination of Irish watercourses and seas with these compounds. A continued monitoring program of otter tissues is essential, ideally with samples from a wider geographical range within the country.

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