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Organochlorine and Mercury Residues in Wild Mammals in Southern Ontario, Canada 1973-74

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Organochlorine insecticides, polychlorinated biphenyls (PCB) as well as mercury seed treatments have been used for 30 to 40 years in the Province of Ontario, Canada. Residues of these compounds in the aquatic biota, and in agricultural products led to restriction on the use of organochlorine insecticides between 1969 and 1971 (FRANK et al. 1970, 1974). Methyl mercury seed treatments were phased out of use between 1972 and 1974. A voluntary restriction was placed on the industrial uses of PCB in 1971. Wild mammal tissues were collected from those areas of the province where such species were readily available and where residues of contaminants had been reported as significant, especially in fish (FRANK et al. 1970, 1974, MILES & HARRIS 1973). The study was intended to measure residues in the commonly occurring omnivorous and carnivorous mammals.

METHODS AND MATERIALS

Field Collection

Wild mammals normally collected by the staff of the Ontario Ministry of Natural Resources and checked for parasites and diseases were used in this study. Those carcases free of rabies were sampled and held in a freezer at -20C until analyzed. Red fox (Vulpes fulva), raccoon (Procyon lotor) and striped skunk (Mephitis mephitis) were collected from five western Ontario counties (Bruce, Grey, Huron, Lampton and Perth) (Fig. 1). Brain, liver and muscle tissues were sampled from each of the above three species. Fisher (Martes pennanti) and marten (Martes americana) were collected from the districts of Haliburton, Muskoka, Nipissing and Parry Sound and mink (Mustela vison) were collected from the county of Simcoe. Only muscle tissue was available from these latter three species.

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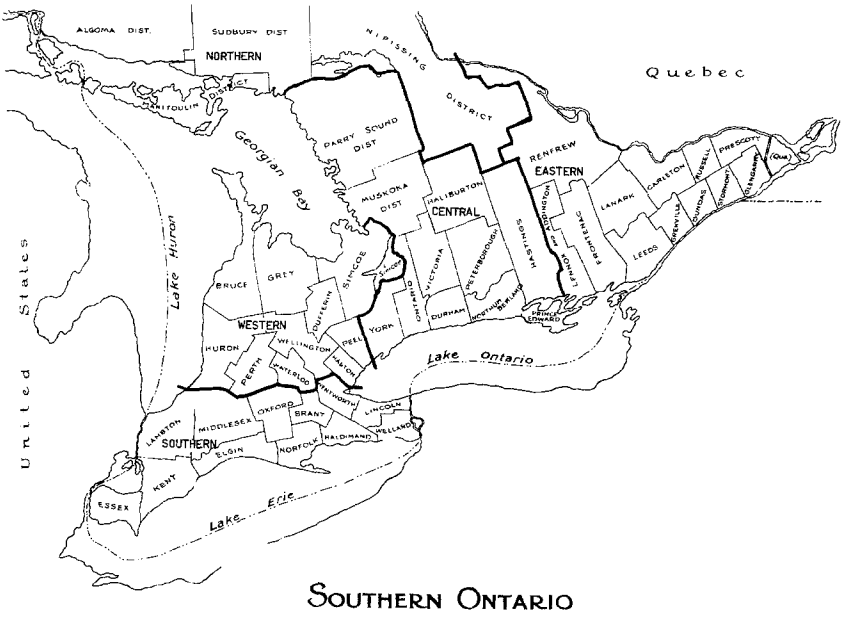

SOUTHERN ONTARIO

Fig. 1. Map of Ontario

Analytical Procedures

(a) Organochlorine compounds: Tissues were macerated and 10 g were extracted by Soxhlet (FRANK et al. 1974). A maximum of 1 g extractable fat was eluted on a Florisil column as described by LANGLOIS et al. (1964). The concentrated eluate was placed on a coconut charcoal column and eluted as described by BERG et al. (1972) and HOLDRINET (1973) to fractionate organochlorine compounds from PCB's. Detection of residues was carried out on a gas chromotograph (GLC) with a $N:^{63}$ detector. 1.8 m Glass columns were packed with 1.5% OV-17 plus 2.5% OV-210 on 100-120 mesh chromosorb. Operating temperatures were 200°C for the column, 310°C for the detector and 235°C for the injection block. The carrier gas was N_2 flowing at 60 mL/min. Quantitation of PCB was by the procedure described by REYNOLDS (1971). Confirmation of residues were conducted according to HAMMENCE et al. (1965) and HOLDRINET (1973). Recovery of DDE, PCB and dieldrin ranged between 80 and 98% with an effective separation of organochlorine insecticides from PCB between 80 and 100%. The data are presented uncorrected.

(b) Total mercury: A 1 g sample of tissue was digested in sulfuric and nitric acid at 63-65°C and mercury was released as described by HATCH and OTT (1968). Mercury was detected as a cold vapour by flameless atomic absorption spectrophotometry at 253.7 nm.

RESULTS

p,p'-DDE, PCB and mercury were identified in all tissues of the six species, while p,p'-TDE was present in some tissue.

DDE and TDE: Mean residues of p,p'-DDE were of a similar magnitude in all three tissues analyzed for fox, raccoon and skunk (i.e. 1.9 to 13 ppb). Skunk tissues contained the higher residues of the three (Tables 1 and 2). Muscle tissues in the fox were the lowest (1.9 ppb) of the six species. Raccoon, skunk and marten contained DDE residues of similar content (i.e. 8.8, 9.3 and 18 ppb) while fisher and mink had muscle tissues with the highest levels of p,p'-DDE (i.e. 61 and 54 ppb).

p,p'-TDE was found in muscle tissues of fisher, marten and mink but not in fox, raccoon and skunk. TDE was present at trace levels in the brains of a percentage of these latter species (Table 1).

With a lower fat content in fisher, marten and mink, residues of DDE plus TDE were much more concentrated in their adipose tissue than in fox, raccoon and skunk. No o,p'-DDE, TDE or DDT or p,p'-DDT was identified in tissue to the limit of detection.

Dieldrin: Dieldrin was detected in muscle tissue of fisher, marten and mink but not in fox, raccoon and skunk. A percentage of brain tissues from these latter three species contained traces of dieldrin (Table 1).

PCB: PCB were present in all tissues of the six species of mammals. The lowest residue was observed in the fox and raccoon (i.e. 12 to 30 ppb) with only slightly higher residues in skunk tissues (i.e. 28 to 43 ppb). Muscle tissues taken from the marten and mink contained similar levels of PCB, namely 150 and 270 ppb respectively, with fisher containing the highest residues (600 ppb).

Mercury: Residues of mercury were detected in all tissues of the six species. Similar levels of mercury were observed in brain and muscle tissues of fox, raccoon and skunk (50-99 ppb). Liver tissues from these three species were almost a magnitude higher (400-950 ppb). Levels of mercury in the muscle tissues of fisher, marten and mink were almost a magnitude higher (330-710 ppb) than muscle from fox, raccoon and skunk, a level similar to that in the liver of these latter species.

Other Organochlorines: No aldrin, endrin, heptachlor, heptachlor epoxide or methoxychlor was detected in tissues of the six species.

DISCUSSION

CLAUSEN et al. (1974) reported similar residues of p,p'-DDE but higher residues of PCB in two arctic fox (Alopex lagopus) from Greenland. The residues of p,p'-DDE were 52 and 220 ppb and the

TABLE 1

Organochlorine Insecticides, PCB and Mercury Residues in Mammals in Southern Ontario 1972-74

Species	Numbers	Tissues		Content in Wet Tissue (ppb)					Fat (%)	Content in Fat (ppb)	
				DDE	TDE	Dieldrin	PCB	Hg		DDE+TDE	PCB
Fisher	15	Muscle	Mean	61.	16.	4.7	600	330	10.0	1100	9000
			SD	140.	18.	3.1	610	150	5.7	1800	13000
Fox[1]	40	Brain	Mean	2.5	<0.1	0.2	17	57	11.0	25	160
			SD	2.3	-	0.3	12	62	1.5	23	100
	51	Liver	Mean	2.6	-	-	14	400	2.9	99	510
			SD	2.1	-	-	8	1600	1.3	83	250
	47	Muscle	Mean	1.9	-	-	12	50	3.3	86	460
			SD	2.1	-	-	10	34	3.4	110	340
Marten	25	Muscle	Mean	18.	0.5	3.9	150	340	2.3	1600	14000
			SD	35.	1.1	6.0	290	180	3.0	3100	4800
Mink	20	Muscle	Mean	54.	3.6	5.3[2]	270	710	1.4	4200	32000
			SD	97.	9.7	9.7	370	310	1.5	3400	37000
Raccoon[1]	38	Brain	Mean	4.2	<0.1	<0.1	19	59	9.9	44	170
			SD	4.2	-	-	14	63	1.7	42	140
	26	Liver	Mean	3.1	-	-	16	950	4.6	100	380
			SD	3.3	-	-	18	1600	4.2	180	320
	41	Muscle	Mean	8.8	-	-	30	54	17.0	54	180
			SD	11.	-	-	40	64	6.9	52	220
Skunk[1]	8	Brain	Mean	13.	0.6	0.3	35	99	8.5	140	400
			SD	9.5	0.4	0.3	23	79	1.3	130	250

TABLE 1 (continued)

Species	Numbers	Tissues		Content in Wet Tissue (ppb) DDE	TDE	Dieldrin	PCB	Hg	Fat (%)	Content in Fat (ppb) DDE+TDE	PCB
Skunk[1]	24	Liver	- Mean	6.	-	-	28	450	5.8	61	510
			SD	14.	-	-	25	850	3.7	49	270
	26	Muscle	- Mean	9.3	-	-	41	53	18.0	57	210
			SD	9.1	-	-	38	38	4.8	58	190

[1] TDE was detected in brain tissue of 18% of foxes, 5% of raccoons and 88% of skunks. Dieldrin was detected in brain tissues of 25% of foxes, 13% of raccoons and 62% of skunks.

[2] Dieldrin levels in extractable fat were mean 760 ppb, SD 1100 ppb.

TABLE 2

Frequency of DDE+TDE, PCB and Mercury in Six Species of Mammals Collected in Ontario

	Content in Wet Tissues (ppb)				
p,p'-DDE+p,p'-TDE	<1.0	1.1-10	11-100	101+	Total
Fisher - Muscle	0	5	9	1	15
Fox - Brain	10	29	1	0	40
Liver	8	43	0	0	51
Muscle	20	26	1	0	47
Marten - Muscle	0	17	7	1	25
Mink - Muscle	0	4	13	3	20
Raccoon - Brain	10	23	5	0	38
Liver	9	16	1	0	26
Muscle	4	29	8	0	41
Skunk - Brain	0	5	3	0	8
Liver	2	20	2	0	24
Muscle	4	14	8	0	26

PCB	1.1-10	10.1-100	101-1000	1001+	Total
Fisher - Muscle	0	1	11	3	15
Fox - Brain	13	27	0	0	40
Liver	14	37	0	0	51
Muscle	25	22	0	0	47
Marten - Muscle	2	16	6	1	25
Mink - Muscle	0	7	12	1	20
Raccoon - Brain	14	24	0	0	38
Liver	15	11	0	0	26
Muscle	9	31	1	0	41
Skunk - Brain	1	7	0	0	8
Liver	4	19	1	0	24
Muscle	5	19	2	0	26

TABLE 2 (continued)

Mercury	Content in Wet Tissues (ppb) 1.1-10	10.1-100	101-1000	1001+	Total
Fisher - Muscle	0	0	15	0	15
Fox - Brain	0	35	5	0	40
Liver	0	35	14	1+1[1]	51
Muscle	0	45	2	0	47
Marten - Muscle	0	0	25	0	25
Mink - Muscle	0	0	17	3	20
Raccoon - Brain	3	29	6	0	38
Liver	0	0	20	6	26
Muscle	1	35	5	0	41
Skunk - Brain	0	5	3	0	8
Liver	0	3	20	1	24
Muscle	0	24	2	0	26

[1] In the 10001+ range.

PCB were 1600, 3900 ppb respectively in the two animals. They also reported finding aldrin, heptachlor epoxide and lindane.

FRANSON et al. (1974) reported residues of BHC, ΣDDT, dieldrin, heptachlor epoxide and lindane in adipose tissues of mink caught in Iowa 1970-71. Residues in the fat were of a similar magnitude for ΣDDT and dieldrin.

NALLEY et al. (1975) reported residues of aldrin, BHC, ΣDDT, dieldrin, heptachlor epoxide, lindane and methoxychlor in raccoon (Procyon lotor) caught 1969 in Florida. ΣDDT residues in omental fat ranged from 0.30 to 4.59 ppm in adults and 0.76 to 1.69 ppm in juveniles. A similar range was reported here. Other organochlorines detected by NALLEY et al. (1975) were not found in raccoons in Ontario.

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