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Organochlorine Insecticide and Polychlorinated Biphenyl Residues in Martens and Fishers from the Algonquin Region of South-Central Ontario

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Use of polychlorinated biphenyls (PCB) and organochlorine insecticides (OCI) has been restricted in the Province of Ontario, Canada, since 1971 (Frank et al. 1979). Nevertheless, environmental persistence coupled with aquatic and atmospheric transmission has enabled PCB and OCI residues to become widespread in the ecosystem (Frank et al. 1979; Zinkl 1982; Safe 1984). Consequent bio-accumulation and bio-magnification of these contaminants in the food web have been widely documented (Frank et al. 1979; Bleavins et al. 1984; Hernandez et al. 1985; Foley et al. 1988). This study reports on OCI and PCB levels in two carnivores, fishers (Martes pennanti) and martens (Martes americana), collected in the Algonquin Region of south-central Ontario in 1976 and 1981, and compares them to data collected for the same species by Frank et al. (1979) in the same area in 1972-74.

Algonquin Region is a forested area of 43,000 km^2 on the Precambrian shield, and has no major industrial or agricultural development. Except for DDT, which was used in the 1950's and 1960's to control biting insects around tourist establishments, there has been little use of OCIs or PCBs in this area. Their occurrence in the Algonquin Region is most likely due to atmospheric transport.

MATERIALS AND METHODS

During the 1976 trapping season (25 Oct.-31 Dec.), carcasses of 97 fishers and 189 martens were collected from trappers in the Algonquin Region. During the 1981 season, 123 fishers and 125 martens were collected from the same area. Sex of each specimen was determined anatomically and age was determined by cementum annuli (Strickland et al. 1982). Muscle and liver samples from each carcass were frozen until chemically analyzed.

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Muscle and liver samples were thawed, and 10 g of each tissue were extracted, cleaned up, and fractionated for organochlorine insecticides (OCI) and polychlorinated biphenyls (PCB) according to Frank et al. (1979). A number of OCIs (DDT, DDD, DDE, heptachlor-epoxide (HPX), α-chlordane (CLD-A) and γ-chlordane (CLD-G), dieldrin (DLD)) as well as PCBs were identified and measured using a gas liquid chromatograph (GLC) equipped with a Ni^{63} detector. OCI and PCB residues were confirmed on a second GLC column equipped with a Ni^{63} electron capture detector with a different set of parameters. PCB estimations were based on a comparison with Aroclor 1254, which most closely resembled the sample chromatograms. OCI and PCB recoveries were checked periodically by fortification of sample tissue homogenates before Soxhlet extraction. Recoveries for OCI ranged from 88-97% while the recoveries for PCB ranged from 85-90%. Data were not corrected for recoveries. The limits of detection were 1 ug/kg for OCIs and 20 ug/kg for PCBs, on a wet-weight basis.

The samples collected in 1976 were mostly from young animals (48% of the martens and 82% of the fishers were <1 year old). In 1981, the samples were selected to include a large proportion of adults (2% of the martens and 20% of the fishers were <1 year old). Because of small sample sizes, data were grouped by species and sex, regardless of age, for statistical analyses. Mean contaminant levels in liver and muscle tissue were compared between years (t-test, $P<0.05$; Tables 1 and 2).

RESULTS AND DISCUSSION

Frank et al. (1979) reported no detectable levels of HPX in fishers or martens in 1972-74. However, we found HPX residues in both species in 1976 and 1981. Between 1976 and 1981, mean levels of HPX increased in muscle tissues of all groups, except male fishers. In liver tissues, mean HPX residues either decreased (female fishers) or remained constant.

Residues of CLD-A and CLD-G were found in liver and muscle of fishers and martens in 1976 and 1981. Frank et al. (1979) did not test for these contaminants in 1972-74. Mean CLD-G levels decreased between 1976 and 1981 in both liver and muscle tissues of male fishers, and livers of female martens, but increased in muscle of female fishers. Mean CLD-A levels decreased between 1976 and 1981 in muscle tissue of male and female fishers, and in the livers of female martens.

DLD residues declined during the ten period in most of the groups tested. Mean DLD residues found in muscle tissues of fishers in 1976 were similar to those reported

Table 1 OCl and PCB residue levels in muscle tissue of martens and fishers from Algonquin Region.

Mean ug/kg wet wt. (+/-SD)

	Marten Muscle									Fisher Muscle									
	Sexes Combined		Males				Females			Sexes Combined		Males				Females			
	1972-74 @	1976		1981			1976		1981	1972-74 @	1976		1981			1976		1981	
N	25	132		67			57		58	15	51		62			46		61	
% Fat	2.3	0.9		1.1			0.8		1.3	10.0	3.4		3.5			1.7		2.9	
	(3.0)	(1.0)		(1.0)			(1.3)		(1.1)	(5.7)	(2.6)		(2.4)			(1.3)		(2.6)	
HPX	ND	0.3	*	3.2			0.4	*	4.5	ND	3.9		3.6			1.0	*	5.7	
		(1.7)		(1.6)			(1.8)		(7.8)		(5.4)		(5.3)			(2.5)		(3.2)	
CLD-G		0.8		1.0			1.1		0.4		2.2	*	0.2			0.7	*	1.8	
		(2.1)		(1.0)			(2.2)		(0.9)		(3.6)		(0.5)			(2.3)		(1.1)	
CLD-A		0.1		0.1			0.4		0.1		2.2	*	0.1			1.0	*	0.1	
		(0.5)		(0.9)			(1.3)		(0.3)		(3.4)		(0.4)			(2.6)		(0.4)	
DLD	3.9	1.4	x	0.3	xx		1.3	x	11.8	xx	4.7	5.4	*	2.3	xx		2.5	*	0.3	xx
	(6.0)	(5.5)		(0.6)			(5.3)	*	(15.6)		(3.1)	(8.5)		(5.8)			(9.1)		(0.9)	
DDE	18.0	3.0	x	1.7	xx		4.1	x	8.1	xx	61.0	29.5		5.0			5.7		5.0	
	(35.0)	(5.8)		(3.6)			(10.0)		(13.9)		(140.0)	(109.7)		(6.3)			(10.3)		(10.7)	
DDD		0.1		0.1			0.1		0.1			4.2	*	0.5			0.9		0.5	
		(1.2)		(0.3)			(0.5)		(0.6)			(11.4)		(1.6)			(3.1)		(2.4)	
DDT		0.8		0.2			1.1		1.4			10.0	*	1.1			3.2	*	0.6	
		(3.3)		(1.2)			(4.1)		(4.0)			(17.6)		(3.0)			(5.9)		(1.7)	
PCB	150.0	18.5	x	40.4	xx		34.3	x	24.8	xx	600.0	103.6	x	227.0	xx		64.8	x	110.5	xx
	(290.0)	(50.0)		(130.2)			(101.8)		(51.2)		(610.0)	(175.5)		(451.6)			(100.9)		(159.6)	

@ = Data from Frank et al. 1979.

ND = not detected

* = significant difference (P<0.05) between 1976 and 1981

x = significant difference (P<0.05) between 1972-74 and 1976

xx = significant difference (P<0.05) between 1972-74 and 1981

Table 2 OCl and PCB residue levels in liver tissue of martens and fishers from Algonquin Region

Mean ug/kg wet weight (+/- SD)

	Marten Liver					Fisher Liver				
	Males		Females			Males		Females		
	1976	1981	1976	1981		1976	1981	1976	1981	
N	132	67	57	58		51	62	46	61	
% Fat	3.6	3.2	4.4	4.4		5.9	3.8	6.8	4.2	
	(2.3)	(2.8)	(4.1)	(4.9)		(4.8)	(3.4)	(5.1)	(5.7)	
HPX	10.4	9.1	12.7	11.4		8.3	5.8	17.0	* 8.7	
	(11.1)	(13.1)	(13.4)	(19.7)		(11.2)	(7.3)	(19.9)	(10.5)	
CLD-G	1.6	1.6	2.3	* 0.9		0.7	* 0.2	1.1	1.7	
	(2.7)	(1.2)	(3.3)	(1.8)		(1.8)	(0.5)	(2.7)	(1.4)	
CLD-A	0.8	0.5	1.0	* 0.2		0.6	0.4	0.9	0.4	
	(1.9)	(1.8)	(2.2)	(0.8)		(1.7)	(1.2)	(2.4)	(1.1)	
DLD	22.1 *	13.8	30.0	* 13.1		34.4	7.1	13.4	* 6.0	
	(17.6)	(18.2)	(32.5)	(21.6)		(140.1)	(11.5)	(11.0)	(8.4)	
DDE	19.5	11.8	34.4	* 7.4		41.6	* 10.7	22.4	* 6.6	
	(42.8)	(20.4)	(61.9)	(15.8)		(119.7)	(18.2)	(40.2)	(9.7)	
DDD	2.4	1.0	3.5	* 0.1		5.4	* 0.9	3.8	1.2	
	(5.8)	(4.3)	(6.5)	(0.7)		(12.3)	(3.6)	(8.6)	(6.6)	
DDT	10.3 *	1.6	12.4	* 1.0		10.2	* 1.6	12.6	* 3.4	
	(14.8)	(4.3)	(14.7)	(2.8)		(15.2)	(3.4)	(21.5)	(9.7)	
PCB	328.1	577.4	573.4	* 284.7		409.5	292.5	611.1	387.5	
	(457.1)	(1410.7)	(849.9)	(353.7)		(588.3)	(529.5)	(726.7)	(775.8)	

* = significant difference ($P<0.05$) between 1976 and 1981

in 1972-74 (Frank et al. 1979), but in 1981 mean DLD levels were lower than those in 1972-74. Mean DLD levels also decreased in fisher muscle between 1976 and 1981. Except for female marten in 1981, which had an unexplained high level of DLD, mean DLD levels in marten muscle decreased between years. In liver tissues, mean DLD levels decreased between 1976 and 1981 in all groups except male fishers.

There were no significant increases in ΣDDT (DDT, DDD, DDE) between 1976 and 1981. Mean DDT residues decreased in liver tissues of both species. Mean DDT levels also decreased in fisher muscle. The persistent breakdown product, DDE, had lower mean levels in marten muscle in 1976 and 1981 than those reported in 1972-74 (Frank et al. 1979), but there was no significant difference in mean DDE levels between any of these years in fisher muscle.

Mean PCB levels in fisher and marten muscle were lower in both 1976 and 1981 than those in 1972-74. Declines in mean PCB residues between 1976 and 1981 were significant only in female marten liver tissue, but the variation between individuals was large. Safe (1984) noted that PCB levels in the environment are slowly decreasing due to their restricted use.

Overall, a greater number of decreases in contaminant levels can be noted in liver tissue than in muscle tissue, particularly in females. This may be attributed to the metabolic activity of the liver in eliminating toxic substances, rather than storing them, as muscle tissue does. It may also be partially accounted for by placental transfer and losses through lactation in the female (Bleavins et al. 1984; Somers et al. 1987).

This report suggests that residues of PCBs and OCIs in fishers and martens in the Algonquin Region of south-central Ontario declined during the ten year period (1972 to 1981) following restrictions on the use of these substances in Ontario. HPX may be the exception to this trend; mean HPX levels in muscle tissue increased during this period. Declines in residue levels between 1976 and 1981 may be greater than indicated because the majority of animals sampled in 1981 were older than those sampled in 1976. As contaminants accumulate with age (Zinkl 1982), one would expect higher, not lower, mean levels in the older animals sampled in 1981 compared to those sampled in 1976.

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