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Tissue Concentrations of Heavy Metals and Polychlorinated Biphenyls in Raccoons in Central New York

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The ubiquitous presence of heavy metals such as lead, mercury and cadmium and polychlorinated biphenyls (PCBs) in wildlife animals has been studied (Clark et al. 1982; Elfving et al. 1978; Wren 1986; Hoff et al. 1977; Erickson and Lindzey 1983; Brunn et al. 1985; Dowd et al. 1985; Henny et al. 1981). Possible sources of these toxicants include pesticides used agriculturally, highway traffic exhaust, landfills, power plants and miscellaneous industrial and other activities. Fish-consuming animals may also absorb heavy metals and PCBs from this dietary source.

Small game hunting and the trapping of fur-bearing animals are actively pursued in Central New York and these animals are exposed to all of the latter pollution sources. It was therefore of interest to determine the concentrations of such toxicants as cadmium, lead, mercury, selenium and PCBs in wildlife animals in this area of New York State.

MATERIALS AND METHODS

The wildlife animals trapped included 16 raccoons, a coyote, and a red fox. The animals were obtained in 1985 from commercial trappers in the locations listed in Table 1. The tissues removed from the freshly caught animals included kidney and liver for the analysis of metals and fat for the determination of PCBs. The tissues were ground, mixed, freeze-dried and subsampled for analysis. Cadmium and lead were determined by conventional stripping voltammetry following wet ashing of the tissue in nitric and perchloric acids. Mercury was determined by digestion of the samples in nitric and sulfuric acids followed by flameless atomic absorption analysis (Hatch and Ott 1968; Ure and Shand 1974). Selenium was determined by wet digestion of the sample and measurement of the fluorescence of piazselenol resulting from the reaction of selenium with 2,3-diaminonaphthalene (Olson 1969). PCBs were determined by Soxhlet extraction of the sample with hexane, isolation by partitioning with acetonitrile and column chromatography on Florisil and analysis by gas chromatography using electron capture detection (US FDA 1971).

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Table 1. Data pertaining to the animals studied

Code	Animal	Sex	Growth[a] stage	Wt kg	Central NY trapping location
1	Raccoon	M	A	11.1	Aurora, NY (near sewage treatment plant)
2	Raccoon	M	A	9.6	Aurora, NY (near sewage treatment plant)
3	Raccoon	F	I	5.5	Genoa, NY (Salmon Creek)
4	Raccoon	M	A	9.0	Ithaca, NY (within city limits)
5	Raccoon	M	A	11.4	Ithaca, NY (within city limits)
6	Raccoon	M	A	11.1	Ithaca, NY (within city limits)
7	Raccoon	F	I	4.5	King Ferry, NY
8	Raccoon	F	I	5.0	King Ferry, NY
9	Raccoon	M	A	8.2	Locke, NY (Tupper Road)
10	Raccoon	M	A	9.3	Locke, NY (Owasco Lake inlet)
11	Raccoon	M	I	4.8	Moravia, NY (Long Hill Road)
12	Raccoon	F	A	9.8	Moravia, NY (Long Hill Road)
13	Raccoon	M	A	10.5	Moravia, NY (Long Hill Road)
14	Raccoon	M	I	4.5	Union Springs, NY
15	Raccoon	M	I	4.5	Union Springs, NY
16	Raccoon	F	A	10.0	Venice Center, NY (Salmon Creek)
	Coyote	F	A	15.9	Lansing, NY
	Red fox	F	A		King Ferry, NY

[a]A = adult; I = immature

RESULTS AND DISCUSSION

The concentrations of cadmium, lead, mercury, selenium, and PCBs in the animal tissues are listed in Table 2. The raccoons trapped within the city limits of Ithaca contained several-fold higher concentrations of PCBs in their body fat and lead in kidney and liver than those of the same sex and maturity (adult males) trapped in rural areas. Raccoons in cities feed on garbage, are exposed to greater concentrations of traffic exhaust or frequent storm sewers or other locations where sources of PCBs and lead may be higher. The contamination of wildlife and other animals by lead contamination along highways has been extensively studied (Williamson and Evans 1972; Jeffries and French 1972; Young et al. 1978; Gilmartin et al. 1985; Young et al. 1986). Raccoons consume aquatic life (fish, snails, crabs, turtles, insects) which can contain PCBs (Wszolek et al. 1979; Morse et al. 1987). PCBs have been reported in tissues of wild and commercial mink populations which consume fish (O'Shea et al. 1981; Hornshaw et al. 1983). Evidence is accumulating to indicate that PCBs are generally ubiquitous environmental contaminants from aerial sources over long distances (Bacci and Gaggi 1985; Gaggi et al. 1985; Buckley 1982).

Mercury in liver and selenium in kidney and liver was higher in most instances in the raccoons than in the red fox or coyote, perhaps reflecting their diet of fish in which these elements tend

Table 2. Results of analysis of the animals for toxic elements and PCBs

	Concentration, parts per million (dry weight basis)										
	Cadmium			Lead			Mercury		Selenium		PCBs
Code	Kidney	Liver	Spleen	Kidney	Liver	Spleen	Kidney	Liver	Kidney	Liver	Fat
1	28.78	7.04	0.95	2.41	1.81	0.37	0.32	0.58	6.8	2.6	0.33
2	8.12	0.76	0.24	2.10	0.41	0.31	0.40	0.12	6.8	1.7	0.18
3	12.45	1.49		2.04	0.45		0.32	0.20	6.0	1.7	0.19
4	13.74	2.56		24.14	37.75		0.43	0.50	5.9	2.7	0.95
5	5.81	0.92		24.41	48.86		0.56	0.98	5.6	2.1	1.60
6	27.52	3.63		10.76	12.41		0.68	0.80	6.2	3.0	2.10
7	5.85	1.05	0.14	2.75	0.86	0.26	0.38	0.34	7.8	3.0	0.20
8	5.88	0.80	0.11	2.81	0.61	0.20	0.36	0.30	7.4	3.1	0.14
9	16.15	2.36	1.04	5.20	11.61	0.45	0.25	0.35	5.2	2.5	0.13
10	35.20	5.36		2.47	1.59		0.50	0.72	6.2	3.0	0.20
11	8.12	0.76	0.24	2.10	0.41	0.31	0.26	0.12	8.8	3.2	0.21
12	5.81	0.92		24.41	48.86		0.40	0.32	8.1	4.0	0.18
13	32.48	6.89	1.45	2.04	1.62	0.25	0.44	1.95	9.3	4.5	0.16
14	7.38	0.90	0.08	1.77	0.68	0.31	0.40	0.21	8.0	2.3	0.31
15	7.33	2.27	0.25	2.15	0.55	0.18	0.31	0.26	7.1	2.7	0.18
16	13.55	2.45	0.19	2.00	0.95	0.12	0.44	0.40	7.4	3.4	0.26
Coyote	0.24	0.12	0.06	1.54	0.26	0.34	0.16	0.05	2.4	0.9	0.18
Red fox	3.21	1.10	1.18	1.17	0.36	0.23	0.42	0.15	5.5	1.9	0.19

to be higher (Bache et al. 1971; Pakkala et al. 1972). Cadmium was notably higher in kidney and liver of the raccoons coded 1, 6, 10 and 13. Those numbered 1 and 10 were captured near the Aurora, New York and Auburn, New York sewage treatment plants, respectively, the effluent of which flow into waters from which they may have consumed fish and other aquatic organisms. Sewage usually contains cadmium as a result of human industrial and domestic activities (Mumma et al. 1984, 1983). Raccoon No. 6 was trapped within the city limits of Ithaca and may have been exposed to urban sources of cadmium.

Associations between tissue elemental concentrations and the sex and maturity of the raccoons may be made. Excluding the raccoons trapped within the city of Ithaca, lead in kidney and mercury in kidney and liver was generally higher in male adult than male immature animals. Cadmium concentration in kidney and liver of rurally-trapped male adult raccoons tended to exceed that in male immature and female adult animals. These associations may reflect a greater foraging ability of the male adult animals. The feeding habits and locale of female raccoons may change during pregnancy and birth of young but it is not possible to predict the effect of these factors on toxicant intake.

It is not possible to draw more definitive conclusions owing to the limited number of animals. Also, due to their variable sources of food and habitat, one can only speculate about the possible sources of toxicants found in tissues of wildlife animals. For instance, raccoon No. 12 showed comparatively high tissue concentrations of lead. An old apple orchard was near the location in which it was trapped. Lead arsenate was used as an insecticide on orchards for many years in New York State but it is not known if this was contributive in this instance. However, cadmium and lead used as pesticides have been shown to concentrate in earthworms and pine voles, respectively (Pimentel et al 1984; Gilmartin et al. 1985) and raccoons do consume soil insects (beetles, grubs, etc.). Animals such as red foxes that forage on mice, voles and larger game could accumulate lead from such food sources especially if the latter prey had been wounded and retained lead shot.

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