

Pesticide and Mercury Levels in Migrating Duck Populations

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Because of the extensive hunting and human consumption of migratory ducks in Iowa the Iowa State Conservation Commission requested the State Hygienic Laboratory to measure the mercury and pesticide levels in various tissues of these birds.

Maximum permissible concentrations for both mercury and pesticides in the edible portion of fish have been established by the Food and Drug Administration. For mercury it is 0.5 parts per million, for DDT residues it is 5 parts per million and for dieldrin and heptachlor epoxide it is 0.3 parts per million.

Using these tolerances as a guide the data on the pesticide and mercury concentrations could be used to determine the potential hazard in human consumption of the ducks with respect to pesticide and mercury levels.

In November of 1970 officers of the State Conservation Commission collected ducks of various species, by shooting, from different locations in the state. This was during the annual southern migration through Iowa. Residues of both mercury and chlorinated hydrocarbon insecticides were probably not affected by their short residence time in Iowa, unless they did extensive feeding here, but reflect accumulations from their more northern summer environment. Mallard ducks were collected from seven locations and composite samples made of the breast muscle, liver and fat of the ducks taken at each individual location. The analyses of these composites are shown in Table I. Five other species were collected from various areas and the breast muscle, liver and fat from all the birds of a given species were prepared as composite samples. The analyses of these other species are shown in Table II.

Methods of Analysis

The composite samples of breast muscle or liver that were analyzed in this study were prepared by grinding the individual tissues in a hand operated meat grinder and then thoroughly mixing them into the composite samples which are listed in Tables I and II.

The fat samples were prepared by cutting the frozen individual fat samples into very small pieces and mincing the composites together thoroughly as they thawed.

The pesticide analyses were carried out by the procedure of Porter, et al (1). The final determinations were made on an F & M Model 400 gas chromatograph equipped with an electron capture detector. The temperatures of the injector, oven and detector, respectively were 200°C, 175°C and 220°C.

Glass columns 4' long by 1/8" I.D. were used for the analysis. A 6%: 4% mixed QF-1:OV-1 liquid phase column was used for quantitation and a 3% OV-1 liquid phase column was used for further confirmation of the identities of the individual pesticides. The analyses for mercury were done by the procedure detailed by Munns and Holland (2). The quantitation was done by flameless atomic absorption using a Perkin Elmer Model 303 atomic absorption spectrophotometer equipped with a Hg hollow cathode lamp.

Results and Discussion

The pesticide data in Tables I and II show that the pesticide concentrations are lowest in the breast muscle and highest in the fat for any of the sets of composites.

Gindal and Peterle (3) analyzed tissues of 11 Mallard ducks for DDT residues after exposure to a marsh treated with DDT. The total DDT residues, by electron capture gas chromatography, in their study are higher than the ones reported here. They report an average liver concentration of 1.05 ppm and breast muscle concentration of 0.36 ppm total DDT residues by gas chromatography for a ratio of liver to breast muscle DDT residue of 2.92.

The ratio of average DDT residues in the liver to those in the breast muscle of the Mallards in Table I is 2.80 for this study (using weighted average values for DDT residues).

The mercury in the tissues has a distribution distinctly different from the chlorinated hydrocarbons, being lowest in the fat and highest in the liver.

There was enough fat sample available to run mercury in five of the composites. In four of the five fat samples analyzed the mercury concentration was less than 0.01 ppm (the lower limit of detection).

Only two samples were significantly above 0.5 ppm mercury concentration. These are the liver samples of the Lesser Scaup and the Shoveller ducks being 1.3 ppm and 1.2 ppm respectively. Because of the limited amount of data it would be difficult to say if these are elevated because of species differences, different summer feeding areas or simply random variations in the samples.

Except for the two values of mercury in the liver, the samples did not show evidence of significant contamination by pesticides and mercury when evaluated against FDA tolerances for fish.

TABLE I

PESTICIDES AND MERCURY IN MALLARD DUCKS

Pesticides-Parts per Billion

Mercury-Parts per Million

Area Collected	No. In Composite	Tissue	Dieldrin	DDE	DDD	DDT	Total DDT Residues	H.E.	Mercury ppm
Ventura Marsh	5	M	7	15		1	16		0.09
		L	72	31		2	33	6	0.30
Rathbun Area	4	M	1	6			6		0.09
		L	3	8			8	2	0.39
		F	8	65		2	67	5	0.02
Sweet Marsh	5	M	1	66	6	4	76		0.08
		L	6	97	7	4	108	4	0.22
		F	26	490	12	58	560	12	<.01
Lake Odessa	5	M	2	7			7		0.04
		L	23	15		3	18	4	0.11
		F	114	161		7	168	9	ND
Ingham Lake	5	M	1	7			7		0.17
		L	3	20			20	2	0.54
		F	10	99		15	114	4	<.01
Riverton-Forneys Lake	10	M	2	19			19		0.06
		L	30	117		6	123	3	0.21
		F	99	384	11	21	416	8	ND
Ruthven	3	M	1	97			97		0.06
		L	12	230	6	11	247	3	0.34
		F	38	590	10	62	662	9	ND

M-muscle; L-liver; F-fat; H.E.-Heptachlor Epoxide; ND-Not Determined
 1 ppm=1,000 ppb

TABLE II
PESTICIDES AND MERCURY IN OTHER DUCKS

Pesticides-Parts per Billion			Mercury-Parts per Million						
Species & Area	No. In Collected Composite	Tissue	Dieldrin	DDE	DDD	DDT	Total DDT Residues	H.E.	Mercury ppm
Lesser Scaup; Sweet Marsh Pool 19 Mississippi R	6	M L F	5 24 98	42 87 480			42 87 517		0.25 1.3 <.01
Pintail; Ventura- Marsh- Rathbun	3	M L F	5 36 154	22 51 149			22 54 201		0.05 0.25 ND
Shoveller; Rathbun- Riverton	3	M L F	9 18 164	28 37 190			28 37 215		0.14 1.2 <.01
Widgeon; Rathbun Riverton	2	M L F		5 12 38			5 12 38		0.06 0.13 ND
Green Wing Teal; Riverton- Ruthven	2	M L F	11 23 162	9 19 81			9 23 106		0.06 0.28 ND

M-muscle; L-liver; F-fat; H.E.-Heptachlor Epoxide; ND-Not Determined
1 ppm=1,000 ppb

References

1. Porter, M.L., Young, S.J.V. and Burke, J.A., J Assoc Offic. Anal. Chem., 53, 1300 (1970).
2. Munns, R.K. and Holland, D.C., J Assoc Offic Anal. Chem., 54, 202 (1971)
3. Dindal, D.L. and Peterle, T.J., Bull. Environm. Contam. and Toxicol. 3, 37 (1968).