Organochlorine Insecticide Residues in Preen Glands of Ducks: Possibility of Residue Excretion

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During the period 1960-1964, dieldrin and other organochlorine insecticides were used extensively for the control of grasshoppers in the western prairies of Canada. In aerial spray operations, some insecticides miss their intended targets with small amounts being carried into the atmosphere either as vapor or by occlusion (ABBOTT et al. 1965, 1966). Although such amounts may be low, they can be 'scrubbed' out by rain and snow, thus making insecticides available for transfer and concentration by food chains and, therefore, for contamination of non-target species such as ducks.

Ducks have a relatively large, bilobed, sebaceous preen gland (uropygial gland) located at the base of the tail. The oily secretion is collected in the central cavity of the gland and secreted through a nipple-like process at the skin surface. This secretion is partially ether-soluble and its lipoidal fraction contains both saponifiable and non-saponifiable fractions (WEITZEL et al. 1952a, 1952b). Because its lipoid content is relatively high (EDKINS and HANSEN 1972) and organochlorine insecticides are preferentially lipid soluble, the gland was examined for residues of DDT, DDE, and dieldrin.

Excretion of organochlorine insecticides has been shown in birds through the egg, as well as in mammals through the expired air, urine, feces, milk, dermal secretions, and the fetus.

Materials and Methods

Twenty-one ducklings of five species (7 gadwalls, *Anas strepera*; 8 pintails, *A. acuta*; 2 blue-winged teal, *A. discors*; 1 lesser scaup, *Aythya affinis*; and 3 baldpates (American widgeon), *Mareca americana*) were collected from an area near Calgary, Alberta, where only dieldrin had been used to control insect outbreaks. The ducklings were killed and frozen within 24 hr of collection. Water and insect material from associated habitats were also collected and frozen until analysis.

Birds were thawed immediately before analysis and the preen glands were dissected out. Samples of whole preen glands were macerated in a Waring Blendor and then extracted with 100 ml of acetonitrile in the

presence of anhydrous sodium sulfate for 5 min, again in a Waring Blendor. The resulting suspension was centrifuged at 2000 rpm for 15 min and the supernatant liquid was decanted into a separatory funnel. Water (5 ml), saturated sodium chloride solution (15 ml), and hexane were added to the supernatant and the mixture was shaken for 2 min. The hexane fraction was separated and evaporated just to dryness in a rotary flash evaporator at 50-60°C. The residue was then dissolved in 100 ml of benzene:acetone (1:19) and extracted by the cold-bath technique of McCULLY and McKINLEY (1964). The concentrated filtrates were analyzed by gas chromatography using two columns consisting of 2.0% and 10.0% QF-1 on 60/80-mesh Chromosorb W.

If background in the chromatograph was appreciable, the samples were subjected to further cleanup by passing the concentrates through a Florisil column (5 g anhydrous sodium sulfate, 10 g Florisil).

Insects were ground in 50 ml of n-hexane and the solvent decanted after 12 min. This was repeated 3 times and the combined extracts concentrated to 25 ml for cleanup by the method of de FAUBERT MAUNDER et al. (1964). Water samples were extracted 3 times with 100 ml n-hexane. These extracts were combined, dried, and concentrated to 100 ml for gas chromatographic analysis.

Results and Discussion

The ducklings used in this study could have obtained their pesticide load only from the environment of their natal site or from the parent bird because of reduced mobility since all except one bird were less than 4 weeks old. Analysis of the insect material, the primary food source of these birds, and the water showed no detectable levels of residual insecticide.

The levels of DDT, DDE, and dieldrin within the preen gland were particularly high (Table 1) when compared to the food source in the environment. The insecticide levels show variation from 0.09 ppm (wet weight) to 2.29 ppm for dieldrin, 0.13 to 0.88 ppm for DDE, and 0.25 to 3.77 ppm for DDT. Because DDT or its analogues and dieldrin were not detected in the food or water, we assumed that those compounds were transferred from the duck to the duckling through the egg. Also, because wild ducks are migratory, we assumed that the adults had picked up the residues during movements in their winter habitat. SHELDON et al. (1963) found that 61% of the waterfowl and all clutches of eggs collected near Yellowknife, Northwest Territories (an unpopulated

area, supposedly uncontaminated) contained DDT and metabolites ranging from 0.0 to 1.0 ppm in ducks and from 1.3 to 4.0 ppm (average 2.2 ppm) in eggs. DDT or its metabolites were found in eggs of black ducks from the Atlantic coast (STICKEL et al. 1963; ZITKO and CHOI, 1972).

TABLE 1

Dieldrin, DDE, and DDT content of preen gland taken from five species of wild ducklings

Species	No. of birds sampled	Average concentration ppm			Ratio DDT:DDE
		Dieldrin	DDE	DDT	
Baldpate	3	0.09	0.27	0.25	0.93
Blue-winged teal	2	0.11	0.13	0.85	6.34
Gadwall	7	0.23	0.56	0.53	0.94
Pintail	8	0.33	0.65	0.60	0.92
Scaup	1	2.29	0.88	3.77	4.30

Animal and plant species vary quantitatively and qualitatively in the degree to which they store and metabolize organochlorine insecticides (HAYES 1965). There is considerable evidence that birds metabolize DDT to some degree to DDE (COOKE 1971; FOSTER et al. 1972) and to DDD (WURSTER et al. 1965). STICKEL et al. (1966) found that, in birds with DDT residues, the production of DDE seemed to be continual and that these levels of residues appeared to be more variable and time-related in liver and other organs than in the brain.

Although direct comparison of residues could be somewhat misleading, the ratio of total DDT to total DDE in a species showed comparable values for baldpate, gadwall, and pintail ducks (0.93, 0.94, and 0.92, respectively). But the ratios for the blue-winged teal (6.34) and scaup (4.30) were higher. The higher ratios could be interpreted to mean that, compared with other birds, the blue-winged teal and scaup either had been exposed to or had eaten food with a higher DDT contamination, or had some physiological mechanisms whereby the preen gland had a greater affinity for storing DDT than for storing DDE, or had relatively greater quantities of DDT transmitted through the egg. DALE and associates (1962) have shown that high-lipoid content

is not the only factor determining the deposition of DDT; metabolism in body organs (HARVE 1967) could also alter the DDT:DDE ratio. There was no apparent correlation between the levels of DDT and dieldrin.

It is concluded that wild ducklings, or any bird with a well-developed preen gland, can excrete lipid soluble insecticides and their metabolites through the preen gland. During preening, these compounds could remain stable or be degraded on the feathers by ultraviolet irradiation (sunlight) and the products subsequently be ingested by the bird. This process would be similar to the secretion of a vitamin D precursor that, through ultraviolet irradiation, is converted to vitamin D and is ingested (HOU 1928, 1930).

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