Dieldrin—^{14}C Residues on Feathers of Birds With Surgically Removed Uropygial Glands[1]

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It is commonly thought that oils on the feathers of birds arise primarily from the uropygial or preening gland and are distributed over the body during preening behavior. It would be reasonable then to assume that organochlorine insecticides present in the body of the bird would also be distributed on the feathers because they are lipid soluble and are mobilized along with fat. DINDAHL (1970) reported finding the uropygial glands of two species of ducks to be generally higher in DDT residue levels than all other tissues except fat. Insecticide residues have been found on the feathers of pheasants administered encapsulated aldrin (Hall *et al.*, 1971). GREICHUS *et al.*, (1974) have shown a significant decrease in numbers of ectoparasites as insecticide residues increased on feathers of double-crested cormorants (*Phalacrocorax a. auritus*) and white pelicans (*Pelecanus erythrorhynchos*) orally administered as a combination of DDE, DDD and DDT. This study was initiated to determine if significant amounts of insecticide residues on the feathers come from within the body of the bird and to determine the pathways of these residues.

Methods and Materials

Six adult white leghorn chickens, seven adult mallard ducks and five young double-crested cormorants were used in the study. The average weights and standard deviations were 1525 g ± 307, 1860 g ± 315 and 1514 g ± 232 for the chickens, ducks and cormorants respectively. In order to assess the importance of the uropygial gland in supplying oils for the feathers, the entire uropygial glands of three chickens, three ducks and two cormorants were surgically removed. The unsutured wounds were examined regularly for the presence of glandular tissue during the 3 week healing period. Two chickens and three ducks with uropygial glands and the three chickens and three ducks without were administered 6.19 uc of uniformly labeled dieldrin - ^{14}C in one ml 80% ethanol. The treatment was injected deep into the right breast

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muscle. Two cormorants with and two without uropygial glands were fed an entire fish which had been injected with 10.36 uc of dieldrin-^{14}C. One bird of each type was employed as a control and received only the 80% ethanol. The birds were placed in small, confining cages with elevated, slat floors to minimize fecal contamination. The chickens and ducks were sacrificed after 48 hours and the cormorants after 24 hours. Feathers were taken from the uropygial, shoulder and left breast area of all birds and also from the head of the cormorants. Feathers were finely cut and mixed. One gram aliquots were placed on a column packed with 10 g Florisil topped with 20 g sodium sulphate. The dieldrin-^{14}C was eluted with 240 ml of a mixture of dichloromethane and petroleum ether (1:1 v/v). Samples were evaporated to 2 ml and placed in 15 ml of scintillation fluid for radioactive counting. Lipids were extracted from chicken feathers by the chloroform - methanol method of FOLCH *et al.*, (1957). One gram samples of uropygial glands were extracted and purified for dieldrin-^{14}C by the method of GREICHUS *et al.*, (1968).

The instrument used for liquid scintillation analysis was a Packard Tri-Carb Series 3375, Liquid Scintillation Spectrometer. Quench correction was determined by automatic external standardization technique.

Dieldrin-^{14}C with a specific activity of 2.36 mc/mmole was obtained from the Shell Development Company, Modesto, California. Examination of the radioactive dieldrin by electron capture gas chromatography revealed no extraneous peaks. Thin-layer chromatography indicated that more than 95 percent of the radioactivity was in the dieldrin band.

Florisil, 60/100 mesh, activated at 650°C (Fisher Scientific Company) was heated at 130°C for 16 hours, mixed with 3 percent distilled water, and sealed in an airtight container. Petroleum ether (boiling range 30° to 60°C), and dichloromethane were Nanograde (Mallinckrodt Chemical Works). The scintillation fluid consisted of 100 mg of 1,4-bis-2-(5-phenylosazole)-benzene (POPOP) and 3 gm of 2,5-diphenyloxazole (PPO) in a liter of toluene. These chemicals were of scintillation grade from Packard Instrument Company, Inc.

Results and Discussion

Chickens, ducks and cormorants with intact uropygial glands had an average of 3.2, 6.1 and 1.7 times more radioactivity per gram, respectively on their feathers than those without uropygial glands (Table 1). However, birds with no uropygial glands had considerably more radioactivity on their feathers than did the controls. The uropygial gland of chickens, ducks and cormorants averaged 3.34, 4.70 and 3.41 grams in weight and had 5040, 7760 and 30,080 dpm per gram of uropygial tissue, respectively.

TABLE 1

Average Radioactivity on Feathers of Control Birds and Birds with or without the Uropygial Gland After Administration of Dieldrin-^{14}C

	Dieldrin-^{14}C Treated				Control	
		With		Without		With
Bird[1]	No.	U.G.	No.	U.G.	No.	U.G.
		dpm/g[2]		dpm/g		dpm/g
Chickens	2	305	3	95	1	27
Ducks	3	630	3	104	1	2
Cormorants	2	6810	2	3925	1	25

[1]Two one gram samples of feathers were taken from the uropygial, shoulder and left breast area of each bird.

[2]Disintegrations per minute per gram of feathers.

Feathers from the area of the uropygial gland had more radioactivity than other areas of the body in chickens and ducks whether or not the uropygial gland was present (Table 2). The cormorant had the greatest amount of activity on feathers from the head whether or not the uropygial gland had been removed. The head area of the chickens and ducks was not sampled. In general radioactivity was found on feathers from all areas examined of both the intact and surgically impaired birds. The average percent of lipid on feathers of chickens with or without the uropygial gland was 1.50 and 1.32, respectively.

TABLE 2

Distribution of Dieldrin-^{14}C on Feathers from Several Body Areas of Birds with or without the Uropygial Gland

	Chickens		Ducks		Cormorants	
	N=2	N=3	N=3	N=3	N=2	N=2
	With	Without	With	Without	With	Without
Area	U.G.	U.G.	U.G.	U.G.	U.G.	U.G.
			dpm/g[1]			
Uropygial	682	160	1,657	184	6,820	3,300
Shoulder	150	63	70	49	6,700	5,265
Left Breast	82	61	163	79	6,910	3,210
Head	---[2]	---	---	---	15,895	8,710

[1] Disintegrations per minute per gram of feathers.

[2] Not analyzed.

These data suggest a mechanism for the distribution of dieldrin-^{14}C onto the feathers other than by way of the uropygial gland. The skin of birds is generally thought not to contain secretory glands. The glandular tissues present include the uropygial gland and a few glandular cells in the vicinity of the ear of some gallinaceous birds (RAWLES, 1960). Using histological techniques, LUCUS and STETTENHEIM (1972) have shown the presence of lipoid bodies in chicken skin epidermis. Secretions from these bodies are a source of fatty material in the corneum and transitional layers

of the skin and between the feather calamus and the lining of the follicle. The work of these investigators provides an explanation of the results in this experiment in that dieldrin-laden lipids could have been secreted onto the feathers by way of these lipoid bodies.

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