DDT and PCB Levels in Lake Coeur d'Alene, Idaho, Osprey Eggs

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Since 1969, we have investigated certain aspects of the ecology of nesting populations of ospreys (Pandion haliaetus) in northern Idaho and northeastern Washington (SCHROEDER and JOHNSON, In press; MELQUIST and JOHNSON, In press). We have censused populations, determined reproductive success and banded nestlings to study migration and survival.

These populations are reproducing successfully; the number of nesting pairs has steadily increased during the past two decades. The threats to nesting success remain of interest however, and, we have attempted to evaluate them. The levels of DDT residues and PCB found in fresh eggs of the Coeur d'Alene population are reported here. Some of the factors which influence exposure of this population to pesticide contamination are also described.

Methods

Single eggs were collected early during incubation in May, 1972 and 1973, from 11 clutches in the Coeur d' Alene watershed. The contents were removed, homogenized in a blender and stored frozen in glass jars which had been rinsed in distilled water and acetone. The eggshells were dried in an oven at 70C for 24 hours. Later, the eggshells and contents were air-shipped to Patuxent Wildlife Research Center, Laurel, Maryland, for shell thickness measurements and pesticide analyses.

The volume of each egg was estimated as $0.48\ LB^2 + 3.69$ (STICKEL et al. 1973) where L and B are the length and breadth in cm. The wet weight of the contents was calculated as the total egg weight less that of the dried shell and 1.45 g, a correction for weight loss due to extraction of the contents and drying of the shell. Shell thickness was determined by micrometer measurement, averaging three determinations at the equator.

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Pesticides and PCB were separated on a silicic acid column and analyzed by gas chromatography on a 4/6% Se-30/QF-1 column. Samples were routinely analyzed for p, p' DDE, p, p' DDD, p, p' DDT, dieldrin, heptachlor epoxide, mirex oxychlordane, cis chlorane, cis nonachlor, hexachlorbenzene and PCB. Results of two samples were confirmed on a gas chromatograph-mass spectrometer. The lower limit of sensitivity for pesticides was 0.1 ppm and that for PCB was 0.5 ppm. Pesticide levels were expressed in mcg/ml of egg volume. Assuming a specific gravity of one, these units convert directly to parts per million (ppm).

Results

DDE, the most common DDT metabolite, ranged from 1.8 to 15 ppm (Table 1). Lesser amounts of p, p' DDD and p, p' DDT were also detected. PCB, probably Aroclor 1260, averaged only 1.2 ppm.

Of the 11 clutches samples, one was later lost when the nest tree toppled (Table 1). Two others contained only the single egg removed for analysis. Of the 8 remaining clutches, total DDT residues were highest (mean 17.6 ppm) in eggs taken from clutches which eventually failed (nests 24, 59, 138). DDT residues averaged 7.1 ppm in eggs from 5 clutches which eventually fledged at least one young. Since the probability of nesting failure from all causes is 0.3 in this population, the probability that the three clutches containing eggs with the highest DDT residues failed by chance alone is less than 0.03.

There was no significant difference in shell thickness between sample eggs from clutches which failed (mean 0.426 mm) and those which fledged at least one young (mean 0.427 mm). Nor, was there a significant difference ($P > .05$) between shell thickness of fresh eggs from successful clutches (mean 0.427 $\pm$ 0.024) and that of 10 addled eggs collected from 7 clutches from 1970-73 (mean 0.456).

There has been a significant reduction ($P < .05$) in shell thickness of osprey eggs from the Pacific Northwest since the advent of pesticide use however. The mean thickness index (RATCLIFFE 1967) of 11 eggs from 5 clutches collected in British Columbia and Washington between 1880 and 1932 was 2.61 $\pm$ 0.10. That of the 11 fresh eggs collected during this study was 2.15 $\pm$ 0.06 (Table 1), a reduction of more than 17%. Shell weight of the museum specimens (mean 6.86 g $\pm$ 0.18) was also significantly greater ($P < .05$) than that of the fresh eggs (Table 1).

TABLE 1

Lipid, DDT and PCB levels and thickness measurements of fresh osprey eggs.

Nest No.	Lipid %	ppm DDE	ppm Other DDT residues	ppm Total DDT	PCB (ppm)	Shell Weight (g)	Thick-ness (mm)	Thick-ness Index	Outcome of Nesting Attempt
17	3.9	6.1	1.7	7.8	1.5	6.88	0.447	2.36	Failed; nest tree fell
23	3.0	9.6	2.0	11.6	1.2	5.83	0.393	1.98	Single egg clutch
24	2.7	12.0	1.5	13.5	1.6	5.60	0.397	1.99	Failed
40	3.0	9.8	1.1	10.9	4.0	6.26	0.420	2.04	2 fledged
57	2.0	1.8	0.2	2.0	nd	7.92	0.517	2.60	2 fledged
59	2.9	15.0	4.1	19.1	1.8	6.54	0.453	2.26	Failed
66	2.7	4.6	0.3	4.9	1.7	6.48	0.400	2.17	1 fledged
103	3.0	9.0	1.0	10.0	nd	5.65	0.380	1.99	1 fledged
126	2.8	7.3	0.5	7.8	nd	6.59	0.417	2.14	2 fledged
138	2.4	14.0	6.1	20.1	nd	6.65	0.427	2.21	Failed
144	2.8	4.6	0.5	5.1	1.2	5.51	0.363	1.86	Single egg clutch
Mean ± SE	2.84 ±0.14	8.53 ±1.24	1.73 ±0.55	10.3 ±1.71	1.18 ±0.36	6.36 ±0.21	0.419 ±0.013	2.15 ±0.06	

nd = not detectable

Discussion

Pesticide-induced shell thinning is well documented both experimentally (review by COOKE 1973) and historically (RATCLIFFE 1970; ANDERSON and HICKEY 1972). Embryonic death was identified as a major cause for the decline of the Connecticut osprey population (AMES and MESEREAU 1964; AMES 1966). Although the shell-thinning syndrome had not been proposed at that time, a subsequent study indicated that shell thinning and egg breakage also occurred in the Connecticut population (WIEMEYER pers. comm.).

The shell weight and thickness decreases observed in the Coeur d'Alene population in comparison with pre-pesticide eggs from the Pacific Northwest are of the same magnitude as those found in eastern populations. ANDERSON and HICKEY (1972) reported significant decreases of 12-18% in shell weight and 21% in shell thickness since 1947 for nesting populations in Florida, Maryland, New Jersey, and Connecticut.

In comparing the thickness of addled with fresh eggs, our sample of eggs failing to hatch may be biased because of the breakage and loss of thin-shelled eggs early in incubation. The occurrence of clutches of single thin-shelled eggs (nests 23 and 144) suggests egg loss since the modal clutch size in this population is three. Nesting failures from all causes amounted to 19 of 70 attempts (27%) in 1973. The 51 successful nestings produced 110 nestlings, an average of 1.57 per attempt.

Pesticide exposure of this population may occur on the nesting grounds, during migration, or on the wintering grounds in Central America. DDT has not been used extensively within the Coeur d'Alene watershed. Tussock moth control with DDT in 1947 and 1965 involved only a small portion of the watershed (EVENDEN and JOST 1948; USDA/FOREST SERVICE 1974). Some local use of DDT is planned for tussock moth control in 1974. Further study is necessary to identify the sources of pesticide contamination in this osprey population.

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