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Reproductive Success of Screech Owls Fed Aroclor® 1248

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Abstract. Aroclor® 1248 was fed to captive screech owls (*Otus asio*) at the rate of three ppm in the diet to determine if reproductive effects such as fewer eggs per clutch, lower hatchability, malformation of the chicks, or higher mortality rates of chicks would appear in this raptorial species as they did in chickens. There were no effects on eggshell thickness, number of eggs laid, young hatched, and young fledged from feeding a low level of Aroclor® 1248 to captive screech owls. The polychlorinated biphenyl (PCB) residues found in the eggs of the dosed birds ranged from 3.9 ppm to 17.8 ppm. Background PCB residues in the diet of all experimental birds ranged from non-detected to 0.62 ppm.

Polychlorinated biphenyls (PCBs) are world-wide environmental contaminants of industrial origin, chemically related to DDT and its metabolites, accumulate as they proceed through the food chain, and they are persistent in the environment. Even though PCBs are being phased out of industrial use in the United States, they will remain in the environment at low levels for many years (Dustman *et al.* 1971).

PCBs, similar to DDT and its metabolites, have been found in bird tissues and eggs and implicated in reproductive abnormalities in both wild and domestic birds. Aroclor® 1242 at 5 and 10 ppm injected into chicken eggs at day 0 of incubation severely limited hatchability. Malformation and reduction of growth rates in chicks were also observed (Carlson and Duby 1973). Aroclors® 1242, 1248, and 1254 fed at 20 ppm to laying hens reduced food consumption, egg production, hatchability, and growth rates of chicks, and Aroclor® 1248 alone increased mortality of chicks (Lillie *et al.* 1974). Aroclor® 1248 was shown to reduce egg production by 10% at 10 ppm when the PCB level in chicken egg approached 3 ppm. Hatchability was reduced to 56% of normal when egg levels reached 3 ppm (Scott *et al.* 1971). Aroclor® 1254 and 1262 at levels of 0.5 and 5 ppm wet weight fed to American kestrels (*Falco sparverius*) caused a breakdown of oestradiol to a more polar metabolite and the suggestion was made that physiological actions of PCBs are similar to those of DDT and its metabolites (Lincer and Peakall 1970).

Experimental studies indicate that certain raptors are sensitive to or-

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ganochlorine insecticides and their metabolites, such as DDT and DDE (Porter and Wiemeyer 1969, McLane and Hall 1972). Declining populations of some raptors have been circumstantially linked to these chemicals. Therefore, this study was undertaken to determine if 3.0 ppm, a low level of Aroclor® 1248, would also affect the reproductive activity of screech owls (*Otus asio*), a nocturnal raptor.

Materials and Methods

Eighteen breeding pairs of screech owls from a captive colony were randomly assigned to outdoor pens 12.19 × 3.05 × 2.43 m. Each cage was equipped with nest box, resting shelter, perch, and a food shelter. Owls were fed Nebraska brand Bird-of-Prey diet. Water was available *ad libitum*.

Nine pairs of owls were randomly chosen to receive 3.0 ppm (wet weight) Aroclor® 1248 which was dissolved in propylene glycol and mixed with the food. The other nine pairs received a control diet which contained propylene glycol equal to that added to the diet of the dosed group. Background levels of PCB in the diet of all birds were found to range from non-detectable to 0.62 ppm.

The study was made through two breeding seasons. The dosed and control diets were fed to the owls beginning on January 7, 1976, 8 weeks before the onset of egg laying. At the time of hatching in each nest, the diet was changed to whole body rodents to allow young to be raised to fledging. All adult pairs were placed back on dosage at the time the young were sacrificed, 60 days after hatching, and continued through the next egg-laying season. Thus, the dose time was longer for the second breeding season than for the first.

The reproductive parameters monitored were number of eggs laid, number of eggs hatched, number of young fledged, and eggshell thickness. Nests were checked daily during the nesting season for eggs and the third egg in each nest was collected for residue analysis and egg measurement. The remaining eggs were left for incubation by the parents. As eggs were broken or became addled, they were removed from the nest and saved. The young birds and unhatched embryos were examined for gross abnormalities.

Eggs for analysis were opened and the contents homogenized. The eggshells were dried at room temperature for two weeks and measured for shell thickness at the equator with a Starrett dial indicator micrometer. The carcass samples were prepared by cutting off the beak, feet, and distal portion of the wing. The gastro-intestinal tract, skin, and feathers were removed, and the carcass was homogenized in a food chopper.

Chemical analyses were performed at Raltech Scientific Services, Inc., in Madison, WI, using the following procedures: The entire sample was air-dried from 4 to 6 days or until it was almost dry, mixed with anhydrous sodium sulfate and desiccated 2 to 3 days, and extracted for 12 hr on a Soxhlet extractor with 300 ml of 50:50 ethyl ether: petroleum ether (v/v). A five ml aliquot was eluted through a Florisil® column with 170 ml 5% ethyl ether in petroleum ether followed by 265 ml of 15% ethyl ether in petroleum ether.

Analysis was made by electron capture gas chromatography. The instrument specifications and conditions were as follows: for PCBs, a Hewlett Packard Model 5710A was used with a glass column, 6 ft. × 4 mm ID, packed with 11% OV-17 + QF-1 on 80/100 mesh Gas Chrom Q. The injector temperature was 250°C; column temperature was 208°C; detector temperature 300°C; and the carrier gas was argon/methane, with a flow rate of 60 ml/min. A Barber Coleman Model 5000 was used with a column 4 ft × 4 mm packed with 5% DC-200 on 80/100 mesh Gas Chrom Q for the determination of dieldrin. The column temperature was 208°C; injector temperature 240°C; detector temperature 208°C. Carrier gas was nitrogen with a flow rate of 8 ml/min.

Lipids were determined in an aliquot of the extract reduced to dryness on a steam bath, and placed in a 40°C oven over night. The recovery rate was 91.2%. The data were not corrected for recovery.

The data were analyzed with a repeated measures analysis of variance, because the same pairs were used in the two years. The t-test was used to determine the difference between years in the dosed fledgling carcass residues (Snedecor and Cochran 1967).

Table 1. Effects of 3 ppm dietary Aroclor® 1248 on Screech Owl reproduction

Treatment group	n	Number eggs laid		Number eggs hatched		Number young fledged		Eggshell thickness (mm)	
		Range	Mean	Range	Mean	Range	Mean	Range	Mean
Control[a]									
1976	9	4–6	4.7	2–5	3.1	0–4	2.5	0.177–0.230	0.210
1977	9	4–6	4.7	2–4	2.7	0–4	2.4	0.196–0.263	0.221
Dose[a]									
1976	9	2–6	4.4	2–5	2.7	1–4	2.3	0.170–0.257	0.225
1977	9	3–7	4.7	1–4	2.3	1–4	2.2	0.200–0.253	0.225

[a] No significant difference ($P > 0.05$) between the control group and the dosed group, or between years for both groups

Results and Discussion

Aroclor® 1248 had no detectable effect on screech owl reproduction (Table 1); nor was there a significant difference in reproduction between years ($P > 0.05$). Mean PCB residues in eggs from control birds was 1.17 ppm in 1976 and 0.68 ppm in 1977 and were significantly less ($P < 0.01$) than those in eggs from dosed birds in 1976 and 1977, 3.32 and 7.12 ppm (Table 2). PCB residues in eggs from dosed birds in 1976 were significantly less ($P < 0.05$) than those found in 1977. Low DDE (0.37 ppm in 1976 and 0.30 ppm in 1977 for controls, and 0.37 ppm in 1976 and 0.46 ppm in 1977 for experimentals). Dieldrin (0.03 ppm in 1976 and 1977 for controls, and 0.05 ppm in 1976 and 1977 for experimentals) residues were found in eggs from both control and dosed birds.

Table 2 reports the residue levels in three downy young and all fledglings. Three downy young of 1 to 4 days of age (one of control parents, two of dosed parents) were found dead in the nest. The residues found in these young appear to reflect the residue levels in the eggs. The residue levels found in the fledglings after receiving a clean diet for 60 days were substantially lower than those in eggs. The PCB residues in the fledglings of dosed parents were significantly higher than those in control fledglings ($P < 0.01$). The PCB residues in the fledglings of dosed parents were significantly higher in 1977 than in 1976 ($P < 0.01$). There was no significant difference between residues of DDE and dieldrin in fledglings of control and dosed parents. Two adult birds, sacrificed 60 days after hatching of the young in 1977, were analyzed for residues (Table 2).

The PCB residues in the eggs from dosed screech owls are higher than those found by Klaas and Swineford (1976) in eggs collected from wild birds in Ohio (range 0.26 to 3.4 ppm, average 1.32 ppm). This was also true for barn owl (*Tyto alba*) eggs collected by Klaas *et al.* (1978) on the Maryland side of the Chesapeake Bay (range N.D. – 7.0 ppm, mean 1.98 ppm). The residues found in the wild owl eggs, however, are higher than those found in the eggs laid by the control birds of this study. Although such wild owls do acquire PCBs in their diets, it appears that they may not acquire enough to be a threat to their reproductive success. Eggs of bald eagles (*Haliaeetus leucocephalus*) collected in 19[illegible] and 1970 contained PCB residues ranging from 1.1 ppm in Alaska to [illegible] ppm in Michigan (Wiemeyer *et al.* 1972). Eggs of ospreys (*Pandion haliaetus*) collected in New Jersey in 1971 through 1974 contained PCB resi-

Table 2. Residues found in Screech Owl eggs and carcass samples of owls dosed with 3 ppm Aroclor® 1248 (ppm wet weight)

		PCB		DDE		Dieldrin	
	n	Range	Mean	Range	Mean	Range	Mean
Eggs[a]							
control 1976	9	0.72– 2.17	1.17c	0.18–0.85	0.37	N.D.–0.06	0.03
control 1977	9	0.76– 1.54	1.08c	0.19–0.59	0.30	0.02–0.05	0.03
dosed 1976	9	2.24– 4.84	3.32b	0.23–0.58	0.37	N.D.–0.12	0.05
dosed 1977	9	3.98–17.8	7.12a	0.10–0.81	0.46	0.03–0.10	0.05
Carcases							
Downy young[b]							
control 1976	—	—		—		—	
control 1977	1	1.87		0.81		0.02	
dosed 1976	1	4.14		0.38		0.07	
dosed 1977	1	4.54		0.36		0.03	
Fledglings[c]							
control 1976	4	0.61– 0.74	0.68b	0.07–0.10	0.08	0.04–0.06	0.05
control 1977	4	0.66– 1.15	0.88b	0.06–0.07	0.06	0.02–0.03	0.02
dosed 1976	10	0.29– 0.98	0.73b	0.02–0.11	0.06	0.02–0.05	0.03
dosed 1977	10	0.96– 2.16	1.37a	0.07–0.32	0.10	0.01–0.05	0.03
Adults							
dosed 1977	2	10.6– 15.0	12.8	0.39–1.28	0.84	0.07–0.09	0.08

Note: values with the same letter are not significantly different
[a] third egg of each clutch
[b] nestlings 1 to 4 days of age found dead
[c] fledglings 60 days old

dues ranging from 2.5 to 36.0 ppm (Wiemeyer *et al.* 1978), which suggests that some of the birds were obtaining more than 3 ppm in their diets.

The mean of the PCB residues found in carcasses of dosed adult screech owls was 12.8 ppm. PCB residues found in the livers of Danish birds of prey, including four different owls, ranged from 1.3 to 272 ppm. The median residue level was 11.5 ppm and the mean was 38.2 ppm (Karlog *et al.* 1971). PCBs were found in owls collected in the mid-Atlantic states; two great-horned owl (*Bubo virginianus*) carcasses contained 7.3 and 1.5 ppm, two barred owl (*Strix varia*) carcasses contained 4.8 and 0.55 ppm, and one screech owl carcass contained 0.48 ppm (personal communication; J. Sheridan, K. Stromborg). Carcasses of birds of prey collected in the Netherlands in 1968 and 1969 contained similar residues. One marsh harrier (*Circus aeruginosus*) contained 9.0 ppm in the liver, three Eurasian kestrels (*Falco tinnunculus*) contained 0.6, 4.5, and 8.3 ppm in the liver, and a European sparrow hawk (*Accipiter nisus*) contained 41.0 ppm PCBs (Koeman *et al.* 1969). Residues in eggs of brown pelicans (*Pelecanus occidentalis*) ranged from 1.9 to 36.5 ppm PCBs (Blus *et al.* 1974).

The PCB residues in both eggs and carcasses of birds dosed with 3 ppm Aroclor® 1248 appear to be in a mid-zone, neither very high nor very low, as compared with residues in the tissues of wild birds. Reproduction was not perceptively affected at this dosage level.

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