Organochlorine and PCB Residues in Tissues of Raptors from Illinois, 1966–1981

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Organochlorine insecticides have been documented to have adverse effects on the reproduction and survival of raptors (Wurster 1969; Stickel 1973; Wiemeyer et al. 1975; Henny et al. 1976; Klaas et al. 1978; Ohlendorf 1981; Fleming et al. 1982; Prouty et al. 1982; Blus et al. 1983; Henny et al. 1983). The organochlorine insecticides aldrin, heptachlor, and chlordane were introduced in Illinois in 1954 for control of corn insect pests (Metcalf and Sanborn 1975). The use of organochlorine insecticides reached a peak in Illinois during 1967 when they were applied to an estimated 5.6 million of the 10 million acres planted to corn (Steffey et al. 1984). Aldrin was applied to an estimated 44.9 million acres of corn soil from 1956 through 1977, heptachlor was used on an estimated 11.6 million acres from 1956 through 1978, and chlordane, which contains heptachlor, was applied to an estimated 2.5 million acres from 1956 through 1978 (Steffey et al. 1984). DDT was used on fields planted to corn from 1945 through 1965 (Steffey et al. 1984). Chlorinated hydrocarbon insecticides were no longer applied to corn soil in Illinois after 1978 (MacMonegle et al. 1984). Polychlorinated biphenyls (PCBs) are industrial pollutants that were introduced in 1929 and are currently present throughout the environment (Dustman et al. 1971).

Because of the persistence of these chemicals in the soil (Kearney et al. 1969; Nash and Woolson 1967; Pimentel 1971), their bioaccumulation in the upper levels of the food chain (Frank et al. 1977; Price 1977), and the difficulty in obtaining samples from protected species such as raptors, we monitored the occurrence of residues of selected organochlorine insecticides and PCBs in tissues of birds of prey to document the level of contamination near the end and following the period of maximum use of chlorinated hydrocarbons in Illinois. The residues examined were DDE (a metabolite of DDT), dieldrin (a metabolite of aldrin), heptachlor epoxide (a metabolite of heptachlor), and PCBs (quantified as Aroclor 1254).

MATERIALS AND METHODS

A total of 68 individuals representing 14 species of raptors were obtained from 1966 through 1981. Most birds were collected from
1972 through 1979. These raptors were killed on highways, confiscated by law enforcement officers, or found disabled after flying into windows or being shot. The specimens were frozen immediately upon possession. Tissue samples analyzed for pesticides were brain, liver, heart, breast muscles (pectoralis and supracoracoideus), and subcutaneous and visceral fat. Wet samples were homogenized, saponified, and then extracted with 50 ml of nanograde hexane. The hexane extract was washed three times with ultrapure water, poured through a funnel of anhydrous Na₂SO₄ to remove residual water, and then placed on a steam bath and reduced to a volume of 2-5 ml under a 3-ball Snyder column. Each sample was fractionated on a 30-gm florisil column. The first fraction was eluted with 90 ml of hexane to recover the PCBs; the second fraction, eluted with 10 percent ethyl ether/hexane, contained the remaining chlorinated hydrocarbons. The samples were then reduced to a volume suitable for gas chromatographic analysis. The analyses were performed using a Varian-Aerograph Series 2100 gas chromatograph with a 63Ni electron capture detector operated at 250°C. The analytical column was a 6' x 1/4" O.D. x 2 mm I.D. glass column packed with 2.5% OV-210 and 1.0% OV-17 coated on a 100-120 mesh Supelcoport. The column temperature was maintained at 190°C and the injection port at 210°C; the electrometer was operated at 4 x 10⁻¹⁰ amperes. The carrier gas was O₂-free nitrogen at a flow rate of 40 ml/min. Retention times of sample peaks were compared with those of standard reference compounds to provide presumptive identification. Quantification was achieved by peak height comparison. Detection limits were calculated to be 0.005 ppm. Because of limited sample sizes and generally low levels of pesticides, statistical tests of differences were not attempted.

RESULTS AND DISCUSSION

The 68 hawks and owls used in this study included 17 belonging to species considered as migrants and 51 belonging to species considered as permanent residents in Illinois (Table I). With the exception of goshawks (Accipiter gentilis), species for which we had the largest sample sizes [barred owls (Strix varia), great-horned owls (Bubo virginianus), screech owls (Otus asio), and red-tailed hawks (Buteo jamaicensis)], are permanent residents (Table I). All of the goshawks were collected during the winter of 1972-1973 when there was an unusually large influx of this rare winter resident. Percentages of all birds (N=68), of migrants (N=17), and of permanent residents (N=51) in which residues of the various contaminants were detected in at least one tissue sample are as follows: DDE--76.5%, 88.2%, 72.5%; dieldrin--85.3%, 64.7%, 92.2%; heptachlor epoxide (HE) --54.4%, 35.3%, 60.8%; and PCBs--26.5%, 17.6%, 29.4%. Thus, 76.5% of all birds of prey sampled were contaminated with residues of DDE, 85.3% with dieldrin, 54.4% with HE, and 26.5% with PCBs. DDE occurred in a higher percentage of migrants (88.2%) than permanent residents (72.5%), whereas detectable levels of dieldrin, HE, and PCBs occurred in a higher percentage of permanent residents. Dieldrin residues were found in 92.2% of the permanent residents examined. Seidensticker and Reynolds (1971) reported low levels of DDE,