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DDT and Hexachlorobenzene Residues in Southeastern Washington Swainson's Hawks (*Buteo swainsoni*)

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In the early 1950's, Swainson's Hawk (Buteo swainsoni) was a common summer resident of southeastern Washington (KING 1953). Since then, this hawk population appears to have declined and its current status is uncertain. Along with this decline, agricultural activity has eliminated most of the area's natural habitat and has introduced undetermined amounts of pesticide contamination. Over 97% of the land in Whitman county is under cultivation and DDT has been widely used to control pea weevil and aphid infestations in fields undergoing dry pea cultivation. Although banned in 1971, Environmental Protection Agency exemptions permitted local, continued use of DDT until 1975 when it was replaced by parathion. The cereal fungicide hexachlorobenzene (HCB) has also been used extensively to treat wheat, oat, and barley seed against smut infestations. Analysis of Starlings (Sturnus vulgaris) collected as part of the National Pesticide Monitoring Program in 1972, 1974, and 1976 showed the HCB was a significant chemical contaminant in southeastern Washington. Levels reported were the highest found in Starlings collected anywhere in the U.S.A. (NICKERSON & BARBEHENN 1975, WHITE 1976). The reproductive effects of DDT contamination have been well documented (COOKE 1973, HICKEY & ANDERSON 1968). Little is known concerning the toxicity of HCB to raptors, but laboratory studies have shown that in high concentrations it has a reproductive effect on Japanese Quail (Coturnix coturnix) (FLETCHER 1973).

This study was undertaken to determine the organochlorine pesticide burden, particularly that of DDT, its metabolites, and HCB in Swainson's Hawk and other raptors nesting in southeastern Washington and possible adverse reproductive affects of these contaminants which might account for apparent local decline of Swainson's Hawk.

METHODS

Addled eggs and nestling carcasses were collected in June, 1977 and 1978 at eight Swainson's Hawk, one Ferruginous Hawk (Buteo regalis), and two American Kestrel (Falco sparverius) nests in southeastern Washington. Entire eggs and carcasses were wrapped in aluminum foil, frozen, and air-shipped to Patuxent Wildlife Research Center, Laurel, Maryland for pesticide analysis. Samples were analyzed for p,p'DDE, p,p'DDD, p,p'DDT, dieldrin, heptachlor epoxide, mirex, cis-chlordane, cis-nonachlor, HCB, oxychlordane, and polychlorinated biphenyls (PCB) using a gas chromatograph equipped with an electron capture detector (CROMARTIE et al. 1975). Residues in two samples were confirmed

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by gas chromatography-mass spectrophotometry. Lower limit of detection was 0.1 ppm based on p,p'DDE. The contents of eggs were converted to an approximate fresh weight using egg volume (STICKEL et al. 1973) and all residues expressed on a corrected wet weight basis.

Clutch and brood sizes were observed at all nests. Nests were revisited prior to the end of the nesting season to determine fledging rates.

RESULTS

Table 1 lists collection sites. I observed a total of 33 Swainson's Hawk, six American Kestrel, and one Ferruginous Hawk nests with clutches. Six, four, and one addled eggs were collected at Swainson's Hawk, American Kestrel, and Ferruginous Hawk nests, respectively. Two carcasses of Swainson's Hawk nestlings were also collected. Overall, samples were relatively free of organochlorine residues (Table 2). All samples contained detectable but low levels of p,p'DDE. The 11 eggs collected contained a mean of 0.65 ppm p,p'DDE (range 0 to 2.9 ppm), but no detectable levels of p,p'DDD or p,p'DDT. Some samples also contained heptachlor epoxide, dieldrin, oxychlordane, and PCB; however, these compounds were present in only trace amounts.

A Swainson's Hawk egg collected in 1977 (sample 1-A-2) contained 5.2 ppm HCB. Residues of HCB occurred in two other Swainson's Hawk eggs in very low concentrations. No HCB was detected in the two nestling carcasses analyzed. Of the American Kestrel and Ferruginous Hawk eggs analyzed, only the American Kestrel eggs contained measurable amounts of HCB. Again only trace amounts were detected.

Table 2 also lists the clutch sizes, brood sizes, and fledging rates for nests from which samples were obtained. Clutch size at Swainson's Hawk nests ranged from two to three with a mean of 2.5 $\pm$ 0.2 ($\pm$ 1 S.E.) (n = 8) eggs per nest. Clutch size for both American Kestrel nests was five eggs per nest. Mean brood sizes of 1.5 $\pm$ 0.2 (n = 8) and 3.0 (n = 2) young per nest were observed at Swainson's Hawk and American Kestrel nests, respectively. The Ferruginous Hawk nest observed contained a clutch of four eggs and a brood of three young. Mean fledging success at Swainson's Hawk nests was 1.3 $\pm$ 0.2 (n = 8) young per nest. At American Kestrel nests the average was 1.5 (n = 2) young per nest. The Ferruginous Hawk nest failed to produce any young. Mean clutch size, brood size, and fledging rates for Swainson's Hawk nests from which samples were taken were similar to means obtained for all nests observed in 1977 and 1978 (n = 33). Mean clutch size, brood size, and fledging rates at all Swainson's Hawk nests were 2.7 $\pm$ 0.1 eggs per nest, 2.6 $\pm$ 0.1 young per nest, and 1.6 $\pm$ 0.1 young per nest, respectively. Comparisons of clutch size, brood size, and fledging rates with observed p,p'DDE and HCB residue levels did not indicate a relationship existed between nest productivity and contamination by either of these pesticides.

TABLE 1

Location of collection sites in southeastern Washington during 1977 and 1978

Sample Number	Species	Type of Sample	County	Location
1-A-1	Swainson's Hawk	egg	Whitman	8.4 km east, St. John
1-A-2	Swainson's Hawk	egg	Whitman	6.4 km south, Pullman
1-A-3	Swainson's Hawk	egg	Whitman	4.8 km southeast, Albion
1-A-4	Swainson's Hawk	carcass	Whitman	2.4 km northeast, Pullman
1-B-1	Ferruginous Hawk	egg	Whitman	6.4 km west, Riparia
1-C-1	American Kestrel	egg	Whitman	1.6 km east, Pullman
1-C-2	American Kestrel	egg	Whitman	1.6 km east, Pullman
1-C-3	American Kestrel	egg	Whitman	3.2 km south, Pullman
1-C-4	American Kestrel	egg	Whitman	3.2 km south, Pullman
2-A-1	Swainson's Hawk	egg	Garfield	2.4 km southeast, Central Ferry
2-A-2	Swainson's Hawk	egg	Garfield	19.3 km east, Central Ferry
2-A-3	Swainson's Hawk	carcass	Garfield	8.1 km south, Central Ferry
3-A-1	Swainson's Hawk	egg	Franklin	1.6 km south, Kahlotus

TABLE 2

Organochlorine residues in the eggs and tissues of raptors nesting in southeastern Washington. Clutch size, brood size, and fledging success are given for each nest.

Sample Number	p,p'DDE	HCB	Dieldrin	Heptachlor Epoxide	Oxychlordane	PCB	Clutch Size	Brood Size	Fledging Success
1-A-1	-	-	-	-	-	-	3	2	2
1-A-2	1.4*	5.2	0.18	0.35	0.07	-	3	2	2
1-A-3	2.9	0.11	0.08	-	-	0.11	2	1	1
1-A-4	0.17	-	0.15	1.55	0.56	-	3	3	2
1-B-1	0.16	-	-	-	-	-	4	3	0
1-C-1	0.16	0.09	-	-	-	-	5	3	0
1-C-2	0.14	0.07	-	-	-	-	5	3	0
1-C-3	0.15	0.08	-	-	-	-	5	3	3
1-C-4	0.17	0.08	-	-	-	-	5	3	3
2-A-1	0.20	-	-	-	-	-	3	2	1
2-A-2	1.20	-	0.09	0.08	-	-	2	1	1
2-A-3	0.53	-	-	-	-	-	2	2	0
3-A-1	0.68	-	-	0.11	-	-	2	1	1

- None detected

* All values in ppm corrected wet weight

DISCUSSION

Analysis of addled eggs and nestling carcasses collected in 1977 and 1978 showed Swainson's Hawk, American Kestrel, and possibly Ferruginous Hawk populations in southeastern Washington to be relatively free of contamination from organochlorine residues. Residues in Swainson's Hawk were not as high as anticipated. Due to its migratory nature (BROWN & AMADON 1968; HOUSTON 1968), it was expected that use of wintering grounds in South America sould increase the pesticide burden of this species (WHITE & CADE 1977). Residues of p,p'DDD and p,p'DDT were not detected in samples and only trace amounts of p,p'DDE were found. These levels were lower than those reported by HENNY & KAISER (1979) for Swainson's Hawk nesting in northeastern Oregon and southeastern Washington. Their study area also received DDT applications in 1974, yet Swainson's Hawk eggs were relatively free of contamination from p,p'DDT or any of its metabolites. The diet of Swainson's Hawk in southeastern Washington consists primarily of small rodents such as northern pocket gopher (Thomomys talpoides), deer mouse (Peromyscus maniculatus), and voles (Microtus spp.). Analyses of small mammal populations following the 1974 DDT application in southeastern Washington indicated that these animals accumulated neither p,p'DDT nor any of its metabolites within their tissues (ANONYMOUS 1975). This finding may explain the low levels observed in these Swainson's Hawk populations.

HCB occurred in 50% of the Swainson's Hawk and all the American Kestrel eggs analyzed. POELKER (1971) reported HCB contamination in American Kestrels and Short-eared Owls (Asio flammeus) collected in southeastern Washington during 1971. HCB in his samples ranged from 0.3 to 5.6 ppm. He analyzed prey species such as Ring-necked Pheasant (Phasianus colchicus), voles, and deer mice and found them to contain HCB in concentrations less than 1.0 ppm. These findings indicated that HCB could be picked up by raptors through their food. Little is known concerning the reproductive effects of HCB contamination. FLETCHER (1973) reported levels as high as 80 ppm were necessary for reproductive failures to occur in Japanese Quail. Low concentrations observed in this study did not indicate that HCB adversely affected the reproduction of either the three species studied.

Mean clutch size of Swainson's Hawks nesting in southeastern Washington was comparable to the mean of 2.5 eggs per nest reported by DUNKLE (1977) and Fitzner (1977) for populations nesting in Wyoming and southcentral Washington. Measurements of eggshell thickness were not made. HENNY & KAISER (1979) reported 6% thinning in Swainson's Hawk eggs in northeastern Oregon and southeastern Washington since 194 They concluded that this level of thinning was not sufficient to lower the reproductive potential of this species. Overall, mean brood size and fledging rates were similar to those reported by Dunkle and Fitzner who found mean brood sizes and fledging rates of 2.2 and 1.5 young per nest, respectively. CRAIGHEAD & CRAIGHEAD (1956) and SNOW (1974) have reported clutch sizes, brood sizes, and fledging rates similar to those I observed for American Kestrel and Ferruginous Hawk. Nests of all three species which failed to produce young did

not contain the highest levels of organochlorine residues among nests studied. Similarity of productivity parameters with published values together with the lack of a relationship between clutch size, egg hatchability, fledging rates, and pesticide residues indicated that pesticide contamination did not adversely affect the reproduction of any of these species.

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