Residues in Common Flicker and Mountain Bluebird Eggs One Year after a DDT Application

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ABSTRACT

Common flicker (Colaptes auratus) and mountain bluebird (Sialia currucoides) eggs were examined 1 year after DDT application and showed a marked difference. Residue levels in mountain bluebird eggs were approximately 10 times higher than in common flicker eggs (5.29 to 0.58 ppm wet weight). These differences can be explained by disparate dietary habits. The mean level in American kestrel (Falco sparverius) eggs collected in the spray area at the same time was 6.42 ppm wet weight.

INTRODUCTION

During June-July 1974, 426,159 acres of forested land were sprayed with DDT in northeastern Oregon, southeastern Washington, and adjacent Idaho to control Douglas-fir tussock moth (Orygia pseudotsugata). DDT (0.75 lb) mixed with 0.94 quart of auxiliary solvent and enough No. 2 fuel oil to make 1 gallon was sprayed from helicopters at approximately 0.75 lb DDT per acre. The spray was shut off over grassland openings of more than 2 acres (Rod Canutt, Monitoring Coordinator, pers. comm.) which may be important because many insectivorous bird species feed there.

In the fall of 1974 we established 300 nest boxes (slightly smaller than standard boxes for wood ducks [Aix sponsa]) in and adjacent to the spray area to attract nesting American kestrels (HENNY et al. 1976). Productivity, residue levels of DDT and its metabolites in eggs and blood sera, and eggshell thickness were monitored for the nesting raptor population in an attempt to evaluate the impact of the operational DDT spray program on non-target birds. However, several other species nested in the boxes including common flickers and mountain bluebirds, which are the subject of this report. Information is sparse concerning the impact of DDT on woodpeckers and passerine birds. Thus, in this report, we will compare the findings reported earlier for American kestrels (HENNY et al. 1976), with those from the common flicker and mountain bluebird. All eggs were collected in the same DDT spray area in 1975.

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METHODS

Eggs were collected 1 year after spraying from three areas: (1) from the spray area (treatment information), (2) 0.1 to 1 mile from spray area (adjacent area information), and (3) 10 or more miles from spray area (control information). One egg was taken at random from each clutch and analyzed for DDT and its metabolites. The nearest distance to the spray area (in 0.1-mile increments) was recorded for each sample collected. This data collecting design allowed us to relate differences in residue levels to distances away from the spray area. However, the number of common flicker eggs collected in the non-spray area was insufficient to permit a further subdivision (i.e., into "adjacent area" and "control"). Eggshell thickness was also measured for the common flickers, but not for the mountain bluebirds because of the small size of the eggs. Productivity rates for each clutch were not recorded--the primary emphasis of the study concerned raptors and time did not permit additional work on these species. The eggs were collected in northeastern Oregon and in northern Idaho.

Residue Analysis for Organochlorine Pesticides

The eggs of the flickers and bluebirds were analyzed for organochlorine pesticides by electron-capture (ECD) gas chromatography using the method of PETERSON et al. (1976). The lowest detectable limit was 0.03 ppm. No corrections were made for recovery. The Tracor 560 with two dissimilar 6-foot columns (OV-1 and QF-1) and Ni^{63} ECD was used. Residue levels in the eggs were adjusted for moisture loss by the procedure of STICKEL et al. (1973). The statistical test we utilized to compare residues in the spray area and non-spray area eggs was based on the exponential distribution. The exponential distribution is said to be long-tailed. For the assumptions, equation, and critical levels for rejecting the null hypothesis see the details in HENNY et al. (1976).

Eggshell Thickness Measurements

After the eggshells dried at room temperature for at least 6 months, we measured eggshell thickness using a Sterrett 1010 micrometer graduated in units of 0.01 mm. Four thickness measurements (including the membrane) were made at the equator of each egg and the mean value used.

RESULTS

Common Flicker

Residue levels of DDT and its metabolites were found in all common flicker eggs collected in 1975 but were relatively low (Table 1, Fig. 1). The residue statistics in Table 1 exclude 1 egg collected 27 miles from the spray area with a reported value of 2.38 ppm. This egg was collected the greatest distance from the

TABLE 1

Residue levels in ppm of DDT and its metabolites (wet weight) and eggshell thickness of common flicker eggs collected in 1975

Category	Spray area	Non-spray area[a]
Residue ppm		
Arithmetic mean	0.58	0.24
Geometric mean	0.53	0.18
Range	0.26-1.29	0.07-0.70
Eggshell thickness (mm)		
Arithmetic mean	0.146	0.145
Range	0.139-0.151	0.137-0.151
SE	0.001	0.002
n	12	8

[a]From +0.5 to 27 miles from spray area.

spray area and yet seemed to have twice the level of DDT and its metabolites as any egg from the spray area. It would greatly distort the observed range and all other statistics, and yet probably only represents an error in the chemistry laboratory or an added source of DDT away from the 1974 spray area. Residue levels in spray area eggs were 2 or 3 times higher than in non-spray area eggs ($P = 0.053$, one-tailed test). Furthermore, no evidence of eggshell thinning was found as the eggshell thickness was nearly identical in the spray area and non-spray area.

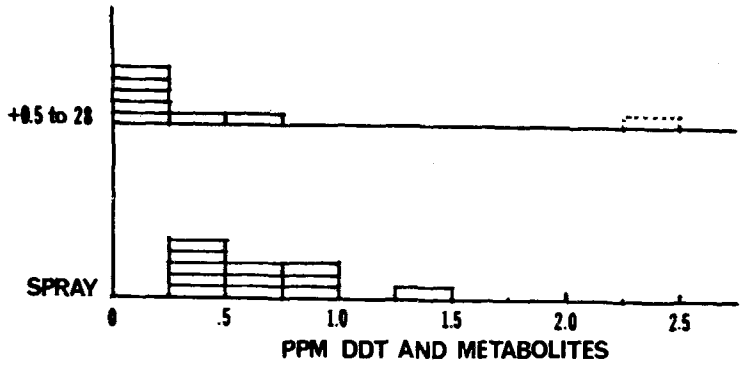

Fig. 1. Residue levels in common flicker eggs in 1975. Numbers on the ordinate refer to distance from the spray area that the eggs were collected (in miles). Each rectangle represents one egg from a different clutch.

Mountain Bluebird

As with the common flicker eggs, all mountain bluebird eggs contained residues of DDT and its metabolites. Background residues in the control area were 1.67 ppm (Table 2, Fig. 2). Within 1 mile of the spray area the residue levels were 2.61 ppm and increased to a mean of 5.29 ppm in the spray area. Residues in the spray area in 1975 were significantly higher than in the control area in 1975 (P = 0.010, one-tailed test).

TABLE 2

Residue levels in ppm of DDT and its metabolites (wet weight) in mountain bluebird eggs collected in 1975

Category	Spray area	Distance from spray area (miles) +0.1 to 1.0	16 to 50
Residue ppm			
Arithmetic mean	5.29	2.61	1.67
Geometric mean	4.28	2.16	1.12
Range	1.20-16.2	1.15-5.39	0.27-5.08
n	19	6	10

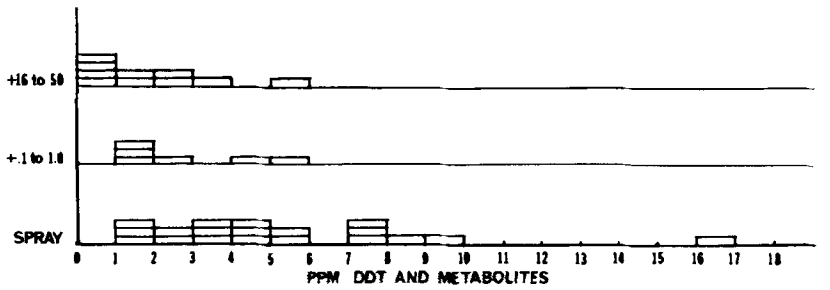

Fig. 2. Residue levels in mountain bluebird eggs in 1975. Numbers on the ordinate refer to distance from the spray area that the eggs were collected (in miles). Each rectangle represents one egg from a different clutch.

DISCUSSION

We must view both the spray and non-spray area residue levels reported from this study in terms of several avian population characteristics. Probably among the most important population characteristics to review are: (1) migratory characteristics (i.e., where do the birds winter? do both species share a common wintering area?), (2) food habits (i.e., do both species have similar diets?), and (3) nesting territory size (i.e., are the nesting territories sufficiently small so that we can be sure the spray area birds were remaining within the spray area?).

Migratory Characteristics

According to ROBBINS et al. (1966) both the common flicker and mountain bluebird are migratory in portions of their breeding range. An evaluation of common flicker bandings (April-September) from eastern Washington, eastern Oregon, and Idaho showed only four recoveries between October and March. Two birds showed no movement while the other two (50 percent) migrated to California (Modesto-Stockton, and Los Angeles). No information on mountain bluebird movement from the Pacific Northwest was available in the banding files. However, observations of mountain bluebirds in the spray area during the winter are rare, with an influx of birds arriving in early spring (Ralph Anderson, pers. comm.).

Food Habits

The difference in amounts of pesticide residues in common flicker and mountain bluebird eggs may be explained by their disparate diets (Table 3). Approximately 50 to 70 percent of the common flicker diet consists of animal food, while over 90 percent of the mountain bluebird diet is animal matter. Furthermore, ants are the dominant food item in the diet of the common flicker, whereas beetles, grasshoppers, locusts, and crickets are most important for the mountain bluebird. We suspect that the animal matter in the diet of the flicker is less contaminated with DDT. The lower contamination may result from ants being less exposed to DDT, or the ants being less capable of storing DDT in their bodies. Furthermore, pesticides are not concentrated in vegetable matter like they can be in animal matter and a relatively high percentage of the flicker diet is vegetable matter.

Nesting Territory Size

Information is scarce on the size of nesting territories for the common flicker and mountain bluebird. SHERMAN (1952) reported flickers moving over one-half mile, and LAWRENCE (1967) stated that her findings were in agreement with those of Sherman. POWER (1966) noted the smallest territory for the mountain bluebird was approximately 100 yards wide, while other territories had no clear boundaries at all, and the resident bluebirds occasionally flew up to one-quarter mile from their nests.

TABLE 3

Food habits of the common flicker and mountain bluebird

Species	Location	No. stomachs analyzed	Animal food	Vegetable food	Primary animal food	Authority
Common flicker	Eastern U. S.	684	60.9%	39.1%	Ants (49.8%)[a]	Beal (1911)
Common flicker	Western U. S.	183	67.7%	32.3%	Ants (53.8%)[a]	Beal (1911)
Common flicker	Oregon	62	52.1%	44.6%[b]	Ants (40.3%)	Neff (1928)
Mountain bluebird	Western U. S.	66	91.6%	8.4%	Beetles (30.1%)[c]	Beal (1915)

[a]A large proportion of the ants eaten are of species that live in the earth. Orthoptera (grasshoppers, crickets, and cockroaches) amounted to only 2.4% in the East and 1.5% in the West.

[b]Dirt and rubbish amounted to 3.3% of the stomach contents.

[c]Orthoptera (grasshoppers, locusts, crickets) 23%, ants 12.5%, weevils 8.1%.

In summary it appears that the flicker may move up to one-half mile from the nest, while the mountain bluebird may move about half that distance (one-quarter mile). Therefore, it is doubtful that many of the flickers nesting in the non-spray area (only two nests within a mile of the spray area) were spending much time in the spray area. In contrast, some "adjacent area" (between 0.1 and 1 mile from the spray area) bluebirds were probably spending a portion of the time in the spray area and the elevated residue levels point to that conclusion. Spray drift, of course, could also contribute to adjacent area eggs containing elevated residue levels.

CONCLUSIONS

At least portions of both the mountain bluebird and common flicker populations leave the spray area during the winter. Furthermore, both species have relatively small nesting territories (i.e., eggs laid within the spray area would be from birds spending most of their time in the spray area). Therefore, we conclude that the residue concentration in eggs of the two species is primarily related to their differing food habits. Residues in the common flicker eggs increased from 0.24 in the non-spray area to 0.58 ppm (an increase of 0.34 ppm), while residues in the mountain bluebird eggs increased from 1.67 ppm to 5.29 ppm (an increase of 3.62 ppm). It should be pointed out here that residue levels in eggs of the American kestrel, in the same spray area, were quite similar to those in mountain bluebird eggs, i.e., 6.42 and 5.29 ppm (see HENNY et al. 1976). This finding is not entirely unexpected in view of the similarity in summer food habits of the two species (FISHER 1893, GRINNELL and STORER 1924).

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