EFFECTS ON FISH AND WILDLIFE OF HEPTACHLOR APPLIED TO ERADICATE THE SUGARCANE ROOT WEEVIL IN APOPKA, FLORIDA

by

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ABSTRACT

A USDA program to eradicate the introduced sugarcane root weevil in the spring of 1969 was studied to assess effects on fish and wildlife. Two basic techniques were utilized: analyses of residue accumulations in selected species, and search for dead animals. Residues increased substantially in birds but not in earthworms, fishes, or aquatic invertebrates. Considerable bird mortality followed treatment and residues in specimens analyzed indicated death from heptachlor poisoning.

INTRODUCTION

In January 1969 the U. S. Department of Agriculture announced plans to treat approximately 800 acres within the city limits of Apopka, Florida, with heptachlor at the rate of 3 pounds per acre. The treatment was part of an effort to eradicate the Puerto Rican sugarcane root weevil from the local area where it had become established. Treatment of a larger area outside of the city limits had just been completed by the Florida Division of Plant Industry.

The Bureau of Sport Fisheries and Wildlife became interested in the treatment because a persistent chemical was being used at a rather high application rate in an urban area. Reports of bird and fish mortality had already been received from the area treated by the State. Previous studies of heptachlor applications at rates of less than 3 pounds per acre indicated that extensive bird mortality was likely (Baker, 1958; Ferguson, 1964; Glasgow, 1956; Kreitzer and Spann, 1968; Lay, 1958; Rosene, 1958; Rosene, Stewart, and Adomaitis, 1961; Rosene, 1965; Smith and Glasgow, 1963; Stickel, Hayne, and Stickel, 1965).

The only fish habitat in the treatment area was a small 13-acre lake which serves as the city water supply. Special precautions were planned to prevent the chemical from entering the water, but effectiveness of these measures and potential residue accumulation through the food chain were of interest.

METHODS

Limitations of funds and manpower made it impossible to attempt an intensive study of the effects of heptachlor applications. Methods employed were selected to give the greatest amount of information with a minimum investment of time and funds. Two basic study techniques were employed—residue analysis and carcass search.

Residue Analysis.

Table 1 summarizes samples that were collected for residue analysis.

The English sparrow was selected as a monitoring species because it is resident, has a small home range, eats both seeds and insects, is easily collected, and is a nonprotected bird. Specimens were collected by shooting. Brains and

TABLE 1

ANIMALS COLLECTED FOR RESIDUE ANALYSIS

Sample	Species	Amount in Sample	Dates Collected	
			Pretreatment	Posttreatment
Birds	English sparrow *(Passer domesticus)*	Pool of 10 birds	2-18 & 19-69	4-9-69
Earthworms	Unknown	½ cup	2-19-69	5-20-69
Forage fish	Bluegill *(Lepomis macrochirus)*	5 fish	2-18 & 19-69	4-8-69
Predator fish	Largemouth Bass *(Micropterus salmoides)*	4 fish	Not Analyzed	4-8-69
Aquatic invertebrates	Snails *(Pomacea)*, Aquatic insects	¼ cup	2-18 & 19-69	4-8-69

carcasses (without skin, feet, head, or entrails) were pooled separately and analyzed.

Earthworm samples were collected by digging in a vacant lot. Gillnets, dipnets, and angling were used to collect fish and aquatic invertebrates from the small lake.

The U. S. Department of Agriculture began treatment on March 20, 1969, using ground equipment to apply 10 percent granules at a rate of 30 pounds per acre. With the exception of certain sensitive areas, the entire ground surface, even under shrubbery, was treated. A jeep-mounted buffalo turbine spreader was used except in yards, gardens, and other inaccessible areas where a hand spreader was required. Sensitive areas not treated included school grounds, hospital grounds, and the lake with a ½-block buffer zone around it.

Our first posttreatment visit to the area was 20 days after treatment began. Samples of sparrows, fish, and aquatic invertebrates were collected. Collection of the earthworm sample was delayed until 60 days posttreatment to allow time for the chemical to enter the soil.

Carcass Search

In planning the search for birds that might be killed by the treatment, several handicaps were quickly apparent. Treatment was to span a period of about 4 weeks. Birds exposed in a treated area might die anywhere, in a treated or untreated area. Flies were attracted to dead birds within minutes after death, and within 2 days maggots made the specimens unsuitable for analysis. Other work obligations permitted only short and infrequent visits to the area. Bird mortality tends to be greatest following the first rain after granular applications, and day-to-day observations were not possible.

Since residential areas were being treated, it was hoped that people would cooperate by reporting dead birds. A short mimeographed leaflet was prepared, explaining that birds might be killed by the treatment and asking that they be picked up, frozen, and turned over to the local Wildlife Ranger. The leaflets were distributed by the State Agriculture Department to landowners as they were contacted for permission to treat their property.

This seemingly workable technique for collecting dead birds proved unsuccessful. Although a great many landowners were reached, only two dead birds and a bantam chicken were turned in. At least one resident was interviewed who told of finding birds that he did not make any effort to preserve or report.

Carcass searches were confined mostly to citrus groves. These were heavily utilized by birds, were easily searched, and did not require a great amount of time for talking to landowners to explain our activity.

The Wisconsin Alumni Research Foundation performed all the analyses for heptachlor, heptachlor epoxide, and any other insecticide which could be determined on the same run. We also asked for a measurement of lipids in each sample.

RESULTS AND DISCUSSION

Residue Analysis.

Results of pre- and posttreatment monitoring samples are shown in Table 2. Heptachlor epoxide increased tenfold in sparrow brains, and over fortyfold in sparrow carcasses following treatment. This is quite a significant increase, especially since it represents average residues in a pool of 10 birds. Also, the treatment had begun only 20 days before and was only two-thirds complete. There was no way of knowing how much time any of the birds had spent in treated areas.

Marked decreases in residues of DDT and its metabolities in the posttreatment sparrow samples contrast with heptachlor epoxide increases. There is no known explanation for this decrease and it is likely not significant.

The posttreatment residue level of 1.69 p.p.m. heptachlor epoxide in sparrow carcasses is sufficient to make them unfit as food for raptors. The average carcass level in dead birds analyzed in this study was 6.91 p.p.m. (Table 3), and this is only 4.09 times the 1.69 p.p.m. found in the sparrow pool. A slight biomagnification in predators could bring these residues to dangerous levels.

Heptachlor epoxide levels in earthworms increased only slightly, from 0.01 to 0.04 p.p.m. This is surprisingly low for the 3-pound per acre application. The posttreatment sample was collected 60 days after treatment began, but this could have been as little as 30 days after the field itself was treated. It is possible that levels would have increased with time, or it may have been that weather had not favored worm work at the soil surface.

Heptachlor epoxide levels in the samples of fish and aquatic invertebrates did not change significantly after treatment. This may indicate that the measures taken to avoid contamination of the lake were adequate. Since movement of the chemical into the aquatic food chain might take considerably longer than the sample period, additional samples would be needed to verify this conclusion.

Carcass Search.

From a study of penned quail, Kreitzer and Spann (1968) found that the most serious bird mortality occurred in the 15 days immediately following heptachlor treatment. Since the Apopka treatment spanned a period of 32 days, it could be presumed that freshly treated areas presented the most serious hazard to birds for a period of 47 days.

Our first posttreatment visit to the area was on the 20th day after treatment began. Although bird mortality was not spectacular, it was not difficult to find dead birds. In one citrus grove which had been treated 10-14 days, we found the remains of 12 birds. Recognizable remains included those of 1 starling *(Sturnus vulgaris)*, 5 ground doves *(Columbigallina passerina)*, 1 robin *(Turdus migratorius)*, and 1 brown thrasher *(Toxostoma rufum)*. In another grove we found 2 English sparrows, 1 brown thrasher, and a blue jay *(Cyanocitta cristata)*.

TABLE 2

INSECTICIDE RESIDUES IN PRE- AND POSTTREATMENT SAMPLES OF ANIMALS COLLECTED FROM THE TREATMENT AREA

Species Sampled	Collected	% Fat	PPM Insecticide		
			DDT-DDE-DDD	Dieldrin	Heptachlor Epoxide
Pool of 10 sparrow brains	Pretreatment	5.08	.88	.02	.05
	Posttreatment	5.47	.29	.01	.53
Pool of 10 sparrow carcasses	Pretreatment	3.08	1.65	.04	.04
	Posttreatment	3.84	.94	.09	1.69
Pool of forage fish	Pretreatment	3.45	1.87	.18	.04
	Posttreatment	3.85	1.32	.08	.04
Pool of predator fish	Pretreatment	-	-	-	-
	Posttreatment	1.70	1.64	.08	.02
Pool of earthworms	Pretreatment	.96	.09	.01	.01
	Posttreatment	.63	.08	Trace	.04
Pool of aquatic invertebrates	Pretreatment	1.76	.22	.05	.03
	Posttreatment	.36	.02	Trace	.00

TABLE 3

INSECTICIDE RESIDUES IN DEAD BIRDS FOUND ON THE TREATMENT AREA AFTER TREATMENT

Species	Tissue	% Fat	PPM Insecticide		
			DDT-DDE-DDD	Dieldrin	Heptachlor Epoxide
Grackle*	Brain	5.12	1.33	1.34	.62
	Carcass	1.20	1.00	.28	.58
Starling	Carcass	1.45	10.36	5.97	5.26
English Sparrow	Brain	5.11	2.81	.39	13.50
	Carcass	.83	2.19	.32	8.74
Blue Jay	Brain	4.75	2.86	.56	9.25
	Carcass	.88	2.81	.64	7.14
Blue Jay	Carcass	1.61	3.67	.36	6.23
Mockingbird	Brain	4.54	1.25	.96	5.31
	Carcass	.79	1.03	.14	2.61
Mockingbird	Brain	3.90	3.50	2.26	12.30
	Carcass	1.26	3.40	1.89	11.50

*This bird was found incapacitated, but still alive.

No attempt was made to estimate total bird mortality, nor to relate bird mortality on a particular grove with the date it was treated. Birds could range freely between treated and untreated groves and might die anywhere. However, we did attempt to follow mortality in one grove first searched on the day after it was treated. On this date we observed a covey of quail *(Colinus virginianus)*, 2 mockingbirds *(Mimus polyglottos)*, 2 blue jays, 2 ground doves, 3 mourning doves *(Zenaidura macroura)*, and several sparrows. We searched intensively for nests without success. The pair of mockingbirds appeared to have established a territory and may have had a nest nearby. We noted dying insects and that some of the birds were obviously feeding on them.

On the seventh day following treatment of this same grove, a search yielded two dead mockingbirds and an unidentified pile of feathers. The mockingbirds were very likely those observed on the day following treatment. Because there had been no rain since treatment, this indicated heptachlor was ingested with contaminated food rather than by drinking from contaminated puddles.

On the 16th day following treatment, another search of the grove yielded one dead blue jay. On the 44th day after treatment, a dead mourning dove and a disabled grackle *(Quiscalus quiscula)* were found.

A total of only seven birds suitable for residue analysis were found after treatment was started. Others that appeared suitable were collected, but had to be discarded because they were filled with maggots. A brown thrasher and a bantam chicken were received too late to be analyzed with the others, but it subsequently developed that they had come from the area treated by the State. Approximately 8 man-hours were spent in searching for dead birds on the first posttreatment visit to the area. Three subsequent visits were incidental to other travel, and search was mostly restricted to the single grove already mentioned. Specimens were prepared for analysis by skinning and removal of feet, wings, and entrails.

On April 23, two days after all heptachlor treatment was completed, four dead fish were observed floating on the small lake. A ½-inch rain had fallen 5 days earlier. The two bream, one bass, and one sucker were all small and were too decayed for residue analysis. This was the only fish mortality observed, and it may have had no relation to the insecticide treatments.

Analyses of six dead birds and one disabled grackle collected following treatment are shown in Table 3. Laboratory data are not available on lethal levels of heptachlor epoxide in birds. However, dieldrin residues have been studied, and it appears that lethal brain residues of heptachlor are very much like those of dieldrin. Both dieldrin and heptachlor are cyclodiene insecticides and there is reason to believe that their effect is additive. Even without considering the effect of dieldrin, it appears that the heptachlor epoxide residues are sufficient to have caused death in all the birds which were found dead.

CONCLUSIONS

From the results of the study, we conclude the following:

1. Heptachlor epoxide residues in birds inereased markedly following treatment.
2. No increase of heptachlor epoxide was detected in fishes or aquatic invertebrates from the lake.
3. Substantial bird mortality followed treatment.
4. Residues of heptachlor epoxide in dead birds analyzed indicated death from heptachlor poisoning.

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