Bull. Environ. Contam. Toxicol. (1990) 45:697–702

Environmental Contamination and Toxicology

Pesticide and PCB Residues for Loggerhead Shrikes in the Shenandoah Valley, Virginia, 1985–88

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The decline in loggerhead shrike (Lanius ludovicianus) populations is widespread and coincides with the use of organochlorines that began in the late 1940's and increased until the 1970's (Morrison 1981; Robbins et al. 1986; Tate 1986). An inhabitant of farmland areas, loggerhead shrikes prey on invertebrates and small vertebrates (Bent 1950), and thus risk exposure to pesticides and other agricultural chemicals. The role of contaminants in the decline of loggerhead shrikes has only been partially assessed (Busbee 1977; Anderson and Duzan 1978; Morrison 1979; Rudd et al. 1981).

Studies of the nesting and winter ecology of loggerhead shrikes (Luukkonen 1987; Blumton 1989) during 1985-88 in the Shenandoah Valley, Virginia provided the opportunity to collect eggs and carcasses for contaminant residue analysis. In this paper we provide pesticide and polychlorinated biphenyl (PCB) residue data for eggs and carcasses collected.

MATERIALS AND METHODS

From 1985 through 1987 we removed eggs from 8 nests that had been abandoned during the incubation stage or had failed to hatch. The nests were located in Highland, Augusta, Rockingham and Shenandoah counties in northwest Virginia. The egg contents from each nest were combined and placed in acetone-rinsed glass jars, then frozen and stored at -20 C before chemical analysis.

Egg contents collected in 1985-86 (n=18) were shipped to Weyerhauser Analytical and Testing Services, Tacoma,

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Washington for chemical residue analysis under quality assurance from Patuxent Wildlife Research Center, Laurel, Maryland. Egg samples were homogenized, extracted in a Soxhlet apparatus, and cleaned on a Florisil column. Pesticides and PCBs were fractionated on a Silicar column (Cromartie et al. 1975). Samples were analyzed on a Hewlett-Packard 5880A gas chromatograph (GC) equipped with dual capillary column/dual electron-capture detectors (ECD) used for organochlorine and PCB analysis. Residue confirmation on the sample containing 26.00 ppm pp'-DDE was done using GC/mass spectrometry.

Eggs collected in 1987 (n=12) were sent to the Pesticide Residue Lab, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Egg contents were analyzed for pesticides and PCBs using procedure described by Bertuzzi et al. (1967). Thawed samples were homogenized, extracted on a Polytron Ultrasonic Generator Model PCU-1 using 65% acetonitrile/water. The pesticides were extracted from the acetonitrile/water using petroleum ether (PE) liquid/liquid partitoning with sample clean-up on a Florisil column. The samples were eluted from the Florisil column with 6% ethyl ether (EE)/PE, 15% EE/PE and 50% EE/PE, respectively. Egg contents were analyzed, on a wet weight basis, using a Tracor 540 GC equipped with ECD and 1219 mm x 2 mm glass column packed with 5% OV-101 on 80/100 mesh Supelcoport.

Seven shrikes, equipped with radio transmitters, died between October 1987 and March 1988 in Augusta and Rockingham counties. Specimens were taken to The Wildlife Center of Virginia, Weyers Cave, Virginia, and necropsies were performed. Histological examinations were performed at John Hopkins University Medical School, Department of Comparative Medicine, Baltimore, Maryland.

Following necropsy, liver, kidney, and brain were removed and placed in individually labeled polyethylene bags and frozen. Pesticide analyses, using procedure described by Bertuzzi et al. (1967), were conducted by the Pesticide Residue Lab, Blacksburg, Virginia. Tissues from birds were analyzed using a Tracor 540 equipped with ECD and 1829 mm x 4 mm column packed with 1.5% SP-2250/1.95% SP-2401 on 100/120 mesh Supelcoport. Samples were analyzed for carbofuran using a Tracor 540 GC equipped with a 1.5% OV-17/1.95% OV-210 column on 100/120 mesh Chromosorb. All results are reported in parts per million (ppm) wet weight.

RESULTS AND DISCUSSION

Oxychlordane and pp'-DDE were present in all samples (Table 1). Residues of pp'-DDE varied almost 600% between the 8 clutches: 26.00, 2.30, 1.63, 1.40, 1.24, 0.57, 0.55, and 0.46 ppm. The highest pp'-DDE residue (26.00 ppm) was detected in a 5-egg clutch abandoned less than 7 days after laying in Augusta County, in 1985. Anderson and Duzan (1978) collected 104 shrike eggs in southern Illinois and reported pp'-DDE residues averaging 3.09 ppm; one clutch had a mean of 17.00 ppm. The authors concluded that eggshell thickness had been adversely affected by pp'-DDE residues.

In our study, 63% of the samples contained detectable residues of heptachlor epoxide, pp'-DDD, methoxychlor, dieldrin, hexachlorobenzene, mirex, trans-nonachlor, and PCB (arochlor 1260, Table 1). Except for PCB, residue levels were below 0.12 ppm. Eggs collected in 1985 and 1986 contained levels of PCB ranging from 0.24 to 1.30; however, PCB was not detected in samples collected in 1987. This may reflect differences in analytical laboratories or actually show a decrease in PCB concentrations.

Necropsies of 7 loggerhead shrikes found no abnormalities that would suggest pesticide or PCB contamination. Mortalities were attributed to collisions with automobiles (n=4), predation by raptors (n=2), and complications caused by radio transmitter attachment (n=1). Histological results were consistent with necropsy conclusions.

Residues of pp'-DDE occurred in all carcass samples (Table 1). An adult male contained 0.07 ppm and 6 subadults contained 2.03, 0.81, 0.33, 0.09, 0.06, and 0.03 ppm. Anderson and Duzan (1978) showed median concentrations of 13.88 ppm pp'-DDE to be present in 88% of 69 shrikes examined from southern Illinois. When samples of fat were analyzed from birds collected during September and January the median level pp'-DDE detected for 7 adult females was 2.38 ppm (range <0.01-66.60), 10 adult males contained 3.31 ppm (range <0.01-28.57), and 3 subadults contained <0.01 ppm (range <0.01-33.33). However, higher levels of pp'-DDE were detected in shrikes collected during April and July (local breeders and their young); 23 adult females contained 15.00 ppm (range 3.07-75.00), 18 adult males contained 26.39 ppm (range <0.01-150.00), and 8 subadults contained 9.25 ppm (range 5.45-33.33). These results show that Illinois breeders may be obtaining most of their DDE body burden south of Illinois on their wintering areas.

Table 1. Residues of organochlorine, organophosphate, and carbamate pesticides and PCB in eggs from 8 clutches[1] and tissue samples[2] from 7 loggerhead shrikes from the Shenandoah Valley, VA, 1985-88.

Compound	Residues, ppm wet weight					
	Eggs			Birds		
	Percent freq. of detection	Median[3]	Range	Percent freq. of detection	Median	Range
ORGANOCHLORINES						
oxychlordane	100	0.06	0.02-0.10	57	0.03	0.01-0.05
op-DDE	38	0.04	0.02-0.05	86	0.09	0.02-0.25
pp-DDE	100	1.37	0.46-26.00	100	0.09	0.06-2.03
op-DDT	25	0.03	0.02-0.04	71	0.03	0.01-0.21
pp-DDT	50	0.10	0.05-0.43	57	0.04	0.01-0.29
pp-DDD	63	0.05	0.01-0.11	0		
heptachlor	13	0.01		29	0.01	
heptachlor epoxide	63	0.02	0.01-0.03	29	0.01	
methoxychlor	63	0.07	0.01-0.10	0		
endrin	13	0.02		14	0.04	
dieldrin	63	0.02	0.01-0.05	14	0.01	
hexachlorobenzene	63	0.02	0.01-0.03	14	0.01	
mirex	63	0.04	0.01-0.04	71	0.12	0.02-0.14
lindane	38	0.02	0.01-0.04	86	0.02	0.01-0.08
cis-nonachlor	50	0.01		0		
trans-nonachlor	63	0.02	0.01-0.02	0		
alpha chlordane	0			14	0.02	
beta chlordene	0			14	0.08	
cis-chlordane	13	0.01		0		
trans-chlordane	25	0.01		0		
ORGANOPHOSPHATES						
dursban	0			29	0.02	0.01-0.03
diazinon	0			29	0.15	0.09-0.20
ethyl parathion	0			43	0.20	0.18-0.23
CARBAMATES						
carbofuran	0			14	0.64	
PCB						
arochlor 1260	63	0.94	0.24-1.30	0		

[1]Clutch = 2 to 6 eggs (mean = 3.75 eggs)
[2]Tissues = kidney, liver, and brain
[3]Median is based on detectable residue samples (≥0.005 ppm wet weight

Other organochlorines detected in the order of percent frequency were; op'-DDE, lindane, op'-DDT, mirex, oxychlordane, and pp'-DDT. The frequency of detection for other compounds was less than 50%. Organophosphates were detected in 43% of the tissue samples (Table 1).

Twelve of 18 (67%) organochlorines detected in eggs occurred in bird tissue samples (Table 1). However, there was no significant relationship between residue levels in eggs and bird tissues (Spearman rank correlation,

r=0.31, P=0.1906). This may be due to the fact that egg clutches were not analyzed from the same nests of birds analyzed.

In this study, loggerhead shrikes contained appreciable levels of pesticide residues; the pp'-DDE level in one clutch was critically high. The effects of contamination on this species, as well as other wildlife, is unclear, primarily because the pesticide concentrations required to reduce populations are unknown. Loggerhead shrike populations in Virginia have declined to a level that has justified this species being added to the State Endangered Species List in 1987.

Acknowledgments. The authors thank K. Finnegan and E. Atkinson for field assistance, and J. Simonds and J. Burroughs for lab assistance. We also thank R. Halbrook for his useful comments on earlier drafts of this manuscript. Financial support was provided by Virginia Polytechnic Institute and State University, the Virginia Department of Game and Inland Fisheries, the U.S. Fish and Wildlife Service, the Bailey Research Trust, and the Rockingham Bird Club.

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Received September 20, 1989; accepted February 2, 1990.