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Organochloride Pesticides Present in Animal Fur, Soil, and Streambed in an Agricultural Region of Southeastern Arkansas

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Running Title: Organochloride Pesticide Residues in Southeastern Arkansas

Abstract

Animals in agricultural settings may be subject to bioaccumulation of toxins. For the last several years, we collected hair samples from bats and rodents in an agricultural area near Bayou Bartholomew in Drew County, Arkansas. Samples were submitted to the Center of Environmental Sciences and Engineering at the University of Connecticut for wide-screen toxin analysis. Several of these samples contained measurable amounts of organochloride pesticides or their metabolites, including some that have been banned for decades, such as dichlorodiphenyltrichloroethane (DDT) and chlordane. In addition, we collected several samples of soil from within an agricultural field, from adjacent edge habitat, from alongside the bank of the Bayou, and from the bed of the Bayou itself. Although none of these samples tested positive for DDT or chlordane, all of the samples except one contained measurable amounts of metabolites from these pesticides. This study raises questions about environmental persistence of DDT/DDE and other organochlorides. There may be risks to wildlife populations that warrant further investigations into effects of long-term exposure to these toxins.

Introduction

Toxic heavy metals and agricultural chemicals are being found in soil and water and pose serious human health and wildlife risks (USEPA 1997). Bats have been demonstrated to be prone to high levels of toxins in some agricultural regions (Geluso *et al.* 1976). This study is part of a longer-term study that will focus on recent evidence that suggests a connection between toxins in bats and susceptibility to WNS (Kannan *et al.* 2010). However, our investigation has led us to consider the possibility that agricultural toxins may be spread through entire landscapes. Herein we report the results of our research so far.

Materials and Methods

Our original focus was on a colony of Rafinesque's big-eared bats (*Corynorhinus rafinesquii*). This bat roosts in abandoned buildings, caves, hollow trees, and under bridges across the southeastern United States (Jones 1977; Trousdale and Beckett 2004). We were made aware of a maternity colony of over 100 individuals roosting in the Taylor House, an abandoned antebellum building located at the edge of an agricultural field adjacent to Bayou Bartholomew in Drew County, Arkansas. We noticed that the agricultural field was routinely being crop-dusted, and grew concerned about the potential impacts to local wildlife.

During the summer of 2014, we began monitoring this colony as part of a project to determine possible effects of agricultural chemicals on the bats. We collected 10 Rafinesque's big-eared bats and took blood and hair samples from each. In addition, we collected a hispid cotton rat (*Sigmodon hispidus*) and obtained blood and hair samples. All animals were released unharmed at the site of capture. Samples were sent to the Center for Environmental Sciences and Engineering (CESE) at the University of Connecticut for wide-screen toxin analysis.

Our preliminary results led us to begin testing other mammals in the vicinity. We found traces of agricultural chemicals in these animals, and decided to again broaden our survey, but because we detected chemicals only in hair samples, we no longer collected blood. In 2015, we collected 7 white-footed deermice (*Peromyscus leucopus*) by Sherman trap. Hair samples were collected and submitted for wide-screen toxin analysis at CESE. The animals were released at the point of capture. Results of the analyses again led us to broaden the scope of our investigations.

In 2016, we captured two specimens of marsh oryzomys (*Oryzomys palustris*) and one hispid cotton rat by Sherman trap and collected hair samples from

each. All rodents were released unharmed at the point of capture. Additionally, we collected a hair sample from a coyote (*Canis latrans*) pup killed on the highway nearby, and collected a blue jay (*Cyanocitta cristata*) feather from the ground at the study site. We also collected water from Bayou Bartholomew, soil from the edge of the Bayou, soil from a point away from the bank but still within the flood plain of the Bayou, and from points within and near an agricultural field adjacent to the Bayou and the Taylor House. All samples were sent to CESE for wide-screen toxin analysis.

Results and Discussion

In 2014, 2 of 10 hair samples from Rafinesque's big-eared bats and the hair sample from the hispid cotton rat contained measurable traces of 4,4-DDT, a pesticide which has been banned since the 1970s, or 4,4-DDE, a metabolite of DDT (Table 1). In 2015, 1 of the 7 hair samples taken from white-footed deermice tested positive for 4,4-DDD, another metabolite of DDT. Another of the 7 contained measurable traces of trans-nonachlor, a component of the pesticide chlordane, which was banned in 1988. In 2016, all 5 environmental samples and 4 of the 5 samples taken from wildlife contained measurable traces of 4,4-DDE. Three of the environmental sites also contained 4,4-DDD. Various samples also contained the banned pesticide heptachlor or its product heptachlor epoxide, cis-nonachlor, a product of chlordane, and the banned pesticides hexachlorobenzene and aldrin.

DDT was banned from general use in the United States in 1972 (USEPA 1990). It is considered to be a persistent pesticide, with a half-life of approximately 3 years, and a 95% disappearance period of 10 years (Brown 1978). Levels that we detected in the environment are not inconsistent with these data, and are comparable to many previous studies (Edwards 1973).

Table 1. Concentration of pesticide residues detected in various samples collected around the Taylor House, Drew County, Arkansas. All concentrations are in parts per billion.

Year	Sample No.	Species and Samples	4,4 DDE	4,4 DDT	4,4 DDD	Trans-nonachlor	Heprachlor epoxide	Trans (gamma)-chlordane	1,2,4,5 tetrachlorobenzene	Hexachlororbenzene	Heptachlor	Aldrin	Cis-nonachlor
2014	3A	*Corynorhinus rafinesquii*	14545.0										
	5A	*Corynorhinus rafinesquii*		3929.0									
	15A	*Sigmodon hispidus*	5323.0										
2015	18	*Peromyscus leucopus*			629.0								
	20	*Peromyscus leucopus*				647.0							
2016	117	*Oryzomys palustris*	87.0				43.5	87.0					
	118	*Sigmodon hispidus*	100.0				60.0		40.0				
	120	*Cyanocitta cristata*	12.8							5.1			
	121	*Canis latrans*	10.7						1.8				
	1	Bayou water	5.7		0.9						15.5	8.3	5.7
	2	Edge of bayou	4.6										
	3	Bayou floodplain	7.5		1.9		4.8						
	4	Trapline	2.5		0.7						21.2		
	5	Cornfield	9.0				0.2		0.7				

However, levels of DDT and its metabolites that we observed in mammals are greater than some that were reported in studies that occurred before the substances were banned (e.g., Korschgen 1970). Very few recent studies have examined residual organochlorines on an ecosystem level, although at least one (Femmer *et al.* 2004) found detectable amounts of some of the same chemicals as in this study in tissues of fish collected in Arkansas and surrounding states. Our sample sizes are small (due to the expense of analysis), but we believe they suggest the utility of further study, especially given the propensity of these pesticides to biomagnification and possible risk to health of wildlife and humans (Snedeker 2001).

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Literature Cited

Brown AWA. 1978. Ecology of pesticides. J Wiley (New York, NY). 525 p.

Edwards CA. 1973. Persistent pesticides in the environment. 2nd ed. CRC Press (Boca Raton FL). 170 p.

Fenner SR, RH Coupe, BG Justus, and **BA Kleiss.** 2004. Concentrations of selected organochlorine compounds in fish tissue in the Mississippi Embayment Study Unit: Arkansas, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee, 1995-99. U. S. Geological Survey Scientific Investigations Report 2004-5006. 36 p.

Geluso KN, JS Altenbach, and **DE Wilson.** 1976. Bat mortality, pesticide poisoning and migratory stress. Science 194:184-186.

Jones C. 1977. *Plecotus rafinesquii.* Mammalian Species 69:1-4.

Kannan K, SH Yun, RJ Rudd, and **M Behr.** 2010. High concentrations of persistent organic pollutants including PCBs, DDT, PBDEs and PFOS in little brown bats with white-nose syndrome in New York, USA. Chemosphere 80:613-618.

Korschgen LJ. 1970. Soil-food-chain-pesticide wildlife relationships in Aldrin-treated fields. The Journal of Wildlife Management 34:186-199.

Snedeker SM. 2001. Pesticides and breast cancer risk: a review of DDT, DDE, and Dieldrin. Environmental Health Perspectives 109 Supplement 1:35-47.

Trousdale AW and **DC Beckett.** 2004. Seasonal use of bridges by Rafinesque's big-eared bat, *Corynorhinus rafinesquii*, in southern Mississippi. Southeastern Naturalist 3:103-112.

USEPA. 1990. Suspended, cancelled, and restricted pesticides. 20T-1002. Office of Pesticides and Toxic Substances, U.S. Environmental Protection Agency, Washington, DC.

USEPA. 1997. Characterization of human health and wildlife risks from mercury exposure in the United States. Mercury Study Report to Congress, vol 7. U.S. Environmental Protection Agency, Washington, DC.