RESIDUES IN FISH, WILDLIFE, AND ESTUARIES

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Mirex Residues in Nontarget Organisms after Application of Experimental Baits for Fire Ant Control, Southwest Georgia—1971-72

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ABSTRACT

Mirex, the only compound approved for control of the red imported fire ant (Solenopsis invicta) *and the black imported fire ant* (Solenopsis richteri), *is normally applied at a rate of 1.40 kg/ha. (1.25 lb/acre). Influenced by recent studies showing that low levels of mirex are toxic to certain nontarget organisms, particularly estuarine species, authors report here on a monitoring study of mirex in three large treatment areas of southwest Georgia. Four formulations of bait were applied aerially in 1971-72. Low-level residues were observed in small terrestrial vertebrates and invertebrates and in fresh-water inhabitants. Levels detected were about the same for all baits. Maximum residues were detected 1-3 months after treatment and gradually declined to low levels of 0.02-1.16 ppm 1 year after treatment.*

Introduction

The chlorinated hydrocarbon insecticide mirex is the only compound approved for control of the red imported fire ant, *Solenopsis invicta*, and the black imported fire ant, *S. richteri*. The insecticide, formulated at a concentration of 0.3 percent in a corncob grit/soybean oil bait, is normally applied at a rate of 1.40 kg/ha. (1.25 lb/acre).

Initially, residues were not considered to be a problem because of the very small quantities of mirex used and its low mammalian toxicity (*1*). However, recent laboratory studies have shown that low levels of mirex are toxic to certain nontarget organisms, particularly estuarine species (*2-4*), demonstrating the need for thorough monitoring of mirex residues in nontarget organisms following mirex bait applications. Several studies have been conducted on birds, other large terrestrial vertebrates, and aquatic and estuarine organisms (*5-12*), but very little work has focused on small terrestrial vertebrates and invertebrates or on fresh-water inhabitants.

The present paper reports the results of a monitoring study of mirex in three large treatment areas in southwest Georgia in 1971-72 following applications of a standard bait formulation and of three experimental formulations.

Methods and Procedures

SAMPLE AREAS

Two experimental test sites were selected within each of three larger treatment blocks in Tift, Turner, and Worth Counties in southwest Georgia.

APPLICATION OF MIREX

Baits used in this study were formulated by Allied Chemical Corporation according to the procedures of Banks et al. (*13*). Four formulations of bait (Table 1) were applied in a series of three treatments (Table 2). Baits were dispersed from an altitude of 700 feet by multi-engine commercial aircraft under the supervision of personnel of the Plant Protection Division, Agricul-

TABLE 1. *Components of mirex bait applied for fire ant control, Georgia—1971-72*

Formulation	Components of Bait, [illegible] by Weight			
	Mirex	Soybean Oil	Corncob Grits	Latex Coating
A	0.3	14.7	85.0	NA
B	0.15	14.85	85.0	NA
C	0.15	18.85	71.0	10.0
D	0.10	18.9	71.0	10.0

NOTE: Treatments A and B represent standard proportions of mirex, 0.3 percent and 0.15 percent. Treatments C and D were latex coated.

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TABLE 2. *Application patterns of mirex bait in three Georgia counties, 1971-72*

Date	County	Formulation: Mirex, %	Area Treated	Bulk Rate[a]
Spring 71	Turner	0.3 (standard)	25,369 ha. (62,640 acres)	1.40 kg/ha. (1.25 lb/acre)
		0.15 (standard)	12,685 ha. (31,390 acres)	1.40 kg/ha. (1.25 lb/acre)
Spring 71	Tift	0.15 (latex coated)	12,150 ha. (30,000 acres)	1.12 kg/ha. (1.0 lb/acre)
		0.10 (latex coated)	14,783 ha. (36,500 acres)	1.12 kg/ha. (1.0 lb/acre)
Fall 71	Worth	0.10 (latex coated)	40,500 ha. (100,000 acres)	1.12 kg/ha. (1.0 lb/acre)
		0.3 (standard)	40,500 ha. (100,000 acres)	1.40 kg/ha. (1.25 lb/acre)

[a] Numbers in parentheses show amount of actual toxicant, i.e., mirex, applied to each hectare.

tural Research Service, U.S. Department of Agriculture (USDA), (now a part of Animal and Plant Health Inspection Service, USDA). All aircraft operated under an electronic guidance system (*14*) and were equipped with auger-fed dispersal systems mounted within the wings of the aircraft.

TREATMENT AND SAMPLING SCHEDULE

Dates of bait application and sample collection were as follows:

Turner County
- Pretreatment samples: May 24-28, 1971
- Baits applied: May 28
- 7-day posttreatment samples: May 31-June 4
- 1-month posttreatment samples: June 21-25
- 3-month posttreatment samples: August 23-26

Tift County
- Pretreatment samples: May 17-21, 1971
- Baits applied: May 25-June 2
- 7-day posttreatment samples: June 14-18
- 1-month posttreatment samples: July 6-9
- 3-month posttreatment samples: September 13-16

Worth County
- Pretreatment samples: September 28-October 5, 1971
- Baits applied: October 5-12
- 1-month posttreatment samples: November 8-12
- 6-month posttreatment samples: April 10-14, 1972
- 1-year posttreatment samples: September 1-8

SAMPLE COLLECTION

Twenty pitfall traps for the collection of invertebrates and small vertebrates (*15*) were placed at sites which had been established randomly in each treatment area. Turner, Tift, and Worth Counties contained 5, 4, and 7 such trap sites, respectively. Hand collections were used to supplement pitfall collections whenever possible. Scientific and common names of species selected appear in Table 3.

Aquatic vertebrates were collected by hand and by seining from farm ponds located in each test area. The areas in Tift County treated with standard 0.15 percent and 0.3 percent baits contained two and one such ponds, respectively; the areas in Turner County treated with latex-coated 0.15 percent and 0.1 percent baits contained four and five collection ponds, respectively. Each of the Worth County test areas contained two collection ponds.

The pretreatment samples from Tift and Turner County and the 7-day posttreatment samples from Turner County were collected in 70 percent isopropanol as described by Markin et al. (*9*). However, authors found that isopropanol leached mirex from trapped specimens and thus distorted the values for mirex residues (*16*); therefore these samples were discarded. Subsequently,

TABLE 3. *Invertebrates and small vertebrates analyzed for mirex residues, Georgia—1971-72*

Scientific Name	Common Name
Insects	
Pictonemobius ambitiosus	Ground cricket
Neonemobius near *mormonius*	Ground cricket
Subfamily Neoinbinae	Immature ground crickets
Gryllus rubens	Southern field cricket
Gryllus firmus	Sand cricket
Gryllus fultoni	Southern wood cricket
Miogryllus verticalis	Stripe headed cricket
Scapteriscus acletus	Southern mole cricket
Scapteriscus vicinus	Changa
Gryllotalpa hexadactyla	Northern mole cricket
Ceuthophilus spp.	Camel crickets
Parcoblatta spp.	Wood cockroaches
Cariblatta lutea	Small yellow cockroach
Chorisoneura texensis	Small yellow Texas cockroach
Ichnoptera deropeltiformis	Dark wood cockroach
Labidura riparia	Riparian earwig
Euborellia annulipes	Ringlegged earwig
Prosapia bicincta	Twolined spittlebug
Spiders	
Latrodectus mactans	Black widow spider
Isopods	
Armadillidium vulgare	Pillbug
Worms	
	(Mixed unidentified earthworms)
Mammals	
Cryptotis parva	Least shrew
Reptiles	
Cnemidophorus sexlineatus	Sixlined racerunner
Scincella laterale	Brown skink
Eumeces laticeps	Greater fivelined skink
Coluber constrictor priapus	Southern black snake
Natrix sipedon fasciata	Banded water snake
Amphibians	
Rana sphenocephala	Leopard frog
Rana catesbeiana	Bull frog
Gastrophryne carolinensis	Narrow-mouth toad
Bufo terrestris	Southern toad
Bufo quercicus	Oak toad
Acris gryllus	Cricket frog
Pseudoacris ornata	Ornate chorus frog
Fish	
Gambusia affinis	Mosquito fish
Lepomis macrochirus	Bluegill
Lepomis cyanellus	Green sunfish
Lepomis marginatus	Dollar sunfish
Fundulus lineolatus	Lined topminnow
Notemigonus crysoleucas	Golden shiner
Micropterus salmoides	Largemouth bass

technical crystals of chlorpyrifos were used in small open glass jars as the killing agent for specimens from pitfall traps.

The pitfall traps were checked everyday or every other day during each sampling period. During each collection period the contents of the 20 traps at each site were combined into one glass jar and quick-frozen in the field with dry ice. Aquatic vertebrates were wrapped in aluminum foil and frozen in the same manner. In the laboratory, all samples from a given treatment area and a single collection period were pooled into one composite. The pooled samples were separated by species and delivered to the Pesticide Research Laboratory, University of Florida, for analysis.

Species were selected to represent a cross-sectional sample of the food web. No pitfall or pond samples were collected within a half-mile of the boundaries of the treatment areas, in order to reduce the chance of contamination by other baits or by movement of animals. The limited widths of the treated areas precluded sampling of birds and larger mammals.

Analytical Procedures

EXTRACTION

Samples dried in air to remove surface moisture, condensate, were weighed and then blended in at least 4 ml acetone per gram of sample at high speed for 4 minutes. The extract was filtered through a Buchner funnel, rinsed with fresh solvent, and transferred to a Kuderna-Danish concentrator. The acetone was partly evaporated on a steam bath, and *n*-hexane was added to the concentrator. The evaporation continued until the volume of hexane was reduced substantially. This procedure essentially removed all the acetone. The hexane was then concentrated to a known volume before cleanup.

CLEANUP

The extract, now in hexane, was cleaned by using florisil column chromatography. Three g of 60/100 mesh PR grade florisil was placed in 1-cm-ID glass columns fitted with a fritted glass disk. The florisil was topped with 2-3 cm anhydrous sodium sulfate and placed in a 150°C oven for at least 3 hours. Then the columns were prewashed with 50 ml hexane, and the washings were discarded. The extract, representing up to 1 g of sample, was placed on the column, and the mirex was eluted with 20 ml hexane. The hexane eluate was concentrated to 1.0 ml before gas chromatographic analysis.

QUANTIFICATION

The gas chromatograph used for analysis was a Packard model 7610 equipped with an electron-capture detector. The glass column, 6 ft by ¼ in., was packed with 2 percent OV-101 on 100/120 mesh Gas-Chrom Q and had a nitrogen carrier gas flow rate of 100 cc/min. Injection port, column, and detector temperatures were 215°, 190°, and 208°C, respectively. The method can detect 0.01 ppm mirex in a 1.0-g sample.

Mirex, which had been added to insects and to fat, brain, liver, and muscle of birds at levels of 0.01-1.0 ppm, was recovered at a rate of 90-100 percent. The identity of mirex was confirmed occasionally by determining a p-value.

Results and Discussion

Mirex residues were found in 10 of the 28 species represented by the 49 pretreatment samples taken in Worth County. One year after treatment, residues in six of these same species were equal to or lower than those in pretreatment samples. In the other samples residues were relatively low 1 year after treatment; 62 percent had less than 0.05 ppm mirex and 92 percent had less than 0.5 ppm. Residues in the pretreatment samples probably resulted from treatment of fire ant mounds by landowners, since this area had not received any large-scale treatments. As noted, pretreatment samples from the Turner and Tift County test areas were cross-contaminated by isopropanol collection and were discarded. The pooled findings did not lend themselves to statistical analysis, and none was attempted. The majority of the 248 post-treatment samples, 71.77 percent, contained mirex residues.

As shown in Tables 4-11, maximum levels of mirex were reached 1 month after treatment, though in a few small vertebrates they were noted 3-6 months after treatment. Among the invertebrates, nymphal ground crickets had the highest residues (Table 4). Two specimens of *Pictonemobius ambitiosus* had residues of 13.20 ppm and 10.20 ppm 7 days after treatment and another cricket nymph in the subfamily Nemobinae had residues of 12.87 ppm 3 months after treatment. Residues were generally higher in crickets than in the other arthropods; wood cockroaches had the second-highest residues. Most arthropods analyzed are omnivorous feeders. Crickets and other arthropods were often found in the old mounds after the ants had died; they probably had fed on the dead ants or the remnants of the bait still in the mound.

The *Neonemobius* near *mormonius* (Table 4) and *Gryllus rubens* (Table 5) crickets have at least two generations of young each year in southwest Georgia. Thus the specimens of these two species taken 1 year after treatment almost certainly had not yet hatched at the time of treatment, and the Nemobinae cricket nymph (Table 4) taken 3 months after treatment probably hatched after the bait applications. It seems likely that the residues noted in these cases were acquired by crickets inhabiting the old mounds as previously described.

Labidura riparia has been found to transfer food by trophallaxis to the nymphs (*17*). Such transfer could

TABLE 4. *Mirex residues in crickets of subfamily Nemobinae according to test site, Georgia—1971-72*

County	Month of Application, 1971	Mirex Applied, g/ha.	Residues, ppm					
			Pretreatment	Posttreatment				
				7 Days	1 Mo	3 Mos	6 Mos	1 Yr
			Pictonemobius ambitiosus (adult ground crickets)					
Tift	May	1.12	D	0.36 (1)		0.15 (3)		
				1.92 (1)				
				5.40 (1)				
Tift	May	1.68	D	ND (1)	5.73 (1)			
Turner	May-	2.10	D		3.40 (1)	0.15 (10)		
Turner	June	4.20				0.91 (2)		
Worth	October	1.12	1.76 (1)		2.06 (2)			ND (1)
Worth	October	4.20	ND (4)					
			Pictonemobius ambitiosus (nymphal ground crickets)					
Tift	May	1.12		13.20 (1)		ND (1)		
Tift	May	1.68		10.20 (1)				
Turner	May-	2.10			1.26 (6)			
Turner	June	4.20			6.08 (5)			
					ND (1)			
Worth	October	1.12	ND (5)		ND (1)		ND (3)	
Worth	October	4.20	ND (4)				0.01 (3)	
			Neonemobius near mormonius (adult ground crickets)					
Tift	May	1.12	D			ND (1)		
Tift	May	1.68	D	2.08 (1)	0.59 (2)	2.26 (1)		
				3.11 (1)	1.43 (1)			
					3.90 (2)			
Turner	May-	2.10	D	D	ND (6)	ND (4)		
Turner	June	4.20	D	D				
Worth	October	1.12	ND (5)		1.01 (1)		ND (5)	0.98 (1)
Worth	October	4.20	ND (1)				0.63 (2)	ND (1)
			Crickets of subfamily Nemboniae (nymphal ground crickets)					
Tift	May	1.12	D			1.06 (1)		
Tift	May	1.68	D		ND (1)			
Turner	May-	2.10	D	D	ND (1)	ND (4)		
					0.84 (29)	12.87 (1)		
					0.86 (9)			
					1.81 (4)			
Turner	June	4.20	D	D	1.28 (14)	ND (30)		
Worth	October	1.12	ND (7)		1.84 (7)		ND (3)	ND (12)
Worth	October	4.20	ND (45)		ND (5)			ND (3)

NOTE: D = discarded cross-contaminated samples.
ND = no residues detected at 0.01 ppm level.
Figures in parentheses represent number of specimens in pooled sample.

account for the residues of mirex found in samples of earwigs (Table 8) 1 year after treatment. The presence of relatively high residues, 21.50 ppm, in shrews (Table 10) was not surprising, since these mammals are insectivores and would be expected to exhibit some biological concentration of mirex. Authors do not know whether the lower levels noted 3 months and 6 months after treatment are an indication of metabolism and excretion or of population turnover.

The residues found in terrestrial and semiterrestrial reptiles and amphibians (Table 10) probably resulted from biological concentration following consumption of animals that contained lower residues. The highest levels in these organisms were noted in cricket frogs (Table 10); slightly lower levels were found in narrow-mouth toads. Residues in all these animals 1 year after treatment were below 0.5 ppm except in one black snake which had 1.16 ppm mirex.

The semiaquatic and aquatic vertebrates (Table 11) generally contained low levels of residues. The highest levels were detected in mosquito fish (Table 11). The only other aquatic animal that contained more than 0.5 ppm mirex was a single specimen of leopard frog which had 1.08 ppm (Table 11) 3 months after treatment. Residues in all aquatic animals 1 year after treatment were 0.09 ppm or less.

Mirex residues appeared relatively quickly in all levels of the ecosystem studied. However, maximum levels appeared in the various organisms at different intervals after treatment, depending to a large extent on the niche occupied by the organism in the food chain. The levels of mirex detected in the organisms 1 year after treatment were comparable to those found by Baetcke et al. (*5*) and Collins et al. (*7*).

All specimens analyzed were taken alive or entered pitfall traps alive, and demonstrated no obvious effects from mirex residues present. Authors observed no mass mortality of nontarget organisms in the field after treatments nor received reports of such mortality. No substantial differences were noted in the population size of any given species when it was tested before treatment and again 1 year after treatment.

No appreciable differences were noted in the residues in nontarget organisms as a result of applications of the various bait formulations. Indeed, amounts detected in the organisms from the area that received the latex-coated 0.1 percent mirex bait were comparable to those detected in organisms from the area that received the standard 0.3 percent mirex bait. This appears to substantiate the observations of Banks et al. (*13*) that less mirex is bound up in the corncob grits and thus more mirex is available to the ants in the latex-coated baits.

Even though residue levels were comparable, it seems logical to assume that the 75 percent reduction in toxicant load afforded by the 0.1 percent mirex bait must result in less environmental contamination. Since the 0.1 percent mirex bait provides excellent control of the ants (*13*), it should be an environmentally acceptable substitute for the standard mirex formulation.

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TABLE 5. *Mirex residues in crickets of subfamily Gryllinae according to test site, Georgia—1971-72*

County	Month of Application, 1971	Mirex Applied, g/ha.	Residues, ppm: Pretreatment	Posttreatment: 7 Days	1 Mo	3 Mos	6 Mos	1 Yr
Gryllus rubens (adult southern field crickets)								
Tift	May	1.12	D		0.23 (4)			
Tift	May	1.68	D			0.01 (15)		
Turner	May-	2.10	D		0.27 (1)	0.01 (26)		
Turner	June	4.20	D			0.03 (4)		
Worth	October	1.12	0.02 (12)				ND (17)	ND (22)
Worth	October	4.20	ND (8)				0.05 (29)	ND (39)
Gryllus fultoni (adult southern field crickets)								
Tift	May	1.12		1.04 (1)				
Worth	October	1.12	ND (22)					ND (1)
Worth	October	4.20	ND (1)					ND (1)
Gryllus firmus (adult sand crickets)								
Tift	May	1.12				ND (3)		
Tift	May	1.68			0.06 (4)	0.02 (36)		
Turner	May-	2.10	D		0.18 (16)			
Turner	June	4.20	D	D	0.41 (2)			
Worth	October	1.12	ND (15)		0.27 (7)		0.05 (2)	0.04 (10)
Worth	October	4.20	ND (32)				ND (1)	0.03 (21)
Miogryllus verticalis (stripe-headed crickets)								
Worth	October	1.12						ND (2) (adults) ND (8) (nymphs)
Worth	October	4.20						ND (6) (nymphs)

NOTE: D = discarded cross-contaminated samples.
ND = no residues detected at 0.01 ppm level.
Figures in parentheses represent number of specimens in pooled sample.

TABLE 6. *Mirex residues in mole crickets according to test site, Georgia—1971-72*

County	Month of Application, 1971	Mirex Applied, g/ha.	Residues, ppm: Pretreatment	Posttreatment: 7 Days	1 Mo	3 Mos	6 Mos	1 Yr
Scapteriscus acletus (adult and nymphal southern mole crickets)								
Tift	May	1.68	D			0.18 (4)		
Turner	May-	2.10	D	D	0.53 (19)	0.04 (6)		
Turner	June	4.20	D	D		0.08 (4)		
Worth	October	1.12	0.10 (13)		0.91 (2)		0.23 (2)	
Worth	October	4.20	ND (32)		ND (3)		0.14 (9)	0.09 (8)
Scapteriscus vicinus (adult and nymphal changas)								
Tift	May	1.68	D		0.05 (1) 1.15 (2)	0.58 (1)		
Turner	May-	2.10	D	D		0.14 (1) 0.34 (2)		
Turner	June	4.20				ND (3)		
Worth	October	4.20	ND (1)				0.06 (9)	ND (2)
Gryllotalpa hexadactyla (adult northern mole crickets)								
Worth	October	1.12	0.10 (6)					0.13 (3)
Worth	October	4.20	ND (1)					ND (1)

NOTE: D = discarded cross-contaminated samples.
ND = no residues detected at 0.01 ppm level.
Figures in parentheses represent number of specimens in pooled sample.

TABLE 7. *Mirex residues in cockroaches according to test site, Georgia—1971-72*

County	Month of Application, 1971	Mirex Applied, g/ha.	Residues, ppm: Pretreatment	Posttreatment: 7 Days	1 Mo	3 Mos	6 Mos	1 Yr
			Parcoblatta spp. (adult and nymphal wood cockroaches)					
Tift	May	1.12	D	3.98 (1)	0.78 (8)	ND (1)		
Tift	May	1.68	D	1.50 (2)	3.74 (7) 6.18 (2)	0.12 (2)		
Turner	May-June	4.20		D		1.41 (2)		
Worth	October	1.12	ND (3)		4.39 (2)		0.19 (6)	ND (2)
Worth	October	4.20	ND (3)				0.22 (1) 0.66 (5)	ND (2)
			Cariblatta lutea (adult small yellow cockroaches)					
Tift	May	1.12	D		ND (1)			
Worth	October	4.20					ND (3)	
			Chorisoneura texensis (adult small yellow Texas cockroaches)					
Tift	May	1.68			ND (1)			
			Ichnoptera deropeltiformis (adult dark wood cockroaches)					
Worth	October	4.20					0.18 (1)	

NOTE: D = discarded cross-contaminated samples.
ND = no residues detected at 0.01 ppm level.
Figures in parentheses represent number of specimens in pooled sample.

TABLE 8. *Mirex residues in earwigs according to test site, Georgia—1971-72*

County	Month of Application, 1971	Mirex Applied, g/ha.	Residues, ppm: Pretreatment	Posttreatment: 7 Days	1 Mo	3 Mos	6 Mos	1 Yr
			Labidura riparia (adult and nymphal riparian earwigs)					
Tift	May	1.12				0.19 (29)		
Tift	May	1.68				0.11 (4)		
Turner	May-	2.10	D			ND (1) 0.23 (8)		
Turner	June	4.20	D		0.63 (3)	0.08 (11)		
Worth	October	1.12	0.02 (48)		ND (1)			0.03 (33)
Worth	October	4.20	ND (214)		ND (4)		0.85 (4)	0.04 (168)
			Euborellia annulipes (adult and nymphal ringlegged earwigs)					
Tift	May	1.12	D		0.43 (15)	0.14 (7)		
Tift	May	1.68	D		2.25 (1)	0.06 (49)		
Turner	May-	2.10	D	D		ND (27)		
Turner	June	4.20	D	D		ND (1) 0.37 (2) 0.61 (4)		
Worth	October	1.12	0.06 (93)				0.13 (12)	ND (18)
Worth	October	4.20	ND (11)		0.51 (3)		ND (3)	0.04 (27)

NOTE: D = discarded cross-contaminated samples.
ND = no residues detected at 0.01 ppm level.
Figures in parentheses represent number of specimens in pooled sample.

TABLE 9. *Mirex residues in miscellaneous invertebrates according to test site, Georgia 1971-72*

County	Month of Application, 1971	Mirex Applied, g/ha	Residues, ppm: Pretreatment	Posttreatment: 7 Days	1 Mo	3 Mos	6 Mos	1 Yr
Ceuthophilus spp. (nymphal camel crickets)								
Tift	May	1.68	D	1.75 (1)	3.60 (1)			
Turner	May-June	2.10	D	D	0.40 (1)			
Turner		4.20	D	D	0.66 (1)			
					2.88 (2)			
Worth	October	1.12	ND (17)				0.12 (21)	ND (3)
Worth	October	4.20	ND (3)				0.01 (7)	ND (2)
Prosapia bicincta (adult two-lined spittle bugs)								
Tift	May	1.12			ND (22)	ND (7)		
Turner	May-June	4.20				3.23 (1)		
Worth	October	1.12	ND (8)		ND (1)			
Worth	October	4.20	ND (25)		0.58 (1)			
Armadillidium vulgare (adult and immature pillbugs)								
Tift	May	1.12	D		0.04 (16)	0.01 (10)		
Tift	May	1.68	D		0.03 (10)	0.02 (5)		
Turner	May-June	2.10		D	ND (1)	ND (1)		
Worth	October	1.12	ND (1)					
Earthworms								
Tift	May	1.12		0.02 (10)	0.49 (20)	0.04 (25)		
Tift	May	1.68			ND (26)	0.03 (10)		
Turner	May-June	2.10	D		0.10 (20)			
Turner		4.20		D		0.49 (10)		
Worth	October	1.12	ND (50)		ND (1)		0.02 (10)	ND (18)
Worth	October	4.20	ND (1)		ND (1)		0.03 (10)	
Latrodectus mactans (black widow spider)								
Worth	October	1.12						0.28 (3)

NOTE: D = discarded cross-contaminated samples.
ND = no residues detected at 0.01 ppm level.
Figures in parentheses represent number of specimens in pooled sample.

TABLE 10. *Mirex residues in terrestrial and semiterrestrial vertebrates according to test site, Georgia—1971-72*

County	Month of Application, 1971	Mirex Applied, g/ha.	Residues, ppm: Pretreatment	Posttreatment: 7 Days	1 Mo	3 Mos	6 Mos	1 Yr
Cryptotis parva (least shrews)								
Tift	May	1.12			21.50 (1)			
Tift	May	1.68	D			5.16 (1)		
Worth	October	1.12	ND (1)					
Worth	October	4.20	ND (2)				1.15 (1)	
							0.78 (1)	
Cnemidophorus sexlineatus (6-lined racerunners)								
Turner	May-	2.10	D	D		0.93 (1)		
Turner	June	4.20		D	0.63 (1)	0.07 (1)		
Worth	October	1.12	ND (1)					
Worth	October	4.20	ND (1)					0.40 (1)
Scincella laterale (brown skinks)								
Tift	May	1.12	D			0.34 (1)		
Worth	October	1.12	ND (2)				0.22 (4)	ND (1)
Worth	October	4.20	ND (3)				0.66 (1)	
Eumeces laticeps (greater 5-lined skink)								
Worth	October	1.12					ND (1)	
Coluber constrictor (black snake)								
Worth	October	1.12						1.16 (1)
Natrix sipedon fasciata (banded water snake)								
Turner	May-June	4.20		D	0.04 (1)			
Bufo terrestris (southern toads)								
Turner	May-June	2.10	D	D	0.94 (5)			
Turner	May-June	4.20	D		0.10 (1)	0.39 (1)		
Worth	October	1.12	ND (3)		0.24 (5)		0.02 (2)	
Worth	October	4.20					ND (1)	
Gastrophryne carolinensis (narrow-mouth toads)								
Tift	May	1.12	D			0.47 (2)		
Tift	May	1.68	D			3.46 (3)		
Turner	May-	2.10	D	D	2.02 (9)	0.41 (14)		
Turner	June	4.20			0.33 (1)	1.06 (2)		
Worth	October	1.12	ND (16)					0.17 (4)
Worth	October	4.20	0.12 (5)					0.04 (1)
Pseudacris ornata (ornate chorus frog)								
Worth	October	1.12					0.10 (1)	
Acris gryllus (cricket frogs)								
Worth	October	1.12			9.27 (2)		0.14 (3)	
Worth	October	4.20			3.01 (9)			
Bufo quercicus (oak toads)								
Worth	October	1.12						ND (5)
Worth	October	4.70						0.08 (2)

NOTE: D = discarded cross-contaminated samples.
ND = no residues detected at 0.01 ppm level.
Figures in parentheses represent number of specimens in pooled sample.

TABLE 11. *Mirex residues in semiaquatic and aquatic vertebrates according to test site, Georgia—1971–72*

County	Month of Application, 1971	Mirex Applied, G/HA	Residues, ppm: Pretreatment	Posttreatment: 7 Days	1 Mo	3 Mos	6 Mos	1 Yr
			RANA SPHENOCEPHALA (LEOPARD FROGS)					
Tift	May	1.68				0.08 (1)		
Turner	May-	2.10		D		1.08 (1)		
Turner	June	4.20			0.24 (1)			
Worth	October	1.12				0.56 (1)		
Worth	October	4.20	ND (1)		0.34 (1)			
			RANA CATESBEIANA (BULLFROGS)					
Tift	May	1.12			0.05 (1)			
Tift	May	1.68				0.15 (4)		
Turner	May-June	2.10	D		0.43 (1)			
Worth	October	1.12	ND (4)		0.08 (12)			0.03 (6)
Worth	October	4.20			0.25 (3)			0.09 (1)
			GAMBUSIA AFFINIS (MOSQUITO FISH)					
Tift	May	1.12	D		ND (10)	0.11 (18)		
Tift	May	1.68	D		0.06 (25)	ND (150)		
Turner	May-	2.10	D		0.02 (20) 0.08 (25)			
Turner	June	4.20	D		0.08 (20)	0.24 (24)		
Worth	October	1.12	ND (25)		0.25 (3)		2.93 (125)	ND (1)
Worth	October	4.20	0.15 (15)		2.25 (10)		1.75 (105)	ND (6) 0.03 (30)
			LEPOMIS MACROCHIRUS (BLUEGILLS)					
Tift	May	1.12	D		ND (69) 0.23 (10)			
Tift	May	1.68	D			ND (12)		
Turner	May-June	2.10	D		ND (5)			
Worth	October	1.12					ND (14)	0.05 (4)
Worth	October	4.20	0.03 (7)				0.02 (16)	ND (1) 0.03 (2) 0.03 (5)
			FUNDULUS LINEOLATUS (LINED TOPMINNOWS)					
Tift	May	1.12	D		0.05 (9)			
Tift	May	1.68				0.04 (10)		
Turner	May-	2.10			0.21 (5) 0.17 (10)			
Turner	June	4.20	D		0.03 (2)			
Worth	October	4.20	0.03 (2)					
			LEPOMIS CYANELLUS (GREEN SUNFISH)					
Tift	May	1.12			0.05 (1)			
Worth	October	4.20			0.05 (1)			
			LEPOMIS MARGINATUS (DOLLAR SUNFISH)					
Turner	May-June	4.20			0.15 (6)			
			NOTEMIGONUS CRYSOLEUCAS (GOLDEN SHINERS)					
Worth	October	1.12	ND (7)				0.09 (11)	0.02 (21)
Worth	October	4.20	ND (1)				ND (8)	
			MICROPTERUS SALMOIDES					
Worth	October	4.20						ND (5)

NOTE: D = discarded cross-contaminated sample.
ND = no residues detected at 0.01 ppm level.
Figures in parentheses represent number of specimens in pooled sample.