

## LARVICIDE TESTS AGAINST BLACKFLIES IN SLOW-MOVING STREAMS

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Considerable research has been conducted on the control of blackfly larvae (*Simulium* spp.) breeding in swiftly flowing mountain streams. Fairchild and Bareda (1945) obtained complete eradication of these insects for distances up to 10 kilometers in mountain streams in Guatemala with 60-minute applications of DDT at 1 p.p.m. Garnham and McMahon (1947) reported the elimination of larvae from an area in Kenya Colony, East Africa, with DDT at 1 to 27 p.p.m. Kindler and Regan (1949) reported nearly complete control in a 5-mile section of a New Hampshire stream with TDE introduced at 1 p.p.m. for 10 minutes at 1-mile intervals. Gjullin *et al.* (1949) found DDT to be the most effective of several insecticides tested against blackfly larvae in Alaska. They obtained complete control for distances up to 880 yards with DDT at 0.3 p.p.m. after 15-minute application periods. However, the control of blackflies breeding in sluggish streams that drain swamps of the southeastern United States has until recently received very little attention.

In 1954, 1955, and 1956 field investigations were conducted to evaluate DDT, dieldrin, and parathion for the control of blackfly larvae in Florida and South Carolina streams where the water velocity varied from no measurable movement to 2.5 feet per second. These meandering streams were located in heavily wooded, relatively flat terrain, and varied considerably in width, depth, and rate of flow. They had sand or mud bottoms, many deep pools, and pondlike enlargements, and contained two or three types of aquatic plants. Riffles formed by logs, roots, accumulations of brush and leaves, and a few slight changes in elevation provided practically all the breeding areas.

The species encountered in these areas were *Simulium slossonae* D. & S., *S. congareenarum* (D. & S.), *S. decorum* Wlkr., the species comprising the *S. venustum* complex, and *Cnephia pecuarum* (Riley). The *S. venustum* complex includes true *venustum* Say, *tuberosum* (Lundst.), and *verecundum* Stone and Jamnback.<sup>1</sup> This closely related group can only be distinguished by the male genitalia. None of these species are injurious to man in these localities, but *slossonae* and *congareenarum* are frequently serious pests of turkeys. Jones and Richey (1956) reported *slossonae* to be a vector of a leucocytozoon disease in turkeys. This was the prevalent species in Florida.

The insecticides were evaluated by comparing pretreatment and post-treatment counts of larvae attached to dead leaves, sticks, and green aquatic vegetation at one or more places downstream from the application site. In some tests the control was determined for only a few days, but in others counts were made for several weeks.

**GROUND TESTS.** In 1954, tests were conducted in South Carolina to compare the effectiveness of DDT applied as an emulsion, as an oil solution, and as granules. A DDT emulsifiable concentrate was introduced for 15 minutes from a dripping apparatus that delivered approximately 50 ml. of liquid per minute. A 5 percent solution of DDT in fuel oil was applied with a hand sprayer and 5 percent granules on 16/30-mesh bentonite were scattered by hand on 30-foot sections of streams.

In 1956, other tests were run in Florida and South Carolina streams to compare DDT emulsions with two parathion form-

<sup>1</sup> Alan Stone, of the Entomology Research Division, determined the many specimens submitted during these studies.

ulations. Parathion was applied as a solution in isopropanol and as a solubilized concentrate containing 1 part of parathion to 4 parts of Triton X-100. Various concentrations of both toxicants were introduced into the water for 5, 10, 20, and 24 or 30 minutes with a dripping apparatus that delivered 100 or 200 ml. of liquid per minute.

The dripping apparatus treatments were applied at points where the water surface was not smooth in order to obtain as much agitation and mixing as possible. No attention was paid to this factor in the tests with fuel oil and granular formulations, as these treatments were intended to simulate airplane applications. The flow of each stream in gallons per minute was estimated by timing the water movement for a predetermined distance in areas where the width and depth were easily determined. A small cork, liquid dye, or a simple Pitot flowmeter was used to assist in ascertaining the flow rate.

Because of the swampy terrain, the heavy, tangled undergrowth, and the non-uniform distribution of blackfly breeding sites, these tests could not be checked at

uniform distances downstream, but observations were made wherever accessible breeding was found.

The tests showing the relative effectiveness of the three DDT formulations are presented in Table 1. All were effective for at least short distances. The emulsion and oil solution at 0.1 p.p.m. caused complete detachment of larvae within 24 to 48 hours for distances up to 400 yards downstream. No effective control was apparent in one stream after 880 yards. The granules at 1 pound per acre eliminated all larvae for at least 193 yards, but the 0.5 pound treatment was ineffective at the single point examined, 250 yards below the introduction site.

The results of the tests conducted in 1956 to compare DDT with parathion appear in Table 2. In Florida, 5-minute applications of parathion at 0.5 and 1 p.p.m. eliminated all the larvae for 0.6 to 1.6 miles in two streams, but 5- to 24-minute applications failed to give good control at 2.3 or 6 miles. In South Carolina 10- to 20-minute applications of parathion at 0.5 and 1 p.p.m. gave 100 percent reductions at 0.24 to 2.8 miles. One

TABLE 1.—Relative effectiveness of various DDT formulations against blackfly larvae in South Carolina streams.

Formulation and Dosage	Station Distance (Yards)	Pretreatment Count <sup>a</sup>	Percent Detachment in 24-48 Hours
<b>Emulsion</b>			
0.1 p.p.m.	50	47	100
	100	50	100
	880	22	9
	20	65	100
	140	218	100
	218	120	100
	268	500	100
<b>Oil solution</b>			
0.1 p.p.m.	60	45	100
	200	62	100
	400	13	100
<b>Granules</b>			
0.5 pound per acre	250	41	0
1.0 pound per acre	83	500	100
	133	500	100
	193	500	100

<sup>a</sup> Average per attachment unit (stick, leaf, or blade of aquatic grass).

TABLE 2.—Relative effectiveness of parathion and DDT as blackfly larvicides applied with an automatic applicator.

Insecticide	Dosage (p.p.m.)	Carrier	Treatment Time (min.)	Stream	Station Distance (miles)	Pretreatment Count <sup>a</sup>	Percent Detachment in		
							24 Hours	48 Hours	72 Hours
Parathion	0.5	Triton X-100 Isopropanol	5	1	1.6	18	100	—	—
			5	2	6.0	21	0	0	0
		10	3	2.3	13	45	45	—	—
		24	3	2.3	76	40	40	—	—
	.74	"	24	3	2.3	36	0	0	0
			20	3	2.3	36	0	0	0
	1.0	Triton X-100	5	2	.6	16	100	—	—
			5	4	1.5	26	0	0	—
		20	4	.27	21	96	100	—	
		20	4	.30	29	74	48	—	
3.4	"	5	4	.31	56	0	0	—	
		5	4	.04	10	100	—	—	
Parathion	.5	Isopropanol	5	5	.57	42	100	—	—
			5	6	.57	41	100	—	—
	1.0	Triton X-100	5	7	1.5 <sup>b</sup>	50	0	40	40
			5	7	1.5 <sup>c</sup>	135	0	96	96
		20	8	1.5	100+	0	0	0	
		20	8	2.75	9	0	0	0	
	1.0	Isopropanol	10	9	1.5	49	80	100	—
			20	9	.24	13	100	—	—
		Triton X-100	10	7	1.25 <sup>b</sup>	4	0	100	—
			20	7	1.25 <sup>b</sup>	9	0	100	—
DDT	1.0	Xylene + Triton X-100	10	10	1.25 <sup>c</sup>	58	0	99+	100
			30	13	2.5	130	0	0	0
	1.0	"	10	10	2.8	33	100	—	—
			20	11	.28	42	99+	99+	—
		Triton X-100	20	12	2.0	19	0	0	0
			30	13	.25	14	100	—	—
	1.0	"	10	10	2.25	111	0	0	0
			30	13	2.25	111	0	0	0

<sup>a</sup> Average per attachment unit (stick, leaf or blade of aquatic grass). Counts were made during each observation period in similar untreated streams with counts ranging from 5 to 100+.

<sup>b</sup> Small branch of main stream.

<sup>c</sup> Main channel of stream.

20-minute treatment gave 100 percent control for 1.25 miles, but none after 2.5 miles. Five-minute applications at 0.5 p.p.m. were effective for 0.57 mile, and partially effective at 1.5 miles in one test, but ineffective at 1.5 miles in another. In both States, DDT at 1 p.p.m. for 10 and 20 minutes was effective for distances up to 0.28 mile in some tests, but not at 0.3 mile or more in others. Dilution of the insecticide in the large and small pools present in streams of this type was undoubtedly a factor in destroying the effectiveness of the insecticide. The slow rate of movement in these streams is indicated in one test, in which a treatment of parathion at 1 p.p.m. gave 100 percent control at the 2.2 mile and 0 at the 2.8-mile point after 21 hours, but 100 percent at the 2.8-mile point after 24 hours.

**AIRPLANE TESTS.** Tests were conducted in South Carolina in March 1955 to evaluate aerial applications of DDT and dieldrin as larvicides. A 5 percent solution of DDT in fuel oil was applied to plots of 11 and 4 square miles at the rate of 2 quarts per acre with a Stearman airplane. The plane flew 90 m.p.h. at an altitude of 100 feet to produce a swath width estimated to be 100 feet. Wind velocities varied from 3 m.p.h. to occasional gusts up to 15 m.p.h. Granules containing 7 percent of dieldrin on attapulgite were applied to a plot 1 mile square with a Piper Cub plane flying 75 m.p.h. at an altitude of 100 feet. This plane was calibrated to deliver 40 pounds of granules

per mile with an effective swath of 25 feet. All treatments were applied in strips by flying swath intervals of 200 yards across the entire area included in the test. Much of the material fell on dry land, but it was hoped a large part of it would eventually reach the streams and in that way control the insects for several months. Counting stations were established at 10 points in the large plot and 5 points in the two smaller ones. The results are given in Table 3.

The DDT spray applied to the large plot gave almost 100 percent control for 2 weeks, and then gradually lost its effectiveness. In the small plot the control rose gradually to 95 percent after 1 week, but dropped to 87-88 percent in the third and fourth weeks. The dieldrin granules completely eliminated larvae for 2 weeks, and the control remained considerably above 90 percent through 4 weeks. Then a drought reduced the water level and breeding in all streams, and the tests were discontinued.

**SUMMARY.** Field investigations were conducted to evaluate DDT, dieldrin, and parathion for the control of blackfly larvae (*Simulium* spp.) in slow-moving streams in Florida and South Carolina.

In Florida parathion at 0.5 and 1 p.p.m. eliminated all larvae for distances up to 1.6 miles in two streams after 5-minute treatment periods, but failed to give good control after 2.3 miles in five others with treatments for 5 to 24 minutes. In South Carolina 10- and 20-minute applications

TABLE 3.—Control of blackfly larvae with aerial applications of DDT sprays and dieldrin granules.

Treatment	Dosage (lb./acre)	Average Pretreatment Count <sup>a</sup>	Number of Counts	Percent Reduction at Indicated Interval after Treatment					
				24 Hours	48 Hours	1 Week	2 Weeks	3 Weeks	4 Weeks
DDT solution <sup>b</sup>	0.2	7.1	380	99+	99+	99+	99+	72	68
Do. <sup>c</sup>	.2	4.1	195	86	86	95	95	87	88
Dieldrin granules	.04	87.2	25	100	100	100	100	94	98
None (check)	—	75	10	0	0	—	0	0	0

<sup>a</sup> Average per attachment unit.

<sup>b</sup> 11 square miles.

<sup>c</sup> 4 square miles.

gave 100 percent reductions for distances up to 2.8 miles before the insecticide was diluted in large pools or by tributary streams. The greatest distance at which DDT was effective was 0.28 mile.

A 5-percent DDT solution in fuel oil applied with an airplane to 11- and 4-square-mile plots at 2 quarts per acre gave 95 to 99 percent control for 2 weeks, and then gradually lost effectiveness. Aerial applications of granules at 0.04 pound of dieldrin per acre eliminated blackfly larvae for 2 weeks, and the control remained considerably above 90 percent through 4 weeks.

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