

The insecticide was applied to each source when most of the mosquito larvae were in the 2nd and 3rd instars. Abate 4E was introduced to the breeding site by using a 3-gallon B & G hand sprayer at an application rate of 1 oz of active ingredient per acre. A Buffalo turbine machine was used to apply the granular Abate 2G at a rate of 5 lbs. per acre.

Results of these field experiments showed that within a period of 24 hr after treatment a total mortality was observed for all 4 species of flood-water mosquitoes used in this study.

The non-target organisms varied in their mortality rates; some were more readily affected by the insecticide than others. All of them, however, returned to their normal population levels after 48 hours. The organisms most susceptible to the insecticide were the cladocerans. A maximum reduction of 40% of the population of cladocerans was achieved within 48 hours after the treatment. On the 3rd and 4th day after application of the chemical, an increase in the number of cladocerans was observed and the population had completely recovered by the 7th day.

The copepods, ostracods, and damselfly nymphs were only slightly affected. A decrease of 10 percent of the population of copepods and ostracods was observed after 24 hours, and the population of these groups of organisms returned to normal levels within 3 days after the treatment. Although damselfly nymphs were found somewhat sluggish in their movements no mortality was observed.

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2466 9

#### LABORATORY EVALUATION OF THE ACTIVITY OF INSECT GROWTH REGULATORS AGAINST *CULICOIDES VARIIPENNIS* (DIPTERA: CERATOPOGONIDAE)

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Insect Growth Regulators (IGRs) have been shown to prevent the emergence of nuisance chironomid midges (Mulla et al. 1974a, 1975) and mosquitoes (Jacob 1973, Mulla et al. 1974b,

Sacher 1971). IGR compounds are especially promising as control agents since they are active against some Diptera resistant to conventional larvicides (Schaefer and Wilder 1972, 1973, Schaefer et al. 1974).

In a previous investigation (Apperson 1975) the biological activities of organochlorine and organophosphorus insecticides were determined against *Culicoides variipennis* Coquillett larvae. The population was found to be operationally resistant to these chemicals. As a consequence, and in our search for effective compounds, a variety of IGRs were tested in the laboratory. This report presents methods of evaluation and research findings.

**METHODS AND MATERIALS.** Field-collected larvae were tested after a 24 hr equilibration period. Twenty late 4th instars were transferred to glass petri dishes containing 100 ml of filtered water (pH 7.5-8.0) from Clear Lake. *Culicoides* require a substrate for pupation and adult emergence. Therefore 3 balls of cotton (Johnson and Johnson®) were placed in each bioassay container. Greater rates of emergence in controls resulted when the cotton fibers were loosened with forceps and spread throughout each petri dish.

The compounds tested were of technical grade. Solutions were prepared on a wt./vol. basis in acetone and diluted to give desired serial concentrations. From 1/2 to 1 ml was added to each bioassay dish, prior to addition of the cotton. Larvae were held in the same containers throughout the tests at 26-28° C under a 12:12 hr light: dark photoperiod. Water in each container was adjusted to pretreatment levels on a daily basis. Pupal exuviae were removed and counted each day until all adults had emerged or all larvae and pupae had died. Duration of the tests ranged from 6 to 9 days. Tests were set in duplicate and replicated at least 3 times on different days. Percent inhibition of emergence was adjusted relative to controls, which varied from 35 to 11%. Methods for testing IGRs against Ceratopogonidae have not previously been published.

The following compounds were evaluated: Dimilin® (TH-6040) (1-(4-chlorophenyl)-3-(2,6-difluorobenzoyl)urea) Thompson-Hayward Co.; Methoprene (Altosid®) (Isopropyl 11-methoxy-3,7,11-trimethyldeca-2,4-dienoate) Zeecon Corp.; R-20458 (4-ethylphenyl-6,7-epoxy geranyl ether) Stauffer Chem. Co.; Mon-858 (2,6, di-tert-butyl-4-( $\alpha, \alpha$ -dimethylbenzyl) phenol) Monsanto Chem. Co.; HE-24108 (3-butyl-2-yl N-(p-chlorophenyl) carbamate) Hercules Powder Co.; RO-203600 (6,7-epoxy-3-methyl-7-ethyl-1-[3,4-(methylenedioxy)-phenoxy]=2- cis/trans-octene) Hoffman La Roche Co.

**RESULTS AND DISCUSSION.** Table 1 presents the effectiveness of IGRs against *C. variipennis* larvae. A broad spectrum of activity was manifested. Dimilin and methoprene were the most active compounds, achieving at least 90% inhibition of emergence at 0.5 ppm and 1.0 ppm, respectively. RO-203600 and HE-24108 were the least active.

Table 1. Biological activity of IGRs against *C. variipennis* larvae.

Conc. (ppm)	Percent Inhibition of Emergence					
	Dimilin	Methoprene	R-20458	Mon-858	RO-20-3600	HE-24108
0.005	7		15			
0.01	7	0	11	0		
0.05	35	42	11	0		
0.1	66	47	16	1	0	
0.5	90	76	33	2	6	
1.0		91	66	12	12	0
5.0			94	33	28	21
10.0			100	88	40	44

Application of 10 ppm of these IGRs resulted in less than 45% inhibition of emergence. In view of the low levels of susceptibility manifested by the *Culicoides* larvae tested relative to other Diptera such as mosquitoes (Mulla 1974a, Schaefer and Wilder 1973, Schaefer et al. 1974), it appears that these IGR compounds may be of no practical use against *Culicoides* species. It should be noted, however, that our results may not accurately reflect the intrinsic susceptibility of *C. variipennis* to these chemicals, since the calculation of percent inhibition of emergence did not include dead adults. Significant post emergent mosquito mortalities have been reported for methoprene (Schaefer and Wilder 1973) and Dimilin (Arias and Mulla 1975) treatments of 4th instars. The work of Hsieh and Steelman (1974) indicates that related species may vary widely in susceptibility to IGRs. Certainly, additional species must be tested before the usefulness of IGRs against Ceratopogonidae can be fully assessed.

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## 2467 9

#### TESTS OF RESMETHRIN WITH SEVERAL SYNERGISTS IN A LABORATORY WIND TUNNEL AGAINST CAGED ADULT MOSQUITOES

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The following research was conducted with resmethrin (SBP-1382) alone and synergized 1:3 with hexanediol, omite, sulfoxide or piperonyl butoxide to determine the effects of the various synergists on the control of adult mosquitoes. The technical resmethrin was a 40% concentrate, and the technical synergized compounds were formulated to contain 15g. of resmethrin plus 45g. of synergist per 100 ml. All compounds were supplied by S. B. Penick and Company.

The testing procedure consisted of exposing