LABORATORY AND FIELD EVALUATION OF THE IGR FENOXYCARB AGAINST MOSQUITOES[1]

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ABSTRACT. A new juvenile hormone mimic [fenoxycarb or RO13–5223 ethyl-(*p*-phenoxyphenoxy) ethylcarbamate] was evaluated in the field against *Culex tarsalis* in stagnant water ponds, *Psorophora columbiae* and *Aedes melanimon* in irrigated pastures. This material, showing high level of activity against *Cx. quinquefasciatus* in laboratory, was found to be highly effective against field populations of the 3 former species. A 5% attaclay granular formation yielded 100% inhibition of emergence in *Cx. tarsalis* at the rate of 0.1 lb/acre ai, 2 days after treatment. The extent of control declined markedly 7 days after treatment. An EC and 1% sand coated granular formulation yielded poor control providing 91 and 69% inhibition of emergence 2 days posttreatment at the high rate of 0.25 lb/acre ai.

The 2 flood water mosquitoes were about 10 × more susceptible than *Cx. tarsalis*. The EC and 1% attaclay granular formulations produced 100% inhibition of emergence of the floodwater mosquitoes *Ps. columbiae* and *Ae. melanimon* in irrigated pastures at the rate of 0.01 lb/acre ai, while *Cx. tarsalis* required 0.1 lb/acre ai for this level of EI. Most of the mortality in treatments with this insect growth regulator was noted in the pupal stage, very few dying in the larval stage or as adults upon emergence. From extensive field studies, it can be concluded that fenoxycarb has excellent potential in operational mosquito control programs.

INTRODUCTION

A number of insect growth regulators have been evaluated in the laboratory and under field conditions against stagnant and flood water mosquitoes (Dame et al. 1976, Mulla et al. 1974). Some of these materials such as methoprene, diflubenzuron, and Bay Sir 8514 exhibited excellent activity against field populations of *Culex tarsalis* Coquillett, *Aedes nigromaculis* (Ludlow) and *Psorophora columbiae* (Dyar and Knab) in California at rates ranging from 0.005–0.10 lb/acre ai (Mulla and Darwazeh 1975, 1979). Some of these IGRs were also equally effective against susceptible and OP resistant strains of *Aedes taeniorhynchus* (Wiedemann) and *Anopheles quadrimaculatus* Say (Dame et al. 1976). In studies conducted thus far, the urea type IGR diflubenzuron was the most effective material tested against mosquito species in irrigated pastures, fresh water ponds, and anaerobic animal waste lagoons (Axtell et al. 1980), Mulla and Darwazeh 1975).

Recently, a novel nonneurotoxic carbamate, IGR fenoxycarb (RO13–5223) exhibited a strong juvenile hormone type activity against several pests of economic and medical importance such as scale insects, mosquitoes, stored product insects and fire ants (Dorn et al. 1981, Kramer et al. 1981, Peley 1982). Fenoxycarb inhibited emergence of adults of the northern house mosquito *Culex pipiens* Linn. for 3 weeks at a concentration of 0.1 ppm, while methoprene and diflubenzuron, at the same conc., lost their activity within 1 and 2 weeks after treatment respectively (Dorn et al. 1981).

The following studies were initiated to evaluate the effectiveness of fenoxycarb against several mosquito species in the laboratory and field, and to determine the effective rate of application for the control of each species in different habitats. In addition, data on the impact of this material on selected nontarget insects coexisting with *Cx. tarsalis* larvae at time of treatment were also gathered.

METHODS AND MATERIALS

Technical grade material and 4 formulations of the IGR fenoxycarb [Ethyl-(*p*-phenoxyphenoxy) ethylcarbamate] were provided for evaluation by Maag Agrochemicals, Vero Beach, FL. The 4 formulations were emulsifiable concentrate (EC 1), 1% sand coated granules, and 1 and 5% fine textured attaclay (30/60 mesh) granules. The technical grade material was evaluated in the laboratory against 4th-instar larvae of *Culex quinquefasciatus* Say, while the 1% sand coated and 5% attaclay granules were tested along with the EC 1 formulation against *Cx. tarsalis* in fields ponds at the Aquatic and Vector Control Research Facility in the Coachella Valley of Southern California. The EC 1 formulation and the 1% attaclay granules were tested against the floodwater mosquitoes *Psorophora columbiae*

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(Dyar and Knab) in Palo Verde Valley of southern California, and against *Aedes melanimon* Dyar in Owens Valley, Inyo Country, California.

LABORATORY EVALUATION. One percent stock solution (w/v) of the technical grade material was prepared in acetone, and serial dilutions were prepared in acetone as needed. The required amount of the proper strength solution (0.1–1.0 ml) was added to 10-oz disposable salad foam bowls (Dixi Marathon Product, American Can Co., Greenwich, CT, 06830) containing 20 4th-instar larvae of *Cx. quinquefasciatus* in 200 ml of tap water. The material was tested on 2 different occasions at 5 different concentrations in triplicate. Along with each test, 3 bowls were left untreated, while 3 bowls were treated with 1 ml of acetone each as checks.

Test organisms were fed brewer's yeast-lab chow mix (1:3) immediately after treatment, and placed in a holding room where temperature was maintained constant at 26°C ± 1. Mortality readings were taken 24 and 48 hr after treatment, and every 3 days thereafter, until all surviving organisms reached the adult stage. On each scheduled reading, dead larvae, pupae, and adults were counted and removed, and normal adult emergence was assessed by counting and removing completely separated pupal exuviae. Larvae utilized in these studies were obtained from a laboratory reared colony at the University of California, Riverside. Only 4th-instar larvae were used as these are difficult to kill with many insecticides. It is also important to note that most IGRs, especially the juvenile type of compounds, induce mortality in the pupal stage rather than the larvae.

All mortality values obtained for each concentration tested were subjected to statistical analysis using linear regression analysis. For brevity purposes the LC_{50} and LC_{90} values in mg/liter were determined.

FIELD EVALUATIONS. *Experimental Ponds.* Studies were conducted at the Aquatic and Vector Control Research Facility in the Coachella Valley of southern California, and detailed description of this facility was published by Mulla et al. (1982). In brief, the facility consists of 64 ponds in 8 rows, each pond measures 18 × 18 ft (30 m^2), and with a cover of bermuda, nut and crab grasses, ranging in length from 3–6 in. Water (pH 9.4) to each pond is supplied from an artesian well, through underground pipeline, and water depth was maintained constant (12 in) by float valves.

Formulations tested in the ponds included the EC 1, 1% sand coated and 5% attaclay granules. The 3 formulations were tested at 0.1 and 0.25 lb/acre ai, utilizing 2 replicates for each rate, and 2 ponds were left untreated. The 1% sand coated and 5% attaclay granules were applied with a salt and pepper shaker provided with an adjustable opening to insure good coverage. The required amount for each rate of EC 1 formulation was mixed with 120 ml of tap water, and applied with a polyethylene squeeze bottle. Mosquito larval population at time of treatment consisted of all the aquatic stages of *Cx. tarsalis.*

To assess the effect of these formulations on larval populations and nontarget organisms prevailing during the duration of these studies, 5 dips per pond were taken prior to treatment and 2, 7, 14 and 21 days after treatment. The 5 dips on each sampling date were combined into 1 sample, preserved in 60% ethyl alcohol, and organisms present were counted and identified under a dissecting microscope in the laboratory. In addition, 2 and 7 days after treatment, 40 4th-instar larvae from each treated and untreated pond were collected and 20 larvae placed in each of 2 isolation units per pond. These units described elsewhere (Mulla et al. 1974), consist of 1 qt polystyrene cups with screen lids, floated inside a styrofoam ring float. Four holes, 4 cm diam each, are spaced and cut around the periphery of the cup, 1.5 cm from its base (retaining small amount of water when the units were removed for assessment), and 100 mesh brass strainer cloth is soldered over the holes to keep out predators and young mosquito larvae. For ventilation, the entire center of the lid is removed, and a 50 mesh brass hardware cloth is soldered to the remaining ring. These sentinel or isolation units floated freely in the pond, providing natural pond conditions for the isolated larvae. Every 3–4 days after larval isolation and placement in the units, mortality readings were taken, and dead organisms were counted and removed, until all surviving organisms reached the adult stage. Inhibition of emergence (% EI) was calculated on the basis of the numbers of larvae placed in the cages. This type of assessment is necessary for determining activity of IGRs which have delayed effect, inducing mortality in stages beyond the treated larval stage.

Irrigated pastures. Against larvae of the floodwater mosquitoes *Ps. columbiae* and *Ae. melanimon,* only EC 1 and 1% fine textured attaclay granules were tested at 0.005, 0.01 and 0.025 lb/acre ai. Against *Ps. columbiae,* tests were conducted in tailwater ditches and in plots in the lower portion of irrigated pastures. The EC 1 formulation was tested in ⅛ acre plots, while the 1% granules were applied either in 0.25 or 0.5 acre plots, depending on the size of mosquito breeding area. In all tests, 2 replicates for each rate of application of each formulation, were established in the same irrigation check,

and 2 checks in the same field were left untreated as controls. These studies were conducted at Halby alfalfa tailwater ditch, located on 6th Ave., west of Highway 95, north of Blythe, and at Bill Luis pastures, located on Keim Blvd. and 18th Ave., south of Blythe, California.

Pastures in the Owens Valley, Inyo County, are considered open range pastures, and irrigated through flood irrigation, without irrigation borders. Therefore, water accumulates in the low spots in the field, where larvae of *Ae. melanimon* were found to be extremely heavy. One-eighth acre plots, 2 per location, were utilized for each rate of application, and 2 plots in a different area of the same field were left untreated as checks. Tests were conducted in Bishop, California, at Jack Tatum pasture, Highway 6 and Dixon Lane; Rob Pierce pasture, Warm Springs Rd., 2 miles east of Highway 395; and Bishop Sewer Farm, Line St. and Airport Dr.

In order to assess the effect of each formulation against floodwater mosquito larvae, 10 dips per plot were taken prior to treatment, and 1, 2, 3 and 4 days after treatment. For assessment of inhibition of emergence, 24 and 48 hr after treatment, larval and pupal cohorts were collected from each treated and untreated plot and 20 larvae or pupae from each plot were placed in 4-oz disposable ice cream cups (Sweetheart Cup Div., Baltimore, MD) containing 100 ml of field water, from which the larvae and pupae were collected. The cups were replicated 3 times, thus using 60 organisms per plot or 120 per treatment. Larval and pupal isolates were placed in the laboratory at the University of California White Mountain Research Station, Bishop, California, where temperature was maintained constant at 27±1°C.

In all field experiments, water temperature was monitored with a minimum-maximum recording thermometer during the duration of each test, and these are shown in the tables. Due to the natural fluctuation in the numbers of larvae and pupae of *Cx. tarsalis* in untreated ponds, and the substantial increase in the number of larvae and pupae of flood water mosquitoes in untreated plots, % reduction (R) was calculated according to the formula of Mulla et al. (1971); $\% R = 100 - \left(\frac{C1}{T1} \times \frac{T2}{C2}\right) \times 100$, where C1 = mean no. of larvae and pupae in check pretreatment, C2 = mean no. of larvae and pupae in check posttreatment, T1 = mean no. of larvae and pupae in treated pretreatment, and T2 = mean no. of larvae and pupae in treated posttreatment. In calculating %R for *Cx. tarsalis* only 3rd–4th instars and pupae were used.

RESULTS AND DISCUSSION

LABORATORY. Dosage response line for fenoxycarb was established against 4th-instar larvae of *Cx. quinquefasciatus* using several concentrations of the technical material prepared in acetone. The effective concentration providing 90% inhibition of emergence was calculated to be 0.02 mg/liter. This range of activity was comparable to that of other IGRs. In earlier studies (Mulla and Darwazeh 1979), diflubenzuron and methoprene were found to induce 90% inhibition of adult emergence in *Cx. quinquefasciatus* at the concentrations of 0.015 and 0.05 mg/liter respectively. From these findings, it appeared that fenoxycarb was more active than methoprene, and almost as active as diflubenzuron. However, diflubenzuron showed good larvicidal activity, while bulk of mortality occurred in the pupal stage following larval exposures to methoprene and fenoxycarb. In the effective range of concentrations, diflubenzuron induces mortality in the interstadial periods, while the other two IGRs do not exhibit this larvicidal property, mortality occurring in stages beyond the treated stage.

FIELD. Against stagnant-water mosquito larvae, substantial reduction in the larval and pupal population of *Cx. tarsalis* was apparent at the rate of 0.25 lb/acre ai with 2 of the formulations tested (Table 1). The EC and 5% granular formulations yielded a maximum overall reduction of 83% and 64% in the immatures respectively at this high rate of application, the lower rate producing little or no reduction when compared to the untreated populations.

As noted above, this material does not induce high mortality in 4th-instar larvae in laboratory, but when combined mortality is assessed for larvae, pupae and adults, marked reduction was noted. Some mortality occurred in the larval and adult stages, but greater mortality occurred upon pupation of the 4th-instar larvae (Table 2). The 5% attaclay granules were the most effective material resulting in no emergence of viable adult in cohorts isolated 2 days after treatment at both rates applied, while 40 and 49% inhibition in emergence occurred in cohorts where larvae were isolated 7 days after treatment at 0.10 and 0.25 lb/acre ai respectively. The EC 1 formulation caused 69% inhibition of emergence at the low rate of 0.1 lb/acre ai, while the high rate of 0.25 lb/acre ai caused 91% inhibition of emergence in cohorts where larvae were isolated 2 days after treatment. Both rates exhibited low activity against larval cohorts isolated 7 days after treatment. The 1% sand coated formulation was the least effective material, causing 52 and 69% inhibition of emergence in cohorts isolated 2 days after treatment at 0.1 and 0.25 lb/acre ai re-

Table 1. Evaluation of various formulations of the IGR fenoxycarb against *Culex tarsalis* larvae in experimental ponds.[a]

Pre- and post-treatment (days)	Mean no. of larvae and pupae/5 dips and % reduction at indicated rates[b]							
	0.10 lb/acre			0.25 lb/acre			Untreated	
	3–4	P	% R	3–4	P	% R	3–4	P
	EC 1							
Pre-	26	13	—	73	9	—	57	8
2	31	4	9	54	15	15	48	16
7	11	7	30	7	2	83	28	15
14	49	1	0	22	0	69	56	1
21	19	12	4	34	3	46	50	4
	1% sand coated granules							
Pre-	37	6	—	33	7	—	57	8
2	32	7	8	29	4	16	48	16
7	10	18	2	17	8	6	28	15
14	36	1	2	39	5	0	56	1
21	26	2	22	74	13	0	50	4
	5% attaclay granules							
Pre-	36	3	—	69	6	—	57	8
2	49	3	0	75	11	0	48	16
7	18	12	0	20	9	42	28	15
14	33	0	4	24	0	64	56	1
21	18	2	38	38	2	36	50	4

[a] Water temp. 18° min–24°C max.
[b] % Reduction calculated by Mulla's formula, based on larvae (3rd and 4th) and pupae.

spectively, and both rates caused only 10 and 11% inhibition of emergence 1 week after treatment (Table 2). It seems that the 5% attaclay granular formulation has good efficacy even at the low rate of 0.1 lb/acre ai, but activity declining in all treatments 7 days later.

Several tests were conducted against floodwater mosquitoes. In the first test conducted in a tailwater ditch in irrigated pastures, the EC 1 and 1% attaclay granules were highly active against *Ps. columbiae* larvae, and both formulations were equally effective, producing considerable mortality in larvae and pupae at 0.025 and 0.05 lb/acre ai (Table 3). Mortality was gradual, occurring upon pupation, and bulk of mortality occurred 2–3 days after treatment. The decline in larvae and pupae in the untreated plots was due to transformation to the pupal and adult stages. However, the decline in larval and pupal population in the treated plots was steeper and there was no emergence of adults. For precise evaluation of inhibition of emergence, pupal cohorts (120 pupae/treatment) from those surviving were isolated and studied in laboratory for mortality and adult emergence. Complete inhibition of emergence was obtained in the pupal isolates, which were collected from the same plots 2 days

Table 2. Efficacy of various formulations of the IGR fenoxycarb against larvae of *Culex tarsalis* in experimental ponds.

Formulation	lb/acre	% Cumulative mortality and % EI in larval isolation units after treat. (days)							
		2				7			
		L	P	A	% EI	L	P	A	% EI
Ec 1	0.10	7	49	13	69	5	2	0	7
	0.25	12	79	0	91	13	22	4	39
1% G	0.10	23	20	9	52	0	7	3	10
sand coated	0.25	29	36	4	69	4	3	4	11
5% G	0.10	19	78	3	100	8	25	7	40
attaclay	0.25	28	67	5	100	11	29	9	49
Untreated	—	7	4	0	11	3	4	0	7

Table 3. Evaluation of two formulations of the IGR fenoxycarb against larvae of *Psorophora columbiae* in alfalfa tailwater ditch.[a]

Pre- and post-treatment (days)	Mean no. of larvae and pupae/10 dips and % reduction at indicated rates								
	0.025 lb/acre			0.05 lb/acre			Untreated		
	L	P	% R	L	P	% R	L	P	A[b]
	1% attaclay granules								
Pre-	256	0	—	370	0	—	473	0	0
1	62	260	40	66	285	55	437	562	0
2	38	97	77	3	73	87	350	715	0
3	0	85	76	0	73	86	0	302	350
4	0	0	100	0	0	100	0	25	471
	EC 1								
Pre-	258	0	—	283	0	—	473	0	0
1	243	70	81	310	180	18	437	2	0
2	143	75	92	51	69	81	350	5	0
3	0	45	97	0	30	92	0	2	50
4	0	0	100	0	0	100	0	5	71

[a] Tested in tailwater ditch in plots size (15 x 50 ft), water temp. 27° min–39°C max. %R by Mulla's formula, based on larvae and pupae.

[b] Adult counts based on the number of pupal exuviae/10 dips. Very few or no adults emerged in the treated plots.

after treatment (data not presented). Inhibition of emergence from pupae isolated from untreated plots was only 6%. This field test clearly demonstrated that fenoxycarb is much more active against *Ps. columbiae* than against *Cx. tarsalis* in the field.

To find the lowest effective dosage against *Ps. columbiae*, the same formulations were applied in another test at lower rates in field plots and in tailwater ditches. On the basis of dipping sampling the 1% attaclay granules produced 90 and 97% overall final reduction in the immatures at the rates of 0.005 and 0.01 lb/acre ai respectively (Table 4). The EC produced essentially similar results in the tailwater ditch and field plots at the same rates. As noted in the first test against this species, there was sharp decline in larval and pupal populations in the untreated plots due to progressive development and transformation into pupae and adults. There was little emergence in the treated plots and the reduction in immatures was due to mortality. More precise assessment was ascertained in pupal isolates (120 pupae per treatment) which were collected 2 days after treatment from the same plots as shown in Table 4. Here, the 1% attaclay granules were also found to be more active at the low rate of 0.005 lb/acre ai, causing 91% inhibition of emergence, while the same rate of the EC formulation caused only 63 and 43% inhibition of emergence in the pupal isolates in tests A and B respectively (data not presented). At the high rate (0.01 lb/acre), the EC formulation yielded 93% EI in both tests A and B while the granular formulation produced 100% inhibition of emergence. From these data, it is clear that the EC formulation is somewhat less effective than the granular formulation.

Five experiments were conducted in irrigated pastures against *Ae. melanimon*. The same 2 formulations (EC and 1% attaclay granules) were tested in irrigated pastures in Owens Valley, in the vicinity of the City of Bishop, Inyo County, California. In 2 separate tests, the 1% attaclay granules were applied at the rates of 0.01 and 0.025 lb/acre ai. In test A, the field dried up 3 days after treatment, prior to the end of the experiment, while in test B complete control was obtained at both rates applied (data omitted). As in *Ps. columbiae* studies, bulk of mortality occurred upon pupation, 2–3 days after treatment. Larval and pupal isolates (120 of each stage per treatment) collected from plots treated with the 1% attaclay granules, 24 and 48 hr after treatment, respectively, further confirmed these findings. Mortality in the larval isolates occurred upon pupation, and complete mortality was obtained in the pupal isolates at both rates applied, thus yielding 100% inhibition of emergence.

In 3 additional tests similar results, as with 1% attaclay granules, were obtained with the EC formulation at the same rates of 0.01 and 0.025 lb/acre ai againat *Ae. melanimon*. Three applications of EC 1 formulation were made at the rate of 0.01 lb/acre, and 2 applications were made at the high rate of 0.025 lb/acre ai. At both rates, in 2 tests, larval population began to decline drastically 2 days after treatment, but the plots dried up before the end of the ex-

Table 4. Evaluation of various formulations of the IGR fenoxycarb against larvae of *Psorophora columbiae* in irrigated pastures

Pre- and post-treatment (days)	Mean no. of larvae and pupae/10 dips and % reduction[a] at indicated rates								
	0.005 lb/acre			0.01 lb/acre			Untreated		
	L	P	% R	L	P	% R	L	P	A
	EC 1, Test A[b]								
Pre-	405	0	—	385	0	—	432	0	0
1	590	0	0	325	0	16	445	0	0
2	0	350	14	2	218	43	45	380	0
3	0	315	22	0	94	76	0	275	51
4	0	0	86[e]	0	0	98[e]	0	0	340
	EC 1, Test B[c]								
Pre-	191	0	—	205	0	—	154	0	0
1	302	0	0	168	0	0	390	0	0
2	0	312	0	0	188	0	0	400	0
3	0	492	0	0	85	59	0	258	61
4	0	0	60[e]	0	0	97[e]	0	0	395
	1% *attaclay granules, Test C*[d]								
Pre-	160	0	—	205	0	—	215	0	0
1	19	120	13	37	113	27	80	160	0
2	60	167	0	57	116	16	125	185	0
3	0	5	90[e]	0	3	97[e]	0	17	275

[a] % Reduction by Mulla's formula, larvae and pupae included.
[b] Tested in a narrow tailwater ditch divided into plots (120 ft x 2.5 ft), water temp. 28° min.–38°C max.
[c] Tested in field plots (120 ft x 45 ft), water temp. as above.
[d] Tested in field plots 161 ft x 135 ft or ½ acre, water temp. 28° min.–39°C max.
[a] Pupal exuviae were present indicating some adult emergence.

periment in test A. In the 3rd test, due to cool temperatures, the rate of development was quite slow and larvae and pupae prevailed in large numbers for longer period. In warmer weather, the immatures change into adults in 3–4 days. Sampling of field populations of larvae and pupae were therefore discontinued after 7 days.

Isolation procedures, however, yielded critical data for all 3 tests where both rates induced complete inhibition of emergence from the larval and pupal isolates (Table 5). In test C, the treatments were made at Bishop Sewer Farm, where sewage water was used for irrigation of pastures. It is worthy to note that this material at the lower rate applied (0.01 lb/acre) was equally effective in clear as well as in polluted water for the control of the pasture mosquito *Ae. melanimon* producing complete inhibition of emergence. The lowest effective rate for *Ae. melanimon,* however, was not determined. It is very likely that a rate of 0.005 to 0.01 lb/acre ai will yield 95% or better control of this floodwater mosquito.

In general, these findings indicate that floodwater mosquitoes (*Ps. columbiae* and *Ae. melanimon*) are 10-fold more susceptible to the IGR fenoxycarb than the stagnant water mos-

Table 5. Evaluation of the IGR fenoxycarb (EC 1) against *Aedes melanimon* in irrigated pastures.

Rate lb/acre	% Cumulative mortality and % EI in isolation units				
	Larval isolates			Pupal isolates	
	L	P	%EI	P	%EI
	Test A				
0.010	0	100	100	100	100
0.025	25	75	100	100	100
Untreated	0	0	0	5	5
	Test B				
0.010	0	100	100	100	100
0.025	0	100	100	100	100
Untreated	5	0	5	4	4
	Test C				
0.01	0	100	100	100	100
Untreated	0	0	0	0	0

[a] 20 larvae or 20 pupae isolated 24 hr and 48 hr posttreatment, respectively, 3 replicates per treatment. A total of 120 larvae or 120 pupae collected from field and kept in field water for emergence in laboratory.
[b] Pupae were also isolated 3, 4, and 5 days after treatment, and results were similar to those for the 48 hr treatment isolation.

quito *Cx. tarsalis*. At the rate of 0.01 lb/acre ai, both formulations (1% attaclay granules and EC 1) produced highly satisfactory control of floodwater mosquitoes, while 0.1 and 0.25 lb/acre ai were required for satisfactory control of the asynchronous stagnant water mosquito. The experimental 1% attaclay granules, however, are light in density and tend to drift. Due to the high activity of this IGR against floodwater mosquitoes, it is difficult to apply the required small amount of 1% granules over a large area and achieve adequate coverage under field conditions. It will be advantageous to prepare and test 0.25 to 0.5% granules, characterized with larger particles to facilitate good coverage, to avoid drift, and to insure penetration in heavy vegetation.

During the duration of the study conducted against *Cx. tarsalis* in experimental ponds in the Coachella Valley, several aquatic nontarget organisms were present and sampled in substantial numbers. These organisms included mayfly naiads (*Calibaetis pacificus* Seeman), dragonfly naiads (*Erythemis simplicicollis* Say and *Anax junius* Drury), and a number of species of diving beetle larvae (Dytiscidae and Hydrophilidae). None of the formulations utilized at the rates applied (0.1–0.25 lb/acre ai) exhibited any marked harmful effects on these organisms (data omitted). These nontarget insects persisted in good numbers in treated and untreated ponds during the duration of the experiment.

In conclusion, the IGR fenoxycarb is a highly effective mosquitocidal compound, which could be used effectively for the control of culicine mosquitoes at the rate of 0.1 lb/acre ai or higher with good margin of safety to nontarget organisms. Floodwater mosquitoes, on the other hand, are much more susceptible (10-fold), and satisfactory control of *Ae. melanimon* and *Ps. columbiae* could be obtained at the low rate of 0.01 to 0.025 lb/acre ai under most typical conditions. This compound is likely to provide effective control of synchronous and asynchronous mosquitoes in many types of breeding sources.

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