CHEMICAL CONTROL OF AQUATIC NUISANCE MIDGES IN RESIDENTIAL-RECREATIONAL LAKES[1]

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ABSTRACT. Chironomid midge larval densities were studied in Silver Lakes, from March–November, 1979. Midges of quantitative importance from Mar-May included species of *Tanytarsus, Procladius* and *Chironomous. Chironomus decorus* and *Procladius* spp. were most prevalent from Jun–July with the former most abundant from August–November.

Chemical abatement measures included the O–P insecticide Abate and 2 urea-type IGR's, Dimilin® and Bay SIR-8514. Applications of Abate at 0.28 kg AI/ha eliminated *Tanytarsus* spp from the benthic samples up to 2 wk posttreatment but had no effect on species of *Procladius* or *Chironomus*. Higher treatment rates, 0.33 kg AI/ha and 0.56 kg AI/ha, similarly had no effect on larval numbers of *Procladius* or *Chironomous* (mainly *decorus*).

Dimilin and Bay SIR-8514 applied at rates of 0.11 and 0.28 kg AI/ha effectively suppressed adult emergence of species of *Tanytarsus* and *Procladius* for up to 2 wk posttreatment, but neither IGR was effective against the more pestiferous midge species *C. decorus*. Coinciding with the IGR treatments was a decline in larval numbers suggesting that the compounds possess larvicidal capabilities.

Research on nuisance chironomid midges produced in residential-recreational lakes in southern California has been conducted for a number of years (Ali and Mulla 1977, 1978; Ali et al. 1978; Johnson and Mulla 1980, Mulla 1974; Mulla et al. 1974, 1975, 1976). Much of this research has been directed toward suppression of nuisance levels of midges using various chemicals, e.g. organophosphorus compounds and IGR's (Ali and Mulla 1977; et al. 1971, 1975, 1976). While many of these insecticides have resulted in adequate control, difficulties have been encountered such as market availability, escalating prices, natural and acquired resistance to the available chemicals (Ali and Mulla 1977). Even though these problems exist, lake residents and users are still in need of practical abatement measures. During 1979 the midge research program at Silver Lakes at Helendale on the Mojave Desert of California involved monitoring the midge larval population densities and the application of larvicidal chemicals. In addition, 2 urea-type insect growth regulators were evaluated in the lakes for efficacy against different midge species. Reported here are the results of this evaluation program and the problems encountered in effectively suppressing nuisance levels of chironomid midges.

MATERIALS AND METHODS

This research was conducted in Silver Lakes located at 800 m elevation, 26 km north of Victorville, San Bernardino County, CA. The 2 lakes in this new modern planned community, North and South Lakes, were previously described by Ali and Mulla (1977).

South Lake was treated 3 times during 1979. The first 2 treatments were made using a 1% granular formulation of the O–P insecticide Abate. The first Abate treatment was applied on May 14, 1979 at the rate of 0.28 kg AI/ha to all the fingers and one-half the surface acreage of the

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shallow areas of the main area. The 2nd treatment on June 20, 1979 was made at a slightly higher rate of 0.33 kg AI/ha again treating all fingers and one-half of the shallow main area acreage. The 3rd treatment of South Lake took place on August 7, 1979 when the IGR's Bay SIR-8514 and Dimilin® were employed. Each IGR was applied at the rates of 0.11 and 0.28 AI/ha to 2 fingers at each rate. Two untreated fingers served as the check.

In the North Lake, 2 Abate (1% G) treatments were made on 3 April and 11 June 1979 treating the 9 fingers and one-half of the surface acreage of the shallow portions in the main area at 0.28 kg AI/ha. A 3rd treatment, September 25, 1979, was made in 2 fingers, one treated at 0.28 kg AI/ha and one treated at 0.56 kg AI/ha. A 3rd untreated finger served as the check. A 4th treatment of this lake was made by using 25% WP formulations of the IGRs Bay SIR-8514 at treatment rates of 0.11 and 0.28 kg AI/ha and Dimilin at 0.28 kg AI/ha.

The 1% Abate granular larvicide was applied to the lakes by a battery operated Cyclone Spreader mounted on the front of a double-hulled pontoon boat (Mulla et al. (1973). Four to 8 swaths were made in fingers and 20–30 swaths were made along the shore line of the main areas of the lakes. The WP formulations were mixed with water in an 11–1 pressurized hand sprayer and applied in the prop wash of the outboard motor of the boat. The same number of swaths were made for the WP treatments as for the granular treatments.

Larval midge populations in North and South Lakes were assessed weekly or semi-monthly from February–December 1979 by using an Ekman dredge (Mulla et al. 1971). Two random dredge samples were taken from the distal third of each finger and 10 from various locations in the main areas of each lake. Larvae were separated from the bottom mud according to Mulla et al. (1971) and sorted in the laboratory by the procedures of Ali et al. (1977). Larvae were counted and taxonomic determinations were made according to Mason (1968) and Oliver et al. (1978).

MIDGE POPULATION DENSITIES IN THE LAKES. The larval population densities in South Lake are graphically shown in Figure 1. The average number of larvae/0.09 m^2 (1 $ft.^2$) of bottom sediment in the South Lake was less than 100 in both the main area and fingers during March and by mid-May exceeded 350 in the fingers and about 200 in the main area. The first Abate treatment reduced the larval density somewhat but not markedly. The larval populations during this period consisted primarily of species of *Tanytarsus* (34–62%) and *Procladius* (32–49%) with some *Chironomus, Dicrotendipes* and *Cricotopus* spp. As seen in Figure 1 the larval populations in South Lake steadily increased through June reaching a peak of more than 725 larvae/0.09 m^2 in the main area and fingers by July 10. A 2nd treatment with Abate granules resulted in no suppression of the larvae. The population density in this lake began to decrease after mid-July and by the end of August reached a low of 60 larvae/0.09 m^2 in the main area and 110 larvae/0.09 m^2 in the fingers. Part of this decline, although not all of it, was due to the treatment by the IGRs. The bulk of the midge fauna during June–July was *Chironomus decorus* Johannsen and *Procladius* spp., each comprising about 40–45% of the collected larvae. Beginning in August a noticeable shift occurred with *C. decorus* comprising up to 95% of the fauna. This species remained predominant from August–November.

The larval numbers in North Lake showed greater fluctuation than in South Lake (Figure 2). During March–May the larval numbers ranged from 100–500 larvae/0.09 m^2 (ft^2) in the main area and from 50–200 larvae/0.09 m^2 in the fingers. The first Abate treatment produced moderate level of suppression of larvae for short periods. During this period *Tanytarsus* was the predominant midge (42–61%) followed by species of

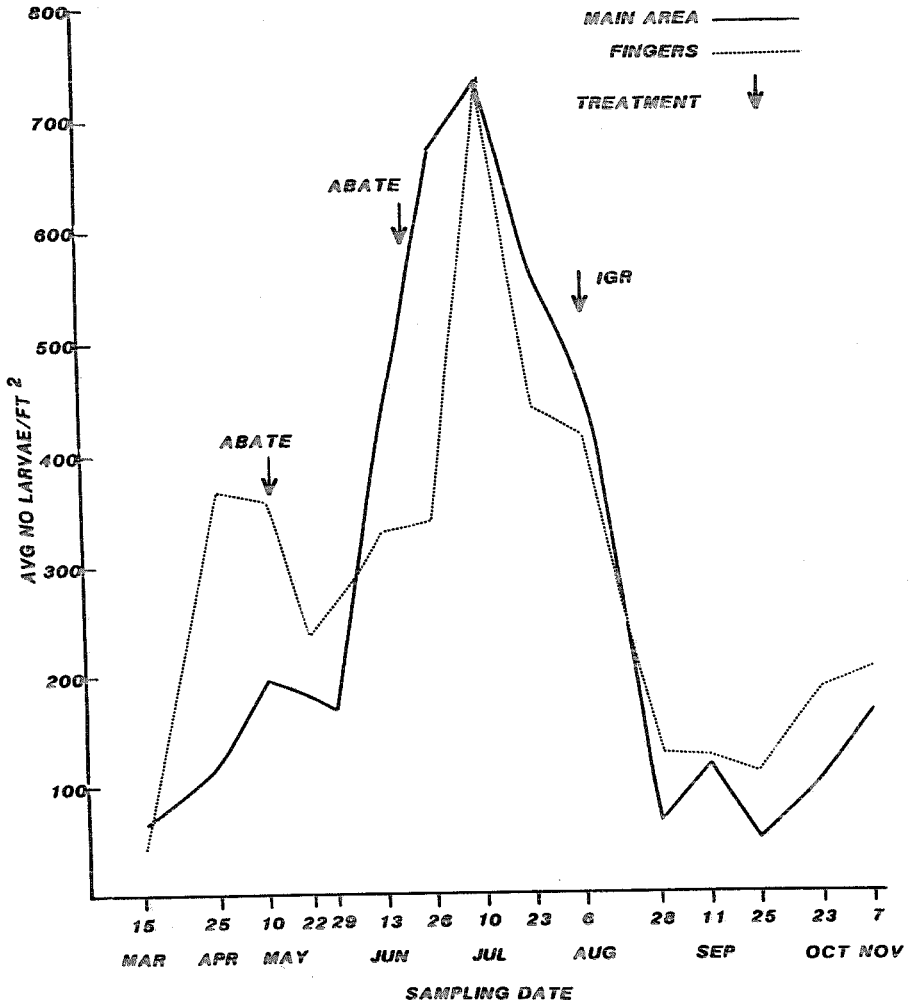

Fig. 1. Average number of larvae/0.09 m^2 (ft^2) collected from portions of South Lake.

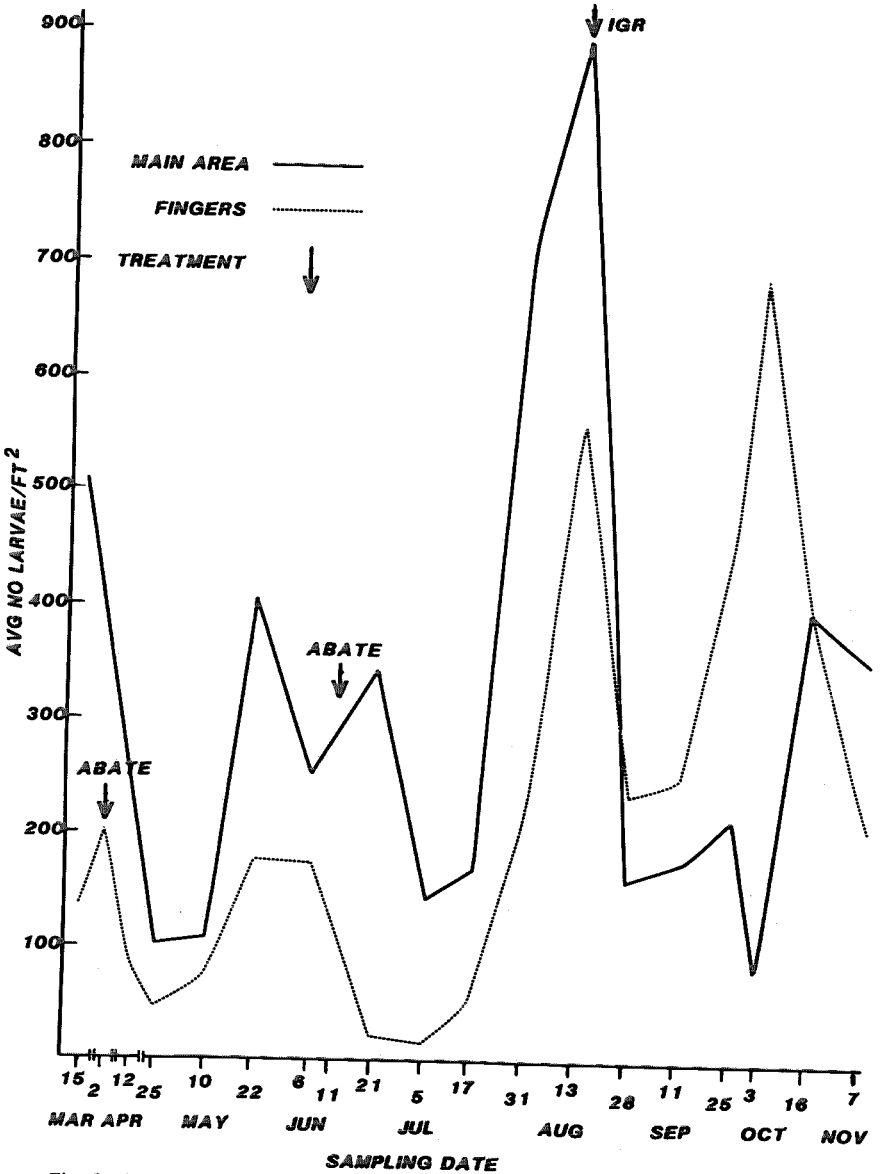

Fig. 2. Average number of larvae/0.09 m² collected from portions of North Lake.

Chironomus and *Procladius*. Larval numbers oscillated during June but they increased dramatically in July and peaked during early August at 550 larvae/0.09 m² in the fingers and about 900 larvae/0.09 m² in the main area. At the peak of the larval populations, the fingers and the main part of the North Lake were treated with the IGRs Bay SIR 8514 and Dimilin. This treatment resulted in marked suppression of larval populations. During June-August a noticeable difference was noted in midge composition between the main area and fingers. In the main area, *C. decorus* comprised over 50% of the midge fauna with species of *Tanytarsus* and *Procladius* representing 40–45% of the collected larvae. In the fingers *Procladius* was predominant with some *tanytarsus*, but until mid-August *C. decorus* was absent from the finger benthic samples. From August–November the larval populations remained above 100 larvae/0.09 m² in both the main area and fingers with *C. decorus* comprising over 90% of the midge fauna.

CHEMICAL TREATMENTS OF SOUTH AND NORTH LAKES. The first Abate treatment of South Lake 0.28 kg AI/ha resulted in a slight reduction of the larval densities from 350/0.09 m² to approximately 225 larvae/0.09 m² by post-treatment (Figure 1). At the 1 wk posttreatment sampling date *Tanytarsus* larvae, a predominant midge species during this time, was eliminated from the benthic samples while species of *Procladius* and *Chironomus* appeared to be unaffected. By the 2nd week posttreatment the effects of this Abate application on *Tanytarsus* had diminished as observed by an increase in their numbers.

The 2nd Abate treatment at 0.33 kg AI/ha had no effect on the larval numbers (Figure 1). During this treatment period *Chironomus* and *Procladius* larvae were predominant and these midge species are known to be resistant to this organophosphorus insecticide (Ali and Mulla 1977).

The 3rd treatment of South Lake was made using the insect growth regulators (IGR) Bay SIR-8514 and Dimilin. These compounds are urea-type and interfere with the molting process of developing insects, i.e. rather than inducing high mortality in larvae outright, they have delayed effects preventing the adult midge from eclosing. For this reason in addition to taking pre- and posttreatment larval samples it was also necessary to assess the number of emerging adults from the treated and untreated areas before and after treatment. The results of these IGR treatments are presented in Table 1. In the Dimilin treated fingers no reduction in the numbers of emerging adults was recorded by 2 days posttreatment at either 0.11 or 0.28 kg/ha treatment rates. However, by 7 days posttreatment the numbers of emerging adults declined to 12/m² in fingers treated at 0.11 kg AI/ha and 24.8/m² in fingers treated at 0.28 kg AI/ha. Adult emergence in the main area of South Lake dropped dramatically from 78 to 5.7 adults/m² 48 h after Bay SIR-8514 application at 0.11 kg/ha. This re-

Table 1. Efficacy of 25% WP formulation of IGRs in South Lake against nuisance midges.

Treatment	kg AI/ha	Av. no. adults/m²		
			Days Posttreatment[a]	
		Pretreatment	2	7
Dimilin	0.11	39.0	47.3	12.0
Dimilin	0.28	27.0	28.5	24.8
Bay SIR–8514 (main area)	0.11	78.0	5.7	5.0
Bay SIR–8514 (fingers)	0.28	43.5	36.0	11.3
Check	—	51.8	70.5	27.8

[a] All adults collected from treated portions 2 and 7 days were *Chironomus decorus*.

duction was due to the elimination of *Tanytarsus* spp. from the emergence traps. Similarly, a decrease in the number of collected adults occurred in the fingers treated at 0.28 kg AI/ha. By 7 days posttreatment the emerged adults/m² had continued to decline in the Bay SIR treated areas and in the untreated check. This reduction in the latter was presumably due to the high rate of diffusion characteristic of WP formulations (Mulla et al. 1976). It is important to note that all adult midges collected from samples of the treated portions of this lake 2 and 7 days posttreatment were *C. decorus*, and that the reduction in the number of emerged adults collected from the entire lake by 7 days posttreatment corresponded to a decline in benthic larval densities, which might be attributed to larvicidal activity exhibited by Bay SIR-8514 (Johnson and Mulla 1980) and Dimilin (Ali and Mulla 1977).

Three Abate treatments were made in North Lake during 1979. After the first treatment in North Lake at 0.28 kg AI/ha the larval numbers in the treated fingers dropped from 200 to less than 50/0.09 m² over a 3 week period. However, the larval densities also declined during this time in the main area which was untreated (Figure 2). This decline in the main area may have been a result of either a natural population decline or diffusion of Abate into the main area of the lake (Ali and Mulla 1977). Since *Tanytarsus* larvae were absent from the posttreatment benthic samples taken from the treated fingers and untreated main area, it is likely that diffusion of the chemical was responsible for this reduction.

As can be seen in Figure 2, the 2nd Abate treatment at 0.28 kg AI/ha had negligible effects on the larval densities in the main area. However, a reduction in larval numbers was noted in the fingers. As with previous treatments, species of *Tanytarsus* were mostly affected by Abate, while *C. decorus* and *Procladius* spp were least affected.

A 3rd application of Abate was made to 2 fingers of North Lake. These 2 fingers were found to contain over 90% *C. decorus* prior to treatment. As can be seen in Table 2 there was no reduction at the lower rate, 0.28 kg AI/ha, and little if any effect recorded at 0.56 kg AI/ha. If *C. decorus* was susceptible to this compound, then the larval densities in the treated fingers would most likely have declined markedly by 7 days posttreatment.

Table 2. Efficacy of Abate against *Chironomus decorus* (90%) in fingers of North Lake.

Treatment and rate (kg AI/ha)	Av. no. larvae/0.09 m²		
		Days Post-treatment	
	Pretreatment	5	7
Abate (0.28)	841	1,784	1,209
Abate (0.56)	1,443	1,126	1,155
Check —	1,056	726	1,372

The results of the IGR treatments made to North Lake are shown in Table 3. Pretreatment adult counts consisted primarily of *C. decorus* with some species of *Tanytarsus* and *Procladius*. By 2 days posttreatment some reduction in numbers of emerged adults was recorded in all treated fingers. The largest decrease from 36.6–12.2 adults/m² occurred in the fingers treated with Bay SIR-8514 at the 0.28 kg AI/ha rate. No suppression of adult emergence took place in the treated fingers at 7 days posttreatment, except in the untreated check. By 14 days posttreatment adult emergence was dramatically reduced in all portions of the lake (Table 3) including the check. This reduction coincided with the sharp decline in larval numbers (Figure 2) probably due to seasonal phenomena. As with South Lake all adults collected in samples from treated fingers 2, 7 and 14 days posttreatment were *C. decorus*.

Based on this work the use of the O-P insecticide Abate provided mediocre control of *Tanytarsus* midges (for about 7–10 days) and had no effect on species

Table 3. Efficacy of IGRs (25% WP) against chironomid midges in North Lake.

		Av. no. adults/m²			
			Days post-ment		
Treatment	kg AI/ha	Pre-treat-ment	2	7	14
Bay SIR	0.11	49	42	41	9
Bay SIR	0.28	37	12	16	4
Dimilin	0.28	17	14	20	3
Check	—	31	39	5	1

Note: All adults collected from treated portions 2, 7 and 14 days were *Chironomus decorus*.

of *Chironomous*, mainly *C. decorus*, or *Procladius*. Consequently, this larvicide will provide some relief for lake residents early in the midge season when species of *Tanytarsus* represent the bulk of the midge fauna, but not against the more pestiferous species such as *C. decorus*. The IGR compounds, Bay SIR-8514 and Dimilin, provided somewhat longer periods of control acting both as a larvicide and adulticide. However, natural tolerance by *C. decorus* to these urea-type IGR's render these compounds less useful. It is possible that temporary control of *C. decorus* may be achieved by increasing the application rate of these IGR's when applied to aquatic habitats in excess of 2 m deep.

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