MOSQUITO PRODUCTION ON A CALIFORNIA RICE FIELD TREATED WITH A NON-SELECTIVE INSECTICIDE

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INTRODUCTION

Mosquito breeding on rice fields in California's Central Valley varies considerably from the north to the southern limit of the crop. In the northern area (Sacramento Valley), both *Culex tarsalis* Coquillett and *Anopheles freeborni* Aitken occur in economically important numbers; larviciding is not generally done because of the extensive area involved. Mosquitofish (*Gambusia affinis* (Baird and Girard)) are stocked to the extent of their availability. In the mid-portion of the Central Valley, e.g. Fresno County, the numbers of mosquitoes on rice fields are fewer; this is especially true for *An. freeborni.* In this area, mosquitofish are also introduced (at ca. 0.25 lb/acre) but larviciding is conducted when larval counts average 0.1 larva/dip. In the southern part of the Central Valley (Kern County), rice is planted for soil reclamation and the total area of the crop is relatively small (<10,000 acres). The Kern Mosquito Abatement District has found that stocking these rice fields with relatively high numbers (>1.0 lb/acre) of mosquitofish eliminates the need of insecticide treatment for controlling *Cx. tarsalis,* which is the species of greatest economic importance in this region of the state.

It was of interest to determine the consequence of treating a rice field, in this southern part of the Central Valley, with a non-selective insecticide early in the growing season and then comparing the mosquito production with that of a control.

MATERIALS AND METHODS

Two adjacent rice fields in Kern County were selected for this study. The more easterly field (Izola-east) was 20 acres and was selected for treatment; the more westerly field (Izola-west) was 30 acres and was used as a control. Aerial photographs were taken of each field and the areas of each paddy were determined gravimetrically (the photograph is cut into paddies and each was weighted and the proportion of the overall area was determined). A map of each field was prepared from the photographs. On these maps 5 sampling spots per acre were marked. One third of these were selected along the mid-portion of the paddies and one-third along each border but no samples were taken within 15 feet of a border to avoid the deeper ditch area where mosquitofish tended to concentrate. Sampling was done weekly by 2 teams of 2 persons each. On each team, one person directed the other, by using the map, to each sampling spot; the second person took one 1-pint dipper of water at each spot and poured it into an enameled pan, counted the larvae and the team partner recorded the results by immature stage. One team sampled even and the other odd numbered paddies on a given week and then alternated the sequence the following week. The numbers of various nontarget organisms present (including Notonectidae, Ephemeroptera, Coleoptera, Anisoptera, Zygoptera, Chironomidae, Corixidae and *Gambusia*) were also recorded and general observations about their occurrence in each field were made.

All paddies of the Izola-east field (100 sampling spots) and 2 large paddies of the Izola-west field (10.6 acres, 53 sampling spots) were sampled weekly beginning June 13 and ending August 16, 1979.

On June 15, the Izola-west field was treated with 0.2 lb AI fenvalerate in 1 gal of water per acre by aircraft; this compound was previously known to be highly toxic to aquatic nontarget organisms (Miura and Takahashi 1976, Miura et al. 1977). The treatment was applied for the purpose of reducing or eliminating all beneficial organisms on one field while the adjacent field (Izola-west) served as a control.

RESULTS AND DISCUSSION

Following the application of fenvalerate to the Izola-east field, large numbers of dead and dying aquatic organisms began to surface. Large dragonfly nymphs, which were not apparent in pretreatment dipper samples, and very high numbers of Chironomidae formed decaying masses across the surface of the water. The *Gambusia* population was almost entirely killed; no live fish were collected in minnow traps placed in the field and monitored after the treatment.

Table 1 shows weekly collections of *Cx. tarsalis* larvae from the treated and untreated fields. At the first posttreatment sampling time (June 20), no immature mosquitoes were observed, which was almost certainly due to the

Table 1. The number of *Culex tarsalis* immature stages collected on 2 adjacent rice fields during a 10 week period of 1979.

	June			July				August		
	13	20	27	5	12	19	26	2	9	16
	Izola-east field (treated 6/15)									
1st instar		0	5	8	28	26	11	16	11	22
2nd instar		0	5	6	14	15	14	26	18	11
3rd instar		0	2	10	5	16	12	26	19	17
4th instar		0	0	13	8	10	23	18	21	17
pupa		0	0	0	2	1	0	0	0	2
total	9[1]	0	12	37	57	68	60	86	69	69
	Izola-west field (untreated)									
1st instar		2	0	0	0	0	0	0	0	0
2nd star		0	0	0	0	1	0	0	0	1
3rd instar		0	0	0	0	0	0	0	0	1
4th instar		1	0	0	0	0	0	0	0	0
pupa	0	0	0	0	0	0	0	0	0	0
total	0	3	0	0	0	1	0	0	0	2

[1] On this first sampling time, only the total number of all immatures were recorded.

treatment. However by the second post-sampling time and thereafter, the presence of all larval stages was continuous. The low numbers of pupae collected were probably due to the sampling method rather than to their absence. The mosquitofish population in the Izola-west (control) field continued to increase, based on records of general observations.

Changes in the relative abundance of aquatic organisms are shown in Table 2. Several taxa gradually began increasing in number after the effect of the treatment had passed, including Anisoptera, Ephemeroptera, Coleoptera, Zygoptera and Chironomidae. However the populations of Notonectidae and Corixidae did not replenish and this is a seasonal rather than a treatment effect. By the middle of July, the rice plants and water grasses grew so dense that they eliminated the entire habitats of backswimmers and corixids in the fields. In the control, the decline in the populations of Ephemeroptera and the lack of increase in populations of Coleoptera, Chironomidae and Zygoptera was apparently due to increased predation by *Gambusia* as the season progressed.

Gambusia began to reappear in the treated field 3 weeks after treatment. They apparently entered from the irrigation ditch supplying the Izola-east field. Their population increased slowly but never reached levels sufficient to provide control during the 10 wk period. However, the fish populations in the control reached very high levels, which reduced numbers of mosquitoes as well as other aquatic organisms (Table 2).

Table 2. The numbers of immature aquatic organisms collected on 2 adjacent rice fields during a 10 week period of 1979.

	June			July				August		
Taxa	13	20	27	5	12	19	26	2	9	16
	Izola-east (treated June 15)									
Culicidae	9	0	12	37	57	68	60	86	69	69
Anisoptera	2	0	0	2	8	7	4	8	4	2
Ephemeroptera	94	0	0	1	4	2	14	11	2	2
Corixidae	31	0	1	0	4	1	0	0	0	0
Coleoptera	13	0	4	5	3	12	26	12	4	8
Notonectidae	5	0	0	0	3	1	0	0	0	1
Zygoptera	0	0	1	3	6	1	8	4	6	3
Chironomidae	32	0	1	11	6	1	8	4	5	4
	Izola-west (untreated)									
Culicidae	0	3	0	0	0	1	0	0	0	2
Anisoptera	0	4	2	0	0	1	0	0	0	1
Ephemeroptera	49	15	22	14	3	13	2	1	0	0
Corixidae	6	5	9	0	0	0	0	0	0	0
Coleoptera	3	13	4	2	9	6	3	0	3	3
Notonectidae	4	7	2	2	0	0	0	0	0	0
Zygoptera	0	11	13	7	0	4	2	2	1	0
Chironomidae	1	2	0	0	4	2	7	2	2	1

Thus, it is clear that a single application of non-selective toxic agent to rice fields can sufficiently disrupt the predator complex so that resurgence of mosquito larvae populations can continue for a long period. The much higher capacity of mosquito populations to increase allows them to reach economically significant numbers long before predators can recover and provide control. This phenomenon must be carefully considered when evaluating the potential impact of a given treatment on pest management strategies, e.g. Schaefer et al. (1981).

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A MERMITHID PARASITIZING *AEDES DECTICUS* IN LABRADOR

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In June 1980, a larval mosquito collection was made at a grassy lake overflow site 2.5 km from Jean Rapids, Wabush, Labrador during a survey of mosquitoes in the Labrador City—Wabush area. A total of 23 mermithid nematodes emerged from the collection of 128 larvae which consisted of *Aedes decticus* Howard, Dyar and Knab, *Ae. canadensis* (Theobald), *Ae. diantaeus* Howard, Dyar and Knab, *Ae. abserratus* (Felt and Young), *Ae. pionips* Dyar and *Ae. punctor* (Kirby). This was the first record of a mermithid naturally parasitizing mosquitoes in the Province of Newfoundland and Labrador, Canada (Ellis and Chapman 1980). As the mosquito larvae were held en masse in 1980, the host species of the nematode could not be determined.

However, in June 1981, further collections were made at the same site. This time the 265 mosquito larvae were reared individually so that the host species of the nematode could be established. Nematodes were collected as they emerged and kept in water in a petri dish at 17°C. Dead larval hosts were identified (Wood et al. 1979). Other specimens that died as larvae or pupae were identified, then dissected and presence or absence of nematodes noted. The rest of the collection was allowed to mature to adults which were identified and then kept over water until they died in case they should deposit nematodes. On the day that they died, they were dissected as a double check on nematode presence or absence. The species composition of the collection in 1981 is shown in Table 1. Of the 7 species represented, a total of 66 (23♂; 43♀) nematodes emerged only from larval *Ae. decticus*. The infection rate in this species was 33.3%. This is the first report of *Ae. decticus* serving as a host for a mermithid parasite (Petersen 1980). In the other larval mosquitoes examined encapsulated mermithids were found in 2.5% and 1.4% of *Ae. canadensis* and *Ae. punctor*, respectively. Observations on the emerged nematodes at 17°C in 1980 showed that they started to molt 10 days after emergence. The molt itself lasted from 8–11 days. However, mating started before the completion of the molt and the first eggs were laid 13 days after the onset of this process. Eighty percent of the eggs developed

Table 1. Mosquito species composition of collection near Jean Rapids, Labrador 1981.

Mosquito species	% of total collection
Aedes abserratus	1.5
Ae. canadensis	14.7
Ae. cinereus	1.1
Ae. decticus	20.4
Ae. excrucians	4.9
Ae. hexodontus	5.7
Ae. punctor	51.7