FIELD TESTS WITH INSECTICIDES AGAINST MOUNTAIN *AEDES* LARVAE IN CALIFORNIA

H. C. CHAPMAN[1] AND L. L. LEWALLEN[2]
Fresno, California

INTRODUCTION. The increasing use of mountainous areas for recreation is reflected in reports by many federal and state agencies concerned with the orderly development of recreational facilities. During recent years in California, the use of mountain recreation areas has greatly increased, with accompanying complaints of mosquito annoyance. The demonstration in valley communities that mosquito control can be satisfactorily achieved, has led to an expectancy on the part of the public for similar relief from mosquitoes in mountain recreational areas. An increasing need for mosquito control recommendations in such areas has been made apparent to the Bureau of Vector Control, California State Department of Public Health.

Previous studies in the Sierra Nevada Mountains of California indicated that oil was effective in eliminating mosquito breeding (Herms and Gray 1944). Roth *et al.* (1947) in Oregon and Rees and Nielsen (1952) in Utah found that DDT gave excellent reductions of *Aedes* broods, principally as a pre-hatch treatment. Since Hunt and Bischoff (1960) reported the presence of TDE in the fat body of fish and other wildlife in Clear Lake, California, after many years of nonexposure to the material, the use of such persistent compounds in close proximity to fish and other wildlife is looked upon with considerable disfavor by many groups.

Preparatory to investigating control measures in mountainous areas, studies were started several years ago on the distribution and ecology of the California mountain *Aedes*. The results of some of these studies are being reported by Carpenter (1961a, 1961b, 1962a, 1962b).

Preliminary studies on the relative effectiveness of some larvicides against mountain *Aedes* in recreational areas were begun in 1962. Organophosphorus and carbamate materials were selected for evaluation since they are less likely to create residue problems and generally present less hazard to fish and wildlife. Prior to field testing, all of the materials were evaluated as to their relative toxicity to rainbow trout fry in the laboratory (Lewallen and Wilder, 1962).

MATERIALS AND METHODS. The following materials were evaluated in the field tests: Bayer 29493 (Baytex)®, 4 lb./gal., emulsion concentrate; Parathion, 2 lb./gal., emulsion concentrate; Malathion, 5 lb./gal., emulsion concentrate; DDVP, 4 lb./gal., emulsion concentrate; Naled (Dibrom)®, 4 lb./gal., emulsion concentrate; Carbophenothion (Trithion)®, 4 lb./gal., emulsion concentrate; Hercules AC-5727, 15 percent, emulsion concentrate; Dylox ®, 50 percent, soluble powder; Bayer 29493, 5 percent, sand core granule, 30 mesh; Parathion, 5 percent, Attaclay—AA LVM, 24–48 mesh; Malathion, 10 percent, Attaclay—AA LVM, 24–48 mesh; Carbophenothion, 25 percent, Attapulgite-RVM-A, 30–60 mesh.

The sprays were mixed by measuring the desired quantity of the emulsion concentrate or soluble powder into the spray can and making the final spray by adding ½ gallon of water. These liquids were applied with a 1-gallon portable, pressurized hand can equipped with a 4-orifice teejet nozzle set at the largest opening (#50015). Pressure was maintained at approximately 30 p.s.i. Granular formulations were applied with a horn seeder (Raley 1961). All dosages were replicated

---

[1] Entomology Research Division, Agric. Res. Serv., U.S.D.A.
[2] California State Department of Public Health, Bureau of Vector Control.

three times. Most plots measured 1/32 of an acre with a few up to 1/8 acre.

Twenty dips with a white-enamel dipper were taken at random within each plot prior to treatment and at 24 and 48 hours following application of the insecticides. The percent reductions were based on the difference in larval numbers dipped prior to and following treatments. Pretreatment and 48-hour larval samples were collected and identified to species in the laboratory. The following additional information was noted in each plot: depth and temperature of water at time of treatment, presence and survival of potential predators and other aquatic organisms, and stage of larval development. Maximum-minimum water temperatures and pH readings were obtained for some plots.

An effort was made to select plots from a variety of habitats that contained different species of mosquitoes. The study areas were located on the eastern slopes of the Sierra Nevada Mountains in Mono County and Yosemite National Park at elevations ranging from about 7,000 to 8,700 feet. A great variety of habitats was used in these tests, ranging from the ideal situation of isolated, open-meadow pools with a minimum of vegetation, to semishaded areas with a moderate amount of seepage passing through the plots, to a contiguous body of deeper water with much emergent vegetation, such as that on a lake margin.

Table 1 shows the distribution of the 78 treatments in the 6 areas, the prevalence of the mosquito species, and the general habitat of each area.

All of the nine species of mountain *Aedes* reported from California by Carpenter (1961a) were present in one or more of the treated plots, with the exception of *Aedes pullatus* (Coquillett). However, substantial numbers of the aquatic stages and several biting adults of the rare (in California) *A. pullatus* were collected adjacent to the treated plots in the vicinity of Silver Lake in Mono County. Such a variety of habitats was present in the Silver Lake area, that larvae of all of the mountain *Aedes* species except *A. ventrovittis* Dyar were collected within about a 2-mile radius.

TABLE 1.—Summary of data showing number of treated plots, the prevalence of *Aedes* spp., and the type of habitat in the various areas.

Area	No. of plots	Species present in order of prevalence	Habitat and remarks
Mono County			
June Lake	7	*increpitus, schizopinax cataphylla, fitchii* (Felt and Young)	Open, isolated, meadow pools
Silver Lake	4	*increpitus, communis*	Shaded pools in conifers with seepage through area
Gull Lake	31	*increpitus, schizopinax cataphylla*	Open, marshy margin of lake with contiguous water areas
Mammoth Lakes	11	*increpitus, cinereus* (Meigen) *schizopinax, hexodontus* Dyar *communis*	Semishaded pools with seepage thru many areas
Yosemite Nat'l Park			
Tenaya Lake	2	*communis, hexodontus cataphylla, ventrovittis*	Coniferous area
Tuolumne Meadows	23	*cataphylla, ventrovittis hexodontus, fitchii*	Open-meadow pools with and without seepage

Aedes increpitus Dyar, *A. cataphylla* [D]yar, and *A. schizopinax* Dyar were most [o]ften encountered in the plots selected for [tr]eatment. No clear-cut differences in [sp]ecies tolerance to the materials was [n]oted. Variables such as water depth, [v]egetation, and water temperature make [it] difficult to obtain such evidence in the [fi]eld. Some plots contained as many as [fo]ur species of mosquitoes, with larvae [ra]nging from the first to fourth instar. It [w]as necessary at times to treat plots that [co]ntained larvae which were predomi[na]ntly less than fourth instar since larvae [of] *A. cataphylla, A. ventrovittis,* and *A. [co]mmunis* (DeGeer) were generally an [in]star or more ahead of their companion [sp]ecies.

Data from the maximum-minimum [th]ermometer indicated a low of 30° and [a] high of 92° F. in the plots. The greatest [da]ily temperature fluctuation in any one [pl]ot was 60° F. (32°–92° F.). A thin [la]yer of ice was often present on the pools [se]lected for treatment and it was necessary [se]veral times to delay dipping and spray[in]g until the ice melted. The temperature [da]ta obtained just prior to treatment [sh]owed a great deal of variance which [w]as due in part to the time of treatment (morning versus afternoon). The average temperature of a series of plots at June Lake treated during some cold weather was 41° F. whereas the water temperatures recorded during the treatment of a series of plots at Tuolumne Meadows averaged 74° F. Many of the materials appeared to be more effective when higher water temperatures prevailed, although other interrelated variables such as depth of the water, seepage through the areas, and the amount of emergent vegetation have to be considered. Some pH readings from plots in meadow pools and lake margins ranged from 6.5 to 6.7.

RESULTS AND DISCUSSION. The results of the treatments are shown in Table 2. Since increased reduction of larvae was invariably obtained from the 24- to 48-hour period following treatment, only the 48-hour control figures are given. Bayer 29493 (*O,O*-dimethyl-*O*[4-(methylthio)-*m*-tolyl] phosphorothioate) was the most toxic compound tested, followed closely by parathion. Hercules AC-5727 (*m*-isopropylphenyl methylcarbamate), malathion, carbophenothion (*S*-[(p-chlorophenylthio) methyl]*O,O*-diethyl phosphorodithioate), and naled (1,2-dibromo-2, 2-dichloroethyl dimethylphosphate) gave good control

[T]ABLE 2.—Relative effectiveness of some insecticides applied as sprays and granules against mountain *Aedes* larvae in field plots. (Average of 3 replications.)

Compound	Pretreatment count: Av. no. larvae/dip	Percent control in 48 hours at indicated dosage expressed in pounds/acre: 0.01	0.025	0.05	0.075	0.1	0.25	0.5	0.75
[Sp]rays									
Bayer 29493	8.9	94	99	100	..	..	..	..	..
Parathion	24.5	..	85	97	100	..	..	..	..
Hercules AC-5727	27.7	..	..	..	..	86	99	99	..
Carbophenothion	22.9	..	..	..	..	51	92	99	..
Malathion	19.0	..	..	..	..	78	94	99	..
Naled	21.1	..	..	..	..	60	95	97	..
DDVP	29.2	..	..	..	..	80	80	94	..
Dylox ®	45.1	..	..	..	..	..	..	..	80
[Gr]anules									
Bayer 29493	17.8	..	..	98	..	..	..	..	..
Parathion	13.9	..	..	..	..	98	..	..	..
Carbophenothion	14.4	..	..	..	..	..	98	..	..
Malathion	18.6	..	..	..	..	..	65	..	..

(92% or better) at 0.25 pound/acre whereas DDVP was somewhat less toxic at this dosage. Dylox® (dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate) was the least toxic of all of the materials tested against the mountain mosquitoes.

Granules appeared to be less effective than the sprays, although the data obtained are based on only one dosage of granules. Incomplete distribution of granular materials with the horn seeder may have been a factor. Excellent distribution and coverage of the plots was obtained with the liquids.

Our observations indicated a good survival of potential predators such as dytiscid and hydrophilid adults and larvae, dragon and damsel fly naiads, caddis fly larvae, and planaria. Nonpredators, such as mayfly naiads and chironomid larvae were apparently not affected by most of the materials. Fairy shrimp were completely eliminated by most treatments.

Acknowledgments. The writers wish to thank Robert H. Soroker, Ernest E. Lusk, and Earl W. Mortenson of the Bureau of Vector Control, and personnel of Yosemite National Park for their aid on this project.

References Cited

Carpenter, S. J. 1961a. Observations on th distribution and ecology of mountain *Aedes* mo quitoes in California. I. Species and their habita Calif. Vector Views 8(10):49–53.

———. 1961b. Observations on the distribu tion and ecology of mountain *Aedes* mosquito in California. II. *Aedes cataphylla* Dyar. Cali Vector Views 8(12):61–65.

———. 1962a. Observations on the distribu tion and ecology of mountain *Aedes* mosquitoes i California. III. *Aedes communis* (DeGeer). Cali Vector Views 9(2):5–9.

———. 1962b. Observations on the distribu tion and ecology of mountain *Aedes* mosquitoes i California. IV. *Aedes fitchii* (Felt and Young Calif. Vector Views 9(4):17–21.

Herms, W. B., and Gray, H. F. 1944. Mo quito control. New York: Commonwealth Fun 2nd ed., pp. 137–141.

Hunt, E. S., and Bischoff, A. I. 1960. Inim cal effects on wildlife of periodic DDD applic tions to Clear Lake, Calif. Fish and Game 46(1 91–106.

Lewallen, L. L., and Wilder, W. H. 196 Toxicity of certain organophosphorus and carb mate insecticides to rainbow trout. Mosqui News 22(4):369–372.

Raley, T. G. 1961. The only moving part the operator. Mosquito News 21(2):142.

Rees, D. M., and Nielsen, L. T. 1952. Co trol of *Aedes* mosquitoes in two recreational are in the mountains of Utah. Mosquito News 12(2 43–49.

Roth, A. R., Yates, W. W., and Lindquis A. W. 1947. Preliminary studies of larvicides snow-water mosquitoes. Mosquito News 7(4 154–156.