from 2 to 7 times for *C. quinquefasciatus* but had little or no effect on *Culex tarsalis* Coq. Two parts per million of 1-myristoylpyrrolidine prevented egg deposition on distilled water of *C. quinquefasciatus* and *C. tarsalis* for 10 and 18 days, respectively.

References Cited

GJULLIN, C. M. 1961. Oviposition responses of *Culex pipiens quinquefasciatus* Say to waters treated with various chemicals. Mosquito News 21(2):109–13.

O'GOWER, A. K. 1963. Environmental stimuli and the oviposition behaviour of *Aedes aegypti* var. *queenslandensis* Theobald (Diptera, Culicidae). Animal Behaviour 11(1):189–97.

OWEN, WILLIAM B. 1963. The contact chemoreceptor organs of the mosquito and their function in feeding behaviour. Jour. Ins. Physiol. 9:73–87.

STEWARD, C. C., and ATWOOD, C. E. 1963. The sensory organs of the mosquito antenna. Canadian Jour. of Zool. 41:577–94.

CHEMOSTERILANT APPLICATION TO AN ISOLATED POPULATION OF *CULEX TARSALIS*[1]

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The feasibility of using a chemosterilant to suppress an isolated, desert population of the encephalitis mosquito, *Culex tarsalis* Coquillett, was investigated in small oases within the Anza-Borrego Desert State Park, San Diego County, California. The ecological and biological features of these isolated populations were observed periodically during the year prior to treatment to ascertain the most appropriate time to sterilize a maximum number of individuals. Corroborating the findings of Weidhaas *et al.* (1961), laboratory tests with apholate (2, 2, 4, 6, 6-hexa) (1-aziridinyl)-2, 4, 6-triphospha-1, 3, 5-triazine) indicated that this compound could be applied at 50 to 75 p.p.m. to the fourth larval stage with low mortality and a high degree of resultant sterility in the adult mosquito.

ECOLOGY AND BIOLOGY. The areas chosen for study were small, isolated seep holes with palms nearby, located about 15 miles east of Borrego Springs. The nearest human habitations were along the edge of Salton Sea which was about 12 miles northeast. Prevailing winds were from the northwest. The surrounding area was dry desert, either barren or supporting growth of ocotillo cactus and other desert plants. The oases included three areas within a 2-mile radius, namely Seventeen Palms, Five Palms Spring, and Una Palm.

After the study was initiated, a large seepage area in the Arroyo Salada Wash, 6 miles east of Seventeen Palms, was discovered. Although this area did not produce mosquitoes to any extent, it was included in our observations and treated with parathion concurrently with the apholate treatments in the oases areas.

Observations on the larval populations were initiated in February of 1963. The potholes under surveillance included 3 at Five Palms Spring, 2 at Seventeen Palms, and 1 at Una Palm. For reasons not understood, one of the water sources at Seventeen Palms was less attractive for mosquito breeding than the other. Rarely

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were larvae found in this source. The other source always had larvae of at least one of the species.

In addition to *C. tarsalis,* other species present included *Anopheles pseudopunctipennis franciscanus* McCracken, *Culiseta incidens* (Thomson), and *Culiseta inornata* (Williston). The effects of apholate were observed only on *Culex tarsalis*. On the basis of high population levels of *Culex tarsalis* during May, June and July of 1963, the 1964 treatment was started in May.

Estimates of larval abundance in the potholes were determined from two random dips at each sampling. The variation in numbers of larvae and species composition at different times of the year are shown in Table 1.

METHOD OF TREATMENT. Prior to treatment the potholes were measured to ascertain the volume of water in each. The amount of technical apholate powder [4] required to treat each pothole at 75 p.p.m. was weighed and transferred to a 100 ml. plastic bottle. Sufficient water was added to the dry powder at the time of treatment to make a volume of 100 ml. The aqueous

[4] Olin Matheson Co., The Squibb Institute for Medical Research, New Brunswick, New Jersey. Technical apholate 99.0 percent actual.

TABLE 1.—Total numbers of larvae and pupae from three desert oases, Anza-Borrego Desert State Park, San Diego County, 1963–1964.

Date	*Culiseta*	*Culex* [8]	*Anopheles* [9]	Totals	No. of dips
2–25–63 [1]	40 [5]	0	0	40	14
4–11–63 [2]	2	26	0	28	8
4–24–63	6	1	0	7	2
5–9–63	3 [6]	15	0	18	14
5–23–63	4	118	0	122	8
6–5–63	6	169	0	175	10
7–31–63	0	33	39	72	10
8–13–63 [3]	0	6	37	43	8
8–29–63	0	16	110	126	14
9–18–63 [4]	0	25	17	42	6
10–10–63 [4]	0	116 [10]	23	139	8
10–30–63 [4]	0	110	25	135	4
11–14–63	8 [6]	26 [11]	7	41	13
12–4–63	368 [7]	7	11	386	14
12–30–63	92 [7]	5	4	101	12
1–15–64	218	0	0	218	12
2–20–64	219	0	0	219	14
3–14–64	48	20	0	68	12
4–15–64	0	5	0	5	12
5–19–64 [12]	0	22	0	22	12
5–27–64 [12]	5	31	0	36	12
6–10–64 [12]	0	6	0	6	12
7–1–64	0	76	6	82	12

[1] All holes at Seventeen Palms contained fish.
[2] Fish removed from all water holes at Seventeen Palms.
[3] Water holes at Five Palms Spring washed out by rain.
[4] Water holes at Five Palms Spring and Una Palm silted in by rain.
[5] *C. inornata.*
[6] *C. incidens.*
[7] Mixture of *C. inornata* and *C. incidens.*
[8] *C. tarsalis* except when indicated.
[9] *A. p. franciscanus.*
[10] Few *C. peus.*
[11] One *Culex pipiens quinquefasciatus* Say.
[12] Treated after dipping.

solution was then pipetted evenly over the water surface of the potholes. The volume of water in each pothole and the amount of technical apholate applied are shown in Table 2.

TABLE 2.—Amounts of technical apholate required for treatment of *Culex tarsalis* breeding sites at 75 p.p.m.

	Source no.	Amount of water (liters)	Amount of apholate (grams)
Seventeen Palms	1	32.174	2.4
	2	43.530	3.25
Five Palms Spring	1	3.200	0.24
	2	3.785	0.28
	3	12.302	0.923
Una Palm	..	9.500	0.713

The first application was made on May 19, the second on May 28, and the final treatment on June 10.

After treatment, each source was covered with 8 mesh hardware cloth for the protection of wildlife. Pans of fresh drinking water were provided at each oasis. After three days the hardware cloth covers were removed.

POST TREATMENT OBSERVATIONS. The dosage applied did not cause excessive mortality of first to fourth instar larvae. At the time of the second treatment, no reduction in numbers of egg rafts or numbers of larvae was noted. At the time of the third treatment no egg rafts were found although first through fourth instar larvae were present in greatly reduced numbers.

One week after the final treatment (June 17) no egg rafts or young larvae were found although a few fourth instars were present.

A final inspection of the area on July 1 indicated that larval counts had returned to levels equivalent to pretreatment.

DISCUSSION. The absence of egg rafts and first instar larvae one week following the final treatment would indicate that the treatments were exerting an influence on the mosquito population. This was supported by the finding that larvae taken from treated water and reared to adults in the laboratory produced very few egg rafts, none of which were viable. First instar larvae treated at 75 p.p.m. in the laboratory produced weak adults that had difficulty leaving the water surface. Most emerging adults perished on the water.

It is our belief now that the three treatments did not reach all overlapping generations.

This study was not of a magnitude to provide conclusive data that might be interpreted broadly in evaluating the chemosterilization technique for mosquito control. It did, however, provide experience with certain useful innovations and refinements in techniques, as well as information on the frequency and number of treatments required to obtain desired results.

Reference Cited

WEIDHAAS, D. E., FORD, H. R., GAHAN, J. B. and SMITH, C. N. 1961. Preliminary observations on chemosterilization of mosquitoes. Proc. N. J. Mosquito Exterm. Assoc. 48:106–9.