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References

FAY, R. W., and MORLAN, H. B. 1959. A mechanical device for separating the developmental stages, sexes and species of mosquitoes. Mosquito News 19:144–147.

HAEGER, JAMES S. 1960. Behavior preceding migration in the salt-marsh mosquito, *Aedes taeniorhynchus* (Wiedemann). Mosquito News 20:136–147.

NIELSEN, E. T. 1957. Use of the electronic flash to record the activity of small animals. Nature 179:1308.

———. 1958. The initial stage of migration in salt-marsh mosquitoes. Bull. Ent. Res. 49:305–313.

——— and EVANS, D. G. 1960. Duration of the pupal stage of *Aedes taeniorhynchus* with a discussion of the velocity of development as a function of temperature. Oikos 11:200–222.

PAUSCH, R. D., and PROVOST, M. W. 1965. The dispersal of *Aedes taeniorhynchus* IV. Controlled field production. Mosquito News 25:1–8.

PROVOST, MAURICE W. 1957. The dispersal of *Aedes taeniorhynchus*. II. The second experiment. Mosquito News 17:233–247.

———. 1960. The dispersal of *Aedes taeniorhynchus*. III. Study methods for migratory exodus. Mosquito News 20:148–161.

WEATHERSBY, A. B. 1963. Harvesting mosquito pupae with cold water. Mosquito News 23:249–251.

THE OVIPOSITION RESPONSES OF TWO SPECIES OF *CULEX* TO WATERS TREATED WITH VARIOUS CHEMICALS

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The larvae of *Culex tarsalis* Coquillett occur in a wide variety of relatively clean roadside ditches, pasture pools, log ponds, and other permanent and semipermanent bodies of water. The larvae of Culex *quinquefasciatus* Say are also present in many of these situations but are found in largest numbers in sewage waters, dairy drain pools, and street drains.

Evidence that mosquitoes are attracted to water containing various chemical compounds has been reported by a number of investigators. O'Gower (1963), in experiments with *Aedes aegypti* var. *queenslandensis* Theobald, found that egg depositions were influenced by olfactory, tactile, visual, chemotactile, and humidity stimuli. Chemoreceptor hairs that can detect appropriate concentrations of several sugars have been found by Owen (1963) on the tarsi, labella, and ligula of *Culiseta inornata* (Williston) and *Aedes dorsalis* (Meigen). Steward and Atwood (1963) have shown that several types of setae on the antennae of *Aedes aegypti* (Linnaeus) are the olfactory end organs that detect odors.

One hundred and fifty-one chemicals were tested in water samples against gravid *C. quinquefasciatus* females by Gjullin (1961) in a search for attractants and repellents that might be of value in control operations. Additional tests of a series of 296 chemicals against *C. quinquefasciatus* are reported here. Some of these chemicals were also tested against *C. tarsalis*.

METHODS AND MATERIALS. The tests were made in a 12 x 12 x 12-inch screen cage fitted with a cloth sleeve on one side. Twenty blood-fed females, not over 8 days old, were used in each test. Acetone or water solutions of the chemicals were added to 350 c.c. of distilled water in 400-c.c. beakers. The chemicals were tested at 5, 25, and 50 p.p.m. In the multiple-choice tests, three beakers containing different concentrations of the chemical and one containing distilled water were used. The beakers were placed in the four corners of the cage. A 10 percent sugar solution was available as food in all cages. The beakers containing the test solutions were placed in the cages on the fourth day after the females had taken their blood meal and were removed 3 days later. Usually blood meals were taken by the females when they were 2 to 5 days old.

The cages were held at 76–80° F. and 55–70 percent relative humidity in a room with an exhaust fan which provided a continuous moderate exchange of fresh air. The room was kept in darkness after the test beakers were placed in the cage except during the period when the eggs were being counted.

The grass infusion used for comparison in some deterrent tests contained 85 grams of grass in 7 liters of water. This mixture, allowed to stand for 5 days or more, was used in the ratio of one part infusion to three parts distilled water.

Results and Discussion. In the multiple-choice tests in which *C. quinquefasciatus* could deposit eggs in distilled water or in different concentrations of chemical, 7 of the 296 compounds appeared to stimulate oviposition. From 2 to 7 times as many egg rafts were laid in waters containing 5 and 25 p.p.m. of these chemicals as in distilled water. Most of the compounds were less attractive at 50 p.p.m. than at lower concentrations. These 7 compounds showed little or no attraction when tested against *Culex tarsalis* at 5, 25, and 50 p.p.m. The results of these tests are presented in Table 1.

The most effective oviposition deterrent found in this group of compounds was 1-myristoylpyrrolidine. In single choice tests it prevented egg deposition by *C. quinquefasciatus* for a minimum of 10 days at 2 p.p.m. in distilled water but was not effective in preventing egg deposition in a grass infusion. No eggs were laid for 18 days or more by *C. tarsalis* on distilled water containing 2 p.p.m. of this material. It prevented egg deposition by this species in grass infusion for a minimum of 2 days at 2 p.p.m. and for 15 days at 4 p.p.m. The grass infusions used were from 3 to 4 times as attractive as distilled water to ovipositioning females of these species.

Summary. Two hundred and ninety-six chemicals were tested in distilled water against gravid *Culex quinquefasciatus* Say to determine if they would stimulate or deter oviposition. Seven of the compounds increased the attractiveness of the water

Table 1.—Egg deposition by two species of *Culex* on chemically treated waters in multiple-choice tests (four replicates in each test).

Compound	Total number of egg rafts laid at indicated dosage in p.p.m.			
	0	5	25	50
Culex quinquefasciatus				
o-Cresol	5	19	14	15
alpha-Ethyl-*p*-methoxybenzyl alcohol	5	14	18	25
Ethyl methylcarbamate	6	21	22	12
Phenethyl methylcarbamate	3	6	19	7
alpha-Conidendrol tetraacetate	3	19	12	18
N-Ethyl-*o*-veratrylamine	3	22	23	7
2,6-Dimethoxyphenol-ethylene oxide reaction product	2	10	15	7
Culex tarsalis				
o-Cresol	11	15	14	18
alpha-Ethyl-*p*-methoxybenzyl alcohol	15	7	14	23
Ethyl methylcarbamate	19	13	26	7
Phenethyl methylcarbamate	7	16	16	11
alpha-Conidendrol tetraacetate	14	18	15	22
N-Ethyl-*o*-veratrylamine	8	14	16	17
2,6-Dimethoxyphenol-ethylene oxide reaction product	10	12	16	10

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.

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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