AGITATION OF WATER SURFACES BY SPRINKLING TO PREVENT MOSQUITO BREEDING

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INTRODUCTION. Heavy rains may not only influence insect behavior, but also cause severe physical damage, especially to the larval stages and eggs, and result in decimation of entire insect populations, such as aphids, chinch bugs and numerous others. For example, Subklew (1939) reported a 50 percent larval loss of a pine caterpillar population, *Bupalis pinarius*, by the mechanical force of heavy rain. The possible effects of rains on mosquitoes seem not to have received much attention, even though it is known that mosquitoes survive poorly in water subjected to wave and wind action. Studies of the effects of such a disturbance, created artificially by sprinkling, are reported in this paper. There are many sites of heavy breeding of mosquitoes in limited areas, where the use of insecticides is unfeasible or undesirable, and it was felt that if some simple means of creating unfavorable conditions could be developed, its control possibilities might be worth exploring.

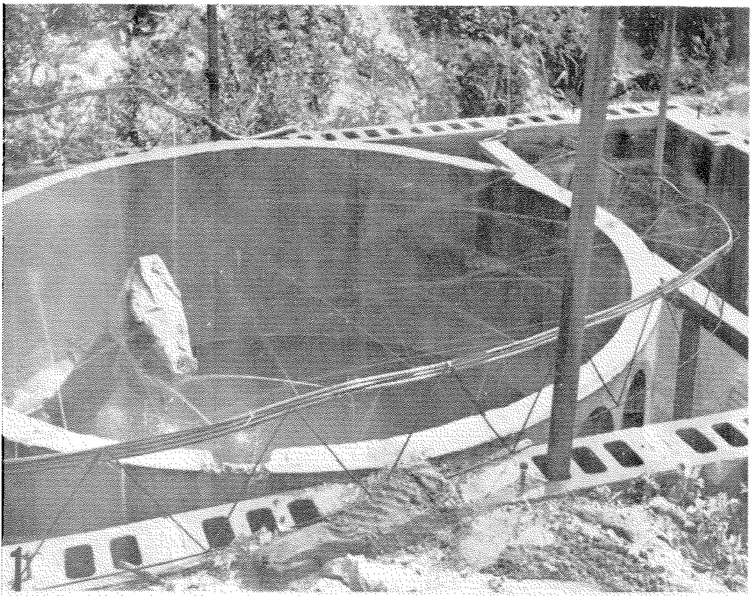
Two appropriate sites were made available for the experiments, one by the State University Agricultural and Technical Institute at Farmingdale, and the other on the Corwin duck farm at Aquebogue, both in Suffolk County. We wish to express our appreciation for the use of these sites.

EXPERIMENT A: DESCRIPTION OF TEST SITE. A circular concrete basin 8 feet in diameter which formed the inner part of a drainage installation on a duck farm (Figs. 1 and 2) offered an excellent test site. It was located between two parallel lagoons or settling beds, 25 feet apart. The upper lagoon was about 600 ft. x 200 ft., the lower one 600 ft. x 90 ft. The test basin was filled 8 feet deep, to within 3 feet of the brim with water that was heavily polluted with duck waste. The water surface was undisturbed. These conditions were especially favorable for *Culex pipiens*, and no matter what was done to eliminate larvae temporarily, repopulation could, and did, occur continuously from the adjacent lagoons and numerous other sources. Furthermore, the nearby duckyards and pens furnished abundant food and resting places for the adult mosquitoes. No larvicides or other control methods were used in the test area before or during the experiments.

An idea of the density of the larval population in the basin may be gained from the fact that one dipper sample contained 1,233 larvae, 471 pupae and egg rafts estimated at about 700. Several hundred adults, both male and female were usually resting on shady portions of the interior walls of the basin.

MATERIALS AND METHODS. The water for sprinkling came from a pipeline in a duckhouse about 100 feet away. For the first three days an adjustable garden hose sprinkler nozzle was used. It was fixed to a board, and placed over the center of the basin, about two and one-half feet above the water surface and directed toward it. In this way disturbance by wind was avoided. It was adjusted so that the outer edges of the cone of water spray just touched the outer edges of the water surface. A medium water pressure was used, regulated from the water tap in the duckhouse.

After the first three days, the described arrangement was replaced by a garden "soak-hose," a flat plastic hose with perforations, commonly used for watering lawns (Figs. 1 and 2). This was attached to the upper edge of a wire frame about 1 foot high arranged around the circumference of the basin, so oriented that the sprinkler holes were directed inward and downward, so that the jets of water played on both the side wall and the surface of the water.



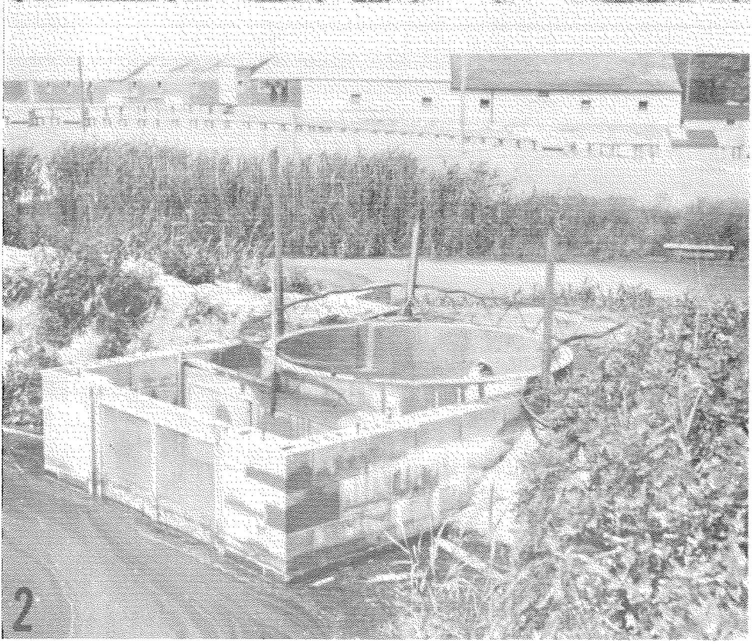


FIG. 1.—Concrete basin breeding site showing installation of sprinkler.
FIG. 2.—Same installation as Fig. 1, showing adjacent duck pens and lagoons.

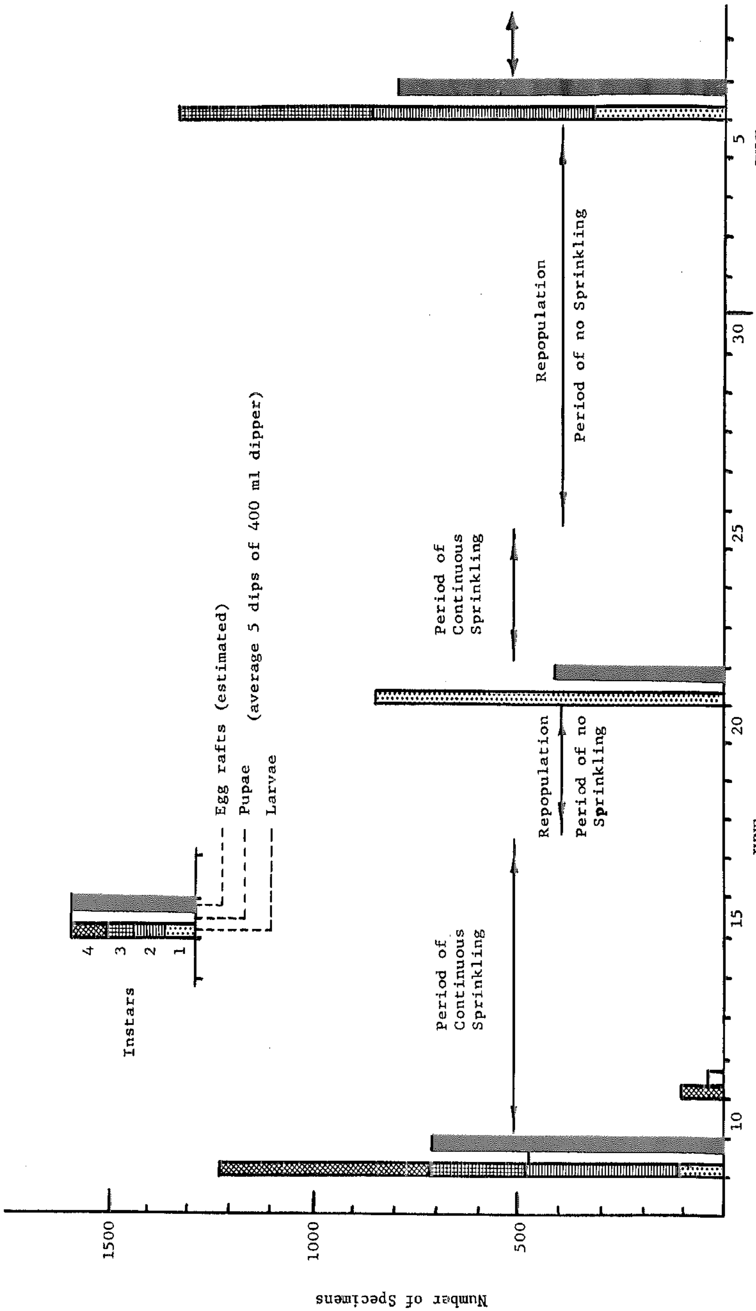


FIG. 3.—Mortality and repopulation at sprinkler test site, Experiment B.

Mosquito larvae and pupae were found to be distributed more or less evenly over the water surface; the counts of larvae and pupae were made by averaging 5 dips. The numbers of egg-rafts were estimated, since owing to clumping it was difficult to count them accurately.

The procedure was to make an actual count just before turning on the sprinkler, then to make observations and estimates each day thereafter during the sprinkling period. The sprinklers were run continuously for several days, followed by a period of no sprinkling. See Fig. 2.

RESULTS. Before the sprinkler was turned on for the first time, on June 9, the count was as follows: 190 first, 356 second, 237 third, and 521 fourth stage larvae (1,233 total), 471 pupae and about 700 egg rafts (Fig. 3). After two days of continuous sprinkling, only about 100 4th instar larvae, 40 pupae, and no egg rafts or early stages of larvae were observed. By June 14, except for a few 4th stage larvae and a few pupae, the entire population had been destroyed. One day later (June 15) no live mosquitoes of any stage were seen. The sprinkling was continued to June 17 to make certain all larvae had disappeared, that no small larvae were missed, and that reinfestation was not occurring.

Sprinkling was stopped on June 17. Very heavy oviposition occurred almost immediately, and by June 21, the count of first stage larvae was 831 per dip, and there were an estimated 400 egg rafts.

After the count on June 21 the sprinkler was turned on again, and one day later, nearly all larvae and egg rafts had disappeared. This would indicate an especially high susceptibility of first stage larvae to this type of disturbance.

The sprinklers were shut off again on June 25, and left off in order to see how fast larvae would develop again. By July 6 third stage larvae had appeared. On this date, average counts per dip were 311 first stage, 537 second stage and 467 third. No fourth stage and no pupae were seen. Egg rafts were very numerous (about 800). The sprinklers were then turned on again and by the next day, all stages including eggs had disappeared. Incidentally it was noted that numerous freshly emerged adults were floating dead, probably killed as they emerged, or shortly thereafter, by the mechanical action of the sprinkling.

These observations would indicate that at least under the conditions described, development and successful emergence could be prevented by sprinkling every 10 days.

EXPERIMENT B. DESCRIPTION OF TEST SITE. The site chosen for investigating the effects of sprinkling on a larger scale was inside a glass house (Fig. 4) which contained a series of 8 interconnected, rectangular, concrete sewage settling tanks, each 8 feet x 16 feet x 20 feet deep (Fig. 5). All the tanks were heavily infested with *Culex pipiens* larvae. The larvae were concentrated largely in the corners and along the sides of the basins. This made it difficult to make accurate population estimates from sample dip counts, which ran as high as 600 larvae per dip. Egg rafts were also very numerous. The water surface was about 4 feet from the top of each tank. Adult mosquitoes, both male and female were numerous, resting on the exposed walls of the basin.

Chicken and turkey houses were located about 500 feet away, so that both food and resting places were close by, and repopulation would occur continuously.

MATERIALS AND METHODS. The sprinkler consisted of the same type of perforated plastic "soak hose" that was described under (a) above. This was attached to a metal pipe support which was placed across the center of the tanks as shown in Fig. 5. Water was obtained from one of the regular water supply taps of the building, from which the pressure was regulated. The jets from the hose perforation were directed downward and were uniformly distributed over the water surface. The noise of these streams hitting the water surface was considerable and may have contributed to repelling the adult mosquitoes, an inference made from the fact that as soon as the sprinklers were turned on, the adult mosquitoes began flying away from their resting places.

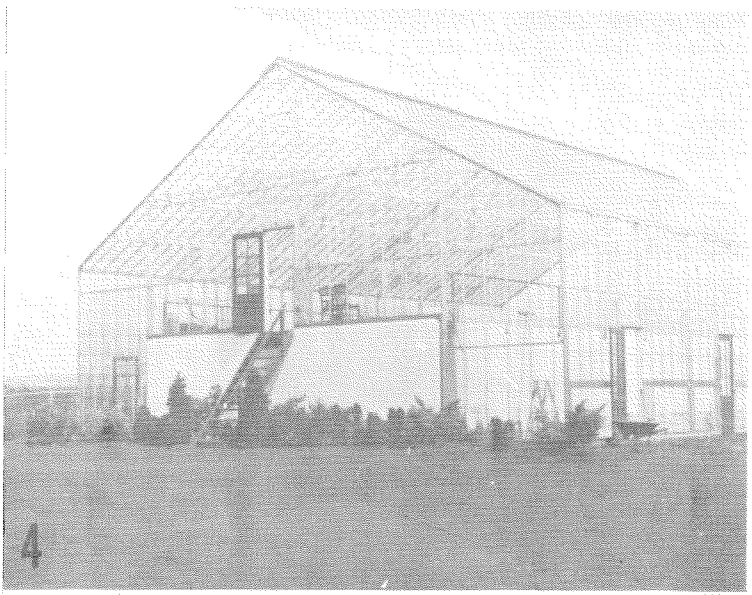


FIG. 4.—Glass house used as enclosure for sewage settling tanks.

FIG. 5.—Concrete sewage settling tanks, showing installation of sprinkler hose.

RESULTS. After the sprinkler system had operated for 3 days (August 6 through 9) only a few larvae (4th stage) and pupae were observed. By August 10, no more larvae or pupae or eggs were seen and the sprinkling was stopped.

Within the next 4 days, heavy repopulation took place, as evidenced by high egg raft and 1st stage larvae counts. The sprinklers were again turned on, and after 2 days, there was a 100 percent mortality.

The success of the sprinkling in preventing mosquito breeding in this situation, which formerly caused a serious problem in the adjacent houses for experimental chickens and turkeys, has resulted in installation of a more permanent arrangement to continue the operations.

DISCUSSION. The results obtained immediately suggest a number of questions. For example, what is the real reason why no more egg rafts appear while sprinkling is going on? Are the females kept away by the noise of the water, or is the disturbance of the water surface the primary or only reason? What accounts for the mortality of the larvae and pupae? Mechanical injury? Prevention of proper orientation to obtain oxygen? Disruption of surface film?

A number of practical questions also occur: What would be the effect of varying the time and frequency of sprinkling; would different water pressures produce different results? In a practical application of the principle would it be more economical and just as effective to use water pumped from the breeding site itself rather than using the clean water with its pressure from the water mains? Other methods of disturbing the water should also be studied, such as air bubbles, air currents, propellers and the like.

Reference Cited

SUBKLEW, W. 1939. Untersuchungen über die Bevölkerungsbewegung des Kiefernspanners (*Bupalus piniarius*). Mitt. Forstwirt. u. Forstwiss. 10:10–51.