A STUDY OF THE USE OF ABATE IN MOSQUITO CONTROL IN SUFFOLK COUNTY, LONG ISLAND, N.Y., IN 1965

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In Suffolk County, on Long Island, New York, the desirability of substituting less persistent insecticides, and biological, mechanical or physical control methods, for DDT in both the salt marsh and upland mosquito control programs has been clearly recognized for some time, particularly in certain special use areas. The studies described in this paper were made in order to determine whether the comparatively new material, Abate, which had favorable test results elsewhere, could be used as a larvicide under certain special conditions, which included: (1) Heavily polluted water in the settling beds or lagoons, yards and pens of duck farms, and in sewage disposal settling tanks of large institutions. Principal species were of the *Culex pipiens* complex. An important consideration at some of the sites was safety to ducks. (2) Salt marshes in State Parks and other special use areas in which there was heavy mosquito breeding both in ditches and in the open marsh. Wildlife, including mammals, reptiles, amphibians, birds, fish, shellfish and other invertebrates, were components of the ecosystem here, and it was desired to protect them.

1. TESTS IN POLLUTED WATER. Recognizing that insecticides may require different dosages in different types of water, including water of varying degrees of pollution, water from several duck farms representing different degrees of pollution was used in these tests. (Figs. 1, 2, and 3) A plastic tub 45 inches in diameter and about one foot deep, capacity 54 gallons, was placed at each site and filled with water from that site (Figs. 4, 5). In each case the water was taken from an area which was breeding *Culex pipiens* subsp. in large numbers. The tubs were thoroughly cleaned with brush and sand after each test. In some tests, natural oviposition and infestation could take place. In other tests, larvae that were already in the water were removed, and known numbers of specific instars were placed in the tubs before the sprays. The spray was applied over the surface as uniformly as possible in very fine droplets with a "Flit-gun" type hand sprayer with an adjustable nozzle. When necessary, a screen was set up for protection from the wind while spraying.

The Abate formulations used were made up from 43 percent emulsifiable concentrate. The label stated: "Active ingredients, *O,O,O',O'*-tetramethyl *O,O'*-thiodi-p-phenylene phosphorothioate, 43 percent; Aromatic petroleum solvent, 39 percent; Inert ingredients, 18 percent. 1 gal. contains 4 lbs *O,O,O',O*-tetramethyl *O,O'*-thiodi-p-phenylene phosphorothioate. (Lot No. 1160–72)." The proper amount to give the desired dosage was mixed in 300 ml. of water, which gave the coverage desired, in each test.

The first series, with polluted water from one source, was designed only to find a suitable dosage range. The water in the tubs contained hundreds of larvae of all stages, as well as egg rafts and pupae. Dosages of 0.005 lb./acre, 0.01 lb./acre and 0.05 lb./acre were included. Two-and-one-half to 3 hours after treatment, the lowest dosage had caused no observed mortality, whereas the highest caused virtually 100 percent mortality. The intermediate dosage caused intermediate mortality.

In the second series, water from three different farms was used to fill the tubs, to determine whether the degree of pollution, as represented in these sites, was a factor to be considered in the performance of the larvicide. Before each spray any larvae, pupae and egg rafts that were

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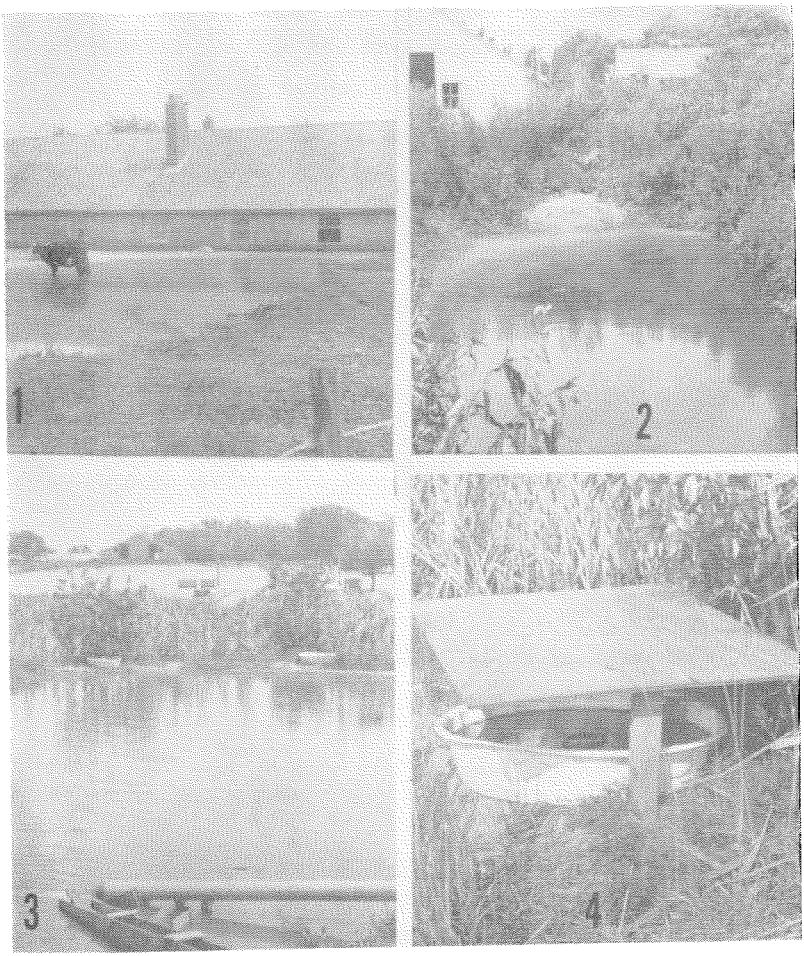
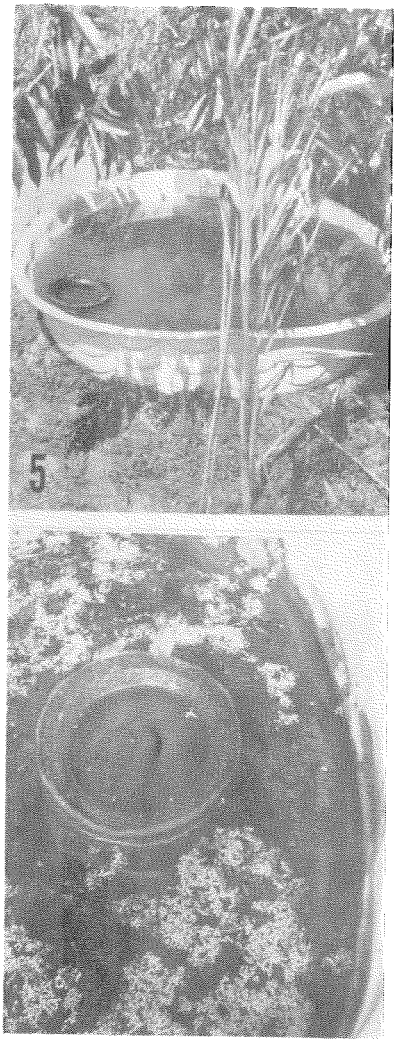


Figs. 1, 2 and 3.—Duck farm sites from which mosquito larvae and water were taken for plastic tub tests. Fig. 4.—Tub containing duck farm water, shaded from sun and protected from rain.

already present were removed, and 200 fourth-instar larvae were introduced into each container. Unfortunately, one of the tubs was stolen on the second day, so that all of the planned comparisons could not be made. However, the differences in mortality between dosages were so clearcut that it was felt that any differences due to relative degree of pollution, in this instance, at least would not have mattered.

Dosages of 0.25 lb. and 0.1 lb. per acre were compared. Sprays were applied on August 3. After 2 hours there was 100 percent mortality with 0.25 pound per acre and 85 percent mortality with 0.1 pound per acre.

In order to test for residual effect, every day from the day after spraying, 200 fourth instar larvae were placed in the tubs, between 10:00 a.m. and noon each day. Counts were made at the same time



FIGS. 5 and 6.—Floating cage, enclosing mosquito larvae colonized in plastic tubs filled with duck farm water.

the next day; after each count, all specimens were removed and 200 more larvae were introduced. It was not until the 6th day that any larvae survived (Fig. 7). On that day, August 9, although there had been complete mortality with the 0.25 lb. per acre dosage, a few larvae (6%) survived the 0.1 lb. dosage. Beginning the next day there was a general and gradual increase in survival with both dosages until the 13th day (August 16), after which there was no further mortality. On the 12th day, i.e., the last day before complete survival, the survival from the higher dosage was 85 percent and from the lower dosage, 96 percent.

In the third series the tests were modified to allow for more precise observing and recording of the effects. A floating cage (Figs. 5 and 6) was designed so that known numbers of larvae of selected stages could be observed, and their reactions recorded in detail. The cage consisted of a floating ring of cork, about 8 inches inside diameter, from which was suspended a cloth bag which just touched the bottom of the tub.

For each test, 10 larvae of each of stages 1, 2, 3 and 4 were placed within the ring, which thus served as a sample of the entire surface of the water in the tub. The behavior of larvae outside of the ring could also be observed with this arrangement. Dosages of 0.1 lb./acre and 0.05 lb./acre were applied.

With 0.1 lb./acre, after 2 hours, all but two larvae, and 1 pupa which had transformed after placement, were dead. Although two larvae were alive, they behaved abnormally, being unable to orient the siphons to the water surface; they died before the next observation. An adult emerged from the pupa.

With the 0.05 lb./acre, 1 pupa and six 4th stage larvae were alive after 2 hours.

In the fourth series, the tubs were covered (Fig. 4), to protect them from rain and modify the light factor. The floating cage procedure was used, as in series 3, with dosages of 0.1 lb./acre and 0.05 lb./acre. This was done late in the summer; the water temperature was 16° C. and the air temperature 20° C. This test was the first of a series, not yet completed, of studies of the influence of factors such as light, temperature and rainfall on the results.

The figures in the tables (Tables 1 and

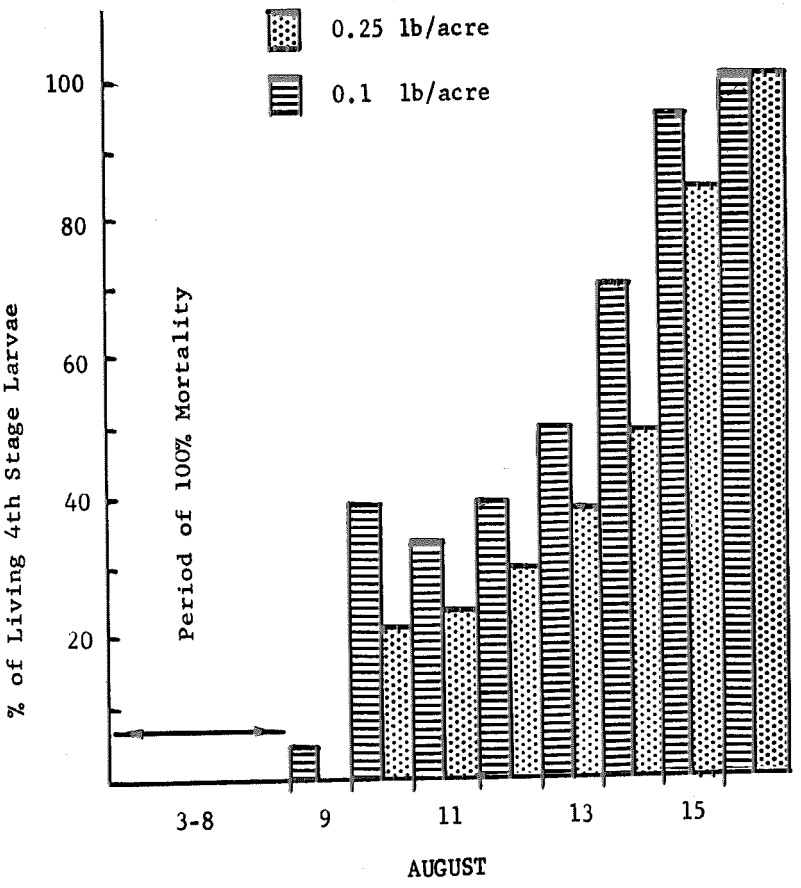


FIG. 7.—Percentage of survival of 4th instar larvae, at daily intervals, after dosages of 0.1 and 0.25 lb./acre, sprayed on August 3; 200 larvae introduced each day thereafter in each container. 2nd series.

2) give an idea of the type of data that was taken. Eleven days after treatment, 10 4th-stage larvae were placed in each of the floating cages. Two days later there were 8 dead larvae, 1 pupa and 1 living larva in each cage.

DISCUSSION AND CONCLUSION, TESTS IN POLLUTED WATER. Advantages of the open, floating cage test method are evident from the observations, especially the ease with which replications can be made. It is planned to use this technique in future tests to attempt to clarify the many details that remain to be studied. Tentative conclusions from the tests with polluted water are summarized briefly as follows:

First and Second series: Dosage of Abate in heavily polluted water should be not lower than 0.05 lb/acre and probably should be higher, e.g. 0.1 lb or 0.25 lb, depending on the degree and kind of pollution, weather conditions and other factors yet to be determined.

Third and fourth series: The more refined techniques and more precise data of the third and fourth series confirm the

TABLE 1.—Number of larvae surviving out of 10 of each stage, after different hourly intervals at 0.1 lb./acre.

Time after treatment	Larval Stages					
	1st Instar	2nd Instar	3rd Instar	4th Instar	Pupae	Totals
2 hrs.	2	2	2	0	0	6
3 hrs.	1	2	0	0	0	3
4 hrs.	0	0	0	0	0	0

TABLE 2.—Number of larvae surviving out of 10 of each stage, after different hourly intervals at 0.05 lb./acre.

Time after treatment	Larval Stages (survivals)					
	1st Instar	2nd Instar	3rd Instar	4th Instar	Pupae	Totals
2 hrs.	9	3	2	6	0	20
3 hrs.	4	3	2	6	0	15
4 hrs.	3	0	1	5	0	9
5 hrs.	1	0	0	0	0	1
6 hrs.	0	0	0	0	0	0

conclusion that the dosages must be not less than .1 lb/acre or at least, should be more than .05 lb/acre, for quick kill, and kill of later stages.

Since a dosage of 0.1 lb./acre did not prevent pupation of 4th stage larvae, it would be theoretically possible for a new population to develop if the treatment was not made until that stage. A dosage of 0.1 lb./acre did not have any longer residual than 0.05 lb./acre, judging from 14-day counts.

2. FIELD OBSERVATIONS IN A SALT MARSH. A marsh of several hundred acres in Heckscher State Park was the source of severe mosquito annoyance to bathers and others who made extensive use of the park facilities. This marsh had long been a heavy producer of *Aedes sollicitans* which had been kept under control through a combination of ditching, draining and spraying. Control had become increasingly difficult, one of the suggested reasons being the possible development of resistance to DDT. This was not definitely determined, but the marsh was a real problem area, and when Abate became available for experimental use, it was decided to use this material in Heckscher Park.

It was not until 1965 that the marsh came under the observation of the author, and became part of an experimental program. Therefore, comparative data from previous years were not available for comparison on any basis except number of sprays applied at different sites in the routine control program. Also, since it was in a heavy use area all the operations could not be carried out as a part of an experimental design. However, the effects of Abate as used from then on could be observed and recorded, and it was considered that such observations as could be made both on mosquitoes and other fauna would be of intrinsic value, and useful as a background for future work.

The previous pattern of operations, because of the demand for more or less complete control, had been to treat at least topically, whenever dip counts showed 10 or more first instar larvae per dip. It was necessary to fit our observations into this routine.

By the time the Abate program was activated one spray of DDT had already been applied, on May 25, which was recorded as a routine early spring application of 0.5 lb. per acre. The plan was for the next spray to be Abate, and then if it appeared to give as good control as DDT, to continue with Abate, as needed, the remainder of the season.

By June 8, first stage larvae were re-

ported again and Abate was applied at 0.05 lb. (30 gals. emulsion) per acre. Another Abate spray was applied at the same rate on June 24, and another on July 12, each time after dip counts showed first stage larvae developing. A local shower, not recorded at the site of the weather station, was reported after the July 12 application. This, plus a heavy rain on the 10th, resulted in flood conditions, and larvae appeared only 3 days after the spray. It was decided to use DDT again on the 15th. By July 21, first stage larvae were found again, following heavy rain on the 18th, and thereafter the Abate schedule was continued. After the Abate application of 0.05 lb. per acre on the 21st of July, the next record of first stage larvae was on August 9. In order to determine if a higher concentration would be effective over a longer period, the dosage was increased for the next two aplications to 0.1 lb. per acre (August 9 and 19), and then increased again to 0.5 lb. per acre for the next application, which happened to be the last that was needed that season. The earlier, increased dosages apparently did not result in any longer period of effectiveness, but it may be that the comparatively heavy dosage of 0.5 lb. per acre on August 30 was responsible for prolonging the larvae-free period to the point where no more sprays were necessary.

DISCUSSION. As pointed out above, direct comparison from one year to the next could not be made because of a lack of comparable data in 1964. However, the number of times spraying was considered necessary somewhere in the marsh because of reappearance of larvae was fewer in 1965, with the Abate program than in 1964 with the DDT program, even though the amount of rainfall was greater in 1965.

All that could be concluded was that a program of Abate treatments seemed to be a very promising substitute for DDT.

FIELD EVALUATION OF TWO MOSQUITO LARVICIDES, ABATE AND DURSBAN, AGAINST *ANOPHELES QUADRIMACULATUS* AND ASSOCIATED *CULEX* SPECIES

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INTRODUCTION. For many years, TVA has been using DDT as a mosquito larvicide. The usual application has been by helicopter at the rate of 0.1 pound DDT per acre, increased to 0.3 pound in densely canopied areas. In 1966, two promising new larvicides, Abate and Dursban, were field tested as potential substitutes for DDT. These chemicals were chosen because preliminary reports from various sources indicated that they had the qualities suitable for effective low volume discharge rates required for helicopter application.

MATERIALS AND METHODS. All field evaluations were conducted along shoreline areas of Dogwood or Redbud Lake (Beech River Watershed Development Authority) located east of Lexington, Tennessee, in Henderson County. Several shoreline segments characterized by quiet, shallow water populated by decaying annual vegetation and thriving water-tolerant plants (*Eleocharis, Juncus, Scirpus, Ludwigia,* small willow, etc.) were used intermittently as representative larval mosquito populations developed.

Typically, evaluation plots were estab-