8447 (1 lb./gal. EC) at 5.0 p.p.m. DDT (75% WP) was ineffective when applied at 20 p.p.m. against the St. Thomas *Ae. aegypti*.

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EVALUATION OF LARGE-SCALE TREATMENT WITH DICHLORVOS FOR THE CONTROL OF *CULEX PIPIENS QUINQUEFASCIATUS* SAY

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The establishment of *Culex pipiens quinquefasciatus* as an important vector in the transmission of St. Louis encephalitis virus (Chamberlain *et al.*, 1959) re-emphasized the need for control measures against this mosquito. The application of the residual-fumigant technique with dichlorvos vapor was a new control approach which originated at Savannah, Georgia, in 1962 (Maddock *et al.*, 1963). The success of these first trials indicated a need for further studies of new formulations and proof of the practicability of operational usage. This work describes such an evaluation of a large-scale treatment with 20 percent dichlorvos formulation in plastic resin.

MATERIALS AND METHODS. The test area selected met two established criteria: (1) the area was a metropolitan portion of the City of Savannah which normally sustained heavy *Culex* production; and (2) it contained a minimum of the hazards normally encountered in a control operation of this type (i.e., danger to personnel working under congested traffic conditions). The area chosen contained 1,284 basins (approximately one-fifth of the catch basins of the city) and extended over 212 city blocks.

Based on previous studies with the sustained-vapor technique in catch basins (Brooks *et al.*, 1963), a 20-gram dichlorvos dosage, characteristic of a 10-inch length of 20 percent dichlorvos-resin formulation, was used throughout the treatment.

Dispenser installations were made in all basins between May 16 and 18, 1963. Within each basin the dispenser was suspended by a 24-inch length of coated copper wire from the front support rod of the basin top. In basins where this rod was missing, dispensers were attached to a perforated metal tape hanger nailed to the upper basin wall.

Evaluation of the overall treatment was based on weekly inspections for *Culex*

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larvae and on 3-hour exposure of adult laboratory-reared *C. p. quinquefasciatus* in selected test basins. Twenty-five basins were utilized during each evaluation. Fifteen of the 25 were tested routinely through the season, while an additional 5 basins were selected randomly for inspection and exposure each week. The remaining five selected basins were left as untreated checks through the test period. As an additional check on the test insect used in each evaluation, two cages of mosquitoes were left in the laboratory, and two were transported to the field together with the specimens used in the exposure tests.

Techniques used for the preparation and exposure of the adult mosquitoes, as well as the techniques of larval measurement, were based on methods used by Brooks and Schoof, 1964a.

RESULTS. Data for the weeks of effective adult control are summarized in Figure 1.

Satisfactory kills in the 15 test basins averaged 14.3 weeks and ranged from 10 to 18 weeks, compared with an average of 14.2 weeks and a range of 13 to 15 weeks in the 5 randomly selected basins. The range of weeks of effective kills in the individual test basins is shown in Figure 2. Excessive average mortalities in the check basins were recorded on weeks 3 and 4. Results between basins tested regularly and those chosen by random selection were quite consistent as both the adult mortalities and incidences of larval infestation appear comparable. The kills of adults in the check basins on weeks 3 and 4 were a result of contamination from an external source.

Temperatures within the test basins remained favorable to dichlorvos vaporization through the entire 18-week test period. The maximum temperatures varied from 94° F. to 106° F., while minimums were recorded from 60° F. to 75° F. Ambient air temperatures at the hour of

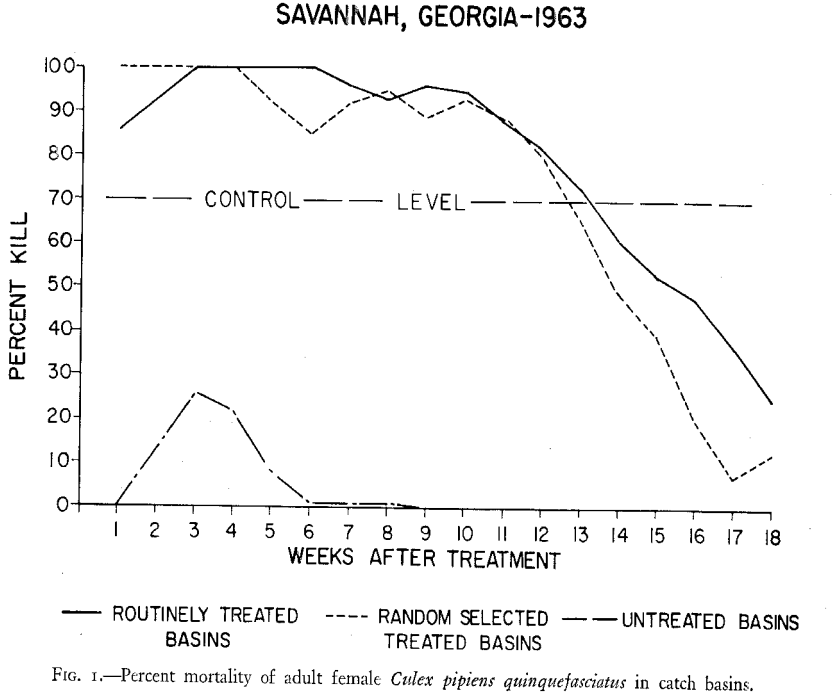

FIG. 1.—Percent mortality of adult female *Culex pipiens quinquefasciatus* in catch basins.

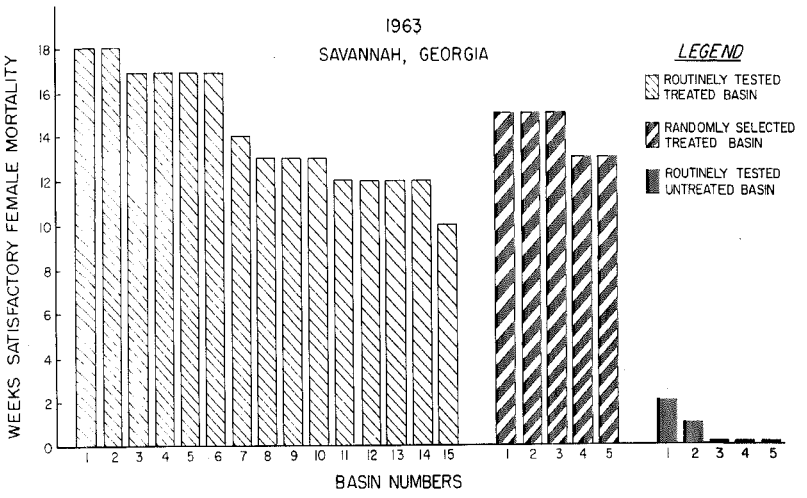

FIG. 2.—Weeks effective control of adult female *Culex pipiens quinquefasciatus* in catch basins.

testing ranged from 60° F to 106° F. Water temperatures of 73° F. to 82° F. were well within tolerance levels for the breeding of *C. p. quinquefasciatus*.

Data on breeding activity are presented in conjunction with the average weekly rainfall (Fig. 3). Larval infestation of treated basins first occurred on the 4th week after treatment. Immatures continued to appear in small numbers through the remaining 14 weeks of the test period. Although low in magnitude, the average number of larvae per dip in the 15 basins routinely inspected reflected the same cyclic pattern apparent in the check basins. The normal late seasonal increases in breeding of *C. p. quinquefasciatus* appeared in September.

DISCUSSION. These studies, as with earlier work by Brooks and Schoof, 1964b, have indicated effective control by this formulation for more than 14 weeks. The wide range of mortality found in the individual basins along with other factors has led to a critical look at the percentage point used to define acceptable control. As a result of this review and laboratory tests, at least three factors emerge which may alter the criteria used in determining the level above which the basin is considered under control.

1. The evaluation techniques for the present work utilized a 3-hour exposure of 3-day-old adults to the treated air volume. Studies of the dispersal of the test species from the basin show that adults evacuate the basin in mass at dusk (apparently light stimulated). However, only 10 percent of the adults that emerged in the 3-hour period prior to dusk will leave the basin on that same day. Therefore, under natural conditions, the period of exposure of adults, with the exception of an extremely small percentage, will be in excess of 3 hours.

2. Tests in a treated catch basin indicate that the newly emerged adult is more susceptible to the dichlorvos vapor than the older test insect. In these exposures pupae were planted in a treated basin and allowed to emerge into the dichlorvos-treated atmosphere. Kill of all newly emerged adults was achieved within 30 minutes through the 18th week after treatment. It follows then that even if the vapor concentration is not sufficient to bring about mortality of 3-day-old test insects, it may yet be strong enough to kill newly emerged

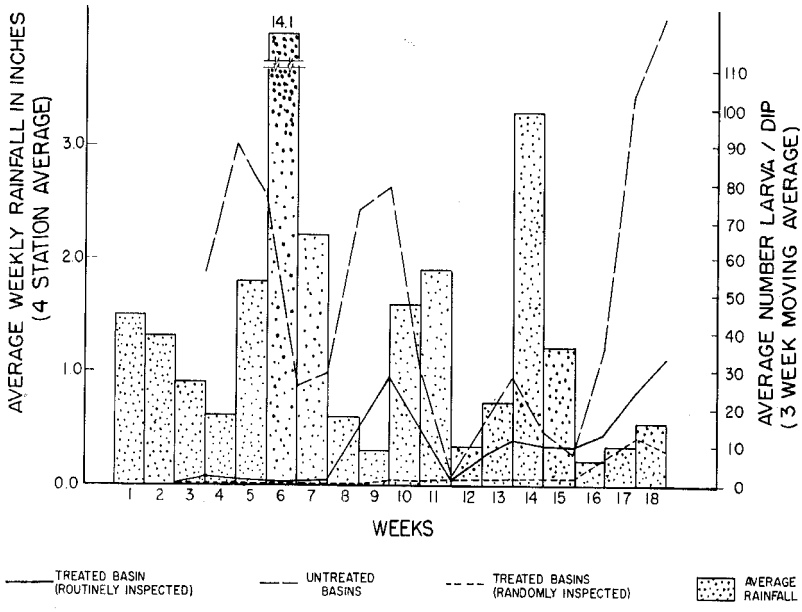

FIG. 3.—Seasonal distribution of rainfall vs. mosquito breeding in catch basins—Savannah, Georgia 1963.

mosquitoes within the basin. The catch basin remains essentially under control since it is incapable of contributing adults to the endemic population of the area.

3. The third factor influencing the interpretation of test data is the hour of the day at which these tests were run. Throughout the period of this evaluation, exposures were carried out between 9:00 a.m. and 1:00 p.m. With the seasonal shift of high temperatures to the latter part of the day the optimal vapor concentration may not have existed at the time of testing, particularly during the later tests in the season.

In the present work, as well as others, the data reveal a suppression of breeding in the treated basins. The reduction of larval activity immediately after dispenser installation would indicate dichlorvos concentrations sufficient to act as a larvicide at the onset of the treatment. Further maintenance of low magnitudes and frequencies of basin infestations presumably were the results of kill or repellency of the mature female entering the basin for oviposition, thus preventing new basin infestations.

The resin formulation used in these field trials has shown handling characteristics superior to other dispensers tested in previous studies (Brooks and Schoof, 1964a). Advantages gained in the field treatment with this unit are as follows:

1. A reduction in dispenser loss from abrasion due to the flexible, tough characteristics of the resin.

2. Ease in installation of the unit since attachment can be made to the dispenser itself without the use of accessory casings or mounting brackets.

The savings in manpower, equipment costs, and time as described by Brooks *et al.*, 1963, remain primary advantages of the residual vapor technique over the conventional spray methods for the control of *Culex* in catch basins.

SUMMARY. A field evaluation of the operational use of the sustained release of dichlorvos-vapor technique for the control of *C. p. quinquefasciatus* was carried out at Savannah, Georgia, in 1963 when 1,284

catch basins were treated in an area extending over 212 city blocks. Satisfactory control of caged adult females exposed for 3 hours averaged 14.2 weeks over the treated area. Larval infestations of basins were greatly reduced after treatment and remained at a low level through the remainder of the season. The activity pattern of newly emerged adults and their greater susceptibility to dichlorvos vapor indicate that the efficacy of this control measure against this species in practice may well exceed the 14-week period reported.

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VARIATIONS IN SOME MORPHOLOGICAL CHARACTERS IN ANOPHELINE LARVAE

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The following variations in some fundamental morphological characters were observed during the examination of anopheline larvae collected in Egypt, U.A.R. and Jordan.

Clypeal Hairs

1. In a fourth stage larva of *A. pharoensis* collected from a breeding place near Cairo, doubling of the right inner clypeal hair was noted (Fig. 1). Thus two inner clypeal hairs occurred on the right side instead of one, each with a separate pit and the two hairs lying parallel and almost touching each other. The length of the two hairs and their branching at the tip was identical with that of the normal left side.

2. In *A. sergenti* larvae from the oases of the Libyan Desert, e.g. Siwa, Bahria, Kharga and Dakhla, it is typical to find all clypeal hairs simple. In some specimens, however, splitting of the outer and posterior hairs was encountered. Usually the splitting is simple but occasionally it is repeated so that up to four branches are produced (Fig. 2).

Fronto-clypeal Markings

1. The usual pattern of the fronto-clypeal