RESIDUAL ACTIVITY OF TEMEPHOS, CHLORPYRIFOS, DDT, FENTHION, AND MALATHION AGAINST *AEDES SIERRENSIS* (LUDLOW) IN FABRICATED TREEHOLES[1]

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ABSTRACT. When temephos, chlorpyrifos, fenthion, and malathion were applied at a rate of 1 lb of technical material per 50 fabricated treeholes (approximately 9 g/hole), malathion gave control of larvae of the western treehole mosquito, *Aedes sierrensis* (Ludlow) for 1 year, fenthion and temephos were effective 3¼ years, and chlorpyrifos gave complete control throughout the 4¾-year test period. Temephos at rates of 1 lb of technical material per 100 and 200 treeholes (approximately 4½ and 2¼ g/hole, respectively) was effective 3 years, and chlorpyrifos again gave complete control throughout the 4¾ years. DDT at a rate of 1 lb of technical material per 32 treeholes (approximately 14 g/hole), also gave complete control throughout the 4¾ years. The holes were fabricated from 2-inch-thick Douglas fir lumber and held 4 liters of water, which was replenished weekly throughout the test.

In 1969, we initiated a study, in fabricated treeholes, of the residual effectiveness of 4 conventional mosquito larvicides, temephos (Abate[R]), chlorpyrifos (Dursban®), fenthion (Baytex[R]), and malathion; DDT was included for comparison. Coincidentally, in 1970, Oldham et al. (1972) initiated a study of the residual activity of some of the chemicals we were testing. The two studies should complement rather than detract from each other.

Our decision to use fabricated treeholes stemmed partially from the difficulty encountered in locating an adequate number of similar sized, naturally occurring treeholes in the same species of tree within easy driving range of our laboratory. But aside from that, a strong argument can be made for using uniformly sized, artificial holes to measure and compare the longevity of insecticides. In fabricated treeholes that are made with sound wood, snugly fitted bottoms and sides can reduce leakage to a slight amount of ongoing seepage, which, in turn, should largely limit the loss of insecticidal effectiveness to codistillation, hydrolysis, and other chemical-altering processes attributable to interactions and reactions within the larval chambers. In naturally occurring treeholes, on the other hand, all the cited processes occur within the larval chambers, and considerable portions of some doses in individual treeholes may be lost through overflow or gross percolation or seepage into adjoining areas of decay. Our objective was the measurement of the loss of insecticidal effectiveness due primarily to the ongoing processes that occur within larval chambers that have comparable pH's, water volumes and water losses, quantities of the same food substances, and exposure to direct sunlight.

The construction and utilization of the holes and the residual effectiveness of the larvicides used in them are the subject of the present paper.

MATERIALS AND METHODS. Except where otherwise noted, we constructed the "treeholes" from 2-inch-thick Douglas fir lumber, Figure 1. Sides of each box were made of 10-inch-wide and ends from 6-inch-wide boards, all 10 inches long. Each unit had an interior bottom made of 6-inch-wide boards. All abutting surfaces were fastened together with wood screws and marine glue. A second, ex-

[1] This paper reports the results of research only. Mention of a pesticide or a proprietary product in this paper does not constitute a recommendation or an endorsement of this product.

terior bottom and a top were made of ½-inch, exterior, Douglas fir plywood. The exterior bottom was fastened in place with boat nails and marine glue. The top was not fastened to the unit. A hole 2 inches in diameter was bored in each top.

None of the containers leaked when completed. However, the tests were to run for an indefinite period, so we pretested the units outdoors for a full year. In most instances, the abutting surfaces developed no leaks, but the boards, especially those that were 10 inches wide, tended to crack deeply and sometimes to split completely along their full lengths. The genesis of the cracks was apparently the continuously increasing pressure exerted on the outer, drier areas of the boards by the inner fibers when they absorbed water and swelled. In any case, the cracks resulted in gross leakage in most boxes. Therefore, various types of steel bands were tested in an effort to close the cracks. The band chosen was one made of zinc-coated, 6-gauge wire with a loop on each end large enough to snugly encircle a 9/16-in bolt. We fashioned the bands with a light sledge and a heavy shop vise. Appropriate tension for the closing of the cracks with the bands was obtained and maintained by tightening the nuts on the 9/16-in bolts. Two bands per container were necessary.

Any seepage area that remained in a box after the bands were tightened was sealed by pouring in a small quantity of a mixture of bentonite and finely ground sawdust in water. Then we poured off the surplus bentonite and sawdust and refilled each unit with 4 liters of fresh tap water in which we had incorporated ca. 0.5 liter by dry measure, of a mixture of finely ground sycamore and willow leaves plus some mosquito larval food. Thereafter, alfalfa pellets were added for larval food as the need arose.

After all boxes had been refurbished and refilled and biological equilibrium appeared to have been reached, each unit was bioassayed with about fifty 2nd-instar

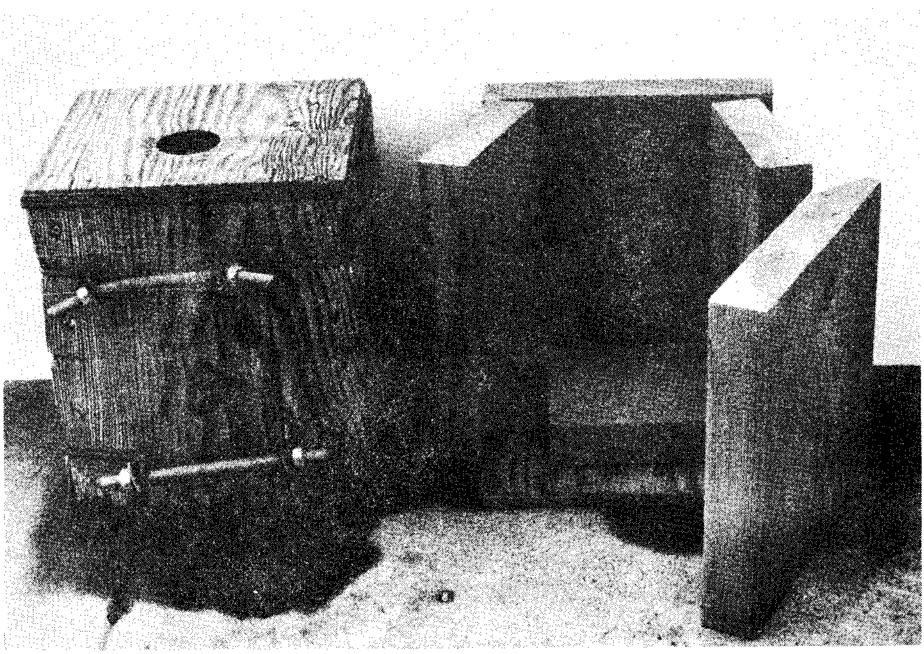

Fig. 1. View of a fabricated treehole plus unassembled components.

A. sierrensis larvae. Since no mortality was observed and development proceeded normally, the boxes were judged to be ready for the test.

The temephos, chlorpyrifos, fenthion, and malathion used in the test were emulsion concentrates; the DDT was used as a 50% wettable powder. The treatment rates for technical temephos and chlorpyrifos were 1 pound per 50, 100, and 200 treeholes (approximately 9, 4½ and 2¼ g/treehole, respectively). The rate for technical fenthion and malathion was 1 pound per 50 treeholes; the rate for technical DDT was 1 pound per 32 treeholes (1 oz of 50% wettable powder, approximately 14 g/treehole). Each dose of each material was replicated five times. Five untreated units were used as controls. The doses of DDT were weighed on a balance; the liquid materials were measured into the units with pipettes. The containers were held on wooden benches in a screened house. Bench position and the dose for each unit were assigned by randomization. Before a unit was bioassayed, the water level was restored to the 4-liter mark. However, between bioassays we maintained water continuously in each unit by weekly replenishments.

A unit with a given dose of insecticide remained in test until it no longer gave complete mortality within 24 hours. As long as a unit remained in test, we bioassayed it at least once each quarter with 75 laboratory-reared 4th-instar larvae of *A. sierrensis,* and occasionally we rechecked with a like number of 4th-instar larvae of *Culex pipiens quinquefasciatus* Say.

RESULTS AND DISCUSSION. Results are given in Table 1. Although the chemicals were constantly in water and despite a slight but noticeable and almost continuous amount of seepage from all test units, all the organophosphorous compounds exhibited considerable longevity. On every occasion, larvae that were introduced into control units developed normally, pupated, and emerged.

We believe the results of our test can be a useful guide for mosquito control districts and for agencies that make recommendations. In general, the differences between naturally occurring and fabricated treeholes are probably no greater than the physical and chemical variations among naturally occurring holes. Thus, within the larval chambers of fabricated and naturally occurring treeholes, the chemical interactions and reactions should be roughly comparable. However, on the average, the quantity of insecticide lost through overflow and seepage is undoubtedly greater from naturally occurring than from fabricated treeholes. Nevertheless, even with considerable loss due to overflow and seepage, chlorpyrifos at a rate of 1 lb/200 treeholes should give about 3 full years of control of *Aedes sierrensis* in the average treehole. With effectiveness of that duration and the large numbers of treatments possible with each pound of material, the average cost of chlorpyrifos per treehole should be low enough to make such treatment economically feasible for mosquito control districts.

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Table 1. Comparative effectiveness of various doses of selected larvicides against larvae of the western treehole mosquito in fabricated treeholes.[1]

Compound	No. of treehole units treated per pound of insecticide	Years of effectiveness
Temephos	50	3¼
Temephos	100	3
Temephos	200	3
Chlorpyrifos	50	>4¾
Chlorpyrifos	100	>4¾
Chlorpyrifos	200	>4¾
Fenthion	50	3¼
Malathion	50	1
DDT	32	>4¾

[1] Each unit, made with 2-inch-thick Douglas fir lumber, had an effective water-holding capacity of 4 liters.

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