DDT IN ALCOHOL AS A LARVICIDE FOR *AEDES AEGYPTI* CONTROL

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The introduction of DDT as a larvicide in campaigns for the extermination of *Aedes aegypti* in Peru has produced extraordinary results in reducing both the time required to eliminate the mosquito from a given area and the over-all expense. In field practice, a saturated solution of DDT (approximately 2 percent) in 95 per cent ethyl alcohol is added to household water containers in the proportion of 1 cc. to each 6 liters of capacity of the containers. The solution is applied by pouring it from a graduate onto the surface of the water or by swishing it onto the sides and bottom of the container, if empty. This does not affect the potability of the water or its use for other household purposes.

While this method, arbitrarily adopted by the Peruvian National Yellow Fever Department to avoid delay, proved to be highly successful, it left unanswered such questions as minimum effective dosage, preferred method of application, influence of the material of the containers used, etc. To place the larviciding program on a more scientific basis, therefore, the following studies were carried out under laboratory conditions.

The small coastal town of Chilca, some 65 kilometers south of Lima, was selected for the experiments because of its nearness to Lima, its high *aegypti* index and the fact that DDT had not been employed in this community. Two rooms were secured in a typical adobe house for carrying out the studies. All of the DDT-treated containers were kept in one room, and the control containers as well as the stock of larvae in the other. Larvae were collected from nearby natural sources the day before they were needed in the studies and placed in a large barrel provided for this purpose.

The containers were treated only once, at the beginning of each experiment. The larvae were introduced on the same day, and at weekly intervals thereafter. In each experiment the water was changed weekly, before the introduction of additional larvae.

EXPERIMENT No. I: To determine the minimum DDT dosage (quantity of a 2 per cent DDT-alcohol solution) necessary for the treatment of baked clay receptacles containing water.

The common 6-liter capacity terracotta jars were filled with water. The dosages ranged from 0.5 to 7 drops per liter of water. The latter figure is roughly equivalent to the dosage of 1 cc. per 6 liters of water which was being successfully used in the field at this time.

Since the dosage of 0.5 drop was seen to be ineffective, it was discontinued after the third week. The dosages of 1 to 7 drops began to kill the larvae during the first six hours and a 100 per cent kill was obtained at 36 hours for a period of 5 weeks. After the fifth week and through the eleventh week the DDT continued to give excellent results at 42 hours.

It is noteworthy that such a small dosage as one drop per liter of water capacity should be so rapidly and uniformly fatal to larvae for well over a month, and that its lethal effect should be so prolonged as to prevent pupation throughout the 11 weeks of observation, although the jar was emptied and refilled with water each week.

Although nearly equal results were secured by the various dosages, Figure 1 does make apparent the more reliable effects of the heavier dosage of 7 drops per liter of water.

EXPERIMENT No. II: To determine the effect of various types of containers on

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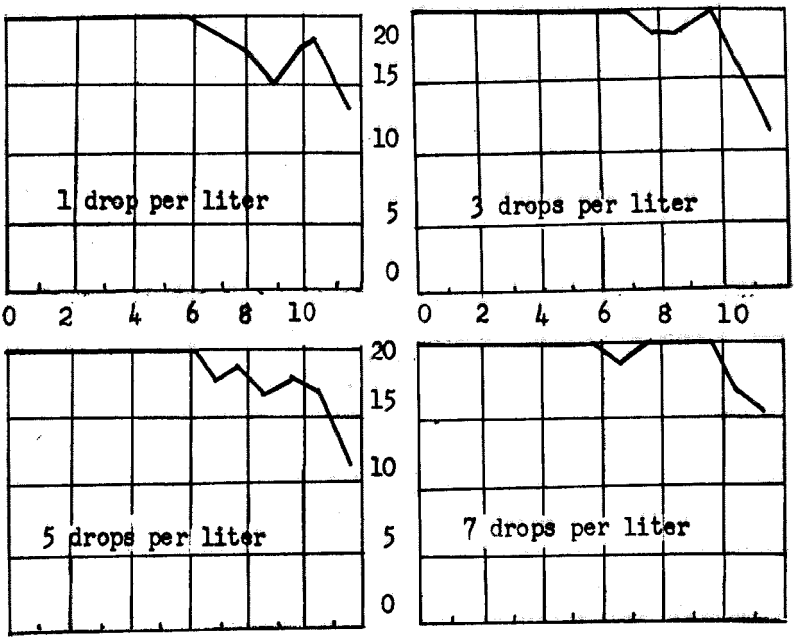


FIGURE 1. Comparison of mortality 36 hours after exposure of 20 *A. aegypti* larvae (vertical scale) placed in container treated with different amounts of a 2% DDT-alcohol solution per liter of water. Larvae introduced each week for 11 weeks (horizontal scale).

the residual action of DDT when applied to the water in the proportion of 1 cc. of 2 per cent DDT-alcohol solution to 6 liters of water. This dosage as well as the method of application is standard practice in the field.

Four of the most common types of containers used along the coast of Peru were selected. These containers were: 1) a small baked clay jar, 2) a large baked clay jar, 3) a concrete-lined tub and 4) a wooden tub (Figure 5).

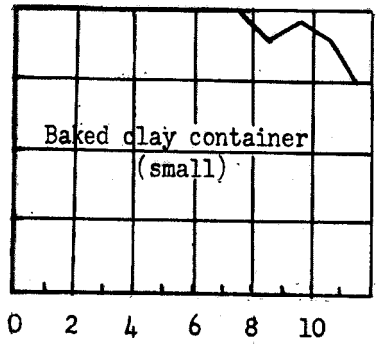
The action of the DDT was practically the same in all containers and the type of material used in the construction of the containers was therefore of no importance. Although a 100 per cent mortality at 36 hours was obtained only for the first 6 or 7 weeks, the subsequent reduction in the toxicity was not marked and a high mortality was secured throughout the 11 weeks reaching 100 per cent in all cases at 42 hours.

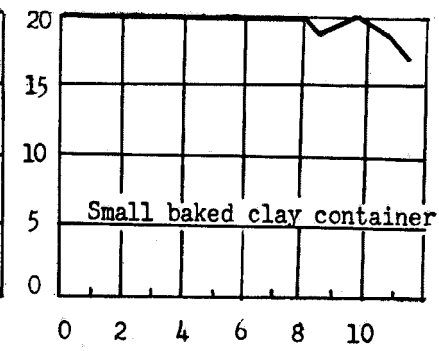
The results obtained in this experiment are presented in Figure 2.

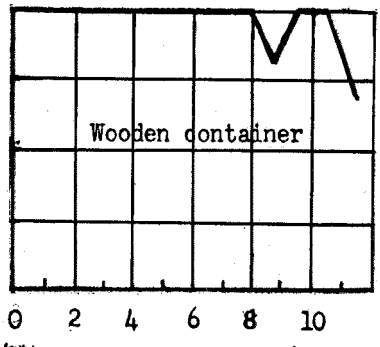
EXPERIMENT No. III: To determine the effectiveness of DDT applied by rinsing the container with a 2 per cent DDT-alcohol solution. The amount of solution used depended on the size and kind of material of the container and was not measured, the excess being poured out.

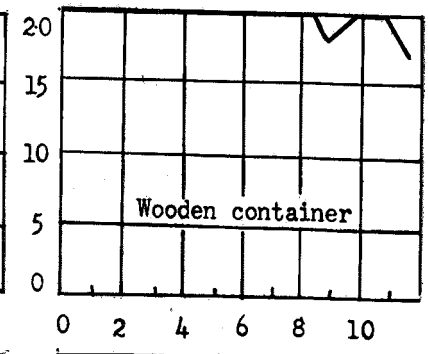
In this test the following containers were used: 1) large baked clay urn, 2) small baked clay urn, 3) wooden barrel, 4) concrete-lined bucket (Fig. 5). After these containers were rinsed with a 2 per cent DDT-alcohol solution, they were partially filled with water and larvae introduced at weekly intervals.

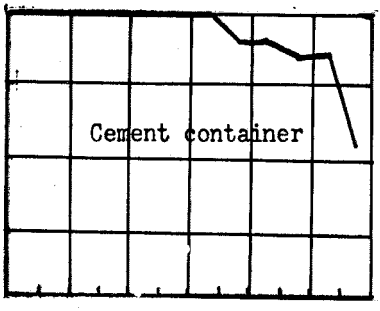
The results were practically the same as those obtained in experiment No. II, so that this method has no advantage. Field practice is to treat all receptacles which might become *aegypti* breeding











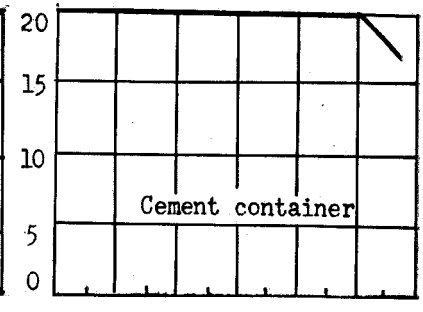


FIG. 2

FIG. 3

FIGURE 2. Comparison of mortality 36 hours after exposure of 20 *A. aegypti* larvae (vertical scale) placed in containers of different materials treated with DDT by the addition of 1 cc. of a 2% alcohol solution per 6 liters of water. Larvae introduced each week for 11 weeks (horizontal scale).

FIGURE 3. Comparison of mortality 36 hours after exposure of 20 *A. aegypti* larvae (vertical scale) placed in containers of different materials treated by rinsing them with a 2% DDT-alcohol solution. Larvae introduced each week for 11 weeks (horizontal scale).

places by pouring in the proper amount of DDT solution whether they contain water at the time or not. The action of the DDT at 36 hours became less effective by the 8th week but continued to be 100 per cent effective at 42 hours throughout the experiment. Figure 3 illustrates this gradual decrease in toxicity at 36 hours over the weeks.

EXPERIMENT No. IV: To determine the variation in killing time of DDT over a period of weeks when the DDT is applied in the form of a 2 per cent DDT-alcohol solution in the proportion of 1 cc. per 6 liters of water. The solution was added directly to the surface of the water as is the practice in the field.

In this test one large baked clay urn was treated and larvae introduced at weekly intervals thereafter, and the mortality noted at 2-hour intervals.

Although the larvae did not begin to die until after 2 hours, evidence of toxicity was noted before the first hour had passed. The larvae were moving more slowly and remained on the bottom of the container, unable to rise to the surface for air.

During the first two weeks after treatment the action of the DDT was intense during the first 8 hours, and thereafter with minor variations it continued to be 100 per cent toxic at 24 and 36 hours.

Figure 4 reflects the gradual decrease in the speed with which the DDT acts, due probably both to passage of time and to the weekly changing of the water.

EXPERIMENT No. V: To determine the effectiveness of treating baked-clay jars with DDT several months prior to placing them in service.

Small baked clay urns were rinsed with a 2 per cent DDT-alcohol solution and placed in storage (away from direct sunlight) for 13 and 14 weeks, respectively. The urns were then filled with water and larvae introduced at weekly intervals to observe the toxicity of the DDT.

In the first container which was tested 13 weeks after treatment no toxic action was noted at 24 hours during the first 2 weeks of testing. Before testing again during the third week of the experiment (15th week after treatment), the container was washed with water to remove the dust film which had collected during the weeks in storage. The container became toxic after washing and continued to be 100 per cent effective at 36 hours until the 19th week after treatment and 100 per cent effective at 48 hours through the 23rd week.

The second container employed a week later also proved nontoxic until washed, after which the DDT proved effective in practically the same degree.

By comparison of this with the other experiments it is evident that some toxicity was lost during the storage period, but the possibility is suggested that jars might be treated advantageously in certain situations at the time of manufacture.

SUMMARY OF RESULTS

1. Under laboratory conditions, 1 drop of a 2 per cent DDT-alcohol solution per liter of water is as effective as 7 drops per liter of water in preventing the larvae of *A. aegypti* from developing into adults in household water containers for a period of at least 11 weeks.
2. The material of the containers used to hold water for domestic purposes in the rural areas of the Peruvian coast (baked clay, wood and cement) does not influence the residual action of DDT against *A. aegypti*.
3. The method of application is not important. The same results were obtained by rinsing the containers with a 2 per cent DDT-alcohol solution and by adding the 2 per cent DDT-alcohol solution to the water in the containers in the proportion of 1 to 7 drops per liter of water.
4. The 2 per cent DDT-alcohol solution begins to affect *A. aegypti* larvae within 1 hour of contact, weakening the larvae to such an extent that they

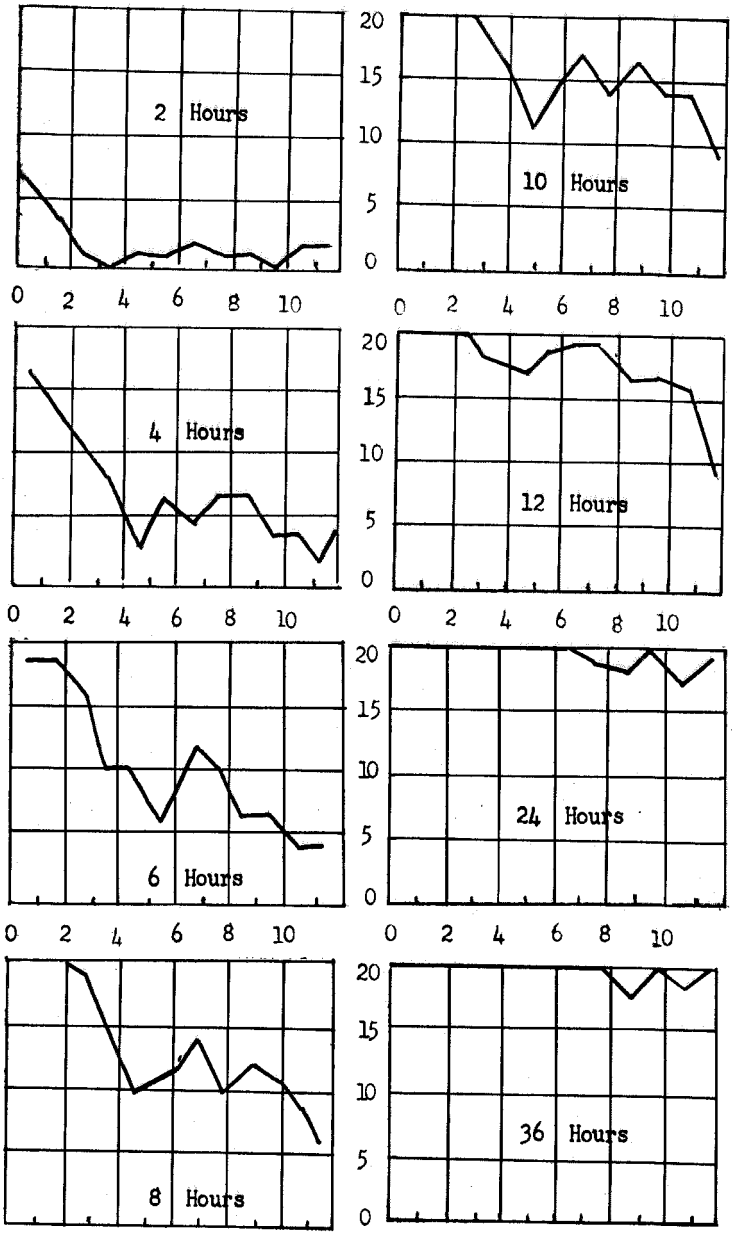


FIGURE 4. Comparison of the killing rate of DDT at different intervals between 2 and 36 hours over a period of 11 weeks (horizontal scale) when applied one time at the rate of 1 cc. of a 2% DDT-alcohol solution per 6 liters of water. Twenty larvae were introduced each week.

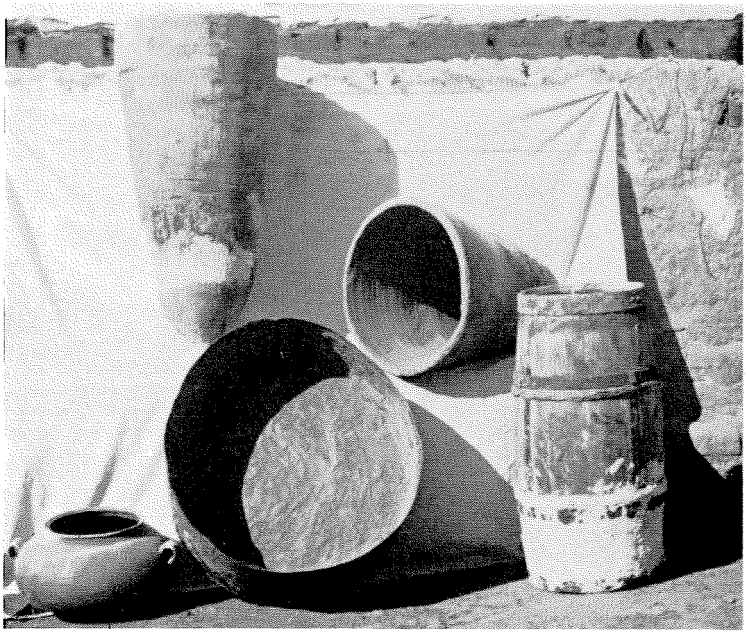


FIGURE 5. Group picture including each type container used in experiments 2 and 3.

begin to die after 2 hours and within 36 hours 100 per cent mortality can be expected. Actually during the first few weeks after treatment the time necessary for a 100 per cent kill is much shorter.

5. The baked-clay container which is the most common type employed in the rural areas can be treated and stored for at least 14 weeks provided it is first washed with water to remove the accumulated film of dust before being used.

CONCLUSIONS

1. A 2 per cent DDT-alcohol solution can be used as a larvicide in *A. aegypti* control with advantage over former methods because of its prolonged residual action and economy of application.
2. In our judgment the recommended dosage is 1 cc. of a 2 per cent DDT-alcohol solution per 6 liters of water capacity, even though under laboratory conditions it was shown that smaller amounts were equally effective. The above dosage assures a greater margin of safety and the amount of DDT is still so very small that it does not represent a danger to the health of the people.
3. Based on the results of the various experiments, the interval between treatments could be extended to 6 weeks. Nevertheless for routine field work it is recommended that a cycle of 4 to 5 weeks be employed to provide a margin of safety.