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LABORATORY TESTS WITH DDT AND DEUTERO-DDT AGAINST MOSQUITOES

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Deutero-DDT, in which the hydrogen atom on the tertiary carbon atom of DDT has been replaced by deuterium, has received considerable study during recent years. Pillai *et al.* (1963) found it to be highly toxic to larvae of 11 DDT-resistant *Aedes aegypti* strains. Brown (1964) suggests the substitution of deutero-DDT against *Ae. aegypti* in situations where resistance to DDT has developed. Zwick (1964) found a higher tolerance to deutero-DDT in Caribbean strains of *Ae. aegypti* than did Pillai *et al.* (1963). This note presents results comparing DDT and deutero-DDT against larvae of four species and as residues against restistant *Ae. aegypti* adults.

Larval susceptibility studies (Table 1) were performed following the World Health Organization standard procedure (Anon. 1960). All strains tested except one were resistant to either DDT or dieldrin or both. Results are given in Table 1.

Increased kills with deutero-DDT in comparison to DDT were obtained against specimens of all strains except susceptible *A. quadrimaculatus*. The greatest difference was obtained with DDT-resistant *Ae. aegypti*, but the concentration required for 95 percent mortality (2.5 p.p.m.) was significantly higher than the concentration of DDT required for the same mortality of susceptible *Ae. aegypti* (0.1 p.p.m., Flynn *et al.*, 1964). Similarly, the LC_{95} of deutero-DDT against chlorinated hydrocarbon-resistant *A. quadrimaculatus* (0.1 p.p.m.) is markedly higher than the

TABLE 1.—Comparison of DDT and deutero-DDT against late 3rd-early 4th instar larvae of four mosquito species

Species resistant to		Percent mortality in 24 hours at ppm					
		2.5	0.5	0.1	0.02	0.004	0.0008
A. quadrimaculatus (dieldrin)	DDT	..	..	100	100	69	..
	deutero-DDT	..	..	100	100	100	25
A. quadrimaculatus (DDT-dieldrin)	DDT	97	91	84	54	27	..
	deutero-DDT	100	100	99	85	47	..
A. quadrimaculatus (susceptible)	DDT	..	..	..	100	96	73
	deutero-DDT	..	..	..	100	99	72
A. albimanus (dieldrin)	DDT	..	..	100	100	43	..
	deutero-DDT	..	..	100	100	92	8
C. p. quinquefasciatus (DDT-dieldrin)	DDT	..	100	89	28	..	..
	deutero-DDT	..	100	100	99	9	..
Ae. aegypti (DDT)	DDT	16	11	1	..	..	..
	deutero-DDT	99	74	36	..	..	..

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TABLE 2.—Residual activity of DDT and deutero-DDT against late 3rd-early 4th instar *Ae aegypti* larvae.

Conc (ppm)	No. weeks of 95 percent or higher kills in 24 hours					
	DDT-resistant		Dieldrin-resistant		Susceptible	
	DDT	Deutero-DDT	DDT	Deutero-DDT	DDT	Deutero-DDT
2.5	0	4	3	>10	>10	>10
1.0	0	<3	3	>10	4	>10
0.5	0	<3	<3	4	3	>10
0.25	..	0	..	3	..	4
0.1	0	0	0	<3	<3	<3

value obtained for DDT against a susceptible strain (0.004 p.p.m.), Mortalities with DDT and its deuterated analogue against susceptible *A. quadrimaculatus* were similar.

Residual larvicide evaluations (Table 2) of these compounds were performed against three strains of *Ae. aegypti* following the method described by Jakob (1965). Residual effectiveness of deutero-DDT persisted for >10 weeks at 0.5 and 1.0 p.p.m. against the susceptible and dieldrin-resistant strains, respectively. However, the maximum concentration of deutero-DDT tested (2.5 p.p.m.) was satisfactory for only 4 weeks against a DDT-resistant strain.

Residual panel studies with deposits from emulsifiable formulations on plywood were conducted against DDT- and dieldrin-resistant adults of *Ae. aegypti* by the technique previously described (Jakob and Schoof, 1963). Exposures were for 1 hour; effectiveness was based on female mortalities at 24 hours. With a dieldrin-resistant strain, DDT at 200 mg./sq. ft. gave satisfactory mortalities (*i.e.* 70 percent or above) for 5 weeks, while exposure to the same dosage of deutero-DDT gave effective kills for 20 weeks, except at week 15. However, during the 20-week period the kills were above 90 percent only through week 13. With DDT-resistant specimens neither compound at 200 mg./sq. ft. was effective at week 1.

The data presented indicate that while DDT-resistant larvae showed an increased response to deutero-DDT, the concentrations required for effective larval mortality (*i.e.* 95 percent) were much higher than corresponding levels with DDT against susceptible specimens. In residual panel tests against DDT-resistant *Ae. aegypti* deutero-DDT was ineffective, but it was significantly better than DDT against a dieldrin-resistant strain. The data indicate little potential for deutero-DDT in situations where *A. quadrimaculatus* or *Ae. aegypti* are resistant to DDT. Such potential is further lessened by the development of new toxicants that are highly effective against resistant strains.

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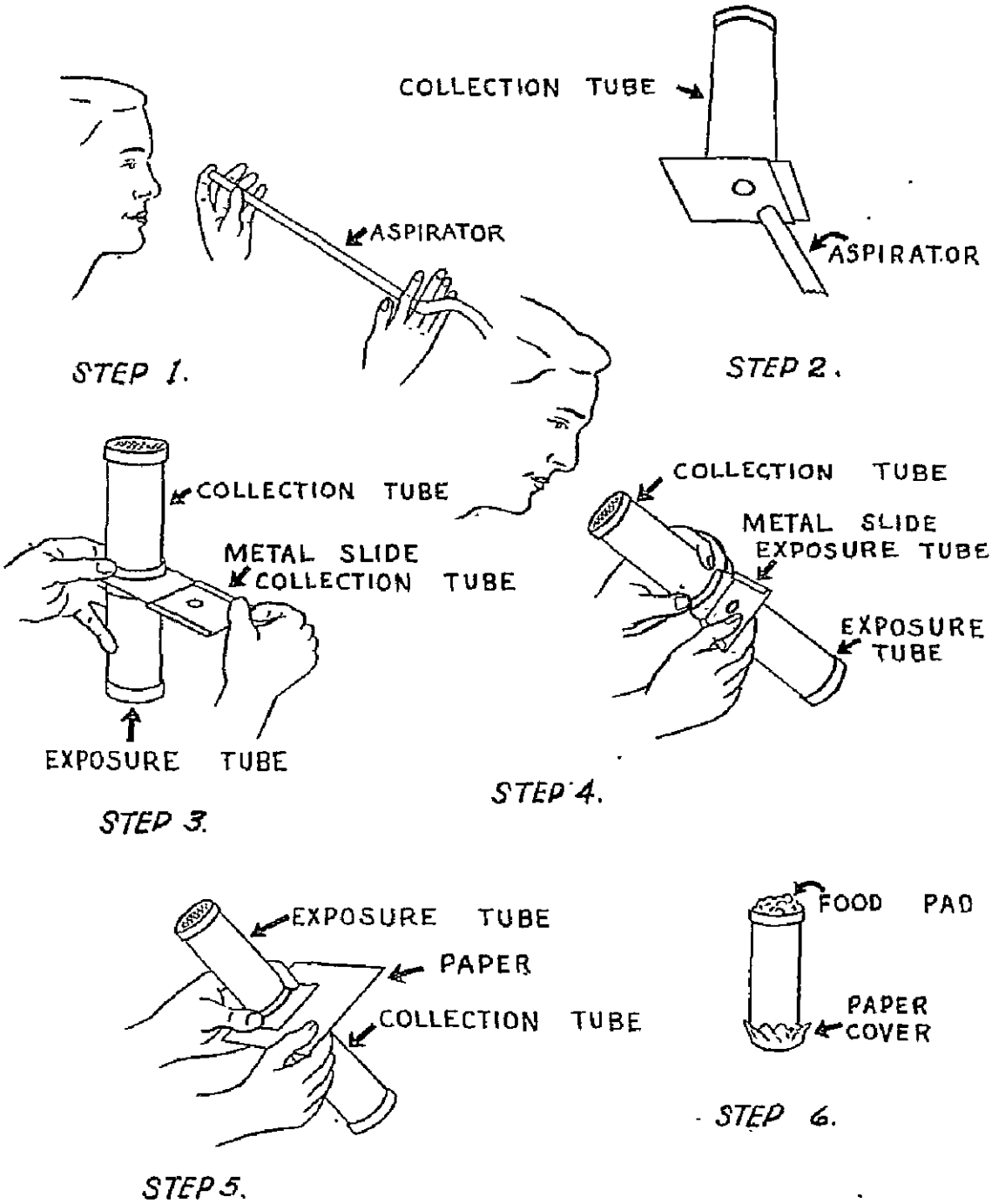

FIG. 2.—Steps in making test.

ever, these results should be verified as in step (c).

(c) Using the concentrations giving the desired mortalities from steps (a) or (b), run four additional replicates of each of these dosages, including a Risella-oil control with each test series. The average mortalities of the five replicates from step (c) + (a) or (b) are taken as the values for establishment of the base level of susceptibility. The lowest insecticidal concentration which showed complete mortality is chosen for the subsequent routine concentration in step (d). If the average

mortality of the five replicates at the highest concentration is at least 95 percent, this concentration may be used in step (d).

(d) After the establishment of the base level of susceptibility, five replicates at the routine concentration chosen in step (c) are run at suitable intervals to detect any change in the response of the field population. If complete mortality again is obtained, no change in susceptibility is indicated. If survivors occur, they may result from seasonal or environmental changes or may indicate physiological resistance. These possibilities are distinguished in step (e).

(e) Run two replicates at each of the concentrations used in step (c). If the results show (1) approximately the same mortalities for concentrations which gave less than 95 to 100 percent mortality in step (c), and (2) mortalities of less than 100 percent for concentrations which originally gave complete mortality, the change is indicative of physiological resistance in the mosquito population. This should be confirmed by a second series of replicates. If the results show a lower mortality for all test concentrations, the change is indicative of a seasonal or environmental variation in response. These types of response are illustrated in Figure 3.

DISCUSSION. The application of the test procedure to field conditions assumes that at least three test concentrations will be available for obtaining the baseline, one giving less than 50 percent mortality and one (or preferably two) giving complete mortality. However, with populations already resistant, such is not possible, e.g., with a strain of *Aedes aegypti* from Cucuta, Colombia, no mortality was obtained even with the maximum DDT

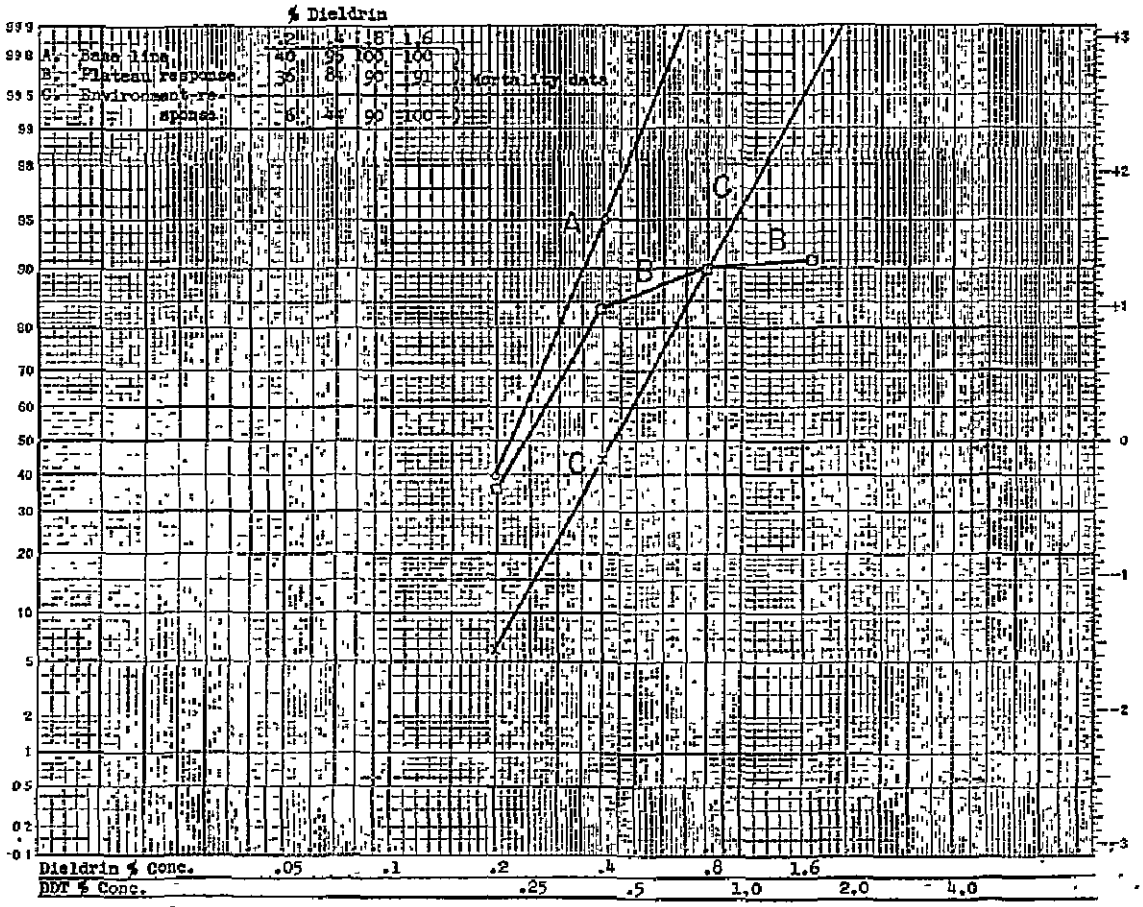

FIG. 3.—Dosage mortality lines.