LABORATORY TESTS ON THE RESIDUAL EFFECTIVENESS OF MALATHION AGAINST *AEDES AEGYPTI* (LINN.) AND *ANOPHELES* SPECIES IN INDONESIA

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INTRODUCTION. An increasing number of anopheline species have developed resistance to DDT and/or dieldrin during the past ten years in Indonesia. When residual spraying of homes with DDT was started in 1952 in coastal villages of Java, DDT resistance by the primary malaria vector, *A. sundaicus* Rdnw., was reported by Crandell (1954). Dieldrin was substituted and to date there are now six species resistant to this insecticide (Brown, 1961); *A. aconitus* Don, *A. annularis* De Rook, *A. barbirostris* V.d Wulp, *A. subpictus* Grassi, *A. sundaicus* and *A. vagus* Don. Fortunately, the primary malaria vectors are not resistant to both insecticides in all regions of Indonesia.

In the event of possible double resistance appearing in any of the primary malaria vector areas, it was advisable to investigate the value of the organophosphorus insecticide, malathion.

MATERIALS AND METHODS. Test-panel surfaces, measuring one-quarter square meter, were constructed from native raw material representing common wall structures used in Indonesian homes; lime-brick (clay bricks cemented together and painted on the outer surface with slaked-lime) spit-bamboo, palm-thatch and wood. The panels were enclosed within a wooden frame by which they could be hung on a wall, or in the case of lime-brick, could be stood on the floor.

Malathion (25 percent wettable powder)[3] was applied at the rate of 2 gm/m^2 using a Hudson sprayer operating with 60 pounds pressure and an 8002T nozzle tip (discharge rate of about 750 ml. per minute). The panels were placed in a vertical position and sprayed at one time. Control panels of each material were constructed but not sprayed with either insecticide or water. All panels were kept in a laboratory room measuring 5.1 x 2.4 meters. The room had a series of closed windows along one wall and free passage of air through louvered openings above the windows and one door to the room. Temperature and moisture data taken with thermometer bulb and sling psychrometer at monthly post-spraying dates indicated averages in room temperature of 67° F. (range, 60–72) and in relative humidity of 66 percent (range, 42–82).

A colony of DDT-resistant *Aedes aegypti* (Linn.) was used as the standard test mosquito. Three-day-old, blood-fed females, in groups of 10 to 15 per test panel, were exposed 30 minutes inside of transparent plastic cones supplied from test kits, following recommendations given for bio-assay tests by WHO (1960). Cone locations on the test panels were changed each test period while cones fixed to control panels remained at the same location for the entire experiment. Test mosquitoes were stored in plastic tubes, 20 cm. long by 4 cm. in diameter, having plastic gauze covers over each end. Cotton pledgets soaked in 10 percent sugar solution were placed on the tops of each tube during a 24-hour post-exposure observation period. Anopheline females (*A. subpictus* Grassi, *A. venhuisi* Bonne Wepster=*nigerrimus* Giles; Reid, 1953) were obtained from field collections made at frequent intervals for supplemental use in the panel tests. Almost all females of both species showed evidence of recent blood meals and these specimens were

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[3] Sample supplied by the American Cyanamid Company, New York, N. Y.

ised and treated in a manner similar to hat described for *A. aegypti*.

Results. The residual effectiveness of malathion on four test surfaces using *A. aegypti* and anopheline species is shown in Table 1. Test mosquitoes dosage rate of malathion gave satisfactory kill of mosquitoes from two to four months after spraying. Poor results with the lime-brick surface were not surprising since malathion undergoes rapid absorption on such surfaces. Rao *et al.*

TABLE 1.—Percent mortality mosquitoes[1] exposed one-half hour to malathion-treated (2 gm/m²) panels one week to six months after spraying

Type mosquito	Time post treatment	Percent mortality on type panel							
		Bamboo		Palm		Wood		Lime-brick	
		Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.
Aedes aegypti	1 wk.	100	0	100	0	100	0	30–30[a]	0–0
	1 mo.	100	0	100	0	100	0	0	0
	2 mo.	82	0	64	0	100	0	0	0
	3 mo.	70	0	82	0	100	0	40	0
	4 mo.	0	0	0	0	100	10	10	0
	5 mo.	0–0	0–0	0–0	0–0	0–10	0–0	0–0	0–0
	6 mo.	0	0	0	0	36	0	0	0
Anopheles subpictus	2 mo.	50	..	80	0	100	0	0	..
	3 mo.	40	0	77	0	100	0	0	0
	5 mo.	25–17	10	20–0	20	20	0	0	0
Anopheles vanhuisi	3 mo.	40	0	100	0	100	0	0	0
	4 mo.	44	10	88	20	100	10	0	0

[1] *A. aegypti:* 3-day old, blood-fed females; 10–15/test. Anopheline spp.: mixed age but nearly all blood-fed; 10–15/test.
[a] Two tests.

laced on wood panels resulted in 100 ercent kill up to four months post-praying and unsatisfactory kill thereafter. *A. aegypti* placed on palm and bamboo anels resulted in satisfactory kill (70 ercent or more) up to three months post-praying. Against anopheline species hese two panels showed that palm gave atisfactory kill up to three months while amboo produced unsatisfactory kill even t two months.

The lime-brick panels gave unsatis-actory kill of *A. aegypti* and anopheline pecies one week and two months post-praying, respectively.

There was no apparent influence on the esults by abnormal changes in tempera-ure and humidity during the test period.

Discussion and Conclusions. The labo-atory results reported here show that cer-ain wall surfaces sprayed with a 2 gm/m² (1960) found this to be true in their use of malathion (2 gm/m²) on mud surfaces (lime-painted or not) against *A. saccharovi* Favr; the same species placed on grass and plywood surfaces resulted in satisfactory kill up to ten weeks post-spraying. Somewhat similar results were reported by Schoof *et al.* (1960) from their malathion tests against *A. albimanus* Wiedemann in El Salvador.

Since bamboo and wood surfaces, and in some regions palm, constitute the more common wall-types used in Indonesia homes, it was recommended to test this insecticide further under actual field conditions. A proposed project of this type including mixtures of malathion with DDT and/or dieldrin, is planned for the future. Satisfactory results from these field tests may provide a reserve insecticide or an alternative formulation of dif-

ferent insecticides for use in delaying resistance to DDT and dieldrin by Indonesia's primary malaria vectors.

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LABORATORY EVALUATION OF MATERIALS AS LARVICIDES AGAINST MOSQUITOES IN NEVADA [1]

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Agricultural chemicals are not extensively used in Nevada and the direct use of these materials against mosquitoes is even less common. The State possesses no organized mosquito abatement districts. Fogging and spraying operations are sometimes conducted by various urban and military groups in an attempt to provide temporary relief against the hordes of *Aedes* mosquitoes that are often produced by flooded situations. Practically all of these efforts are directed against adult mosquitoes. The public clamor for some form of control measure against mosquitoes fluctuates with the amount of water available for irrigation during the growing season and has recently largely subsided because of 3 consecutive years of drought (1959–61).

The following studies were conducted in 1960 to obtain baseline data on th toxicity of some commonly used larvicide against several of the more important pe species.

METHODS. Fourth instar larvae of *Aede dorsalis* (Meigen), *A. melanimon* Dya *A. nigromaculis* (Ludlow), *Culiseta i ornata* (Williston), *Culex erythrothora* Dyar, and *Culex tarsalis* Coquillett wer collected in the field and carefully tran ported to the laboratory. The test proc dure consisted of placing 25 larvae i 400-ml. glass jars containing 250 ml. c acetone-distilled water suspension of th various toxicants. Mortality counts wer taken after 24 hours, the criterion f mortality being the inability of the larv to surface. Those pupating were not i cluded in the counts. Controls (distill water) were included in the counts. Th tests were conducted at approximate 75° F. The data are based on 4 to replications with each compound.

[1] In cooperation with the Nevada Agricultural Experiment Station, Reno, Nevada.