Dosage-Mortality Response of Anopheles quadrimaculatus Exposed to DDVP Vapour

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A potentially useful new tool in the control of malaria vectors, the residual fumigant technique, was reported in 1959 by Mathis et al. As part of a series of studies with this technique, experiments were conducted to determine the concentration of DDVP (O,O-dimethyl-2,2-dichlorovinyl phosphate) in the air necessary to kill female Anopheles quadrimaculatus with a 4-hour exposure. Such information would be valuable in estimating vapour concentrations without resorting to chemical analysis. In addition, evaluation of the toxicological hazards of the technique is dependent upon a knowledge of the concentrations which will be employed under field conditions.

The tests were conducted in paper-lined 6-foot (1.8-m) cubical test chambers equipped with an exhaust system which was calibrated to furnish one air exchange every three minutes. DDVP vapour was produced by passing dried nitrogen gas through

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a glass tube packed with a roll of fibre-glass cloth saturated with purified DDVP. The rate of vapour production was controlled by varying the flow of nitrogen.

The concentrations of DDVP vapour in the chamber during mosquito exposure periods were measured by collecting air samples on activated alumina columns, eluting the columns with acetone-water solutions, and determining the phosphorus content of the eluates colorimetrically.

Approximately 50 susceptible *A. quadrimaculatus* of mixed sexes were placed in screen wire cages, 3½ inches in diameter and 4 inches long (approximately 9 cm x 10 cm), which were closed with nylon netting. In the initial series of tests, a cage of insects was suspended at each of two positions in the chamber. Air samples were obtained within a few inches of the cages.

In these tests, there was a wide variation in the mortalities of female mosquitoes as related to the DDVP vapour concentrations; in some cases 100% were killed when exposed to a concentration as low as 0.009 µg of DDVP per litre of air; in other cases none were killed with concentrations as high as 0.022 µg per litre. The LC50 was estimated to fall somewhere between 0.007 and 0.020 µg per litre.

During these tests, 74 paired exposures with mosquitoes and houseflies showed a definite relationship between their mortalities. The mosquito mortalities were higher than the fly mortalities. When the mosquito kills were greater than 95%, the fly mortalities were more than 20%. Mosquito mortalities between 50% and 90% compared with from 0 to 40% mortalities for flies, the majority being between 9% and 21%. When the mosquito kills dropped below 50%, the housefly mortalities were 10% or less, mostly under 8%.

The apparently poor relationship between DDVP vapour concentration and mosquito mortalities could not be attributed solely to biological variation. Further experiments indicated that, at these low concentrations, air currents in the exposure chamber produced more distinctive concentration streams in the air than previously observed at higher dosage levels. Therefore, in a second series of tests the arrangement of the test specimens was altered in relation to the location of the air sample intake. Six screen cages were arranged around a central one and fastened together. Mosquitoes were placed in three of the alternating peripheral cages and the related air sample was obtained from inside the central cage. Two such sets of cages were used in each test at the same locations as in the previous experiments.

The resulting dosage-mortality curve (see accompanying figure) shows that minor variations in the average concentration greatly affect the resulting mortalities; this finding at least partially explains the apparent discrepancies in the first series of tests. Mortalities of 10% to 90% normally occurred at concentrations between 0.007 µg and 0.010 µg of DDVP per litre of air—a range of only 0.003 µg. If it is considered that the air samples in actuality represent an average concentration over a period of four hours, it is hardly surprising that the slight variations in concentration, as sampled during the first tests, were frequently not reflected in the biological results.

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See note by Maddock, Sedlak & Schoof on page 643 of his issue.
In studies in a simulated aircraft passenger cabin (Maddock et al.) involving 17 replications, 100% kills of DDT-resistant female *Aedes aegypti* and susceptible *Anopheles quadrimaculatus* were obtained with exposures of 30 minutes to concentrations of 0.08 and 0.14 μg of DDVP per litre of air, respectively. At concentrations between 0.20 and 0.31 μg of DDVP per litre of air, 100% knockdown occurred within 10 minutes after the 30-minute exposure period.