# OPERATIONAL AND SCIENTIFIC NOTES

## WIND TUNNEL EVALUATION OF COMMONLY USED ADULTICIDES AGAINST NEW ORLEANS *AEDES AEGYPTI*

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Dengue is well established in the Caribbean and the virus continues to be imported to the continental USA by infected travelers (Centers for Disease Control 1984). The threat of a dengue introduction into New Orleans has prompted us to conduct wind tunnel evaluations on some common adulticides to select an adequate candidate for emergency control of New Orleans *Aedes aegypti* (Linn).

Malathion (91%), heavy aromatic naphtha (HAN), HAN-malathion (2:1 v/v), Scourge (18% resmethrin and 54% piperonyl butoxide technical (PBO)) and naled (90%) were evaluated against *Ae. aegypti* colonized in 1981 from eggs collected in ovitraps throughout urban New Orleans. Malathion was also tested against a wild population of *Ae. aegypti* collected throughout New Orleans in 1983 as eggs, and reared to adults. In addition, malathion and resmethrin-PBO were tested against the long established Rockefeller strain of *Ae. aegypti.*

For each test, serial dilutions of insecticides were made in reagent grade acetone. The tests were done with a wind tunnel consisting of a tube 16.3 cm in diameter through which air was blown at 1.8 m/sec (Mount et al. 1976). One-half ml of each concentration was atomized at a pressure of 30.3 kPa, 70 cm upwind of the exposure point. Mosquitoes were aspirated into cardboard testing cages 8.6 diam × 5.4 cm deep with 16 mesh screening. Each cage contained 25 female mosquitoes, 2–4 days old. Two cages of mosquitoes were tested per dilution and there were 5–8 serial dilutions per test plus 2 control cages exposed to acetone only. Each wind tunnel test consisted of 2–11 replicates. After exposure, mosquitoes were aspirated into cardboard holding cages, and supplied with a raisin and water moistened cotton ball. Mortality counts were made after 24 hrs. Control mortality never exceeded 5%. The log-dosage response was determined by probit analysis according to Finney (1971).

The 24 hr $LC_{50}$'s and $LC_{90}$'s, 95% fiducial limits, and slope for each insecticide are presented in Table 1.

Resmethrin-PBO was the most effective adulticide against the New Orleans colony of *Ae. aegypti,* ca. 5 times more effective than malathion. The addition of HAN to malathion increased the effectiveness of malathion ca. 1.6 times. Malathion alone was 2 times more toxic than HAN and 2.5 times more toxic than naled. The HAN-malathion combination is probably more effective for two reasons. First, HAN has slight insecticidal properties of its own and therefore potentiates the malathion. HAN, which dissolves paraffin, might also penetrate the exoskeleton better than malathion alone, so with the combination more insecticide would be absorbed by the mosquito.

*Aedes aegypti* resistance to malathion, though not anticipated, could develop since malathion has been used for adulticiding in urban New Orleans for the past 20 years. Fox (1973) demonstrated that malathion resistant *Ae. aegypti* will revert to susceptible levels after 3 years of colonization. Wind tunnel tests indicated there was no significant difference in susceptibility to

Table 1. Toxicity of selected insecticides (% A.I.) to adult New Orleans *Aedes aegypti.*

| Insecticide | Strain of *Ae. aegypti* | 24-hr. $LC_{50}$ | 95% Fiducial limits | 24-hr. $LC_{90}$ | 95% Fiducial limits | Slope | No. of dilutions/ replicate | No. of replicates |
|---|---|---|---|---|---|---|---|---|
| Malathion | Rockefeller | 0.024 | 0.022–0.026 | 0.070 | 0.063–0.079 | 2.7 | 6 | 5 |
| | N.O. Colony | 0.028 | 0.027–0.030 | 0.069 | 0.066–0.073 | 3.2 | 9 | 11 |
| | N.O."Wild"[1] | 0.040 | 0.038–0.044 | 0.090 | 0.081–0.100 | 4.1 | 7 | 2 |
| HAN[2]— Malathion (2:1) | N.O. Colony | 0.016 | 0.014–0.017 | 0.042 | 0.037–0.049 | 3.0 | 6 | 3 |
| HAN[2] | N.O. Colony | 0.059 | 0.055–0.063 | 0.121 | 0.112–0.131 | 4.1 | 6 | 5 |
| Scourge[3] | N.O. Colony | 0.0045[4] | 0.0043–0.0047 | 0.013[4] | 0.012–0.014 | 2.7 | 9 | 10 |
| | Rockefeller | 0.0025[4] | 0.0024–0.0026 | 0.007[4] | 0.006–0.008 | 2.9 | 7 | 5 |
| Naled | N.O. Colony | 0.096 | 0.093–0.099 | 0.188 | 0.183–0.194 | 4.4 | 7 | 9 |

[1] Field collected, laboratory reared.
[2] Heavy aromatic naphthol.
[3] 18% resmethrin/54% piperonyl butoxide technical.
[4] Based on amount of resmethrin only.

malathion between the New Orleans laboratory colony and the highly susceptible Rockefeller strain of *Ae. aegypti*. Wild New Orleans *Ae. aegypti* were only 1.4 times more tolerant to malathion than the 4-year old New Orleans colony, indicating that resistance has not developed in the field population.

World Health Organization larval susceptibility tests indicate that the New Orleans colony was highly tolerant to DDT (Beard 1983)[1] possibly indicating cross-resistance to pyrethroids (Plapp and Hoyer 1968). The New Orleans *Ae. aegypti* colony and the Rockefeller strain of *Ae. aegypti* were similar in susceptibility to resmethrin-PBO; the New Orleans colony was only 2 times more tolerant. It is possible to explain this difference by comparing the different lengths of time the two strains have been colonized before testing. The Rockefeller strain was colonized in 1959 vs. the New Orleans in 1981. Colonization over an extended period tends to reduce heterogeneity which was likely to be more pronounced in the older colony (Mitchell 1983).

These results indicate that resmethrin-PBO and HAN-malathion would be adequate adulticides for *Ae. aegypti* control in the event of an emergency. Resmethrin-PBO is ca. 4 times the cost of HAN-malathion at the same level of effectiveness. Therefore HAN-malathion (2:1) is the most cost-effective adulticide against New Orleans *Ae. aegypti*.

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## A NEW CAGE FOR OBSERVING MATING BEHAVIOR OF WILD *ANOPHELES GAMBIAE* IN THE LABORATORY[1]

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Control of anopheline vectors of malaria and filariasis in tropical areas, where their impact on human health is heaviest, has often failed. Research into the behavior and genetics of these mosquitoes, with the aim of developing alternative control methods; depends on successful laboratory colonization, however, a number of species do not mate successfully under laboratory conditions, which hinders colonization. This problem may be overcome by selection or by applying artificial mating techniques, but the resulting laboratory-adapted strains have limited value for studies regarding mating behavior under natural conditions. During my work on mating behavior of two sibling species of the *Anopheles gambiae* complex in northeastern Tanzania, it proved difficult to elicit mating in the laboratory in wild, unselected, mosquitoes. This paper describes a special cage in which a marked improvement in swarming and mating activity of wild material was obtained.

In mosquitoes mating is associated with swarming of the males (Downes 1969). For *Anopheles gambiae* Giles and *An. arabiensis* Patton all available information suggests that swarming is a prerequisite for mating (Jones and Gubbins 1978, Charlwood and Jones 1980). In nature swarming of these species typically occurs over flat, open ground under the open sky in villages and starts about 10 min after sunset, lasting for about 20 min (Marchand 1984). When the virgin offspring (larval stage reared in the laboratory) of wild-caught mothers were held in standard 30 × 30 × 30 cm cages under artificial

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