OPERATIONAL AND SCIENTIFIC NOTES

SUSCEPTIBILITY OF FEMALE *AEDES ALBOPICTUS* FROM TEXAS TO COMMONLY USED ADULTICIDES[1]

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Since the discovery of an established population of *Aedes albopictus* (Skuse) in Houston, TX, in August 1985 (Sprenger and Wuithiranyagool 1986), there have arisen a number of important questions about this exotic mosquito species. Mosquito control practitioners and public health officials along the Texas Gulf coast are particularly concerned about the susceptibility of *Ae. albopictus* to currently labeled insecticides and the virtual lack of insecticide susceptibility data involving this recently introduced species. These concerns have been intensified by a newspaper report indicating that this species is resistant to common insecticides such as malathion (Falda 1986), the most commonly used mosquito adulticide in Texas. The Centers for Disease Control (1986) and the Pan American Health Organization (1987) have indicated that repetitive monitoring of *Ae. albopictus* populations susceptibility to insecticides is essential.

Data that are currently available involving *Ae. albopictus* susceptibility to insecticides are almost exclusively Asian in origin (World Health Organization 1986). Since the exact origin and insecticide exposure history of *Ae. albopictus* populations introduced into the United States is unknown, it is impossible to use insecticide susceptibility data from particular Asian localities. Most mosquito susceptibility research in Asia has involved the larval stage (Herbert and Perkins 1973, Takahashi et al. 1985). Various Asian populations of *Ae. albopictus* larvae have been shown to be resistant to a wide variety of insecticides (World Health Organization 1986). In contrast, populations from other Asian areas are susceptible to cyclodienes (Herbert and Perkins 1973) and organophosphates (Gould et al. 1971).

Despite the numerous reports of resistance, control of adult *Ae. albopictus* with insecticides has proven effective on several occasions. Gould et al. (1971) reported short-term control of this species in villages in an insular region of Thailand, using ground applied malathion fogs. During outbreaks of dengue in China, this species was effectively controlled with ULV applications of malathion (0.45 liter/ha) and fenitrothion (0.30–0.45 liter/ha) (Luh and Zhu 1983). *Aedes albopictus* and *Ae. aegypti* (Linn.) populations were substantially reduced in urban areas of Malaysia when a mixture of pyrethrins (1.2 gm/ha) and a synergist (1.9 gm/ha) were applied from the ground using a Leco HD ULV cold aerosol generator (Pant 1983).

Preliminary data from Houston and New Orleans indicate that adult *Ae. albopictus* populations in these areas are relatively resistant to malathion. However, they are susceptible to resmethrin (Centers for Disease Control 1986, Khoo et al. 1988).

This study was undertaken to further clarify the degree of susceptibility of Texas adult *Ae. albopictus* populations to 4 currently labeled insecticides: bendiocarb, malathion, naled and resmethrin. Two Texas *Ae. albopictus* populations were used in the study, one collected from Houston and the other from Liberty County. Sufficient eggs of the Houston population were collected in the field so that the adults developing from these eggs were used in the susceptibility tests. Few eggs of the Liberty County population were collected; subsequently, this population was reared in the laboratory through 4 generations in order to obtain sufficient numbers of adult females.

The mosquito susceptibility values for *Ae. albopictus* were compared with 2 laboratory strains of *Ae. aegypti*: the UTMB strain, in colony for ca. 25 years, obtained from D. W. Micks, University of Texas Medical Branch, Galveston, TX, and the TAMU strain, which has been in colony for ca. 12 years at Texas A&M University. The 2 strains of *Ae. aegypti* were chosen because they represent long-established, insecticide-susceptible laboratory colonies. In addition, this species may also be a target for control in the case of a vector-borne disease outbreak.

All mosquitoes were reared using techniques developed at the TAMU Mosquito Research Laboratory for maintenance of *Aedes* (*Stego-*

[1] This research was conducted in cooperation with the Agricultural Research Service, USDA and approved for publication as TA 24128 by the Director of the Texas Agricultural Experiment Station.

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myia) species. Mosquito susceptibility tests were conducted using 3–4-day-old females. A vial bioassay procedure modified from Plapp (1971) was used to test mosquito susceptibility. Each technical grade insecticide was serially diluted to the appropriate concentration using acetone. Insecticides were pipetted into 20-ml glass vials (6 replicates/concentration), then acetone was added to attain a final volume of 0.5 ml. Control vials were treated with 0.5 ml of acetone only. All vials were manually rotated on their side until the solvent evaporated. A small cotton pad (ca. 0.75 cm^2) soaked with 10% sucrose solution was placed in the bottom of each vial. Mosquitoes were lightly anesthetized with carbon dioxide and placed on a chill table for counting. Ten females were placed in each vial, and the vials were plugged with cotton. Mortality was recorded after 24 hours.

The data were analyzed using the SAS Probit Program (SAS 1985). The analyses yielded LC_{50}, LC_{95} and 95% confidence interval values in micrograms of insecticide per vial. Slope (a measure of the homogeneity of the population response to each insecticide) was also provided.

There were no significant differences in insecticide susceptibility when comparing strains of the same species; however, there were significant differences between the 2 species. The 4 mosquito strains did not significantly differ in their susceptibility to bendiocarb and resmethrin and are therefore considered susceptible to these chemicals. The 2 *Ae. albopictus* strains were significantly different ($P < 0.05$, nonoverlapping 95% confidence limits) from the 2 *Ae. aegypti* strains in their response to naled at the LC_{95} level.

The 2 strains of each species did not significantly differ in their response to malathion; however, there was a significant difference in susceptibility between the 2 species. The responses of the 2 field strains of *Ae. albopictus* were significantly different ($P < 0.05$) compared to the responses of the *Ae. aegypti* strains (Table 1). As is indicated by the slopes of the dose/mortality lines and LC_{95}, the difference in insecticide susceptibility between the 2 species became greater as the insecticidal concentration increased.

The malathion resistance observed in the Houston and Liberty strains of *Ae. albopictus* used in this study is consistent with that previously reported for the Houston and New Orleans populations of this species (Centers for Disease Control 1986, Khoo et al. 1988). *Aedes albopictus* resistance to malathion and other insecticides has been extensively reported in Asia (Herbert and Perkins 1973, World Health Organization 1986). Adult *Ae. albopictus* populations were found to be partially resistant to malathion in Thailand (Gould et al. 1971) and resistant to organophosphates and carbamates in Sri Lanka (World Health Organization 1986).

Table 1. Insecticide susceptibility of adult females of 2 wild Texas strains of *Aedes albopictus* and 2 laboratory strains of *Aedes aegypti* to 4 commonly used adulticides using a vial bioassay procedure. Lethal concentration (LC) values are reported as micrograms of insecticide per vial.

Species	LC_{50} (μg/vial)	LC_{95} (μg/vial)	Slope
BENDIOCARB			
Ae. albopictus (Houston)	0.05	0.14	3.5
Ae. albopictus (Liberty)	0.09	0.17	5.1
Ae. aegypti (TAMU)	0.04	0.11	3.6
Ae. aegypti (UTMB)	0.03	0.06	5.0
MALATHION			
Ae. albopictus (Houston)	0.15	4.65	1.1
Ae. albopictus (Liberty)	0.13	1.61	1.4
Ae. aegypti (TAMU)	0.05	0.16	2.8
Ae. aegypti (UTMB)	0.05	0.14	3.1
NALED			
Ae. albopictus (Houston)	0.07	0.35	1.9
Ae. albopictus (Liberty)	0.05	0.13	2.8
Ae. aegypti (TAMU)	0.04	0.07	4.0
Ae. aegypti (UTMB)	0.02	0.04	4.0
RESMETHRIN			
Ae. albopictus (Houston)	0.03	0.12	2.5
Ae. albopictus (Liberty)	0.04	0.13	2.5
Ae. aegypti (TAMU)	0.02	0.04	3.5
Ae. aegypti (UTMB)	0.02	0.07	3.3

As for the current situation in Texas, malathion resistance may be a problem in the event of a disease outbreak for 2 reasons: 1) malathion is the most widely used adulticide along the Gulf coast and mosquito control practitioners may be reluctant to use alternative chemicals, and 2) to break the cycle of transmission during a disease outbreak, a high percentage of vector mortality is required and resistance seems to be a greater problem at higher lethal concentrations.

It should be stressed that the data presented here are from the laboratory and may not reflect the ability to control this species in the field. Although insecticide resistance has been shown in various Asian *Ae. albopictus* populations, excellent adult control has been obtained during disease outbreaks using pyrethrins (Pant 1983), malathion (Gould et al. 1971) and fenitrothion (Luh and Zhu 1983). There is a need for mosquito susceptibility tests to be performed on both larval and adult *Ae. albopictus* populations from around the United States. This will enable mosquito control practitioners and public health officials to choose the most effective control agents and practices.

The authors express their sincere appreciation to Charles Schaefer, Department of Entomology, University of California, Berkeley, CA, Dan Sprenger, Harris County Mosquito Control District, Houston, TX, and Matthew Yates, Director, East Baton Rouge Mosquito and Rodent Control District, Baton Rouge, LA, for their critical reviews of this manuscript and valuable comments.

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