Behavioral Responses of *Aedes aegypti* (Diptera: Culicidae) Exposed to Deltamethrin and Possible Implications for Disease Control

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ABSTRACT Behavioral responses of nine *Aedes aegypti* (L.) strains, six from recent field collections and three from the long-established laboratory colonies, were tested under laboratory-controlled conditions by using an excito-repellency test system. All nine strains showed significant behavioral escape responses when exposed to deltamethrin at the standard field dose (0.02 g/m^2), regardless of background insecticide susceptibility status (susceptible or tolerant/resistant). Insecticide contact irritancy played a predominate role in overall female mosquito escape responses, whereas noncontact repellency was not observed at levels significantly different from paired noncontact control tests ($P > 0.01$). Among the six field populations, the Jakarta (Indonesia) Toba (north Sumatra), and Bangkok female mosquitoes showed rapid exit (>78%) during 30 min of direct contact with insecticide-treated surfaces, whereas the other three strains demonstrated only moderate escape responses (32–56%) from the chambers. Moderate escape responses during direct insecticidal contact also were observed in the three laboratory test populations (44–60%). Higher percentage of mortality was observed from laboratory strains (8–33%) that failed to escape compared with nonescape females of field strains (2–16%), possibly a reflection of background deltamethrin susceptibility status. We conclude that contact irritancy is a major behavioral response of *Ae. aegypti* when exposed directly to deltamethrin and that rapid flight escape from areas exposed to space sprays or surfaces treated with residual pyrethroids could have a significant impact on the effectiveness of adult mosquito control and disease transmission reduction measures.

KEY WORDS *Aedes aegypti*, behavioral avoidance, excito-repellency, deltamethrin

BILLIONS OF PEOPLE, ESPECIALLY in the tropical and subtropical world, are at risk of infection for dengue fever and dengue hemorrhagic fever. Annually, 50–100 million people are estimated as being infected with dengue viruses worldwide (Gubler 1997). The viruses responsible for dengue disease in humans are transmitted primarily by *Aedes aegypti* (L.), a notoriously efficient vector mosquito that often resides in and near human dwellings and preferentially feeds on humans (Gubler 1997). Despite research progress, a completely effective and commercially available dengue vaccine is not yet available. Prevention of this disease remains almost entirely dependent on using vector control, most methods of which remain the most effective means of reducing virus transmission potential in the usually densely populated and impoverished regions of the world (Reiter and Gubler 1997, WHO 1999). Unfortunately, *Ae. aegypti* has proven tremendously difficult to control because of its close association and exploitation of domestic and peridomestic human environments. The most effective proven methods for disease prevention has been by vector reduction, either through larval habitat elimination ("source reduction"), or control of habitats, often using more expensive (and less efficient) approaches for mosquito vector control by various chemical or biological means.

Although some populations of *Ae. aegypti* have been found physiologically resistant to a wide range of insecticides (Brown and Pal 1971, WHO 1992), the true impact of resistance on adult and larval vector control has been circumstantial. In addition to toxicity, many synthetic pyrethroids have inherent properties that irritate (excite) and/or repel insects (Threlkeld 1985). Dating back >25 yr, reports have documented the excito-repellency properties of deltamethrin on mosquitoes, mainly examining behavioral responses of *Anopheles* species (Coosemans and Sales 1977, Pell et al. 1989, Roberts et al. 2000, Chareonviriyaphap et al. 2001). Relatively little has been published on the avoidance behavior of *Ae. aegypti* exposed to any insecticide (Kennedy 1947, Lal et al. 1965, Hadaway et al. 1970, Moore 1977).

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