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DISCRIMINATING LETHAL CONCENTRATIONS AND EFFICACY OF SIX PYRETHROIDS FOR CONTROL OF *AEDES AEGYPTI* IN THAILAND

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ABSTRACT. Establishing baseline insecticide discriminating doses is crucial in accurately determining susceptibility status and changing temporal patterns of physiological response in mosquito populations. Pyrethroids are the predominant chemicals used for controlling adult *Aedes aegypti* and *Ae. albopictus*, both vectors of dengue viruses, in Thailand. Presently, only 2 pyrethroids, permethrin and λ-cyhalothrin, have published diagnostic dose rates for monitoring *Ae. aegypti*. This study established the diagnostic lethal concentrations for 6 different pyrethroids available in Thailand for dengue vector control. United States Department of Agriculture insecticide-susceptible strain of *Ae. aegypti* was used to establish the baseline concentrations for subsequent susceptibility testing of field populations. Our findings showed lower discriminating concentrations for λ-cyhalothrin and permethrin than those recommended by the World Health Organization (WHO), at 2.5- and 1.7-fold lower dosing, respectively. The susceptibility status of 3 different geographical populations of field-collected *Ae. aegypti* were tested using the standard WHO procedures. All 3 field strains demonstrated varying levels of physiological resistance to each compound. We conclude that establishing the baseline diagnostic concentration of an insecticide is of paramount importance in accurately determining the susceptibility status in field-collected mosquitoes. If possible, discriminating doses should be established for all insecticides and test assays run concurrently with a known susceptible strain for more accurate monitoring of resistance in mosquito populations in Thailand.

KEY WORDS *Aedes aegypti*, pyrethroids, diagnostic concentration, Thailand

INTRODUCTION

Many tropical and subtropical countries around the world present risk for dengue fever and dengue hemorrhagic fever. Between 2.5 and 3 billion people (two-fifths of the world's population) are at risk of contracting dengue, many of whom live in the Southeast Asian region (WHO 2002). With an estimated 50–100 million people having symptomatic dengue infection each year, the majority of cases occur primarily in crowded, impoverished urban regions of the world (Gubler 1998, Gibbons and Vaughn 2002). In Southeast Asia, dengue hemorrhagic fever, a severe manifestation of dengue, has shown a disturbing increase from an annual rate of <10,000 in the 1960s to >200,000 in the 1990s (Gibbons and Vaughn 2002). In Thailand, there were 115,845 reported dengue cases and 141 deaths in 2010, which represented a small fraction of the actual number of mild and asymptomatic infections that same period (MOPH 2010). The 4 different virus serotypes (DEN-1, -2, -3, -4) are transmitted by mosquitoes, primarily *Aedes aegypti* (L.), a highly efficient vector mosquito because of its close association with humans and exploitation of domestic and peri-domestic environments, most notably in dense urban areas. As yet, no commercial multivalent dengue vaccine is available; therefore, prevention of this disease remains almost entirely dependent on using methods of control that attack both adult and immature stages of the mosquito. Vector control remains the most effective means of reducing risk of virus transmission (Reiter and Gubler 1997, WHO 1999). Unfortunately, *Ae. aegypti* has confounded most organized control efforts to bring vector population densities below sustainable thresholds to eliminate transmission.

In Thailand, the standard vector control techniques are based on use of chemicals and source reduction of larval habitats. Many chemical compounds, including organophosphates, carbamates, pyrethroids, and so-called bio-rational pesticides (bacterial toxins and insect growth regulators) have been used in national public health vector control programs (Reiter and Gubler 1997, WHO 1999). In Thailand, pyrethroids, e.g., deltamethrin, cyfluthrin, and permethrin, are common AIs in many commercial products designed for controlling household adult *Ae. aegypti*. However, control efforts have been hampered by the development of resistance to many of these insecticides by *Ae. aegypti* throughout Thailand (Chareonviriyaphap et al. 1999; Somboon et al. 2003; Sathantriphop et al. 2006; Thanispong et al. 2008, 2010). The selection pressure for developing resistance to pyrethroids has largely been attributed to the frequent and pervasive use of the same chemical class of

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