

## Insecticide resistance of *Aedes aegypti* and *Culex quinquefasciatus* in Thailand

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In this study, nine strains of *Aedes aegypti* mosquitoes from different localities in Thailand were subjected to susceptibility tests against commonly used insecticides for vector control in Thailand. *Aedes aegypti* from different localities were strongly resistant to DDT and permethrin, except for one strain from Chiang Mai (Chiang Mai-P) that was found to be susceptible to permethrin. In contrast, most *Ae. aegypti* strains are susceptible to deltamethrin and alphacypermethrin, except that Bangkok and Nonthaburi strains showed incipient resistance to deltamethrin and alphacypermethrin, respectively. Various levels of malathion and propoxur susceptibility were also detected in *Ae. aegypti* strains; however, two strains of *Ae. aegypti* (Satun and Nonthaburi) were found to be completely susceptible to malathion. The insecticide susceptibility level in three strains of *Culex quinquefasciatus* was also investigated. The results indicated strong resistance to DDT and moderate resistance to permethrin. Two strains from Bangkok and Nonthaburi were found to be completely susceptible to malathion and propoxur. One strain from Pathum Thani showed incipient resistance to both compounds. We conclude that deltamethrin and alphacypermethrin are still effective insecticides for the dengue control program and malathion and propoxur may be alternative insecticides to control *Cx. quinquefasciatus*. © Pesticide Science Society of Japan

**Keywords:** insecticide, resistance, *Aedes aegypti*, *Culex quinquefasciatus*, Thailand, pyrethroids.

### Introduction

Several countries continue to experience endemic and re-emerging dengue fever (DF) and dengue hemorrhagic fever (DHF).<sup>1)</sup> Annually, millions of people are estimated to be infected with dengue virus worldwide.<sup>2,3)</sup> In Thailand, outbreaks of DHF were first recognized in 1958 and subsequently the disease has expanded throughout the country.<sup>4)</sup> Approximately 40,000 cases of dengue with a mortality rate of 0.09 (per 100,000 people) were reported in 2007.<sup>5)</sup> In spite of continued vigilance in control methods, dengue cases remain a major health threat in Thailand. The reason is unclear but is possibly related to the increase of human and economic activities in urban and semi-urban zones. Moreover, traditional water storage practices increase the breeding sites for *Aedes aegypti*, a primary vector of DF and DHF in Thailand.<sup>6,7)</sup>

*Aedes aegypti*, a daytime biting mosquito, is highly anthropophilic, often resides in and near human dwellings and preferentially feeds on humans.<sup>1,8,9)</sup> This species has been found to be highly adapted to all man-made and natural environments and is a potential vector of dengue.<sup>10–12)</sup> The key to preventing dengue transmission is to reduce human-vector contact using synthetic chemicals.<sup>13–17)</sup> Several synthetic insecticides, including organochlorines, organophosphates, carbamates and synthetic pyrethroids, have been used in dengue control programs.<sup>18)</sup> DDT (organochlorine) was widely used to control *Ae. aegypti* after the first dengue epidemic in 1958.<sup>19,20)</sup> Deltamethrin (synthetic pyrethroids) is currently one of the most commonly used insecticides in public health programs and has been the mainstay for the emergency control of *Ae. aegypti* adults in Thailand since 1994.<sup>18,21)</sup> Temephos (organophosphate) is commonly used in water containers for the control of *Ae. aegypti* larvae. Ultra-low-volume (ULV) applications of fenitrothion and malathion are used during the peak period of adult *Aedes* populations, especially during the rainy season.<sup>16)</sup> Additionally, many synthetic pyrethroids, *i.e.* resmethrin, tetramethrin, permethrin, cyper-

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