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Research

Susceptibility of *Aedes aegypti* and *Aedes albopictus* (Diptera: Culicidae) to Temephos in Thailand and Surrounding Countries

Manop Saeung,[1] Ratchadawan Ngoen-Klan,[1] Kanutcharee Thanispong,[2] Vithee Muenworn,[3] Michael J. Bangs,[1,4] and Theeraphap Chareonviriyaphap[1,5]

[1]Department of Entomology, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand, [2]Division of Vector Borne Diseases, Department of Disease Control, Ministry of Public Health, Nonthaburi 11000, Thailand, [3]Department of Entomology and Plant Pathology, Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, Thailand, [4]Public Health & Malaria Control Department, PT Freeport Indonesia/International SOS, Kuala Kencana, Papua, 99920, Indonesia, and [5]Corresponding author, e-mail: faasthc@ku.ac.th

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Abstract

Aedes-borne virus disease control relies on insecticides to interrupt transmission. Temephos remains a key chemical for control of immature stage *Aedes* in Thailand and much of Southeast Asia. However, repeated use of insecticides may result in selection for resistance in vector populations, thus compromising operational intervention. Herein, the phenotypic response to temephos by *Aedes aegypti* (L.) and *Aedes albopictus* (Skuse) collected in Thailand and surrounding countries is presented. Data from 345 collection sites are included: 283 from literature review (244 sites with *Ae. aegypti*, 21 with *Ae. albopictus*, and 18 having both species sampled), plus 62 locations with *Ae. aegypti* in Thailand conducted between 2014 and 2018. Susceptibility assays followed WHO guidelines using the recommended discriminating dose of temephos (0.012 mg/liter) against late third to early fourth instar *Ae. aegypti*. Findings revealed 34 locations with susceptible *Ae. aegypti*, 13 with suspected resistance, and 15 indicating resistance. Published data between 1999 and 2019 in Thailand found *Ae. aegypti* resistant in 73 of 206 collection sites, whereas 3 locations from 11 sampled with low-level resistant in *Ae. albopictus*. From surrounding countries conducting temephos assays (Cambodia, Lao PDR, Myanmar, Malaysia, and Singapore), resistance is present in *Ae. aegypti* and *Ae. albopictus* from 27 of 56 and 19 of 28 locations, respectively. Routine insecticide susceptibility monitoring should be an operational requirement in vector control programs. Given the wide distribution and apparent increase in temephos-resistance, alternative larvicidal compounds must be considered if chemical control is to remain a viable vector control strategy.

Key words: *Aedes aegypti*, *Aedes albopictus*, temephos susceptibility, resistance, Thailand

Aedes-borne viruses (dengue, chikungunya, Zika, and yellow fever) represent the most important group of arthropod-borne viral diseases globally (Kraemer et al. 2019). In particular, dengue is one of the most serious and prevalent mosquito-borne diseases. The global expansion of dengue has many root causes, but expanding urbanization, increased human mobility, and the inexorable spread and stability of competent mosquito vectors are among the primary reasons (Gubler 2011). In Thailand, dengue is a high-priority public health threat resulting in tens of thousands of reported cases annually (Nisalak et al. 2003, Thavara et al. 2006,MOPH 2019). Nearby countries to Thailand, including Cambodia, Vietnam, Lao People's Democratic Republic (PDR), Myanmar, Malaysia, and Singapore, have very similar dengue epidemiology and concerns (Kumaran et al. 2018, Gintarong et al. 2018, Ang et al. 2018, Hung et al. 2018, Vannavong et al. 2019). Globally, *Aedes*-borne viruses such as dengue are priority 'neglected' tropical diseases requiring programmatic management for sustained dengue vector control interventions (WHO 2018). The global threat demands renewed efforts on advancing integrated approaches for vector control combining current methods and new innovations (WHO 2017, Roiz et al. 2018).

Dengue disease was first recognized in Thailand in 1958 with the largest recorded epidemic occurring in 1987 with 170,630 cases and 896 deaths (Halstead 1992). Dengue cases are reported every year, but varying in number temporally and spatially throughout the country (Limkittikul et al. 2014, Pongsumpun and Chanprasopchai 2017). Without a fully effective multivalent dengue vaccine,