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Status of insecticide resistance in *Anopheles* mosquitoes in Ubon Ratchathani province, Northeastern Thailand

Anchana Sumarnrote¹, Hans J. Overgaard^{1,3,4}, Nattapol Marasri¹, Bénédicte Fustec^{1,3}, Kanutcharee Thanispong², Theeraphap Chareonviriyaphap^{1*†} and Vincent Corbel^{1,3*†}

Abstract

Background: Malaria is common in hilly, forested areas along national borders in Southeast Asia. Insecticide resistance in malaria vectors has been detected in a few countries in the Greater Mekong sub-region (GMS), representing a threat to malaria control and prevention. This study aims to determine the insecticide resistance status of *Anopheles* mosquitoes in Ubon Ratchathani province, northeastern Thailand, where increasing number of malaria cases were reported recently.

Methods: Mosquitoes were collected in 2013–2015 using human landing and cattle bait collections in six sites during both the rainy and dry seasons. Mosquitoes were first morphologically identified to species and their susceptibility status to deltamethrin (0.05%), permethrin (0.75%) and DDT (4%) investigated, according to WHO guidelines. Bioassays with the synergists PBO and DEF were carried out to address the role of detoxifying enzymes in insecticide resistance. DNA sequencing of a fragment of the voltage-gated sodium channel gene was carried out to detect knock-down resistance (*kdr*) substitutions at position 1014 in resistant species.

Results: Due to low vector abundance, complete bioassays ($n \geq 100$ mosquitoes) were only achieved for *Anopheles hyrcanus* s.l., which was resistant to all insecticides tested (mortality ranged from 45 to 87%). Suspected resistance to DDT was found in *Anopheles barbirostris* s.l. (mortality 69%), but it was susceptible to deltamethrin (mortality 97–100%) and permethrin (mortality 100%). Although insufficient number of primary vectors were collected, results showed that *Anopheles dirus* s.l. and *Anopheles maculatus* s.l. were susceptible to deltamethrin (mortality 100%). *Anopheles nivipes* and *Anopheles philippinensis* were susceptible to all three insecticides. PBO significantly increased mortality to deltamethrin and permethrin in pyrethroid-resistant *An. hyrcanus* s.l. None of the sequenced specimens presented the L1014F or L1014S mutation.

Discussion: This study shows that insecticide resistance is present in potential malaria vectors in northeastern Thailand. The absence of *kdr* mutations in all *Anopheles* species tested suggests that metabolic resistance is the main mechanism of pyrethroid resistance. This study provides new findings about insecticide susceptibility status of potential malaria vectors in northeastern Thailand that are deemed important to guide malaria vector control.

Keywords: Malaria, Vectors, *Anopheles*, Pyrethroids, DDT, Resistance, Synergists, *kdr*

*Correspondence: faasthc@ku.ac.th; vincent.corbel@ird.fr

†Theeraphap Chareonviriyaphap and Vincent Corbel contributed equally to this work

¹ Department of Entomology, Faculty of Agriculture, Kasetsart University, Bangkok, Thailand

Full list of author information is available at the end of the article