



Discriminating lethal concentrations for pyrethroid compounds used in susceptibility monitoring of *Anopheles epiroticus*, a malaria vector in Thailand



Watcharin Phoomkhong^a, Michael J. Bangs^{a,b}, Theeraphap Chareonviriyaphap^{a,*}

^a Department of Entomology, Faculty of Agriculture, Kasetsart University, Bangkok, 10900, Thailand

^b Public Health & Malaria Control Department, International SOS, Kuala Papua, 99920, Indonesia

ARTICLE INFO

Keywords:

Anopheles epiroticus
Synthetic pyrethroids
Susceptibility assay
Discriminating concentrations
Thailand

ABSTRACT

Anopheles epiroticus is a malaria vector in Thailand found primarily along coastal areas with brackish water habitats. Insecticides, particularly pyrethroid class compounds, are commonly used to control malaria vectors in Thailand. The lack of specific discriminating lethal concentrations for *An. epiroticus* has possibly compromised a more accurate assessment of physiological susceptibility to various chemicals. The routine assessment of vector response to insecticides is a key program management component to prevent or mitigate the development of resistance. The purpose of this study was to determine the discriminating (diagnostic) lethal concentrations of five common synthetic pyrethroids (deltamethrin, permethrin, bifenthrin, lambda(λ)-cyhalothrin, and alpha(α -cypermethrin) used in Thailand for malaria control, against a susceptible colonized population of *An. epiroticus*. Final discriminating concentrations were 0.006% deltamethrin, 0.349% permethrin, 0.033% bifenthrin, 0.012% λ -cyhalothrin, and 0.0009% α -cypermethrin. Using concentrations established for each chemical, a field population of *An. epiroticus* from southern Thailand was found completely susceptible to each concentration. Periodic monitoring of insecticide susceptibility of *An. epiroticus* and other malaria vector species is needed to assess the efficacy of chemicals and guide insecticide policy and control programs.

1. Introduction

Anopheles epiroticus Linton & Harbach is a member of the Sundaicus Complex in the Pyretophorus Series, a larger grouping of important malaria vectors spanning Asia and Africa (Harbach, 2013). The *Anopheles sundaicus* species complex consists of at least six closely related sibling species, *An. sundaicus* s.s. (Rodenwaldt), *An. epiroticus*, *An. sundaicus* species A, B, D and E (Dev and Sharma, 2013; Dusfour et al., 2004b; Harbach, 2017). The species complex is predominately found near coastal zones, utilizing fresh, brackish and saltwater habitats to propagate. Published data indicates that larvae tolerate salinity concentrations ranging from 0% to 11%, i.e., from freshwater (< 0.05%) to exceeding much greater than normal seawater (3.5%) (Dusfour et al., 2004a). This species complex typically prefers partially sunlit water, stagnant or slow moving, containing floating green algae and other forms of aquatic vegetation (Sinka et al., 2011). The species complex is endemic to Vietnam, Myanmar, Thailand, Cambodia, peninsular Malaysia, western and south-central Indonesia, Malaysian Borneo, and the Andaman and Nicobar Islands in the Indian Ocean (Brandling-Bennett et al., 1981; Linton et al., 2001; Reid, 1968; Sukowati and Baimai,

1996). In Thailand, only *An. epiroticus* is present and appears restricted along coastal areas and islands of the eastern and southern parts of the country (Linton et al., 2005; Rattanarithikul et al., 2006; Scanlon et al., 1968; Sukowati et al., 1999).

Members of this species complex are recognized as malaria vectors in coastal areas and on islands in South and Southeast Asia (Dusfour et al., 2004a; Linton et al., 2005; Sukowati et al., 1999); however, their relative importance as vectors varies by locality and epidemiological factors influencing transmission (Dusfour et al., 2004a, 2007; Elyazar et al., 2013). *Anopheles epiroticus* has been incriminated as a malaria vector along coastal areas and islands of mainland Southeast Asia and India (Adak et al., 2005; Dusfour et al., 2004a). This species has been incriminated as a vector of malaria on islands and coastal zones in Thailand (Harinasuta et al., 1974; Prasittisuk, 1985). *Anopheles epiroticus* presents both endophagic and exophagic blood feeding habits, and across its geographical range. It has been described as a predominately endophilic and anthropophilic species, while also displaying exophilic and zoophilic behaviors in different locations (Dusfour et al., 2004a; Reid, 1968; Ritthison et al., 2014). Owing, in part, to its more limited distribution, this species is primarily regarded

* Corresponding author.

E-mail addresses: watcharin.percy@gmail.com (W. Phoomkhong), bangs_michael@yahoo.com (M.J. Bangs), faasth@ku.ac.th (T. Chareonviriyaphap).