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IRRITANT AND REPELLENT RESPONSES OF *ANOPHELES HARRISONI* AND *ANOPHELES MINIMUS* UPON EXPOSURE TO BIFENTHRIN OR DELTAMETHRIN USING AN EXCITO-REPELLENCY SYSTEM AND A LIVE HOST

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ABSTRACT. Feeding responses of *Anopheles harrisoni* and *An. minimus* were evaluated following exposure to 2 pyrethroid insecticides, bifenthrin or deltamethrin, using an excito-repellency test system in the presence and absence of live host cues. The results demonstrated that contact irritancy was the primary action of bifenthrin or deltamethrin in both mosquito species. There was no noncontact repellency effect elicited by either insecticide. *Anopheles minimus* showed rapid escape response with high mortality rates following direct contact with deltamethrin in the absence of a host and delayed escape responses when a host was present. Similarly, exposure of *An. minimus* to bifenthrin also elicited a delayed escape response in the presence of a host but with lower mortality rates. In experiments using *An. harrisoni*, the presence or absence of a host had no significant effect on behavioral responses to either insecticide ($P > 0.05$). We conclude that deltamethrin elicited stronger irritant chemical effects than bifenthrin but that behavioral responses in vector populations are dampened in the presence of an available host. This information is useful for estimating probability of pathogen transmission when using irritant chemicals in proximity to a blood-meal source.

KEY WORDS *Anopheles* behavior, bifenthrin, deltamethrin, Thailand

INTRODUCTION

There are currently several vector control options available for disease prevention. However, insecticides continue to be one of the mainstays of operational programs. Among insecticides, pyrethroids are the most commonly used chemicals for indoor residual spraying to reduce the survival of vectors entering houses. Moreover, pyrethroids are the only insecticides currently recommended for insecticide-treated mosquito nets. Two of the pyrethroids are bifenthrin and deltamethrin. Bifenthrin is a non–alpha-cyano pyrethroid, and is used to treat mosquito nets (Hougard et al. 2002, Batra et al. 2005, Chouaibou et al. 2006). Deltamethrin is an alpha-cyano pyrethroid and is a recommended for indoor residual spraying (WHO 2006). Both pyrethroids affect the nervous system, causing paralysis in insects as a knock-down effect (Haug and Hoffman 1990, Nguyen et al. 1996, WHO 2001, Hougard et al. 2002, Doyle et al. 2009). Apart from toxic properties of insecticides, these same compounds can elicit changes in a mosquito's behavioral response. One of those behavioral changes is termed "irritancy," which increases activity of mosquitoes. The disturbance of resting mosquitoes is the most obvious result of irritation, causing a mosquito to leave treated surfaces before acquiring a lethal dose; therefore repeated contact is required before mortality occurs (Kennedy 1947, Muirhead-Thomson 1960, Roberts et al. 2000). Another behavioral change is "repellency," used to refer to the stimulation of a vector by a chemical that results in mosquito movement away from the treatment source; this can occur without direct contact with the treated surface (Dethier et al. 1960, Barton Browne 1977).

Behavioral responses can be objectively and quantitatively assessed by using an excito-repellency test system (Roberts et al. 1997). It was first developed in 1970 in an attempt to access the behavioral responses of mosquitoes to insecticides (WHO 1970). Through several studies, the test system has been further modified and improved to evaluate the behavioral responses of various mosquito species (Quinones and Suarez 1989, Ree and Loong 1989, Evans 1993). In 1997, the improved test system distinguished between 2 distinct types of behavioral responses (Chareonviriyaphap et al. 1997, Roberts et al. 1997): contact irritancy (defined as insects leaving an insecticide-treated surface after tarsal contact with the residual chemical) and noncontact repellency (an insecticide to act from an area effect, diverting insects away from treated surfaces without actual physical contact with the chemical). Later, a portable version was developed that allowed direct assessment of mosquito behavior at field sites (Chareonviriyaphap et al. 2002).

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