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INSECTICIDE-INDUCED BEHAVIORAL RESPONSES OF *ANOPHELES MINIMUS,* A MALARIA VECTOR IN THAILAND

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ABSTRACT. This study was designed to determine the behavioral responses of 2 test populations of *Anopheles minimus* females to DDT at 2 g/m^2, deltamethrin at 0.0625 g/m^2, and lambdacyhalothrin at 0.0369 g/m^2 using an improved excito-repellency escape chamber. One test population was colonized in 1993 and referred to as a young colony. The 2nd field test population was collected from Ta-Soa County, Tri-Yok District, Kanchanaburi Province, in western Thailand and referred to as a wild population. Results showed that females of both young and wild test populations rapidly escaped from direct contact with DDT, deltamethrin, and lambdacyhalothrin. Lambdacyhalothrin exhibited the strongest irritant effect on female mosquitoes, followed by DDT and deltamethrin. Fewer females escaped from test chambers without direct contact with treated surfaces but the response was significantly different from that of the controls ($P < 0.05$). The noncontact response is indicative of a noncontact repellent action. Both contact irritancy and noncontact repellency are involved in *An. minimus* escape responses. Experimental hut studies that include monitoring of house-entering populations of *An. minimus* are needed for a meaningful assessment of noncontact repellent actions.

KEY WORDS Avoidance behavior, excito-repellency, malaria, vector

INTRODUCTION

Anopheles minimus Theobald is one of the most efficient malaria vectors in Southeast and East Asia (Reid 1968). In Thailand, *An. minimus* is considered to be a primary vector of malaria (Ayurakit-Kosol and Griffith 1956, Sucharit et al. 1988). One of the principal methods of malaria abatement has been through various methods of vector control to reduce transmission risk. Among these, extensive intradomicillary use of DDT has been conducted for chemical control once or twice a year (Prasittisuk 1995, Chareonviriyaphap et al. 1999). In spite of a long-term use of DDT, no record of physiologic resistance in *An. minimus* to DDT has been reported in Thailand. Well-documented behavioral responses of vectors to DDT raised the issue of avoidance behavior having a role in malaria prevention and in the suppression of insecticide resistance in malaria vectors (Roberts and Andre 1994, Roberts et al. 2000). Avoidance behavior is defined as the ability of insects to avoid insecticide-treated surfaces. Two forms of behavioral responses have been reported, as described in Chareonviriyaphap et al. (1997). The term avoidance behavior can also be used to describe the response that is stimulated by the combination of both irritancy and repellency (Chareonviriyaphap et al. 1999). No information on insecticide avoidance behavior of *An. minimus,* especially by noncontact repellency, has been previously reported.

In addition to DDT, insects also demonstrate behavioral responses to synthetic pyrethroids (Threlkeld 1985, Roberts and Andre 1994, Chareonviriyaphap et al. 1997). Several pyrethroids have been extensively introduced for malaria control in Thailand for impregnated bed-net and intradomicillary spraying, especially deltamethrin (Chareonviriyaphap et al. 1999). The continuing use of pyrethroids should be a major stimulus for extensive studies on the significance of pyrethroid avoidance behavior of *Anopheles* malaria vectors in Thailand. Moreover, avoidance behavior to insecticides by *An. minimus* is given little, if any, consideration. This is unfortunate because the role of irritant and repellent actions of pyrethroids should be clearly defined for malaria vectors before large-scale control programs are started and limited malaria control resources are expended.

Several test systems have been used in behavioral tests of insecticides against malaria vectors using the modified World Health Organization (WHO) excito-repellency test box (Bondareva et al. 1986, Quinones and Suarez 1989, Ree and Loong 1989), but no test system has been fully accepted (Roberts et al. 1984, Evans 1993). In recent years, Roberts et al. (1997) proposed a test system to discriminate between contact irritancy and noncontact repellency. The test system was standardized and used by Chareonviriyaphap et al. (1997) and subsequently by Bangs et al. (unpublished data). Unfortunately, this test system was cumbersome, and required much time for attaching test papers. Chareonviriyaphap and Aum-Aong (2000) developed an improved collapsible, metal excito-repellency test chamber for behavioral tests on mosquitoes (Fig. 1). As described in this report, the improved test system was used to study the behavioral responses of a young colony and a wild population of *An. minimus* against 3 different insecticides, with and without physical contact with insecticides.

MATERIALS AND METHODS

Anopheles minimus test populations

Young colony: This colony was maintained in the laboratory for 7 years. It was originally col-

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