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INSECTICIDE-INDUCED BEHAVIORAL RESPONSES IN TWO POPULATIONS OF *ANOPHELES MACULATUS* AND *ANOPHELES SAWADWONGPORNI*, MALARIA VECTORS IN THAILAND

VITHEE MUENWORN,[1] PONGTEP AKARATANAKUL,[1] MICHAEL J. BANGS,[2] ATCHARIYA PARBARIPAI[3] AND THEERAPHAP CHAREONVIRIYAPHAP[1,4]

ABSTRACT. Behavioral responses of 2 wild-caught populations of *Anopheles maculatus* (Theobald) and *Anopheles sawadwongporni* Rattanarithikul and Green to operational field doses of DDT (2 g/m^2) and permethrin (0.5 g/m^2) were characterized using an excito-repellency test system. Both test populations, collected from animal quarters at Ban Pu Teuy, Sai Yok District, Kanchanaburi Province, western Thailand, were found completely susceptible to DDT and permethrin. Specimens from 2 test populations quickly escaped from direct contact with treated surfaces from 2 insecticides compared with paired controls. Noncontact repellency response to DDT was significantly pronounced in *An. sawadwongporni* ($P < 0.05$) and comparatively weak in *An. maculatus*, but it was statistically greater than individually paired controls ($P < 0.05$). We conclude that contact irritancy is a major behavioral response of both field populations when exposed directly to DDT and permethrin, whereas noncontact repellency to DDT also produced a significant escape response in *An. sawadwongporni*.

KEY WORDS Behavioral avoidance, irritancy, repellency, *Anopheles maculatus*, *Anopheles sawadwongporni*, DDT, permethrin, Thailand

INTRODUCTION

Members of the *Anopheles (Cellia) maculatus* complex are important vectors of malaria throughout the Oriental Region, including Thailand, Indonesia, Malaysia, and the Philippines (Reid 1968). This complex contains at least 8 closely related species and is differentiated based on variability in morphological, behavioral, and genetic characters (Green et al. 1985, Rattanarithikul and Green 1986, Chiang et al. 1991, Kittiyapong et al. 1993, Bangs et al. 2002). In Thailand, 6 species have been reported, including *An. maculatus* s.s. Theobald, *Anopheles sawadwongporni* Rattanarithikul and Green, *Anopheles dravidicus* Christophers, *Anopheles notanandai* Rattanarithikul and Green, *Anopheles willmori* (James), and *Anopheles psuedowillmori* (Theobald) (Green et al. 1985, Rattanarithikul and Green 1986, Rattanarithikul and Harbach 1990, Kittayapong et al. 1990, Green et al. 1992). Three species have been incriminated as important vectors of malaria in Southeast Asia, including *An. maculatus* s.s. (Reid 1968), *An. willmori* (Pradham et al. 1970), and *An. pseudowillmori* (Green et al. 1991). *Anopheles sawadwongporni* is a common species often found in high density throughout Thailand, especially along the border provinces with Myanmar and Malaysia (Disease Control Department 2005), and this species has been shown to be an important vector of *Plasmodium falciparum* in the country (Rattanarithikul et al. 1996).

For decades, DDT was routinely used for malaria control as an indoor residual spray (IRS) in Thailand. DDT use was halted for all public health use in 2001 after a progressive phaseout period beginning in 1995 (Chareonviriyaphap et al. 2000). The reasons for DDT removal from the malaria control inventory were politically and operationally based. A combination of cost and the gradual increase of poor community compliance to IRS in some areas all contributed to the chemical being removed permanently from organized malaria control (Chareonviriyaphap et al. 1999). Interestingly, the development of DDT resistance by vector mosquitoes was not documented in Thailand or provided as a reason for terminating its use. DDT was gradually replaced by two potent pyrethroids, deltamethrin and permethrin (Chareonviriyaphap et al. 2000). From the beginning, deltamethrin has been used primarily for IRS and permethrin applied for treatment of netting material used in bed-nets and curtains (Chareonviriyaphap et al. 2004, Disease Control Department 2005).

Although DDT was withdrawn, it was done without good understanding or appreciation of the impact its loss would have on vector populations in terms of behavioral avoidance and malaria transmission reduction. Behavioral responses of mosquitoes to insecticides influence vectorial capacity of vectors by altering or disrupting normal behavioral activity (Sparks et al. 1989, Klowden 1996, Costantini et al. 1999).

[1] Department of Entomology, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand.
[2] Preventive Medicine & Occupational Health, Naval Hospital Bremerton, Navy Region Northwest, 2850 Thresher Avenue, Silverdale, WA 98383.
[3] Faculty of Liberal Arts and Science, Kasetsart University, Kampheangsean, Nakhon Pathom 73140, Thailand.
[4] To whom correspondence should be addressed.