Characterization of deltamethrin resistance in field populations of *Aedes aegypti* in Thailand

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ABSTRACT: Five field collections of adult *Aedes aegypti* mosquitoes from different areas in Bangkok and Pathum Thani provinces were subjected to susceptibility tests against deltamethrin. Low levels of resistance were detected among all populations tested (RR_{50}= 8-17.2) compared to the susceptible strain, Bora (French Polynesia). Among the five populations tested, the BKH (Bang Khen, Bangkok) and PSC (Phasicharoen, Bangkok) populations showed a higher level of deltamethrin resistance than the other three populations (RR_{50} of BKH= 17.2, and of PSC= 13.6) and cross-resistance to DDT was observed in these strains. Biochemical analysis showed a significant elevation of mixed function oxidases enzyme activity in all populations. There was an elevation of non-specific esterases in all populations except BKL, and there was no consistent association of glutathione S-transferases with deltamethrin and DDT resistance, although not all populations were bioassayed for DDT. The partial cDNA sequence of the *para*-type voltage-dependent sodium channel (IIS4-IIS6) was determined for BKH and PSC populations. Common amino acid substitution, leucine to phenylalanine in the IIS6 region, found for insects including *Anopheles gambiae* was not found in either the BKH or the PSC populations. However, two other amino acid substitutions (proline substituted with serine at position 64 in the PSC population and leucine with phenylalanine at position 69 in the BKH population) were found in the IIS5-IIS6 inter-segment region sequenced. The role these substitutions play in target site resistance is uncertain at this time. ***Journal of Vector Ecology* 30 (1): 144-150. 2005.**

Keyword Index: *Aedes aegypti*, deltamethrin, resistance mechanism, biochemical assays, Thailand.

INTRODUCTION

Dengue haemorrhagic fever (DHF) remains a serious disease in Thailand, and the mosquito *Aedes aegypti* has been incriminated as the main vector. Over 140,000 cases and 250 deaths were reported annually in Thailand (Annual Epidemiological Surveillance Report 2001). Control of *Ae. aegypti* vectors in Thailand has relied on the organophosphate and carbamate insecticides, including temephos, fenitrothion, malathion, and propoxur since 1950 (Chareonviriyaphap et al. 1999a). At the same time, DDT was used for insect control in Thailand particularly in agricultural areas (Chareonviriyaphap et al. 1999a). Since 1992, synthetic pyrethoids have been the primary insecticides used in agriculture and public health. During endemic seasons, deltamethrin, cypermethrin, and permethrin are the main synthetic pyrethroids used to control adult *Aedes* mosquitoes through mass spraying (Vector Borne Disease Annual report 2002-2003). Additionally, household insecticide products (aerosols, mosquito coils, mats, and liquid forms) containing synthetic pyrethoids such as permethrin, d-tetramethrin, and esbiothrin have been commonly used, especially in cities such as Bangkok (Paeporn et al. 1996). To date, deltamethrin is used for space spraying in adult *Aedes sp.* mosquito control, either alone or in combination with other synthetic pyrethroids (Vector Borne Disease Annual report 2002-2003).

Common insecticide resistance mechanisms include alteration of target sites and increased enzyme activities of non-specific esterases, glutathione S-transferases (GSTs), and P450-mediated monooxygenases or mixed function oxidases (MFOs) (Oppenoorth 1985, Price 1991, Hemingway and Ranson 2000). GST has been shown to be responsible for DDT resistance in mosquitoes (Brogdon and Barber 1990, Grant et al. 1991), while non-specific esterases have been shown to be involved in resistance to organophosphates, carbamates and, to a lesser extent, pyrethroids. The monooxygenases are reported to play a role in the metabolism of pyrethroids, activation and/or detoxification of organophosphorus insecticides and, to a lesser extent, carbamate resistance (Hemingway et al. 2004). Target site resistance in pyrethroids and DDT is due to reduced affinity of sodium channels resulting in delayed knockdown time (knockdown resistance; *kdr*). The *kdr* is associated with point mutations in the *para*-type voltage-dependent sodium channel gene (Sorderlund and Knipple 2003). A single mutation (leucine to phenylalanine) at position 1014 in the domain II segment 6 (IIS6) of the sodium channel gene is the molecular basis of *kdr* in several insects such as *Musca domestica* (Williamson et al. 1996), *Anopheles gambiae,* and *Culex pipiens* (Martinez-Torres et al. 1998, 1999).

In Thailand, resistance to DDT has been recognized for decades in *Ae. aegypti* (Neely 1966). Recently, several cases