Current Susceptibility Status of Malaysian *Culex quinquefasciatus* (Diptera: Culicidae) Against DDT, Propoxur, Malathion, and Permethrin

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ABSTRACT A nationwide investigation was carried out to determine the current susceptibility status of *Culex quinquefasciatus* Say populations against four active ingredients representing four major insecticide classes: DDT, propoxur, malathion, and permethrin. Across 14 study sites, both larval and adult bioassays exhibited dissimilar trends in susceptibility. A correlation between propoxur and malathion resistance and between propoxur and permethrin resistance in larval bioassays was found. The results obtained from this study provide baseline information for vector control programs conducted by local authorities. The susceptibility status of this mosquito should be monitored from time to time to ensure the effectiveness of current vector control operations in Malaysia.

KEY WORDS *Culex quinquefasciatus*, WHO bioassay, insecticide susceptibility, cross-resistance, Malaysia

Culex quinquefasciatus Say (Diptera: Culicidae) is the most common Malaysian nuisance mosquito (Yap et al. 2000a, Low et al. 2012). It is also a potential vector of urban lymphatic filariasis caused by the nematode parasite, *Wuchereria bancrofti* in Malaysia (Vythilingam et al. 2005). Around the world, its significance as a vector of bancroftian filariasis (Samuel et al. 2004), West Nile virus (Sardelis et al. 2001, Pitzer et al. 2009), Saint Louis encephalitis virus (Jones et al. 2002), Ross River virus (Lindsay et al. 1993), and Japanese encephalitis virus (Nitatpattana et al. 2005) has been well documented.

Application of organochlorines, organophosphates, carbamates, and pyrethroids remain as the main control agents in vector control programs. However, the extensive use and over-reliance on insecticides have contributed to insecticide resistance development through the selection of certain genes (World Health Organization [WHO] 2006). In fact, insecticide resistance is not a new phenomenon and is an increasing problem worldwide. *Cx. quinquefasciatus* from different parts of the world have been reported to be resistant to various insecticide classes (Bisset et al. 1997, Chandre et al. 1997, Liu et al. 2004, Sathantriphop et al. 2006, Kasai et al. 2007, Pridgeon et al. 2008). Among the various mosquito control approaches, adulticiding with ultra low volume (ULV) fogging, thermal fogging, surface residual spray, or household insecticide products are specifically designed for the control of adult mosquitoes (Yap et al. 2000b). In many urban and suburban areas, larviciding is the most widely used method for the control of *Cx. quinquefasciatus* larvae, as high levels of adult organochlorine and organophosphate resistance have been reported (Chavasse and Yap 1997).

To date, no nationwide investigation of insecticide susceptibility status of wild *Cx. quinquefasciatus* has been reported in Malaysia. Over the years, the susceptibility status of wild *Cx. quinquefasciatus* against insecticides has been focused in the Klang Valley (Kuala Lumpur and Selangor), Pahang, and Penang (Reid 1955, Wharton 1958, Thomas 1962, Lee and Tadano 1994, Lee et al. 1997, Nazni et al. 2005) districts. There has been a dearth of information regarding the insecticide susceptibility status of wild *Cx. quinquefasciatus* in other districts of Malaysia. Hence, the present article is the first attempt to quantify the susceptibility status of wild *Cx. quinquefasciatus* against four active ingredients representing four major insecticide classes from each state of Malaysia, including East Malaysia. The findings of this study will be a timely reminder and an early warning to local authorities that systematic insecticide resistance management is essential for the improvement of current vector control operations in Malaysia.

Materials and Methods

Mosquito Strains. Mosquito larvae were collected from stagnant water at residential areas in each state

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