MOSQUITO SPECIES AND OUTDOOR BREEDING PLACES IN RESIDENTIAL AREAS IN MALAYSIA

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Abstract. We conducted mosquito surveillance at outdoor breeding habitat in 459 households at 7 urban locations in Putrajaya, Malaysia from January to December 2010 to determine the predominant species and breeding locations. The most common species found at all locations was *Aedes albopictus*. Gardening utensils were the most common breeding sites. Of the 1,885 mosquito larvae specimens found, 1,774 (94.1%) were *Ae. albopictus* larvae, 84 (4%) were *Ae. aegypti* larvae and 27 (1%) were *Culex quinquefasciatus* larvae. The Aedes index for each of the locations was higher than the goal set by the Ministry of Health for Malaysia. However, the container index at each of the locations was within the goal. The Breateau index was above the goal set by the Ministry of Health at Precinct 9B1 but the other locations were within the goal.

Keywords: *Aedes albopictus*, *Aedes aegypti*, *Culex quinquefasciatus*, mosquito surveillance, Aedes index, container index, Breateau index

INTRODUCTION

Mosquitoes have nearly worldwide distribution, being found throughout the tropics and temperate regions (Rueda, 2008). They thrive in a variety of habitats including fresh water and brackish water (clear, turbid and polluted) but do not thrive in marine habitats with high-salt concentrations (Rueda, 2008). The most important pest and vector species belong to the genera *Anopheles*, *Culex*, *Aedes*, *Psorophora*, *Haemagogus* and *Sabethes* (Service, 2000). In Malaysia common mosquitoes belong to genera *Anopheles*, *Culex* and *Aedes*. Mosquitoes can spread diseases such as dengue, malaria, filariasis, yellow fevers, and Japanese encephalitis. Urbanization has increased the habitats suitable for *Aedes* mosquitoes, especially *Aedes aegypti* (WHO SEARO, 2008). In cities where vegetation is abundant both *Aedes aegypti* and *Aedes albopictus* (Skuse) can occur together. Generally *Aedes aegypti* (Linnaeus) is the dominant species depending on the habitat (WHO SEARO, 2006).

Residential areas are often located in close proximity to major mosquito midge breeding sites, including construction sites. Vegetation corridors between community areas and breeding sites provide a dispersal route for biting insects. Trees and shrubs planted near dwellings, provide harborage sites for mosquitoes and biting midges (Scott, 2002). *Aedes* mosquitoes can breed in variety of natural and man-made

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containers, such as water storage jars, cement tanks, other water jars, plastic tanks, flower vases, animal feeders, ant traps, and trash, such as glass, plastic bottles, cans, coconut husks and tires (Thavara *et al*, 2001; Chareonviriyaphap *et al*, 2003). Domestic containers such as cement tanks and plastic containers are major breeding habitats for *Aedes* mosquitoes in India (Balakrishnan *et al*, 2006). The aim of this study was to identify breeding habitats and mosquito species in Putrajaya, Malaysia.

MATERIALS AND METHODS

Study site

Putrajaya, an urban area situated 30 km south of Kuala Lumpur, embraces the concept of an intelligent garden city. It has landscaped lakes and parks. Putrajaya covers 4,931 hectares which has previously been an oil palm plantation. Nearly half of Putrajaya is natural, with its landscape having been extensively reworked with lush greenery and botanical gardens crisscrossed by large bodies of water and wetlands. We studies 3 residential locations in Putrajaya: Precinct 9, Precinct 11, and Precinct 16. The selection of these areas was based on a high incidence of dengue cases reported in the Putrajaya Health Office annual reports for 2006-2009. Precinct 9 is located on the western edge of Putrajaya at 2° 56′ N, 101° 40′ E and has a total area of 1,887 km^2. It is one of the larger precincts in Putrajaya. Precinct 9 has a number of high density, high rise residential blocks. Precinct 11 is located at the northwestern corner of Putrajaya at 2° 57′ N, 101° 40′ E and has an area of 4,245 km^2. Precinct 16 is located near the northern main area of precincts at 2° 55′ N, 101 42′E and with a total area of 1,554 km^2. It is a medium-size precinct in Putrajaya.

Data collection

Every third house was inspected for mosquito breeding in the potential breeding sites. The pipette method was used for collecting the mosquito larvae. A total of 459 representative households from seven selected localities were covered by the larval surveys at the study sites. A larval survey was conducted at outdoor areas from January to December 2010, with assistance from the staff of the Vector Control Unit. Permission was obtained from the residents to examine for potential breeding habitats. Mosquito larvae were collected from breeding sites and placed in specimen bottles and labeled.

Entomological studies

Mosquito larvae species identification was performed using the key provided by the Ministry of Health Malaysia (1986). Three larval indices: *Aedes* index (AI), container index (CI), and Breteau index (BI) were calculated using WHO guidelines (WHO SEARO, 2006). The specimens were then, preserved in 70% alcohol for storage at the Zoological Museum, Institute of Biological Science, University of Malaya and given a catalogue number.

The *Aedes* index (AI) is percentage of houses infested with larvae and/or pupae. It was calculated as follows:

$$AI = \frac{\text{Number of houses found positive for } \textit{Aedes aegypti}/\textit{Aedes albopictus}}{\text{Number of houses inspected}} \times 100$$

The container index (CI) is the percentage of water-holding containers infested with larvae or pupae. It was calculated as follows:

$$CI = \frac{\text{Number of positive containers}}{\text{Number of containers inspected}} \times 100$$

The Breteau index (BI) is the number of positive containers per 100 houses inspected. It was calculated as follows:

$$BI = \frac{\text{Total number of containers positive for } \textit{Aedes aegypti}/\textit{Aedes albopictus}}{\text{Number of houses inspected}} \times 10$$

RESULTS

Of 175 containers positive for mosquito larvae, 1,885 mosquito specimens were collected during the larval survey from January to December 2010. One thousand seven hundred seventy-four specimens (94%) were *Ae. albopictus* larvae, 84 (5%) were *Ae. aegypti* larvae and 27 (1%) were *Cx. quinquefasciatus* larvae.

Fig 1 shows the types of breeding habitats identified during the larval survey. The main breeding habitat was gardening utensils (44%). Gardening utensils included flower pots, flower pot plates, and watering cans. Other breeding habitats were artificial containers (23%), building design (9%) (floor trap, floor and sand trap), discarded items (7%), rubbish bins (6%), tires (5%), water storage comtainers (3%) and natural habitat (3%). Natural habitats were composed of tree holes, ponds and banana leaves.

Breeding habitat by type of mosquito larvae found during January - December 2010 is presented in Table 1. *Aedes albopictus* mosquito larvae were found in all breeding habitat types, while *Aedes aegypti* larvae were only found in gaderning utensils and rubbish bins. *Culex quinquefasciatus* larvae were also found in several habitat types such as gaderning utensils, rubbish bins, building design and tires.

Table 2 shows that the *Aedes* index (AI) at each of the 7 study sites was higher than the cut-off standard of the Ministry of Health Malaysia (1%). The container index (CI) at each of study site was less than the cut-off standard (10%). The Breteau index (BI) at one study site was higher than the cut-off and at another site was equal to the cut-off (5).

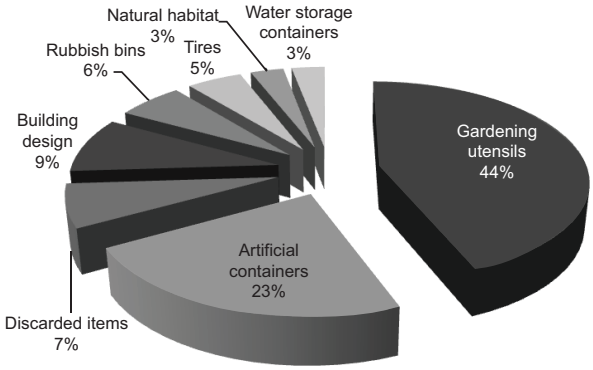

Fig 1–Mosquito breeding habitats identified during a larval survey in Putrajaya.

DISCUSSION

Studies of the distribution and relative abundances of mosquitoes in urban/suburban areas of Pepang Island, Malaysia indicated that *Cx. quinquefasciatus* (Say), *Ae. albopictus* (Skuse) and *Ae. aegypti* (Linnaeus) were the most abundant species (Yap, 1975). In our study *Ae. albopictus* was the predominant larval species found outdoors. Other species found outdoors were *Ae. aegypti* and *Cx. quinquefasciatus. Ae. aegypti* larvae are usually found indoors but in this study *Ae. aegypti* was found outdoors along with *Ae. albopictus* and *Cx. quinquefasciatus*. Our results agreed with those of Rathor (1996), who found *Ae. aegypti* was found breeding in natural receptacles, such as tree holes, but always near humans. Chareonviriyaphap *et al* (2003) found both *Ae. albopictus* and

Table 1
Breeding habitat by type of mosquito larvae found during January 2010-December 2010.

Habitat	*Ae. albopictus* No. (%)	*Ae. aegypti* No. (%)	*Cx. quinquefasciatus* No. (%)	Total No. (%)
Gardening utensils	72 (43)	2 (67)	2 (40)	76 (43)
Artificial containers	40 (24)	0 (0)	0 (0)	40 (23)
Rubbish bins	10 (6)	1 (33)	1 (20)	12 (7)
Discarded items	13 (8)	0 (0)	0 (0)	13 (7)
Building design (*eg*, floor traps, and sand traps)	15 (9)	0 (0)	1 (20)	16 (9)
Tires	8 (5)	0 (0)	1 (20)	9 (5)
Natural habitats	5 (2)	0 (0)	0 (0)	5 (3)
Water storage containers	6 (3)	0 (0)	0 (0)	6 (3)
Total	169 (100)	3 (100)	5 (100)	177 (100)

Table 2
The *Aedes* index, container index and Breteau index at the seven study sites in Putrajaya.

Locality	*Aedes* index	Container index	Breteau index
Precinct 9B	1.3% [a]	1.1%	1
Precinct 9B1	6.4% [a]	5.6%	8[a]
Precinct 9G1	1.8% [a]	3.3%	4
Precinct 11A1	2.3% [a]	1.7%	2
Precinct 11A2	3.1% [a]	3.2%	5
Precinct 11A5	3.4% [a]	2.8%	4
Precinct 16	1.6% [a]	1.0%	2

[a]Above cut-off levels

Ae. aegypti breed outside rather than inside. Rao (2010) found *Ae. albopictus* to be a container breeder and it breeds in both natural and manmade habitats. *Ae. albopictus* is found in both natural and man-made containers with organic debris (Rattanarithikul and Panthusiri, 1994). Thavara *et al* (2001) found *Ae. albopictus* preferred outdoor breeding habitats such as coconut husks and coconut floral spathes. Nyamah *et al* (2010) found all containers with *Ae. albopictus* larvae were outdoors and three out of four containers positive for *Ae. aegypti* were outdoors. While *Ae. aegypti* commonly breeds and feeds inside houses, *Ae. albopictus* is more common outside in open spaces with shaded vegetation and suitable breeding sites, such as car tires and garbage dumps (WHO,1986). *Ae. albopictus* was the most common mosquito species found in this study area.

The main breeding habitat for mosquitoes in our study was gardening uten-

sils such as flower pots, flower pot plates and watering cans. In Putrajaya residents liked to have a mini gardens outside their houses. Nyamah *et al* (2010) also found the main breeding sites for *Aedes* spp were flower pots, flower pot plates, vases and watering cans. In the study from Thailand (Chareonviriyaphap *et al*, 2003), the main breeding site for *Aedes* mosquitoes was flower vases. Anything that retains water is a potential breeding site for *Aedes* mosquitoes (Isaacs, 2006). Kusumawathie and Fernando (2003) found water storage tanks and barrels were the major breeding sites for *Aedes* mosquito in Sri Lanka. Every house in our study in Putrajaya had sand traps which increased the mosquito population. Construction sites and the building of roads, drainage ditches and canals can create artificial breeding sites for mosquitoes and biting midges (Scott, 2002). Discarded tires are also common breeding site especially for *Ae. albopictus* (Rao, 2010). *Ae. albopictus* was found to be breeding in all types of containers in our study including gardening utensils, artificial containers, rubbish bins, discarded item, buildings, discarded tires, natural habitat and water storage containers. This is agrees with the findings of Chareonviriyaphap *et al* (2003) from Thailand. Gardening utensils were the preferred breeding sites for all 3 mosquito species found in our study: *Ae. albopictus*, *Ae. aegypti* and *Cx. quinquefasciatus*. In this study *Ae. albopictus* was found in all kinds of containers, both natural and artificial, however *Ae. aegypti* was found only in artificial containers. These results are similar to a study from Thailand (Thavara *et al*, 2001).

Mixed breeding of *Ae. albopictus* and *Cx. quinquefasciatus* in the same container was found in the small number of containers in our study, similar to the findings of several studies (Chan *et al*, 1971; Yap and Thiruvengam, 1979; Chang and Jute, 1994; Chen *et al*, 2009). Mixed breeding with *Ae. albopictus* and *Ae. aegypti* in the same container was not found in our study.

In our one year mosquito survey the *Aedes* index (AI), we found was above the cut-off level specified by Ministry of Health Malaysia. The container index (CI) was within the cut-off level in our study areas. The Breteau index (BI) was above the cut-off level in Precinct 9B1 only. The AI, BI and CI were all higher in Precinct 9B1 due to the greater number of breeding sites. *Aedes* mosquitoes are primarily container breeders and can thrive in both clean and contaminated water in both natural and artificial containers (Kusumawathie and Fernando, 2003). Other factors were influenced by the awareness of the residents towards mosquito borne diseases. Environmental factors such as rainfall, humidity and temperature can contribute to fluctuations in the indicies.

Regular rainfall helps maintain permanent mosquito breeding sites, such as swamps and ponds. However, heavy rain can flush mosquito larvae out of their breeding sites and drown pupae (Scott, 2002). Chakravati and Kumaria (2005) found rainfall, temperature and relative humidity affected the mosquito breeding activity. The House indices, BI and CI were reported to be high in post-monsoon in India (Sharma *et al*, 2005). Rainfall, temperature and relative humidity are important factors to consider when planning dengue programs.

Balakrishnan *et al* (2006) found larval control measures are needed to contain outbreaks of dengue. Education regarding breeding sites should be given to residents. Town planning and home designs should be modified to reduce

mosquito breeding sites. In this study we identified mosquito breeding sites and mosquito species. Effective measures to prevent mosquito breeding can use this information to reduce the risk of dengue outbreaks by control of the vector population (Koedraadt *et al*, 2006).

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