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
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 km². 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 km². 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 km². 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:

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

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:

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

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 containers (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 gadinging utensils and rubbish bins. *Culex quinquefasciatus* larvae were also found in several habitat types such as gardening 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).

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.

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

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

<table>
<thead>
<tr>
<th>Locality</th>
<th><em>Aedes</em> index</th>
<th>Container index</th>
<th>Breteau index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precinct 9B</td>
<td>1.3% a</td>
<td>1.1%</td>
<td>1</td>
</tr>
<tr>
<td>Precinct 9B1</td>
<td>6.4% a</td>
<td>5.6%</td>
<td>8 a</td>
</tr>
<tr>
<td>Precinct 9G1</td>
<td>1.8% a</td>
<td>3.3%</td>
<td>4</td>
</tr>
<tr>
<td>Precinct 11A1</td>
<td>2.3% a</td>
<td>1.7%</td>
<td>2</td>
</tr>
<tr>
<td>Precinct 11A2</td>
<td>3.1% a</td>
<td>3.2%</td>
<td>5</td>
</tr>
<tr>
<td>Precinct 11A5</td>
<td>3.4% a</td>
<td>2.8%</td>
<td>4</td>
</tr>
<tr>
<td>Precinct 16</td>
<td>1.6% a</td>
<td>1.0%</td>
<td>2</td>
</tr>
</tbody>
</table>

*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-
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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 indices.

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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