Larval Infestations of *Aedes aegypti* and *Ae. albopictus* in Nakhonsrithammarat, Thailand

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**Abstract**

This study investigated the prevalence of *Aedes* larvae in two different topographical areas (i.e. seaside and mountainous area) and in two faith-based communities (i.e. Buddhist and Muslims). Samples were collected by using the stratified simple random sampling with a total of 400 households from all communities in 31 sub-districts. The results showed that *Aedes* larvae were mostly found in artificial containers including water containers in bathrooms, potted plants, animal pans, concrete tanks and water jars. *Ae. albopictus* larvae were found in higher numbers in the seaside area than in the mountainous area. All three *Aedes* larval indices: Container Index (CI), House Index (HI) and Breteau Index (BI), indicated a high risk of DHF transmission in both locations and faith-based communities. We also found that the HI in Muslim households was more than in Buddhist households.

**Keywords**: Dengue vectors, *Aedes aegypti*, *Aedes albopictus*, location, religious community, Container Index, House Index, Breteau Index, *Aedes* indices.

**Introduction**

The dengue vectors in southern Thailand are primarily *Aedes aegypti* and *Ae. albopictus*. An epidemic of DHF occurred in southern Thailand (e.g. Samui Island in 1966 and 1967) where *Ae. aegypti* and *Ae. albopictus* were abundant and widespread. *Ae. albopictus* is capable of breeding in a wide range of container types and water-holding receptacles. In Thailand, *Ae. albopictus* has been found in forested habitats ranging in elevation from 450 to 1800 m as well as in a variety of other habitats in rural and suburban areas.

There are several factors which influence DHF incidence. These include water storage, climatic and vector factors. Container factors comprise of shape, type, size of water surface, type of materials, lids and also water consumption characteristics. Climatic factors comprise of monthly average rainfall, vapour pressure and maximum, minimum and mean temperatures. Vector factors comprise of mosquito density, behaviour, vector competence, food level, duration of development, size at emergence, flight range, survival and biting activity. Because preventative care is an increasingly important part of the strategy, social factors that influence its use must be more closely investigated.

Nakhon Si Thammarat province is located in southern Thailand near Samui Island (Figure 1).
Since 1984, there have been several cyclic DHF outbreaks in this area, especially in 1990 when a large outbreak occurred. Thereafter, dengue epidemics decreased but reappeared again in 1998\cite{13} and 2002. The number of deaths in Nakhon Si Thammarat was the highest in Thailand in the year 2002 (i.e. DHF morbidity rate was 631.40 cases per 100,000 populations and the fatality rate was 0.92)\cite{14}.

In recent decades, epidemiologists have increasingly investigated the relationship between faith-based communities and health. Cultural practices among Buddhists and Muslims in accordance with their religious tenets may have an impact on health and disease transmission\cite{15,16}. The objectives of this study were to identify major sources of larval breeding sites using \textit{Aedes} indices, comparing their prevalence in seaside and mountainous areas, and also comparing the degree of infestation in Buddhist and Muslim households.

**Materials and Methods**

**Data collection**

A questionnaire survey was conducted in Nakhon Si Thammarat province (located 8° 32’ 16.5” N latitude and 99° 56’ 50.7” E longitude) in April-May 2004 covering two different topographical areas (i.e. seaside and forest covered mountainous areas which is drained by a large number of small rivers in the Gulf of Thailand) and two religious communities (i.e. Buddhists and Muslims). Samples were collected in households from all communities in 31 sub-districts using the stratified simple random sampling. Topography and religious communities were assigned as strata. One person in the assigned household was identified as a sample unit. There were 100 Buddhist and 100 Muslim households in the seaside area, and 100 Buddhist and 100 Muslim households in the mountainous area.
Entomological studies

Larval surveys were conducted in the study area using a fishnet. All larvae breeding in very small containers were emptied through the fishnet. Larger containers were sampled by dipping the net in the water, starting at the top of the container and continuing to the bottom in a swirling motion that sampled all edges of the container\(^\text{17}\). Mosquito larvae were placed in plastic bags and transported to laboratory for identification up to species level using Rattanarithikul and Panthusiri\(^\text{18}\) keys.

Three larval indices: House Index (HI), Container Index (CI) and Breteau Index (BI) were worked out as per standard WHO guidelines. Breeding places were sampled both indoors and outdoors within 15 m of the houses\(^\text{3,19}\). The water jars were classified into two categories: small water jars (<500 L) and large water jars (≥500 L).

Statistical analysis

All variables were tested for normality using the Komogorov-Smirnov test and transformed when necessary. The equality of variances was evaluated using Levene’s test. Descriptive statistics of the data were analysed. The numbers of mosquito larvae in different water containers were compared using independent sampled t-tests. The number of mosquito larvae, the number of Aedes larvae and the number of positive containers in the two locations, the two communities and their interactions were analysed using a two-way ANOVA. The larval indices were compared using Chi-square tests. The number of water containers per household in the two locations and the two communities were compared using the Mann-Whitney U-test. All significant tests were two-tailed.

Results and Discussions

Larval abundance indices

CI was not different in the two locations and in the two communities and there was no interaction between the locations and the religious communities (Chi-square: Location: \(\chi^2 = 0.18\), ns; Religious community: \(\chi^2 = 0.18\), ns; Location x Religious community interaction: \(\chi^2 = 0.22\), ns, Figure 2 a, b). HI was different between Buddhist and Muslim households (Chi-square: Religious community: \(\chi^2 = 4.06\), \(P < 0.05\), Figure 2 b) but HI was not different between the seaside and mountainous areas and there was no interaction between the locations and religious communities (Chi-square: Location: \(\chi^2 = 2.53\), ns; Location x Religious community interaction: \(\chi^2 = 2.44\), ns, Figure 2 a, b). BI was not different between the two locations and the two religious communities but there was interaction between the locations and the religious communities (Chi-square: Location: \(\chi^2 = 0.36\), ns; Religious community: \(\chi^2 = 0.23\), ns; Location x Religious community interaction: \(\chi^2 = 4.68\), \(P < 0.05\), Figure 2 a, b).

The National Institute of Communicable Diseases\(^\text{20}\) defined high risk of DHF transmission when BI was ≥50, HI ≥10, and low risk of transmission when BI was ≤5, HI was ≤1. All larval indices from our study indicated high risk of DHF transmission in both locations and communities. Other studies on DHF in Thailand have shown similar trends\(^\text{1,3}\). We found that HI in Muslim households was more than in Buddhist households (Chi-square test: \(\chi^2 = 4.06\), \(P < 0.05\)). However, a study by Luemoh et al.\(^\text{1}\) reported that HI in Buddhist households was 81.2 whereas in Muslim households HI was 0. There was some interaction between location and religious community in BI. We found that Buddhist households in the seaside area had higher BI.
than the Muslim households. On the other hand, Muslim households in the mountainous area had higher BI than in Buddhist households.

**Mosquito larvae**

We collected a total of 4001 mosquito larvae from all containers. 33.6% of containers were infested with *Ae. aegypti*, 13.6% infested with *Ae. albopictus*, and 32.8% infested with both species. *Ae. albopictus* larvae were found in higher numbers in the seaside area (X±S.D. = 1.39±5.17) than in the mountainous area (X±S.D. = 0.84±3.38) (Mann-Whitney U test, U=17 618.50, n₁=n₂ =197, P<0.001).

There were higher numbers of *Ae. aegypti* larvae in water containers in bathrooms and concrete tanks than the number of *Ae. albopictus* larvae (Table 1). There were no differences in the number of *Ae. albopictus* and *Ae. aegypti* larvae found in pot plants, animal pans, tyres and small water jars (Table 1).

<table>
<thead>
<tr>
<th>Type of water containers</th>
<th><em>Ae. aegypti</em></th>
<th><em>Ae. albopictus</em></th>
<th>Statistical test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water containers in bathrooms</td>
<td>0.3±1.8</td>
<td>0.0±0.1</td>
<td>t_{319}=2.439*</td>
</tr>
<tr>
<td>Concrete tanks</td>
<td>0.9±3.0</td>
<td>0.0±0.2</td>
<td>t_{55}=2.091*</td>
</tr>
<tr>
<td>Potted plants</td>
<td>0.2±0.8</td>
<td>0.4±2.0</td>
<td>t_{56}=0.422</td>
</tr>
<tr>
<td>Animal pans</td>
<td>0.1±0.5</td>
<td>0.1±0.4</td>
<td>t_{102}=0.429</td>
</tr>
<tr>
<td>Small water jars</td>
<td>0.5±2.4</td>
<td>0.7±5.8</td>
<td>t_{388}=-0.523</td>
</tr>
<tr>
<td>Large water jars</td>
<td>1.3±5.6</td>
<td>0.4±3.7</td>
<td>t_{257}=1.642</td>
</tr>
<tr>
<td>Natural containers</td>
<td>0.0±0.1</td>
<td>0.0±0.1</td>
<td>t_{240}=0.000</td>
</tr>
</tbody>
</table>
Table 2. The mean (±S.D.) number of mosquito larvae, the number of Aedes larvae and the number of positive containers in different locations in Buddhist and Muslim households (*P<0.05)

<table>
<thead>
<tr>
<th>No. of</th>
<th>Seaside area</th>
<th>Mountainous area</th>
<th>Statistical tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Buddhist</td>
<td>Muslim</td>
<td>Location</td>
</tr>
<tr>
<td>Mosquito larvae</td>
<td>11.85±56.92</td>
<td>10.40±33.00</td>
<td>10.38±27.94</td>
</tr>
<tr>
<td>Aedes larvae</td>
<td>0.45±2.19</td>
<td>2.45±6.98</td>
<td>2.75±11.16</td>
</tr>
<tr>
<td>Positive containers</td>
<td>4.67±8.07</td>
<td>2.15±1.01</td>
<td>2.76±1.81</td>
</tr>
</tbody>
</table>

Water containers

The numbers of mosquito larvae, Aedes larvae and positive containers were not different between seaside and mountainous areas, or between Buddhist and Muslim households (Table 2). However, there was some interaction in the number of Aedes larvae between location and religious community (Table 2). 

Number of water containers per household

Buddhist households had a higher number of water containers in the bathrooms, pot plants, large water jars and indoor containers but a lower number of artificial outdoor containers than Muslim households (Table 3). In the seaside area, there were higher numbers of water containers in the bathrooms per house and large water jars but a lower number of small water jars than in the mountainous area (Table 3). This suggests that the people who live in the seaside area use large water jars for water storage. We found a higher number of small water jars in the mountainous area as the people who live there use small water jars for pickling vegetables. Animal pans did not differ significantly between the two locations and the two religious communities (Table 3). Our results confirmed the findings of Thavara et al.[3] that water storage jars and concrete tanks in bathrooms were the main breeding sites of Aedes larvae. However, Thavara et al.[3] did not distinguish between Ae. aegypti and Ae. albopictus larvae in their study.

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Table 3. Mean (± S.D.) number of water containers per household

Mann-Whitney U test, n₁, n₂ represent sample sizes, n₁=n₂=200 households
Indoor containers comprise of cabinet/table bottom plate, pot water plant and freezer/refrigerator
Artificial outdoor containers comprise of used can, plastic bottle, old car, old boat and drum
(*P<0.05, **P<0.01, *** P<0.001)

<table>
<thead>
<tr>
<th>Type of water container</th>
<th>Seaside area</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Buddhist</td>
<td>Muslim</td>
<td>Buddhist</td>
<td>Muslim</td>
<td>Location</td>
<td>Religious communities</td>
</tr>
<tr>
<td>Water containers in bathrooms</td>
<td>1.50±0.64</td>
<td>1.29±0.81</td>
<td>1.43±0.73</td>
<td>1.00±0.83</td>
<td>U=17760.5*</td>
<td>U=15655.0***</td>
</tr>
<tr>
<td>Pot plants</td>
<td>0.23±0.65</td>
<td>0.02±0.14</td>
<td>0.11±0.31</td>
<td>0.07±0.29</td>
<td>U=19952.0</td>
<td>U=18284.0**</td>
</tr>
<tr>
<td>Small water jars</td>
<td>1.24±2.45</td>
<td>1.08±2.13</td>
<td>1.05±1.40</td>
<td>1.34±1.57</td>
<td>U=17734.5*</td>
<td>U=19542.5</td>
</tr>
<tr>
<td>Large water jars</td>
<td>1.83±3.35</td>
<td>1.77±3.29</td>
<td>0.99±1.21</td>
<td>0.58±1.31</td>
<td>U=17459.5*</td>
<td>U=17391.5*</td>
</tr>
<tr>
<td>Indoor containers</td>
<td>3.13±2.20</td>
<td>2.44±2.01</td>
<td>3.39±2.17</td>
<td>2.23±2.01</td>
<td>U=19938.5</td>
<td>U=14686.5***</td>
</tr>
<tr>
<td>Artificial outdoor containers</td>
<td>0.46±2.67</td>
<td>3.67±9.65</td>
<td>0.63±2.69</td>
<td>1.62±5.14</td>
<td>U=19720.0</td>
<td>U=17556.5***</td>
</tr>
<tr>
<td>Animal pans</td>
<td>0.30±0.93</td>
<td>0.25±0.67</td>
<td>0.16±0.55</td>
<td>0.34±0.84</td>
<td>U=19982.0</td>
<td>U=19007.5</td>
</tr>
</tbody>
</table>

References


