Breeding Sites of *Aedes* Species Mosquito in Mandaue City, Cebu, Philippines

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**ABSTRACT**

A survey on the breeding sites of *Aedes* species mosquito in Mandaue City, Cebu, Philippines, was conducted for the development of an integrated community-based dengue control program. The study included the identification of *Aedes* species breeding sites and an interview of households on their practices towards dengue prevention. Villages of six Barangays (lowest level of formal local administration) with the highest and lowest dengue incidences based on 2013 to August 2014 record of City Health Office were sampled for the study. Barangays with the highest dengue incidences include Banilad, Canduman and Subangdako, while the three remaining Barangays with the lowest number of dengue incidences include Casili, Tingub and Opao. Twenty households were purposively chosen per Barangay. A total of 219 breeding sites were identified and infested with mosquito larvae. Of the 219 breeding sites surveyed, 110 were infested with mosquito larvae comprising *Ae. aegypti* (92.86%) and *Ae. albopictus* (7.14%) in Barangays with high dengue incidences. One hundred nine breeding sites from Barangays located in areas with lowest dengue incidences were infested with *Ae. aegypti* (81.82%) and *Ae. albopictus* (18.18%). Of the 219 breeding sites surveyed, barrels/drums had the highest infestation rate of larvae amounting to 43.64% and 61.47% in both Barangays with high and low dengue incidences. In sun-exposed containers (outdoor), 87.27% were identified in Barangays with high dengue incidences and 91.74% from low dengue incidences areas. The presence of higher number of mosquito breeding sites that were infested with larvae was not correlated to the dengue incidences in both areas.

**Keywords:** *Aedes aegypti, Aedes albopictus, dengue incidences, breeding sites, Mandaue City, Cebu Philippines*

**INTRODUCTION**

Mosquitoes are tiny two-winged insects belonging to Family Culicidae, Order Diptera that are widely distributed across the globe which mostly occur in tropical countries of Asia, Oceania, Africa and the Americas (Amin *et al.*, 2000; Wichmann *et al.*, 2003 and Jacobs, 2006) There are over 3,500 species (Reiter, 2001) of mosquitoes so far identified, about 1,000 are considered vectors of disease-causing pathogens. Their ability to carry viruses and other disease-causing pathogens caused a variety of health problems and even deaths such as malaria, dengue, yellow fever, West Nile fever, encephalitis, lymphatic filariasis and chikungunya. Of the 60 species dangerous to man, two, *Aedes aegypti*, the primary and *Aedes albopictus*, the secondary vectors are known vectors of dengue viruses with the former as the primary vector and the latter as the secondary vector.

With an estimated 3.6 billion people in more than 124 countries...
infected annually by dengue viruses causing Dengue Fever (DF), and Dengue Hemorrhagic Fever (DHF) the world population is at risk. Clinical studies recorded annual cases, of 100 million and 250,000 dengue hemorrhagic fever around the world (Yamada et al., 2000) resulting to 20,000 deaths (Dash et al., 2012; Khormi et al., 2012). According to the current estimates of World Health Organization in 2014 half a million people are being hospitalized annually and about 2.5 % died majority of whom are children.

In South-East Asia and the Western Pacific Regions around 1.8 billion are at risk with increasing epidemic frequencies and number of cases as well as spatial distribution of mosquito vectors. Dengue infections are rapidly spreading in areas and these heavily influenced the socio economic development of the affected countries, families and individual patients.

In the Philippines, dengue is one of the eight leading infectious diseases (DOH, 2010) and the country is in the list of “high risk” zones of dengue (Mahilum, 2005) with major dengue epidemics recorded in 1966, 1983, 1998 and 2001. The 1998 epidemic marked the country as the worst in history with 35,648 cases and 514 deaths. As a high risk zone, the Department of Health launched the National Dengue Prevention and Control Programme with Central Visayas and National Capital Region as pilot sites mobilizing community-based prevention and control epidemic areas.

In 2011 the country ranks first among the member states of WHO Western Pacific Region in recorded dengue cases with 25,975 cases and 654 fatalities (Arima et al., 2013). In 2013 from January to September, dengue cases reported was 148,279 but decreased to 59,943 or 59.57% in 2014 in the same period according to the National Epidemiology Center of the Philippines. In Central Visayas reported a total of 2,479 cases with 10 deaths (CFR-0.4%). This is reported from the different disease reporting units (DRUs) between January and September 2014. The cases were 79.7% lower compared to the same period of the previous year having 12,233 cases with 41 deaths (CFR-0.3% (RESU-7, 2014). Meanwhile Mandaue City which is one of the hot list city in Central Visayas, recorded 458 cases with one death for the year 2013 from January 2014, there were 87 cases with 1 death (Mandaue City Health Office, 2014).

Since there is no specific treatment and vaccine yet for dengue infection at present, the best way is to focus on control and prevention (WHO, 2014). So far the most effective prevention and control on DENV transmission (Halstead, 1980) is to combat the vector (A. aegypti and A. albopictus).
This can be achieved through public education and community participation in clean up drive programs. The first step of any prevention and control program is getting to know where these two mosquito vectors breed, hence, this study.

METHODOLOGY

The study site is Mandaue City, Cebu, Philippines, (Figure 1). It is located on the central coastal plains of Cebu Province, predominantly a lowland area and extremely flat about 77.37% within the 0-8% slope category. It is located at coordinates of 10°20′N 123°56′E, bordering on the north by the Municipality of Consolacion, on the east by the Mactan Channel, on the southwest by Barangay Banilad (Cebu City), on the northwest by Barangay Talamban (Cebu City), and on the south by Cebu North Reclamation. It has land area of 3,487 hectares comprising 27 Barangays, all of which are classified as urban (United Nations Environment Programme [UNEP] 2009). The city is classified as a highly urbanized and industrialized city (City Planning and Development Office [CPDO] 2014) which is home to about 10,000 industrial and commercial establishments. It is strategically located in between the two major cities, Cebu City and Lapu-Lapu City.

Based on the 2010 Census of Population and Housing (CPH), Mandaue City posted a total population of 331,320 persons as of May 1, 2010 (Philippine Statistics Authority [PSA] 2013). From 1960 to 2010, the city experienced a rapid growth of population. For the period of 50 years, the population increased for almost 11 times making the city as a highly urbanized city in the early nineties. In the year 2013, the city reported a total of 458 dengue cases with 1 death. The top 3 Barangays with the highest incidences are: Banilad, Canduman and Subangdaku (Table 1), while those with the lowest incidences are: Casili, Tingub and Opao (Table 2).
Table 1. Top 3 Barangays in Mandaue City with the Highest Recorded Dengue Incidence, January 2013 to August 30, 2014

<table>
<thead>
<tr>
<th>Barangay</th>
<th>January to December 2013</th>
<th>January to August 30, 2014</th>
<th>Total Number of Dengue Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banilad</td>
<td>40</td>
<td>11</td>
<td>51</td>
</tr>
<tr>
<td>Canduman</td>
<td>32</td>
<td>13</td>
<td>45</td>
</tr>
<tr>
<td>Subangdako</td>
<td>37</td>
<td>6</td>
<td>43</td>
</tr>
</tbody>
</table>

Table 2. Top 3 Barangays in Mandaue City with the Lowest Recorded Dengue Incidence, January 2013 to August 30, 2014.

<table>
<thead>
<tr>
<th>Barangay</th>
<th>January to December 2013</th>
<th>January to August 30, 2014</th>
<th>Total Number of Dengue Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casili</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Tingub</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Opao</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

Twenty randomly selected households with breeding sites infested with mosquito larvae were interviewed as to their practices in dengue prevention. The housewife was the preferred main source of information.

A purposive sampling design was used throughout the survey conducted in the top 3 Barangays with the highest number of dengue incidences and the 3 Barangays with the lowest number of dengue incidences (Table 1 and 2). Twenty households per Barangay were interviewed, preferably the mother. During the households survey, the identification of breeding sites by ocular observation and listing any containers that holds water, both indoor and outdoor location that was infested with mosquito larvae was done. The number of larvae in each breeding site was estimated accordingly. Five samples of larvae were taken from each Barangay and 3 larvae of 4th instar in each sample were identified in the laboratory by using the taxonomic key of Becker et al., (2003). Sterescope was used during the identification.

The survey questionnaire was designed to collect data on people’s practices in dengue prevention and control in all the infested breeding sites found in each household. Data on dengue incidences from January 2013 to August 2014 were taken from the Mandaue City Health Office to determine the top three (3) barangays with the highest and lowest dengue incidences (Table 1 and 2) respectively. Prior to the conduct of the actual interviews in each barangay, a letter asking permission to conduct interviews in their barangays with the assistance of the barangay health workers was sent to each of the six barangay captains. After given the permission, interviews with the selected households proceeded as well as the systematic search for the presence of water holding containers or storage both indoor and outdoor. Also noted was the condition of each breeding site, whether, covered or not and the number of larvae in each infested breeding site were counted.

All water containers positive with larvae were listed according to the breeding site category given below;

1. 1-20L-water containers
2. 20-50L-water containers
3. Barrels/drums
4. Discarded tires
5. Flower pots tin cans/plastics and other breeding sites.

Infested breeding sites were examined and the larval counts were estimated based on the following category;

- **1-10** larvae = (+ -)
- **11-25** larvae = (+)
- **26-50** larvae = (+++)
- **50** above larvae = (+++)
Five samples were collected from each of the six barangays. Third (3rd) and fourth (4th) instar larvae were collected by a water dipper and placed in glass bottles with water from its breeding site. For taxonomic identification, only the 4th instar larvae were collected.

RESULTS AND DISCUSSIONS

Infested breeding sites that were found in the study area were categorized into 7 types, namely: water container up to 20L, water container 21L to 50L, barrels/drums, discarded tires, flower pots, tin cans/plastics and other breeding sites. Other breeding sites include empty bottles, discarded aquarium, tub, ice bucket or coolers, rubber made storage, earthen pots or jar, pit or catch basin and roof gutters (Figure 2).

![Figure 2. Larval Counts in High and Low Dengue Incidence Area](image_url)

In the three barangays with the highest number of dengue incidence, barrels or drums were the most abundant breeding sites having a frequency of 43.64% followed by the water containers at 20.91% (n=23); other breeding sites at 14.55% (n=16); water container 21L to 50L at 13.64% (n=15); tin cans/plastics at 4.55% (n=5); discarded tires at 1.82% (n=2) and lastly, the flower pots that had the lowest number at 0.91% (n=1). Respondents on this area practiced storing water and they were used to store in large size containers that have a water capacity of more than 100 liters.

From the area with the lowest number of dengue incidences, barrel/drums were the top breeding sites having a frequency of 61.47% (n=67), then followed by water container up to 20L at 14.68% (n=16), other breeding sites at 10.09% (n=11), discarded tires at 6.42% (n=7), tin cans/plastics at 3.67% (n=4), water container 21L to 50L at 2.75% (n=3) and lastly, flower pots that had the lowest number at 0.92% (n=1). Households in this area also used large size containers for water storage.
Based on the result of this study, it was found out that a water storage used had a capacity of 50 to 200 liters. These are the barrel/drum in which both areas had the highest frequency counts. The dominance of barrels/drums in this study was in line with the result of the study conducted by Edillo et al., (2012) in Cebu City where residents used to store water in the large size container than the smaller size. Similarly, in Muntinlupa, the study of Cruz et al., (2008) revealed that drums are one of the major breeding habitats. This can be attributed to the presence of large amount of water that the container can hold or the volume of water which offers a good site for breeding. According to Vivas and Falconar (2005) and Lin et al., (2009) mosquito vector is productive in large containers. The study by Phong and Nam (1999) in Vietnam; Chadee (2004) and Brown et al., (2004) in Trinidad and Tobago also support the results of this study. However, the study of Abdalmagid and Alhusein (2008) from Sudan entomological survey stated that the highest number of breeding sites was found in pots.

During the interview, households purposively use the bigger size containers for rain water collection and for water reserve from the main source, the Metropolitan Cebu Water District (MCWD). It is being utilized for general purposes like cleaning, washing, watering of plants, flushing for toilet, animal bath and incase for fire incidents. This method of water collection offers various advantages which are mainly to save money for water bills and direct availability whenever there will be a water service disruption. These findings are similar with the study of Schapia et al., (2012) in Albay Province where people use drums for rain water collection. Interestingly, the area with the lowest dengue incidences recorded also the highest number of large-size containers which are the barrels/drums which accounts to 67 (61.47%) of the total breeding site category compared to the area with high dengue incidences that has only 48 (43.64%). Two of the barangays from the low dengue incident area, namely; Barangay Tingub and Barangay Casili are located far away from the city, physically hilly in land structure and got their sources of income from livestock raising and plants for landscaping. Barangay Casili is one of the two remaining barangays of Mandaue that is considered rural (CPDO 2014). The households are not that close to each other compared to the area with high dengue incidences. Owners of the said businesses are using large-size containers particularly plastic or metal drums for storing water as reserved water. The said business requires reserve water if in case the supply of water from the main source is poor or has a service disruption, purposively for cleaning purposes for livestock house, animal bath and maintenance for plants, thus the use of large size containers for storing water is being practiced. Whereas in high dengue incidence area, two of the Barangays namely: Banilad and Subangdako belong to the 5 most populous barangays in Mandaue City (CPDO 2010) and houses are close to each other. Similarly, respondents are used to storing water in large size containers over smaller one. Generally, the local community from both areas used the same water containers with respect to their sizes due to thier convenience and that they are more advantageous compared to those smaller ones. Lastly, the lowest frequency counts for both areas were observed in flower pots containers. In high dengue incidence area, flower pots are not commonly used due to the space considering that the houses are close to
each other while in low dengue incidences area some flower pots are used but usually drained.

The result of this study implies that, it is not a guarantee that a higher number of infested containers or breeding sites will result to a higher number of incidences. Considering from the low dengue incidence area, there are more large size containers found compared to the high dengue incidence area. Therefore the counts of breeding site is independent from the number of dengue cases. Even if they do have the highest frequency of large size containers it cannot be assumed that the mosquito present on the area is carrying the dengue virus. The high prevalence of infection in high dengue incidence area can increase the infection itself because the more that the infected host is susceptible to the bite of non-infected mosquito and eventually this mosquito will bite the other hosts where the dengue virus is being transferred. The result from the high dengue incidence area collaborated with the study of Reiter (2001) that a high density of carrier breeds on the stored water led to higher transmission of the virus. The statement was in contrast from the result in low dengue incidence area. Lastly, the natural habitat such as tree holes, plant leaf axils and hollow stones are good breeding sites of the mosquito which are hard to control due to accessibility reasons.

*Aedes aegypti* is the primary vector and the secondary is *Aedes albopictus*. *Aedes aegypti* species are recognized as most efficient vector because of its infestation that are closely associated with human dwellings (Raju 2003) while the *Aedes albopictus* is primarily rural. Below is the table presentation of the *Aedes* species found in the study area (Table 3).

<table>
<thead>
<tr>
<th>Study Area</th>
<th>Ae. aegypti</th>
<th>Ae. Albopictus</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Dengue Incidence Area</td>
<td>39 (92.86%)</td>
<td>3 (7.14%)</td>
<td>42</td>
</tr>
<tr>
<td>Low Dengue Incidence Area</td>
<td>36 (81.82%)</td>
<td>8 (18.18%)</td>
<td>44</td>
</tr>
</tbody>
</table>

Given in Table 3 are the percentage of the primary and the secondary vector of dengue virus found in the breeding sites from the study area. The result revealed that *Ae. aegypti* which is the primary vector infested both areas of which 92.86% from high dengue incidence area and 81.82% from low dengue incidence area. *Ae. albopictus* as the secondary vector infested both areas but has the lower percentage compared to *Ae. aegypti*. This was supported by the study of Chen et al., (1994) that the use of containers for water storage was one of the good habitat of *Aedes* species.

Since the vector is distributed to both areas, it implies that even if the certain location has more breeding sites or less breeding sites, as long as the primary and secondary vector is present, it cannot be concluded that a certain location can be equated to its breeding sites from the dengue incidence. Several factors could be a reason behind the prevalence of dengue infection in the
area. One example is the natural habitat of the mosquitoes that produce a density of population which is hard to control due to its accessibility in carrying the virus. Normally, dengue vector will fly from one place to another to look for blood and can fly as far as 1km. This could explain that the virus might come from the adjacent area. Lastly, the isolation of the virus within the area could be attributed to the dengue infection. If the area has more infected persons, then there is a bigger chance of the mosquito to carry or transfer the virus to other individuals.

The larval counts found in the breeding sites of the six barangays showed that majority of them contained more than 50 of which 45 or 40.91% larvae were coming from the barangays with high dengue incidences and 65 or 59.63% are from the low dengue incidence barangays. Barangays with high dengue incidence had the highest number of larval infestation at 3 of the 4 breeding sites category. The breeding sites with larval counts of 11-25; 1-10 and 26-50 were higher than those in barangays with lower dengue incidence. Of the entire breeding sites category and in both high and low dengue incidence barangays, barrels and drums are consistently on top containing 50 and above larvae.

The 50 and above larval counts was more in barangays having low dengue incidences than those with high dengue incidences. This is because more number of large-sized containers were used such as barrels/drums that are able to hold larger volume of water and more space for breeding hence, a large number of larvae can live and survive. This observation was similar to that of Su et al., (2012) in Caloocan where Aedes mosquitoes were abundant in barrels and other large containers (Vivas and Falconar (2005); Lin et al., 2009).

Dengue incidence is not dependent on the larval counts present in the breeding sites and is not correlated to
the expected number dengue incidences. According to Scott and Morrison (2003) the risk of the infection within the human population cannot be accurately or effectively predicted by entomological measure as dengue scientists wanted to.

In Figures 4a and 4b are the breeding sites locations for high and low dengue incidence barangays. The top three most used are barrels/drums (44), next are 1-20L containers (19) and other breeding sites at 11 containers respectively.

**Figure 4a.** Location of the Breeding Sites in High Dengue Incidence Area

**Figure 4b.** Location of the Breeding Sites in Low Dengue Incidence Area

Households of the six barangays preferred to place the large-sized containers outdoor as they occupy bigger space and usually below the roof gutter for collecting rainwater. Respondents also revealed that change of water to large containers is done only when water supply is abundant like during rainfall otherwise they remain in the same locations. In this the same practice was observed by Zaw et al. (2012) in Lahore Pakistan where most of the rainwater are stored outdoor. With these
findings where majority of the breeding sites in all six barangays were located outdoor, households are providing conducive breeding sites which *A. aegypti* vector preferred due to the availability of sunlight needed for faster larval growth.

The results in this study is similar to that of Shapira *et al.* (2012) where the pupae were mainly found outdoor. Although the pupa was excluded in this study, eventually the larva will become a pupa. In contrast Chan *et al.* (1971) claimed that in their study majority of the *A. aegypti* were bred indoor. Overall results herein implies that more breeding sites located outdoor could produce more mosquito vectors but still could not be the basis of predicting the number of incidence in the area.

CONCLUSION AND RECOMMENDATIONS

The findings of this study showed that the frequency of the breeding sites regardless of the larval counts, is not directly correlated with the number of dengue incidence in an area. Whether the breeding site is located indoor or outdoor, open or covered, these are not sufficient predictors of risks of dengue infection on human populations. Since at present the dengue vectors, *A. aegypti* and *A. albopictus* cannot be eradicated, one of the best practices is to remove the breeding sites to reduce their population. Storing water in various containers usually practiced by residents in barangays with both high and low dengue incidence is bad because it provides good breeding sites of the mosquito vectors that can result to a higher chance of transmitting dengue virus. Other factors that can affect the dynamics of the infection such as natural habitat of the carriers which is hard to control like plant axels or tree holes should be considered. Most mosquitoes are able to fly at a distance of almost 1 km looking for blood so the chance of mosquitoes carrying the dengue virus from the infected mosquito from other places is higher. Also the isolation of the virus within the area could increase the potential of a dengue incidence in an area.

The researchers recommended the following:

1. Residents of the barangays with both high and low dengue incidences shall continue the practice of using large-sized containers for cleaning, and shall raise their awareness on the proper handling of all water type containers like covering them properly.
2. The Barangay health officials and concern agencies shall properly implement the appropriate use of larvicide as a means of preventing and controlling the spread of mosquito vectors in their community.

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