Medically Important Mosquitoes (Diptera: Culicidae) Identified in Rural Barangay Binubusan, Lian, Batangas Province, Philippines

Anna Theresa A. Santiago and Florencia G. Claveria

1Department of Biology, College of Arts and Sciences, University of the Philippines Manila, Padre Faura St., Manila, Philippines
2Biology Department, College of Science, De La Salle University, Taft Avenue, Manila, Philippines
3Center for Natural Science and Ecological Research, College of Science, De La Salle University-Manila, Taft Avenue, Manila, Philippines

Larval mosquito collection was performed in Barangay Binubusan, Lian Municipality, Batangas Province during the last quarter of 2008 from October to December to determine the mosquito populations present in the area. Mosquito larvae were collected from various habitats, namely: rice paddy, sunny pond, open residential canal, shaded pond, and abandoned tire. A dichotomous key was devised for the identification of local mosquito fauna. A total of 1,128 mosquito larvae were collected during the study period, comprising 958 (84.93%) Culex, 125 (11.08%) Aedes, and 45 (3.99%) Anopheles. The highest larval collection was recorded in November consisting of 100% Culex spp. Five Culex species were identified: Culex quinquefasciatus (51.86%), Culex vishnui (14.0%), Culex tritaeniorhynchus (9.84%), Culex whitmorei (8.78%) and the first reported presence of Culex mimeticus (0.53%) in the country. Aedes species were represented by Aedes vexans (5.94%), Aedes aegypti (4.34%), and Aedes niveus (0.80%). Anopheline mosquitoes were represented only by Anopheles flavidrostris (3.99%). Of the species identified, only Ae. aegypti and An. flavidrostris have been documented of public health importance in the country.

Key Words: Aedes aegypti, Anopheles flavidrostris, Culex quinquefasciatus, dichotomous key

INTRODUCTION

A total of 279 species, subspecies, and varieties of mosquitoes are known to be present in the Philippines including members which are considered vectors of viral and parasitic infections of public health importance (Cagampang-Ramos et al. 1985). The archipelagic nature of the Philippines and the varied geophysical conditions of the country’s major islands contribute to mosquito diversity and distribution. Certain species of mosquito have preferential breeding habitats that provide optimum conditions for proliferation, thereby establishing the endemcity of the diseases that these mosquitoes transmit. With the inevitability of climate change brought about by human activities, mosquito-borne diseases are expected to be redistributed to formerly non-endemic regions (Dhiman et al. 2008; Hales et al. 2002; Epstein et al. 1998). Vector control through mosquito surveillance and vector ecology studies are considered significant tools in the reduction of morbidities and mortalities due to major vector-borne diseases such as, malaria, filariasis, and dengue (Overgaard 2007; Santiago & Claveria 2008). Targeted mosquito surveillance in identified breeding sites are ideal for preventing mosquito-borne diseases which

*Corresponding author: claveriaf@dlsu.edu.ph
are mostly arboviral in nature, especially in cases where transmission foci are sporadic and mosquito infection rates may be low (Gu et al. 2008).

Species identification through larval chaetotaxy is a fundamental component of larval surveillance (Harrison & Rattanarithikul 1973). Although the need to produce a comprehensive larval identification key for the Philippines is necessary, the construction of area-specific identification keys is equally valuable since mosquito species are geographically isolated in each of the major Philippine islands. The present study provides information on the richness and comparative morphology of larval mosquitoes collected from various habitats in Binubusan, Lian Municipality, Batangas Province, Philippines.

MATERIALS AND METHODS

Study site
Batangas Province is under the Philippine political Region 4A, which is at the southwestern rim of Luzon. It is composed of 20 cities and 14 municipalities that rely on fishing, shipping, oil refineries, natural gas processing, and tourism for economic development (Provincial Government of Batangas Philippines 2008). Based on recent Field Health Services Information System report of the Department of Health (2006 and 2007), dengue and malaria were recorded among the top 10 causes of morbidity in the region. In 2006, Batangas reported a single case of filariasis in a male 50 to 64 years of age. This is an implicit indication of the presence of mosquito vectors in the province. The coastal municipality of Lian, Batangas is a 3rd class, partially urban municipality where five out of 19 barangays are classified as urban. Among the rural barangays of Lian is Binubusan, which has a recorded a population of 4,144 as of the August 2007 census (National Statistical Coordination Board 2008) and served as the main study site.

Field collection of larval mosquitoes
Bodies of water were inspected and five larval breeding sites were identified. Larval mosquitoes were collected from a rice paddy (N13°57'57.3",E120°37'37.2"), sunny pond (N13°57'44.8",E120°38'25.6"), open residential canal (N13°57'42.8",E120°38'16.1"), shaded pond (N13°58'44.8",E120°37'51.0"), and abandoned tire (N13°58'44.9",E120°37'50.9") (Figure 1). Sample breeding sites were limited to open areas and possible larval breeding areas inside residential areas were not inspected. The breeding areas were inspected and larval collection was carried out twice during the last two weeks of each month from October to December 2008. All five sites were sampled for October, while November and December collections were limited to the open residential canal and rice paddy since the shaded pond and sunny pond were dried.

Figure 1. Larval mosquito collection habitats: (A) rice paddy, (B) sunny pond, (C) shaded pond, (D) abandoned tire, and (E) open residential canal, in Barangay Binubusan, Municipality of Lian, Batangas Province, Philippines, 2008.
out from November to December. The abandoned tire was removed from the site by locals by November.

A modified version of Belkin’s standard dipping method (Service 1993) was used. The approximate surface area of a sampling habitat was measured in square meters (m2) and the position was determined through a handheld Garmin etREx GPS receiver for future monitoring and validation. Water collected from each dip was poured onto a white pan where mosquito larvae were collected using a disposable plastic Pasteur pipette, and transferred into labeled screw cap specimen containers. The total number of larvae collected from each sampled habitat was recorded. Collected larvae were killed in hot water and preserved in 70% ethanol for laboratory identification.

Larval mosquito identification
Mosquitoes were identified up to the species level through microscopic observation of the morphology of terminal abdominal segments, antennae and clypeal hairs of 3rd-4th instars. The larval identification keys of the Walter Reed Biosystematics Unit online pictorial key on Lucid3 platform (2009), Rueda (2004), Reuben et al. (1994), and Baisas and Dowell (1967) were used. A dichotomous key was devised to describe all identified larvae in the study.

RESULTS
A total of 1,128 mosquito larvae were collected during the study period, comprising 958 (84.93%) Culex, 125 (11.08%) Aedes, and 45 (3.99%) Anopheles. The highest larval collection was recorded in November consisting of 100% Culex spp. Only Anopheles flavirostris (3.99%) larvae represented the anopheline mosquitoes (Figure 2). Three Aedes species were identified: 67 (5.94%) Ae. vexans, 49 (4.34%) Ae. aegypti, and 9 (0.80%) Ae. niveus larvae (Figs. 2C, 3A &B).

Five Culex species were identified: 585 (51.86%) C. quinquefasciatus, 157 (13.92%) C. vishnui, 111(9.84%) C. tritaeniorhynchus, 99 (8.78%) C. whitmorei, and 6 (0.53%) C. mimeticus (Figures 2B &3C & Figure 4).

Among all the breeding habitats surveyed, the rice paddy and the shaded pond were the richest in terms of mosquito species present since Culex, Anopheles, and Aedes were collected in these areas (Table 1). The dominance of genus Culex is evident with C. vishnui considered to be the most widely distributed, as it inhabited the rice paddy, open residential canal, and shaded pond. The abandoned tire was inhabited only by C. whitmorei. The following identification or dichotomous key was devised to describe the larvae collected (3rd - 4th instar) in the study (Figures 2-4).

1: Siphon at 8th abdominal segment present; ventral palmate hairs absent........................................2
   Siphon at 8th abdominal segment absent; ventral palmate hairs present ........................................3

2: Siphon with several hairs or hair tufts .................4
   Siphon with a single hair or hair tuft .................5

3: Inner clypeal hairs simple and widely separated; large tergal plates; antepalmate hairs on abdominal segment VII simple or branched apically; leaflets of thoracic palmate extended into long points ..


Figure 2. Identified mosquito larvae: (A) Anopheles flavirostris showing ventral palmate hair (v); (B) Culex tritaeniorhynchus siphon with weak hair tufts (arrows); and (C) Aedes aegypti lateral view of comb scales.
Inner clypeal hairs simple and widely separated; large tergal plates; antepalmate hairs on abdominal segment VII branched near the base; leaflets of thoracic palmate taper into short blunt points ...

......................Anopheles flavirostris

4: Siphon hairs or hair tufts are ct ..................6 Siphon with weak hairs or hair tufts of 2-5 branches; air tube 6 or more times as long as wide; comb scales are rounded at the tip ......................

......................Culex tritaeniorhynchus

5: Antennae spiculate; air tube with acus.............7 Antennae smooth; air tube without acus; comb scales in a single row; comb scales with lateral spines; ventral brush (seta 4-X) branched..........

Aedes aegypti

6: Siphon length is <5 times of width...............8 Siphon length is >5 times of width ...............9

Santiago ATA and Claveria FG: Medically Important Mosquitoes Identified in Lian, Batangas, Philippines.

Figure 3. Siphons of (A) Aedes niveus showing acus (a) and pecten teeth (p); (B) Aedes vexans; and (C) Culex quinquefasciatus.

Figure 4. Siphons of (A) Culex mimeticus; (B) Culex vishnui; and (C) Culex whitmorei.

Table 1. Larval mosquito species distribution according to breeding habitat in Binubusan, Municipality of Lian, Batangas Province, Philippines, 2008.

<table>
<thead>
<tr>
<th>Mosquito Species</th>
<th>Rice Paddy</th>
<th>Open Residential Canal</th>
<th>Shaded Pond</th>
<th>Sunny Pond</th>
<th>Abandoned Tire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aedes aegypti</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aedes niveus</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aedes vexans</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anopheles flavirostris</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culex mimeticus</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culex quinquefasciatus</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culex tritaeniorhynchus</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culex vishnui</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culex whitmorei</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DISCUSSION

Compared to the 279 known mosquito species that thrive in the country, only nine species were identified in the breeding sites during the study period. *Aedes aegypti, Ae. vexans, An. flavirostris, C. quinquefasciatus, C. tritaeniorhynchus, and C. vishnui* are widespread in the country, while *Ae. niveus* and *C. whitemorei* are mainly distributed in Luzon (Rozeboom & Cabrera 1964; Cagampang-Ramos et al. 1985). While *C. mimeticus* is prevalent in neighboring Southeast Asian countries, Japan, Korea, China, Hong Kong, and Taiwan (Sirivanakarn 1976; Reuben et al. 1994), its existence in the country has not been reported, until this study.

Among the species identified in the current study, *Ae. aegypti* and *An. flavirostris* are of medical importance in the country. *Aedes aegypti* has been reported as the principal vector of dengue fever (Lian et al. 2006; Mahilum et al. 2005; Cruz et al. 2008). Of the 489 breeding sites in Cebu City, the discarded tires registered the highest breeding site (69.4%) of *Ae. aegypti* (Mahilum et al. 2005). Interestingly the *Ae. aegypti* larvae collected in the study were picked from the open residential canal, and none were recovered from the sample tire. In other countries, other than dengue, *Ae. aegypti* transmits urban yellow fever (Vezzani and Schweigmann 2002; Dhang et al. 2005). In urban areas *Ae. aegypti* thrives best under condition of high humidity and rainfall (Cheong 1967), and preferentially breeds in clear water in artificial containers and flourishes in close association with humans (Hales et al. 2002; Troyo et al. 2007; Seng et al. 2008).

*Anopheles flavirostris* established as the most efficient vector of malaria in the country (Rozeboom and Cabrera 1964) was found only in the rice paddy and shaded pond, consistent with findings of Baisas (1957) and Overgaard (2007).

While other *Aedes* species identified have not been reported of medical importance in the Philippines, *Ae. niveus* has been incriminated as a vector of dengue both in humans and forests canopy tree-dwelling monkeys in Malaysia (Rueda 2004), and *Ae. vexans* that preferentially feeds on large mammals and birds is a secondary vector of the West Nile virus (Tiawsiirup et al. 2008). Though there are no reports on the association of the widespread *C. quinquefasciatus, C. vishnui, and C. tritaeniorhynchus* with transmission of infectious agents in the country, these species have been incriminated as potential vectors of Japanese B encephalitis in Indonesia, Vietnam, and Japan (Reuben et al. 1994; Hasegawa et al. 2008; Stoops et al. 2008), and the West Nile virus (Zinser et al. 2004). It is noteworthy to mention that *C. quinquefasciatus* has been identified to carry the filarial worm *Wuchereria bancrofti* in the country, but is considered to have poor vector competence (Kron et al. 2000).

In summary, the species identified in Barangay Binubusan, Lian, Batangas comprise the most dominant *C. quinquefasciatus* and two medically important species, *Ae. aegypti* and *An. flavirostris*, associated with the transmission of dengue and malaria, respectively, in the country. We also recommend expanding the coverage of the survey in similar sites inhabited by *Aedes* and *Anopheles* species in other barangays of Batangas province. Current information should be useful to the programs in the municipality intended to control mosquito population so as to protect their constituents from the risk of mosquito-transmitted diseases.

REFERENCES


DHANG CC, BENJAMIN S, SARANUM, MM, FOOK CY, LIM LH, AHMAD NW, SOFIAN-AZIRUN M. 2005. Dengue vector surveillance in urban residential...


