Anopheles composition in the malaria endemic region of Gracias a Dios, La Mosquitia, Honduras: 2017 – 2018

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Honduras is currently on its way to reaching malaria elimination. In 2019, the country registered 381 total cases.

- Malaria case counts have dramatically decreased beginning in 2017 (68.9% reduction from 2016 to 2017 and 90.8% reduction from 2016 to 2019).

- Historically, the Department of Gracias a Dios (GAD) has registered the largest number of cases in the country.
  - In 2019, GAD registered 190 of the total 381 national cases.

- Indoor Residual Spraying (IRS) is the primary VC intervention in Honduras, although select departments also receive LLINs in targeted foci, including within GAD.
Historically, the three highest risk municipalities in GAD are Puerto Lempira, Villeda Morales, and Brus Laguna. These municipalities were selected as entomological sentinel sites.

GAD has unique ecological and sociological characteristics including:

- Conditions of difficult access.
- Predominantly Moskitia indigenous population that is highly mobile throughout GAD and with neighboring Nicaragua.
- Historical presence of various species of *Anopheles* and differing ecological niches.

![Malaria Cases by Locality, 2019](image)

<table>
<thead>
<tr>
<th>Municipality of Infection</th>
<th>Cases</th>
<th>Projected 2019 Population</th>
<th>Incidence, Cases per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHUAS</td>
<td>0</td>
<td>9,011</td>
<td>0.00</td>
</tr>
<tr>
<td>BRUS LAGUNA</td>
<td>3</td>
<td>14,423</td>
<td>0.21</td>
</tr>
<tr>
<td>JUAN FRANCISCO BULNES</td>
<td>5</td>
<td>6,454</td>
<td>0.77</td>
</tr>
<tr>
<td>PUERTO LEMPIRA</td>
<td>143</td>
<td>55,973</td>
<td>2.55</td>
</tr>
<tr>
<td>RAMON VILLEDA MORALES</td>
<td>39</td>
<td>10,403</td>
<td>3.75</td>
</tr>
<tr>
<td>WAMPUSIRPI</td>
<td>0</td>
<td>6,017</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Monthly entomological collections were conducted in three sentinel sites to understand vector species composition, their spatial and temporal distribution, and bionomics.

**Sentinel Sites:**
- Puerto Lempira - *Kaukira*
- Villeda Morales - *Raya*
- Brus Laguna - *Brus Laguna*

**Entomological Activities:**
- Larval sampling
- Human landing catches (HLCs)

**Collection Period:**
- October 2017-December 2018
- Monthly sampling in each site
Objective: Determine the entomological factors that drive transmission in GAD for optimization of vector control (VC) intervention implementation and to achieve malaria elimination.

<table>
<thead>
<tr>
<th>Larval Habitat Characterization</th>
<th>Human Landing Catches</th>
<th>Species Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Methods:</strong></td>
<td><strong>Methods:</strong></td>
<td><strong>Methods:</strong></td>
</tr>
<tr>
<td>• Larval habitat identification and characterization was carried out by local Environmental Health Technicians (EHTs).</td>
<td>• 1 house per sentinel site; 1 night per site; <strong>6pm-6am</strong> once a month.</td>
<td>• Morphological identification carried out for each adult and larval specimen collected.</td>
</tr>
<tr>
<td>• Temporary and permanent potential larval habitats (PLHs) were identified and georeferenced; PLH type was also was recorded.</td>
<td>• Community volunteers with supervision by EHTs; rotated volunteers indoors and outdoors every hour.</td>
<td><strong>Taxonomic Key Used:</strong></td>
</tr>
<tr>
<td>• Larval surveys were conducted for each PLH.</td>
<td><strong>Indicators Collected:</strong></td>
<td>“Compendio de claves taxónomicas de entomología para Centro América y Panamá”</td>
</tr>
<tr>
<td><strong>Indicators Collected:</strong></td>
<td>• Adult composition and distribution (occurrence, density, seasonality).</td>
<td></td>
</tr>
<tr>
<td>• Immature Vectors (larval habitat availability, larval habitat occupancy, and larval density).</td>
<td>• Adult behavior (human biting rate, biting time, and biting location).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Parity of Collected Female Adult Mosquitoes</td>
<td></td>
</tr>
</tbody>
</table>
Potential larval habitats were identified and larval surveys conducted. The majority of potential sites are characterized as temporary.

### Types of Potential Larval Habitats Identified at Each Sentinel Site

<table>
<thead>
<tr>
<th>Sentinel site</th>
<th>Status</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Permanent</td>
<td>Temporary</td>
</tr>
<tr>
<td>Kaukira</td>
<td>15</td>
<td>44</td>
</tr>
<tr>
<td>Brus Laguna</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Raya</td>
<td>9</td>
<td>53</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>44</strong></td>
<td><strong>116</strong></td>
</tr>
</tbody>
</table>

- **Main vectors** found during larval surveys included *An. albimanus* and *An. crucians*.
- Only **1 larval habitat positive** for *An. gabaldoni* during the collections.
- **72.5 %** of the identified potential larval habitats were categorized as temporary.
Human Landing Catches (HLCs) Results: Key differences in adult vector composition and distribution (occurrence, density, seasonality) can be seen across the 3 sentinel sites.

- **Brus Laguna** recorded the greatest species diversity.
- **Raya** recorded the greatest total densities of adult mosquitoes.
- **Kaukira** recorded peak densities of *An. gabaldoni* and *An. albimanus*.  

**HLCs-Brus Laguna:** 87% captured outdoors.  
**HLCs-Villeda Morales:** 60% captured outdoors.

*Graphs showing the distribution of mosquitoes across different sentinel sites.*
HLCs Results: Across all sites a total of 1,169 adult *Anopheles* mosquitoes were captured; 66.3% corresponded to *An. albimanus*, 29% to *An. gabaldoni*, 4.5% to *An. crucians*, and 0.2% belonged to other species.

**Brus Laguna** - 68% of total collected mosquitoes were *An. albimanus*

**Kaukira** - 59.6% of total collected mosquitoes were *An. gabaldoni*

**Raya** - 91% of total collected mosquitoes were *An. albimanus*
HLC Results: Adult *An. albimanus* behavior (human biting rate and biting location) was recorded as predominantly outdoor biting with peak biting occurring in the evening hours across all 3 sentinel sites.

- Peak *An. albimanus* biting activity occurred approximately between 6:00pm and 10:00pm with some variance based on sentinel site.

- 74% of all *Anopheles* spp. collected were captured outdoors.
Dissections were also conducted to understand the parity status of HLC adult female field-caught mosquitoes in the three sentinel sites in GAD. 70% of female mosquitoes captured in sentinel sites during HLCs throughout the collection period were parous.
A spray timing analysis was conducted incorporating malaria case, entomological surveillance, and precipitation data to determine when to best time IRS in Kaukira in 2019 to increase effectiveness of the intervention while also considering operational constraints.

The entomological data served as an input into the spray timing analysis for proactive IRS programming in Kaukira. Results were used to estimate an “ideal” spraying timing in 2019 (2 rounds with bendiocarb).

**SITUATION:**
The malaria program wanted to accelerate elimination efforts by transitioning from reactive to proactive IRS in Kaukira, a key approach for malaria elimination.

**CHALLENGE:**
Determining when to best time IRS given short residual effect of available insecticide (bendiocarb), and presence of *Plasmodium vivax* infections and *Anopheles* densities.

**OBSERVATIONS AND LIMITATIONS:**
- Data show peak infections occur between September and April corresponding to peak in *An. gabaldoni* densities. A secondary peak in vector densities (*An. albimanus*) occurs around June.
- Major operational limitations include difficult access to communities due to climatic patterns and rains, and short residual effect of insecticide (~3 months).

**Spray Timing Analysis Recommendation:**
- 1\(^{st}\) spray round in June 2019 timed with peak vector densities.
- 2\(^{nd}\) spray round in mid-November 2019 to provide coverage through mid-February (historic peak in cases).
Conclusions and Recommendations

Findings and Conclusions:

- Vector species composition, spatial and temporal distribution, and bionomics varied across the three sentinel sites.
- 66.3% of all mosquitoes collected across all three sites were *An. albimanus* followed by *An. gabaldoni* (29%) and *An. crucians* (4.5%), and other species (0.2%); 74% of all mosquitoes collected exhibited outdoor biting; peak biting occurred in the evening hours.
- Primary vectors collected across all three sites during larval surveys included *An. albimanus* and *An. crucians*. Only one larval habitat was positive for *An. gabaldoni*.
- Kaukira is unique because *An. gabaldoni* was the primary vector in terms of overall densities during the collection period, but also because the proportion of *An. gabaldoni* when compared to *An. albimanus* was higher during October-January (corresponding to the high transmission season).
- The baseline entomological collections from Kaukira were used to time two IRS spray rounds in 2019.

Next Steps:

- Conduct an epidemiological and entomological impact analysis for the 2019 IRS spray rounds carried out in Kaukira and determine if the timing was appropriate. Use the analysis to inform timing of the 2020 spray rounds.
- Additional studies are required to evaluate the role of each species, especially *An. gabaldoni*, in malaria transmission dynamics in GAD.
- Taxonomic identification of *An. gabaldoni* requires molecular confirmation because the key currently used in Honduras shows differences in the results of this species compared to keys used by other countries in the region.
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