PROSPECTS AND ENTOMOLOGICAL CHALLENGES FOR MALARIA ELIMINATION IN LATIN AMERICA

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Situation of Malaria in the Region of the Americas, 2000-2013

Confirmed malaria cases per 1000 population, 2014

63% reduction in morbidity
82% reduction in mortality

Figure 2. Malaria morbidity and mortality in the Americas, 2000 - 2013

Confirmed cases per 1000 population

- Insufficient data
- 0
- 0-0.1
- 0.1-1
- 1-10
- 10-50
- 50-100
- >100

Global Malaria Programme
Situation of Malaria in the Region of the Americas, 2000-2013

Countries in Elimination or pre-elimination phase
13 out of 21 countries
Situation of Malaria in the Region of the Americas, 2000-2013

Figure 9. Financing for malaria, 2000 - 2013

Figure 8. People protected by Indoor Residual Spraying (IRS) and Insecticide-Treated Nets (ITNs), 2000 - 2013

* Data not available for the years 2000-12 for Haiti, from 2005-11 for Suriname and 2006-08 for Venezuela. Data available only for the year 2006 for French Guiana.
MALARIA IN COLOMBIA

MALARIA CASES IN COLOMBIA 1990 - 2014

IRS and LLINs, besides prompt Diagnostic and Treatment
Larvicides in some scenarios – poor evaluation of the efficacy
IRS and LLINs, besides prompt Diagnostic and Treatment
Larvicides in some scenarios – poor evaluation of the efficacy
International Centers of Excellence for Malaria Research (ICEMR) – 2010 - 2017

- Uganda
- Malawi
- West Africa
- Southern Africa
- Indians
- China
- Latin America
- Amazon
- Southern Asia
- Pacific

Global Malaria Programme

World Health Organization
Species present

**SPECIES COMPLEXES**

COI sequences
Barcode
Mosquito Barcoding Initiative

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**An. pseudopunctipennis**

**AN-52**
(near An. pseudopunctipennis)

**An. neivai**

**AN-51**
(near An. neivai)

**An. nuneztovari C**

**An. albimanus**

**AN-50**
(near An. albimanus)
Species of Anopheles

17 species


4 new species

AN-50 near An. albimanus
AN-51 near An.neivai
AN-52 near An.pseudopunctipennis
AN-53 near An.apicimacula

Confirmation of:
An.nuneztovari C
An.albitarsis I

Global Malaria Programme
Entomological Inoculation Rate in Colombia

TOTAL MOSQUITOES ANOPHELES LONGITUDINAL STUDY

<table>
<thead>
<tr>
<th>Species / Locality</th>
<th>CORDOBA</th>
<th>NARIÑO</th>
<th>VALLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>An. albimanus</td>
<td>15</td>
<td>18</td>
<td>311</td>
</tr>
<tr>
<td>An. albimanus B</td>
<td>7144</td>
<td>51</td>
<td>1</td>
</tr>
<tr>
<td>An. albitarsis I</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>An. apicimacula</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>An. argyritarsis</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>An. calderoni</td>
<td>138</td>
<td>1528</td>
<td>1</td>
</tr>
<tr>
<td>An. darlingi</td>
<td>47</td>
<td>16</td>
<td>470</td>
</tr>
<tr>
<td>An. neivai</td>
<td></td>
<td>2</td>
<td>57</td>
</tr>
<tr>
<td>An. neomaculipalus</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>An. nuneztovari C</td>
<td>1235</td>
<td>1395</td>
<td>1417</td>
</tr>
<tr>
<td>An. oswaldoi</td>
<td>6</td>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>An. pseudopunctipennis</td>
<td>1</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>An. punctimacula</td>
<td>1</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>An. rangeli</td>
<td>1</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>An. triannulatus</td>
<td>61</td>
<td>53</td>
<td>33</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>1368</td>
<td>1529</td>
<td>2278</td>
</tr>
</tbody>
</table>
PROPORTION OF MOSQUITOS *Anopheles* CAUGHT INDOORS AND OUTDOORS BY HLC

Latin American ICEMR - LONGITUDINAL STUDY 2012 - 2013

<table>
<thead>
<tr>
<th>Location</th>
<th>An.calderoni</th>
<th>An.albimanus</th>
<th>An.darlingi</th>
<th>An.nuneztovari</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdoor:</td>
<td>70%</td>
<td>63.5%</td>
<td>57.4%</td>
<td>53.3%</td>
</tr>
</tbody>
</table>

Global Malaria Programme

World Health Organization
HUMAN-VECTOR CONTACT AND SLEEPING PATTERNS OF THE POPULATION IN LATIN AMERICA

Hourly biting pattern of Anopheles nuneztovari, An. albimanus, An. calderoni and An. darlingi occurring both indoors (solid lines) and outdoors (dashed lines) at different study sites. The grey area represents the proportion of the human population predominantly spending time indoors and sleeping, during the times shown on the abscissa of each graph.

Quinones et al., in preparation
An overall of 66% of the bites could be protected by LLTNs

40% unprotected

Quantification of the human-vector exposure while people is sleeping, and before going to sleep under a LLTN in Colombia

\[ B_{u,t} = B_{o,t} (1 - S_t) + B_{i,t} S_t \]

mean biting rate experienced by an unprotected individual at each time of the night \( t \)

\[ \pi_S = \frac{\sum_{t=5 \text{ pm}}^{24} B_{u,t}}{\sum_{t=5 \text{ pm}}^{24} B_{i,t}} \]

the proportion of human exposure during which an ITN is in use

Killeen et al., *BMC Infectious Diseases* 2006, 6:161

- Estimate amount of human-vector contact indoors, while sleeping
- Estimate amount of human-vector contact outdoors, and indoors before or after sleeping.

Figure 4. Human-vector contact estimates in the indoor and outdoors given the biting behavior of the Anopheles species and the exposure of the people. Pie charts illustrate the overall amount of exposure occurring indoors and outdoors.
HABITS OF THE POPULATION AT DUSK AND EARLY NIGHT

Photos of J.Escobar, Iscuandé, Nariño - Colombia
“Bromeliad – Malaria”
In LA

Larval habitats of species of the Subgenus Kerteszia

Global Malaria Programme

HUMAN – VECTOR CONTACT

VECTOR SPECIES OF THE SUBGENUS KERTESZIA
A CHALLENGE FOR CONTROL

Human – vector contact of *An. (Kerteszia) neivai* in Nariño, Colombia

Human – vector contact of *An. (Kerteszia) pholidotus* in Tolima, Colombia

Indoors
Outdoors
POSSIBILITY FOR LSM - TYPES OF LARVAL HABITATS

- **Cordoba**
  - TOTAL FOUND: 180
  - Positives: 71 (40%)

- **Valle**
  - TOTAL FOUND: 700
  - Positives: 88 (12.6%)

- **Nariño**
  - TOTAL FOUND: 244
  - Positives: 42 (17%)

Locations:
- Cordoba
- Valle
- Nariño

Other sites:
- Lagoon
- Stream
- Pond
- Ditch
- Other

**Total Found**

- Fish Pond
- Total Found in Cordoba: 180
- Total Found in Valle: 700
- Total Found in Nariño: 244

**Positives**

- Cordoba: 71 (40%)
- Valle: 88 (12.6%)
- Nariño: 42 (17%)
SUMMARY OF CHALLENGES

- **New species** to describe and study – species complexes.

- **New vectors**: i.e. *Anopheles calderoni*

- **Early and outdoors human vector contact** (≈40%)

- **Complementary control measures needed**, besides LLINs or IRS.

- Human-made and permanent larval habitats – possibility to treat larval habitats.

- Attention towards other vector-borne diseases in Latin America: Dengue, Chikungunya, Zika.

THANK YOU
Insecticide resistance

Figure 2. Latin American (LA) region, including countries in the LA and Amazonia International Centers of Excellence for Insecticide Resistance in Areas under Investigation by the International Centers of Excellence for Malaria Research: A Challenge for Malaria Control and Elimination.