Mapping of Anopheline mosquitoes: An example from Thailand
Globally: Malaria incidence dropped 30% (WHO 2014)

Figure 8.9 Percentage change in malaria mortality rates, 2000–2013

Percentage change in malaria mortality rates, 2000–2013

- Estimated malaria deaths equals zero
- Decrease >75%
- Decrease 50–74%
- Decrease 25–49%
- Decrease <25%
- Increases in malaria mortality rates
- No malaria transmission, 2000
- Not applicable

Source: WHO estimates
Goal and objectives of GMS strategy: Eliminate malaria in GMS by 2030

1. Interrupt transmission of falciparum in the areas of multidrug resistance by 2020 and in all areas of GMS by 2025

2. Reduce malaria in all high transmission areas to less than 1 case per 1000 population at risk and initiate elimination activities by 2020

3. Prevent the reintroduction in area where it has been interrupted.
Malaria in GMS (WMR 2013)

Malaria cases in GMS 2013

Map showing geographical regions: MYANMAR (BURMA), CHINA, VIETNAM, LAOS, THAILAND, CAMBODIA.
2015 REPORT

- 22,199 malaria cases (Thai cases)
- *Plasmodium falciparum* (40%)
- *Plasmodium vivax* (50%)
Malaria remains prevalence along the forested and hilly areas of border regions and southern peninsular in Thailand.

Source: Chareonviriyaphap et al. (2000), BOE (2014-2016)
Malaria cases in Thailand: declined 25.32% from 2015-2016

Malaria cases (Jan 1st – Oct 7th, 2016)

- **13,773 cases** were reported
  - Thai >> 9,196 cases
  - Non-Thai >> 4,577 cases
- API > 0.21 cases per 1,000 population
- P. vivax (75.52%): P. falciparum (15.32%)

Top 3 provinces
- Yala
- Ubon Ratchathani
- Tak

Source: BVBD (2016)
Actions against parasites: prophylaxis, early diagnosis and treatment of cases

Actions against mosquitoes: vector control programs and protection against Anopheles vectors
VECTORS
### Anopheles species complexes in the world

<table>
<thead>
<tr>
<th>Continent</th>
<th>Number</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>America</td>
<td>5</td>
<td>22</td>
</tr>
<tr>
<td>Africa</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>Australo-Pacific</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Europe</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>23</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
High biodiversity in the Oriental Region

Numerous *Anopheles* species complexes such as:

- **An. barbirostris** (6 species)
- **An. culicifacies** (5 species)
- **An. dirus** (8 species)
- **An. fluviatilis** (3 species)
- **An. gigas** (3 species)
- **An. leucosphyrus** (9 species)
- **An. lindesayi** (4 species)
- **An. minimus** (3 species)
- **An. nivipes** (2 species)
- **An. subpictus** (4 species)
- **An. sundaicus** (4 species)
- **An. maculatus** (9 species)

56 known species
Distribution of the three species of the Minimus complex*

- An. minimus: major vector
- An. yaeyamaensis: non-vector
- An. harrisoni: major or secondary vector?
Distribution of the 8 species of the Dirus complex

* Extension of *An. cracens* in Sumatra not shown
Distribution of the 8 species of the Maculatus Group
Distribution of the 4 species of the Sundaicus complex
Molecular evidence of misidentification of Anopheles minimus as Anopheles fluviatilis in Assam (India)

O.P. Singh, N. Nanda, Vas Dev, Prerna Bali, Mohammad Sohail, A. Mehruinisa, T. Adak, A.P. Dash

2

CONFIRMATION OF ANOPHELES VARUNA IN VIETNAM, PREVIOUSLY MISIDENTIFIED AND MISTARGETED AS THE MALARIA VECTOR ANOPHELES MINIMUS

Wim van Bortel, Ralph E. Babacke, Ho Dong Trung, Patricia Roelants,

Department of Parasitology, Prince Leopold Institute of Tropical Medicine, Antwerp, Belgium, Department of Entomology and Biomedical Sciences Theme, The Natural History Museum, London, UK, National Institute for Malaria, Parasitology and Entomology, Hanoi, Vietnam, Department of Invertebrates, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

Abstract. Malaria control programs in Southeast Asia are faced with several questions concerning vector behavior and species identification, which need to be answered to consolidate and further improve the results of control practices. The vector system in Southeast Asia is complex because of the number of species potentially involved in...
Validity of these morphological characters

<table>
<thead>
<tr>
<th>REFERENCES</th>
<th>COUNTRY, IDENTIFICATION TECHNIQUES</th>
<th>% MISIDENTIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green, 1990</td>
<td>Thailand, Morphology/ isozymes</td>
<td>37% overall</td>
</tr>
<tr>
<td>Van Bortel et al, 1999</td>
<td>Vietnam, Morphology/ isozymes</td>
<td>33% overall</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11% for <em>An. minimus</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>38% for <em>An. harrisoni</em></td>
</tr>
<tr>
<td>Rwegoshora et al, 2002</td>
<td>Thaïland, Morphology/ Green, 1990</td>
<td>71.7% for <em>An. minimus</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.7% for <em>An. harrisoni</em></td>
</tr>
<tr>
<td>Chen et al, 2003</td>
<td>China, Morphology/ SSCP</td>
<td>50% overall</td>
</tr>
<tr>
<td>Sungvornnyothin et al, 2006</td>
<td>Thailand, Morphology/AS-PCR</td>
<td>12% for <em>An. minimus</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>53% for <em>An. harrisoni</em></td>
</tr>
</tbody>
</table>
Mosquitoes in Thailand (2013)

438 Mosquito species

Anopheles 73 species

Anopheles species complex

Definition: A complex of sibling (or cryptic) species is composed of morphologically undistinguishable species having different role in pathogen transmission (from main vector to non-vector)

It is important to identify correctly these sibling species in order to define efficient vector control programs targeting the vectors
Member of complex found in Thailand

DIRUS (5 from 8)
- An. dirus
- An. baimai
- An. cracens
- An. scanloni
- An. nemophilous

MACULATUS (7 from 8)
- An. maculatus
- An. sawadwongporni
- An. notanandai
- An. dravidicus
- An. rampae
- An. willmori
- An. pseudowillmori

MINIMUS (2 from 3)
- An. minimus
- An. harrisoni
- An. aconitus

An. dirus
An. baimai

An. maculatus
An. sawadwongporni
An. pseudowillmori
Minimus Complex and related species

Presectoriel pale spot (PSP), Humeral pale spot (HP)  Jaichapor et al. 2005

Morphological identification + Molecular identification
Anopheles minimus complex

Malaria vectors in forested foothills of SE Asia
VECTORS

Non silicone tube  Liquid nitrogen tank

Minimus complex and related species  by Garros et al. (2004)

Dirus complex by Walton et al. (1999)

Maculatus Group by Walton et al. (2007)

DNA mosquito extraction

DNA amplification by PCR

Run electrophoresis

Mosquito species
Distribution of Dirus Complex identified by molecular techniques

DIRUS (5 from 8)
- An. dirus
- An. baimai
- An. cracens
- An. scanloni
- An. nemophilous

Vector of malaria
Non-vector of malaria
VECTORS

DIRUS COMPLEX
Distribution of Maculatus Complex identified by molecular techniques

MACULATUS (7 from 9)
- An. maculatus
- An. sawadwongporni
- An. notanandai
- An. dravidicus
- An. rampae
- An. willmori
- An. pseudowillmori

Vector of malaria
Non-vector of malaria
MACULATUS COMPLEXES
Distribution of Minimus Complex identified by molecular techniques

MINIMUS (2 from 3)

An. minimus
An. harrisoni

Vector of malaria
Non-vector of malaria
MINIMUS AND MACULATUS COMPLEXES
Summary

Precise identification of malaria vector species is needed in order to define efficient vector control programs targeting the right vectors.

Using various non morphological tools, geo-referenced maps were generated from both published and non published data to generate an updated, countrywide distribution of malaria vectors in Thailand.

11 maps showing the distribution of 18 species and 20 tables with GPS coordinates on malaria vector distribution from Thailand were available.

Information from vector distribution map is very helpful in preparation of the precise malaria transmission zoning map of the country and help precisely target the areas at risk.
THANK YOU