# SAMBA'S EIGHTH INTEGRATIVE THINK TANK
# Bath, 11-15 June 2018

# HOW WE CAN EFFECTIVELY REDUCE THE POPULATION OF *AE. AEGYPTI*?

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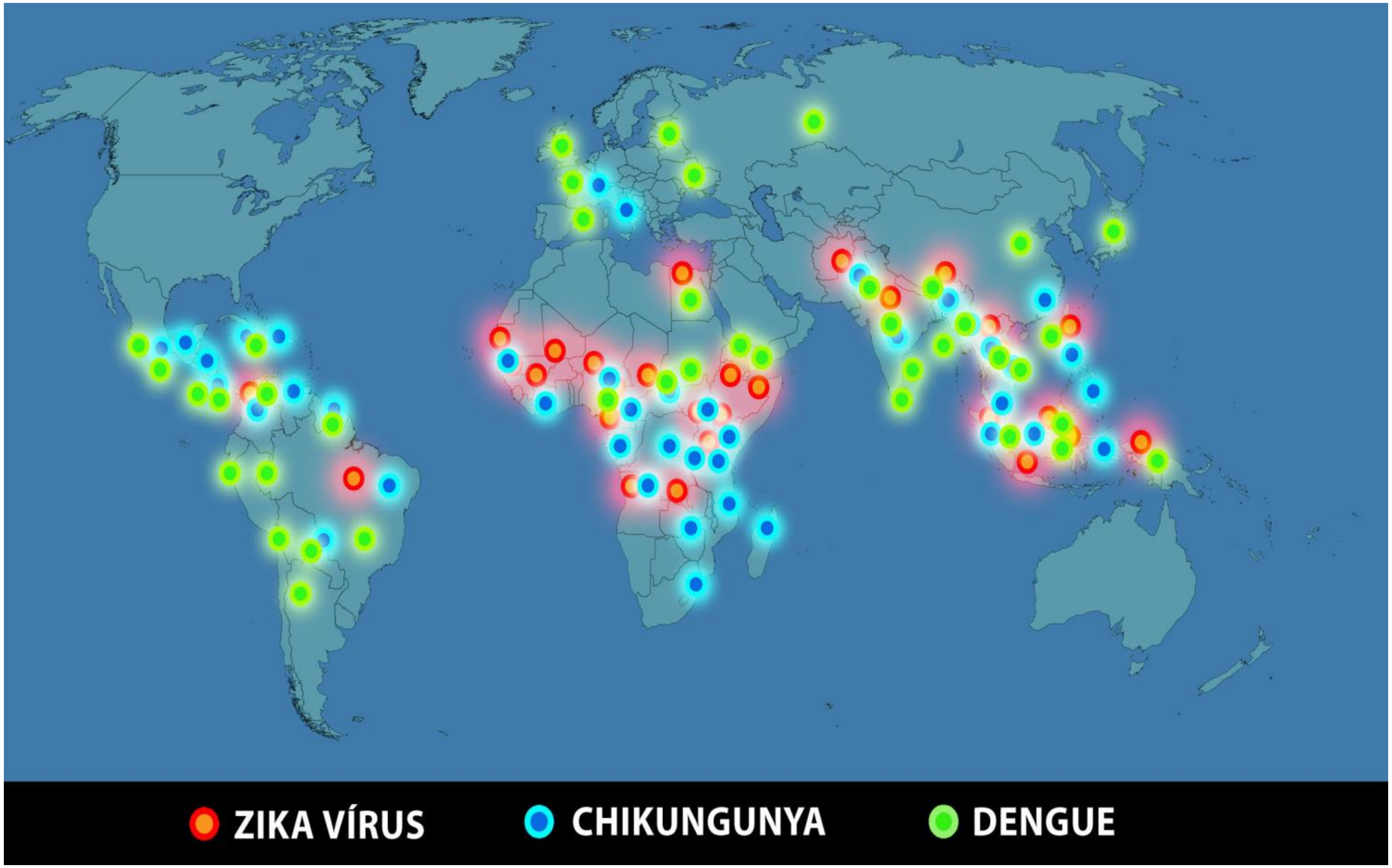
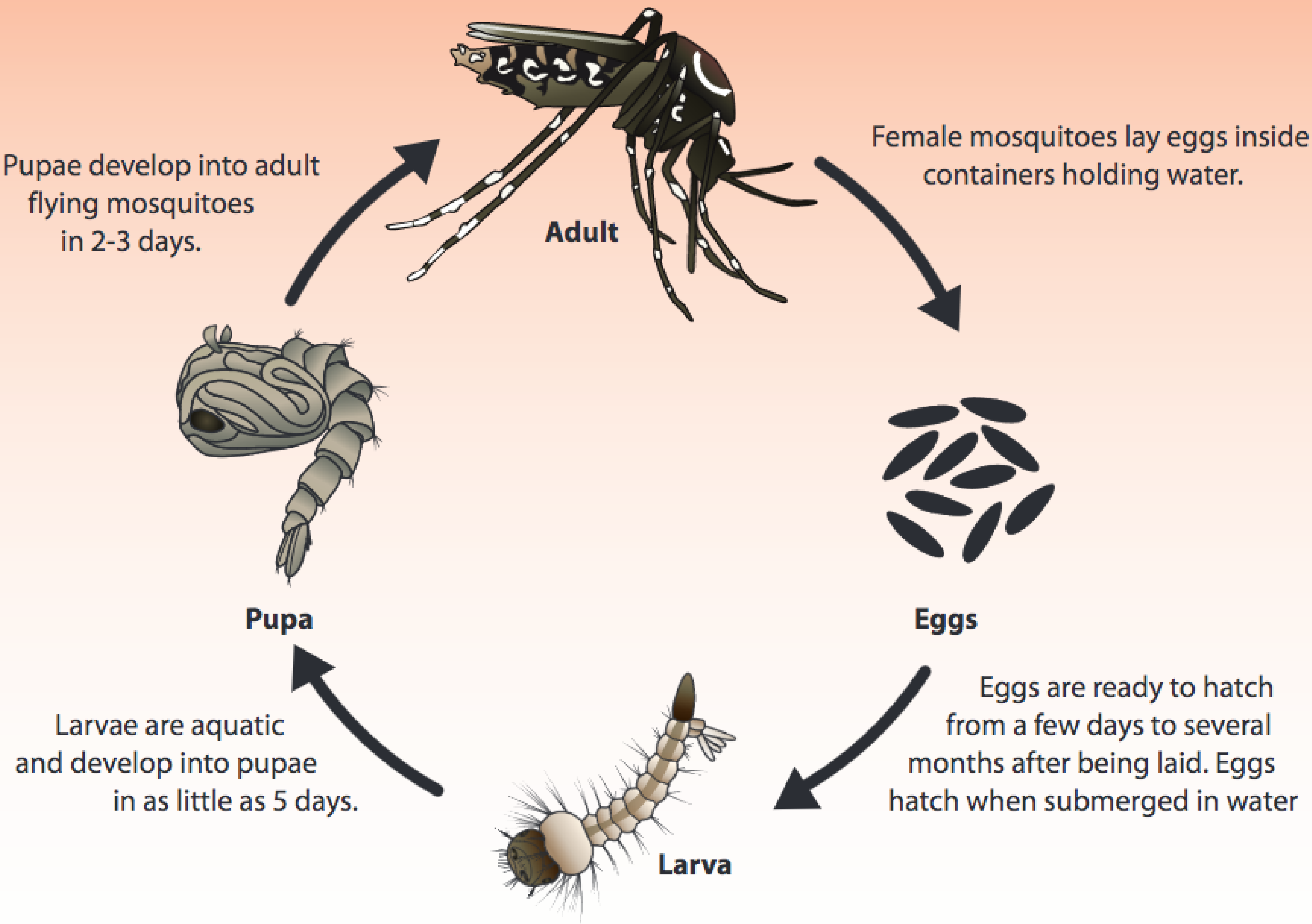
# ARBOVIROSE TRILOGY IN THE WORLD



# *Aedes aegypti*



EGGS

PUPA

The female can live around 30 days where will perform up to 10 gonadotrophic cycles and will be able to bite dozens of people, putting hundreds of eggs and ... transmitting dengue

LARVE

ADULT

# CONTROL LIMITATIONS

- ✓ Quick replacement of eliminated containers (<3 months)
- ✓ Productive containers can not be disposed of (eg, water storage containers)
- ✓ Presence of cryptic ovoposition sites (can not be seen)
- ✓ The larvicides have no prolonged residual effect
- ✓ There is resistance to economic larvicides (eg, Abate) and to adulticides (eg, malathion, pyrethroids)
- ✓ There are no ovicides against *Aedes aegypti*
- ✓ Adulticides (ULV) are generally applied from the street or the air and do not reach places of rest inside houses
- ✓ Adult mosquitoes are not removed indoors (eg, residual spraying, space spraying)
- ✓ Absence of entomological surveillance or evaluation of control measures (lack of follow-up)

# CRYPTIC OVOPOSITION SITES

- ✓ Dependence on the visual search of ovoposition sites.
- ✓ The presence of cryptic, highly productive breeding/ovoposition sites is increasing:
  - Nigeria (septic tanks). Irving-Bell et al., 1987)
  - Australia (Sewers, wells, mines, septic tanks, rain drains, gutters on roofs, Kay et al 2000, Russell et al., 2002, Montgomery & Richie 2002)
  - Colombia (Drains of rains in all the city, González & Suarez 1995)
  - Puerto Rico (Septic tanks, water meters, Barrera et al., 2008)
  - Brazil (Elevated water tank, gutters and water on roofs in the shade, Pilger et al., 2011).
  - México (rainwater drainages; Manrique-Saide et al., 2012

# WHY DOES THE CONTROL OF LARVAE/PUPAE FAIL?

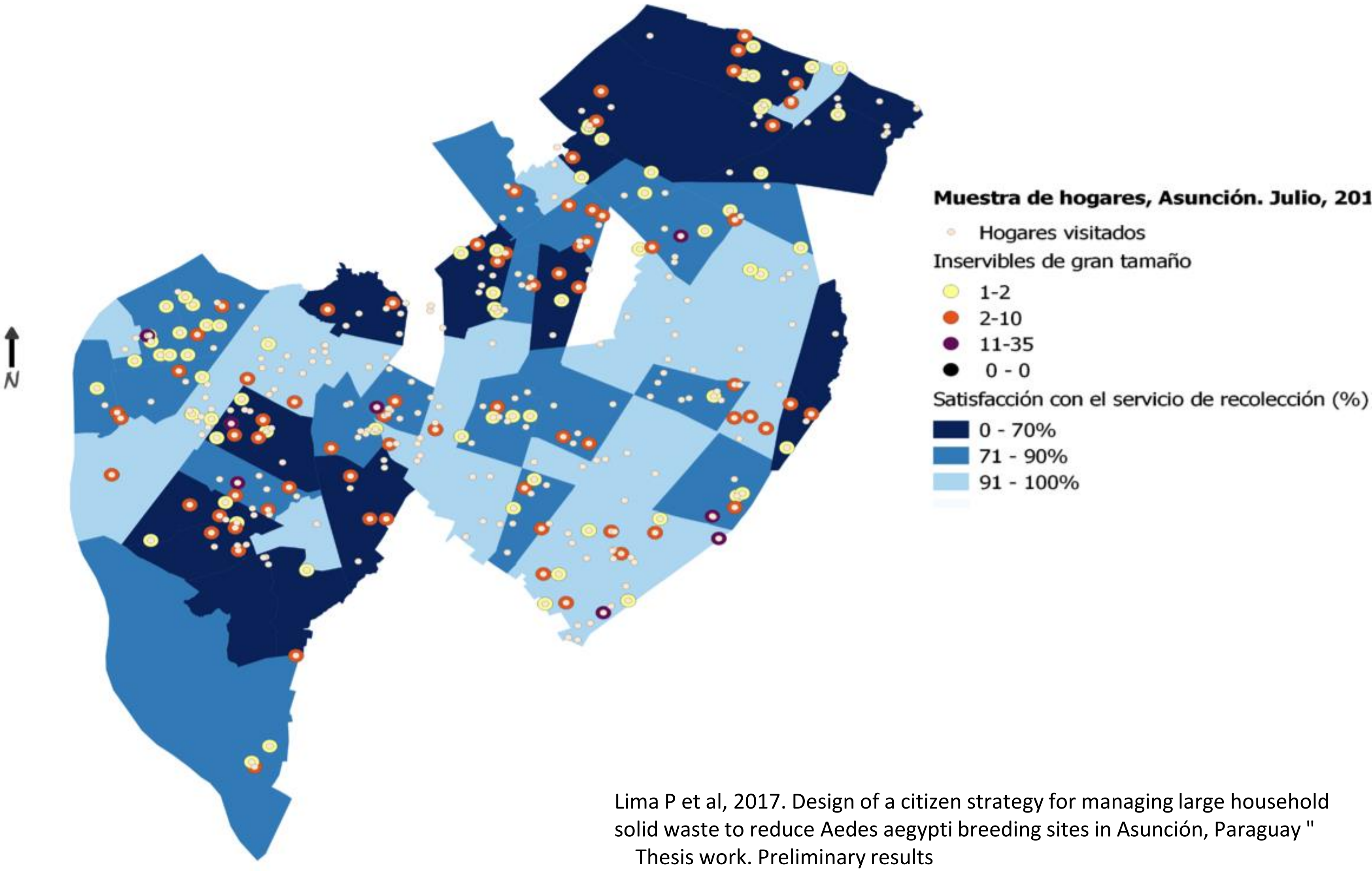
Suppose you want to reduce the breeding of *Aedes aegypti* in a community and inspect the houses to apply control of immature

- ✓ If 30% of the houses are closed or refuse, you can only reduce the mosquito population by 70% (1.00 x 0.70)
- ✓ If the larvicide or the elimination of ovoposition sites is 80% (0.70 x 0.80) can only eliminate 56% of the mosquitoes
- ✓ If a further 20% of efficiency is lost from this 56% (treatments reported but not performed, recipients that were not treated or found, errors in transcription of data, etc.) (0.56 x 0.80) would end with a reduction of only 45 %.

In this way, unknowingly, it fails in the control of the population of *Ae. aegypti*, particularly if an evaluation of the final impact is not made (measuring the change in the adult population).


Gentileza: Dr. JL San Martin

## DISTRIBUTION OF LARGE UNUSABLE CONTAINERS AND SATISFACTION WITH THE COLLECTION SERVICE




Lima P et al, 2017. Design of a citizen strategy for managing large household solid waste to reduce Aedes aegypti breeding sites in Asunción, Paraguay " Thesis work. Preliminary results

## COLLECTION OF INMATURE STAGES OF AE. AEGYPTI IN DIFFERENT TYPE OF CONTAINERS IN ASUNCION PREMISES, 2017

| Potential ovoposition sites | Number | Number of houses | % Houses | % Positive container |
|---|---|---|---|---|
| Animal drinkers | 319 | 264 | 75.4 | |
| Gutters | 244 | 197 | 56.3 | |
| Water drums | 70 | 26 | 7.4 | |
| Pots with dishes | 82 | 21 | 6.0 | |
| Flower pots | 32 | 19 | 5.4 | 9.4 |
| Ponds | 30 | 8 | 2.3 | 33.3 |
| Tanks or cisterns | 7 | 4 | 1.1 | 42.9 |
| Bottles | 2774 | 176 | 50.3 | |
| Disposable cuvettes | 547 | 166 | 47.4 | |
| Other disposable | 343 | 126 | 36.0 | 0.3 |
| Discarded domestic appliances | 248 | 90 | 25.7 | 5.6 |
| Used tires | 53 | 28 | 8.0 | |
| Axils of leaves | 129 | 55 | 15.7 | |

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## RELATIONSHIP BETWEEN THE EXISTENCE OF OBJECTS IN DISUSE AND SOCIAL AND CULTURAL VARIABLES

| Independent Variables | Odd ratio | Coefficient | p Value |
|---|---|---|---|
| Neighborhood with poor collection coverage * | 2.17 | 0.78 | 0.01 |
| Low user satisfaction with the service | 1.87 | 0.62 | 0.08 |
| Precarious housing | 2.14 | 0.76 | 0.14 |
| Minor education to the finished secundary school | 1.14 | 0.14 | 0.67 |
| It considers the objects in disuse useful * | 13.25 | 2.58 | 0.00 |
| Payment for informal collection | 1.73 | 0.55 | 0.10 |
| Constant | | 2.61 | 0.00 |

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**Table 1. Collection of *Ae. aegypti* immatures by container type from residential premises in Mérida, Yucatán, México during March 2007–February 2008 and May 2009–July 2010**

| Container characteristics | | 2007–2008 | | | | 2009–2010 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Larvae | | Pupae | | Larvae | | Pupae | |
| Container type | Capacity (liters) | No. | % of total | No. | % of total | No. | % of total | No. | % of total |
| Discardable containers filled by rain | | | | | | | | | |
| Small discarded containers[a] | <5 | 989 | 42.6 | 300 | 59.6 | 3,000 | 21.9 | 497 | 15.3 |
| Larger discarded containers[a] | 5–20 | 293 | 12.6 | 40 | 8.0 | 3,102 | 22.7 | 1,045 | 32.1 |
| Tires | <5 | 135 | 5.8 | 40 | 8.0 | 1,736 | 12.7 | 387 | 11.9 |
| Nondiscardable containers filled in part by human action | | | | | | | | | |
| Flower pots | <5 | 216 | 9.3 | 50 | 9.9 | 1,485 | 10.8 | 186 | 5.7 |
| Buckets | 5–20 | 389 | 16.7 | 30 | 6.0 | 3,200 | 23.4 | 822 | 25.2 |
| Nondiscardable containers filled mostly by human action | | | | | | | | | |
| Vases | <5 | 45 | 1.9 | 15 | 3.0 | 0 | 0 | 0 | 0 |
| Cement troughs (aquatic plants) | 20–40 | 88 | 3.8 | 15 | 3.0 | 147 | 1.1 | 15 | 0.4 |
| Cement troughs (animal water) | 20–40 | 19 | 0.8 | 8 | 1.6 | 412 | 3.0 | 125 | 3.8 |
| Large earthen jars | 40–60 | 10 | 0.4 | 5 | 1.0 | 107 | 0.8 | 22 | 0.7 |
| Swimming pools | >200 | 33 | 1.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Metal or plastic drums | 200 | 30 | 1.3 | 0 | 0 | 238 | 1.7 | 93 | 2.9 |
| Plastic water tanks | >200 | 32 | 1.4 | 0 | 0 | 131 | 1.0 | 39 | 1.2 |
| Plastic containers | 20–100 | 24 | 1.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cement water tanks | >200 | 19 | 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cement cisterns | >200 | 2 | 0.1 | 0 | 0 | 120 | 0.9 | 26 | 0.8 |
| Total | | 2,324 | 100 | 503 | 100 | 13,678 | 100 | 3,257 | 100 |

There was no overlap between residential premises included for the studies conducted in 2007–2008 versus 2009–2010.
[a] Small discarded containers include e.g., bottles, cans, and plastic bags, and similar items; larger discarded containers include e.g., washing machines refrigerators, and similar items.

Mérida proves successful in removing discarded containers as important immature development sites, then we should see dramatic changes in the most productive container types in the future as the mosquito is forced to switch to other container types, which perhaps also will be easier to include in highly targeted mosquito control interventions.

GARCIA-REJO´N ET AL.: PRODUCTIVE CONTAINERS FOR Ae. aegypti IMMATURES. J. Med. Entomol. 48(3): 644‹650 (2011); DOI: 10.1603/ME10253

Table I. Mean number of eggs laid by *Aedes aegypti* females under different temperature and humidity.

| Tempe-ratures | 60% rh Eggs mean±SE (n) | 60% rh Oviposition variation (y) | 80% rh Eggs mean±SE (n) | 80% rh Oviposition variation (y) |
|---|---|---|---|---|
| 25ºC | 85.99±3.16 [a, B] (102) | 4 – 160 (37.25%) | 99.08±3.56 [a] (92) | 4 – 155 (55.43%) |
| 30ºC | 82.89±3.33 [b, B] (111) | 2 – 143 (37.84%) | 75.75±5.03 [b] (75) | 1 – 144 (45.33%) |
| 35ºC | 54.53±4.81 [c] (55) | 1 – 126 (14.55%) | 59.62±3.41 [c] (79) | 2 – 132 (7.59%) |
| TOTAL | 78.25±2.2 (268) | | 79.29±2.53 (246) | |

n= number of females laid eggs. y= percentage of females with total ovipositions ≥100 eggs.
Capital letters indicate comparison of values in the same column and small letters show comparison among values in the same line. Regardless of the size same letters represent values without significant differences. Different letters means numbers statistic different ($p < 0.05$).

Females responded to an increase in temperature by reducing egg production, oviposition time and changing oviposition patterns.

At 25 ºC and 80% relative humidity, females survived two-fold more and produced 40% more eggs when compared to those kept at
35 ºC and 80% relative humidity.

However, in 55% of females kept at 35 ºC and 60% relative humidity oviposition was inhibited and only 15% females laid more than 100 eggs, suggesting that the intensity of the temperature effect was influenced by humidity

De Almeida Costa et al Revista Brasilera de Entomología 04(5):488-495, 2010

# RECENT CONCLUSIONS AND SUGGESTIONS

- Abad-Franch et al 2013 found:
  - (i) 'rapid larval surveys' yielded dwelling infestation indices that were markedly lower than the site-occupancy rates based on ovitrap data,
  - (ii) control campaigns had negligible effects on site-occupancy.
- Suggestions:
  - (i)the use of adult mosquitoes to transfer potent larvicidal particles from contaminated 'dissemination stations' to clean breeding sites and
  - (ii) the release of mosquitoes carrying transgenes or specific Wolbachia strains that impair reproduction and/or reduce competence to transmit dengue virus.

Padilla-Torres SD, Ferraz G, Luz SLB, Zamora-Perea E, Abad-Franch F (2013) Modeling Dengue Vector Dynamics under Imperfect Detection: Three Years of Site-Occupancy by Aedes aegypti and Aedes albopictus in Urban Amazonia. PLoS ONE 8(3): e58420. doi:10.1371/journal.pone.0058420

# KEY POINTS AND QUESTIONS

- ✓ We have to concentrate our attention to the *Ae. aegypti* productive sites.
- ✓ Why are these large solid wastes good producers of mosquitoes?
- ✓ How quickly do small containers need to be cleared?
- ✓ How many small containers are equivalent to one large container?
- ✓ How is this affected by oviposition site searching behaviour, the accumulation of beneficial microbial communities, predation of mosquito larvae, chance effects?
- ✓ How is adult mosquito density profile related to container density profile? How does this affect disease transmission. What is the impact of removing containers i) systematically, ii) at random? If large containers cannot be removed, what is impact of regular larvicide application?
- ✓ How do we expect infection risk in a household to be related to container density? Does this match with what is observed? What is the potential effect of autodissemination stations (ADS) for oviposition impeders?
- ✓ How many are required? Where should they be placed relative to container distribution?


Thank you!!!

Muchas gracias!!!