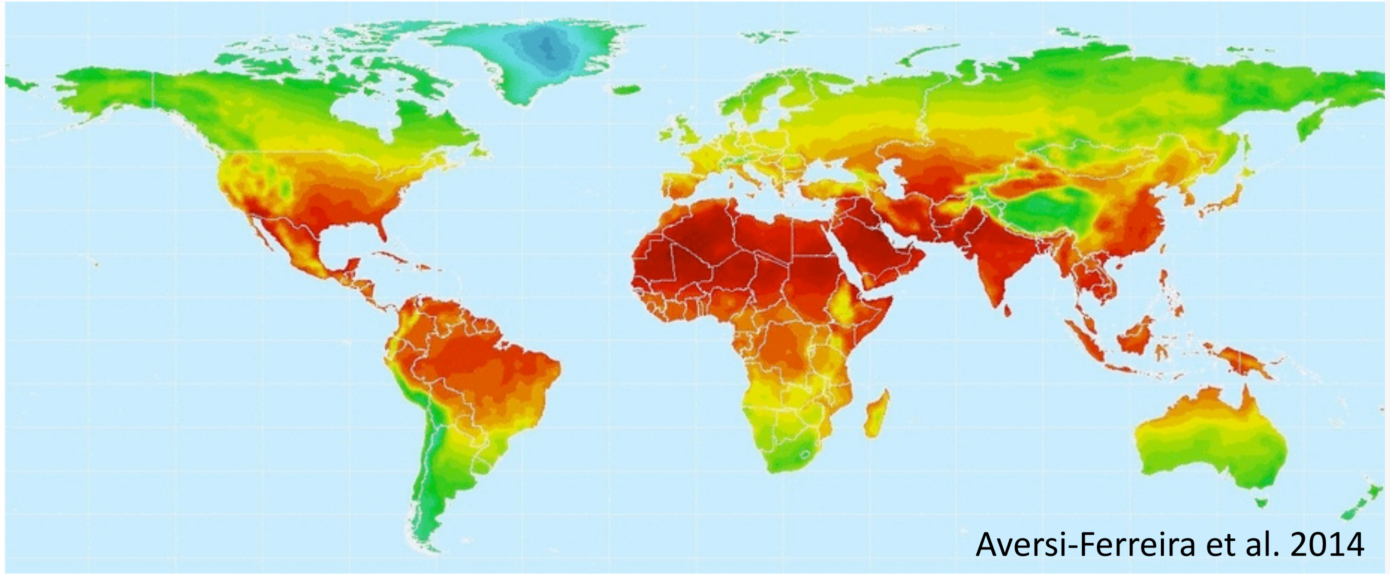
# Microclimate and Mosquitoes in Athens, GA

Michelle Evans, Courtney Murdock

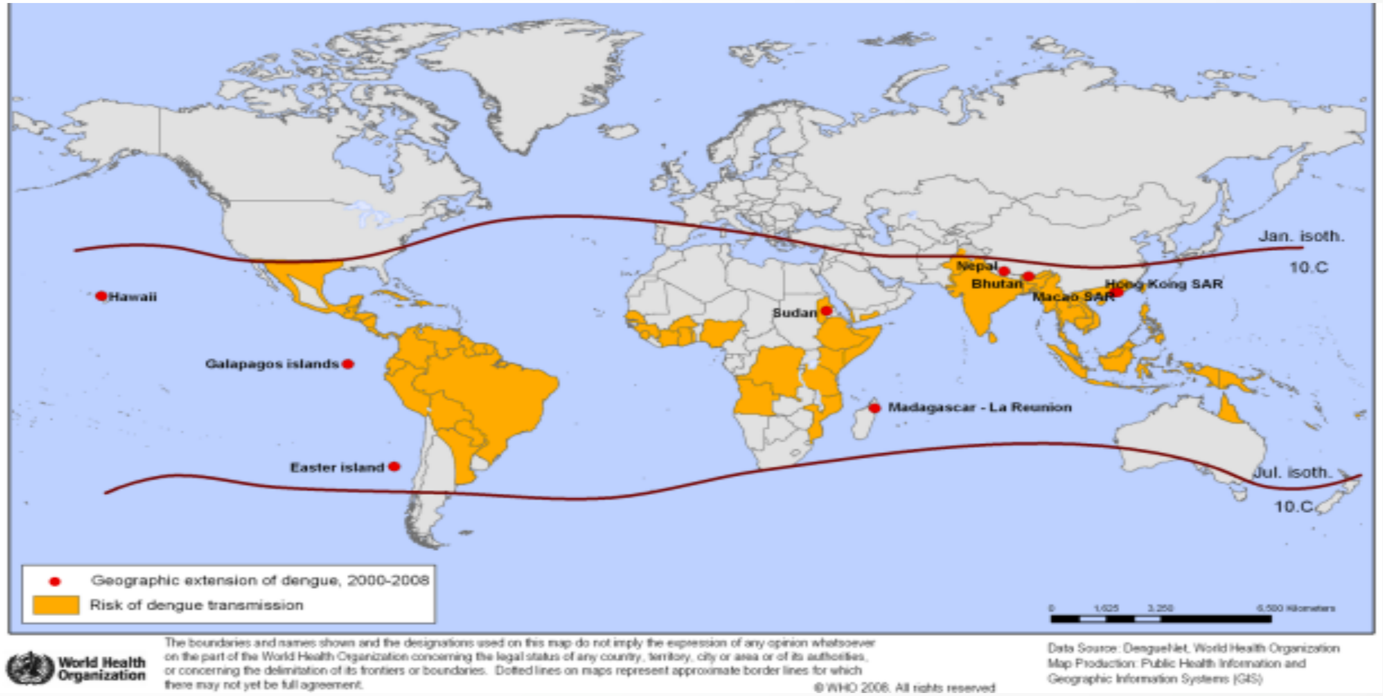
October 12, 2016

Georgia Mosquito Control Association Annual Meeting

Global Annual Mean Temperatures




Areas with Known
Dengue Transmission



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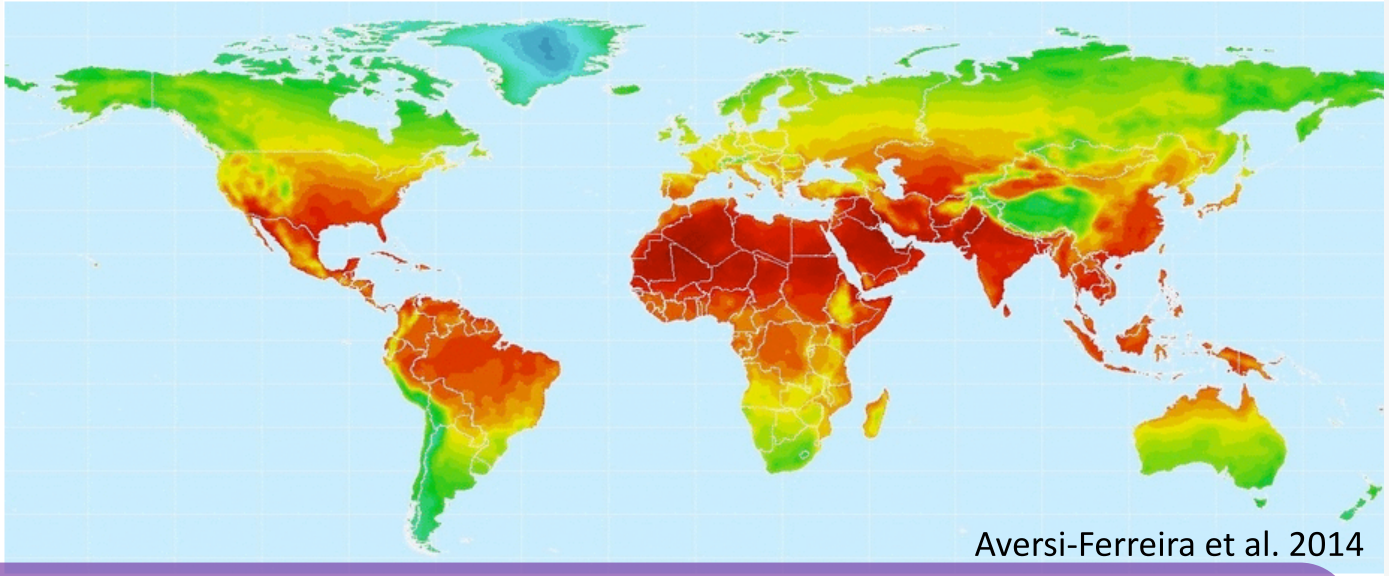
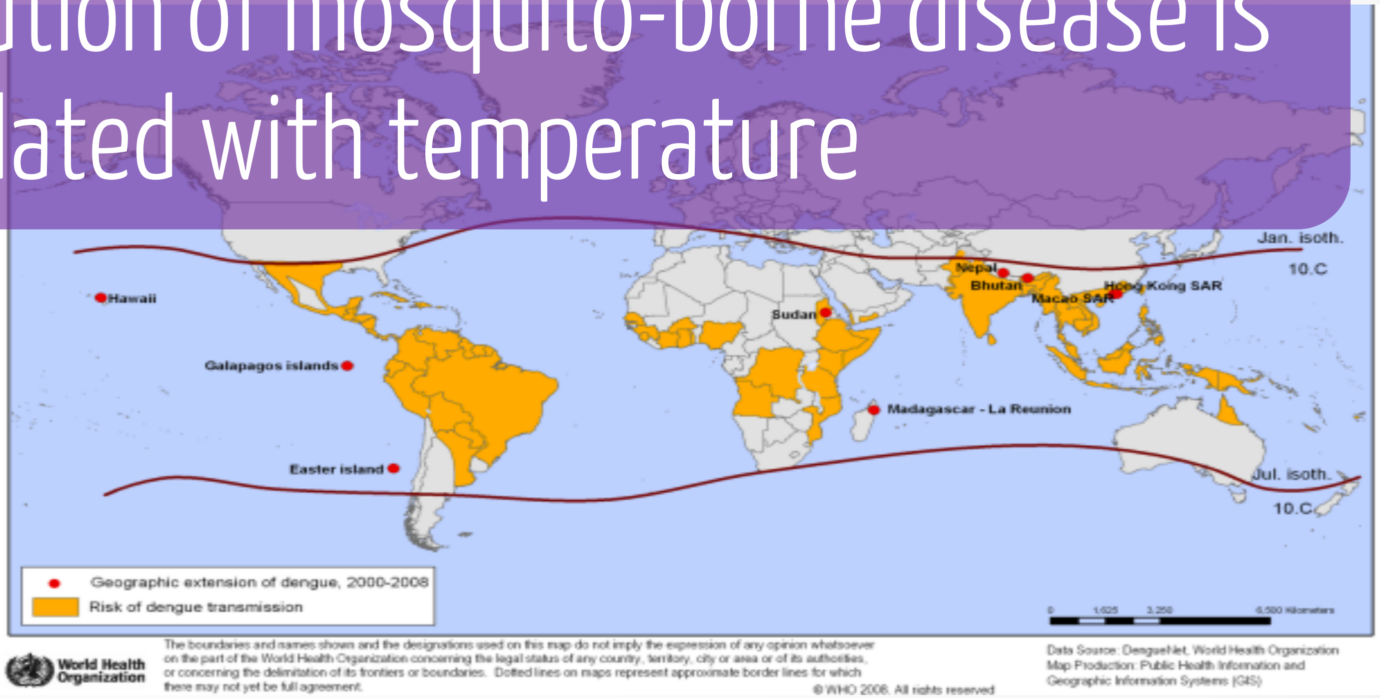



The geographic distribution of mosquito-borne disease is highly correlated with temperature

Areas with Known Dengue Transmission



# Understanding the link between malaria risk and climate

**Krijn P. Paaijmans[a,1], Andrew F. Read[a,b], and Matthew B. Thomas[a]**

Center for Infectious Disease Dynamics, [a]Department of Entomology, Chemical Ecology Laboratory, and [b]Department of Biology, Mueller Laboratory, Pennsylvania State University, University Park, PA 16802

Edited by Burton H. Singer, Princeton University, Princeton, NJ, and approved June 8, 2009 (received for review March 27, 2009)

# GLOBAL-SCALE RELATIONSHIPS BETWEEN CLIMATE AND THE DENGUE FEVER VECTOR, *AEDES AEGYPTI*

MARIANNE J. HOPP[1] and JONATHAN A. FOLEY[2]

[1]*International Research Institute for Climate Prediction (IRI), Monell Building, LDEO, 61 Route 9W, Palisades, NY 10964-8000, U.S.A.*

[2]*Center for Sustainability and the Global Environment (SAGE), Institute for Environmental Studies, 1225 W. Dayton Street, 1139, University of Wisconsin, Madison, WI 53706-1612, U.S.A.*

RESEARCH ARTICLE

# Large-Scale Modelling of the Environmentally-Driven Population Dynamics of Temperate *Aedes albopictus* (Skuse)

**Kamil Erguler[1]*, Stephanie E. Smith-Unna[2,3], Joanna Waldock[1,4], Yiannis Proestos[5], George K. Christophides[4,5], Jos Lelieveld[1,6], Paul E. Parham[7,8]***

NAS

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Curr Clim Change Rep
DOI 10.1007/s40641-015-0022-6

CLIMATE CHANGE AND HUMAN HEALTH (LS KALKSTEIN AND R DAVIS, SECTION EDITORS)

# Climate Change and the Crystal Ball of Vector-Borne Disease Forecasts

Aaron Bernstein[1,2]

ANNALS OF THE NEW YORK ACADEMY OF SCIENCES
Issue: *Human Health in the Face of Climate Change*

# Urban climate versus global climate change—what makes the difference for dengue?

Renaud Misslin,[1,a] Olivier Telle,[2,3,a] Eric Daudé,[2] Alain Vaguet,[1] and Richard E. Paul[4,5]

[1]Centre National de la Recherche Scientifique, UMR 6266 IDEES, Rouen, France. [2]Centre des Sciences Humaines, UMIFRE 20 CNRS-MAE, Delhi, India. [3]Centre National de la Recherche Scientifique, UMR 8504 Geographie-cités, Paris, France. [4]Institut Pasteur, Unité de la Génétique Fonctionnelle des Maladies Infectieuses, Paris, France. [5]Centre National de la Recherche Scientifique, Unité de Recherche Associée 3012, Paris, France

# The issue of scale-mismatch

150 mi resolution

12 mi resolution

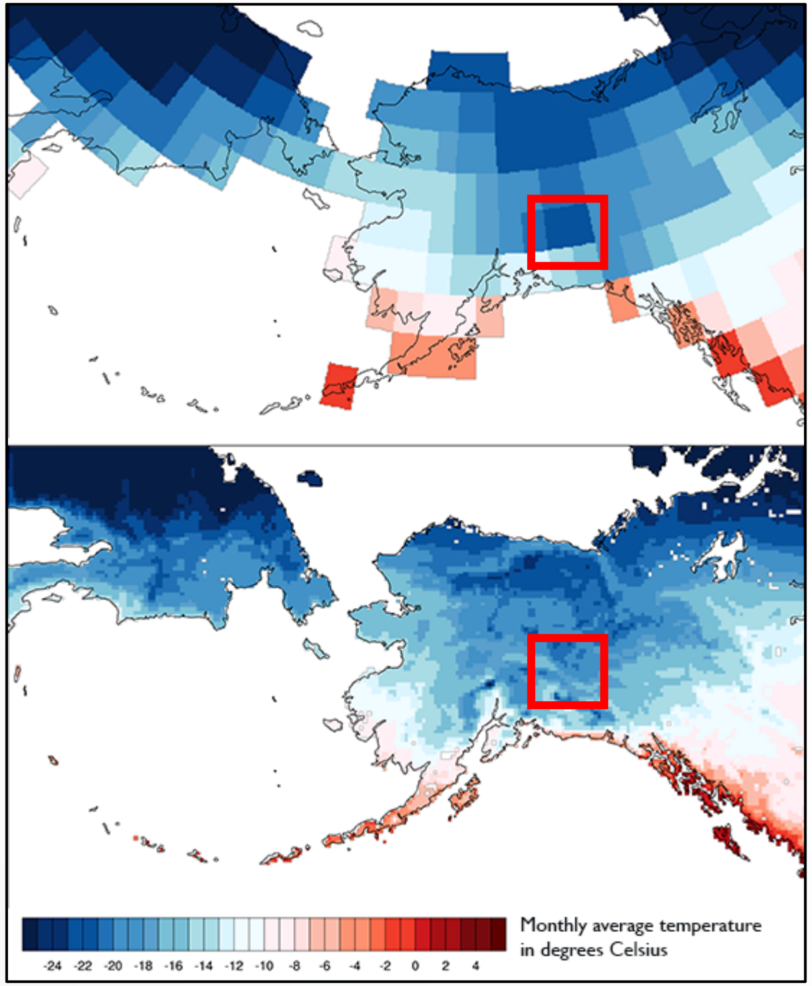
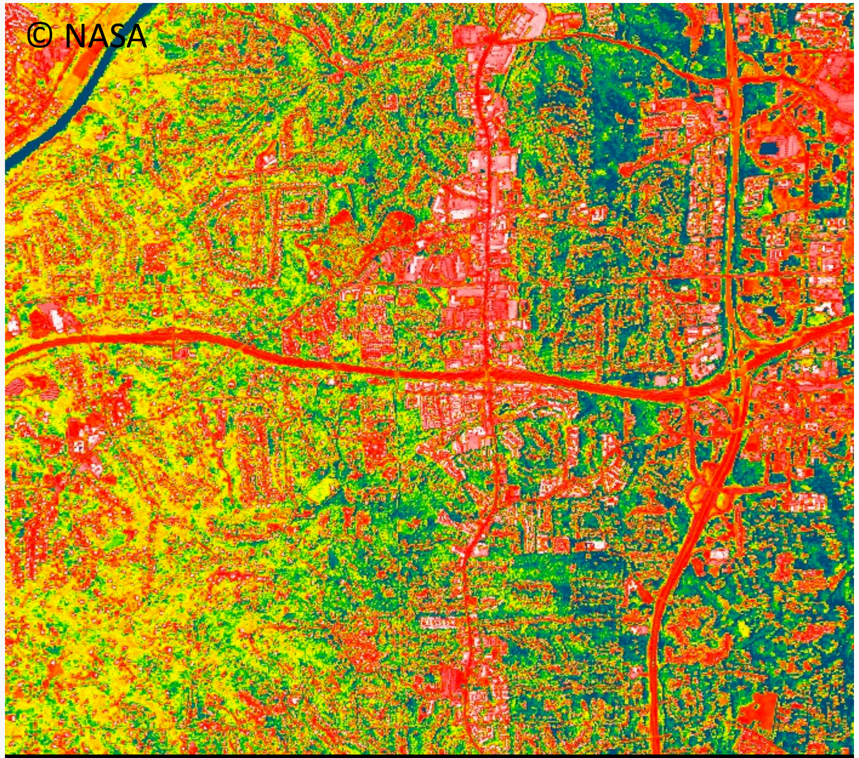



Photo Credit: Univ. of Alaska - Fairbanks

Climate data is often recorded at a coarser scale than mosquitoes experience...

Leading to incorrect predictions of disease risk

# Mosquitoes require an even finer scale




Land Surface Temperatures in Atlanta, GA

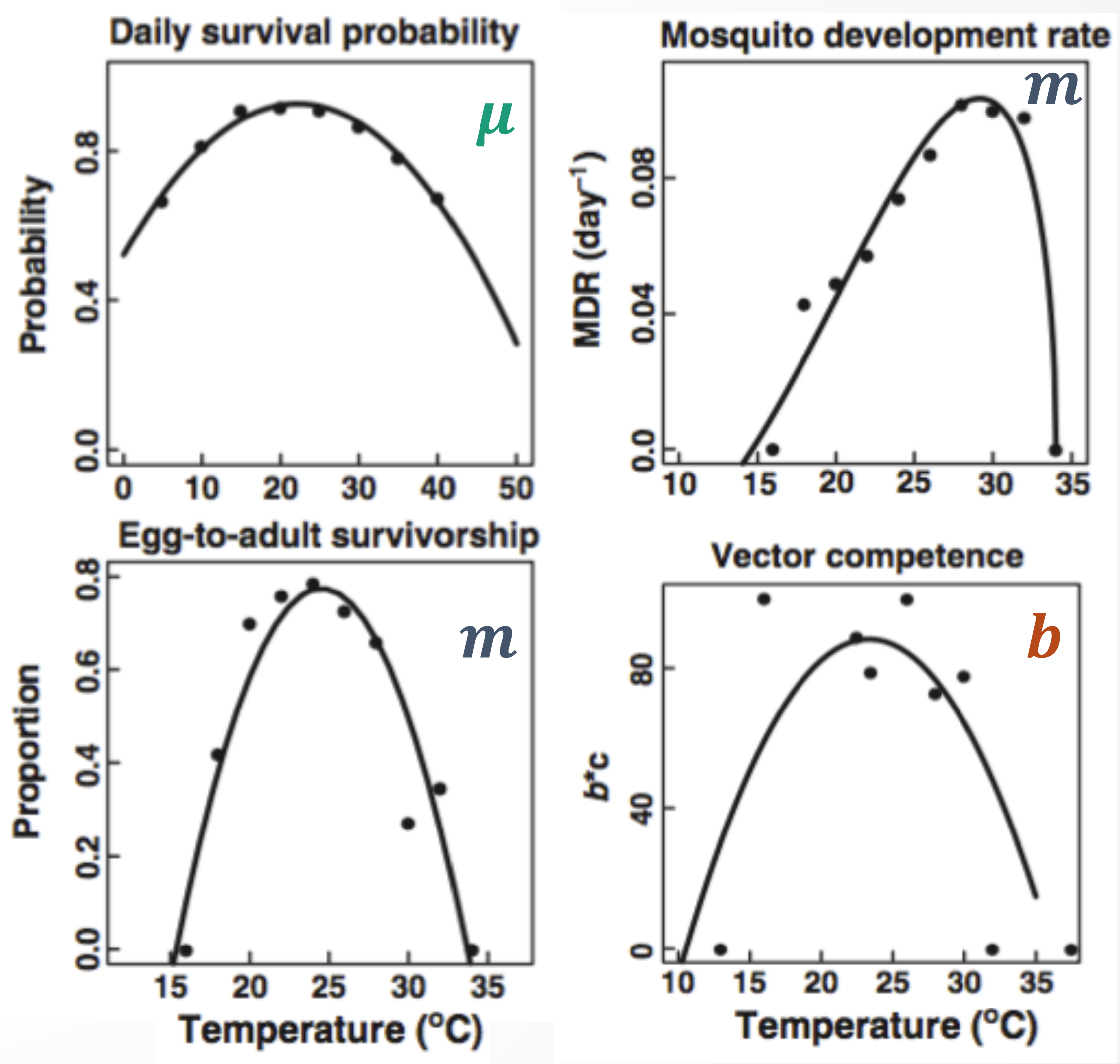
- Developed landscapes have a wide range of climates, termed microclimates
- Current predictions of vector borne disease focus on a much coarser scale, ignoring the heterogeneity of the landscape

How is mosquito-borne disease risk impacted by fine-scale changes in microclimate across a heterogeneous landscape (e.g. a city)?

# Temperature and Mosquito Traits

- The relationship between temperature and mosquito life-history traits are unimodal
- Many traits contribute to the overall vectorial capacity of a mosquito, i.e. the rate at which future infections arise from one mosquito
- Most traits are not well parameterized, often relying on other species or few data points

$$VC = \frac{ma^2be^{-\mu EIP}}{\mu}$$




Mordecai et al. 2012

How does urban microclimate impact the mosquito traits that vectorial capacity depends on?

Do these changes in traits ultimately lead to changes in mosquito-borne disease risk across human-modified landscapes?

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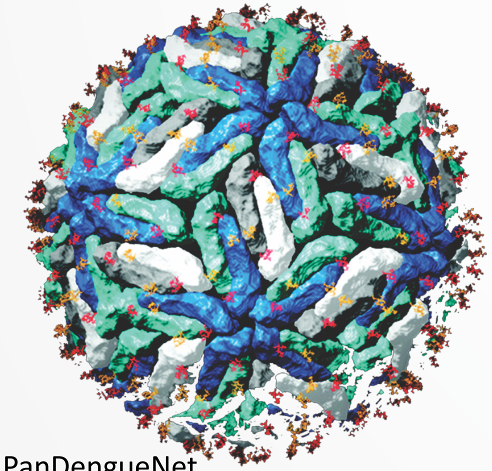
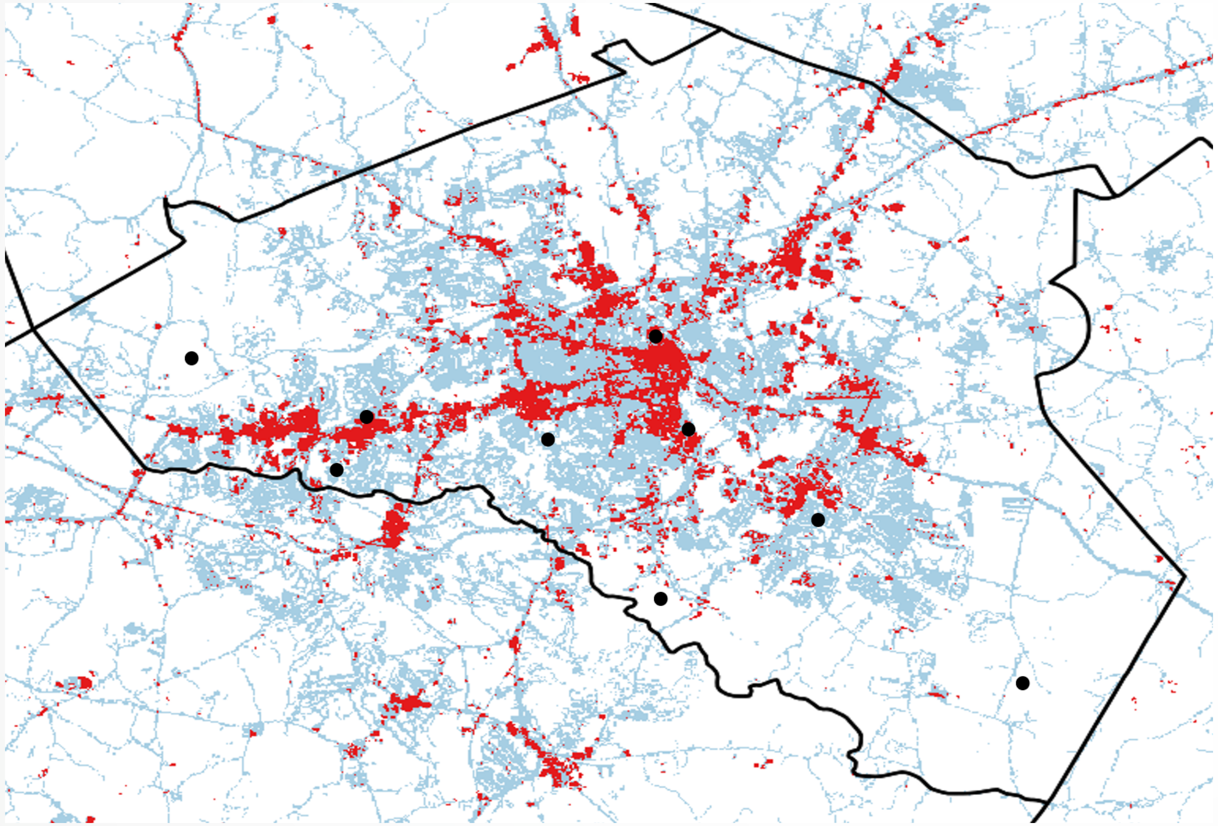


©PanDengueNet

**Model System:**

Dengue Virus in *Ae. albopictus* mosquitoes

# Experimental Design



http://narsal.uga.edu/glut/data-stats/georgia-impervious-surface-trends


Rural


Suburban


Urban

Summer & Fall Trials, 2016

# Experimental Design cont.

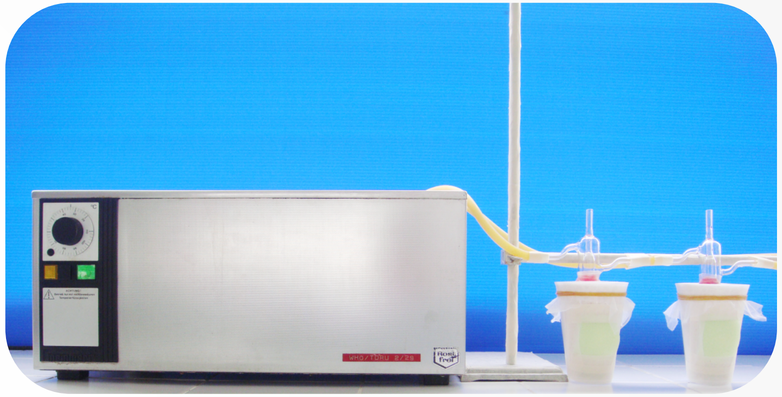
## At each 30 x 30 m site:

100 1st instar Ae. albopictus larvae

1 L leaf infusion

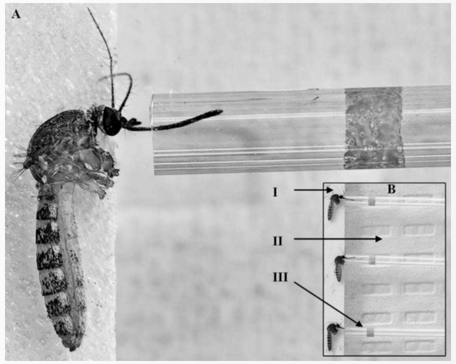
**x4**

Offered dengue infectious blood meal to *Ae. albopictus* aged 4-6 days old



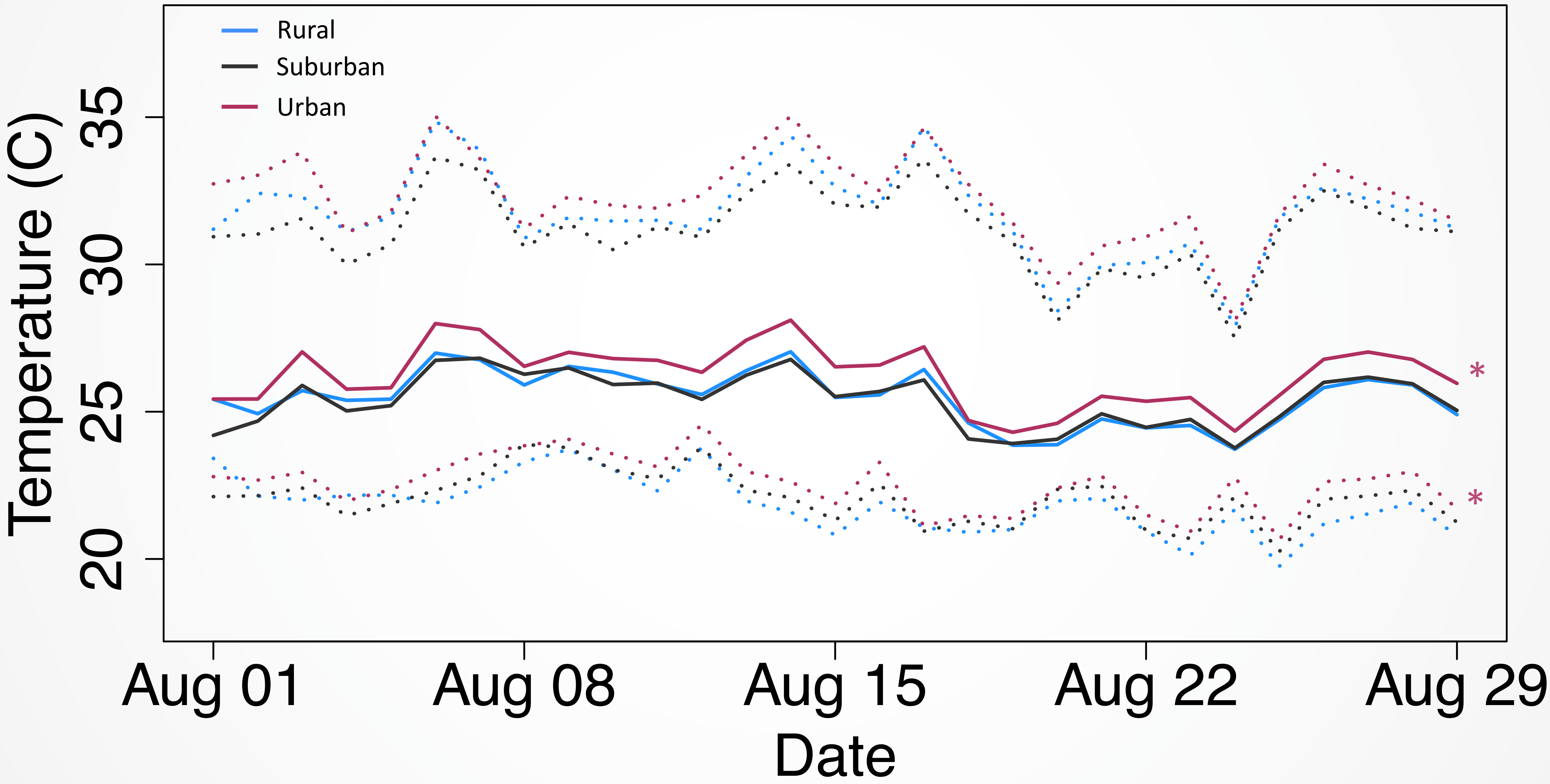
Choochote & Saeung 2013

Tested mosquitoes for dengue infection and infectiousness 14 and 21 days post infection (dpi) & measured wing length



© UnDark

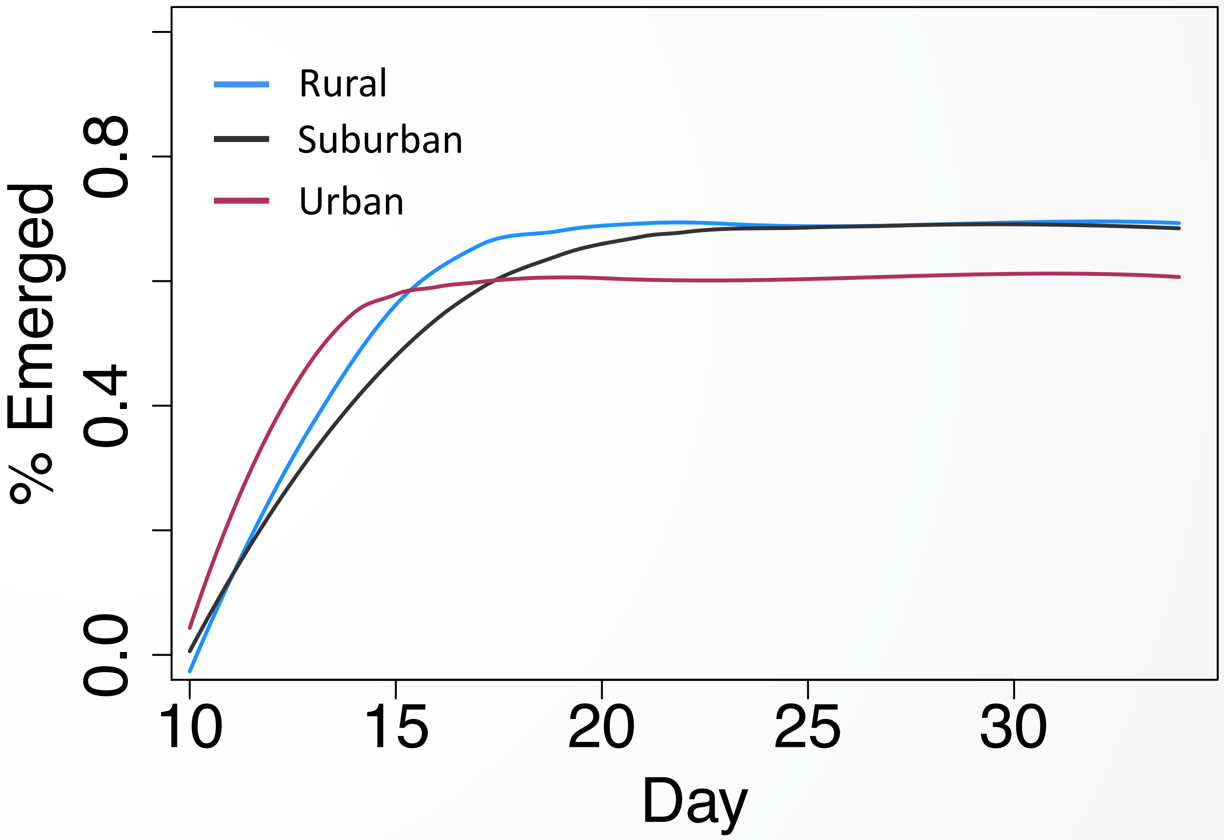
# Average Temperatures



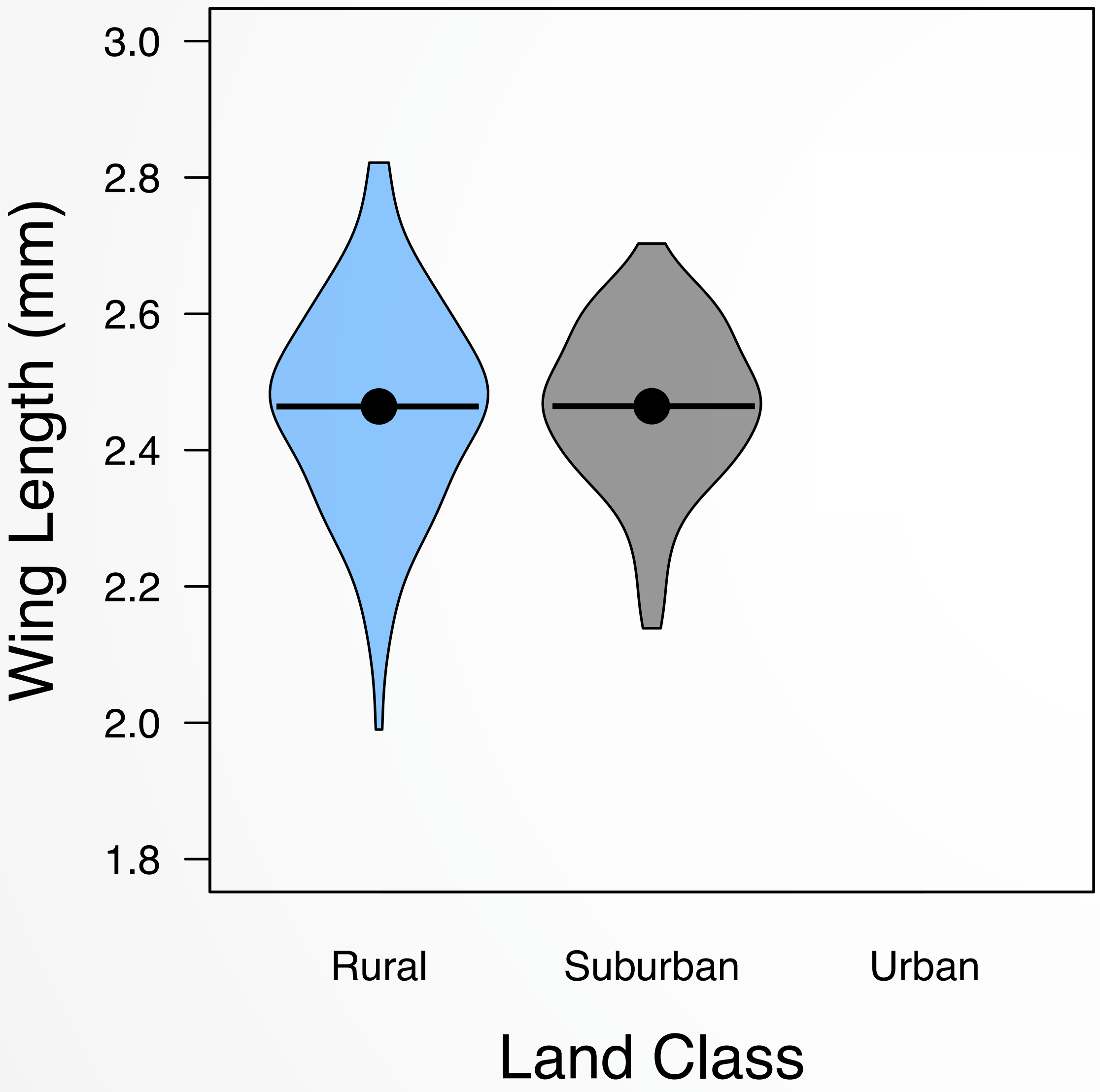
# Female Emergence

Although not significant, there were several trends...

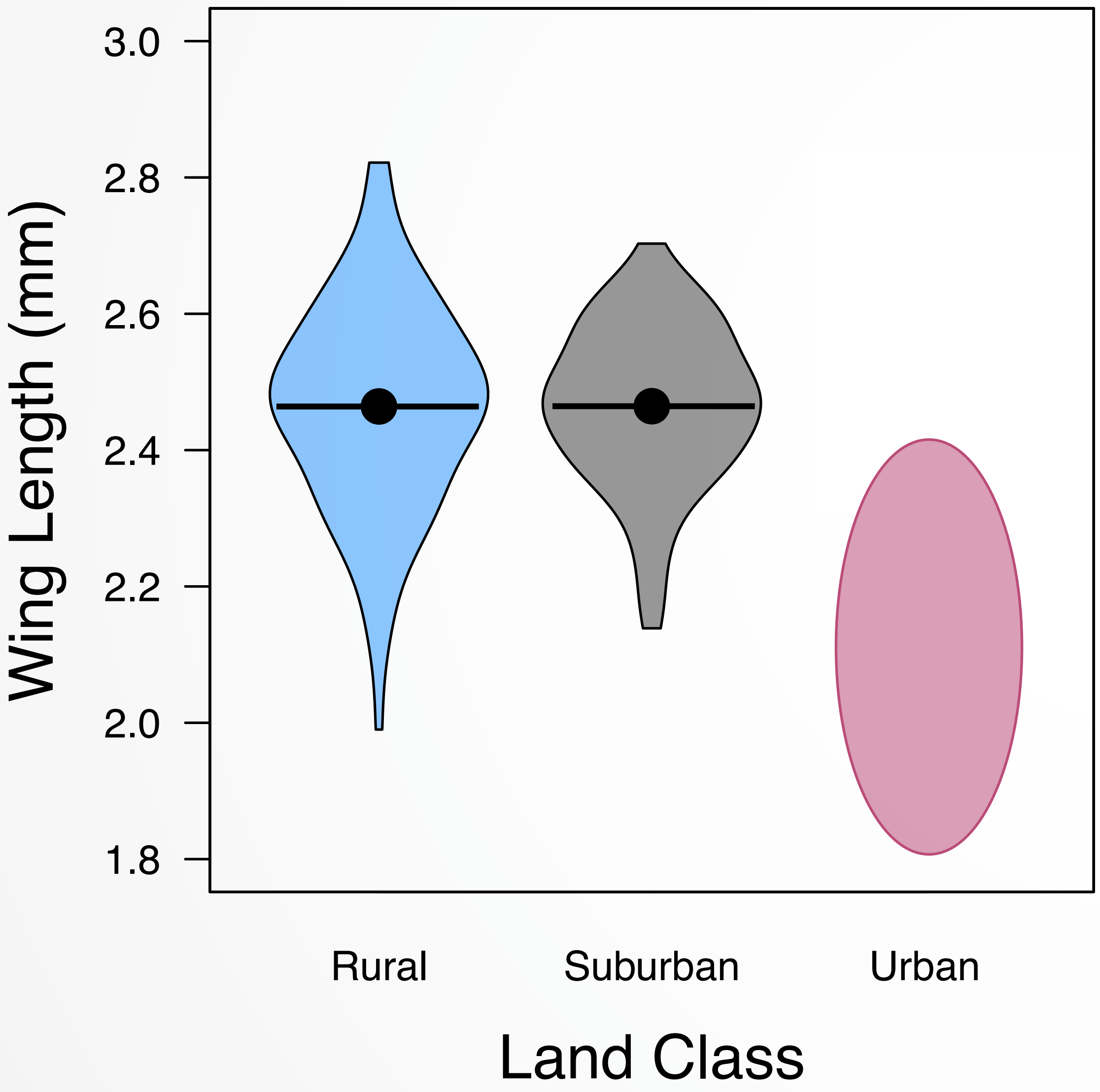
- Mosquitoes emerged earlier and at a faster rate in urban land classes
- Fewer larvae emerged in urban land classes than in rural or suburban



# Female Wing Length



# Female Wing Length



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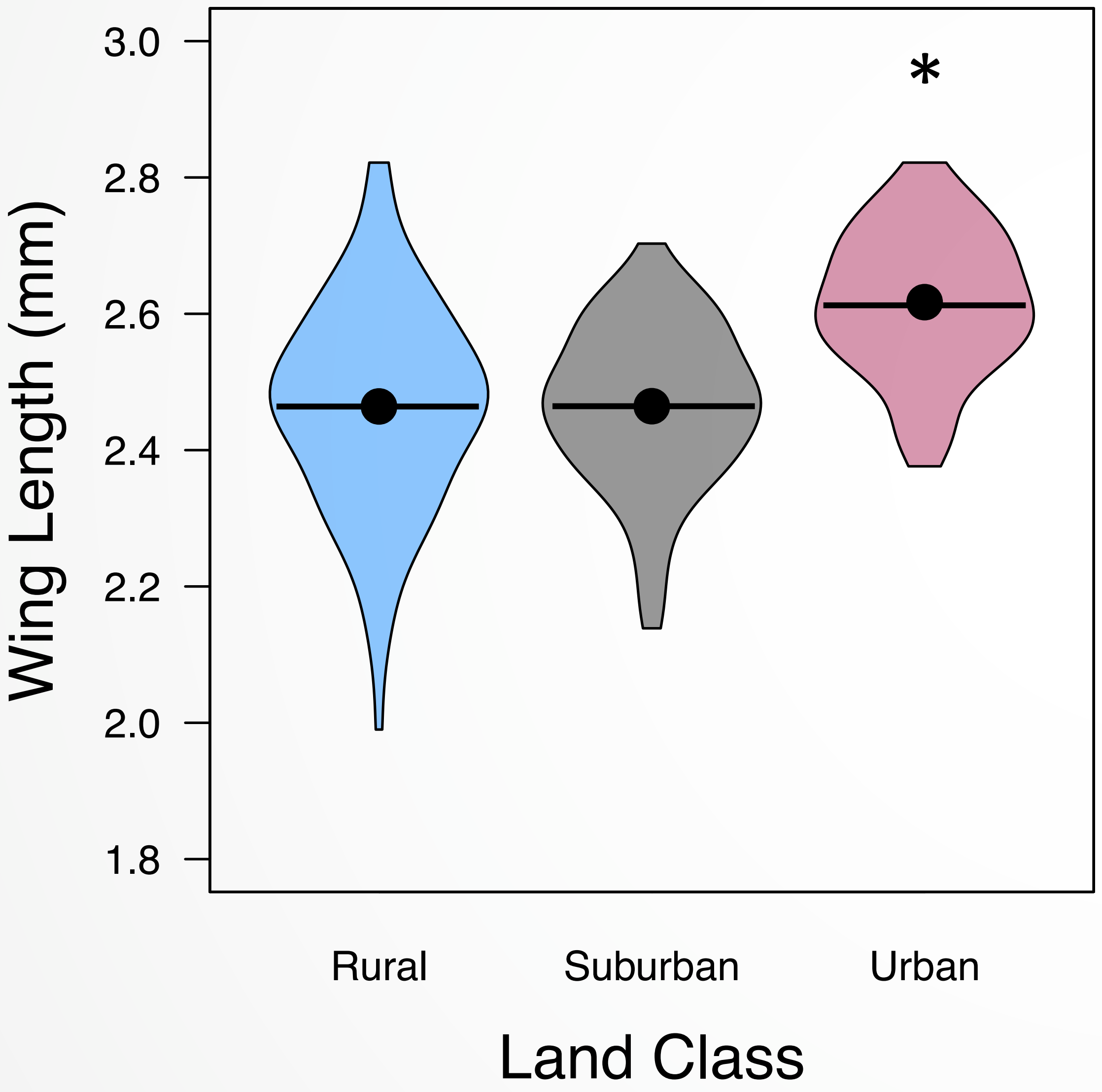

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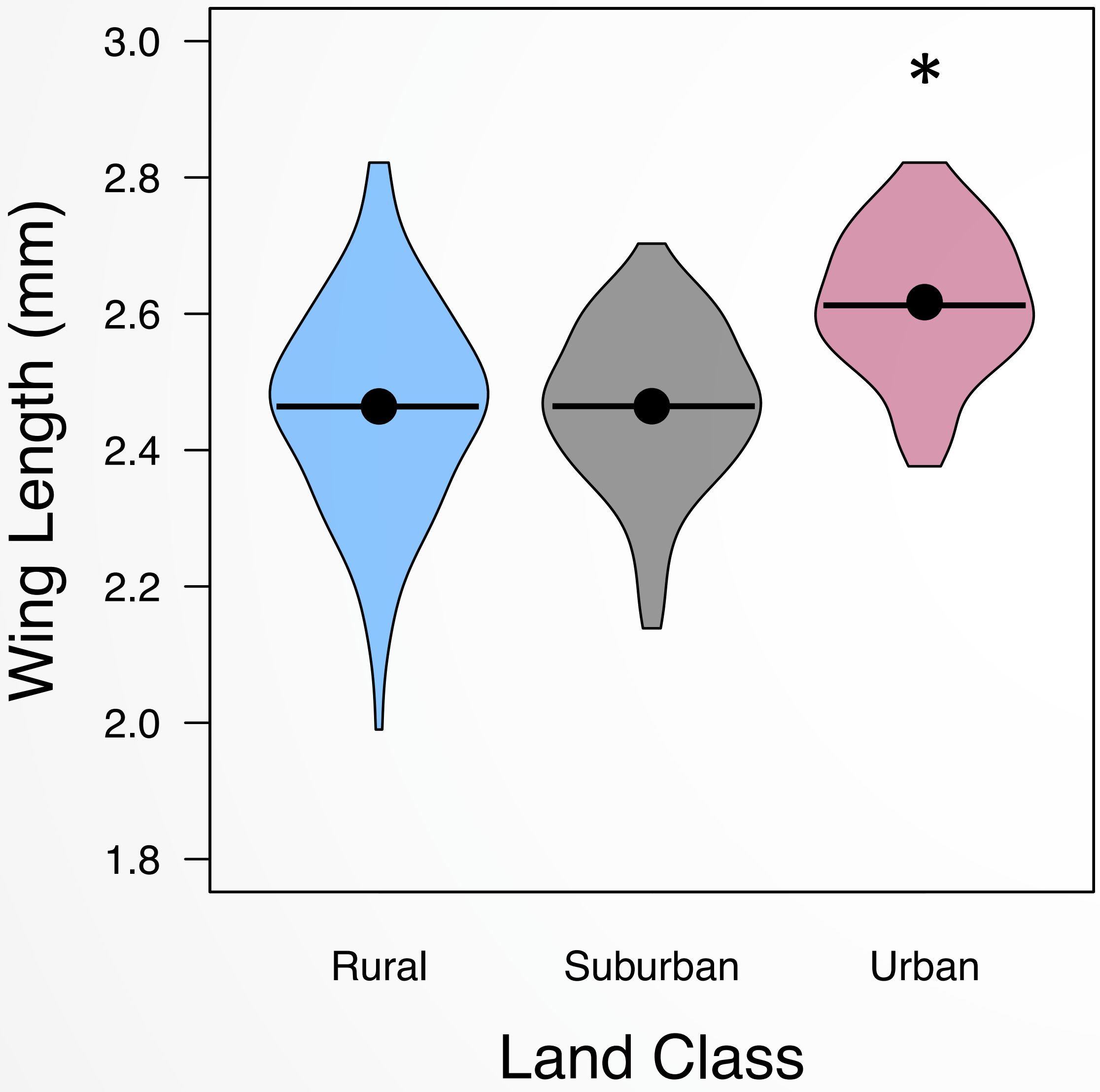


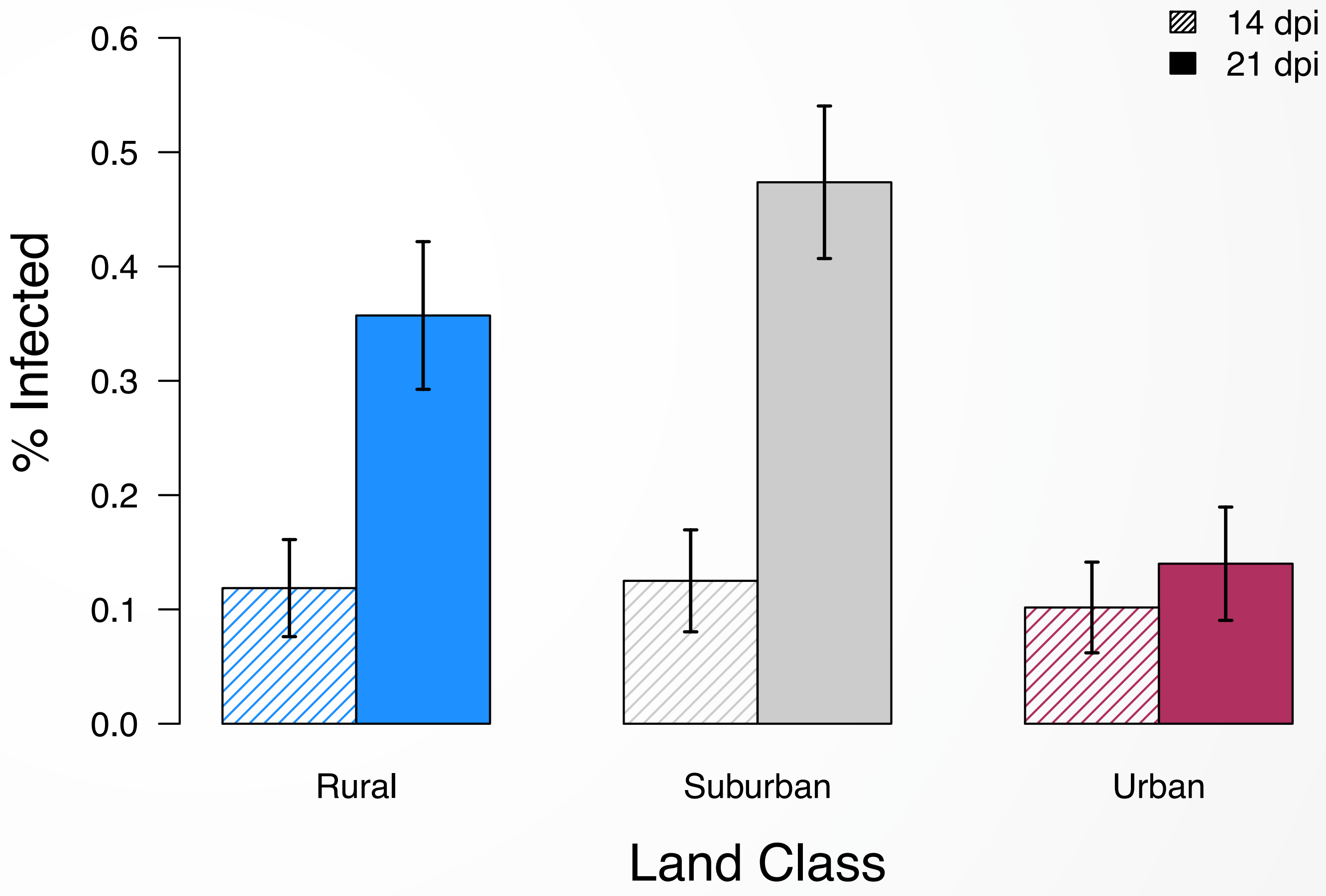

- Mosquitoes in urban sites were significantly larger
- There was a wider range of mosquitoes from rural sites than others

Why the unexpected results?

- Only a subsample (n=60) of ~200 females per site
- These mosquitoes were ones that survived dengue infection, and smaller mosquitoes may not have survived to the sample time point

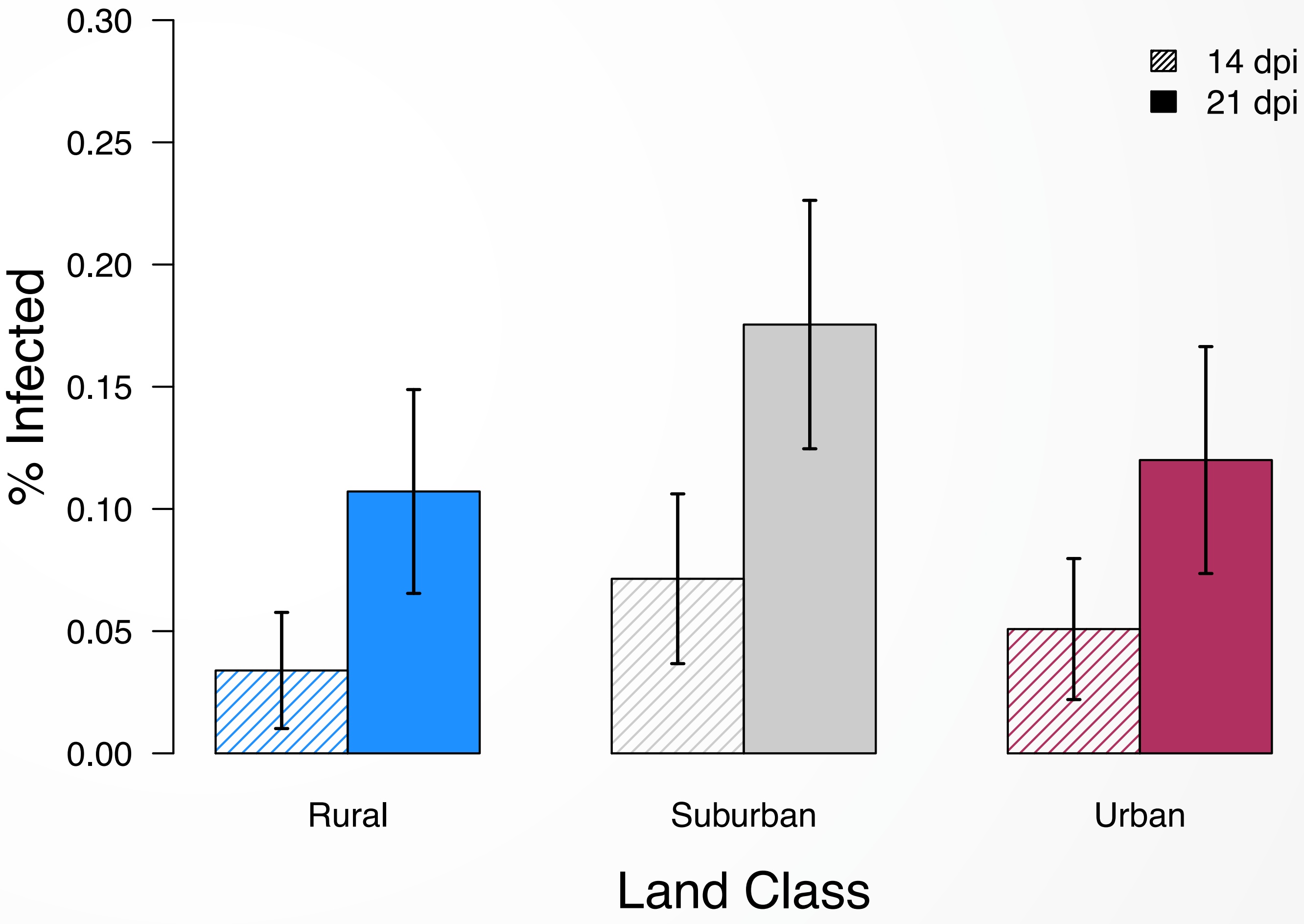
# Mosquito Infections (Body)

- Mosquitoes sampled at 21 days were significantly more likely to be infected than those at 14 days
- Urban sites had the lowest infection rates
  - Perhaps due to the larger body size
- Suburban mosquitoes were slightly more likely to be infected than rural



# Mosquito Infectiousness (Saliva)

- No clear trend in infectious mosquitoes
- Lower numbers of infectious mosquitoes vs. infected mosquitoes (body)
- Between 0 – 25% infectious rates by site



# Implications for Disease Risk

$$VC = \frac{ma^2 b e^{-\mu EIP}}{\mu}$$

Lower larval emergence rates

Higher fecundity rates

No change in infectious mosquitoes

Higher larval mortality

Faster EIP rate (maybe)

Next step: Calculate vectorial capacity for each site using these parameters we measured in the field

# Complementary Work

- Currently conducting the fall trial of this experiment
- Bi-weekly adult sampling
- Larval habitat sampling
- Incorporate field-derived data into a spatial and temporal model of mosquito-borne disease risk



# Thank you!

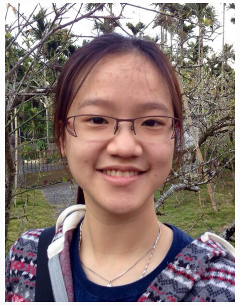
## The Murdock Lab

Nikki Solano
(REU Student)

## Research Assistants

Diana Diaz

Justine Shiau



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Integrative Conservation Ph.D. Program

CENTER FOR THE ECOLOGY OF INFECTIOUS DISEASES

The Graduate School
THE UNIVERSITY OF GEORGIA
1785

mvevans@uga.edu

mvevans89 mv_evans