Effects of Latitudinal Variation on *Aedes albopictus* Life History Traits

Georgia Mosquito Control Association Meeting

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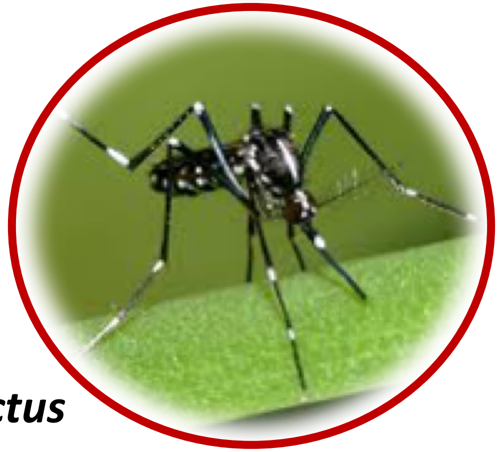
THE UGA® COLLEGE OF VETERINARY MEDICINE
Department of Infectious Diseases

Mosquitoes are important vectors of human disease

Anopheles ssp.

Aedes ssp.

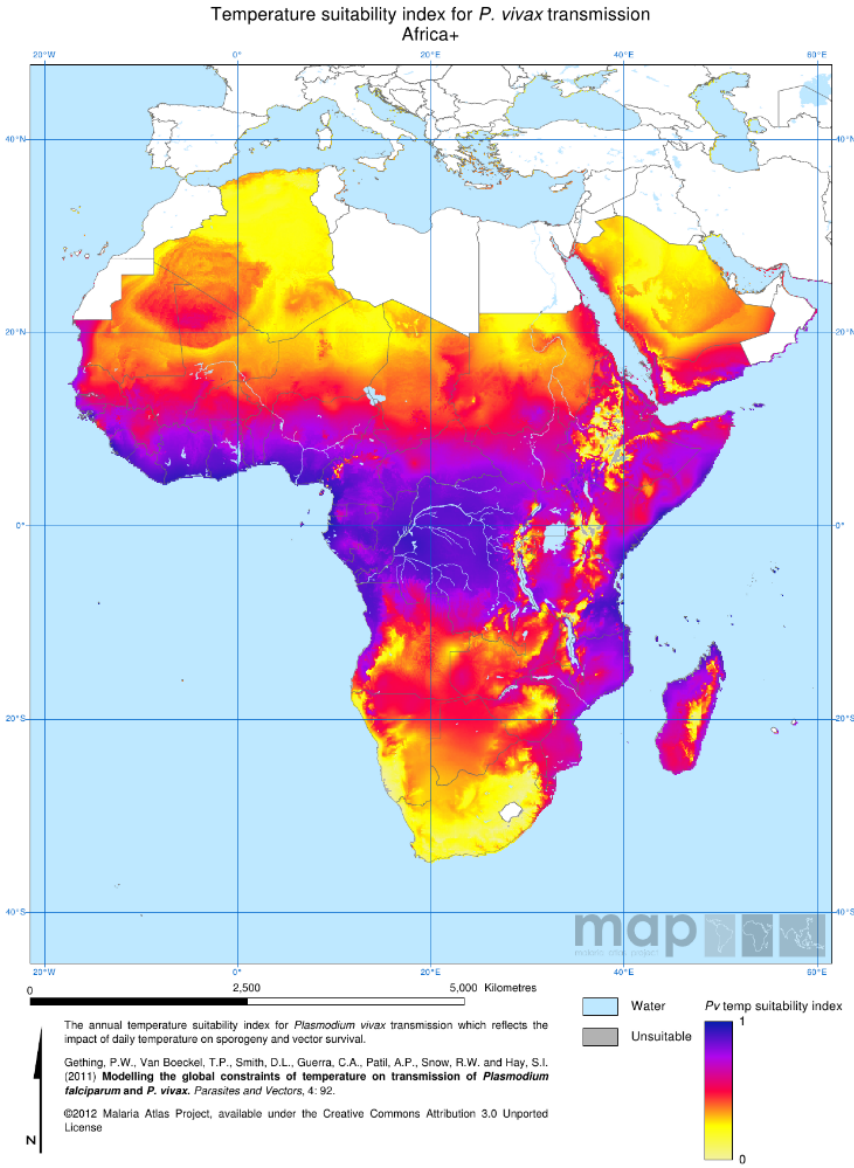
Culex ssp.

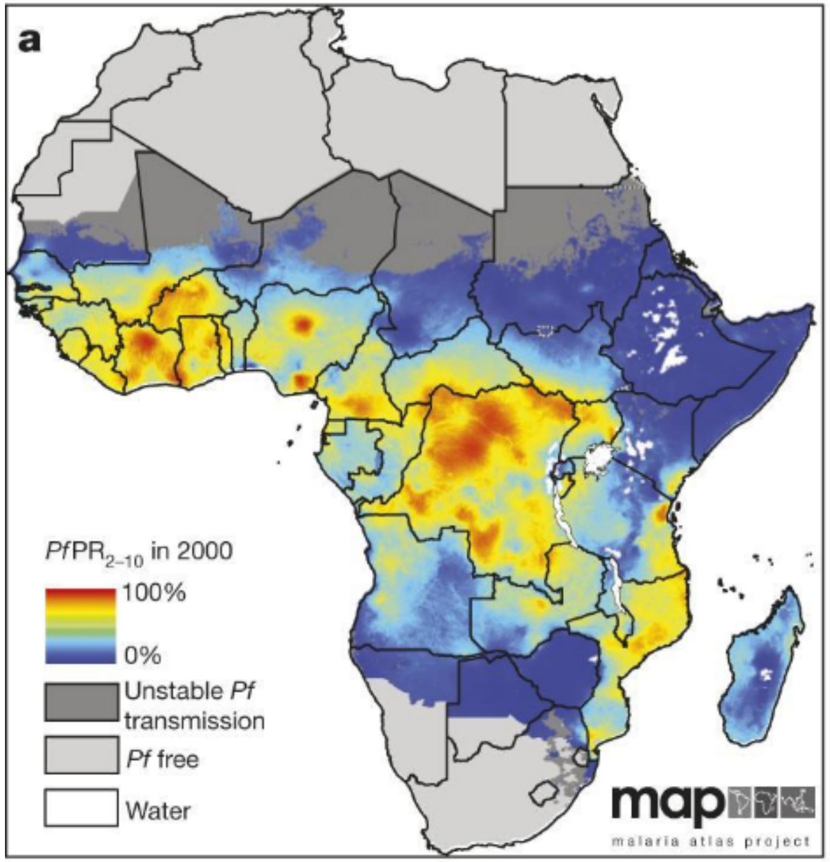


Aedes albopictus

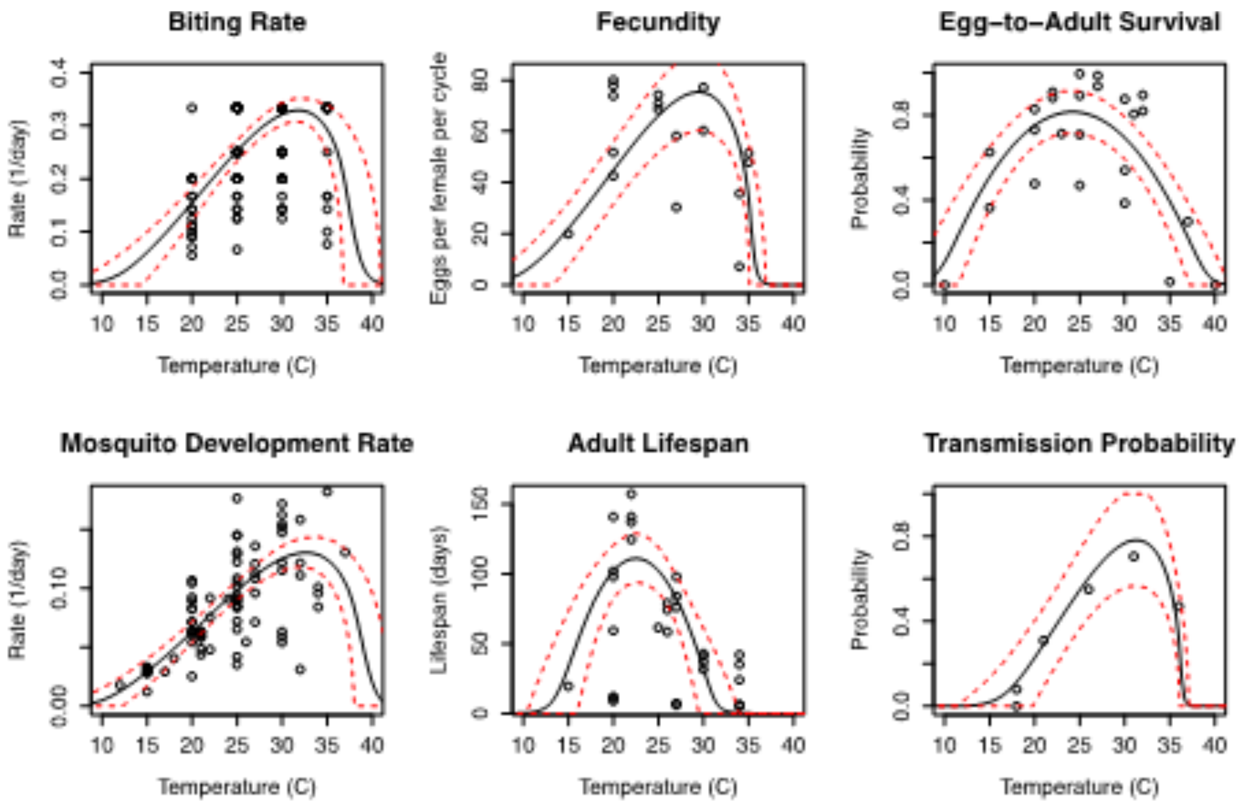
Anopheles freeborni : http://www.cdc.gov/malaria/about/biology/mosquitoes
Aedes albopictus photo: Susan Ellis www.bugwood.org
Aedes aegypti and Culex quinquefasciatus photo: Center for Disease Control Public Health Image Library

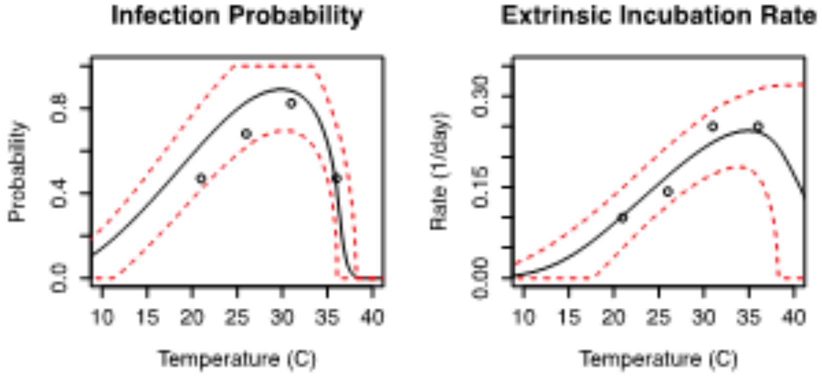
Temperature is an important driver of mosquito-borne disease transmission





Temperature affects important mosquito and pathogen traits





Mordecai et al.
(Under review)

Transmission Risk:

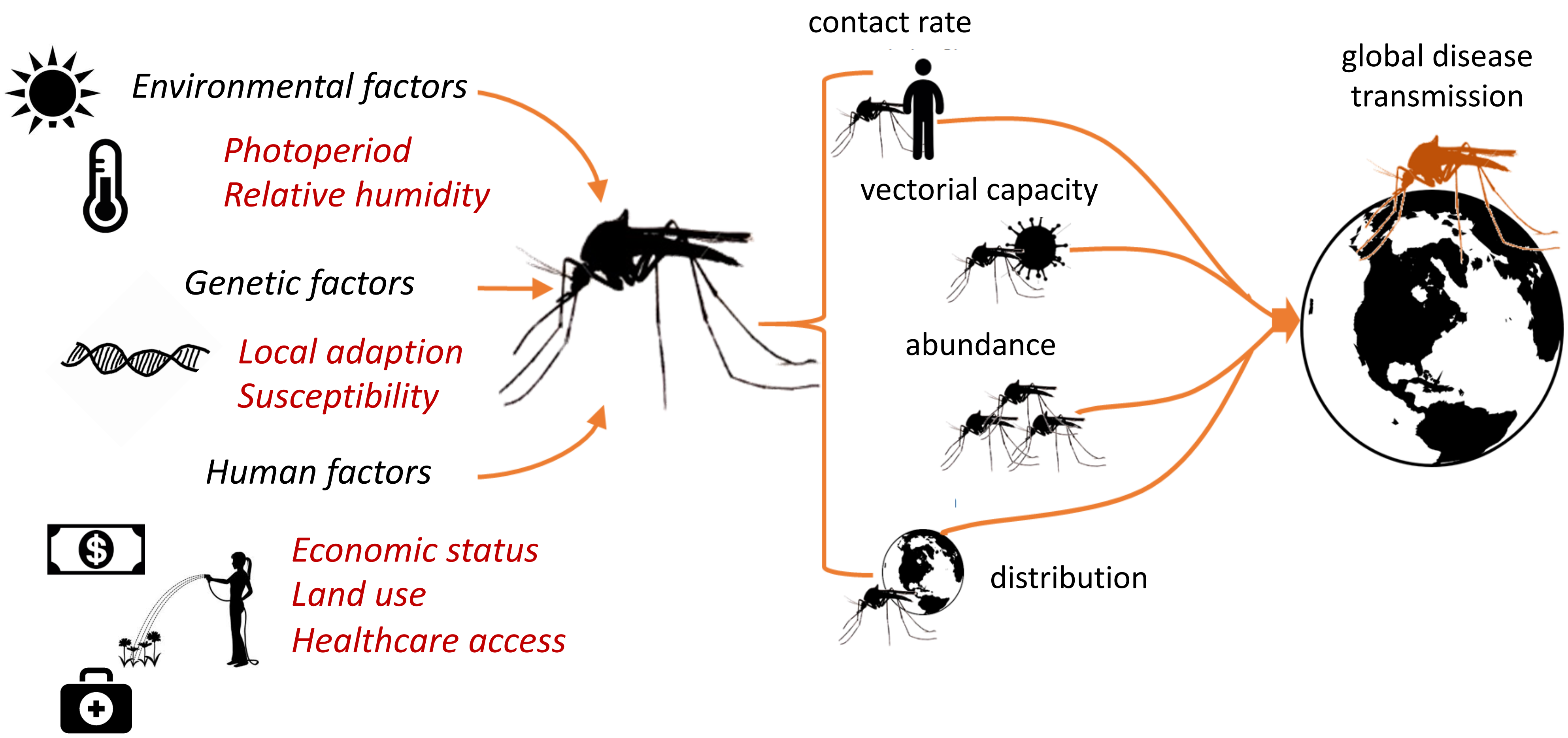
$$M = \frac{EFDpe}{\tau e \mu}$$

$$R_o = \left(\frac{Ma^2bc^{-\mu EIP}}{Nr\mu}\right)^{1/2}$$

However, there are problems with these transmission models:

- Mechanistic models lack thorough characterization.
- Lack of data on specific species-pathogen pairs
- Temperature alone does not capture all of the variation
- **Fails to incorporate ‘real-life’ complexity**

Many factors influence mosquito-borne disease transmission



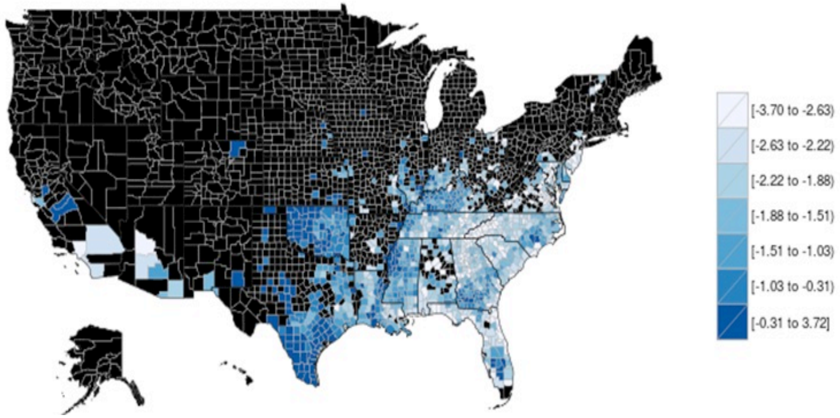
The identification of important sources of 'real-life' variation is essential to understanding of mosquito-borne disease dynamics

Research Objectives

1. Assess the extent of variation in life history traits of *Ae. albopictus* populations across their distribution in the United States
    - If there is variation, what are the key drivers? (environment, genetics?)
    - Is there evidence of local adaptation?

2. Quantify the extent that *Aedes albopictus* populations vary in their capacity to transmit emerging arboviruses

3. Integrate mosquito traits, pathogen traits, and human risk factors to generate a transmission risk map across the United States



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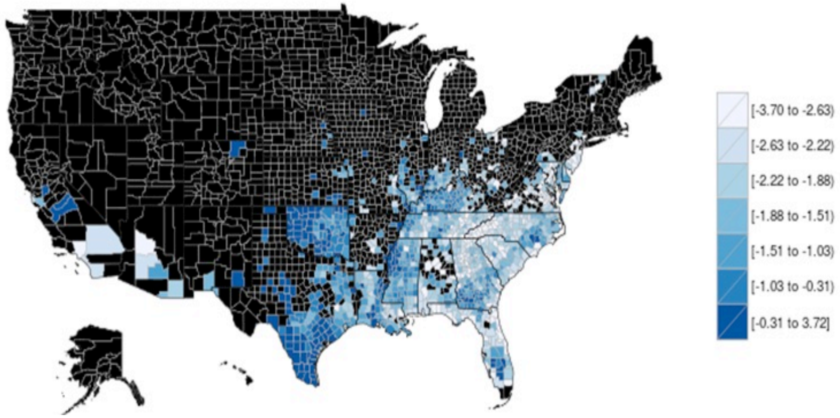
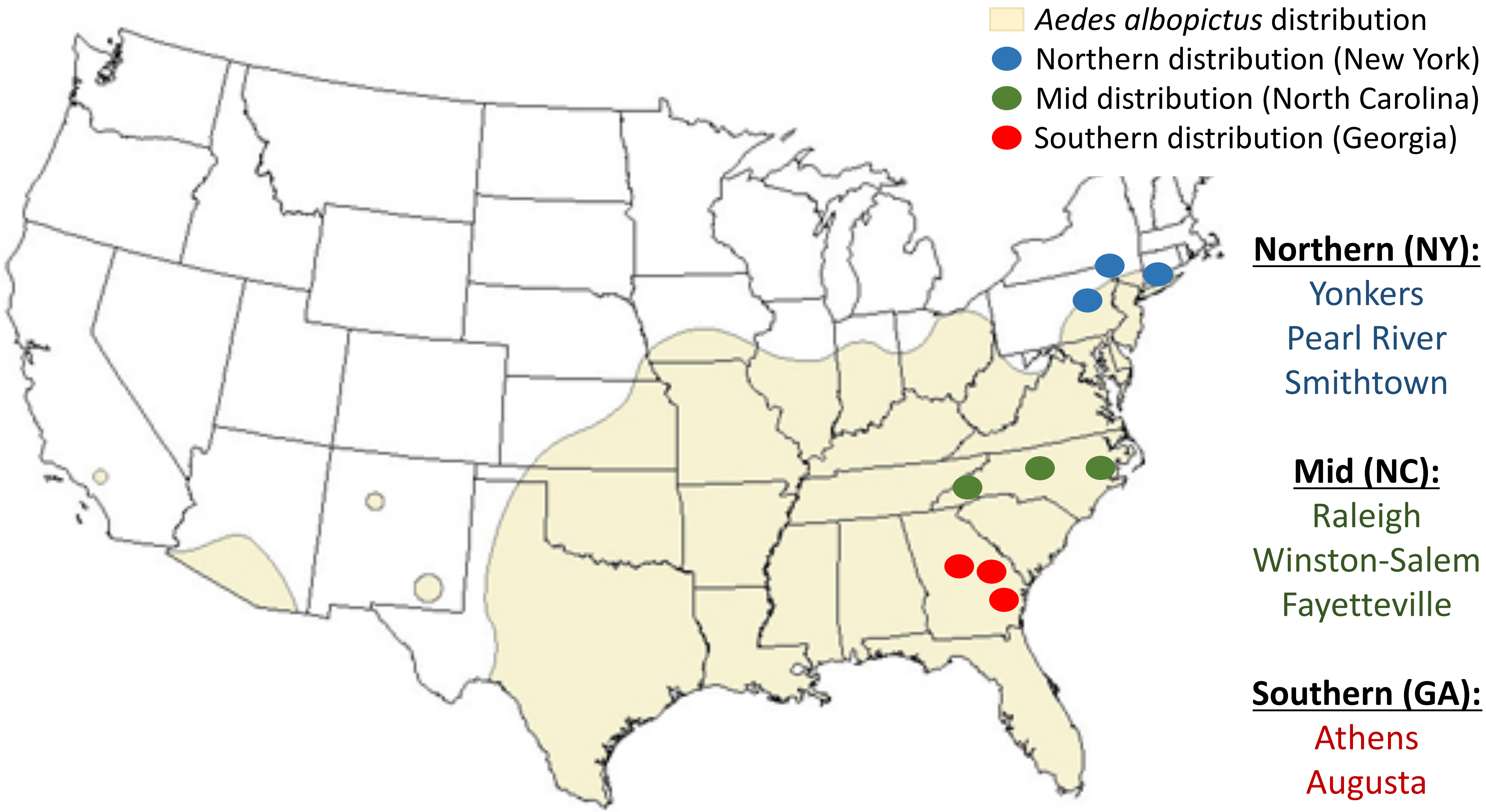


Mosquito Collection Sites



Northern (NY):
Yonkers
Pearl River
Smithtown

Mid (NC):
Raleigh
Winston-Salem
Fayetteville

Southern (GA):
Athens
Augusta
Savannah

Mosquito Larval Collections

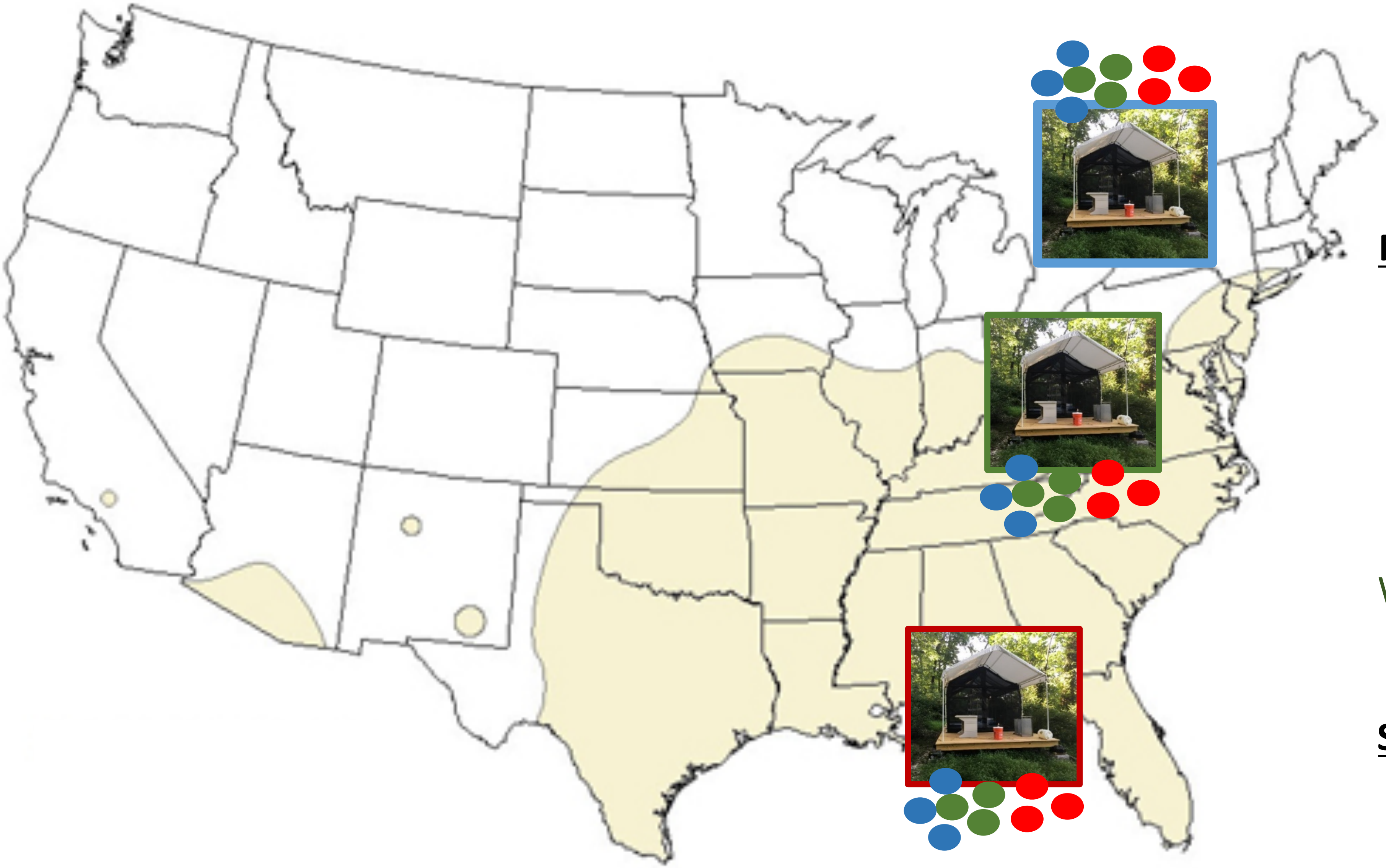
4 collection sites

x9 cities

5 containers

x4 sites

Common Garden Transplant in a Semi-field Enclosure



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Aedes albopictus Life History Traits

N = 50 per tray

1. Proportion of adult emergence (pe)

2. Time to adult emergence (τe)

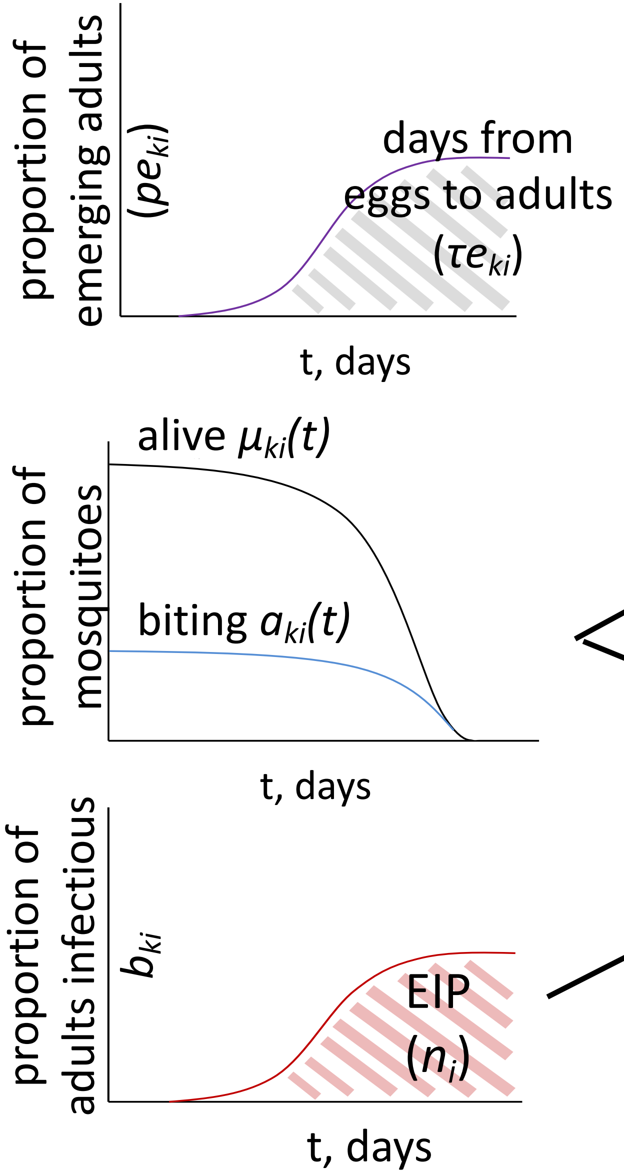
N = 20 per population

1. Daily mortality (μ)

2. Number of eggs a female lays each day (*EFD*)

3. Number of bites a female takes each day (*a*)

Estimating Lifetime Transmission Potential



$$m_{ki}(t) = \frac{EFD_{ki}(t)pe_{ki}(t)}{\tau e_{ki}\mu_{ki}(t)}$$

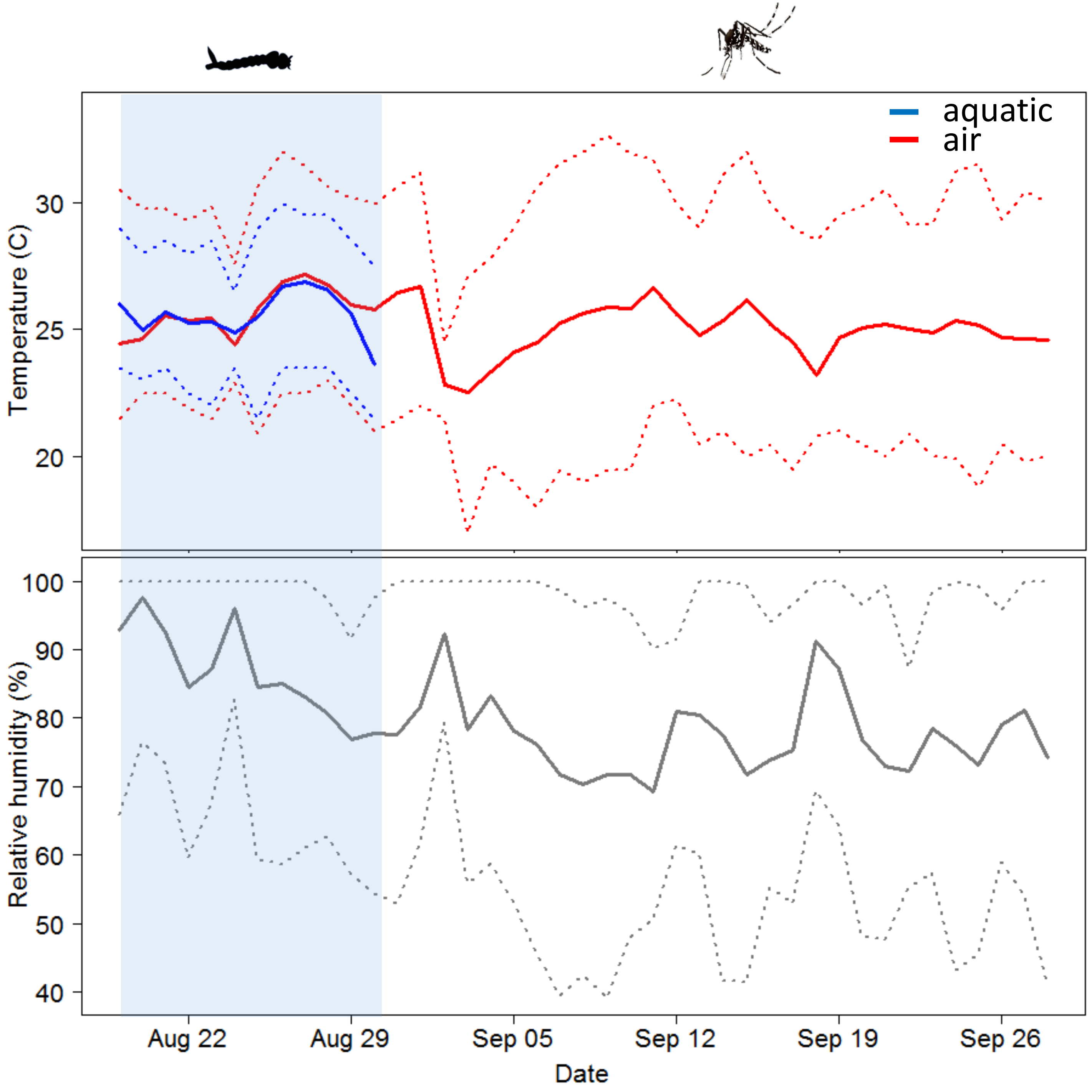
Local Vectorial Capacity$_K$:

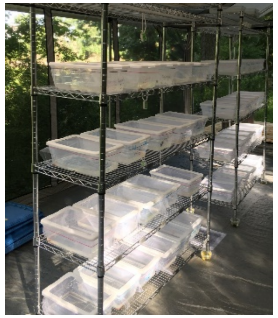
$$VC_{ki}(t) = \frac{m_{ki}(t)a^2{}_{ki}(t)b_{ki}(t)e^{-\mu_{ki}(t)n_{ki}}}{\mu_{ki}(t)}$$

Mosquito Environment in the Georgia Field-enclosure

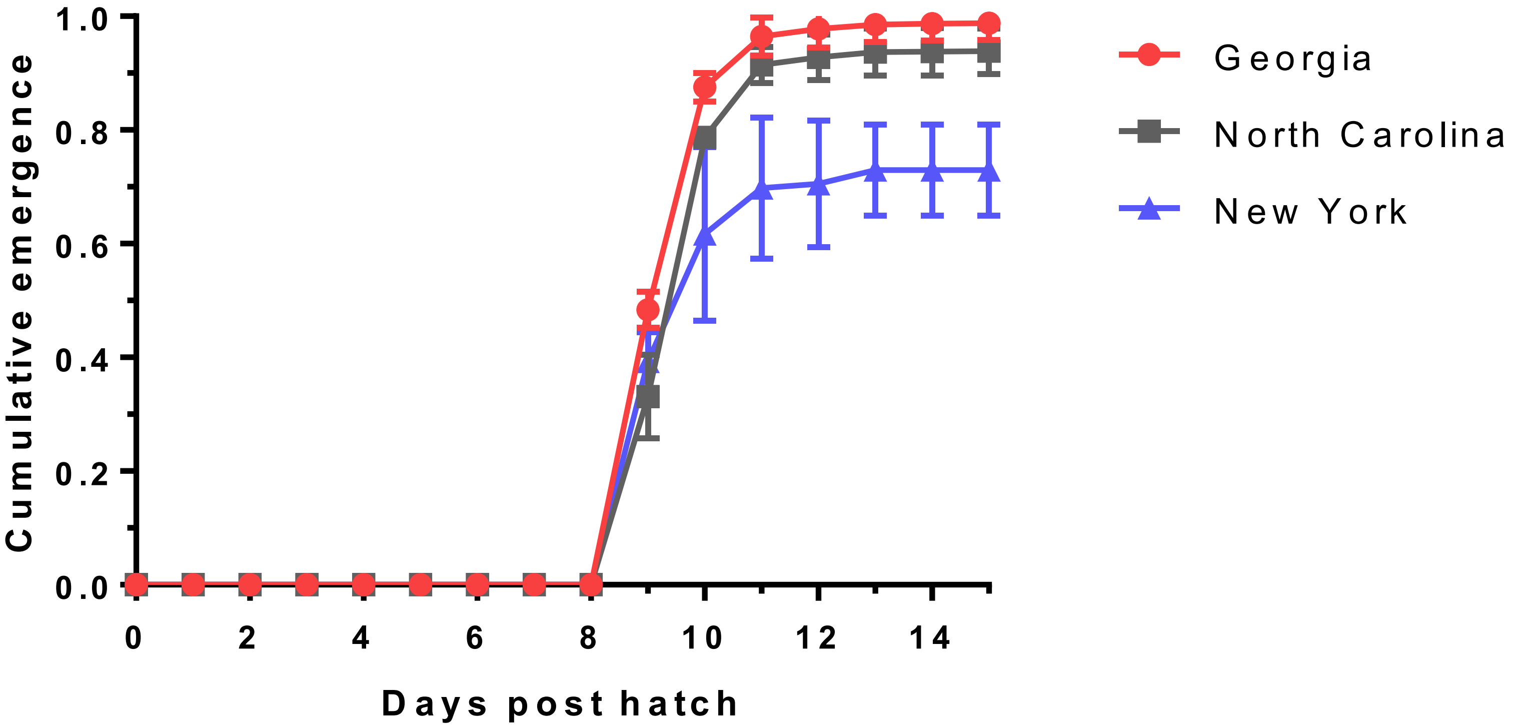
Southern (GA):

T_{mean}	25.2°C
T_{max}	30°C
T_{min}	20.7°C
RH_{mean}	80.1%
RH_{max}	98.1%
RH_{min}	56.2%



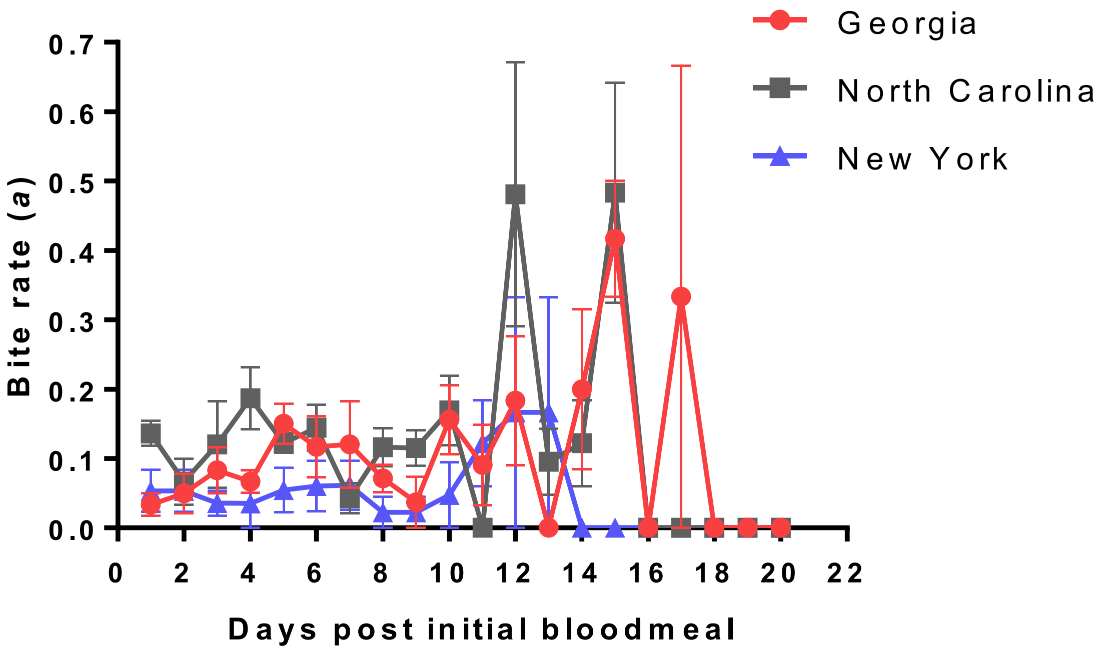


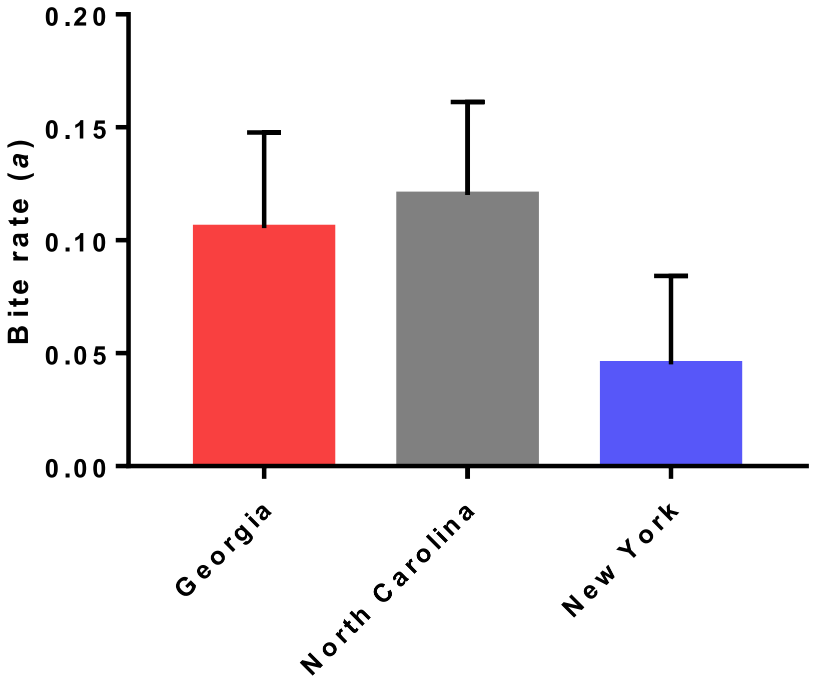
Aedes albopictus from NY had the lowest emergence in Georgia



The majority of emergence events occurred over 2-3 days

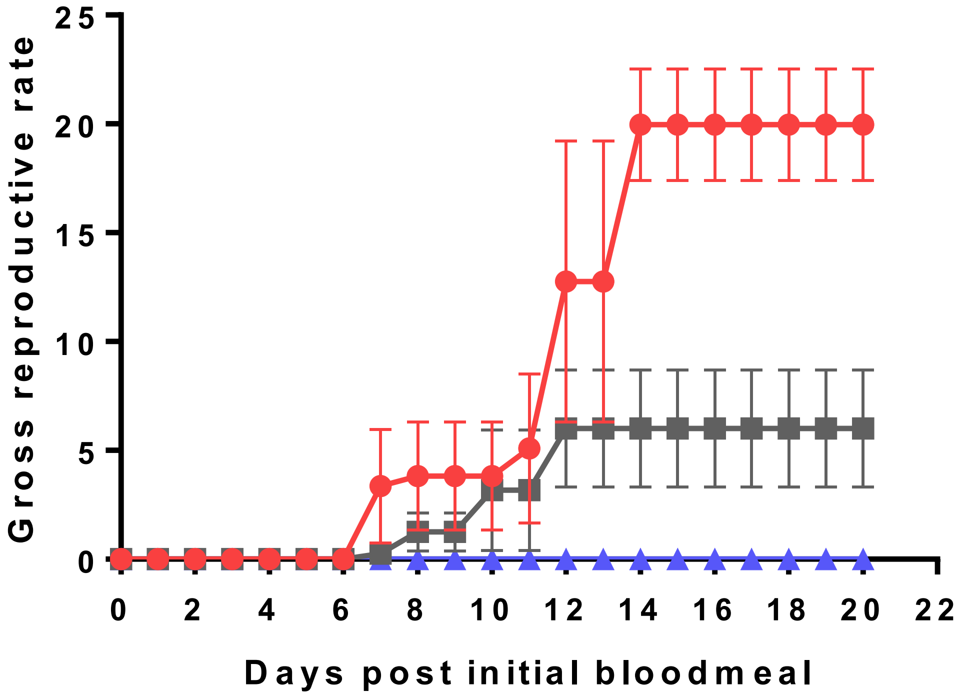
Females from NY had the lowest bite rate in Georgia

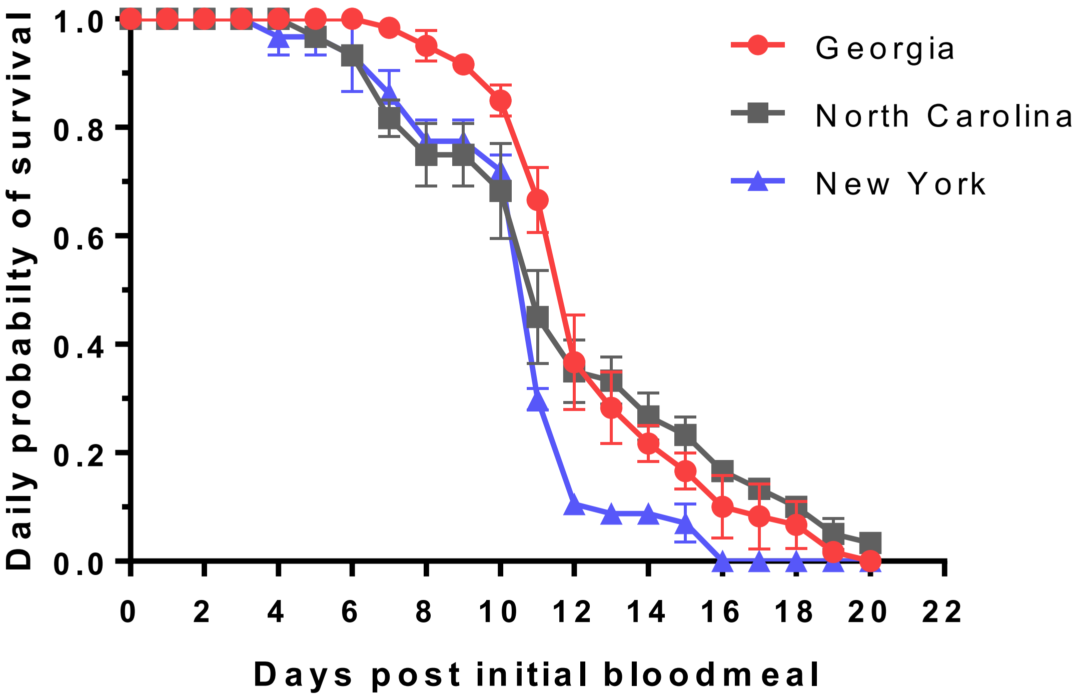




Bite rates across all populations were low (5 -12%)

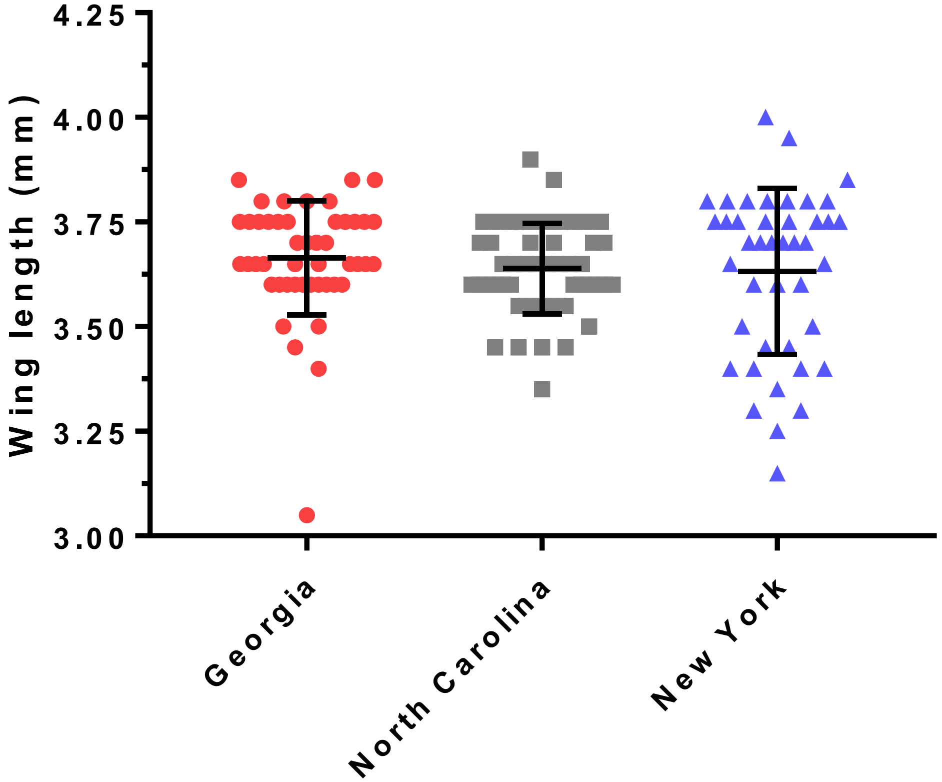
Fecundity and survival display a latitudinal trends in Georgia





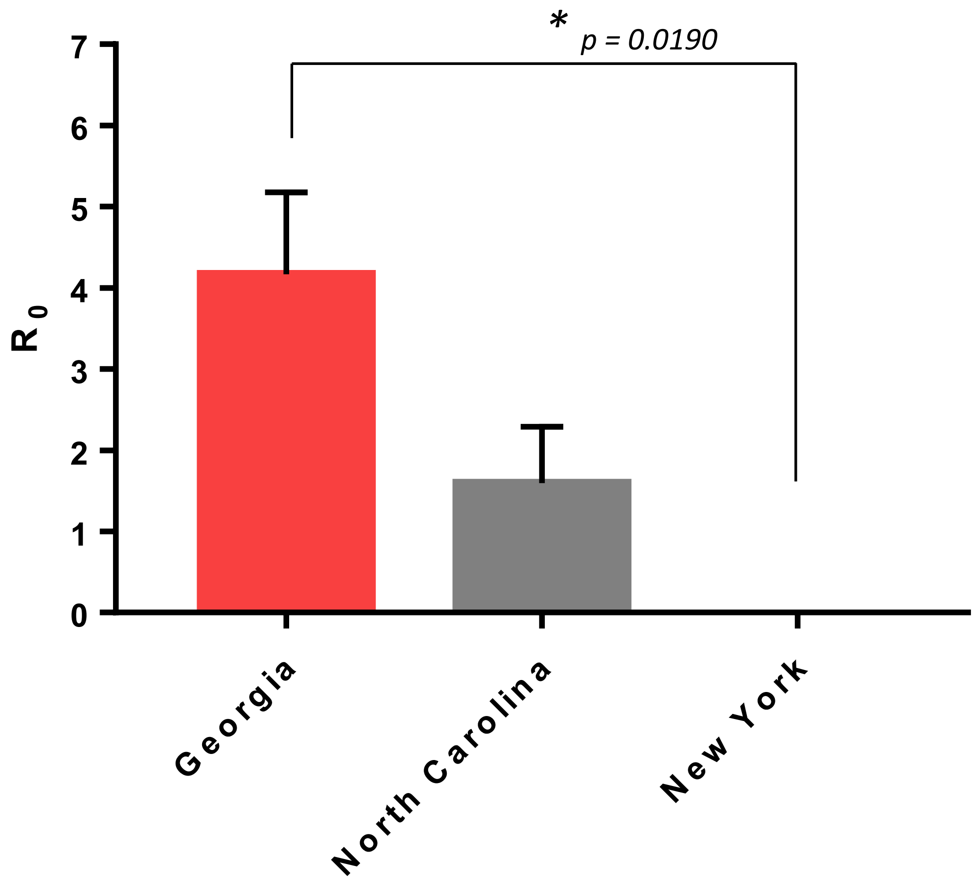
NY populations did NOT produce any eggs and had the lowest probability of survival

Female adults had comparable wing lengths

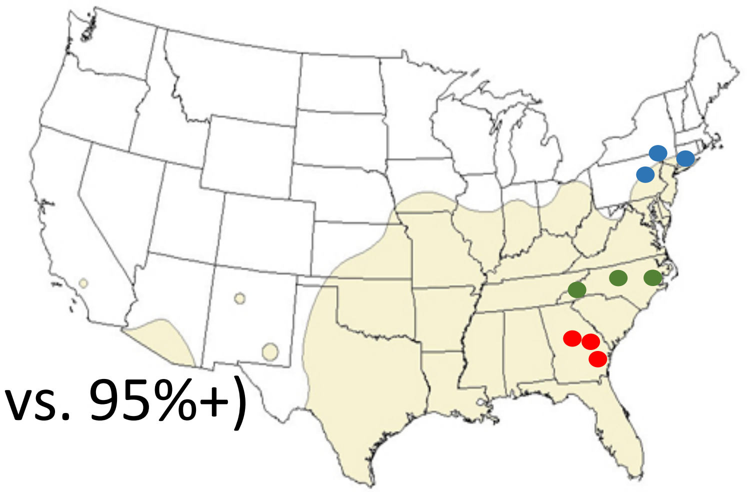


In this case, body size is not an accurate predictor of fecundity

Georgia populations are most fit in Georgia



"Home" populations are most fit -> suggestive of local adaptation



Recap (So far….)

1. Adult emergence
   - The majority of adult emergence occurred over 2-3 days
   - NY populations had lowest emergence proportions (70% vs. 95%+)

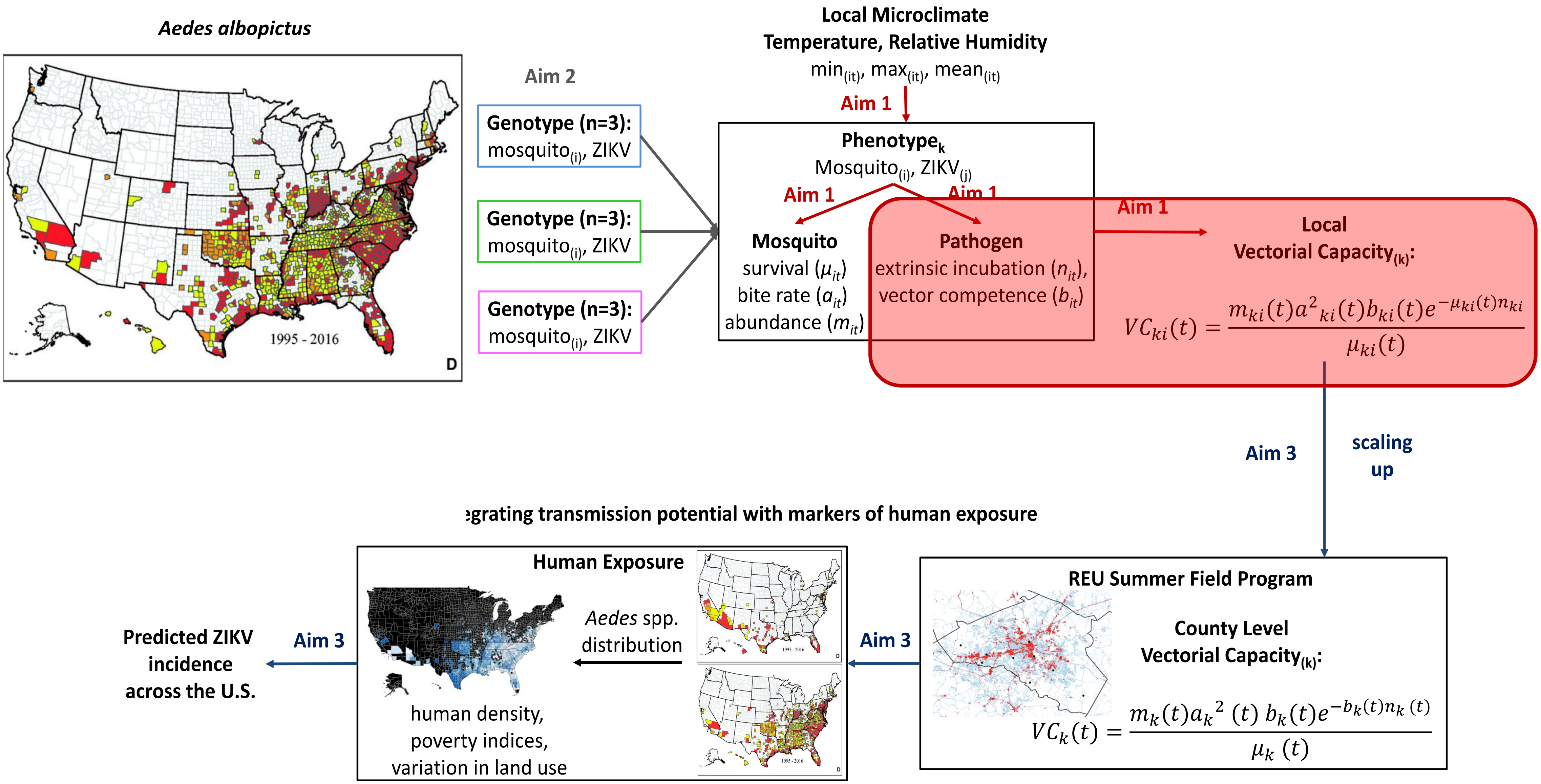
2. Adult life history traits
   - Bite rates were low, with NY having the lowest
   - Fecundity and daily mortality followed a latitudinal trend
   - 'Home' populations were most fit
   - Wing lengths from all populations were comparable

3. Incorporate the NC & NY datasets
   - Variation?
     - within site (*population effects*)
     - across sites (*environmental effects*)

There IS an effect of mosquito population on many life history traits (in Georgia…)

Distinct mosquito populations represent an important source of variation

Next on the agenda….



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