LARVAL COMPETITION ALTERS THE THERMAL NICHE OF VECTOR MOSQUITOES

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ESA Ft. Lauderdale

8 August 2016

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Mosquitoes have temperature-dependent vital rates

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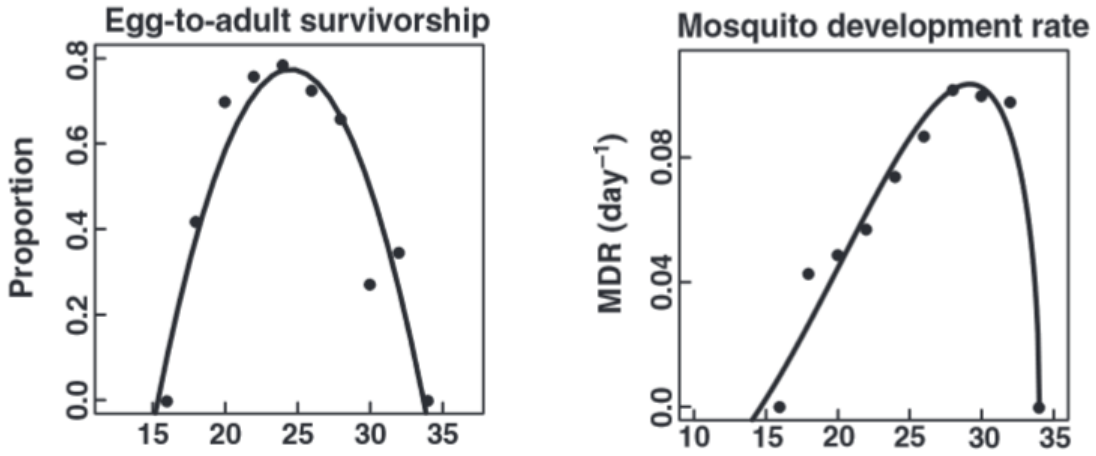
LARVAL STAGE
Survival
Development



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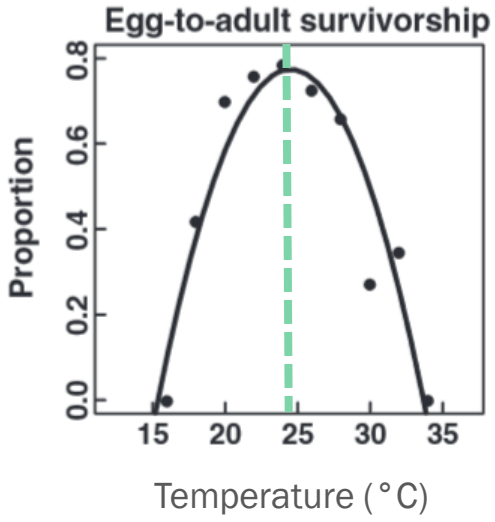
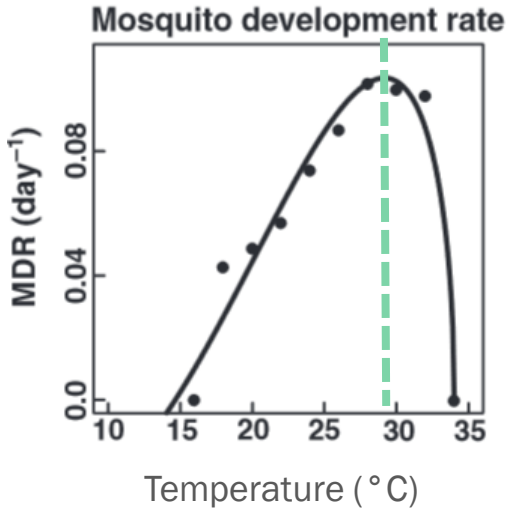
(from Mordecai et al. 2013)

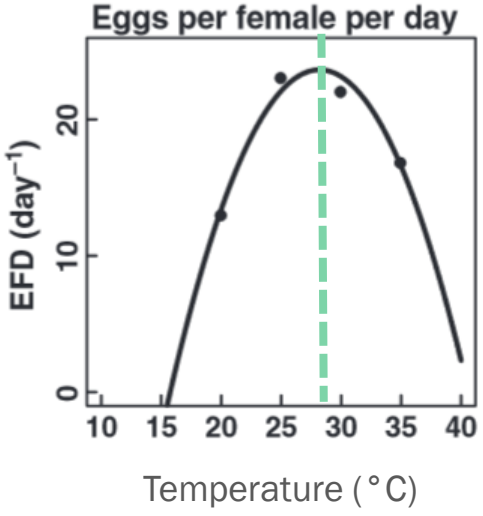
Mosquitoes have temperature-dependent vital rates

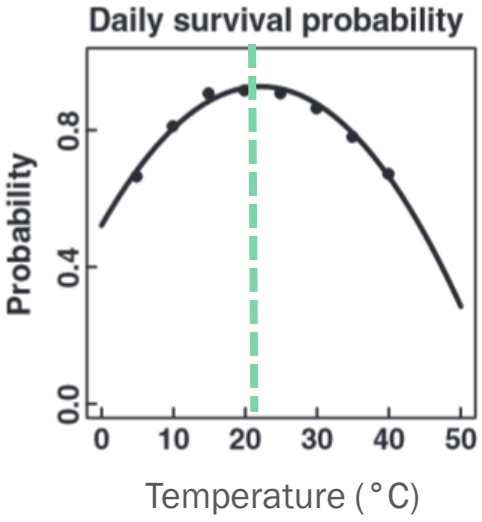
LARVAL STAGE
Survival
Development

ADULT STAGE
Fecundity
Longevity









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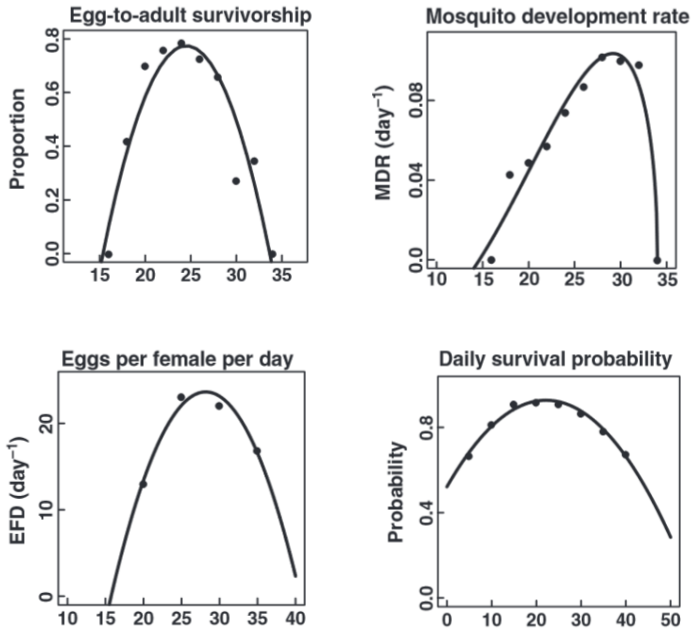
Vital rates determine a species' thermal niche

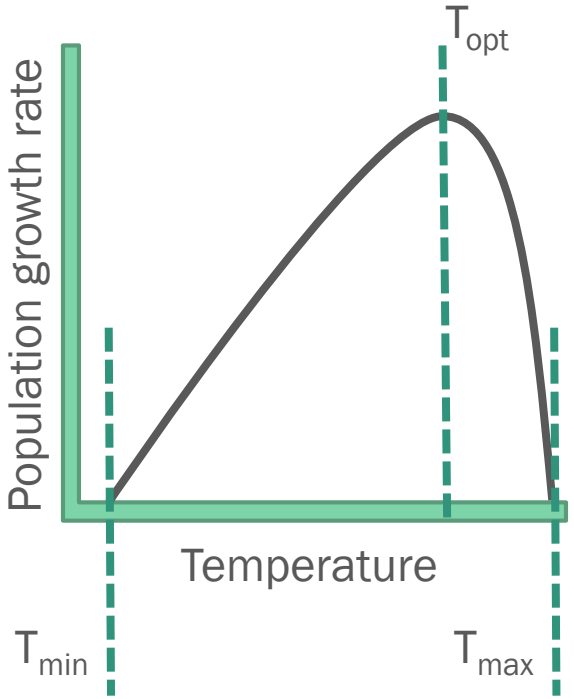
Temperature-dependent vital rates



Population growth rate

$$r' = \frac{ln\frac{1}{N_0}\sum A_x f(\overline{w}_x)}{D + \frac{\sum xA_x f(\overline{w}_x)}{\sum A_x f(\overline{w}_x)}}$$

Thermal niche



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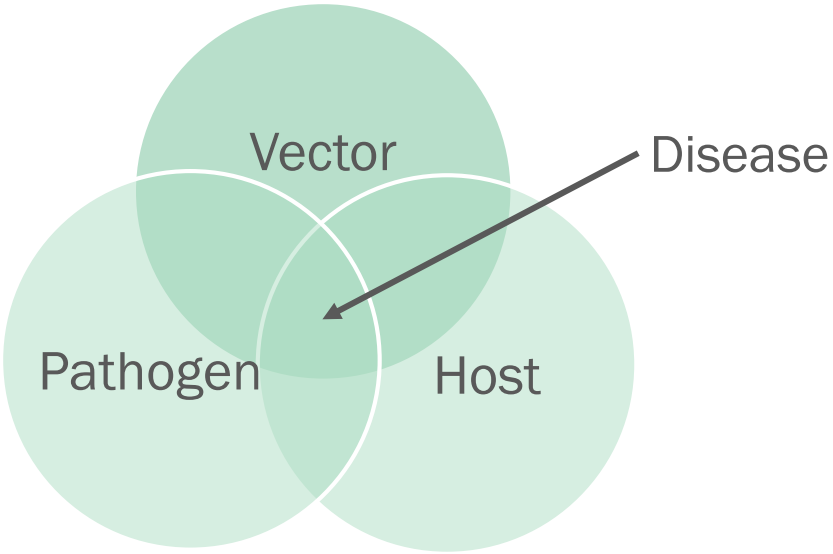
Why is thermal niche important?



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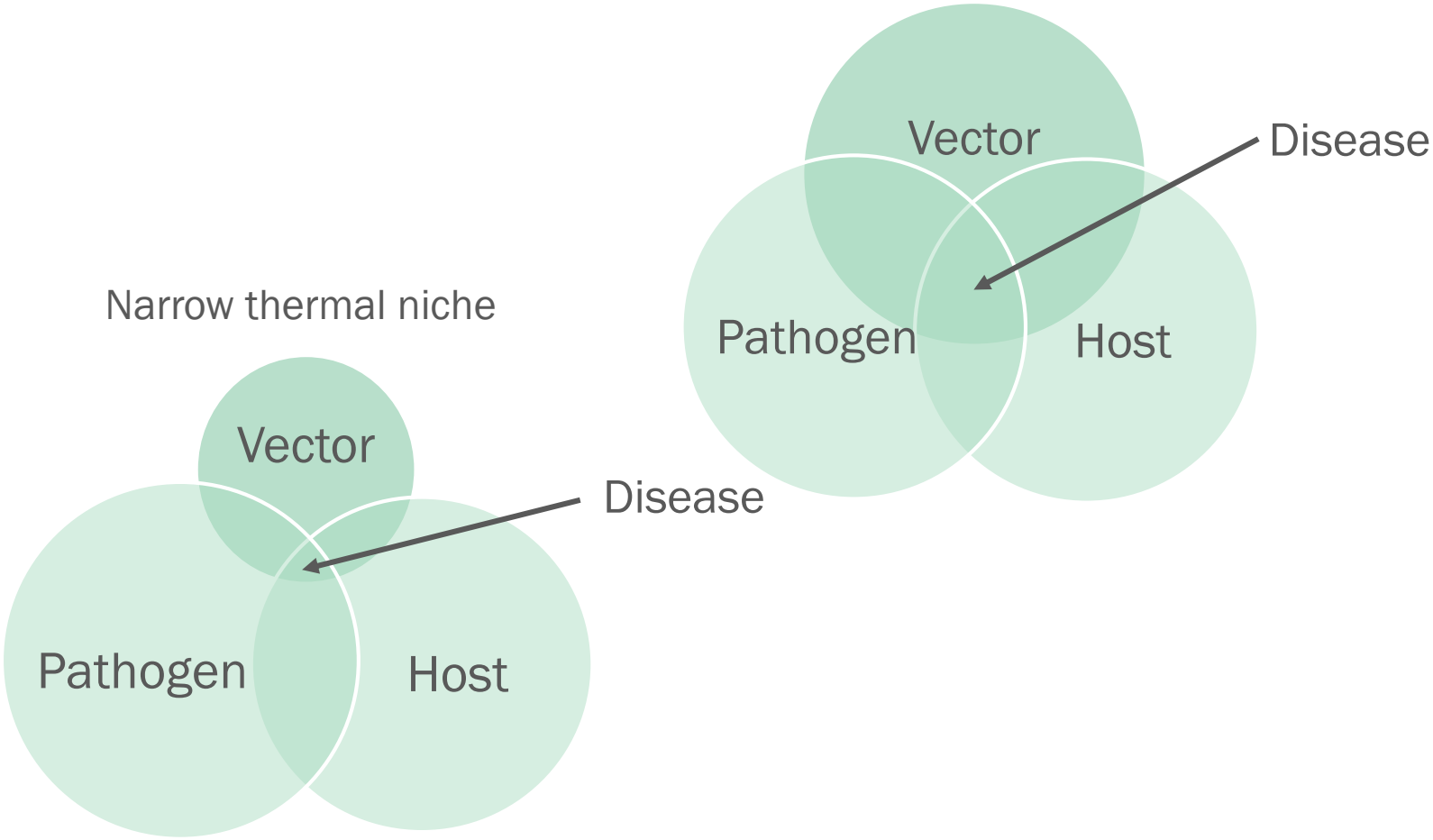

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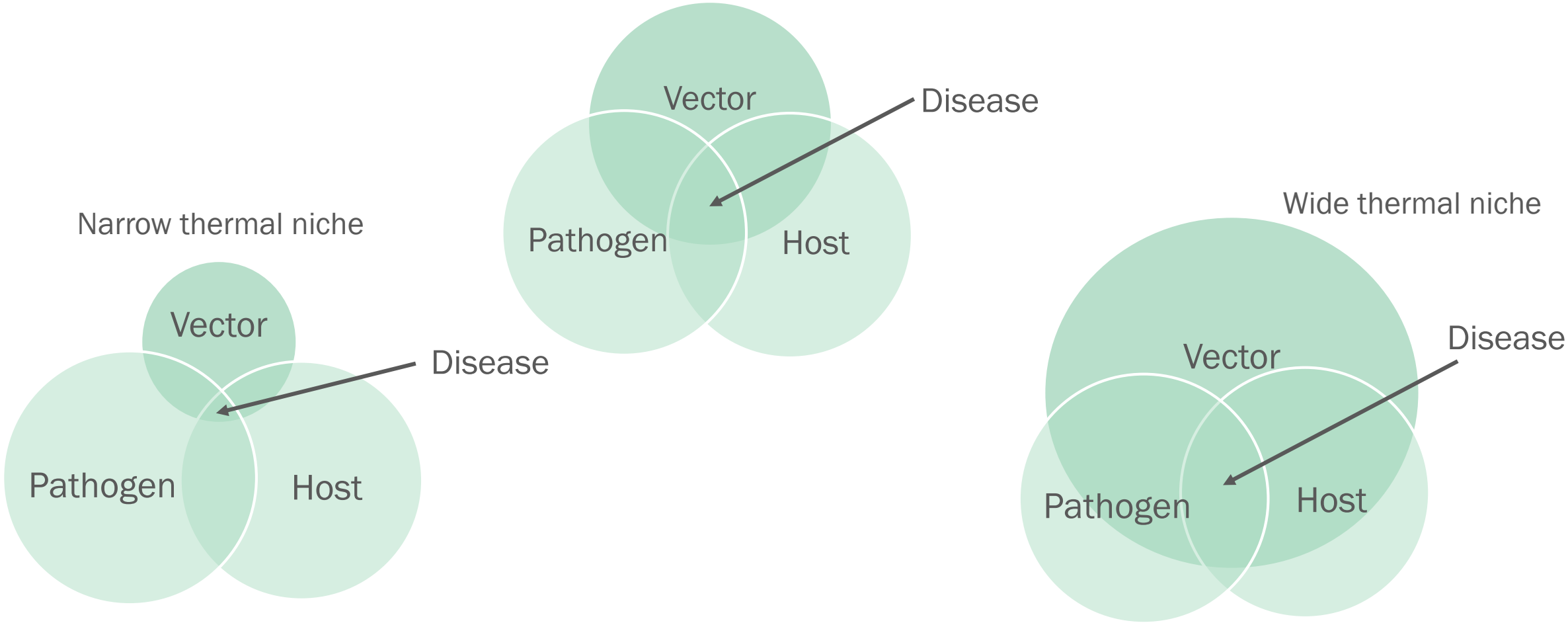
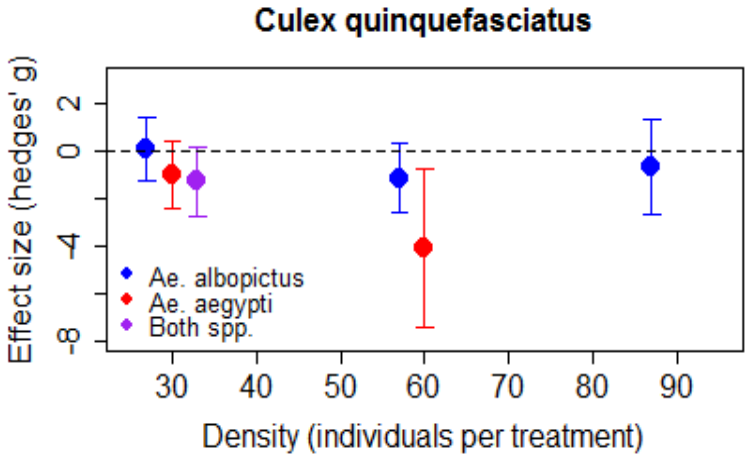
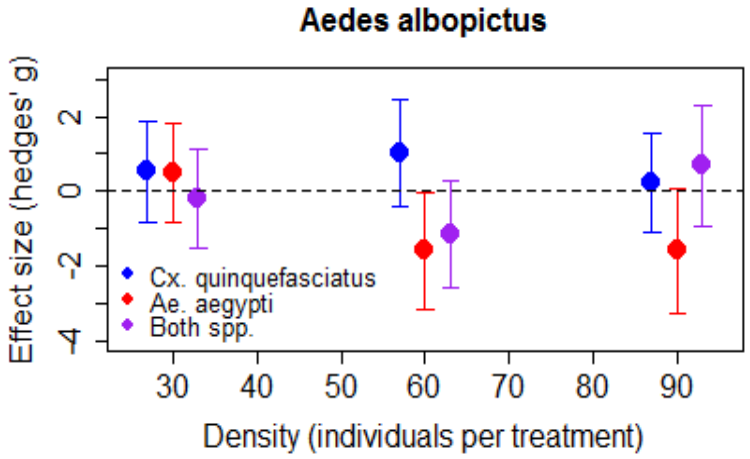
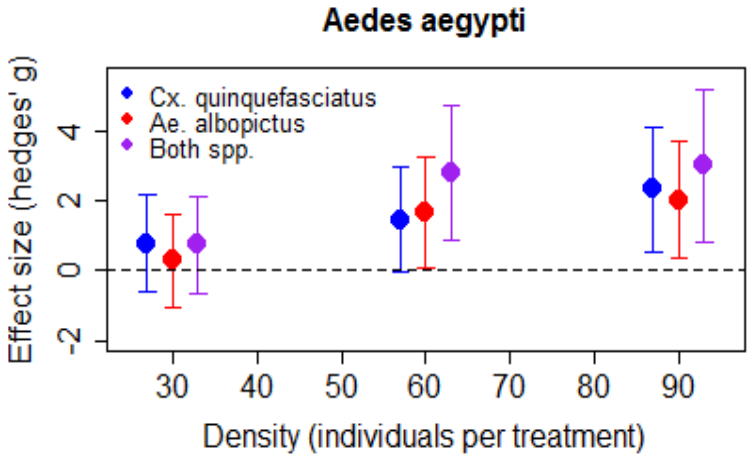


Species interactions can also impact vital rates







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Bowden and Drake, in prep

How does temperature alter species interactions?

Intraspecific larval competition vs. interspecific larval competition

Δ Thermal optimum \ Δ Thermal min/max	NO	YES
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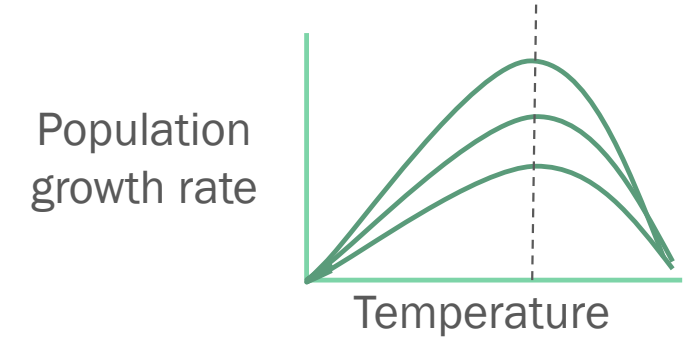
NO		
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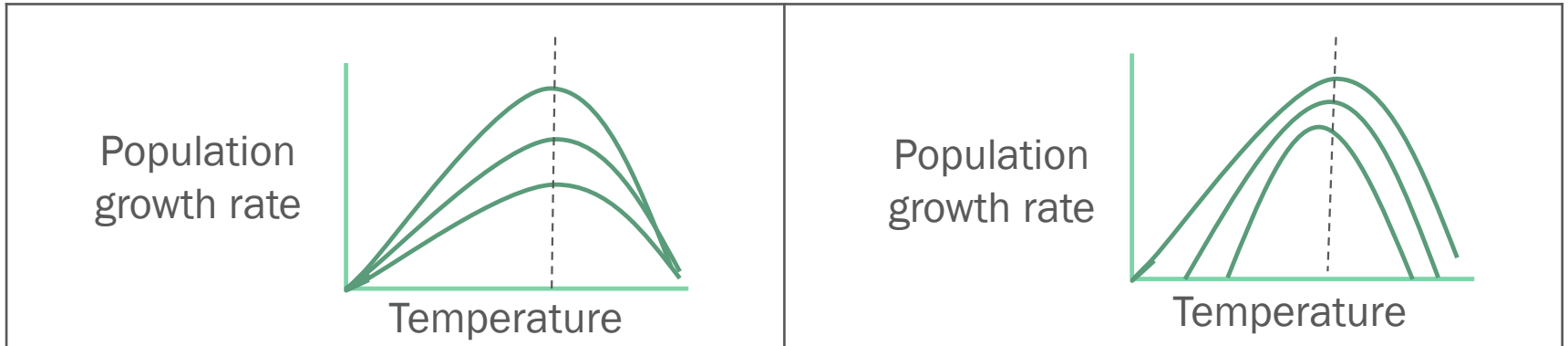
NO		
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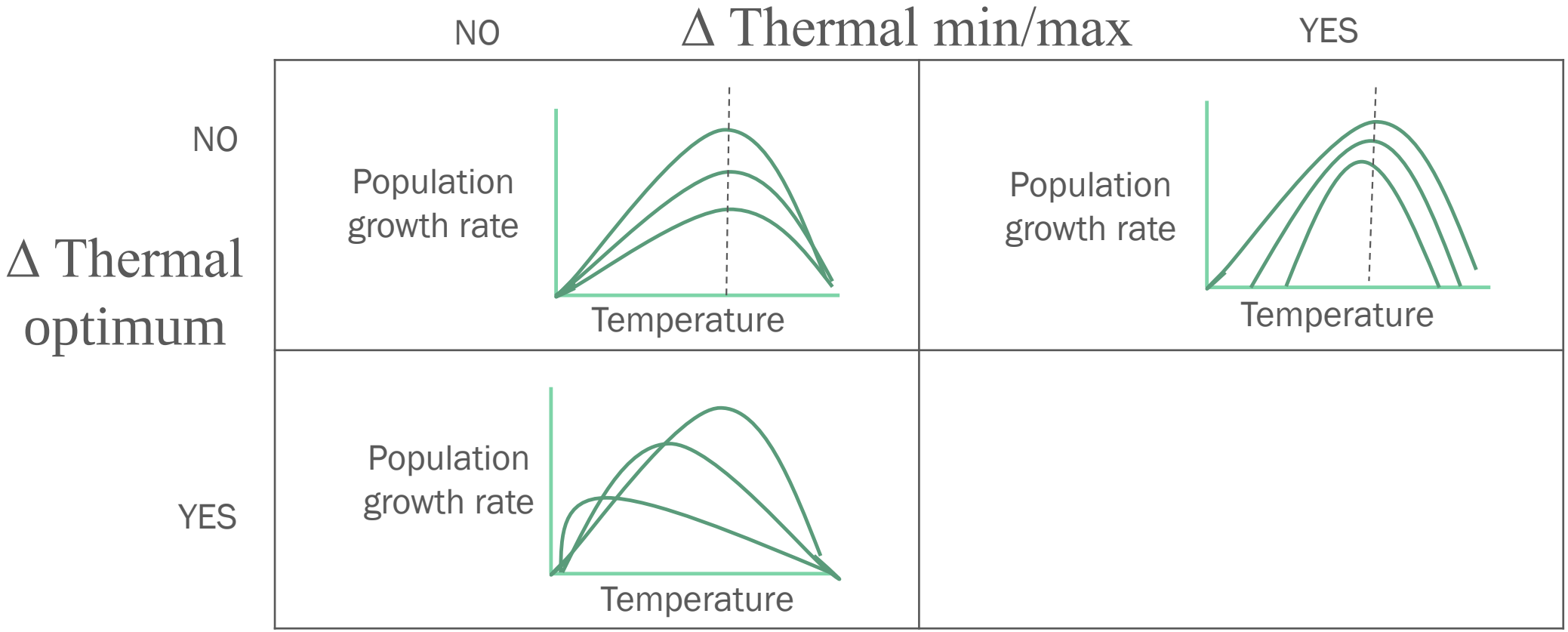

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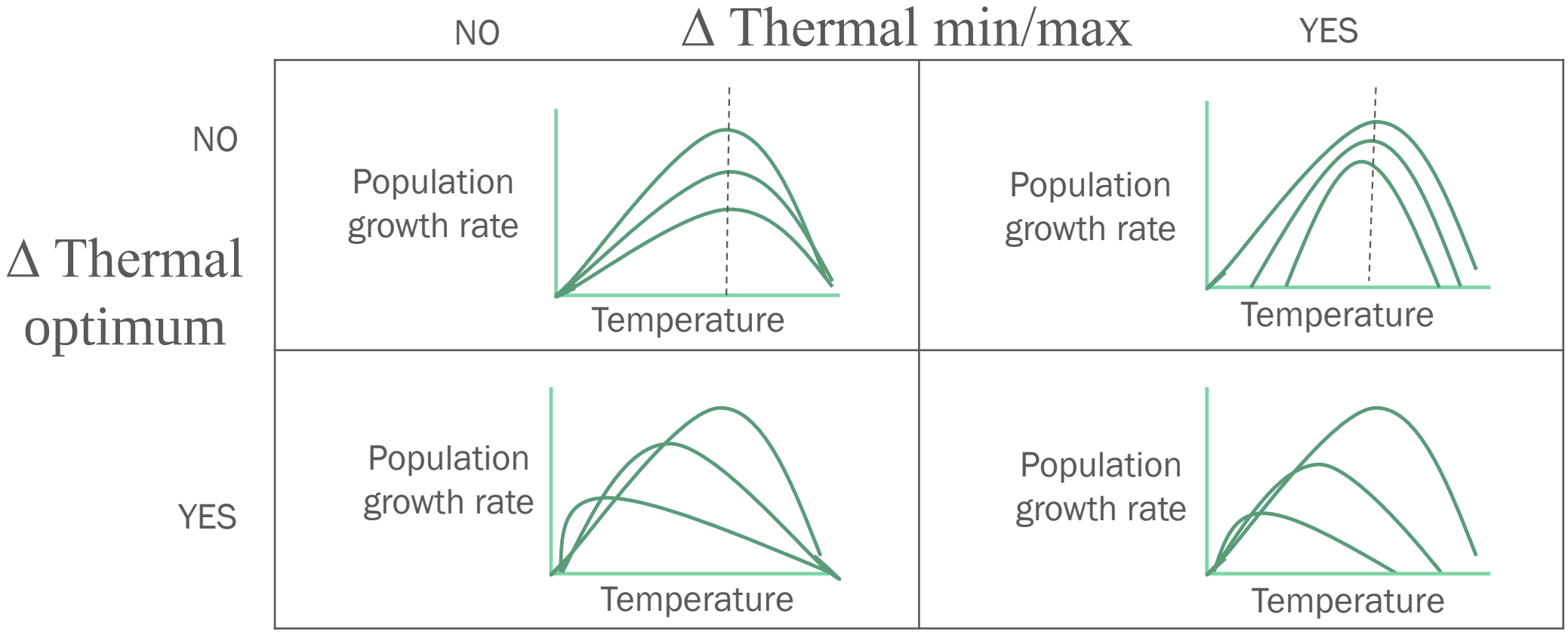

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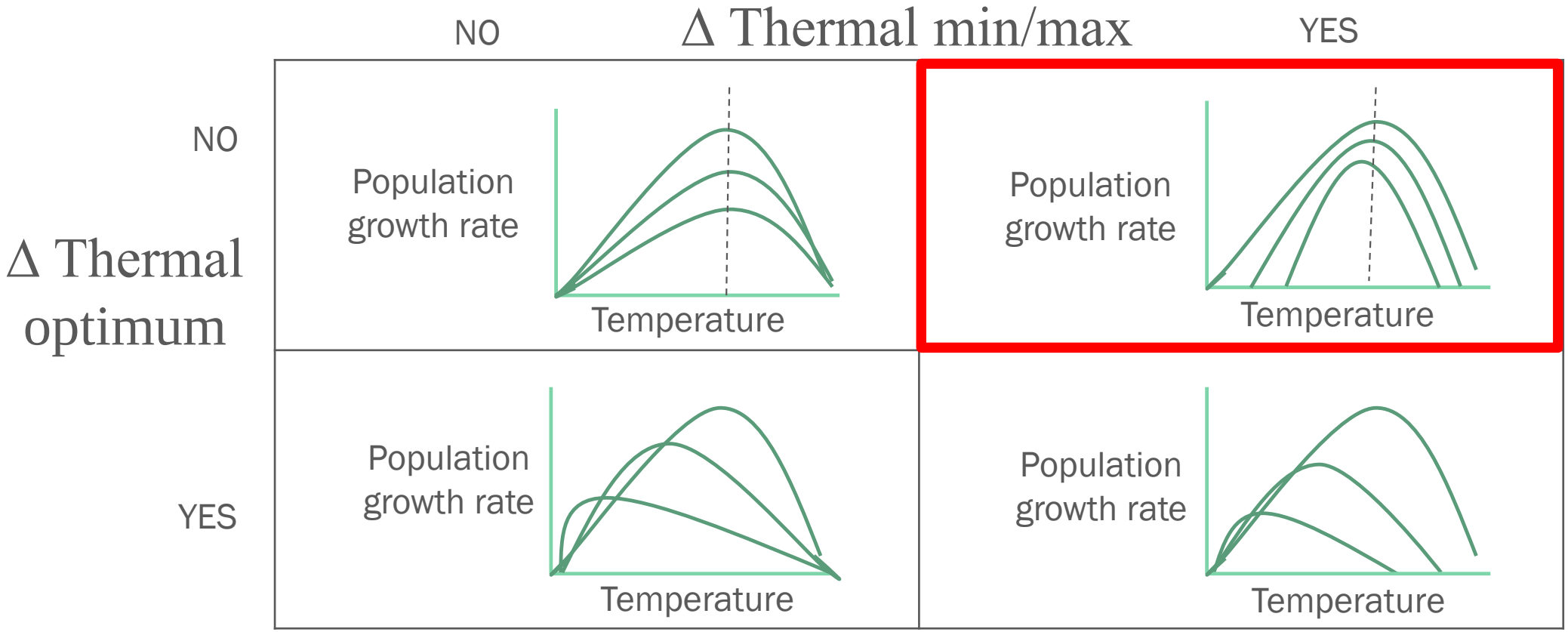

Selection of vector community

Selected 3 species with overlapping geographic ranges and similar preferences for larval habitat

Culex quinquefasciatus

Primary WNV vector in the southeast U.S.

Aedes albopictus

Invasive species and vector of Yellow fever, dengue, and chickungunya viruses

Aedes aegypti

Primary vector of dengue, chickungunya, and Zika viruses

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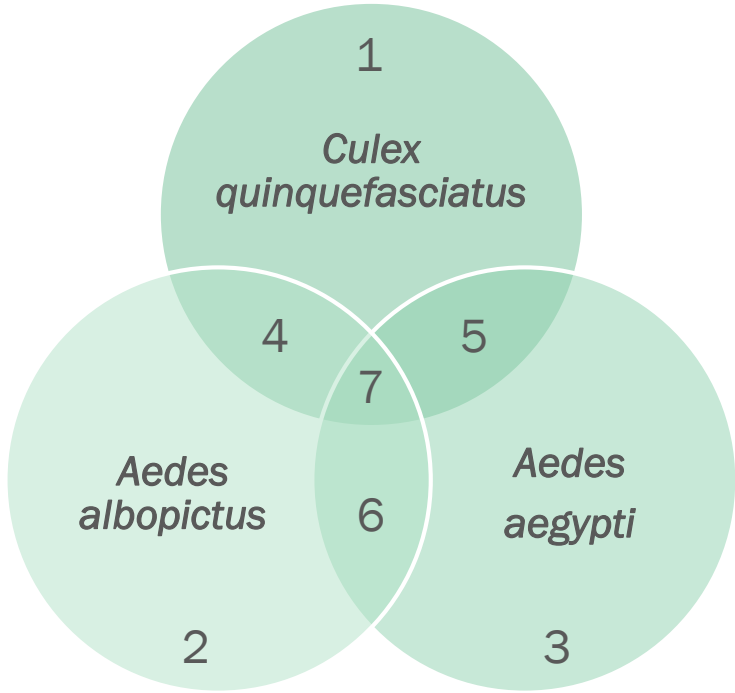
Competition experiments in laboratory microcosms

- Substitutive design at low density
  - 30 individuals in 200 mL of DI water
- 7 species treatments x 5 temperature treatments x 5 replicates
- Temperature gradient from 21-33°C; treatments every 3°C
- Incubated at constant temperature for 21 days and collected newly emerged adults every 24 hours
- Collected data on development time, egg-to-adult survival, and body size

Experimental design



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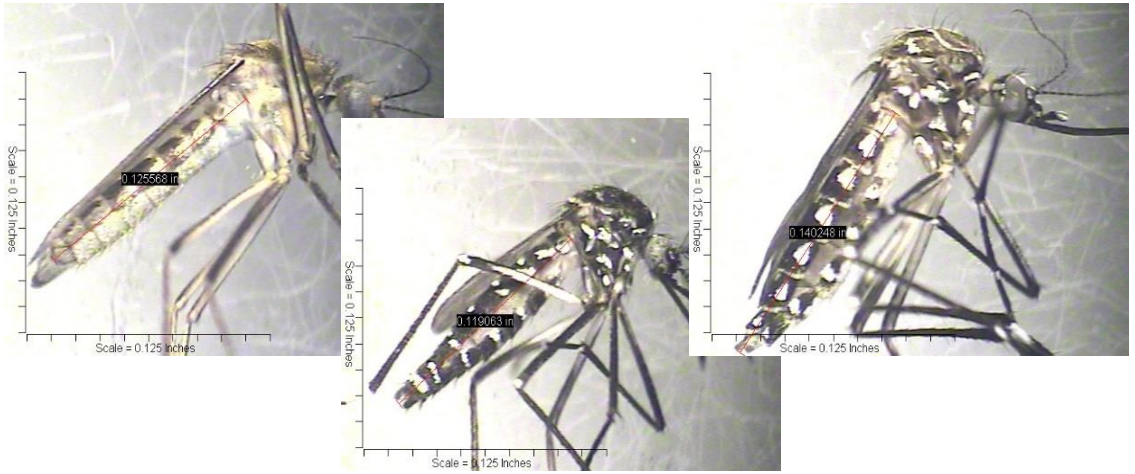
Estimating population growth rates and thermal niche

- For each emerged adult
  - Development time
  - Body size (proxy for fecundity)
- For each treatment
  - Egg-to-adult survival
- Used to estimate intrinsic rate of increase (Livdahl and Sugihara 1984)

$$r' = \frac{ln\frac{1}{N_0}\sum A_x f(\overline{w}_x)}{D + \frac{\sum xA_x f(\overline{w}_x)}{\sum A_x f(\overline{w}_x)}}$$



Temperature-dependent effects of interspecific competition on intrinsic growth rates

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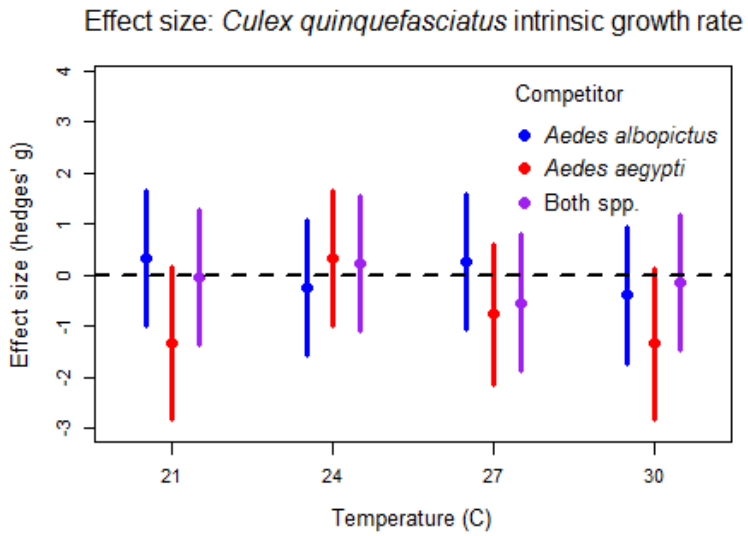

Unable to detect an effect of interspecific competition on population growth rates at any temperature

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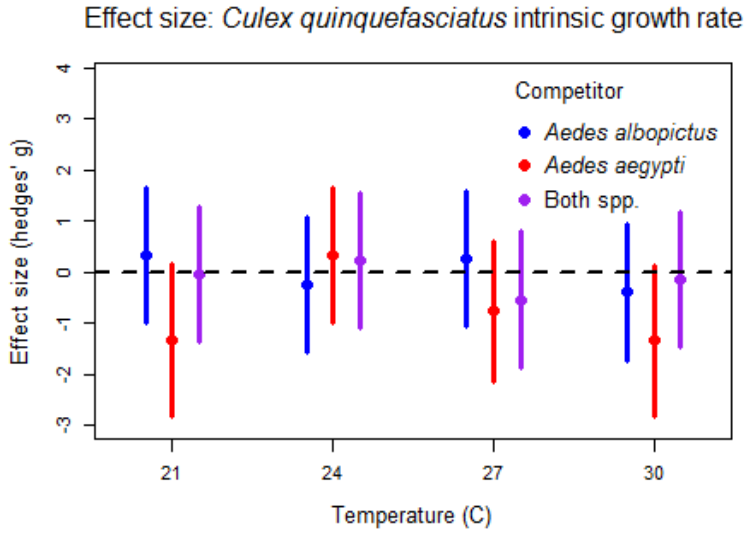

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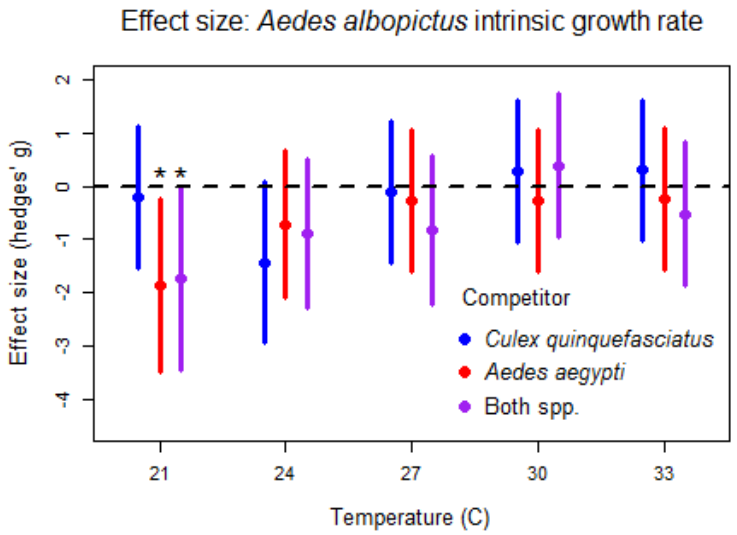
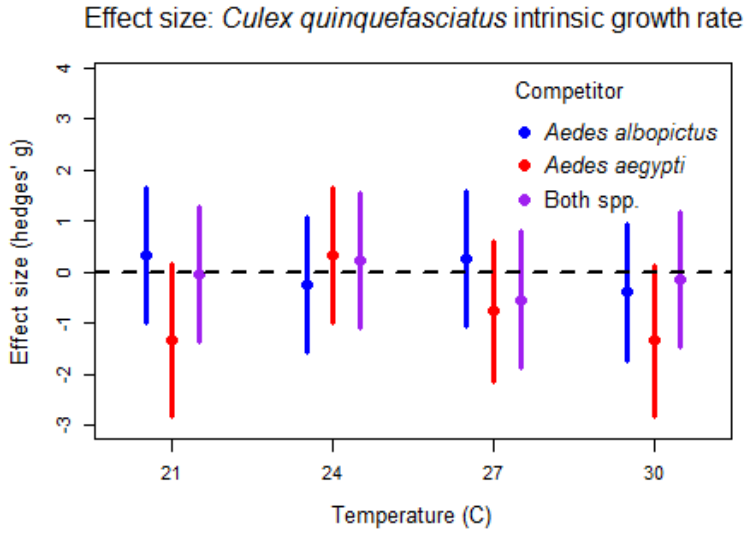


Interspecific competition **decreased population growth rates** at low temperatures

Temperature-dependent effects of interspecific competition on intrinsic growth rates



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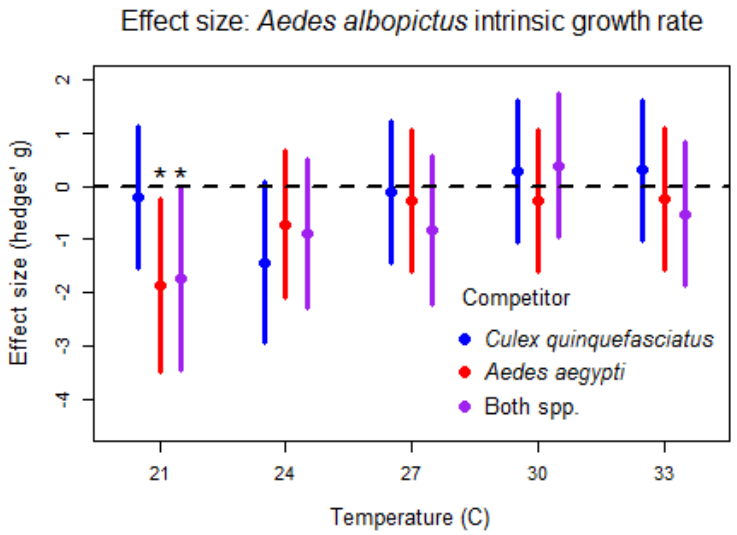

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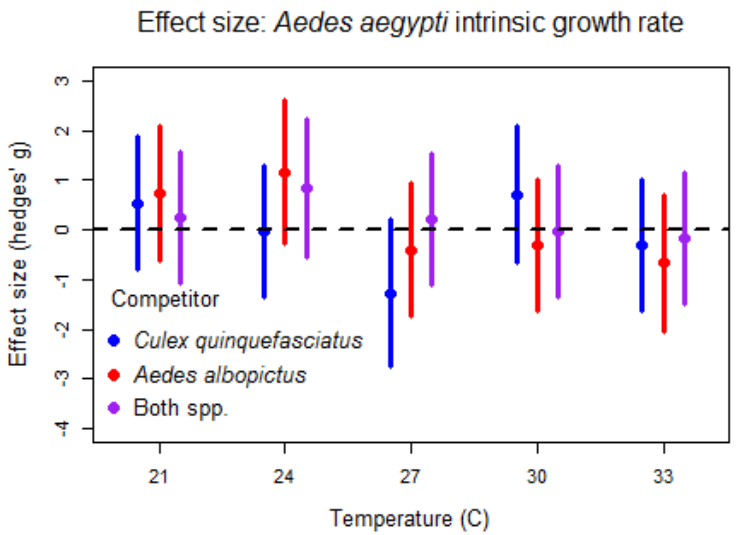

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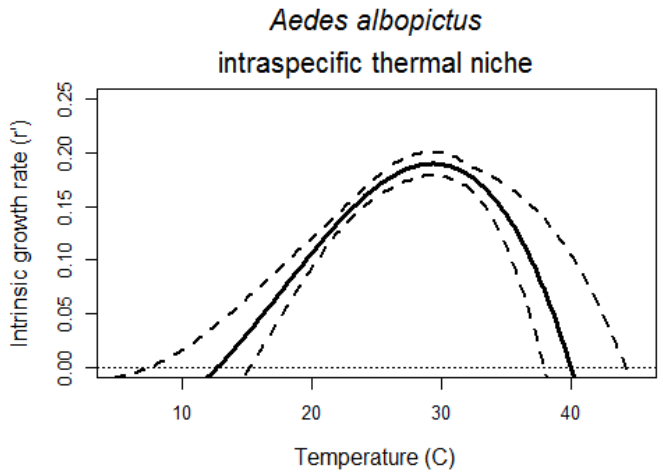
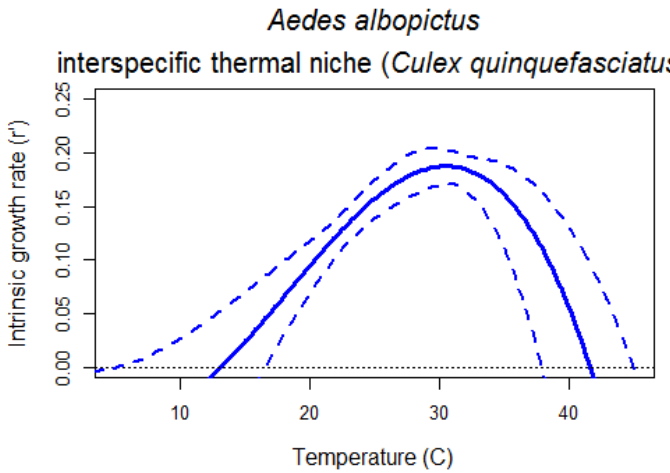
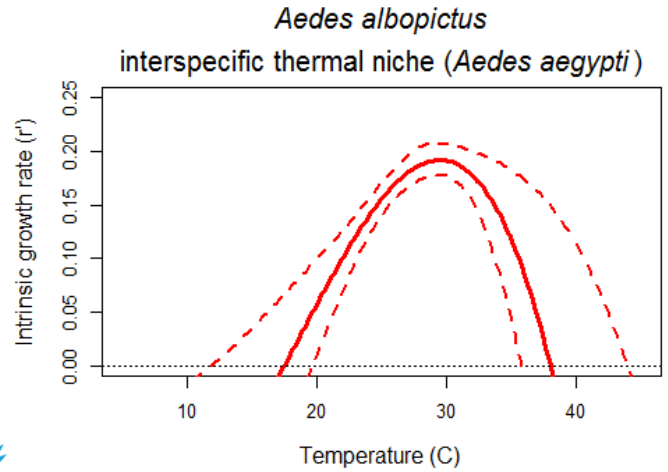
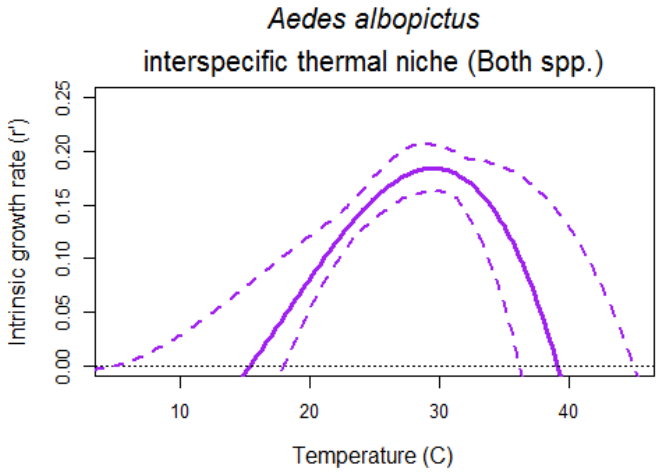
Estimating the thermal niche for population growth









$$y = cT(T - T_0)(T_m - T)^{1/2}$$

Fit Briére curves to intrinsic growth rate estimates

Bootstrapped growth rate estimates x10,000 and fit curves to each to estimate uncertainty around thermal niche

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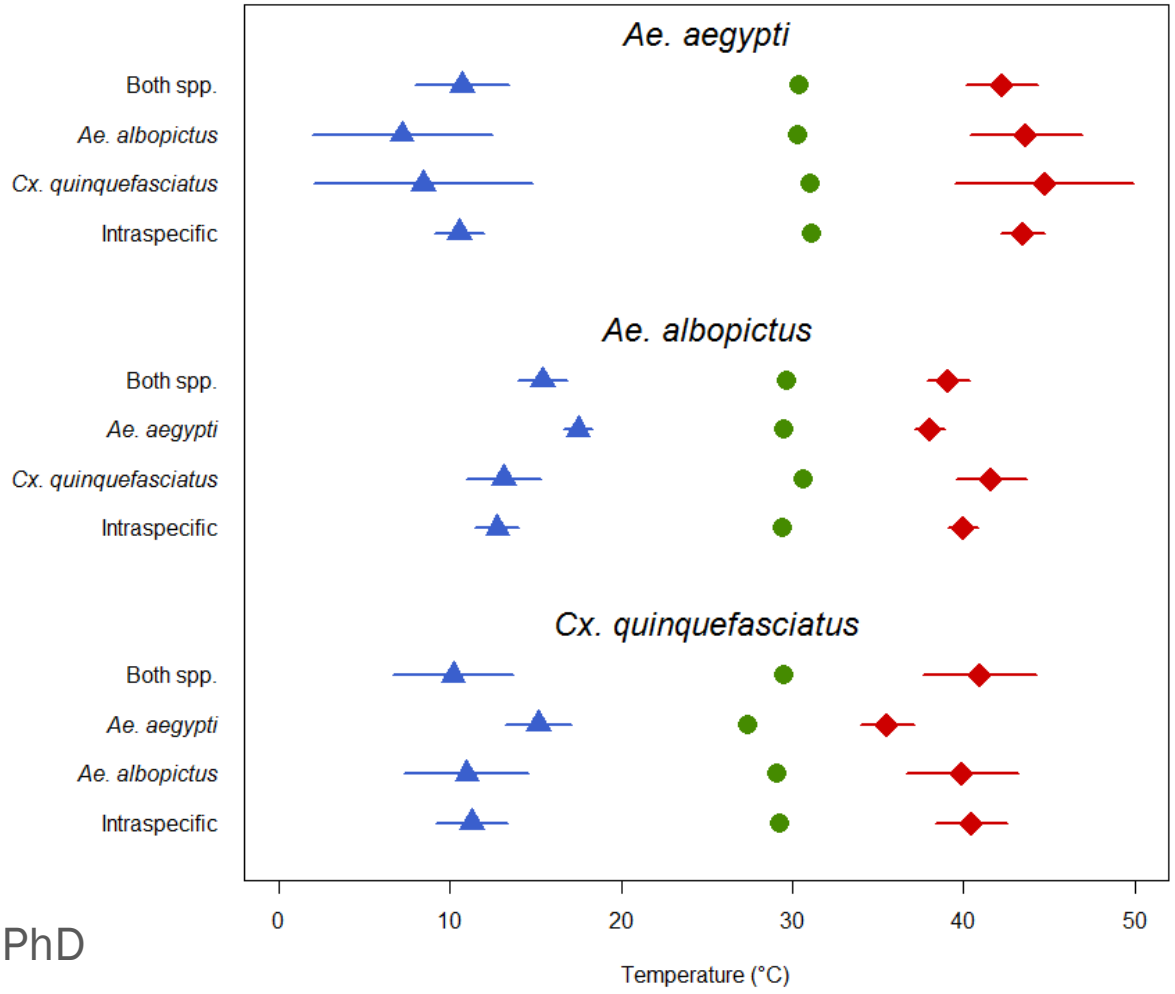
Temperature-dependent effects of interspecific competition on intrinsic growth rates



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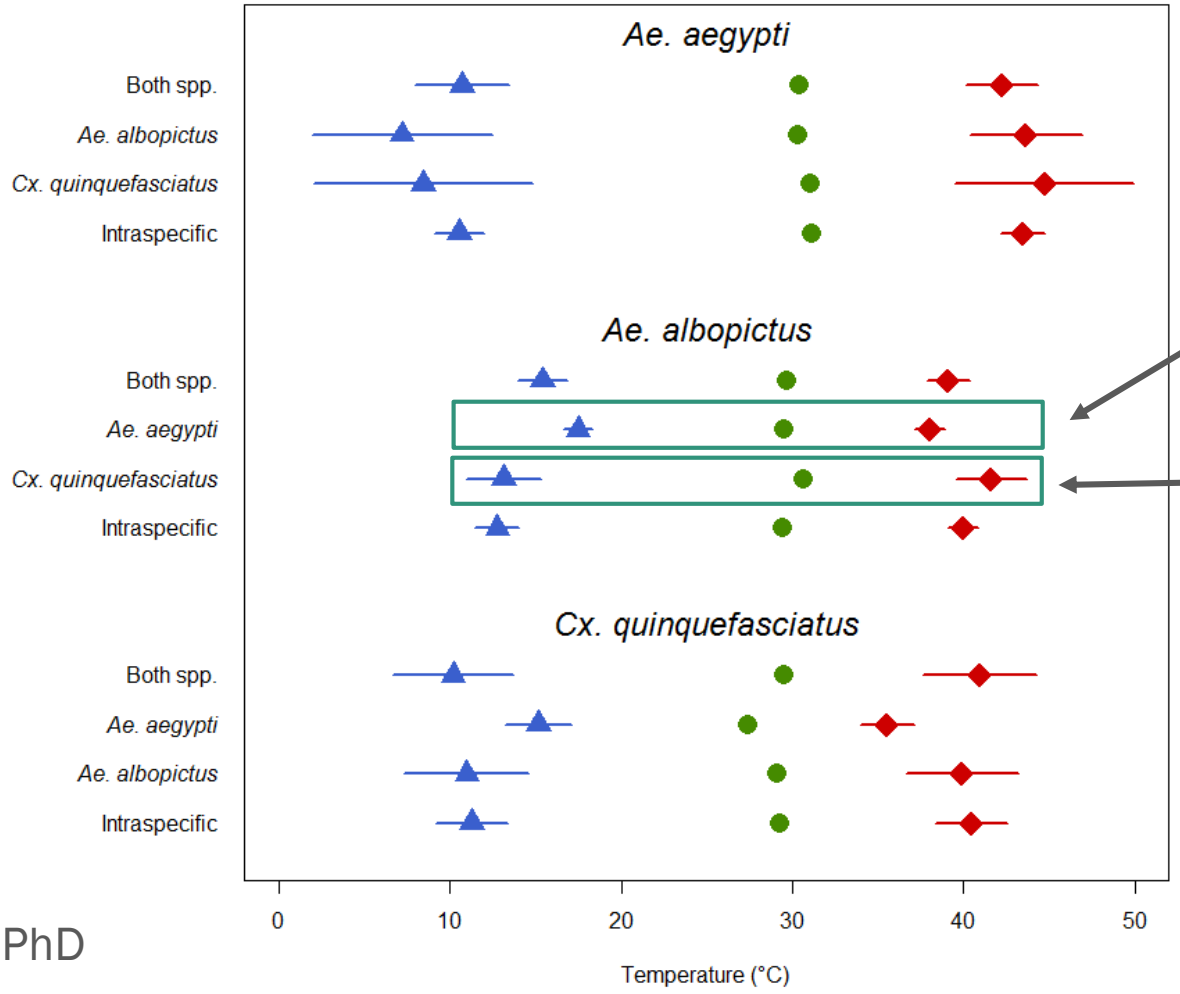

Competition with *Ae. aegypti* **increases T_0** and **decreases T_m**

Competition with *Cx. quinquefasciatus* **increases T_{opt}**

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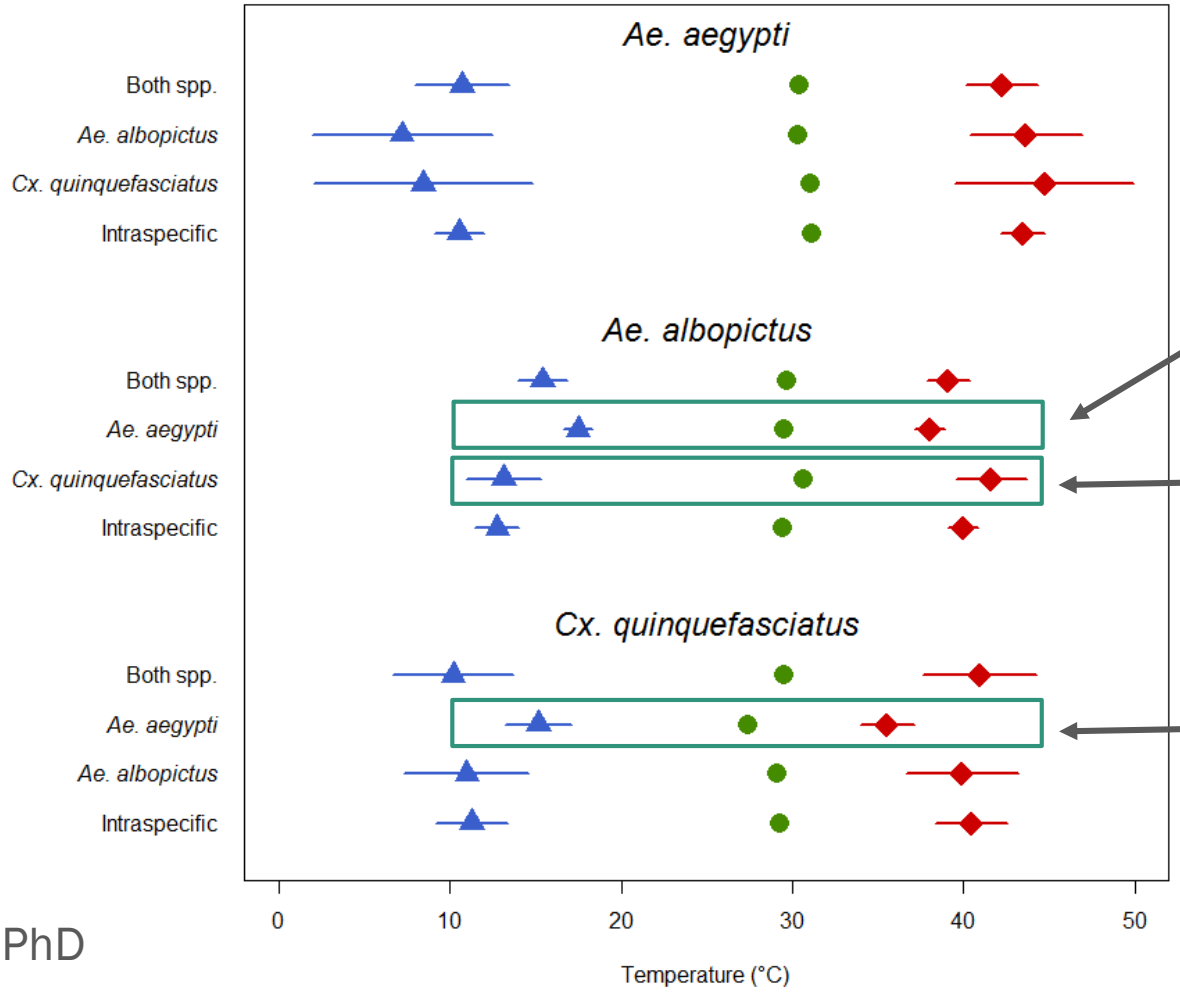

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Competition with *Ae. aegypti* increases T_0 and decreases T_m and T_{opt}

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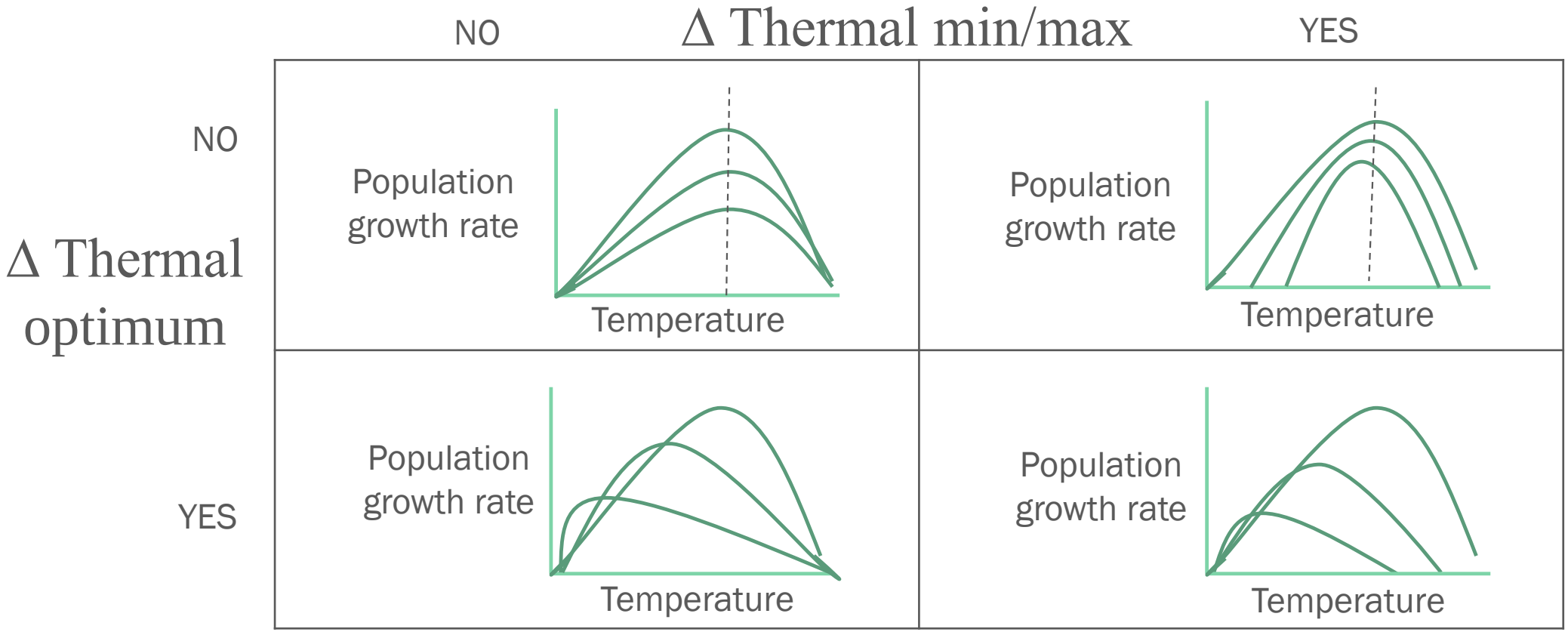
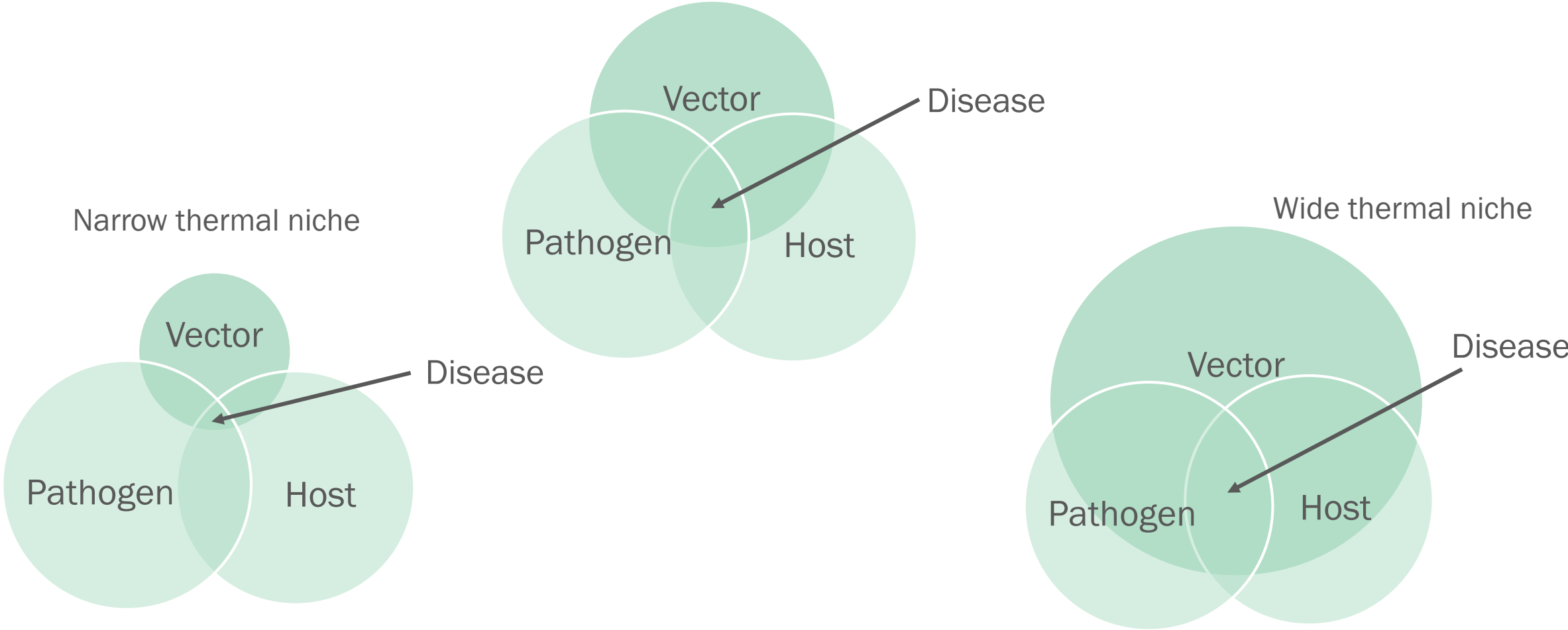


Why is thermal niche important?

Changes in vector thermal niche = Changes in disease transmission niche



Relevance to natural populations

- Mapping current and future differences in thermal niche-based geographic distribution under each competitive scenario
- **Where are distributions reduced, and by how much?**

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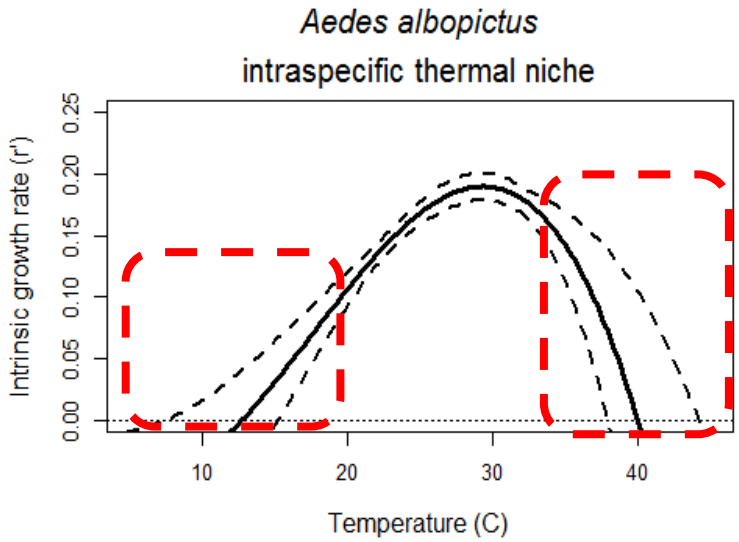
- **Need empirical data from "extreme" temperatures to decrease uncertainty in thermal niche estimates**



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QUESTIONS?

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Twitter: @MamaBPhD