How does overall population density and temperature affect the fecundity of female *Ae. aegypti* mosquitoes?

Lindsey Jones[1], Michelle Evans[2], Courtney Murdock[2]

[1]Albany State University, Albany, Ga, [2]Odum School of Ecology, University of Georgia, Athens, Ga

Introduction

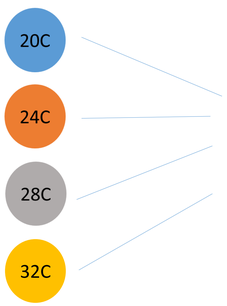
Mosquito-borne diseases such as Zika, yellow fever, chikungunya, and dengue are easily influenced by environmental factors in transmission. Past studies have shown evidence that environmental factors such as temperature and population density individually influence disease transmission but it has not been determined which of these environmental factors have the most impact on the life cycle of a female *Ae. aegypti* mosquito. This research explores how abiotic (e.g. temperature) and biotic (intra- and inter-specific competition) factors affect the fecundity of female *Ae. aegypti* mosquitoes. It is hoped in the future that by exploring these environmental factors it could be a beginning point on predicting potential areas that consists high risk of disease transmission.

Objectives

1.) How does temperature during the larval stage affect adult female fecundity? (Figure 5.)
2.) How does overall density and the density of a competitor (*Anopheles stephensi*) during larval stage affect adult female fecundity? (Figure 6.)
3.) What is the interaction between temperature, overall density and density of the competitor on fecundity? (Figure 7.)
4.) How does temperature and larval density affect population growth via fecundity?(Figure 8.)

Methods

- Reared 1st instar *Ae. aegypti* larvae and *An. stephensi* in mason jars. (Figure 2).
- Placed larvae in incubators at 4 different temperatures and 12 different densities (Figure 1).
- Following emergence, female *Ae. aegypti* and *An. stephensi* were blood fed and were each placed in individual fecundity tubes at 28ºC (Figure 3).
- Collected eggs for counting (Figure 4).
- Used fecundity and the number of adults emerging / day to estimate mosquito per capita growth rates (Equation 1)



Low Density	Medium Density	High Density
32:0	64:0	128:0
24:8	48:16	96:32
16:16	32:32	64:64
8:24	16:48	32:96

(Figure 1. *Ae. aegypti* : *An. stephensi*)

Equation 1

Per Capita Growth Rate Equation :

$$r' = \frac{\ln \frac{1}{N_o} \sum_x A_x F_x}{D + \frac{\sum_x X A_x F_x}{\sum_x A_x F_x}}$$

N_o - # of females initially
Σ - Sum
A – # of mosquitoes emerge that day
F – Fecundity
D - # of days it took mosquitoes to mature
X – Day

Figure 2.

Fecundity tube
Figure 3.

Figure 4.

Results

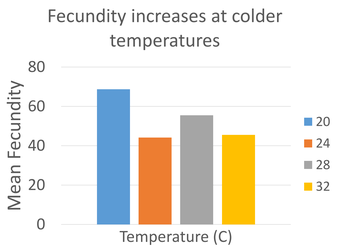


Figure 5.

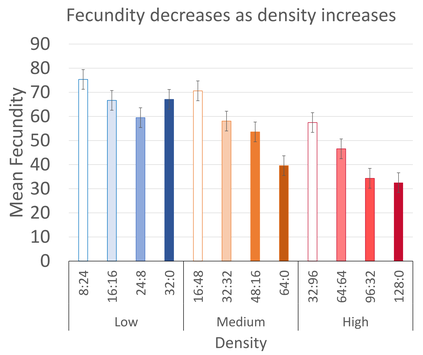
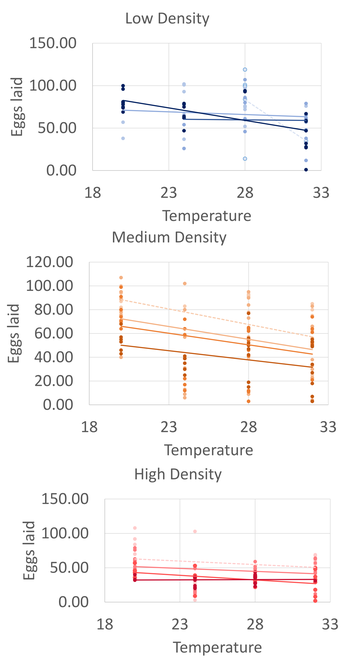
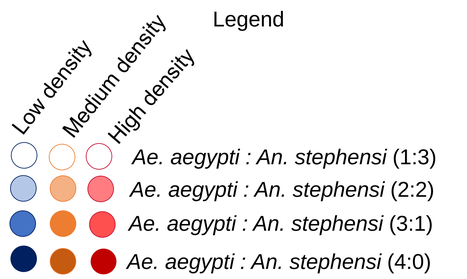


Figure 6.

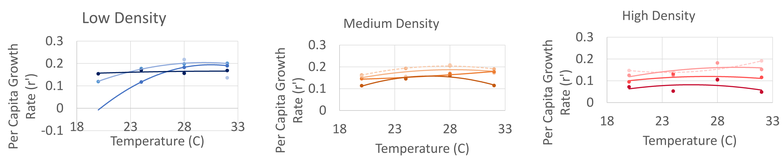
Mean Fecundity over Temperature and Density Interaction (Figure 7.)





- For all densities, except 8:24, 16:16, and 16:48 fecundity decreases at 32ºC.
- Low densities 16:16 and 16:48 fecundity are not affected by temperature and density.
- Low density 8:24 is an outlier due to we had no emerging adult females in the 20ºC and 24ºC temperatures.

Per Capita Growth Rate (Figure 8.)



Refer to Legend in Figure 7.

Conclusion

- Fecundity increases at the colder temperatures compared to hotter temperatures potentially due changes in mosquito metabolism and overall body size with temperature
- Fecundity decreases as density increases due to increased competition with conspecifics and *An. stephensi* for food, resulting in changes in mosquito body size and egg production.
- Temperature, overall density, and density of the competitor interacted to affect fecundity, suggesting the effects of biotic factors could quantitatively and qualitatively vary across different thermal environments.
- By calculating the per capita growth rate, we concluded that the temperature, overall density, and density of competitor decreases the population growth rate of *Ae. aegypti* as the densities increases.

Future Directions

- Do another replicate of the 8:24 density for four of the temperatures.
- Set up a 32:96 density treatment for 28ºC
- Measure wing length to predict fecundity.
- Do statistical analyses

Acknowledgements

This research was supported through the Population Biology of Infectious Diseases REU Program with Odum School of Ecology at the University of Georgia. We would like to thank the lab members in the Courtney Murdock's lab in the College of Veterinary Medicine who assisted with this research. We are also extremely grateful for the National Science Foundation for funding this research.

References

[1]Christiansen-Jucht, et.al. (2014). *Parasites & Vectors*(*7*): 489. [2] Livdahl, & Sugihara, (1984) Journal of Animal Ecology(53): 2. [3] Lounibos, et. al (2002). Journal of Vector Ecology

Population Biology of Infectious Diseases
REU site @ UGA