Thermal Ecology of *Anolis* Lizards of Cayos Cochinos, Honduras, and Their Vulnerabilities to Climate Change

Anolis lemurinus, the forest-habitat species on Cayo Menor.

Ryan Kimlong Huynh

Department of Ecology & Evolutionary Biology and Princeton Environmental Institute

Advisor: Professor Stephen W. Pacala

Princeton University, Princeton, NJ 08544 USA

Anolis alllisoni, the open-habitat species on Cayo Menor.

INTRODUCTION

Over the next 100 years, temperatures are predicted to rise approximately 2°C with dire predictions for the survival of terrestrial species (IPCC 2007, Thomas et al. 2004). Recent studies (Huey et al. 2009, Deutsch et al. 2008) emphasize that warming may have worse effects for species thermally adapted to function within a specific temperature range in the tropics.

Specifically, I wanted to scrutinize what I see as a complication in what Huey et al. (2009) put forth: although there is more risk for thermally-specialized species living in the tropics, the study grouped its specimen species, tropical lizards, into a *single category*. I wanted to investigate whether there are behavioral and thermo-physiological differences between lizards living in two different habitat types: **forest** versus **open-habitat** (Figure 1 and Figure 2).

Thermoregulation is a behavioral trait of species to maintain particular internal body temperatures for life functions (Angilletta 2009). Kearney et al. (2009) recently put forth a study which determined that the impact of warming on thermoregulation in part depends on the vegetation cover of a habitat.

← **Figure 1.** Understory vegetation and canopy cover are less dense in ***Open-habitat,*** and as a result more sunlight reaches the forest floor.

← **Figure 2.** **Forest** habitats, are, relative to open-habitats, much cooler, with more canopy cover, shade, and less exposure to sunlight.

My Questions:

I traveled to Cayos Cochinos, Honduras, with Operation Wallacea for eight weeks to conduct field work on two anole species: *Anolis lemurinus*, the forest-habitat anole, and *Anolis allisoni*, the open-habitat anole.

- Would thermoregulatory behavior between species in the two habitat types would be different?
- How would climate change affect each lizard species' performance, running speed, differently?
- Overall, would one species benefit while another species is ecologically and thermally jeopardized?

HYPOTHESES

- Part 1. Open-habitats have warmer, broader thermal distributions.
- Part 2. Open-habitat anoles thermoregulate more often.
- Part 3. Warming temperatures affect forest anoles more due to a more vulnerable, smaller, performance curve.

METHODS

Testing the Hypotheses: **Part 1**. Using OTMS (Figure 3), I measured and compared **operative temperatures** (T_e), or non-thermoregulating temperatures; it is similar to ambient temperatures but accounting for the biophysical and behaviorial properties of the species (Angilletta 2009). **Part 2**. Compared T_e with internal body temperatures (Figure 3) of anoles to assess the amount of thermoregulation. **Part 3**. Captured anoles, and tested them across a thermal gradient to measure running-speed (Figure 3) at various temperatures to construct **performance curves** (Figure 4). Performance curves can be used as an indicator of fitness relative to temperature (Angilletta, 94 2009).

Figure 3. Data collection: Clockwise from top-left: an **OTM**, model with ambulatory temperature recording every 10 minutes for 2 weeks (30 OTMS per trial; two trials per habitat type); taking anole body temperature with **cloacal thermocouple**; another angle of same measurement; testing lizard running speed via marked dowel and prodding with soft-bristled paintbrush (speed determined by high speed camera and Eagle Eye motion analysis software.)

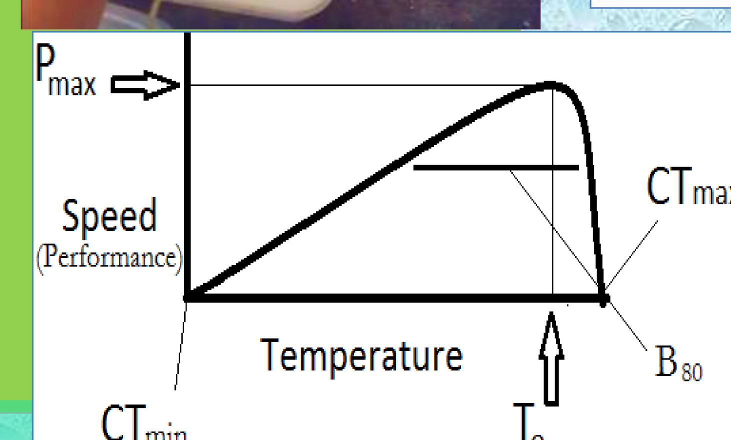


Figure 4. Structure of a generic thermal performance curve. P_{max} is the sprint speed at which the peak of the curve lies and corresponds to T_o, the optimal temperature for performance. B_{80} describes the range of temperatures at which performance is greater than 80% of P_{max}. CT_{max} is the upper temperature at which performance drops to zero. CT_{min} is the lower temperature at which performance is zero. Beyond CT_{max} are potentially fatal temperatures.

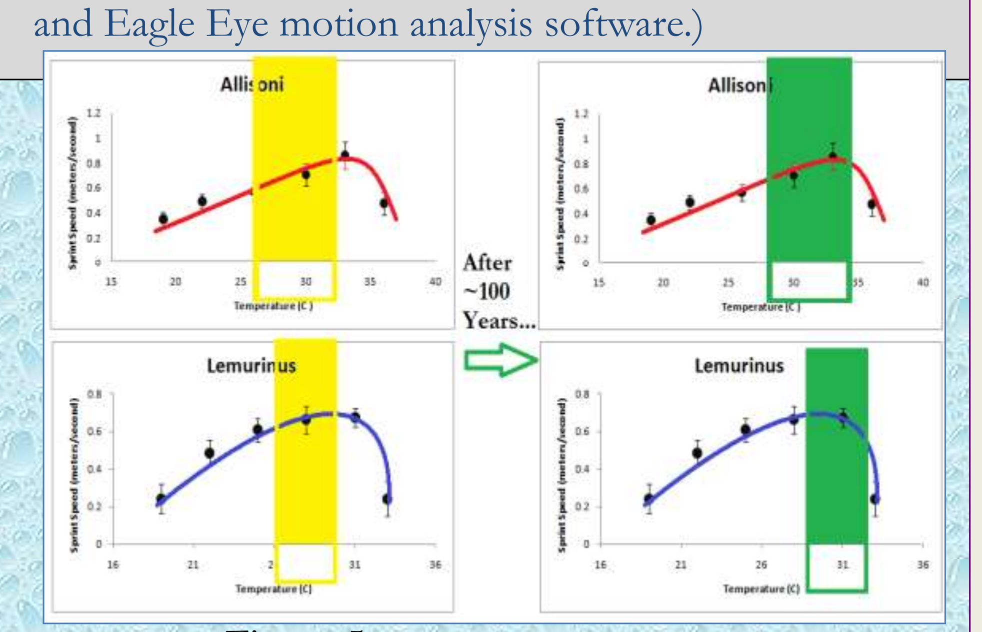
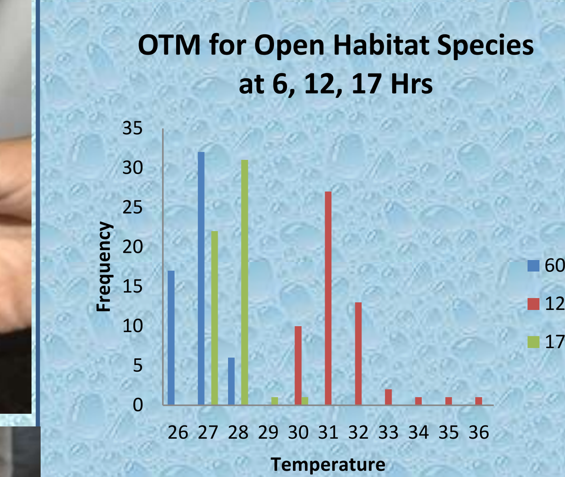
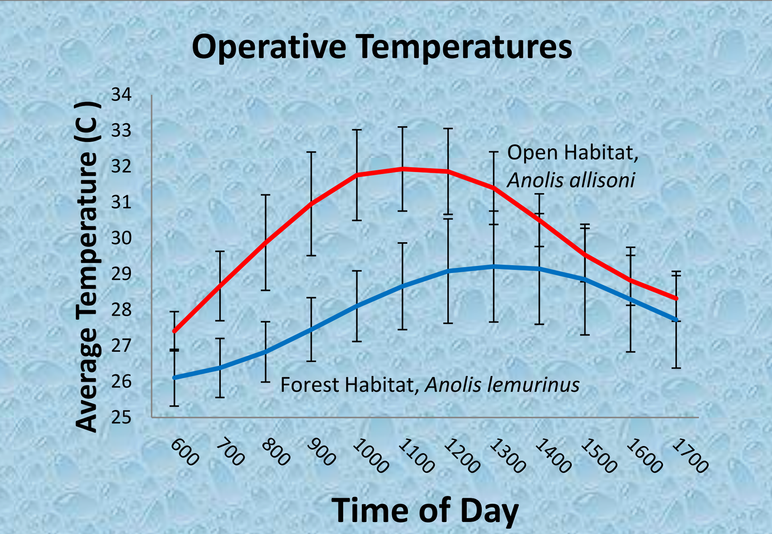
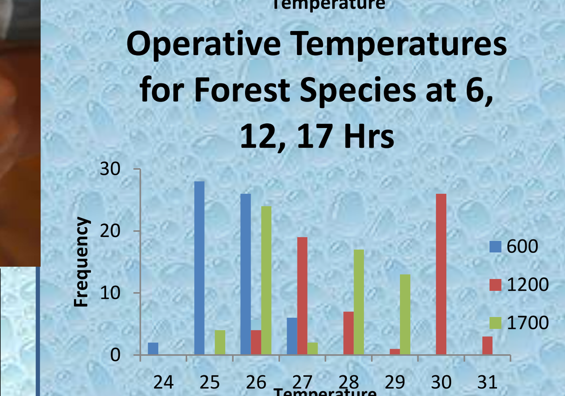


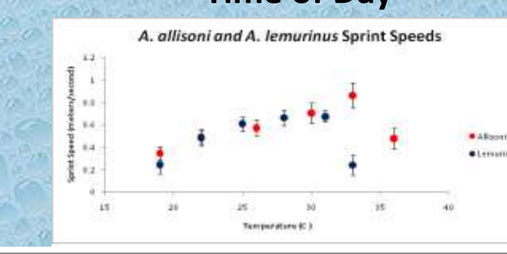
Figure 5. Illustration of how warming may affect Performance Curves

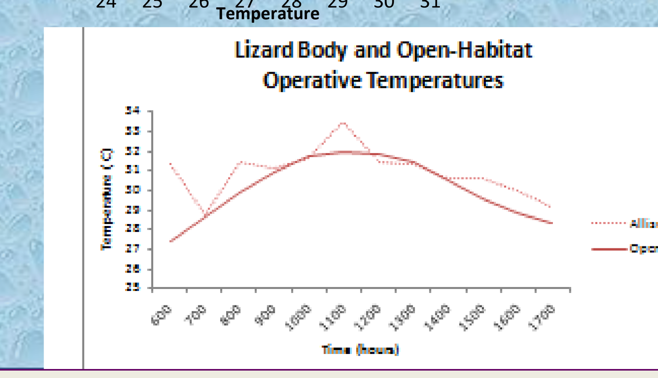
RESULTS

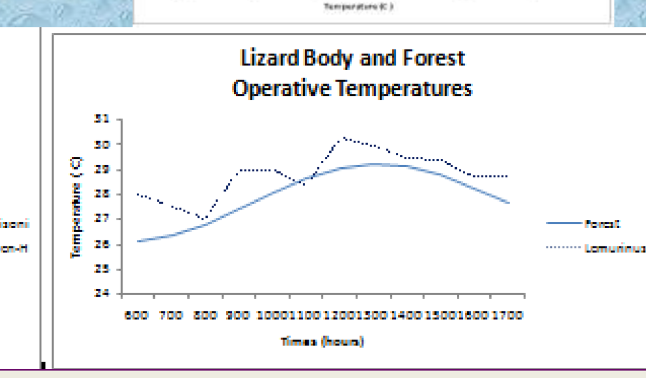












- Two habitat types have distinctly different thermal distributions (top 3 graphs),
- Thermoregulatory behavior are similar—maintained body temperature nearby ambient conditions (bottom 2 graphs),
- Open-habitat *Anolis allisoni* would have **increase** in performance
  - due to ambient temperatures moving closer to their thermal maximum for optimal performance (Figure 5) or see table for values,
- Forest-habitat *Anolis lemurinus* would have **decrease** in performance
  - from having more ambient temperatures outside of their thermal breadth and environmental temperatures would be further from their thermal optimum as well as closer to their critical thermal, maximum, meaning more *potentially fatal* temperatures… (Figure 5) or see table for values,
- I also began an investigation into resource partitioning between the two species and found differences, but cannot fully conclude whether the two species would compete or cohabitate if forced to live in the forest should the open-habitats become uninhabitable from warming.

Anolis allisoni:	*Anolis lemurinus:*
P_{max}: 0.877 m/s	P_{max}: 0.743 m/s
T_o: 33.92 degrees C	T_o: 29.38 degrees C
P_{max}*.80 for thermal breadth value: 0.7016 m/s (thermal breadth values must bmeet this speed)	P_{max}*.80 for thermal breadth value: 0.594 m/s (thermal breadth values must meet this speed)
B_{80}: 29.48-35.36 or 6.01 degrees C	B_{80}: 25.46-31.5 or 6.04 degrees C
CT_{max}: 37.4 degrees C	CT_{max}: 33.74 degrees C

Table of Performance (Running Speed) Curve Values

CONCLUSIONS

There is ultimately cause for ecological concern because I showcases how within the tropics there is a lose-win situation: that warming can simultaneously hurt *and* enhance two tropical species living in two distinct habitats. Conservationists and researchers also need to acknowledge the within-habitat forest/open-habitat dichotomy and take into account the thermal environment when evaluating warming vulnerability.

Citations

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