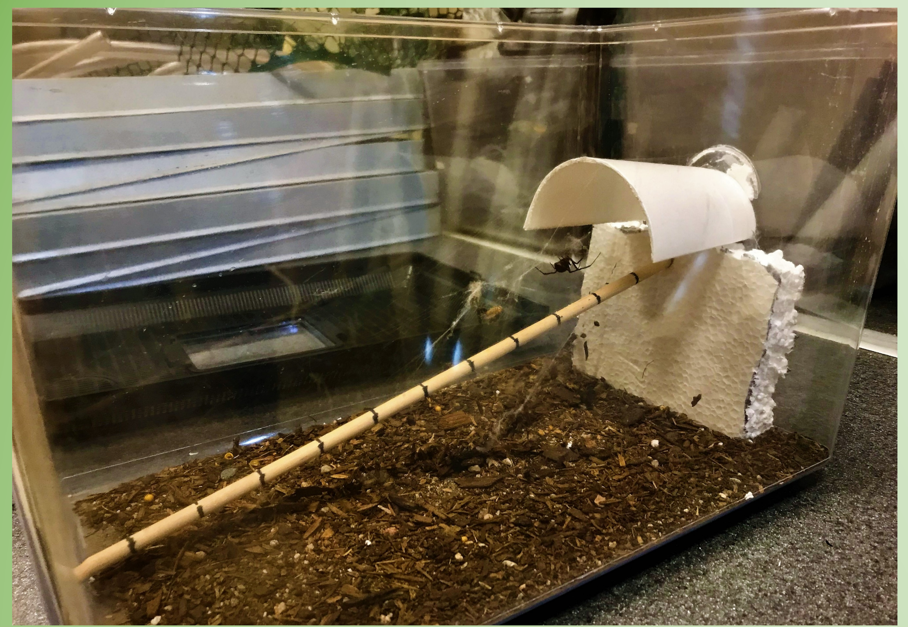

The Effect of Urban Heat Related Hormones on the Behavior of the Western Black Widow Spider

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Introduction

- We are interested in how urbanization, and specifically the urban heat island (UHI), affects the behavioral and physiological mechanisms that shape biodiversity.
- Generally, Phoenix experiences a 3°C urban heat island (UHI) relative to the surrounding Sonoran desert, though much variation exists across varied urban land uses (1).
- The Western black widow spider (*Latrodectus hesperus*) is a species that thrives in urban Phoenix habitats (2).
- Previous research shows that the black widow microclimate is typified by a 6° C UHI effect (27° vs. 33°), and that this slows development and increases spiderling voracity and cannibalism behavior (In prep.).
- Our data also suggest UHI temperatures drastically elevate 20-hydroxyecdysone (20E) levels (In prep.), a steroid hormone that regulates ecdysis (molting) (3).
- This study sought to directly manipulate 20E levels to assess their effect on *L. hesperus* foraging.
- We predicted that elevated 20E levels would lead to the heightened voracity associated with UHI temperatures.

Methods

- 24 sexually mature *L. hesperus* females from 7 separate families were reared in a laboratory setting at a temperature of 27° C.
- The treatment group (N = 12) was exposed to 0.125 ng [20E] per mg of spider mass on a weekly basis while the control group (N = 12) received acetone only.
- Mechanism of delivery of hormone was via cuticle absorption following CO_2 anesthetization.
- Foraging voracity was scored by applying a standardized vibration to the web and recording latency (secs) to attack.
- Repeated measures were obtained every other week in a 12 x 8 x 6 in terrarium (see photo).

Results

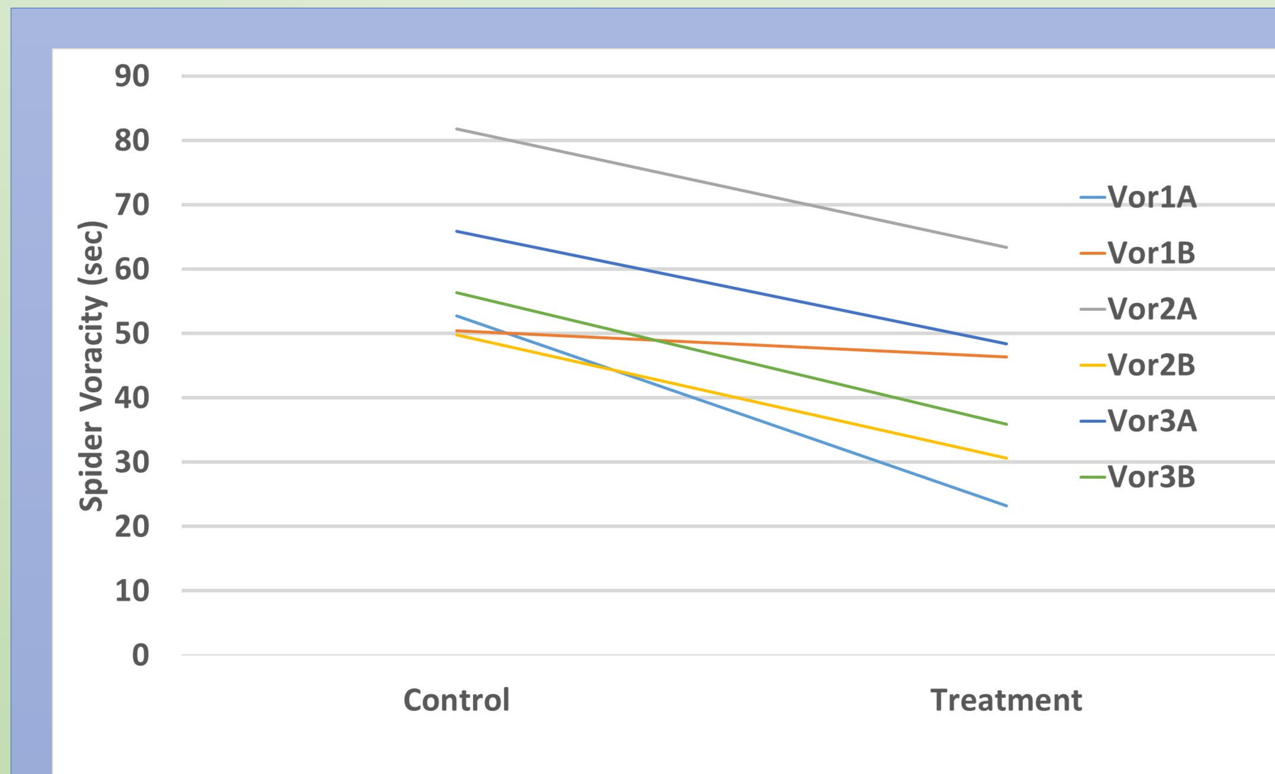

Figure 1. Average spider voracity 24 and 96 hours after dosing for three cycles. Treatment spiders exhibited notably greater voracity than control 24 hours following first dosing (Vor1A, p = 0.15).

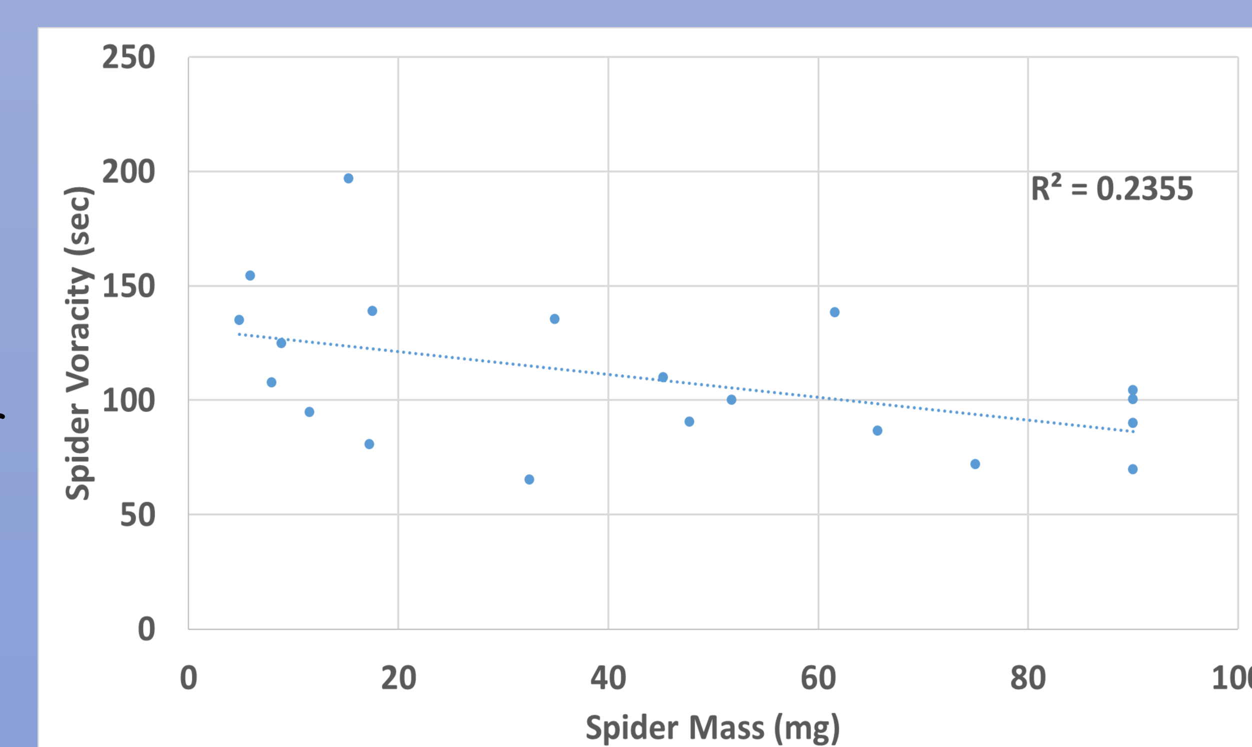

Figure 2. Average spider voracity as a function of spider mass in dosage cycle 1. Spider mass was a significant predictor of spider voracity in dosage cycle 1 (p = 0.03).

- Mass did not differ between treatments ($F_{1,18}$ = 0.62, p = 0.44) and family was not a significant predictor of voracity ($F_{6,13}$ = 0.98, p = 0.48).
- Levels of voracity were highly repeatable across individual spiders in each trial (ICC = 0.654, $F_{19,95}$ = 2.89, p < 0.0001).
- Voracity 24 hours after dosing (A) was not significantly different from voracity 96 hours after dosing (B) (Paired t = 1.61, d.f. = 19, p = 0.12).
- Treatment with 20E led to a non-significant trend to speed up voracity across all 3 repeated measures (see Fig. 1; $F_{1,17}$ = 2.66, p = 0.12).
- Specifically, during cycle 1 of 20E dosing, treatment spiders were 2x faster to attack than control spiders 24 hours after dosing ($F_{1,17}$ = 2.21, p = 0.15)
- Spider mass was a significant indicator of spider voracity only in the first round of dosing (R^2 = 0.24, F = 5.54, d.f. = 1,18, p = 0.03) where heavier spiders attacked more quickly (see Fig.2).

Discussion

- Our data suggest black widow behavior is highly repeatable, and only in trial #1 did we find an effect of spider mass.
- This result calls into question the idea that urban pests thrive because of behavioral plasticity.
- We found no difference between spider voracity 1 and 4 days following treatment, suggesting the behavioral effects of 20E linger.
- In contrast, we found that response to 20E was greater after exposure 1, and waned in applications 2 and 3.
- Given that 20E typically pulses in the days preceding a molt, it is possible that a spider's physiology allows it to habituate to high levels of the hormone.
- Focusing only on the first trial, we found spider voracious response to be 2x faster when exposed to 20E, a marginally non-significant difference given the high levels of variation within treatments.
- Future work will look for effects of 20E on other behaviors, as well as looking at the effect of 20E on desert lineages that have never experienced UHI conditions.

References

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