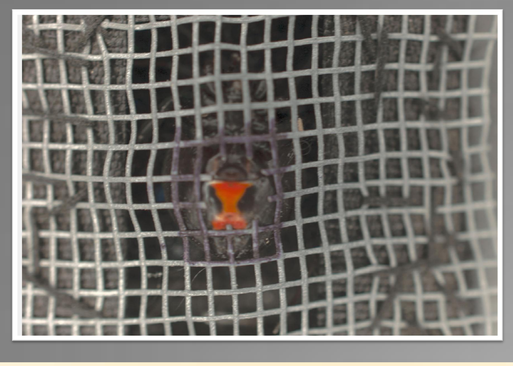

Ecology and Color Morphology of Urban Black Widow Populations

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INTRODUCTION

Urban habitats are the most rapidly growing type of environment, thus providing the opportunity to study the ability of organisms to cope with 'human-induced-rapid-environmental-change' (HIREC) [1].

The ability of certain taxa to thrive in urban ecosystems is speculated to be the result of phenotypic plasticity [2].

The Western black widow spider, *Latrodectus hesperus*, often infests urban areas throughout metropolitan Phoenix, Arizona.

Previous work has demonstrated strong spatial variation in the widow's ecology across urban Phoenix [3].

Adult female *L. hesperus* display a red hourglass on their abdomen, which we have shown to be a plastic color signal that fluctuates with foraging success [unpubl. data].

Here, we test for relationships between widow ecology, body condition and hourglass color and size.

We predict the hourglass will vary across urban Phoenix, and that this variation will be condition-dependent.

MATERIALS AND METHODS

We followed 10 adult female spiders from 8 subpopulations for 10 weeks. Missing focal individuals were replaced weekly.

For each aggregation we measured the following:

- Population density (# female spiders per meter squared)
- Male abundance, nearest neighbor distance, web volume
- Female body condition (mass/cephalothorax width) [4]

For each focal female we measured hourglass:

- area (from digital images using image J software)
- brightness, hue, and saturation (from digital images using Adobe Photoshop CS5.1 software and recently developed methods) [5,6]

Statistical Analysis:

- We tested for an effect of temporal (seasonal) variation with repeated measures ANOVA.
- We tested for an effect of site, after accounting for any effect of body condition, with a 1-way ANOVA with site as a random factor and body condition as a co-variate.
- Pairwise comparisons between sites were made using Bonferroni post-hoc tests ($\alpha<0.001$).
- Linear regression was used to examine the relationship between body condition and hourglass area, hue, saturation, and brightness.

RESULTS

Population density

As we have shown previously [3], population density varied across Phoenix (Fig. 1 $F_{7,174}=3.331$, $p=0.002$). Notably, our South Phoenix population was 4x more densely populated than our West Phoenix population ($p<0.001$).

Hourglass brightness

Hourglass brightness varied significantly across the season ($F_{3,144}=3.713$, $p=0.013$), tending to be highest in the first measure and lowest in the last measure. There was also a strong effect of site on hourglass brightness (Figure 2. $F_{7,174}=5.187$, $p<0.001$). Specifically, spiders from the Chandler population had the brightest hourglasses ($p<0.001$). It should be noted that by removing the Chandler widow population from the analysis, the effect of site on brightness becomes non-significant ($F_{6,149}=0.922$, $p=0.481$).

Condition-dependence

Hourglass area was positively correlated with body condition (Figure 3. $R^2=0.132$, $F_{1,181}=27.456$, $p<0.001$). Condition, however, did not predict hourglass hue, saturation, or brightness (all $p>0.05$).

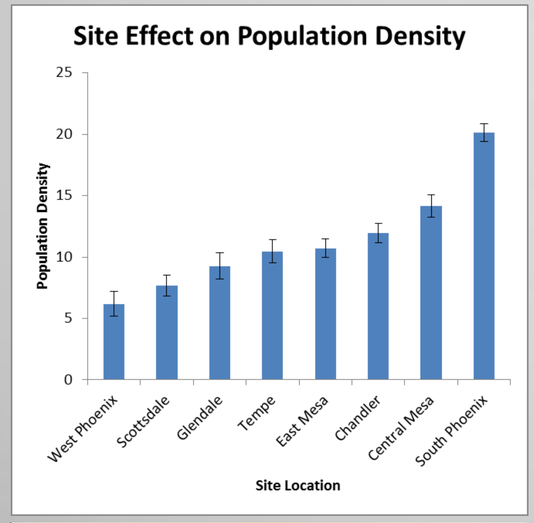

Figure 1. Population density was 4x greater in South Phoenix than West Phoenix.

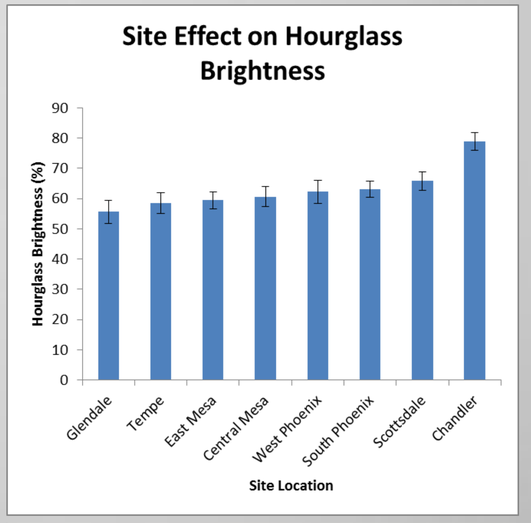

Figure 2. Widows in the Chandler aggregation had the brightest hourglasses.

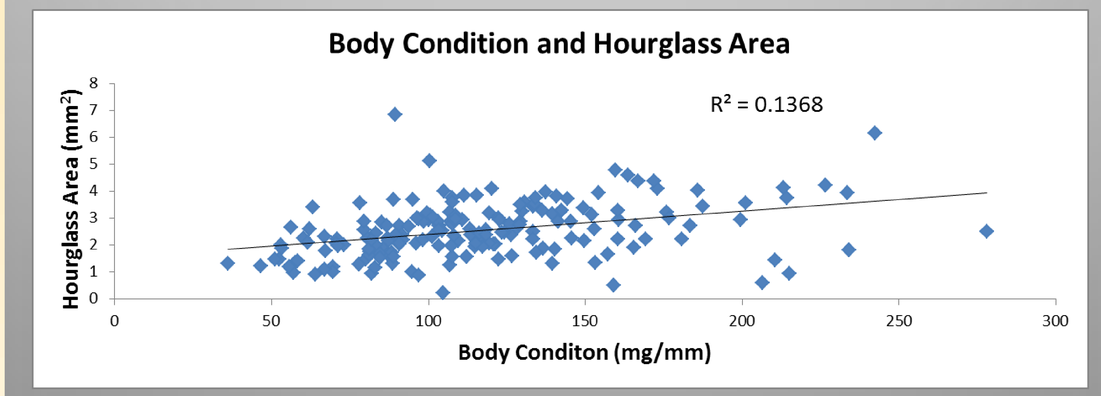

Figure 3. Widow body condition is positively correlated with hourglass area.

DISCUSSION

We continue to find evidence that widow population density varies dramatically across urban Phoenix. Anecdotally, the present data and past datasets indicate that heavily infested sites tend to be disturbed (e.g. irrigated) but otherwise infrequently used by humans (e.g. infrequent landscaping and foot traffic).

Hourglass brightness proved to be affected by spatial and temporal variation. This suggests that hourglass luminance may be incredibly plastic, and thus capable of rapidly responding to the effects HIREC. A similar result has been shown in cosmopolitan fruit flies (*Drosphila kikkawai*), where color variation has been linked to urbanization [7].

Our data also suggest that widows in superior condition display larger hourglasses. Thus, we have now shown that hourglass size fluctuates with foraging success, both in the lab and in the field.

Given the hourglass has long been thought to serve as an aposematic warning signal to enemies, and our data suggest this signal is condition-dependent, current work tests the prediction that high-condition spiders are better able to avoid enemies.

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