

Using Animal Behavior to Understand the Impact of Urbanization: Do Urban Black Widows Behave Differently from their Desert Counterparts in the Field or the Lab?

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INTRODUCTION

- Urbanized environments tend to modify diversity in ecological communities, creating a winning and losing campaign for native species [1].
- The black widow spider, *Latrodectus hesperus*, is native to the Sonoran Desert but found at a much higher density in the metropolis of Phoenix, AZ [2].
- Urban and desert black widows are highly diverged genetically [3], and our lab has shown that desert black widows are more cannibalistic than urban spiders in the lab [4].
- To disentangle what shapes urban behavior and life history, we need a combination of field observations and lab experiments to control complex environments [5].
- Based on the differing cannibalistic qualities we predict that desert spiders will be bolder and more voracious in both field and lab settings.

METHODS

- We sampled a total of 23 adult female black widows from 4 urban sites (N=11) and 4 desert sites (N=12). Urban sites were located within metro Phoenix, AZ. Desert sites were >25 km from metro Phoenix. All sites were >3.5 km from each other.
- Field assays were conducted in June/July 2019. Spiders were then collected and given 6 weeks in the lab to acclimate under 12:12 reverse photo period, fed 1 cricket per week, and housed in 72-liter plastic tubs 57 x 38 x 33 cm at room temperature. Lab assays were conducted in early September.
- The body condition of each individual was estimated using their total mass. This was taken at the beginning and end of both the field and lab portions of the experiment.
- **Boldness** = #1 latency in seconds to re-emerge from refuge after disturbance of short bursts of compressed air sprayed directly at the spider from approximately 30 cm away. #2 distance in cm from refuge entrance that spiders were found in foraging posture.
- **Voracity** = latency in seconds to attack artificial, standardized prey vibration placed 20 cm away in the web. Vibrations were simulated using an electric toothbrush.

RESULTS

- Habitat of origin had no significant effect on voracity in the field or lab, distance in the field/lab, and boldness in the lab (all $p > 0.119$). A marginal difference was found where urban spiders were bolder than desert spiders in the field (see Fig.1, $F_{1,21} = 4.235$, $p = 0.052$).
- All three behaviors in the the lab from both habitats displayed significant repeatability (Intraclass Correlation Coefficient ICC > 0.355, $p < 0.003$). Additionally, field distance had significant repeatability (ICC = 0.565, $p < 0.001$). Boldness and voracity in the field had poor repeatability (ICC < 0.194, $p > 0.062$).
- A significant time effect occurred in the lab for distance and voracity ($F_{2,20} < 5.471$, $p < 0.019$) whereas boldness was more marginally affected ($F_{2,20} = 3.307$, $p = 0.0597$; see Fig. 2).
- We found significant correlations in the lab between boldness/distance (see Fig. 3, $R = -0.630$, $p = 0.001$), voracity/distance (see Fig. 4, $R = -0.454$, $p = 0.026$), and boldness/voracity ($R = 0.454$, $p = 0.030$). However those correlations did not exist in the field ($R \pm 0.333$, $P > 0.121$).

DISCUSSION

- We found the black widow's behavior (regardless of the habitat of origin) to be highly repeatable, and unrelated to a spider's mass.
- Recently urban and desert black widows have proven to be highly diverged genetically [3] and yet those genetic differences led to no significant behavioral differences between urban and desert lineages.
- These data do not support the idea that urban pests thrive because of their behavioral plasticity.
- However, these three behaviors were correlated with each other, suggesting the notion of a behavioral syndrome (consistent individual differences correlated across contexts) [6].
- The lack of plasticity and the presence of a syndrome suggest maybe it thrives in said environment because it arrived with the optimal syndrome. There is no need or ability to be plastic.
- Future work should examine these behaviors in a broader spectrum of situations (i.e. field behavior of urban spiders cross-fostered in desert habitat and vice versa) to see which correlations are stable and at which context.

Fig. 1 The effect of field vs lab boldness

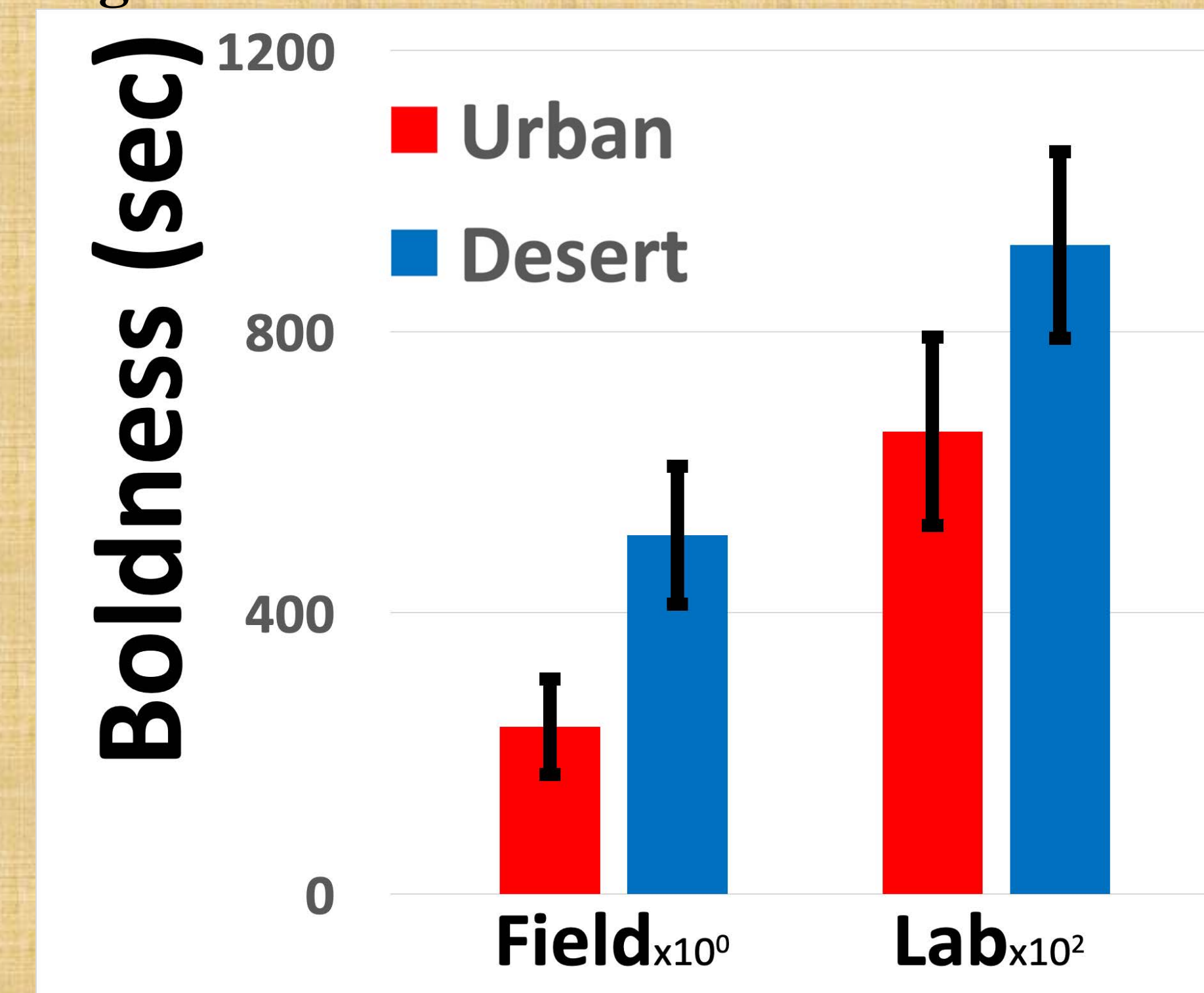


Fig. 2 The effect of time on lab behavior

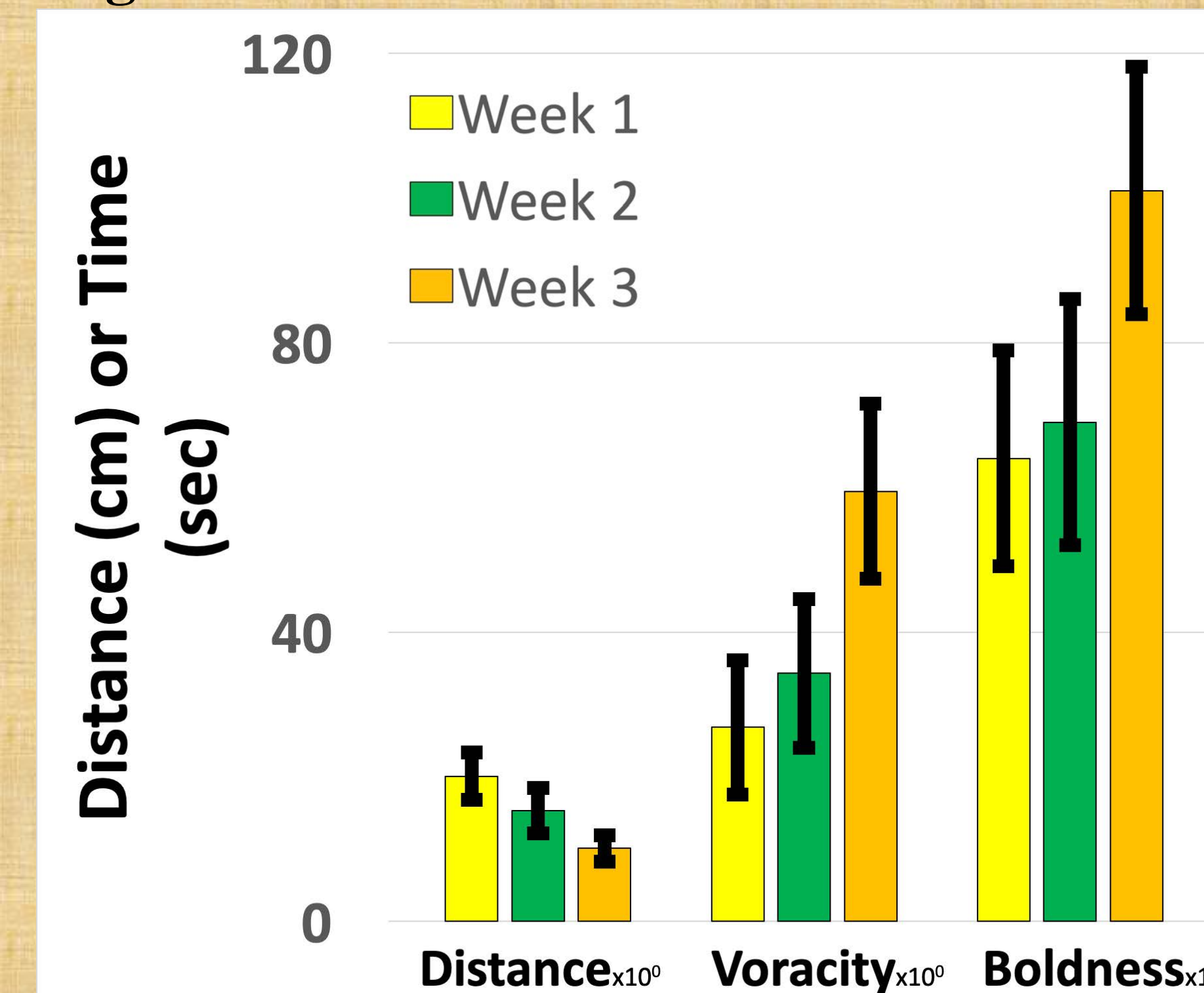


Fig. 3 The effect of distance on boldness

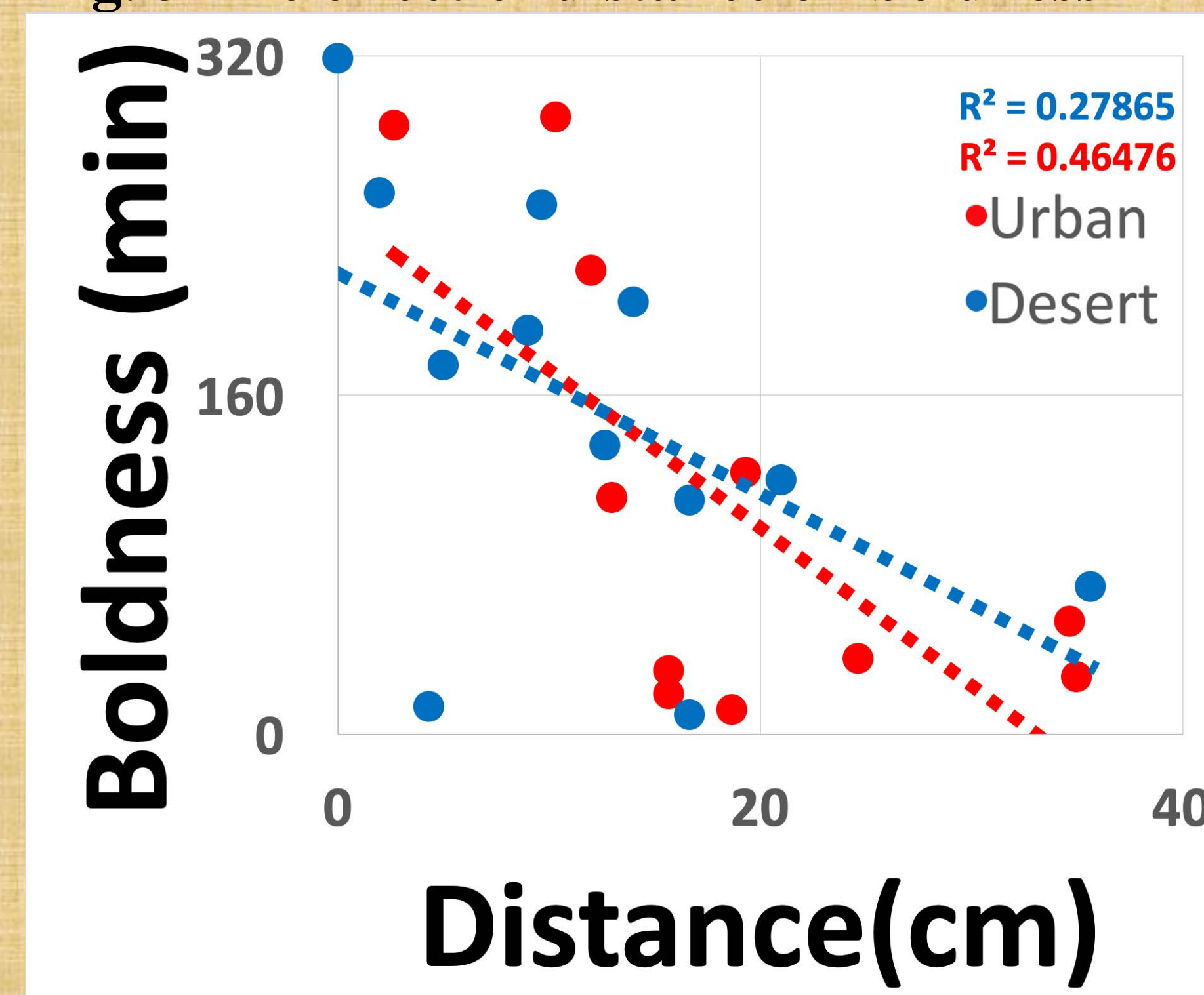
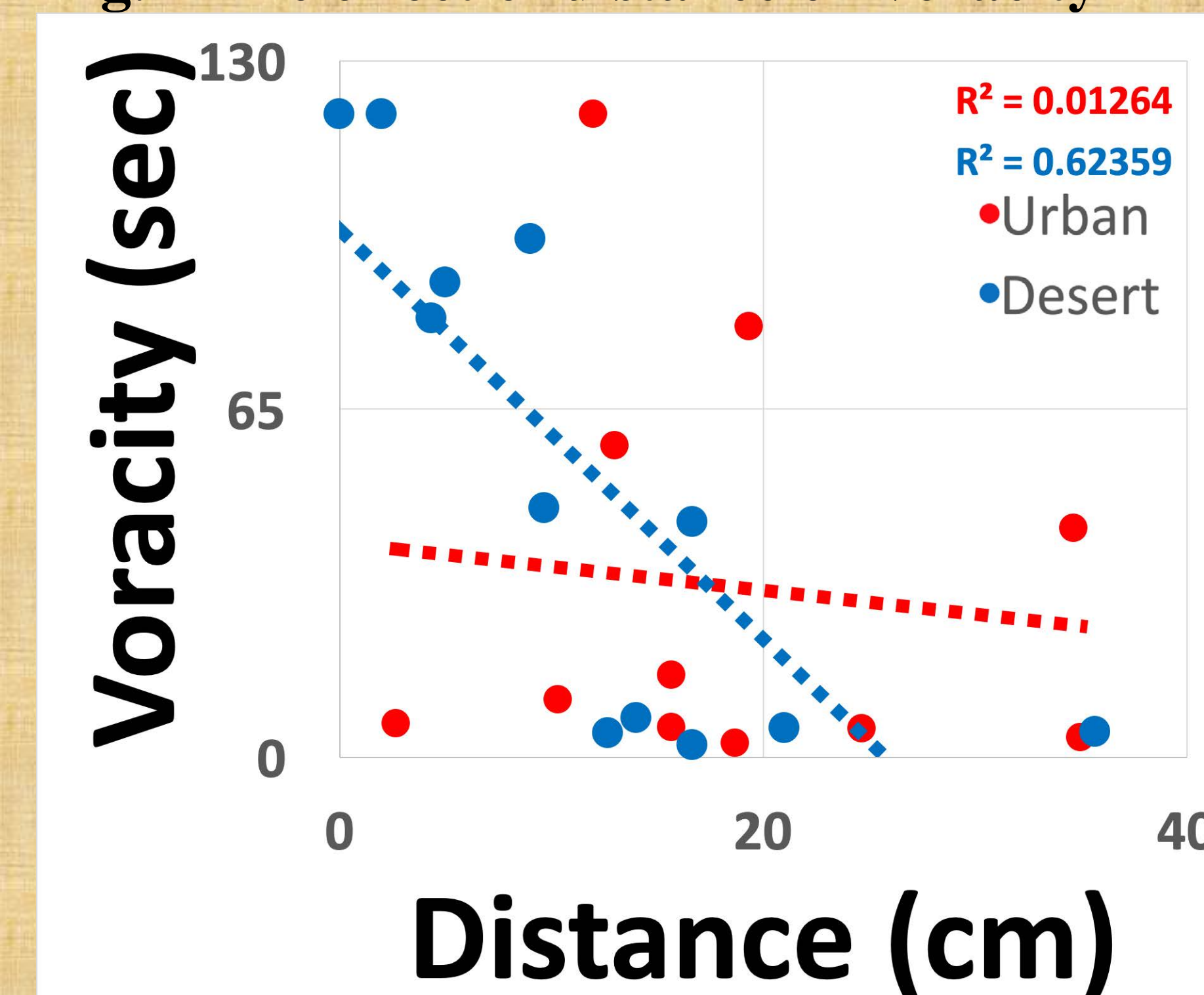


Fig. 4 The effect of distance on voracity



LITERATURE CITED

- 1) Alberti, M. 2015. Trends in Eco and Evolution, 30:2, 114-126.
- 2) Johnson, J.C. et al. 2012. The American Midland Naturalist, 168, 333-340.
- 3) Miles, L. et al., 2018. Molecular Ecology, 27, 3219-3230.
- 4) Johnson, J.C. et al. 2019. Unpublished.
- 5) Calisi, R. et al. 2009. Hormones and Behavior. 56:1, 1-10.
- 6) Sih, A. et al. 2004. Trends in Eco and Evolution, 9:7, 372-378.

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