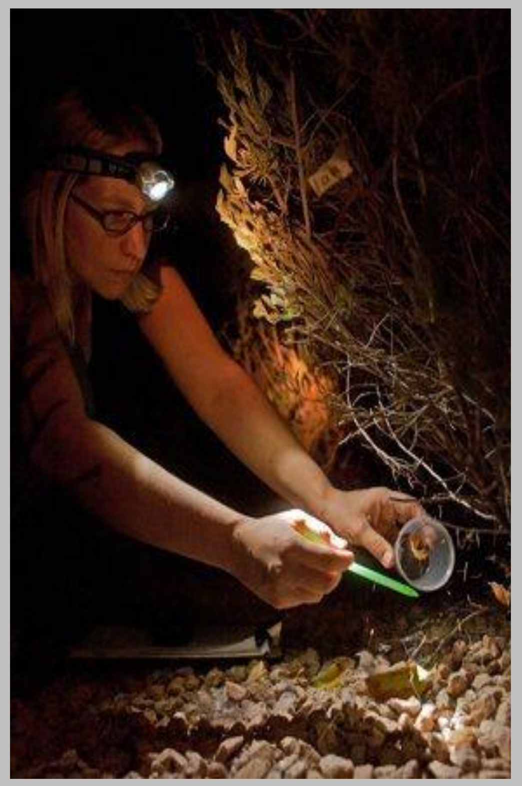

The stoichiometry of urban pests: nutrient composition in an arthropod predator-prey system across metropolitan Phoenix

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INTRODUCTION

- Understanding the impacts of 'human-induced rapid ecological change' (HIREC) has recently been described as a 'grand challenge' for ecologists[1]. Given that half the world's population now resides in urban centers, urbanization is an prevalent example of HIREC that deserves study[2].
- Urbanization often results in the loss of native species diversity at the expense of a few urban-adapted taxa also known as 'urban exploiters'[3]. However, it remains unclear why urban exploiters thrive following human disturbance, while others species are lost.
- The western black widow spider , *Latrodectus hesperus,* and its most common prey item in urban Phoenix, the decorated cricket (*Gryllodes sigillatus*) thrive in disturbed, urban habitat—often forming dense aggregations (i.e. infestations). Recently, we have shown that the average body mass and population density of urban *L. hesperus* are well predicted by their foraging success on *G. sigillatus*[4]. Furthermore, *L.hesperus* average body mass, population density and prey abundance vary significantly across urban Phoenix aggregations. As such, we were interested to learn more about the mechanisms underlying this predator-prey relationship among urban pests.
- Specifically, ecological stoichiometry (ES) allows for the quantification of multiple chemical elements and the balance of energy in ecological interactions[5]. Currently, in urban ecology, ES is used to understand how urbanization alters food web dynamics[6].
- Here we test the hypothesis that urban habitats are spatially heterogeneous. Thus, we predict the carbon-nitrogen (C: N) stoichiometry of *L. hesperus* and *G. sigillatus* will show high levels of spatial variation. Moreover, we predict that *G. sigillatus* C: N stoichiometry shapes *L. hesperus* C:N stoichiometry across 10 urban sites within the greater metropolitan Phoenix, AZ area.

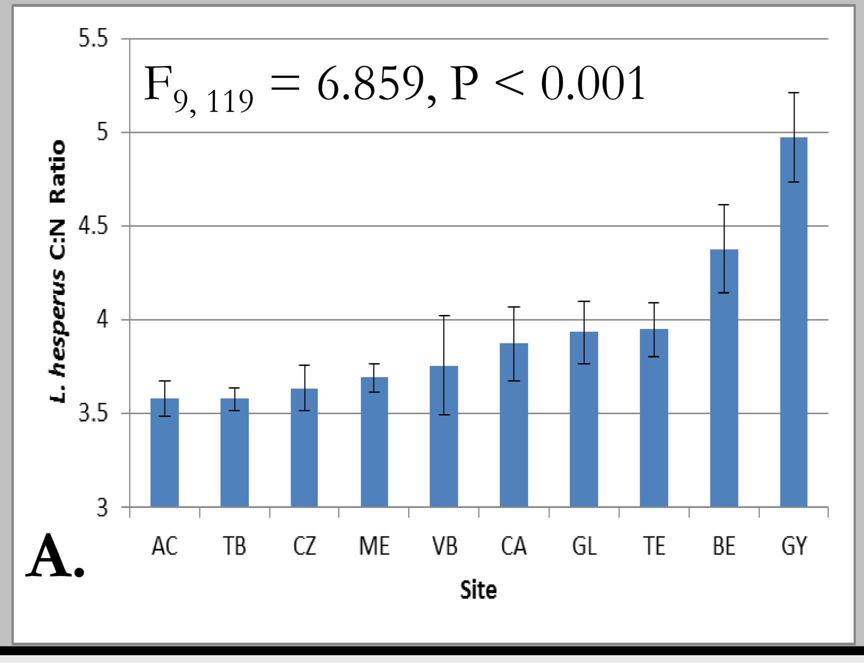
METHODS

- Urban collection sites (see Fig 1) were chosen if they met the following criteria: 1) sites had to be a minimum of 8 km apart and 2) sites had to contain a minimum of 10 female widows within 5000 m^2 (i.e. infestations). All sites were commercial subhabitats with xeric landscaping.
- *L. hesperus* webs were located visually and all penultimate and adult females were captured from a site. *G. sigillatus* were collected within a 10m^2 area of any *L. hesperus* web located at a site. Crickets and spiders were collected from mid-August to mid-September 2010. Samples were stored at -20°C for later chemical analysis.
- All samples were dried at 60°C for 120 hours. *G. sigillatus* were ground into a homogenous powder using a ball mill (*Spex-Certiprep 8000D*) and analyzed for % C and % N using a *Perkins-Elmer 2400 CHN analyzer*. *L. hesperus* were cut longitudinally, and a subsample was analyzed for % C and % N using a *Perkins-Elmer 2400 CHN analyzer*.

Fig 1. Black widow aggregations studied across Phoenix, Arizona (Map from Trubl *et al.* 2012).

RESULTS

Nutrient composition proved to be variable between sites in terms of the C: N ratio ($F_{9,119}$ =6.859, P<0.001, see Fig. 2a) and % N of black widows ($F_{9,119}$ = 5.157, P < 0.001), and the C: N ratio ($F_{9,99}$ = 2.123, P = 0.035, Fig. 2b) and the % N of the decorated cricket ($F_{9,99}$ = 2.07, P = 0.04). High C: N ratio of the decorated cricket was significantly associated with increased % N of black widows across urban Phoenix ($F_{1,9}$ = 6.512, P = 0.034, Fig. 3).



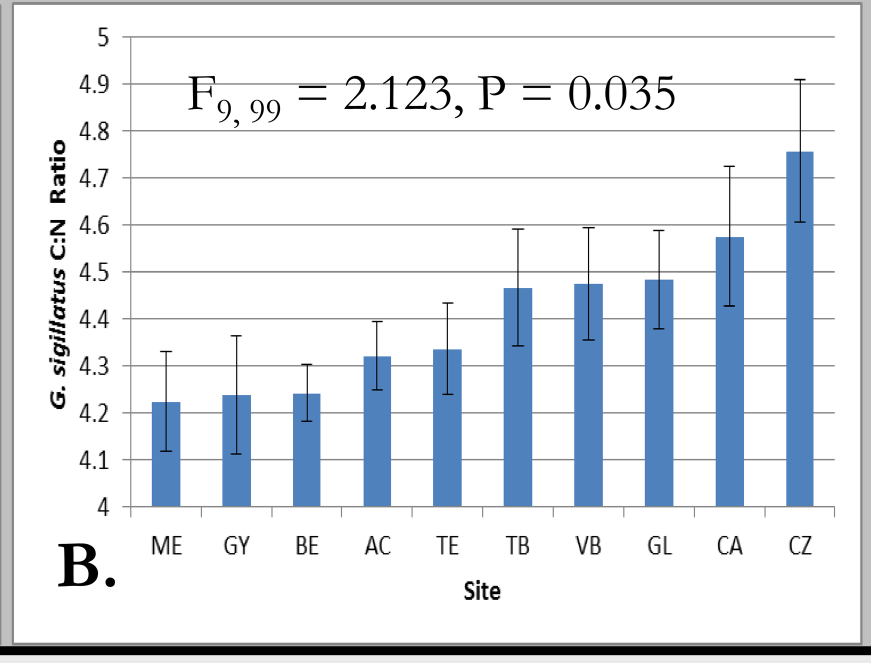


Fig 2. **A**. C: N ratio of black widows and **B.** the decorated cricket across 10 urban sites across metropolitan Phoenix, AZ.

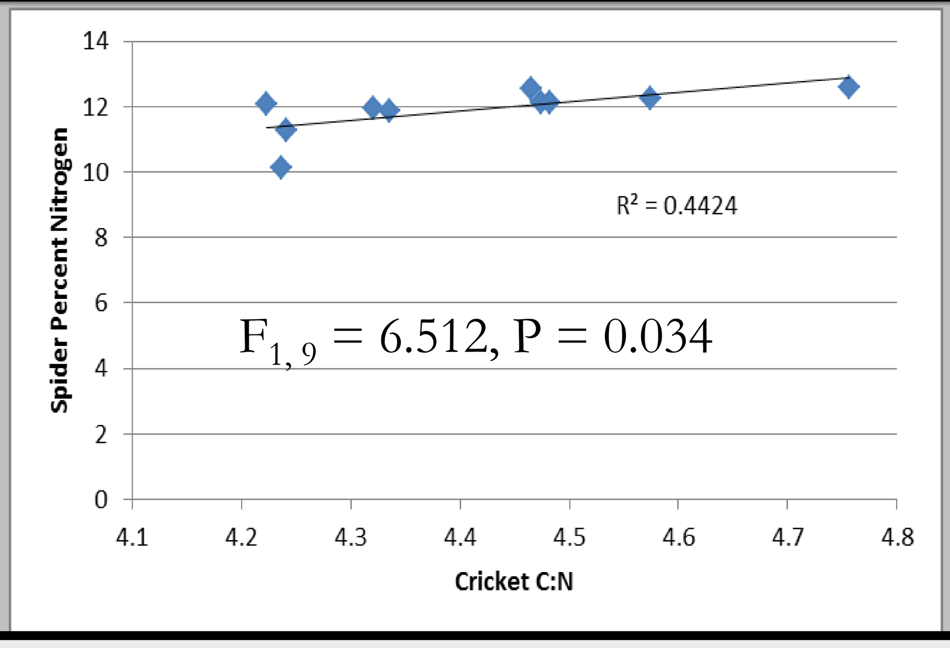


Fig 3. *G. sigillatus* C:N ratio is a strong predictor of *L. hesperus* % N across urban Phoenix, AZ.

DISCUSSION

- We found strong site variation in C: N ratios similar to that described by Trubl *et al.* (2012) for widow population ecology parameters[4]. Because that previous study also found black widow foraging success on *G. sigillatus* was a significant predictor of spider mass and population density, we were surprised here to find very few correlations between cricket and spider nutrient composition.
- The one relationship documented showed black widow % N increase as cricket (prey) C: N increases. This rather perplexing result suggests to us that widows are deriving N from a different prey source.
- Alternatively, arthropod nutrient composition across Phoenix could be a product of genetic differences across urban sites. However, preliminary results in a population genetic study of black widows, including all sites within this study, indicate no genetic clustering by sites (i.e. high gene flow between these sampling locales).
- Future work will include the addition of Phosphorus (P) content of the black widows and decorated crickets across the sites studied herein. As P limitation increases with increasing trophic levels[7], generalist arthropod predators, such as *L. hesperus* that experience high prey abundance but lower prey diversity (i.e. less nutrient diversity) characteristic of urban environments, may face strong P limitation.
- Multiple prey types will be included in future analyses to better represent the widows complete diet and better describe urban Phoenix's arthropod food web.

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