Urban behavioral ecology of the western black widow spider (*Latrodectus hesperus*): from solitary, desert predator to urban pest

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ABSTRACT

The bite of a widow spider has long been considered to be one of the most painful and dangerous of all North American spiders. One result of urban expansion into desert habitats is that humans are encountering widow spiders more and more frequently. Indeed, in Western cities such as Tucson and Phoenix, the local widow species, *L. hesperus,* is so common in and around homes that many residents, particularly those with small children, have begun contracting with pest control agencies to spray for widow spiders. Despite the fact that many pesticides are currently labeled for use against spiders, pesticides are, in fact, largely ineffective at killing web-building spiders such as widows. This is because widow spiders rarely leave their web and thus does not come into contact with toxins sprayed indiscriminately. *The goal of our research program is to develop a comprehensive understanding of the differences that exist (behavioral, ecological and genetic) between desert and urban populations of black widows.* Urban behavioral ecology is in its infancy, but an understanding of the behavioral ecology of urban pests of medical importance will be important if we hope to control pest populations and avoid broad-scale pesticide applications. Here we outline preliminary data obtained on urban *L. hesperus* populations. Future works will involve comparisons with relatively undisturbed desert populations.

1. WEB INVASION & CHEMICAL CUES

•Black widows build messy 3-dimensional "cob"-webs, (see photo below)

•When prey come into contact with the sticky web they become entangled, thus facilitating capture by the spider.

CANNIBALISM

•Web contests between widows can result in cannibalism

•Web contests/cannibalism may be common in high-density, urban infestations typical in Phoenix

•Chemical cues from a spider's web may provide conspecific intruders with information on food availability and/or the risk of cannibalism.

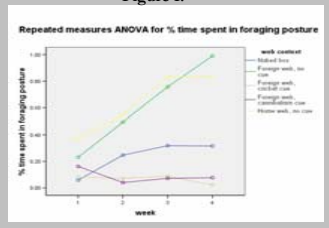
•**In particular, we predicted that the presence of chemical cues indicative of cannibalism would reduce web invasion behavior.**

•Results (see Figure 1) showed that web invasion and occupation was curtailed in webs containing prey chemical cues. However, cannibalism cues and heterospecific prey cues elicited this response equally.

•This effect intensified over the course of the 4-week experiment, suggesting habituation or condition-dependence as explanations.

•Whatever its cause, this shift over time did not exist when spiders were exposed to chemical cues from prey (conspecific and heterospecific)

Figure 1.



•Thus, widow spiders can use chemical cues to adjust their web invasion behavior, but do not appear to discriminate conspecific prey cues from heteropsecific prey cues.

2. DEATH FEIGNING: ADAPTIVE SHYNESS OR SPIDER PERSONALITY?

•Death feigning (thanatosis), or voluntary rigidity following disturbance, is a common anti-predator behavior in black widows (see photo), with feigning durations varying from 20 seconds to over 24 hours!

DEATH FEIGNING

•Past works have suggested that thanatosis is adaptively based on past experience (e.g. predation risk), or current state (e.g. hunger level).

•Behavioral syndromes (behavioral correlations across multiple contexts), sometimes referred to as animal personalities, are a hot topic in behavioral ecology.

•For example, thanatosis may not itself be adaptive, but instead may be mechanistically coupled with other traits (e.g. behavioral pleiotropy), and therefore be correlated with other advantageous components of the spider's behavioral repertoire (e.g. feeding voracity).

•**We predicted thanatosis would be most prevalent in spiders with little previous exposure to predation risk. In addition, if thanatosis is physiologically costly, or results in lost foraging opportunities, then it should be restricted to spiders in the best feeding condition.**

•**Alternatively, we predicted that if thanatosis is part of a behavioral syndrome, then (1) it should be highly repeatable across time within individuals, and (2) it should be correlated with the expression of other behavioral components of the syndrome (e.g. feeding voracity).**

•Results showed no difference in thanatosis between spiders from a harassed treatment and a control group that had no prior exposure to harassment (t= 1.01, d.f.= 19, p= 0.32)

•Furthermore, a spider's feeding condition did not predict thanatosis (r^2_{163}= 0.01, p= 0.13,).

•However, thanatosis was highly repeatable within individuals, across 8 repeated measures over the course of a spider's lifetime (intra-class correlation coefficient = 0.34, $F_{20,140}$= 5.14, p< 0.0001).

•Finally, these same spiders are currently the focus of study with respect to their foraging and mating behavior. It remains to be seen if thanatosis is correlated with these other aspects of the black widow behavioral repertoire, thus constituting a behavioral syndrome.

•In sum, thanatosis does not appear to be shyness adaptively modulated to a spider's past experience or current condition. Instead, thanatosis is a remarkably consistent trait within individuals, and therefore has the potential to be part of a behavioral syndrome, or spider's "personality".

3. WIDOW GENETIC VARIATION

In collaboration with Geoff Morse of ASU West, our lab is employing amplified fragment length polymorphisms (AFLPs) to quantify genetic variation within and among local populations of black widow spiders. Individual variation (both genetic and behavioral) is largely ignored in the field of behavioral ecology, and we are interested in understanding how and why individual animals and isolated populations are different. Population-level variation will allow us to better understand how spiders adapt to varying ecological conditions. In particular, in collaboration with CAP-LTER, we are trying to characterize differences (behavioral, ecological, and genetic) between urban widow populations and desert widow populations. Urban and desert spiders live very different lives in that (1) urban populations tend to occur in dense aggregations (infestations), and (2) as a result of their coexistence with human development, urban populations encounter significantly higher prey abundance. We aim to document the genetic variation underlying population differentiation and examine whether genetic variation is correlated with phenotypic variation that allows individuals to thrive in their different habitats. We hope this will allow us to understand why black widows are such successful urban pests and perhaps suggest ways to control their spread that do not employ futile, large-scale pesticide applications. We would like to thank SRP, CAP-LTER and Barrett, The Honor's College for financial support.

4. NO SPIDER LEFT BEHIND:

EDUCATION AND OUTREACH WITH BLACK WIDOWS

Following the lead of the Ecology Explorer's program, we aim to use our study system to attract the interest of K-12 teachers and students to an ecological understanding of their surroundings. Beginning with lessons on spider safety, we will train students and teachers in the natural history of black widows, and engage them in long term studies of the behavior and ecology of these fascinating spiders. This will take the form of field experiences viewing the contrast between urban and desert widow habitat, as well as lab experiences, in which a term-long rearing experiment will demonstrate the importance of both genes (full sibships) and environment (food regime) on the development of interesting widow behaviors such as cannibalism. Past experiences suggest that black widows are outstanding ambassadors for urban ecology, and that they are particularly effective at capturing the imagination of tomorrow's scientists