Conspecific silk cues shape the habitat preferences of black widows

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INTRODUCTION

The Western Black widow spider (*Latrodectus hesperus*) is a common pest that thrives in disturbed, urban habitat including the Phoenix metropolitan area. Because the black widow's venom includes a potent neurotoxin, research on this venomous urban pest is of medical importance.

Habitat preferences are predicted to maximize benefits (e.g. access to food and/or suitable shelter) while minimizing costs (e.g. search time) (1). In particular, habitat choices of web-building spiders like the black widow are critical as web construction is an energetically costly behavior.

Recently, the study of conspecific cue attraction in habitat assessment has received attention by conservation biologists (2). The use of conspecific chemical cues by web building spiders (i.e. silk left by conspecifics) has been shown to reduce the costs associated with habitat assessment (3).

Female black widows are known to make habitat choice decisions favoring areas with chemical cues left by their prey (Johnson, unpubl. data). In addition, urban areas are often infested with high-density populations of black widows in which a number of females produce webs in close proximity, sometimes overlapping one another (Trubl & Johnson, unpubl. data). Such "social" aggregations of spiders are often thought to be made up of related individuals (4). Whether or not urban Phoenix black widow infestations involve close relatives is a question currently being examined in our lab.

Here we tested the hypothesis that habitat preferences are shaped by (1) the detection of conspecific chemical cues, and (2) the relatedness of spiders producing those silken cues.

Specifically, we predicted that (1) spiders will prefer to settle on web-building substrates containing conspecific chemical cues (black widow silk) and (2) spiders will prefer web-building substrates containing chemical cues from a full sibling over unrelated cues.

METHODS

Urban Microhabitat Enclosures

Spiders were contained within ten replicate microhabitat cells (3.8 m in circumference and 0.3 m tall) constructed of aluminum siding buried into the soil (see photo). Four cinder blocks (20 x 20 x 10 cm) were placed equidistance from one another other in each cell each approximately 6 cm. inside of the aluminum siding wall.

Conspecific Chemical Cues

In each replicate enclosure, two randomly selected cinderblocks diagonal from each other were chosen as sites for original web building. One black widow spider, each from a different family, was confined to their respective cinder block by a smaller enclosure (0.9 m in circumference and 0.3 m high) and was allowed to build web for 10 days.

Spider Habitat Preference

After 10 days, spiders were removed and their 3-dimensional webs were deconstructed to the extent that all silk was made flush with the cinderblock. The remaining two, non-focal cinderblocks in each enclosure were left devoid of chemical cues. One focal spider, related to one of the two web building individuals, was introduced into the center of each cell at dusk. After initial introductions, each spider was observed for the first 30 minutes to record direction of movement, distance traveled, and first block choice. An additional four checks were made at 15 minute intervals to score location and activity. Subsequent daily checks noting location and activity were conducted until spiders failed to relocate for two consecutive days.

RESULTS

By random chance, we would expect blocks containing chemical cues to be chosen 50% of the time. The initial block chosen by spiders differed very little from this prediction (Fig. 1a). In contrast, after 3 days, a number of spiders had relocated such that 80% of spiders settled on blocks with silk (Fig. 1b). This trend was not found to be significantly different from that expected by chance cues (Chi-square goodness of fit test: χ^2=3.6, p>0.05).

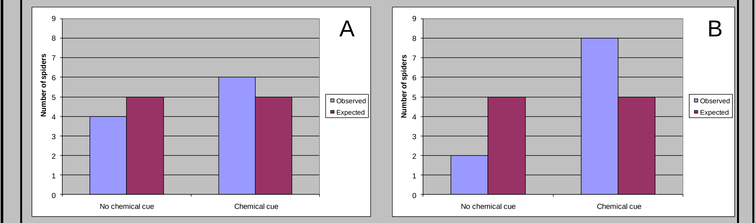

Figure 1. The change in the number of individuals that were observed and expected to have chosen web building substrate with or without chemical cues across the A) initial location choice, and B) location after 3 days.

Considering all three habitat options (no silk 2/4, related silk 1/4, and unrelated silk 1/4) the initial block chosen by spiders differed very little from that expected by chance (Fig. 2a). However, after 3 days, a number of spiders had relocated such that 60% of spiders had chosen blocks with unrelated silk, which is significantly different than the 25% expected by chance (Chi-square goodness of fit test: χ^2=6.8, p<0.05; see Fig. 2b).

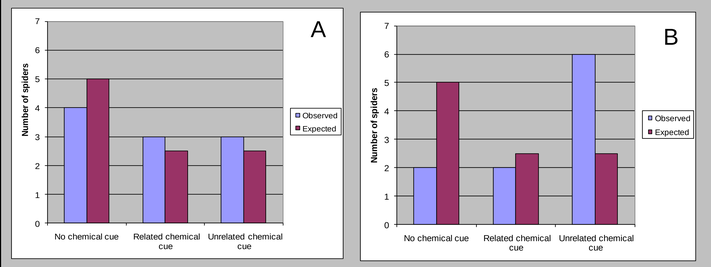

Figure 2. The change in the number of individuals that were observed and expected to have chosen web building substrate with no chemical cues, related chemical cues, and unrelated chemical cues across the A) initial location choice, and B) location after 3 days.

DISCUSSION

We found a non-significant trend for spiders to choose cinderblocks with conspecific chemical cues. This trend is consistent with previous findings showing that spiders use conspecific chemical cues to make habitat choices (3,5).

However, given the choice of related silk, unrelated silk, and no silk, black widows significantly preferred to settle where unrelated chemical cues were present. Thus, counter to our original prediction, spiders preferred to avoid habitat previously colonized by a full sister.

Recent studies on the evolution of sociality indicate that kin recognition, and a decrease in cannibalism of kin, is a pre-requisite for these aggregating communities (6). As such, black widows may be avoiding habitat previously colonized by a sister to reduce competition and/or cannibalism among close relatives.

Interestingly, while we called a spider's location at day 3 its final habitat choice because this was the point at which no spider relocated for 2 consecutive days, spiders did relocate in the subsequent week apparently in response cool temperatures, strong winds and the worst hail storm seen in decades. After this storm, 9/10 spiders had settled on cinderblocks on the South side of their enclosure. This may have been due to strong winds moving South to North, such that cinderblocks on the South side of the enclosure offered spiders the most shelter from high winds.

Future research on the biotic and abiotic factors determining habitat choice by black widows will help us understand why urban infestations occur, and potentially aid in controlling this explosive population growth. Subsequent trials of this experiment will be continued in the spring to bolster sample sizes and determine whether the trends seen here are statistically significant.

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LITERATURE CITED

1. **Alcock, J.** 2005. Animal behavior: An evolutionary approach. 8th ed. MA: Sinauer Aocciates, Inc. 564 p.
2. **Reed, J. M. and Dobson, A. P.** 1993. Behavioral constraints and conservation biology: conspecific attraction and recruitment. *Trends in Ecology and Evolution*, **8**, 253-255.
3. **Salomon, M., Vibert, S., and Bennet, R. G.** 2010. Habitat use by western black widow spiders (*Latrodectus hesperus*) in coastal British Columbia: evidence of facultative group living. *Canadian Journal of Zoology*, **8**, 334-346.
4. **Roeloffs, R. and Riechert, S. E.** 1988. Dispersal and Population-Genetic Structure of the Cooperative Spider, *Agelena consociata*, in West African Rainforest. *Evolution*, **42**, 173-183.
5. **Bilde, T., Maklakov, A. A., Taylor, P. W., and Lubin, Y.** 2002. State-dependent decisions in nest site selection by a web-building spider. *Animal Behavior*, **64**, 447-452.
6. **Bilde, T. and Lubin, Y.** 2001. Kin recognition and cannibalism in a subsocial spider. *Journal of Evolutionary Biology*, **14**, 959-966.