



# Chemical prey cues influence microhabitat preferences of black widow spiders

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## INTRODUCTION

•Predator-prey systems involving arthropods have been instrumental in the rapidly growing study of kairomones, or chemical cues emitted by one organism that are exploited by another organism (1).

•For example, chemical cues can allow predators to detect prey, and allow prey to avoid predators (2).

•Male widow spiders (*Latrodectus* spp.) have been shown to use kairomones to detect the mating status (3) and body condition (4) of potential mates.

•Web-building spiders make a critical microhabitat selection decision when they invest the time and energy required to build and maintain a web.

•Thus, natural selection may favor spiders that use chemical cues emitted by their prey to build webs in prey-abundant microhabitats.

•The Western black widow spider (*Latrodectus hesperus*) builds messy, 3-D cobwebs throughout desert and urban habitats of the Western United States.

•In particular, urban Phoenix populations of widows can be densely populated (e.g. 0.3 spiders/m<sup>2</sup>) relative to desert populations (0.006 spiders/m<sup>2</sup>, Johnson, unpublished data).

•The toxicity of widow spider venom (5) combined with their ability to form dense urban infestations often results in failed efforts to control widow spiders with pesticides. Thus, we argue that an understanding of the population ecology of urban infestations is critical in efforts to control this urban pest.

•Here, using an outdoor enclosure to mimic urban habitat, we present the first study to ask whether or not this common urban pest bases its microhabitat selection on chemical cues from prey.

## METHODS

### Urban Microhabitat Enclosure

We used an outdoor enclosure approximately 7 m<sup>2</sup> in area consisting of chain link fencing and chicken wire (see photo). Within this enclosure, a 6 m<sup>2</sup> area was defined by a metal wall roughly 0.75 meters tall that contained all study animals. Within this primary containment area we buried aluminum flashing into the soil to divide the larger plot into 16 cells of equal size (1.5 m<sup>2</sup>) to contain individual spiders.

### Cricket Chemical Cue

One corner from each cell was chosen at random to be the focal corner. In the focal corner five House crickets (*Acheta domesticus*) were placed with food and one clean rock under an upturned plastic tub approximately 61 cm x 30.5 cm x 61cm. The first wave of crickets remained in the tub for three days. Another wave of five crickets was added to each focal corner on the fourth day, and another five were added on the fifth day. On the sixth day all crickets living and deceased were removed from the enclosure along with their food and the plastic tubs. The focal corners were finished by the addition of two squares of egg crate that had previously housed live crickets. Non-focal corners were equipped with a clean rock and two squares of egg crate lacking prey cues.

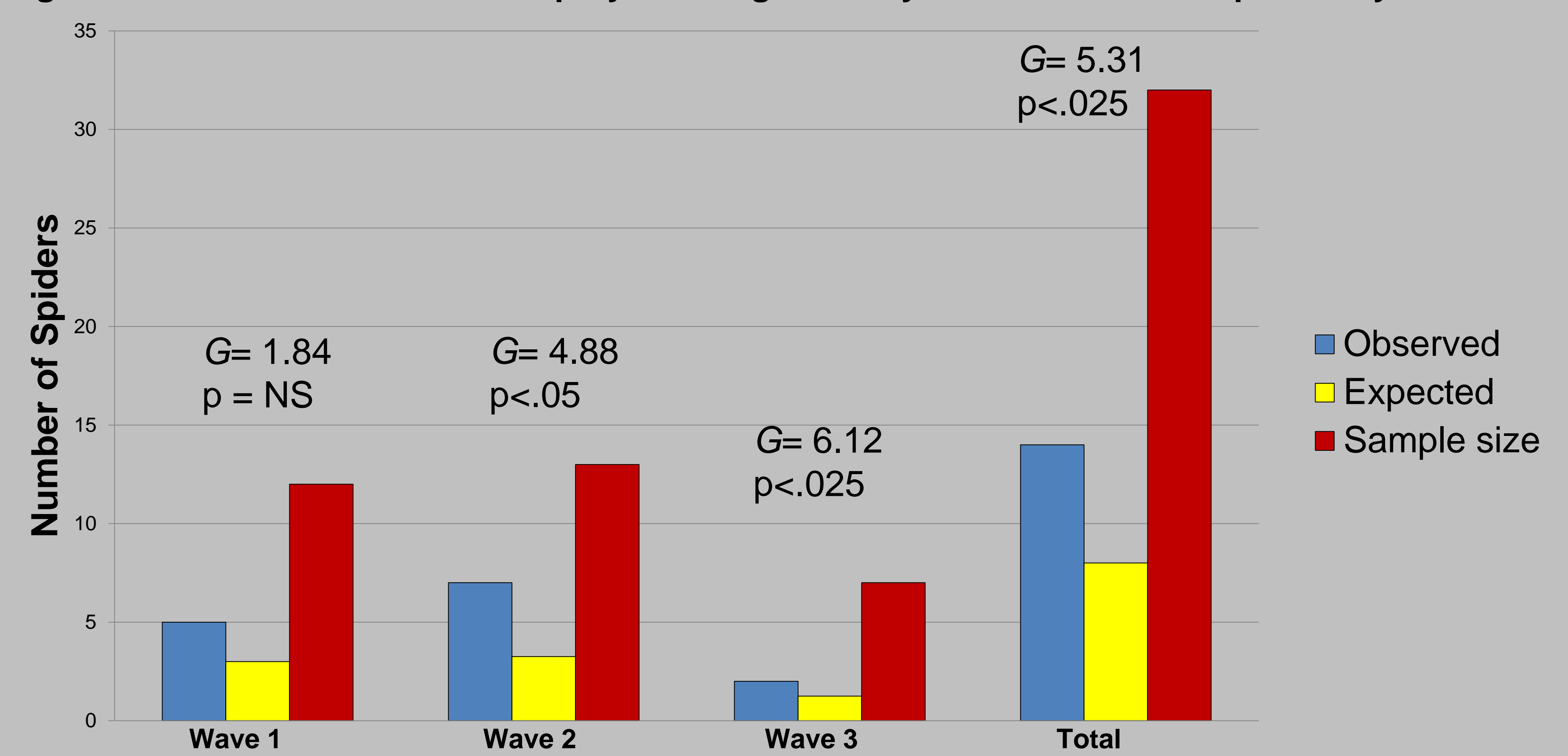
### Spider Habitat Preference

All spiders used in trials were adult females obtained from urban habitats and were weighed (mg) prior to use in the experiment. At dusk, one spider was released in the center of each cell. We made an initial observation as to their direction of movement and in six subsequent checks at 15 minute intervals scored their location. If any spider remained missing for three intervals, egg crates and rocks were gently maneuvered to determine the location of the spider. The next day an A.M. and P.M. location check was conducted. On the third day a final A.M. observation was made and this was considered to be the final habitat preference as no spiders relocated after this point. Any spiders missing at day three (see Discussion) were excluded from the data analysis. To obtain a sufficient sample size we ran three sequential waves of the above protocol to reach a total sample size of 32 spiders making a day three habitat selection.

## RESULTS

In each of the three experimental waves, spiders preferred to build webs in focal corners (see Fig. 1). Given that four corners were available and the probability spiders would select the focal corner by chance was 25%, spiders selected the corners with prey cues significantly more often than by chance in Waves 2, 3 and the three waves combined. No significant differences were detected across the three waves.

Fig. 1 Widows select habitat with prey cues significantly more often than expected by chance



## DISCUSSION

•Our findings support the hypothesis that female black widows use chemical cues from prey to make adaptive habitat selection decisions.

•These results are consistent with previous findings that showed both male (4) and female widows (unpublished data) can detect the feeding status of female widows from silken cues and adjust their behavior accordingly.

•Thus, our work on the use of kairomones by this web-building species can be added to the extensive work demonstrating kairomone use by non web-building species (2).

•Twenty-nine percent (16/48) of the spiders that began our experiment were missing after 3 days! As the outer walls of the enclosure were confirmed to be too tall and slick for spiders to escape, this level of disappearance is astonishing. While we documented two cases of cannibalism in our trials, such conspecific predation events are easily confirmed by the presence of a wrapped spider in the predator's web. Instead, 14 females went unaccounted for in our trials. Anecdotal observations suggest that black widows were being preyed upon by geckos and lizards that were confirmed to have entered the enclosure.

•In sum, urban black widow habitat preferences are influenced by chemical cues left by prey. Given the propensity for urban populations to swell to alarming densities, we need to have a thorough understanding of what biotic and abiotic factors attract black widows if we hope to limit the growth of their populations in urban areas.

## LITERATURE CITED

1. Dicke M & Grostal P (2001) Chemical detection of natural enemies by arthropods: An ecological perspective. *Annu Rev Ecol Syst* **32**, 1-23.
2. Persons MH, Walker SE & Rypstra AL (2002) Fitness costs and benefits of antipredator behavior mediated by chemotactile cues in the wolf spider *Pardosa milvina* (Araneae: Lycosidae). *Behav Ecol* **13**, 386-392.
3. Stoltz JA, McNeil JN & Andrade MCB (2007) Males assess chemical signals to discriminate just-mated females from virgins in redback spiders. *Anim Behav* **74**, 1669-1674.
4. Johnson JC, Trubl P, Blackmore V & Miles L (In revision at *Proc. Roy. Soc. B.*) Male mate choice in black widows: chemical and physical cues allow males to avoid sexual cannibalism by poor-condition females.
5. Muller GJ (1993) Black and brown widow spider bites in South Africa—a series of 45 cases. *South African Medical Journal* **83**: 399-405.