The Plasticity of Black Widow Web Building Strategies Based on Prey Type

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Abstract: Black widow spiders show various displays of plasticity in order to survive such as; hunting and phenotype plasticity to capture live prey. Do black widow spiders show a display of plasticity with web building strategies in relation to prey type? Studying this question required a two-group design of 12 with each group being fed either flying or non-flying prey. 24 juvenile widows were chosen out of a group maintained within the lab from around the Stillwater area. Juvenile webs were examined every two weeks to see if the most-dense portion of the web changed in height in response to the prey given. After 15 weeks of observation it was found that there is a significance between the height of the most-dense portion and prey type which helped support our hypothesis that black widows change their web building strategies based on prey type.

Keywords: Web Strategies, Web Plasticity, *Latrodectus mactans*

Introduction

Predators are ubiquitous in every ecosystem and rely on catching live prey for food. As prey have also adapted to avoid being eaten, coevolution has resulted in an arms race between predator and prey. There are multiple strategies that have been used by all kinds of predators to more efficiently capture prey such as; ambush, stalking, mimicry, and camouflage to draw in prey, as shown in octopus camouflaging to the environment around them (Hanlon *et. al* 2010). An example of a hunting strategy where the predator ambushes their prey is that of the African Red Trapdoor spider (*Ctenizidae*), which lays silk threads outside of its burrow that it has cleverly covered with a flap of earth and when it senses movement across these threads it quickly jumps out of the door and drags its prey into the burrow (Buchli 1969). In addition to evolving different prey capture strategies over evolutionary time, some predators need to adapt their prey capture strategies to temporal changes in the availability of different types of prey.

Spiders are apex predators that help to control insect populations (Nyffeler and Benz 1987) either with direct consumptive effects or indirect effects (Oswald Schmitz). To study the plasticity of juvenile, southern, female black widow spiders (*Latrodectus mactans*), located in the south-western portion of the United States, we observed the way the black widow structures its web based on different prey types.

Black widow spiders are polyphagous predators and feed on multiple kinds of arthropods based on abundance of prey (Salomon 2011). Black widow spiders have a broad breadth of phenotypic plasticity. With the ability to change color based on environment (Gburek et. al 2014), prey switching behavior (in which they switch prey types based on abundance) (Villina *et. al* 2014), and even the ability to change the way they build their webs based on the availability of prey (Zevenbergen et.

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al 2008). Different prey has different traits and, hence, these spiders may need to adapt their prey capture strategies to specific prey types. One significant factor that differs among prey is their use of flight. Some insect groups frequently fly, while others more often crawl. Capturing flying versus crawling prey may require different web-building strategies.

The overall goal of this study is to see if black widow spiders do show plasticity in prey capture. I predicted that the widows will show a difference in the height of web density in response to the prey type they received. The prey that will be used consist of two groups of flies (*Drosophila hydei*); one group of flies have a genetic mutation that doesn't allow them to fly. We predicted that black widow spiders are able to change the structure of their webs to catch different types of prey.

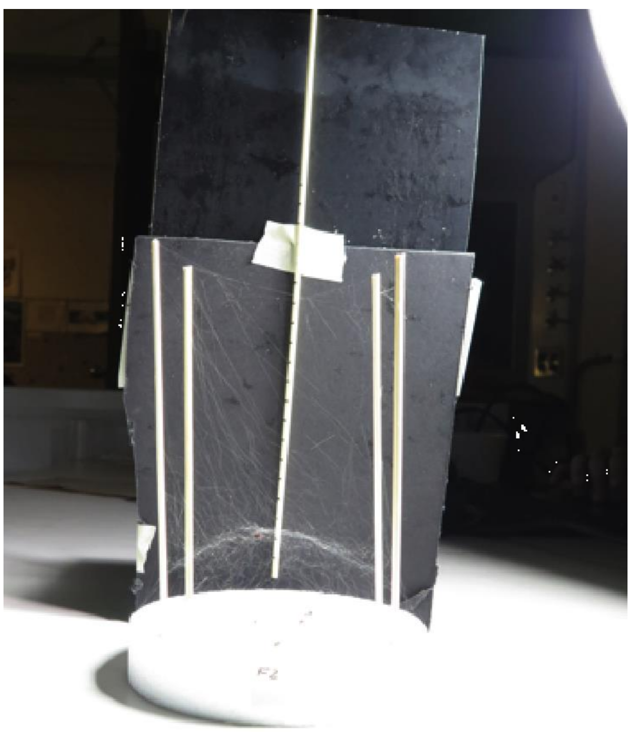

Figure 1 – Display of container set up during picture

Methods

The experiment itself is a two-group test consisting of juvenile black widow spiders separated into two groups with each group receiving different prey types. Female widows were collected from around the Stillwater area and maintained within the lab until egg sacs were produced and hatched. The newly hatched widows that were used for this experiment were maintained in the lab and were fed two to three *Drosophila hydei* twice a week for a period of 15 weeks. The first group of widows continued to receive flies with a genetic mutation that inhibits flight and the web structure was observed. The second group were introduced to flies that do not have a genetic mutation and their webs was observed as well. The goal of the study was to observe the plasticity of black widow spiders in their response to flight or flightless prey.

To test our hypothesis, we have chosen to use 24 juvenile *Latrodectus mactans* and using a random number generator, assigned 12 juveniles to the two treatment groups of flying vs non-flying prey. The containers (Width 16cm, Height 21cm) consist of Styrofoam circles (radius 6cm) with four posts creating a square to allow for the widow to climb and form a web (Figure 1). The bottom of the container was lined with Vaseline ® to prevent the widow from climbing. All juveniles were fed 2 to 3 nonflying flies twice a week for two weeks, so that they stabilize a web. To visualize the web, we put the widows into a black room and a picture was taken. Every two weeks after the initial web was built, the resulting webs were destroyed to see if there

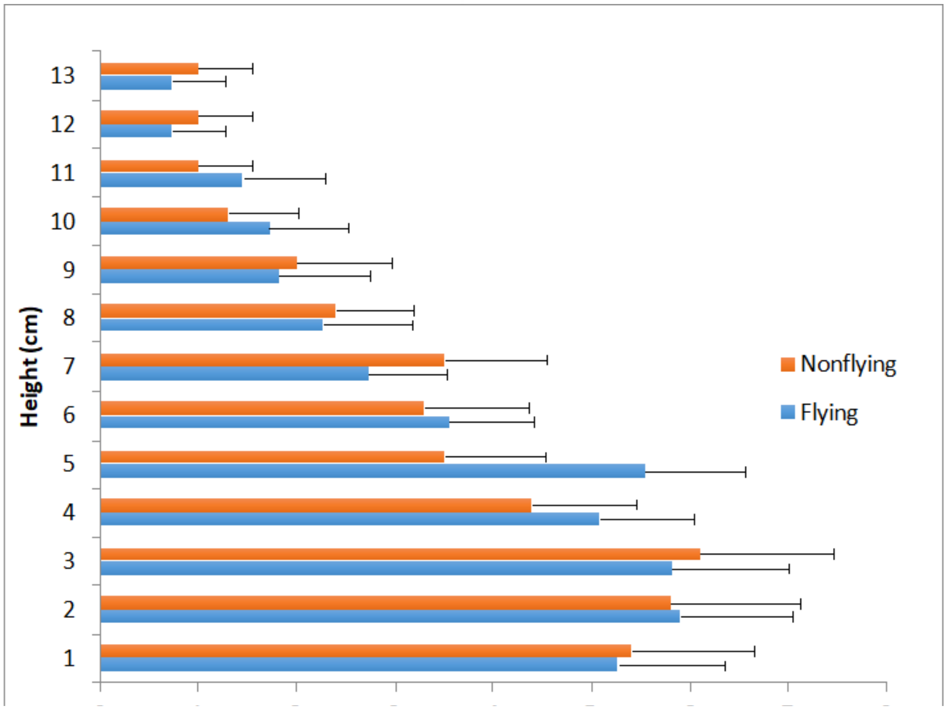

Figure 2 - There was a broad range in the average relative density between the two treatment groups. There was no significant difference between the two groups at the beginning of the study (treatment: F = 0.0090, p *= 0.9236; height: F = 8.0857,* p *< 0.0001; treatment × height F = 0.2662,* p *= 0.9936).*

is a difference in the web structure after a prey type was introduced.

Measuring the density of each cubic centimeter was determined by observing the amount of threads that crossed each centimeter and numbering the percent of density within each square where 1 is the least dense portion and 10 is the greatest density, the numbers were then cataloged within a excel document for the three sets of pictures taken. We also measured the height of the widow at the time of the picture being taken as well as the position the spider was in for a possible future study on behavior and prey type.

Results

In the first observation period, there was no significant difference between the webs of juvenile widows fed either flying or non-flying prey (Figure 2; 0.009, p = 0.9236). Spiders in both treatments built webs in which the densest area of web was located within 0-5 cm with progressively less web material up to 13 cm (Figure 2).

However, in the second set of pictures there was a significant difference in web structure between spiders fed flying and non-flying prey (Figure 3; treatment x height: F = 13.22, p = 0.0004). Spiders in the flying treatment showed an even more distinct peak in the location of the densest area of web at 2 cm, while spiders in the non-flying treatment showed a broader range over which the densest areas of their webs were located (Figure 3).

Discussion

The first set of pictures (Figure2) shows that there was no significance at that time between the height of the densest portion of web and prey type but during the second pictures (Figure3), shows that there is significance between height density and prey type. Thus, showing that black widows do express plasticity in regards to web building strategies and prey type. This was expected with the widows being given time to adapt to the change from the prey they had been fed previous to the start of the study. Since widows do tend to have a more-

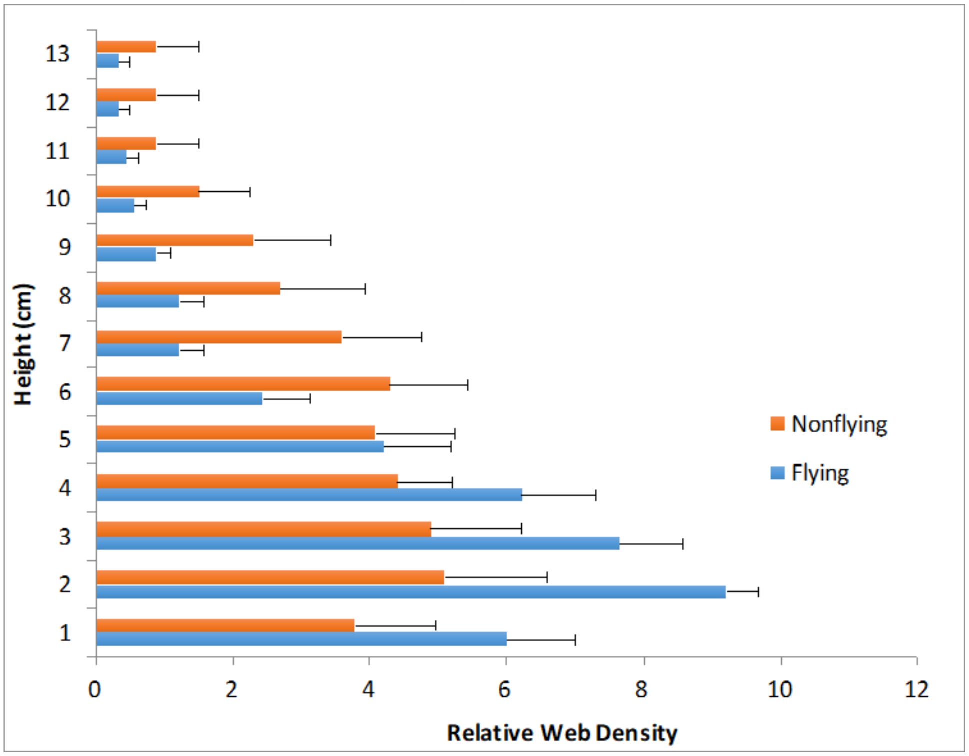

Figure 3 - The flying treatments have high relative density in lower portions of the web, while the nonflying treatments still show the same broad range of relative density. This shows a significant different between the two treatment groups after the widows were able to adjust to the prey given (treatment: $F = 3.0709$, $p = 0.0811$; height $F = 13.2208$, $p < 0.0001$; treatment × height: $F = 2.5215$, $p = 0.0040$).

are able to change the structure in response to the change in prey.

Some possible future studies could be ones seeing if there is a correlation between their personality and the prey type by looking at the height and position of the black widow within each treatment. Measuring where the widow was located as well as what position the widow was in could lead to further understanding as to the behavior of a widow during times of stress or in relation to prey location.

dense proportion of web above where they hide, the flying treatment shows that the widows would hide lower and build their sticky treads higher to catch their prey. The non-flying showed a broad range of densities which we believe are due to the greater variety of strategies being used to capture the pray as they were able to climb the bamboo shoots.

With these results in mind we can see how the widow changes not only their strategies but as well as their behavior such as in the experiment done by Zevenbergen and seeing that widows change the structure of their webs based on availability. Like other vertebrates, widows show plasticity in various ways, even with having web capture be their primary source of prey capture they

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