Honors Research (Bio 4950H and 4952H) Application

Your Name: [redacted]

Mentor's Name: [redacted]

Mentor's Department: Division of Biological Sciences

Title of Project: Spatial Orientation and Memory in a Jumping Spider (Phidippus audax)

Background Information on Project: Salticidae, commonly known as jumping spiders, is a family that contains about thirteen percent of all spider species. These spiders are known for many of their unique behaviors. For example, the genus Maratus, commonly known as the peacock spider, is known for their amazingly complex and colorful mating displays. Though their jumping ability is what defines them, the family is a whole is also considered to be extremely intelligent animals. When hunting the spiders present highly complex behaviors rarely exhibited by animals of their size, which has attracted significant attention from behavioral ecologists (Bednarski, Taylor, & Jacob, 2012). It has been reported that before approaching a prey item Portia labiata will scan their environment then path through whatever terrain they have in order to get to their prey, even if they have to move away from the prey along the route (Tarsitano, 2006). Portia fimbriata is among the most "intelligent" of the jumping spiders. Also, it has been shown to learn specialized attacks for specific prey items. When hunting a web building spider fimbriata was observed vibrating the web to imitate a captured bug and waiting for gusts of wind to shake the web before running across it (Tarsitano, Jackson, & Kirchner, 2012). Phidippus audax have the same sort of prey as Portia does and, therefore, may have adapted very similar hunting techniques. Essentially, in my experiment I will be fusing the concept of testing path selection along with looking for learned hunting techniques. Combining these tests allows for in lab testing of both movement behavior through path selection and cognition based on improved hunting speeds.

Experimental Approaches: This project combines focal observation with experimental manipulations to evaluate path selection and spatial memory in Phidippus audax. The experiments are conducted inside an experimental arena with completely white walls. The arena is made of a white cardboard material, the base is 52 cm x 76 cm and the height is 50 cm (Figure 1). An arena without features (i.e., visual patterns) is used to avoid the possibility that other cues besides those provided by the structure of the path are used for path selection. The enclosure contains various dowel structures, which form potential pathways for the spider to move on in order to reach the prey. Two types of path are available, both paths begin in the same location, however they differ in their endpoint. One path is constructed to be impassable, in a way that a spider could climb onto it but cannot reach the prey using it. The other path constructed to be passable so the spider can take a continuous route to the prey. Each of the enclosures has an open top. This allows me to position video camera above the arena so that the trial doesn't have to be directly observed but can be saved and viewed later on. This setup allows me to collect data on the speed and path selection of the spiders and to study their navigation and learning abilities. Once a spider has reached a learning criteria, which is set as having seven trials of the previous nine trials be successful, I will modify the paths to evaluate spatial memory. To do so, during the second stage of the experiments, I will place a blinder around the passable pathway so that when the spider is going down that path it can no longer see the prey. This will test whether the spiders are able to remember that the path they are on leads to the prey despite not being able to see the prey the path to the prey at that moment. After the spider successfully completes that stage, using the same seven successes out of the previous nine trials system, it would move on to stage three. In stage three there will be a gap added onto the passable path in addition to the blinder. This gap, which would be of approximately 0.15cm, would not limit the ability of the spider to use the path, but will eliminate the vibrations caused by the prey. This will help allow us to analyze any effect that the lack of those vibrations has on the spiders' ability to path to the prey. With the addition of sound and vibration monitors we can also collect data on the movement of the prey (i.e., a tethered cricket) and see if their movement has any influence on the movement of the spider throughout the trial. The goal is to have at least fifteen spiders complete each stage so I will begin with at least thirty spiders. In the end, we will evaluate the speed and frequency of success for each spider as it goes through the individual trials then again with each spider's data between the separate trials.

Predicted Outcomes: I predict that the majority of spiders will find their way from the starting position to the prey on a consistent basis. This is supported by the trials I have run thus far in which almost every spider was able to explore the arena and found the prey. These original trials have been limited, from lack of test subjects (spiders are more abundant during spring and summer seasons), but one spider also showed signs of learning. This spider was observed taking an alternate path than its former successes then continuing to take that path for several subsequent trials. Overall, I expect that I will be able to collect an extensive amount of data on path selection and data in support of these spiders having learning capabilities and on to what extent they can learn and remember. This project will contribute to our current understanding of cognition and behavior in invertebrate species. In addition, it can shed some light into the formation of memory and if there are similarities between different groups in this process.

Overall Significance: The understanding of the cognitive abilities of invertebra widely misunderstood commonly and scientifically. I believe that measuring the learning and memory capabilities of these spiders can help to improve our understanding of the true ability of their simpler brain structures.

Cited Literature:

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