A Comparion of the Size of the Female Golden Orb-Spiders *Nephila clavipes*) to the Number of Males Associated with the Web

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Abstract

In this study we looked at the size of female Golden Orb-Spiders (*Nephila Calvipes*) in relation to the number of males on her web. We photographed and measured the female spiders and counted the number of males. We found that there was a negative correlation between the female's size and the number of males on her web.

Introduction

The largest of the orb-weaving spiders, Golden Orb-Spiders (*Nephila clavipes*) are native to continental North and South America, and are commonly found in warm, tropical regions. Adult females weigh about 1 g and are about 2.5 cm long, while the males are significantly smaller, about one-tenth the size of females. This phenomenon of size disparity, known as sexual dimorphism, is a common trait in many species of spiders and is associated with sexual cannibalism (wherein a female is liable to cannibalize her mate before, during, or after copulation). As well as being a fraction of the size of females, the males also undergo 2-3 fewer instars, but develop much slower so that they reach maturity at the same time. The female Golden Orb-Spider builds the web and inhabits the center of the orb, while one or more males may inhabit her web, feeding on her prey.[1] Larger males seem to succeed more often when there is competition between males: they mate more often, and with more females; they may displace the sperm of smaller males in the female receptacle; finally, when aggressive interactions occur between males the larger male often wins and has a higher likelihood of gaining access to the female.[2] However, an upper limit to the size of males exists. Without this limit, the female would not be able to sustain the several males which live on her web. The female Golden Orb-Spider is more aggressive towards larger males, but there is no evidence to suggest that there is any female selection of males.

Nevertheless, the size disparity between males and females can be beneficial for both sexes. A male's small size may facilitate: easier locomotion and his search for a female; reduced female flight response by limiting motion on her web; reduced female pre- and post-copulatory aggression; male escape if the female is aggressive; male cohabitation and commensalism in the female web; and a reduced risk of feeding and moulting during growth. The female benefits from a male's small size because he is a smaller drain on any

[1] Preston-Mafham
[2] Vollrath

resource shared. The male and female benefit from the male's smaller size because it allows for larger females with a higher investment in her eggs.[3]

During the mating process, females emit pheromones onto their web which signals that they are ready to mate. In search of these pheromones, the males leave their nests upon maturing and begin their "roving" instar wherein they wander until finding a web. Although it is possible to mate with an already-gravid spider, the first male spider who successfully mates with a female is guaranteed that some of the offspring will be his. Virgin female spiders emit a unique pheromone which attracts more males because of their need to insure offspring[4].

In our experiment, we hypothesized that through observation we would find a positive correlation between the size of a female and the number of males on her web. We reasoned that there were many reasons why males would congregate on the webs of larger females, including: males would be more likely to "select" a larger mate, if selection occurs at all; a larger female would be more beneficial for the male.

Materials and Methods

In this experiment we used a Nikon D5100 to photograph *N. Clavipes* in the area immediately surrounding the ITEC field station. Using ladders and a macro lens we were able to capture clear images. A scale was set during the first photograph. We found the ideal distance away from the spider to photograph from. Then we photographed a ruler from the same distance to use as our scale in Adobe Photoshop. When photographing the spiders we recorded the place we found them, the number of males present on the web and if the female was gravid or not. After photographing numerous females on camera we transferred these photos to Adobe Photoshop. Using Photoshop, we measured the photographs of the Golden Orb-Spiders, using a photograph of a ruler as a model for this scale. After measuring all of the Golden Orb-Spiders their size was recorded in a table. Through the website http://www.socscistatistics.com/ we performed a Spearman's Rho Correlation Test for our hypothesis using the calculator. We performed a total of four tests, the first one utilized all the data, the second one excluded the two outliers, the third excluded gravid females and the last one excluded both the outliers and the gravid females. Using Excel, we created graphs utilizing necessary information in order to understand the behavior of Golden Orb-Spiders.

[3] Vollrath
[4] Preston-Mafham, pp. 92

Results

Over the span of two days we photographed 30 spiders, 16 on the first day and 14 on the second day. Each trip out was around 1 hour long. When we looked at these pictures two spiders were left out, as their pictures were not clear enough to accurately measure the length of the body. Looking at the lengths of the female spiders (Figure 1), most of the spiders were within a 1.5-2.5 centimeter range. The smallest female spider was just over 0.5 centimeters at approximately 0.6 centimeters and the largest was just under 3.5 centimeters at approximately 3.4 centimeters. In Figure 2 compares the length of the female spider to the number of male spiders on her web. There were two outliers with 7 males on one web. When a Spearman's Rho test was performed on all of the pieces of data the r-value was -0.38 and the p-value was 0.046, showing that the results are statistically significant. When the test is performed on the data excluding the two outliers the r-value was -0.47 and the p-value was 0.016, which is also statistically significant. An r-value of -0.32and a p-value of 0.117 is given when testing using all of the data excluding the gravid females. This is not statistically significant. Finally when a Spearman's Rho test is performed on the data excluding the outliers and the gravid females, the r-value was -0.46 and the p-value was 0.024, which is statistically significant. This suggests a negative correlation between the size of the female and the number of males present on her web. Thus discounting our original hypothesis.

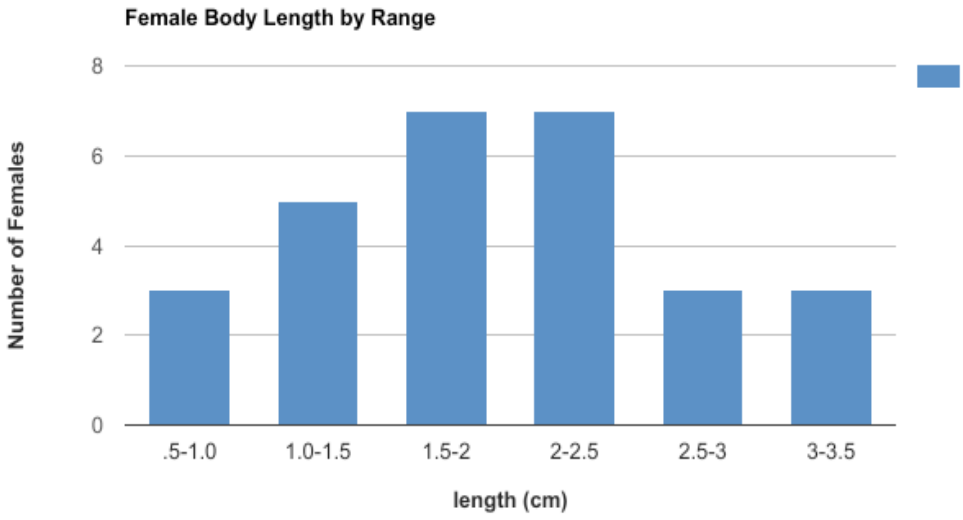

Figure 1: Female Body Length by Range for Golden Orb-Spiders. The length of the female's bodies are separated into 6 different categories the first spanning between 0.5 centimeters and 1.0 centimeters. This continues up by a 0.5 interval all the way up to 3.5 centimeters.

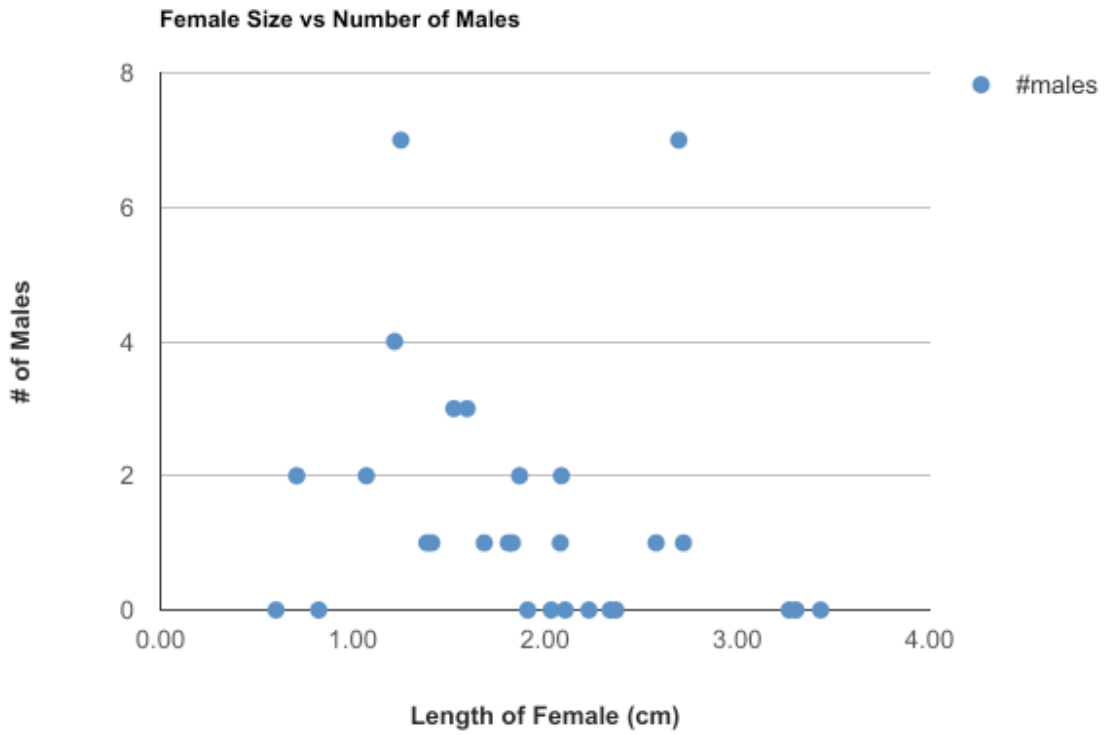

Figure 2: Female Size vs Number of Males in Golden Orb-Spiders. Figure 2 outlines the number of males on a female's web compared to her size. This graph includes the two outliers, both of which lie at 7 males on the web. These two data plots may be incorrect because it is possible that many of the males counted are of a different species that are often present on the Golden Orb-Spiders' webs.

Table 1: This table shows the individual female spider's subject number, the female's body length, the number of males present on her web and if she is gravid or not. This is all of the data collected with the exception of the two spiders excluded because of their photograph's lack of clarity.

Subject #	length (cm)	#males	Gravid?
1	1.39	1	n
2	0.71	2	n
4	2.58	1	n
5	1.22	4	n
6	2.70	7	n
7	1.25	7	y
9	1.83	1	n
10	1.41	1	n
11	2.34	0	n
12	1.81	1	n
13	2.08	1	n
14	1.68	1	n
15	1.91	0	n
16	1.07	2	n
17	1.59	3	n
18	2.23	0	n
19	0.82	0	n
20	2.72	1	n
21	2.37	0	n
22	1.53	3	n
23	2.11	0	n
24	1.87	2	n
25	2.09	2	y
26	3.27	0	n
27	3.43	0	y
28	3.31	0	n
29	2.03	0	n
30	0.60	0	n

Table 2: Data Table 2 is the females Golden Orb-Spiders' body lengths by range. The overall range is between 0.5 centimeters and 3.5 centimeters. There is a total of six groups, each with the interval of 0.5 centimeters. The two groups with the most spiders were the 1.5-2 centimeter group and the 2-2.5 centimeter group with seven spiders in each range.

Range (cm)	Number of Females
.5-1.0	3
1.0-1.5	5
1.5-2	7
2-2.5	7
2.5-3	3
3-3.5	3

Discussion

Our results contradict our original hypothesis: that there will be more males on a female's web the larger she is. Instead, we found that there is a negative correlation between the two variables. Our data suggests that the smaller the female is, the more males appear on her web. Our results combined with exsisting research suggests that there is not a copulatory mate selection process but, rather that the mating process is more random and depends on where a male settles after the roving instar. Upon further analysis, it stands to reason that smaller females may be easier to mate with because they have gone through fewer instars and are therefore less aggressive.[5] Furthermore, a smaller female spider is less likely to have already been gravid; some of the smaller females we found may have been virgin spiders who, as previously stated, emit a unique pheromone which attracts more males.[6]

Our sources of error include having several different scientists in the field collecting data. Our scientists' inexperience with field research and discrepancies between styles of data collection may have caused skewed data collection. Another possible source of error could be the counting of some of our samples incorrectly: we may have overcounted our numbers of males because at first we did not know that there could be more than one species inhabiting a web, so we counted as male each spider that we found within a female's web. In addition, our equipment was occasionally faulty and at times it was difficult to obtain a clear image in order to measure the size of the female spiders. A final source of error could be human error in taking the photos. The Photoshop program we used relied on all the photos being taken from the same distance and there was no way for us to do this accurately every time. If we had more time to do this experiment we would have collected more data, specifically on gravid females. We would have also liked to put more research into interactions involving gravid females and their place on their webs.

Conclusion

Over the course of two days we photographed, measured and compared the lengths of female Golden Orb-Spiders to the number of males on her web. Contradictory to our hypothesis, we found that the smaller the female is, the more males appear on her web. These results can be explained by the spider's mating habits and behavior. It is possible older the female, the more aggressive she becomes and the less time it takes her to finish a meal. These two factors make it significantly harder for a male to successfully mate. This study is important because spiders are important and beneficial to the surrounding

[5] Preston, p.125
[6] Preston, p. 92

environment. As a part of an ecosystem they have a part to play and their role reduces the number of bugs present, something which directly impacts humans.[7] Understanding their mating habits is a big part of understanding the species. Overall we discovered that the data we collected suggests a negative correltion between the female's size and the number of males on her web.

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