Exploring How Web Angles of Golden Orb Spiders Vary with Changing Habitat

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Abstract

In this study, we looked at the angles of webs belonging to Golden Orb Spiders found in three distinctly different habitats: webs attached to man-made structures, webs found outside the rainforest in dense early successional plots, and webs located in the heart of the rainforest itself. We hypothesized that **(1)** the angle of spider webs in nature would vary more than the angle of webs built upon man-made structures, and that the angles of webs in early successional plots and the rainforest would be less vertical and more acute. **(2)** Webs in the rainforest would have angles that more closely resembled those found on man-made structures. We thought that spiders might take advantage of their surroundings to build the perfect web, and as such, with a lack of vertical support options in a natural setting, wouldn't be able to construct a web of ideal angle. Our results matched our hypotheses, although the relatively small sample size of webs found in the rainforest limited our ability to conclude that the data patterns observed were statistically significantly different.

Introduction

Golden Orb Spiders, scientifically known as *Nephila clavipes*, are abundant in Costa Rica and Panama, especially during the dry season (December – January) and the early to middle rain season (July – August). These spiders are commonly found in forest clearings and lowland and mid-elevation habitats. (Lubin 1983)

Golden Orb Spiders have a significantly strong silk, which they use to construct their structural spiral orb. Their webs are asymmetrical and vertical. On one or two sides of the orb are clumps of non-sticky threads, which are called barrier webs. (Lubin 1983) The

spider's entire orb is a sticky trap used to catch their prey. When our team observed the spiders, we noticed that all the webs were vertical and slightly angled.

A few scientists suggest that the vertical webs are more affective for catching prey because if the prey escapes, they will fall into lower strands and still be caught. (Eberhard 1989). Bishop (1992) cited research that found that vertical sticky nets were more effective at catching prey than those at 45° and that horizontal sticky nets were the least effective. Buskirk (1975) noted that the angle of webs were also related to habitat structure. Buskirk's

observation connects directly to our hypotheses, relating to how the web angles of Panamanian Golden Orb Spiders vary with changing habitation patterns. Prior to collecting our data, we hypothesized that **(1)** the angle of spider webs in nature would vary more than the angle of webs built upon man-made structures, and that the angles of webs in early successional plots and the rainforest would be less vertical and more acute. **(2)** Webs in the rainforest would have angles that more closely resembled those found on man-made structures. Our null hypothesis is that there would be no difference between web angles between sites.

Materials and Procedures

To conduct this experiment, our group separated the ITEC property into three distinct habitats: the man-made areas, the early successional plots, and the rainforest. In each location, we found 10 or more spider webs belonging to Golden Orb Spiders and proceeded to measure the angle of these webs with the iPhone application *Theodolite.* In order to ensure the most accurate possible measurements, we matched a PVC pipe to the web slant and traced the pipe itself. After collecting data from all three sites, we ran tests to look at the variability and statistical significance of our results.

Results

Upon inputing all data into a table (see below), we discovered that the mean web angle of Golden Orb Spiders was highest in instances of webs found on man-made structures, followed by webs found in the rainforest, and lastly webs found in early successional plots. T-tests showed P value .005 when comparing web angles by man-made structures when compared with those in the early successional plots and a P value of .057 when comparing web angles by man-made structures compared with webs in the forest. Finally, standard deviation tests illustrated the fact that on average, each value in the set of web angles from man-made structures and the rainforest are roughly the same distance from the mean of their respective sets, while each value in the set of web angles from the early successional plots is roughly 25% farther from the mean (i.e. More varied).

Table 1. Web angle data from spiders found on man-made structures, in early successional plots, and in the rainforest. Calculations include mean, median, variance, and standard deviation.

	Man-Made Structure Angle °	Early Sucessional Angle °	Rainforest Angle °
	72	69	72
	74	76	65
	71	53	81
	74	61	66
	74	70	64
	*50	57	64
	82	50	60
	79	55	64
	77	81	74
	71	60	70
	71	65	
	74	63	
	68	66	
	73	67	
	71	74	
	76		
Mean	72.3	64.5	68.0
Median	73.5	65	65.5
Variation	47.3	77.0	38.9
Standard Deviation:	6.9	8.8	6.2

* 0utlier data point

Table 2. P values for TTEST for 3 comparisons of web angles between those found on man-made structures, in early successional plots, and in the rainforest.

			P value	
Man-Made Structure	vs	Early Sucessional	0.005	<< .05
Man-Made Structure	vs	Rainforest	0.057	

Early Sucessional	vs	Rainforest	0.126	

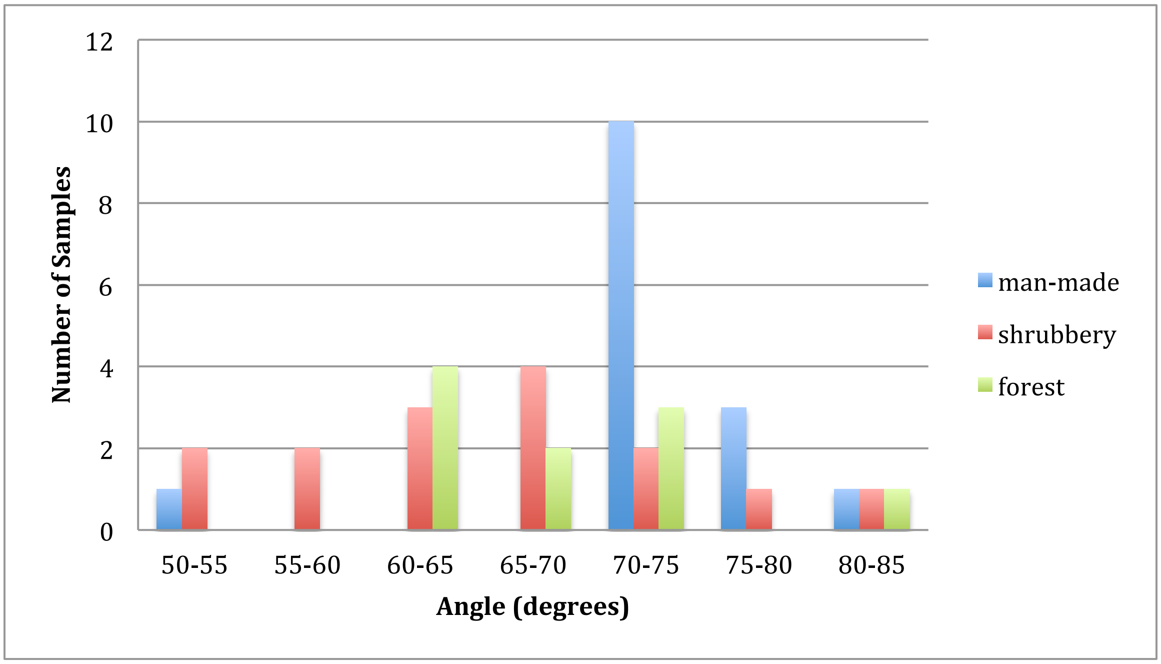

Figure 1. Distribution of the data we collected on the web angles of spiders found on man-made structures, in early successional plots, and in the rainforest.

Discussion

After completing our experiment, we observed that both of our hypotheses were supported. Namely, when dropping the 50-degree outlier, that the Golden Orb Spider's webs *did* vary more in nature than on man-made structures, and that in turn those webs in nature were less vertical. Although the web angles found in the forest were not significantly different than the webs found on man-made structures, the T-Test was only .007 away from proving to be significantly different, making it very close to call. Furthermore, the average of web angles in the forest was 3.50 degrees closer than the average of the early successional plot webs, which supported our earlier thought that webs found near better vertical structure would be less varied than those without it.

In transferring our results into a graph, we showed the distinct concentration of web angles between 70-75 degrees of spiders found on man-made structures. In fact, if we were to drop our outlier of a 50-degree web angle, we could support the notion that the webs found on man-made structures have the least variance in angle. The variance value drops to 12.7 (as compared to 73.5) when this outlier is removed. Furthermore, this graph also supports our earlier assumption that the webs in the rainforest most closely resemble those found on man-made structures.

Since we observed that Golden Orb Spiders have a lot of support options for building their webs attached to man-made structures, the fact that they build webs at angles of low-mid 70's range hints at the possibility of a Golden Orb Spider web angle "sweet spot." It makes sense then, that spiders in the forest and the early successional plots have trouble consistently building webs with the angular "sweet spot" because there are fewer vertical support structures in the rainforest and even less in the early successional plot areas.

In our project, there are a couple sources of error and design improvements we would make to enhance any future experimentation, mainly relating to our method of measurement. During field research and data collection, we had one person using an iPhone application and another using PVC pipe. We also had different people using the app, and they possibly could've used it in different ways and therefore interpreted the results differently. If we were to do this project again, we could have a set method of collecting the data going in, so it doesn't change over time. Another source of error was time spent in each habitat. We spent more time collecting data from man-made structure webs and early successional plot webs, and less so with webs from the rainforest, making that sample size the smallest. Due to this small yield of results, we were unable to definitely support that some of our results were statistically significantly different. Overall, if we were to do this project again, we could start in the rainforest, and then base the rest of our project off of that experience. It would also be fascinating to specifically isolate individual aspects of the architecture (both natural and unnatural) surrounding our webs, and attempt to find patterns relating to how the geometry of the web and the web supports could be affecting the Golden Orb Spiders patterns of habitation, mating, or even positioning.

Conclusion

All in all, we conducted a successful experiment that supported both of our original hypotheses. We concluded that the spiders in man-made structures have webs of higher angles than those found in natural settings, and that these webs rarely vary from a mid-70 degree position. Furthermore, we noted that the Golden Orb Spider’s web angles in natural settings appear to be more variable than those built in man made structures.

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