WEB RECONSTRUCTION AND REPAIR BY ARANEID SPIDERS

SARA CHRISTINE GOODWIN

Abstract. The cost to benefit ratio of spider web construction and repair depends on the spider's store of energetic and material resources as well as the probability of future captures. The relationship between costs and benefits will determine if a spider will repair or rebuild a damaged or destroyed web. For the nocturnal araneids of this study, who build and abandon a new web every night , costs and benefits are dynamic throughout their active period. During the middle of the night, response to damaged webs decreases from the high repair response directly after dusk. The rates of repair and reconstruction during this middle period are also much slower than they are just before dawn. This study supports the idea that web maintenance is of greatest importance during the first and last hours of the araneid's nocturnal period.

INTRODUCTION

Most builders of orb webs are members of the spider family Araneidae. A number of Araneids are nocturnally active, building new webs every night shortly after dusk and abandoning them before dawn the next morning. Orb web spiders are not hunters. Rather they must wait for prey. Once a web is constructed, they exercise no direct control over the rate of capture. Therefore, the physical characteristics of the web, e.g. size and strength, as well as time and location of placement, are the only means by which a spider can affect its foraging.

I examined the temporal change in web construction and maintenance over the course of a night. Web construction and repair is costly in both energetic and material resources. The ability of a spider to meet these demands can change depending on the amount of previous building effort and energy storage due to previous insect consumption. Among araneid spiders that abandon their webs at dawn, possible benefits of an intact web are likely to change over time. The decision to repair or rebuild a web will be determined in part by the likelihood of capturing additional prey. I predicted that repair of damaged webs would be most likely and rate of repair would be rapid if damage occurred early in the evening, as spiders would restore their ability to capture their first meal. I also expected reconstruction efforts of destroyed webs would be greatest and quickest at the beginning as well as at the end of the night, as dusk offers the spiders their first chance at a meal and dawn offers the last. For a spider that has not consumed enough to meet its metabolic needs for the next day, the last, early morning captures may be crucial.

METHODS

I conducted observations and manipulations on the night of 15-16 February 1997 on the Stone bridge, a suspension bridge at La Selva Biological Station, Costa Rica. I chose 32 similarly sized webs of spiders of the same morphotype and similar size. At 19:00, 23:00, and 04:00, I destroyed eight webs by breaking all their connections to the bridge railing. The webs collapsed and were considered destroyed. The inhabiting spider of each web was closely watched to insure that it did not fall off the bridge, and the web material was left on the railing. For each trial, I selected 8 new webs. Fifteen minutes after the beginning of the destruction trials, I damaged an additional eight webs by cutting a hole 8 cm in diameter adjacent to and under the hub. I used webs of the same eight spiders in each of the damage trials, except when the web had been abandoned, and then I selected a new, intact web. During the three trials, I checked each web and recorded spider response at 10 min intervals for a period of 60 min for the damaged webs and 90 min for the destroyed webs. After the periods of close observation, I checked the webs once an hour. I classified responses as either repair, reconstruction, abandonment, or no response, if the spider remained present but made no building efforts.

RESULTS

Observed construction behavior:

Construction of a new web began by building a frame of silk in the corner of two railing bars. The spider crossed the frame with spokes, joining then at a point to create a hub. Once these spokes were established, the spider laid a preliminary, wide-spaced spiral starting at the center. With this support structure in place, the spider traveled down a spoke to the end and started another spiral of sticky silk. The thread spiraled from the outside in, and the strands were laid much closer than in the first spiral. Approaching the hub, the first, preliminary spiral was removed and replaced with the thread of the viscid spiral.

The first part of damage reparation was the replacement of the cut spokes. This did not replace the missing capture surface, but re-established the paths of travel. Spiders often stopped repairs at this stage. Further reparations involved new material. The hole was never simply patched, but the spider removed and replaced the entire damaged, viscid spiral.

Test results

There was a significant decrease in spider response to web damage in the middle of the night (23:00) (Table 1A). This was manifest by both a decrease in the number of repairs (G-test, G=20.17, df=18, P<0.001), as well as an increase in the time to make repairs (Fig.1, 1 way ANOVA, F=5.87, df=12, P=0.017). Data used to assess repair rates included the repairs made after the 60 mins of close observation. Abandonment of damaged webs tended to occur more often towards dawn(Table 1A, G-test, G=5.01, df=21, P=.08). The likelihood of rebuilding or abandoning a destroyed web did not change over the three trials (Table 1B, G-test, G=1.19, df=18, P=.88). The rate of reconstruction was fastest during the late trial (Fig.2).

DISCUSSION

Dusk offers nocturnal araneids the first chance to feed after a day without foraging. Dawn offers the last chance before webs are abandoned. These are the periods in which maintenance of the web is most important, and spiders are more likely to respond to damage. The middle of the night showed a lull in response to web damage as well as in rate of repair. It is possible that after an early feeding bout, the spiders must digest, and web repair in order to catch another meal becomes a low priority. Another possibility is that during this middle period, insect activity is lower than at the ends of the night, and therefore likelihood of catching a meal is low during these hours. The greater proportion of damaged web abandonments during the late trial, might be due to satiated spiders choosing to prematurely abandon damaged webs. In the period before first light, the cost of web repair might be too high for a possible benefit of a last few captures. The hungry spiders would repair their webs quickly to chance a last capture before dawn, the possibility of a benefit outweighing the cost.

Abandonment was likely when a web was completely destroyed. One-fourth to one-half of the spiders of destroyed webs abandoned the web site. The original site might be considered too risky for a second web resulting in the spider moving to another location for construction of a new web. Spiders that abandoned destroyed webs might have exhausted their energetic and material resources, and may be unable to undertake the task of full web reconstruction. Reconstruction of new webs was fastest in the last hours of the night. In that period, spiders have their greatest potential of stored energy from a night of feeding, and quick construction increases the possibility of last captures. I expected the early trial to have a quick rate of reconstruction as well. The results showed that early reconstruction took as long as it did in the middle of the night. It is possible that the araneids are unable to build a second web immediately after the first without recuperation. Further studies should examine web repair rates under treatments in which capture rates and spider satiation were manipulated.

Table 1: Frequency of response types to damage and destruction. Sample size = 8.

A. Damaged Webs

after 60 min	early (19:00)	middle (23:00)	late (0:400
no response	0	6	1
abandonment	0	1	3
repair	8	1	4

B. Destroyed Webs

*after 300 min	early (19:00)	middle (23:00)	late (0:400
no response	1	1	1
abandonment	2	3	4
repair	5	4	3

*Assessed data for destroyed webs included web reconstructions beyond the 90mins of close observation