INTRASPECIFIC INTERACTIONS IN FEMALE GOLDEN ORB-SPIDERS *(NEPHILA CLAVIPES)*

GREGORY K. EATON, JOSHUA R. MOONEY, DUSTIN R. RUBENSTEIN, AND MATTHEW J. UNGERER

Abstract. We investigated intraspecific interactions in golden orb-spiders, a neotropical orb-weaving spider. These spiders occur in solitary webs or in colonies of several webs characterized by large females holding central web positions. We hypothesized that colony dynamics are influenced by a dominance hierarchy among females, that this hierarchy may be based on female size or initial web possession, and that more productive web territories would be claimed by another female if the resident was removed. It appears that a size-based dominance hierarchy exists in female golden orb-spiders with larger females inhabiting larger webs within a colony. More parasites are supported by colonies and on larger webs within a colony implying that these webs may be more productive than solitary or small webs. However, these webs were not claimed by remaining females when the resident females were removed.

Key Words: Orb-weaver, Corcovado, dominance hierarchy

INTRODUCTION

The golden orb-spider *(Nephila clavipes)* is the largest of the neotropical orb-weaving spiders. It occurs in solitary webs or colonies of more or less connected webs inhabited by several females, males and numerous other smaller spiders. The webs are asymmetrical vertical orbs constructed of strong yellow silk and are very common in the understory of primary and secondary forests and disturbed areas of lowland and mid elevations. Large females dominate the webs and are often the sole providers of food for the smaller males and other "kleptoparasitic" spider species (Lubin 1983). These web parasites eat prey that the female discards or smaller insects that are caught in the orb weaver's web or use her web as support to build their own smaller webs (G. K. Eaton, pers. obs.).

Preliminary observations suggested that the largest female occurred on the largest web in a colony. We hypothesized that a size-based dominance hierarchy influences interactions within a colony and predicted that larger females would out-compete smaller females for empty webs. Alternatively, initial web possession may be a determinant in web dominance. If this is true, resident spiders will outcompete intruders of similar size. Finally, female rank in a colony may be related to the number of males and parasites supported by her web. We predicted that larger females would occupy larger webs, support a greater number of males and web parasites, and that these webs would be quickly claimed by another female if the resident female were removed.

METHODS

This study was conducted on 6-8 February 1998, in primary and secondary forest adjacent to La Estacion Biologica Sirena, Corcovado National Park, Costa Rica. We made initial observations on solitary and colonial webs for background and control data. We counted number of males and parasites on 27 solitary webs and on each web in 13 colonies. We observed which female was on the largest web in 29 colonies, and observed 11 colonies to record females that changed webs or web positions within colonies over a 24 hour period. Our first experiment consisted of removing the largest female from 13 colonial webs and recording the position of remaining spiders 24 hrs later. These observations were compared to the 11 unmanipulated control colonies. In our second experiment, we pitted a resident spider on a single web against an intruder of equal size (mean difference in length = 0.94 mm or 1 %). In our third experiment, we pitted small vs. large females (mean difference in length = 6.82 mm or 26 %) on single webs that had not been originally occupied by either female (neutral webs). For the latter two experiments, we identified individual

females by body length and introduced both females on opposite sides at the base of the web. Occupation patterns (wins) were determined 24 hrs later when we recorded the identity of the female that occupied the center of the web.

Experiments comparing small vs. large spiders and resident vs. intruder spiders were analyzed with Chi-square tests in which the null hypothesis was that either competitor would win half of the time. One-way ANOVAs tested the effect of web size within colony on number of males and parasites, and the effect of colony versus solitary webs on number of males and parasites per web. Numbers of males were log transformed prior to analysis. We used G-tests to compare the proportions of webs claimed by another spider and for the movement patterns of smaller female spiders in the female removal experiments.

RESULTS

In 28 of 29 colonies, the largest female was on the largest web. In 11 of 11 control colonies, the smaller female never changed webs or web position. When the largest female was experimentally removed from her web, the smaller female never took over the larger web ($G = 0.00$, $P > 0.97$), but the smaller female left the colony 2 of 10 times ($G = 2.76$, $0.05 < P < 0.1$); expected values for both tests generated from control colonies.

When two spiders of different size were placed on the same unoccupied web, the larger spider occupied the center of the web (win) 14 of 15 times ($X^2 = 24.0$, $dF = 1$, $P < 0.0001$; Fig. 1). This differed from the null hypothesis that either spider would have an equal chance of winning the web. When an intruder spider of equal size was added to an occupied web, the resident spider continued to occupy the web (win) 8 of 14 times (Fig. 2). This differs from the expected proportion of 0 out of 11 based upon the control webs with no additions ($G = 9.96$, $P < 0.001$), but did not deviate from the null hypothesis of equal occupancy probabilities for the two spiders ($G = 0.14$, $P > 0.9$).

Female webs supported a variety of parasite spiders and male golden orb-spiders. Neither the number of males per web nor parasites per web differed between colonies and solitary webs ($F_{1,38} = 0.15$, $P = 0.24$ and $F_{1,38} = 0.26$, $P = 0.62$ for males per web and parasites per web respectively, Fig. 3). The total number of males did not differ between colonial and solitary webs ($F_{1,38} = 0.81$, $P = 0.37$), but the total number of parasites was significantly higher in colonial webs ($F_{1,38} = 6.06$, $P = 0.018$). The number of males per web did not differ between the smallest and largest web within a colony ($F_{1,20} = 1.67$, $P = 0.21$), but parasites per web were higher in the larger webs ($F_{1,12} = 10.50$, $P = 0.0041$; Fig. 4).

DISCUSSION

It appears that a dominance hierarchy based on size, but not initial web possession, can influence female interactions in golden orb-spider web colonies. Dominant females were found on the largest webs within colonies and tended to have more associated males and web parasites. We lacked direct measures of productivity such as prey capture rates between webs. Because male golden orb-spiders and web parasites are both in some way dependent on support of the female spider and her web, this may indicate that larger webs are more productive. We found no difference per web between colonial webs and solitary webs in these surrogate measures of productivity. These results suggest that there is no advantage or disadvantage to colonial living, but Balser (1992) found that solitary webs had higher prey capture rates than colonies on a per web basis. Total parasites and males within colonies are higher than solitary webs. This could offer some advantages or disadvantages to resident spiders. For example, procurement of mates may be easier in colonies than in solitary webs.

We had hypothesized that smaller females within a colony are subordinate in the sense that they live on an inferior web. Smaller females were associated with fewer males and web parasites, as expected if web productivity was lower. However, smaller females did not move from their original web to claim the larger web of removed females, suggesting that small webs may be equally suitable habitat. It could also be that switching webs is not in the behavioral repertoire of golden orb-spiders, but we observed several (~ 3) aggressive interactions between resident females and smaller invading females, usually leading to death and consumption of the invader. These interactions were never observed between larger resident females and smaller counterparts within her colony, even if they were on her web. This phenomenon could be explained by relatedness of females within natural colonies, or by familiarity leading to tolerance between females. If relatedness or familiarity allow tolerance between females, then switching of

smaller females from one colony to another should lead to attempts by the larger resident to kill or evict the new female. An unexpected result from the female removal experiment was that the smaller female vacated the colony 2 out of 10 times when the dominant female was removed. It is possible that smaller females, rather than being suppressed by the larger female, actually benefit from her, perhaps due to occasional access to prey items.

Male golden orb-spiders may also have a dominance hierarchy, with dominant males located in the web hub, nearest the largest female. Whether this is the case and if it may be based on male size dominance or female choice could be tested by experiments to evaluate the effect of size, web familiarity and familiarity among males on male competitive interactions.

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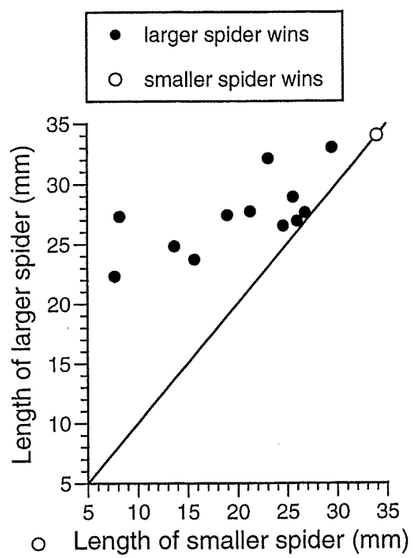

FIG. 1. Outcome of dominance interactions among female spiders for spider pairs that differed in their relative size. The smaller spider never won in 15 trials.

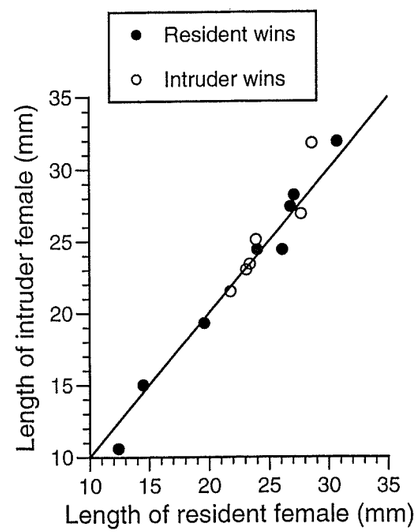

FIG. 2. Outcome of dominance interactions when femal intruder spiders were placed on the web with similar sized resident spiders. The resident spider won 8 of 14 trials.

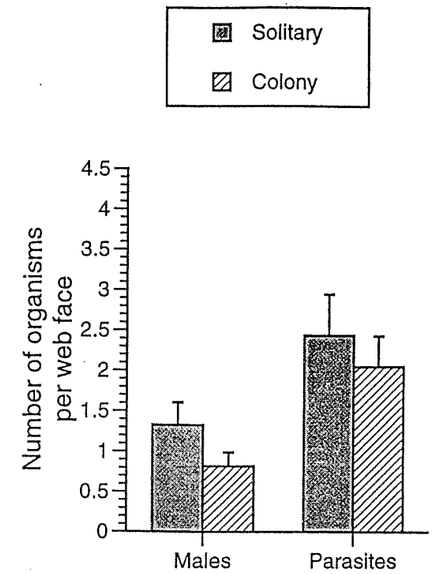

FIG. 3. Males and parasites on solitary vs. colonial web faces (mean ± SE, n = 13 and 27 for colonial and solitary webs respectively).

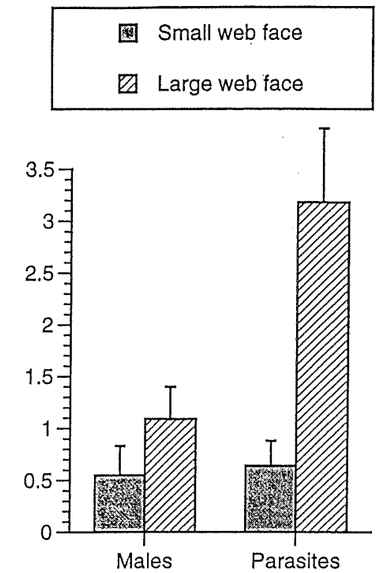

FIG. 4. Male and parasites in small vs. large web faces within colonies (mean ± SE, n = 11).