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OBSERVATIONS ON *LOXOSCELES RECLUSA* (ARANEAE, SICARIIDAE) FEEDING ON SHORT-HORNED GRASSHOPPERS

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ABSTRACT. Observations on *Loxosceles reclusa* Gertsch & Mulaik 1940, feeding on various species of short-horned grasshoppers are presented. In this paper, prey attack strategy, duration of feeding, and behaviors surrounding feeding are reported. The spiders routinely fed on prey larger than themselves. Lightly touching prey with palps prior to feeding was always observed. The first quick bites and the first attachment sites were mostly peripheral, with later attachment sites central, on the head, thorax or abdomen. Feeding times, typically 3–10 hours, ranged up to 23 hours 38 minutes. The first long attachment was usually on a peripheral location of the prey (antenna or leg), but subsequent long attachments were more often central. Overall, 39.5% of long attachments were on the main body of the prey (not antenna or leg). Long attachments were then frequently followed by web spinning, or uncommonly, bradykinesia. Rocking, tugging or pulling at prey between attachments was common. The slow feeding from multiple sites on the prey appears to be an efficient strategy for this sit-and-wait predator to extract maximum nourishment from the large prey.

Keywords: Brown recluse spider, feeding, arachnid behavior

Loxosceles reclusa Gertsch & Mulaik 1940, a species of recluse spiders found throughout the Midwestern USA, is of considerable interest medically because envenomation can cause significant cutaneous necrosis and, less commonly, severe systemic manifestations including hemolytic anemia and renal failure (Anderson 1997). Greater understanding of the details of feeding behavior of this species may have medical implications and this has motivated us to study in detail the feeding activities of *L. reclusa* on one type of prey. We studied the attack and feeding sequence of *L. reclusa* on various species of short-horned grasshoppers. We recorded latency of bites, duration of feeding, bite sites and movements of the spider during the feeding sequence.

METHODS

Fifty-six spiders (29 females, 19 males and 8 juveniles) were selected at random from a colony of 600 individually housed *L. reclusa*. All were captured from houses and outbuildings in Phelps, Dent, and Texas Counties in south central Missouri (between latitudes 37°32′ and 37°56′N, and between longitudes 91°41′ and 91°58′W) and had been in captivity from 10 days to over two years. Spiders were fed domestic crickets in captivity (one cricket per spider every 2–3 weeks) and, before our trials, prey were withheld for intervals varying from 3–98 days. The average interval between the previous feeding and the observed feeding were similar for all three groups: males: mean = 27.25 days, females: mean = 28.08 days, and immatures mean = 30.43 days. Spiders for the study were all housed individually in glass jars (5.7 cm diameter × 5.7 cm height) and were left in these jars for the feeding observations. No water source was provided, and the spiders were kept under room light with window light during the day and artificial light in the evenings, but no nocturnal light. Prey for this study consisted of short-horned grasshoppers, captured from lawns in Phelps and Dent Counties, Missouri. Total body sizes for these grasshoppers ranged from 7.9–19.1 mm.

Biting and feeding behaviors were observed after dropping one grasshopper into the spi-

Figure 1.—*Loxosceles reclusa* palpating a grasshopper, a behavior that was present in all observed predations ($n = 56$). Note that the prey length is greater than that of the spider predator.

der's cage at a distance of three to five centimeters from the spider. The grasshoppers were partly immobilized by severing the posterior legs at the femoral-tibial junction. This was done to allow easier capture by the spider and easier observation, but this most likely changed the number of quick bites on the posterior leg. Observations were made at a distance of 1 m to minimize disturbance to the spider. We recorded latency to first bites (time from introduction of prey to first bite), latency to long attachment (time from introduction of prey to long attachment) and duration of long attachments. Two types of bites were observed: quick bites and long attachments. We define a long attachment as an attachment lasting more than two consecutive minutes. All shorter bites are called quick bites. We recorded location of first bite, number of quick bites, actions before and after web spinning, and locations of all long attachments. Students' t-test statistics for the study, assuming normal distributions with unequal variances, were calculated using the PAST online statistics calculator (http://folk.uio.no/ohammer/past/). Voucher specimens were deposited in the Denver Museum of Nature and Science, Denver, Colorado.

RESULTS

Generally, before feeding, the spider lightly touched the prey with both palps (Fig. 1) prior to delivering a first bite. This behavior occurred in all observed predations. The latency to the initial bite averaged 5.58 ± 9.86 min after introduction of the prey, with differences between groups not significant except for females vs. immatures (males vs. females, $t = 1.23$, $P = 0.23$; males vs. immatures, $t = 2.13$, $P = 0.05$; females vs. immatures, $t = 2.14$, $P = 0.04$).

Generally, *L. reclusa* delivered one or two quick bites before a long attachment, but the total number of quick bites ranged from zero to ten (Fig. 2). Within two minutes of the first bite, the prey ceased almost all movement and the spider then began a long attachment (Table 1). The latency to the first long attachment for females was significantly longer than the corresponding times for juveniles ($t = 2.548$, $P = 0.016$) but not different for males ($t = -1.650$, $P = 0.107$). Feeding duration was longest for females (Table 1, females compared with all other spiders, males and immatures combined, $t = -3.784$, $P = 0.002$).

The quick bite sequence was extremely rapid, with the spider darting in, biting, and jumping back, normally within a fraction of a second. Data pooled from all three spider groups show that this sequence involved one or two bites in 58% of cases (Fig. 2). These bites are delivered to easily accessible peripheral parts of the prey, either legs or antennae (Figs. 3 & 4), allowing *L. reclusa* to rapidly deliver enough venom to paralyze the prey. After the first quick bite, the spider retreated quickly, as noted by Carrel (pers. comm.). Both the peripheral attack strategy and the quickness of biting and withdrawal observed in the earliest bites were observed consistently. The quick bite sequence was usually followed by a retreat and wait (holding) stage that averaged 15.55 ± 22.63 minutes. The longest holding stage noted for the 56 spiders observed was 139 minutes. For some spiders, the first bite was a ''long attachment'' (Fig. 2).

During feeding, spinning of silk was observed generally before a long attachment or after a long attachment (Fig. 5). Spinning was also seen when the spider was introduced to a new jar. Web production seemed to be used to immobilize the prey for a possible additional feeding, seen in 48% of the fifty-six observed predations. In 23.5% of cases, web spinning terminated the feeding sequence. A variation seen in one instance in this series and in one other observed instance is a slow stepping around the prey, a distinct pattern of bradykinesia confined to feeding. Frequently, the spiders walked around the jar spinning

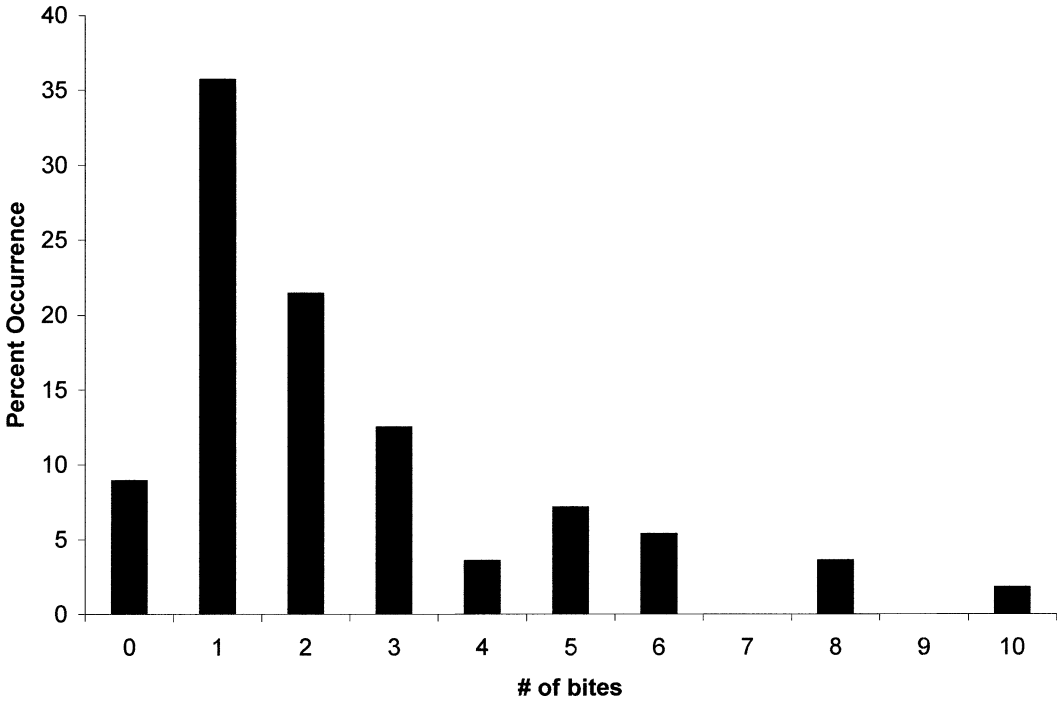

Figure 2.—The number of quick bites inflicted by *L. reclusa* on a grasshopper is typically one or two, but ranged from zero to ten. Within two minutes of these quick bites, the prey ceased almost all movement.

variable amounts of web after they had completely finished feeding on the grasshopper.

It was noted that all successful feedings (those feedings in which the spider had at least one attachment longer than two minutes) lasted at least three hours. The longest feeding reported here lasted over twenty-three hours. One other feeding lasted over 47 hours, though this was not included in this series due to the inability to observe the complete feeding. Disruptions were observed twice during feeding, and in each case the spiders resumed feeding after a brief pause, once at the previous feeding site, and the other at a different site.

DISCUSSION

The preferred initial *L. reclusa* feeding sites of legs and antenna (Fig. 4) confirm those observed by Hite (1966), who noted ''when feeding on grasshoppers up to 35 mm in length, the most commonly selected part is a leg or an antenna.'' The preferred feeding sites cannot be generalized to all prey, as the spider appears to adapt its feeding sequence to prey morphology. As Hite noted for 1383 feedings of house flies to *L. reclusa*, head, abdomen, and thorax accounted for 39%, 26%, and 15% of feeding sites respectively, with legs accounting for only 20% of feeding sites (Hite 1966).

Table 1.—Mean latency of first quick bite and first long attachment and feeding duration, with standard deviations, for *L. reclusa* feeding on short horned grasshoppers.

Spider	Mean latency of first quick bite	Mean latency of 1st long attachment	Duration of feeding
Immature (n = 8)	2.14 ± 1.95 min	15.63 ± 16.59 min	690.25 ± 190.76 min
Female (n = 29)	8.00 ± 13.72 min	41.93 ± 45.77 min	737.62 ± 318.39 min
Male (n = 19)	4.59 ± 3.64 min	26.00 ± 19.99 min	391.63 ± 178.58 min

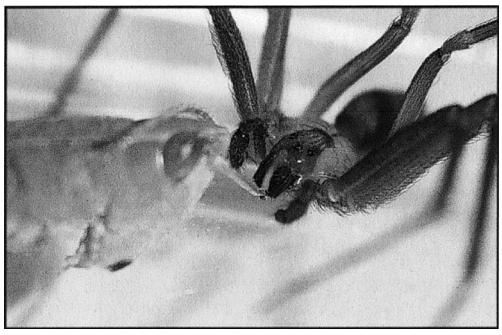

Figure 3.—*Loxosceles reclusa* feeding on grasshopper antenna. The antenna is chosen as a site for the first long attachment in 32.1% of feedings, but is chosen as a long attachment site in only 16.1% of cases overall.

The ability of *L. reclusa* to survive in captivity for long periods of time without prey is well known and the spiders are frequently found in areas where prey is only available sporadically. Here it was observed that *L. reclusa* can take larger and potentially hazardous prey that exceed the weight of the predator.

The behavior of *L. reclusa* indoors in a confined environment could differ from *L. reclusa* behavior in its natural environment. Greenstone (1999) noted that starvation, generally undertaken to increase the likelihood of feeding, might alter metabolic rates and therefore affect feeding behavior. This argument may be less valid for *L. reclusa* than for some other species. Hite (1966) noted that *L. reclusa* feedings appear to be less frequent than other species. Hite also observed a mature female *L. reclusa* surviving 297 days, nearly ten months, without food or water. We observed

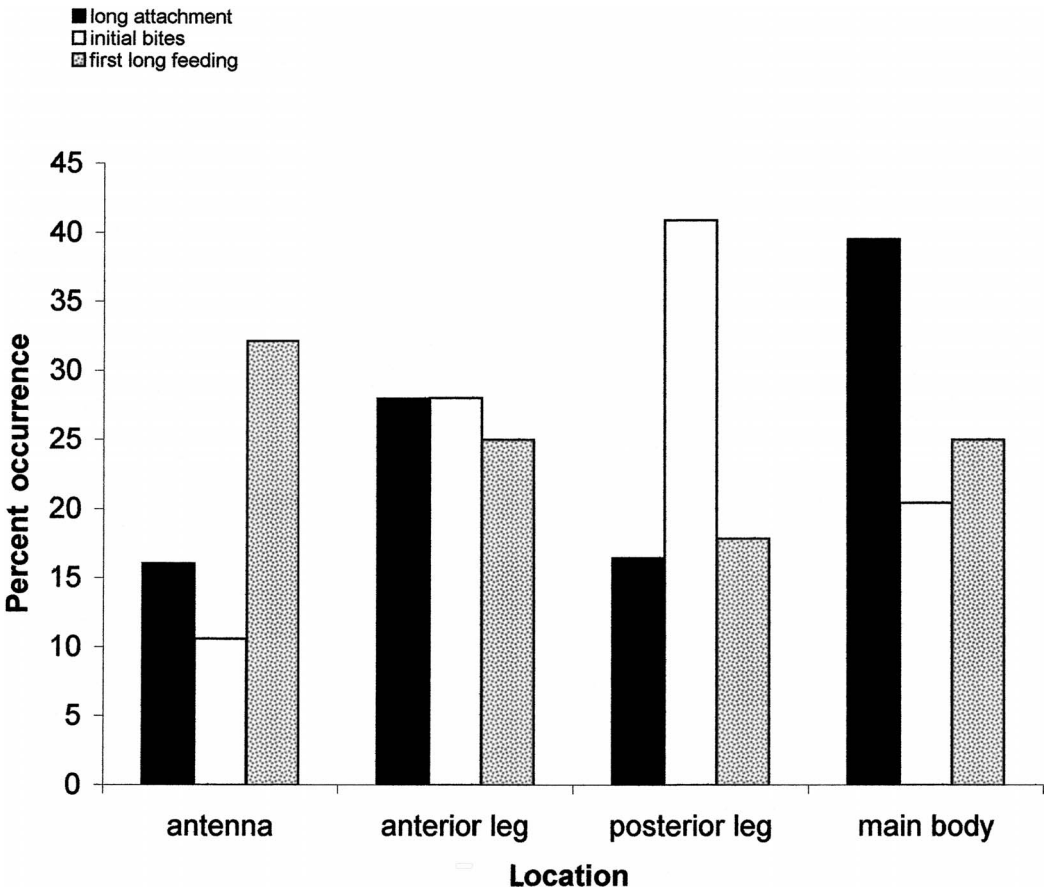

Figure 4.—Location of quick bites and long attachments of *L. reclusa* on prey.

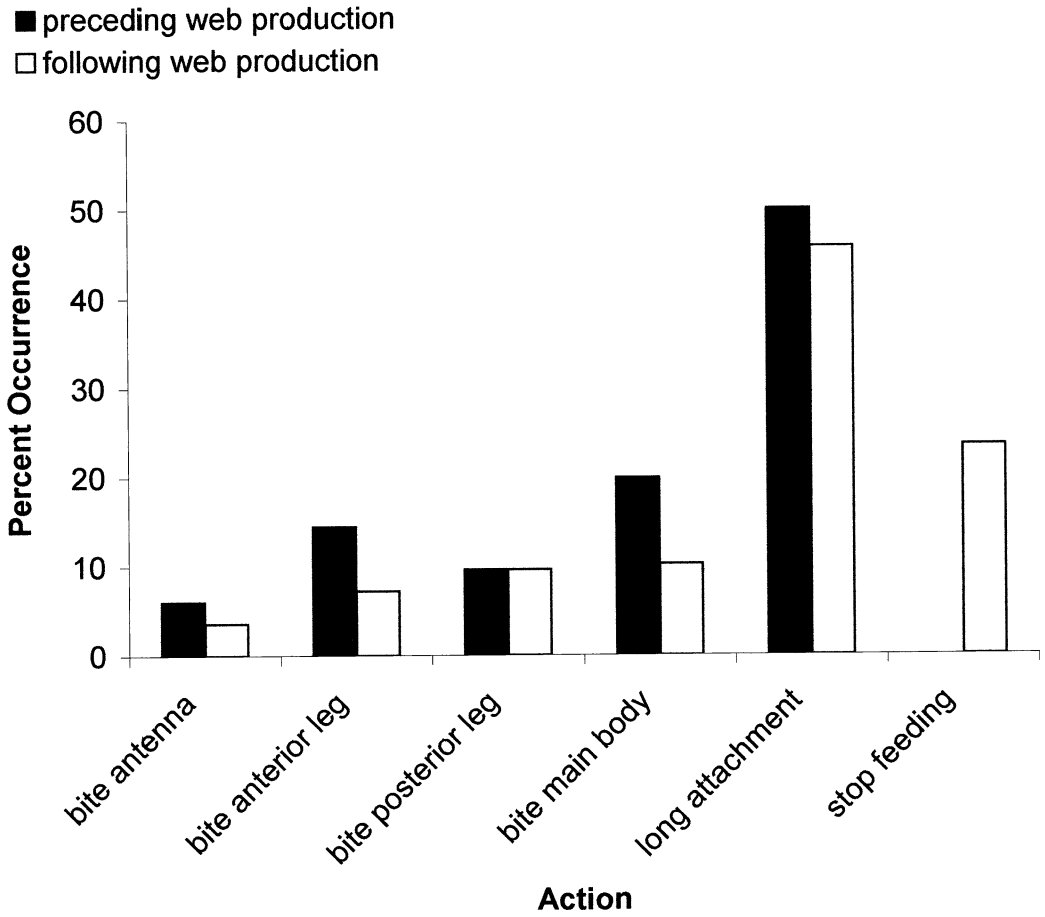

Figure 5.—Actions preceding and following web production. Long attachments are the most common actions preceding and following web production.

a mature *L. reclusa* female similarly survive 545 days. The intervals since the last feeding, 3–98 days, were well within the feeding intervals that the spider may encounter in its typical confined indoor habitat. As *L. reclusa* appears to prefer confined areas, our indoor experimental environment may not differ significantly from the situation the spider has been in when it bites humans. The behavior of the spider under these conditions is therefore of medical importance but it should be noted that most bites of humans are made under different circumstances than the predatory bites studied here.

Human encroachment on *L. reclusa* territory may have changed the natural environment for this spider and it may now be true that a significant portion of all *L. reclusa* live indoors. Hite (1966) found 430 of 626 spiders collected in indoor locations and 196 spiders in outdoor locations. Vetter & Barger (2002) trapped 2,055 *L. reclusa* in a single home in Kansas. However, we do not know what natural conditions outdoors allow high densities of *L. reclusa*. In an ongoing study, high densities of *L. deserta* in packrat dens are being investigated.

One potential problem with methodology is the variation in time since the last feeding, ranging from 3–98 days. This variation could influence spider behavior. We could find no systematic difference in behavior as a result of time since last feeding. Figure 6 shows total duration of feeding vs. time since last feeding, which appear only modestly correlated. For the 16 feedings with duration 12 days or less, the feeding duration is 598.5 ± 269.04 minutes, vs 621.75 ± 279.62 minutes for the 16

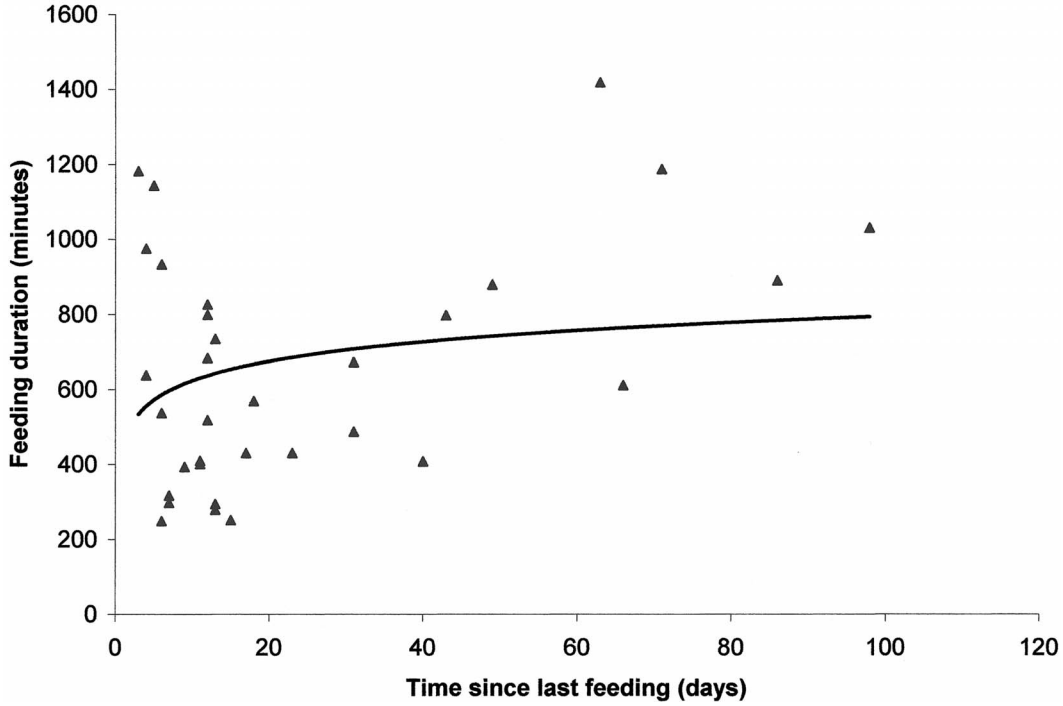

Figure 6.—Time elapsed since the last feeding vs. duration of feeding. A best-fit line shows a slow increase in feeding time with longer intervals between feedings. A minimum feeding time of about three hours was seen.

feedings with duration 13 days or more, a difference that is not significant ($t = -0.24$, $P = 0.81$).

In summary, *L. reclusa* feeding begins with quick bites and is followed with successively more central attachments. Females tended to take longer with all phases of feeding. The use of quick bites allows *L. reclusa* to take large and potentially dangerous prey. Attributes of these spiders such as the mechanics of the legs, joints, and fangs appear to be adapted for swinging in and out quickly, without physically overpowering prey. The venom appears to be effective when injected at peripheral sites. The long duration of feedings for *L. reclusa* that we report here, frequently exceeding 10 hours, are incompatible with a frequent feeding regimen. The ability to utilize large prey efficiently may be very important to the spiders in times of low prey abundance. Further explorations of the adaptive value of longer feeding times, the utilization of large meals and mode of action of the venom in insects is needed.

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