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# Reproductive behaviour of the tarantula *Aphonopelma chalcodes* Chamberlin (Araneae: Theraphosidae)

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## Summary

Before inseminating females, adult male tarantulas must perform the process of sperm induction, during which time they load their palps with sperm. Searching adult males use webs spun along the ground by females to locate female burrows. A brief courtship may precede insemination. Males insert their palps alternately several times over a period averaging 2¼ minutes. The pair separate quickly, the male being unharmed. Data collected here and reported elsewhere for other species suggest that multiple matings by adult male tarantulas are common.

## Introduction

The reproductive behaviour of three species of tarantulas has previously been reported in the literature. The species studied were *Eurypelma californica* Ausserer (Baerg, 1928), *Dugesiella hentzi* (Girard) (Baerg, 1958; Petrunkevitch, 1911b), and *Cyrtopholis jamaicola* Strand (Petrunkevitch, 1934). Similar observations on *Aphonopelma chalcodes* Chamberlin are given here for the first time.

## Material and Methods

Field studies were conducted at Molino Basin, Pima County, Arizona situated at an elevation of 1350 m in the Santa Catalina Mountains. Adult males and females were collected from this site, and additional males at an altitude of 800 m at the foot of the Santa Catalina Mountains. Upon capture, spiders were placed in individual containers with a label giving the date and locality of capture. They were transported to the laboratory at night to reduce heat stress.

The spiders were housed separately in wide-mouth gallon jars supplied with at least 2 cm of a mixture of equal parts soil and peat moss, along with a cup of saturated tissue paper as a water source. A label giving each tarantula a file number was placed on the side of each jar. Tarantulas were kept under artificial laboratory lighting, and no attempt was made to control photoperiod. The temperature was maintained at 23-27°C throughout the study. Each individual was fed once a week on a variety of arthropods.

Males discovered in the act of sperm induction (loading the palps with semen) were observed with as little disturbance as possible. The initial time of observation was recorded along with the time of completion. One-minute intervals were selected at regular intervals throughout the period, and the number of palpal contacts with the semen droplet located on the sperm web was counted and recorded.

Observations of matings were made in the laboratory (n = 33) within a 15-gallon glass aquarium with the bottom lined with gravel. Preinseminating behaviour was described in notes. The number of palpal insertions, duration of each palpal insertion and order of palpal insertions were recorded. Times were taken from a watch with a second hand. From these data the ranges and averages for the number of insertions for each palp, total duration of insemination, and the time from termination of insemination to loss of physical contact between the partners (time to disengagement) were calculated. In the field courtship behaviour was observed twice, but on only one occasion did the male tarantula successfully inseminate a female.

## Results

### *Sperm Induction*

Before insemination can occur male spiders must charge their palps with sperm previously deposited onto a sperm web from the gonopore on the ventral surface of the abdomen (see discussions by Petrunkevitch, 1911b and Gertsch, 1949). Four males were observed in the laboratory performing sperm induction. One of these males was also seen first constructing an elevated sheet web large enough to cover all of his abdomen and the posterior half of the cephalothorax, using the side of the jar for support. During this phase the front two pairs of legs remained outside the web. The spider, positioned on his dorsum, had his ventral surface directed towards the web as it was formed. When the web was completed the emboli of the palps were moistened between the

chelicerae for 11 minutes. A drop of semen was then deposited onto the underside of the web. The spider then emerged from under the web and assumed an upright position over it from where the palps were extended down under the edge of the sheet to contact the semen. The palps were dipped into the semen alternately at a rapid rate for a time of 52 minutes in the one complete observation. Since only one individual was discovered while engaged in sperm web construction before the filling of the palps had begun, the total duration could not be determined for the other three. This male completed sperm induction 241 minutes after observation began (Table 1). The observed duration of palpal filling ranged from 23-85 minutes (n = 4) with the rates of palpal dips ranging from 110-159 dips per minute (n = 10 sample minutes). Near the end of palpal filling, the spider often interrupted his work and probed the web sheet briefly with the palps. One male inserted the emboli of the palps between the chelicerae 3 minutes after completion of palpal filling. Two males partially or totally destroyed the web sheet after the semen drop had been exhausted. One male achieved partial destruction of the web sheet by pulling on it three times with the chelicerae. The second male achieved complete destruction of the web by inserting his palps under the anterior edge of the web sheet and then walking backwards until the rigidly positioned palps cut through the entire sheet.

One of the males observed in sperm induction had matured in the laboratory. This allowed the fixing of the interval between maturation and first sperm induction as 10 days. A second such male was seen with the remains of his first sperm web sheet 21 days after maturation.

According to Baerg (1928), an individual male may charge his palps more than once, as he recorded one male of *Eurypelma californica* Ausserer from Arkansas forming four sperm webs while under laboratory conditions. One male *A. chalcodes* that had been captured in the field constructed a sperm web one day after laboratory insemination, while another male did so two days after insemination. These males probably had performed this procedure at least once before capture. Four males out of 39 maintained in the laboratory formed three sperm webs before death, but none ever attempted a fourth, although some might have done so had they been given as ready access to females as were Baerg's male tarantulas.

*Insemination*

In the field, males discovered females in or near their burrows and attempted to inseminate them at once. Males seemed to react to the web surrounding the burrow, as suggested by combined field and laboratory observations. One male, upon touching the lip silk of a burrow with his second left leg, began to tap heavily on the burrow lip with his front legs, causing the emergence of the female from her burrow. This resulted in a 2-minute insemination, after which the female made a rapid retreat within her burrow. Another wandering male greatly increased his pace approximately 20 cm from the burrow of a juvenile and paused at the lip, suggesting that males may also show a positive reaction to the webs of immatures. The male was unable to differentiate the juvenile from an adult female and only departed because the juvenile escaped into its burrow. The ability of males to respond merely to the web of another tarantula was demonstrated in the laboratory by allowing a female to walk over some soil while web spinning. This female was removed from the enclosure and replaced by an adult male. The male probed the ground with his palps and tapped the substrate with the front legs, exactly as the male at the lip of the female burrow mentioned earlier. The same procedure, but without the exposure of the soil to the female beforehand, yielded none of this behaviour on the part of the male.

Once physical contact was achieved with the female, she reared up on her hind legs, exposing her fangs in an apparently aggressive position. If the female remained quiet the male oscillated his entire body rapidly up and down several times while slowly moving his palps alternately, or tapped the anterior part of her body with his front legs, or combined these acts. This caused the female to assume the apparently aggressive position if she had not done so upon original contact. Males never entered into insemination until this position was adopted by the female. The ventral portion of the male's front leg tibiae is equipped with a spur which he inserted beneath the female's spread fangs as the pair faced each other. This allowed the male to maintain the

fangs at a discrete distance from his body while further pushing the female back and up on her hind legs, exposing her genital area. At this time as well as during insemination some females resisted by pushing against the male with their front legs and pedipalps. If she got free or managed to dislodge one of her fangs from the male's tibial spurs, the male at once withdrew, but approached again and attempted to restrain the female. Two females used their hind legs to push away a male already in the act of insemination, resulting in an abnormally short mating.

The male may initiate insemination with either palp, and individual males may switch initial palps in different inseminations. The male's right palp entered the female's right opening to the spermathecae while the male's left palp entered the female's left opening to the spermathecae. The number of palpal insertions per palp based upon 33 observations ranged, for the right palp, from zero to nine insertions, with a mean of 3.5 and, for the left palp, ranged from one to seven insertions, with a mean of 3.8. A perfect alternating pattern of palpal insertions was evident in 27 inseminations out of the 33 observed. In 5 inseminations both palps were employed, but a perfect alternating pattern was not maintained. In the remaining insemination only the left palp was used, being inserted 4 times. The durations of insemination and the times from the termination of insemination to termination of physical contact of the pair were based on 30 and 29 observations, respectively. The duration of insemination, including any pauses between insertions, ranged from 22 seconds to 353 seconds, with a mean of 136 seconds. The time to disengagement ranged from 1 to 116 seconds, with a mean of 31 seconds. Once the male was free from physical contact with the female, he was relatively safe, as tarantulas react mainly to tactile stimuli. The male always ran rapidly out of range of the female's perception until stopped by the confines of the aquarium.

Males mated more than once. The greatest number of matings by one male in the laboratory was three. It is likely that, given the opportunity, some males may exceed this number of matings.

| Species | Time to form web | Time to fill palps | Rate of palpal contacts for both palps | Total duration | Author |
|---|---|---|---|---|---|
| *Cyrtopholis jamaicola* Strand | 20 | 90 | 190-192 | 141 | Petrunkevitch (1934) |
| *Eurypelma californica* Ausserer | 40 | 105 | 270-300 | 176-181 | Baerg (1928) |
| *Dugesiella hentzi* (Girard) | 40 | 90-100 | 180 | 160-175 | Baerg (1958) |
| *Dugesiella hentzi* (Girard) | ND | 115 | 160-200 | 180-240 | Petrunkevitch (1911b) |
| *Aphonopelma chalcodes* Chamberlin | ND | 23+-85+ | 110 | 241+ | |

Table 1: Comparisons of sperm induction in four species, with times in minutes and rates given as number per minute. A plus (+) indicates observation was begun while the behaviour was in progress. ND indicates no data available.

## Discussion

*Sperm Induction*

The process of sperm induction has been observed for several species, and the results from these observations are compared with those of *A. chalcodes* in Table 1. Gertsch (1949) supplied data on this behaviour for tarantulas in general, giving the total duration as 180 to 240 minutes, with 60 or more minutes being taken up by the filling of the palps as they contact the semen alternately at a rate of 100 to 150 times per minute. The sperm web was either destroyed or deserted. Petrunkevitch (1911b, 1934) and Baerg (1928, 1958) observed essentially the same sequence of events which consisted of forming the sheet web, the spider sliding on its dorsum under this web while continuing to spin, insertion of the emboli of the palps between the chelicerae, deposition of the semen drops, the filling of the palps with the palps contacting the semen alternately, and the desertion or destruction of the web upon completion. The earliest stage in which observations were begun with *A. chalcodes* was when the spider was on its dorsum under the web sheet and spinning. It was from this point to the termination of the process that gave the duration of palpal filling as 52 minutes and the total duration of the entire process as 241+ minutes. Petrunkevitch (1934) observed in *Cyrtopholis jamaicola* Strand from Jamaica the presence of an adhesive substance on the web sheet just before the deposition of the semen.

In *A. chalcodes* there was individual variation in the behaviour of the spider toward the sperm web upon termination of palpal filling. Some deserted it intact, while others used the fangs, pedipalps, front legs, or combinations of these to achieve varying amounts of destruction. *C. jamaicola* destroyed the web with the legs, palpi and fangs (Petrunkevitch, 1934), while *E. californica* of Arkansas used only the fangs for this purpose (Baerg, 1928). *Dugesiella hentzi* (Girard) from Arkansas destroyed its web (Baerg, 1958), while the same species from Texas left it intact (Petrunkevitch, 1911b). This indicates variation both within and between species in this behaviour.

Males perform this act several times during their adult lives as indicated from laboratory observations, with a maximum of three observed for an individual *A. chalcodes* male. A male of *C. jamaicola* formed six sperm webs over a 9-week period (Petrunkevitch, 1934), while Baerg (1958) counted 12 inseminations by a single male of *D. hentzi* and stated that each insemination was preceded by the construction of a sperm web.

In the laboratory, two males of *A. chalcodes* constructed their first sperm webs 10 and 21 days after maturation. Baerg (1958) gave 3 to 15 days in the field for *D. hentzi.*

In the species examined, essentially the same sequence took place. The durations of various steps varied along with the rates of semen palpal contacts, but these could be a function of ambient temperatures, which were not stated by the authors, rather than being related to the species that was observed. The ability of individual males to form several sperm webs appears to be widespread among tarantula species.

*Insemination*

The observations presented earlier for *A. chalcodes* were similar to those recorded for other species in the literature. Petrunkevitch (1911b) and Baerg (1958) observed the inseminations of *D. hentzi*, while the insemination of *E. californica* was reported by Baerg (1928); Baerg's work dealt with Arkansas tarantulas, while Petrunkevitch used tarantulas from Texas. Petrunkevitch (1911b) and Baerg (1928) agreed that males required direct physical contact with the females to become aroused, but later Baerg (1958) altered this statement to state that the male was aroused by the web of the female, as found here for *A. chalcodes*. This is in direct contradiction to Platnick (1971), who grouped families of spiders based upon courtship and placed the Theraphosidae among the families in which direct physical contact with the female was essential for male arousal.

Baerg (1928, 1958) noted that, as found for *A. chalcodes*, once physical contact was established by the male, the female either reared up, exposing her fangs, or if she remained quiet the male struck her with the front pair of legs. The second pair of legs may also be used on some occasions (Petrunkevitch, 1911a, 1911b). No body oscillations by the male have been reported previously. Baerg (1928) stated that each palp was inserted once and the total duration of palpal insertions was 60 seconds in *E. cali-*

*fornica*. Males of *D. hentzi* were reported to insert a single palp once for 30 seconds (Petrunkevitch, 1911b) after drumming on the sternum of the female with the palps, or to exhibit an alternate insertion pattern with each palp being inserted up to two times over a total duration of 120 to 125 seconds (Baerg, 1958). The number of times that individual palps were inserted as reported in the literature was less than the three to four observed in *A. chalcodes*, but since the average total duration of insertions was 136 seconds, only slightly above that reported by Baerg (1958) for *D. hentzi*, the average duration of individual palpal insertions must be less in *A. chalcodes* than in *D. hentzi*. The drumming seen by Petrunkevitch (1911b) was also present in *A. chalcodes* but seemed to serve to locate the openings to the female's spermathecae into which the palps were inserted.

Contradictory statements have been made regarding the number of spermathecal openings in the female tarantula. Gertsch (1949) gave the number as two, while Kaston (1948) claimed the existence of only a single, median opening. While observing the palpal insertion pattern of *A. chalcodes* it became clear that there are two distinct locations for insertions, one to the right, the other to the left of the female's body midline, indicating Gertsch (1949) to be correct for this species.

Baerg (1958) noted that males rarely were killed by the female during insemination and observed that one male of *D. hentzi* inseminated 12 times. No male of *A. chalcodes* was harmed by the female, but the maximum number of inseminations for any one male was less that Baerg's figure, being three.

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## Nomenclatural Note

The following Opinion has been published recently by the International Commission on Zoological Nomenclature (*Bull.zool.Nom.* **35**(4): 216-220, 31 May, 1979).

Opinion No. 1119. *Amaurobius* C. L. Koch, 1837, and *Coelotes* Blackwall, 1841 (Araneae): conserved under the plenary powers.

Editor