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Mating behavior of *Sickius longibulbi* (Araneae, Theraphosidae, Ischnocolinae), a spider that lacks spermathecae

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Abstract. We describe the mating behavior in the spermatheca-lacking theraphosid species *Sickius longibulbi* Soares & Camargo 1948. The behavior in captivity of nine pairs of *S. longibulbi* was videotaped and analyzed. The mating of this species presented an uncommon theraphosid pattern. There is little in the way of overt courtship by the male, the primary behavior seen being the male's use of legs I and II to touch the female's first pairs of legs and her chelicerae. Sometimes the male clasped one of the female's first pairs of legs, bringing her close to him. While the female raised her body, the male clasped her fangs and held her tightly with his legs III wrapped around her prosoma. The male seemed to try to knock the female down, pushing her entire body until she lay on her dorsum. In this phase we observed the male biting the female on the sternum or on the leg joints. When the female fell, the male attempted to position himself at an angle of 90° from the female. These movements appear to demand a lot of energy, particularly because the female is not passive during the mating. Our findings suggest that copulating in this position is, for the male, more successful than adopting other positions because it allows his extremely long palpal bulbs to deposit more sperm in the female oviduct where - since she lacks spermathecae - she retains the sperm. We suggest that the further he reaches into the oviduct, the greater the chance that he will fertilize the female's eggs.

Keywords: Mating behavior, reproductive success, tarantula, courtship, copulation

The family Theraphosidae is widespread in tropical and subtropical regions of the world, but the biology of theraphosid spiders is poorly known. Studies on the mating behavior of this family have been limited to a few species, namely *Dugesiella hentzi*, [now *Aphonopelma hentzi* (Girard 1852)] (Petrunkevitch 1911); *Eurypelma californicum* (Ausserer 1871) (now considered *nomen dubium*) (Baerg 1928); *Plesiopelma longisternale* (Schiapelli & Gerschman 1942) (Costa & Pérez-Miles 1992, 2002); *Aphonopelma chalcodes* Chamberlin 1940 (Minch 1979); *Brachypelma klaasi* (Schmidt & Krause 1994) (Yáñez et al. 1999); *Aphonopelma* sp. (Shillington & Verrell 1997); *Oligoxystre argentinense* (Mello-Leitão 1941) (now *Catumiri uruguayense* Guadanucci 2004); *Grammostola mollicoma* (Ausserer 1875); *Homoeomma uruguayense* (Mello-Leitão 1946); *Acanthoscurria suina* Pocock 1903; *Eupalaestrus weijenberghi* (Thorell 1894) (Costa & Pérez-Miles 2002); and *Xenodendrophila gabrielli* Gallon 2003 (now *Encyocratella olivacea* Strand 1907) (Kumar 2004). A prevalent pattern emerges from the available literature on theraphosid mating: courtship typically entails the male performing body vibrations and palpal drumming, with this being followed by clasping (i.e., to hook female's fangs or some appendage with the male tibial apophysis). In studies so far, mating always occurs with the male positioned in front of the female, with the male raising the female's body, allowing the male to reach the genital opening with his embolus.

Here we describe an unusual mating behavior in Theraphosidae, found in the species *Sickius longibulbi* Soares & Camargo 1948. This small Brazilian theraphosid is remarkable because of the absence of spermathecae, being the first Mygalomorphae species described to have this feature (Bertani & Silva, Jr. 2002).

Adults and juveniles of *S. longibulbi* were collected during a faunal rescue upstream of the dams of U.H.E. Sérgio Motta [21°32′ S, 52°05′ W] in the states of Mato Grosso do Sul and São Paulo, Brazil, in 2000. These are small theraphosids measuring about 20 millimeters in total body length (including chelicerae and excluding spinnerets) in both males and females. Voucher specimens from this study were deposited in the collection of the Laboratório de Artrópodes, Instituto Butantan, Brazil. The specimens were maintained separately in the laboratory in individual plastic cages with wet cotton wool and fed regularly with beetle larvae (*Tenebrio* sp.) and crickets (*Grillus* sp.).

Nine matings were recorded between 2000 and 2003. The male was introduced either into the female's cage (90 millimeters in diameter covered with soil: pairs 1 and 4 in Table 1); or both were introduced simultaneously into an arena floor of 450 × 360 mm covered with soil (Pairs 2, 3, 5, 6, 7, 8 in Table 1); at room temperature, in the morning or the afternoon. In one case, (pair 9 in Table 1), the female was placed two weeks before the mating encounter in a cage with soil of 300 × 300 × 150 mm of length / width / depth. She constructed a retreat under a Petri dish, allowing us to see her behavior inside it. All encounters were videotaped using a Handycam Sony TRV 15.

Since the females lack spermathecae, it is difficult to determine if they are adults. Consequently, in our experiments

Table 1.—Behavioral summary of the nine observed matings of *Sickius longibulbi*. Total = Percentage of individuals that exhibited each behavior at least once. F = male introduced in female's cage (90 mm in diameter covered with soil). A = male and female introduced simultaneously into an arena floor (450 × 360 mm covered with soil). R = male introduced in female's cage that constructed a retreat (300 × 300 × 150 mm covered with soil).

Pair	Courtship (male)	Courtship (female)	Male hug	Male bit	Male pushing (attempts)	Male pushing (success)	Male balance (attempts)	Palpal insertions on 90°	Mating in an angle close to 90°	Mating in usual theraphosid position	Mating duration (min)	Encounter
1	No	No	3	1	4	3	2	0	1	5	45	F
2	No	No	1	1	3	1	0	0	0	3	5	A
3	No	No	1	1	7	3	13	0	7	0	13	A
4	No	No	1	1	1	1	3	1	2	0	6	F
5	No	No	1	0	1	0	0	0	0	1	3	A
6	No	No	1	2	2	1	0	0	0	1	5	A
7	Yes	No	1	1	4	3	2	1	0	3	13	A
8	No	No	1	2	3	3	0	0	0	1	22	A
9	Yes	Yes	1	2	3	2	1	0	0	1	10	R
Total	22%	11%	100%	88%	100%	88%	55%	22%	33%	77%	3 to 45	

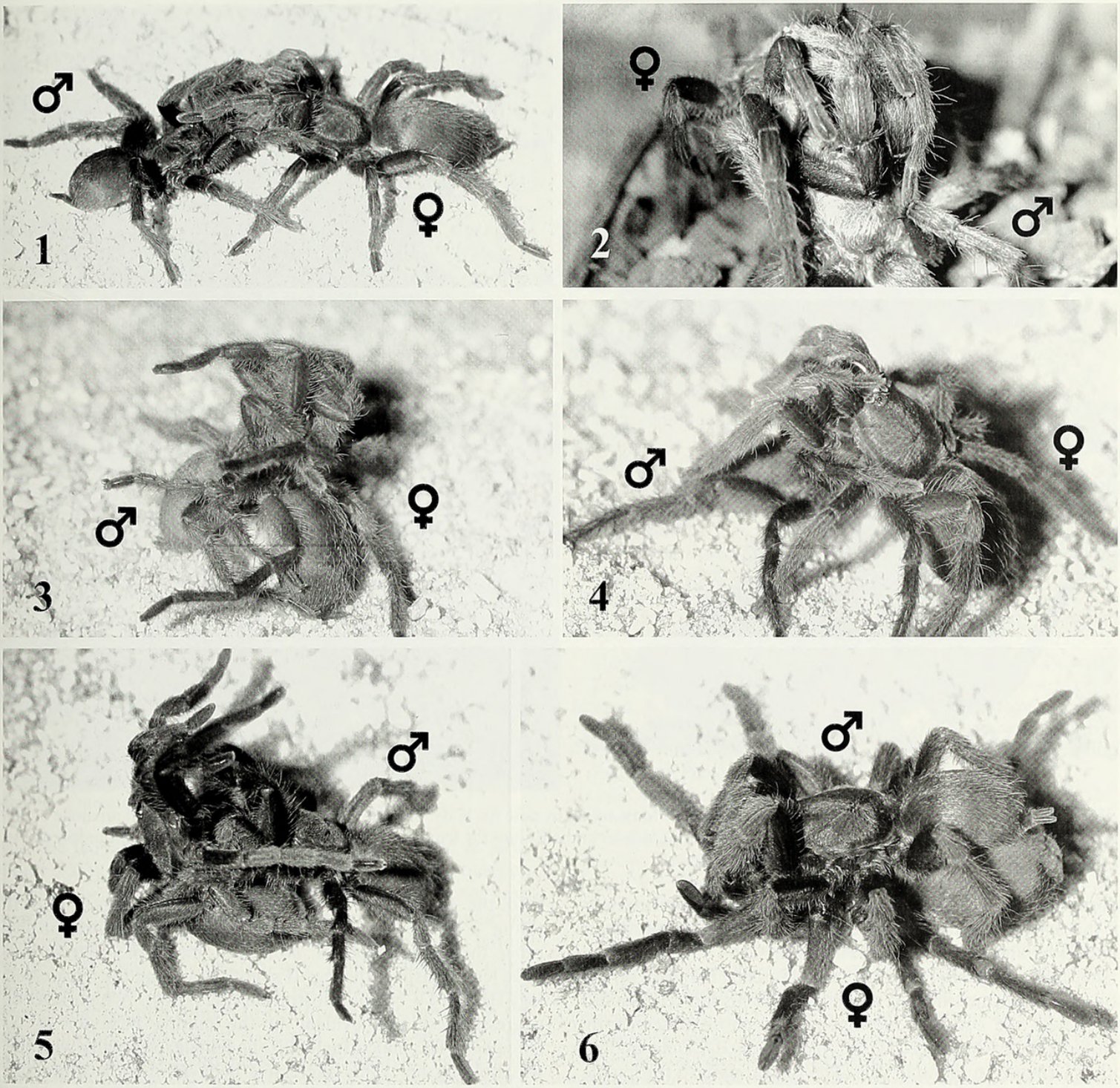
we used only the larger females and only if they did not have eggsacs. As the specimens came from the wild, it was not possible to determine if the females used in the experiments already had sperm inside them, since they are able to keep male sperm even after some molts (Bertani & Silva, Jr. 2002).

There was a common pattern when *S. longibulbi* mated (Figs. 1–9, Table 1). First, the male approached the female, touching the substrate with his legs I and II with very fast movements. He also moved his third legs and scratched his palps against the substrate. Then, the male touched the female with his legs I and II on her first pairs of legs and on the chelicerae (Fig. 1). The male sometimes clasped one of the female's first pair of legs, using his leg I tibial apophysis and a leg I metatarsal ventral apophysis (see figs. 4, 5 of Bertani & Silva, Jr. 2002; see also Fig. 11). The tibial apophysis was hooked on the female leg and then the curved metatarsus I was flexed catching the female leg (Fig. 12) and bringing her close to him. The curvature of metatarsus I, the incrassate tibia I, and the presence of an apophysis on the ventral metatarsus I are characteristics found in *Sickius longibulbi*, as well as *Porrhothele antipodiana* (Hexathelidae) (Jackson & Pollard 1990) and *Fufius* spp. (Cyrtaucheniidae) (pers. obs.). *Euagrus* spp. (Dipluridae) has similar structures on leg II (Coyle 1986). These structures are similar in form and function; i.e., used to clasp legs or palps, though the clasped appendages vary: in *Euagrus* the male clasps the female's femur II (Coyle 1986) and in *Porrhothele* he clasps the female's palpus (Jackson & Pollard 1990).

In *S. longibulbi*, when the female raised her body, the male clasped onto her fangs using the tibial apophyses (Fig. 2), and held her tightly with legs III around her prosoma (we call this behavior "hug") (Fig. 3). Subsequently, the male touched the female's posterior legs with his legs III many times (Fig. 4), appearing to be trying to knock her down, pushing and making her fall (the "male pushing attempts" and "male pushing success" in Table 1). In this phase we observed *Sickius longibulbi* males also moving their fangs many times, raising and lowering them near the female's sternum. Often, the male bit the female on the sternum or on the leg joints ("bite"; Table 1) and it was possible to see hemolymph droplets on the bitten region. Sometimes, the pair was in the usual position when the male suddenly pushed the female in a very fast movement (Fig. 5). This is a critical phase and the male was not always successful (Table 1). When the male succeeded, the female ended up lying on her dorsum, with the male over her, holding her tightly (Fig. 6). Subsequently, the male seemed to try to balance himself angled up at 90° to the female's horizontal body axis (the "balance" in Table 1) (Figs. 7–8). In this position the male inserted his long, slender embolus into the female genital opening (Fig. 9). Afterwards the male fell laterally, unclasping and moving away from the female.

Palpal insertions into the female's genital opening were difficult to see but seemed to occur with the spiders in the usual theraphosid copulatory posture. However, sometimes insertion was with the female lying on her back and the male in an angle approximately 90° in relation to the female axis (Table 1). In this position, however, it could be easily seen (Fig. 9).

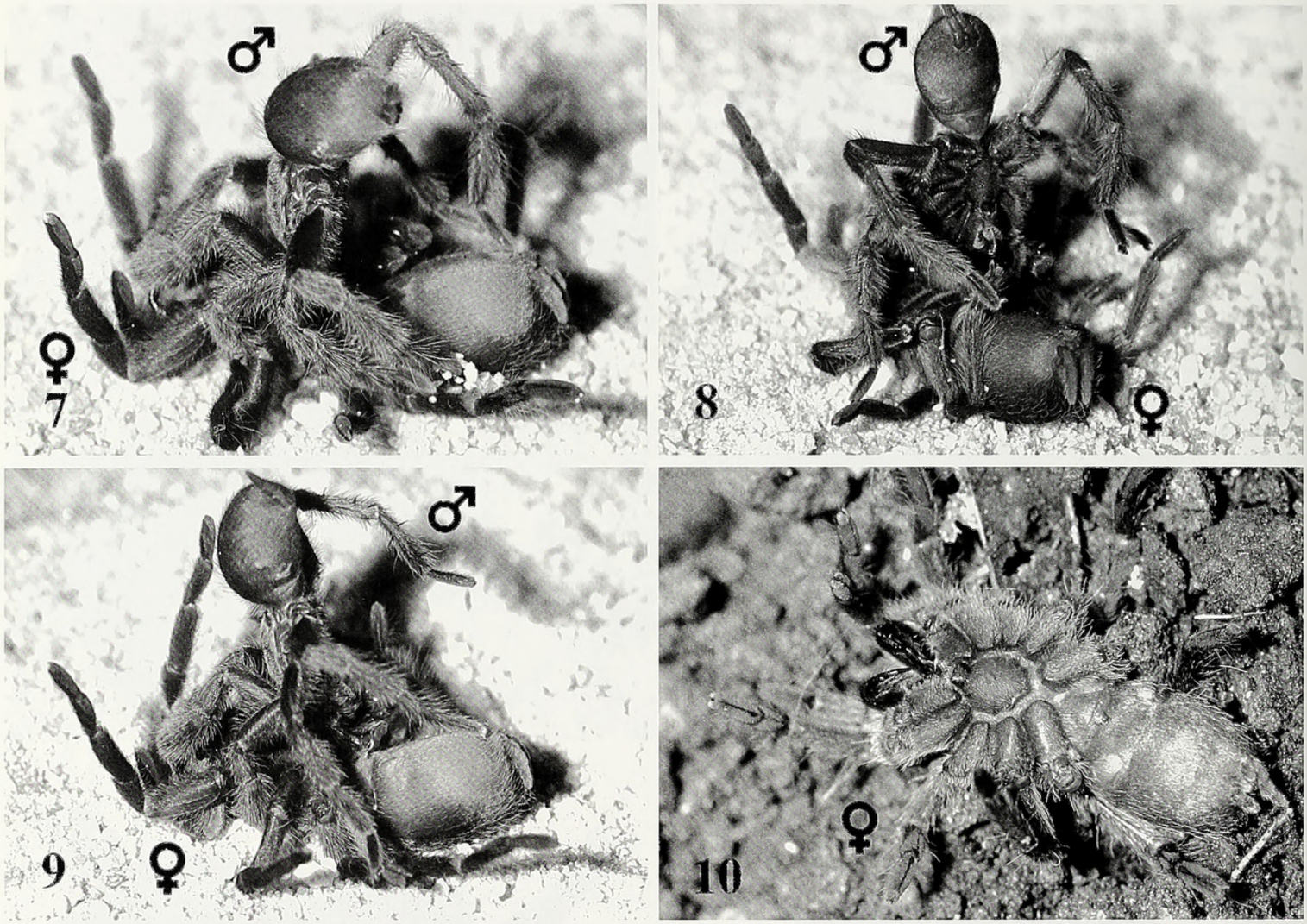
When bitten, the female remained motionless and the male sometimes continued mating or even calmly went away from



Figures 1–6.—*Sickius longibulbi* mating. 1. Male approaching the female, touching her with his anterior legs. 2. Male leg I tibial apophysis clasping the female fangs. 3. Male holding the female tightly with his legs III around her prosoma ("hug"). 4. Male touching the female's posterior legs with his legs III. 5. Male suddenly pushing the female in a very fast movement. 6. Female positioned with her back on the substrate. Photos: R. Bertani.

the female when the mating was over. In one mating sequence (pair 4), the male bit a female that was lying on the ground, walked on her, and then went away (Fig. 10). For several minutes, the female stayed totally immobile. Afterwards, she recovered and walked away. This type of behavior has not been described for any other theraphosid and may indicate that the male venom can be used to calm the female.

As shown above, several points in the mating behavior of *Sickius longibulbi* were clearly different from the prevalent theraphosid pattern. Theraphosid courtship usually consists of palpal and leg movements, body vibrations, and clasping (Yañez et al. 1999; Costa & Pérez-Miles 2002). In all species studied to date, the male positions himself in front of the female when mating, with both bodies tilted up and with the male extending his palps under the female and inserting them into her genital opening (Foelix 1996). Even in *Encyocratella olivacea* Strand 1907 (Gallon 2005) (formerly *Xenodendrophila gabrielli* Gallon 2003), the only other theraphosid known to lack spermathecae (Gallon 2003), courtship is similar to that of other tarantula spiders, with palpal tapping and body



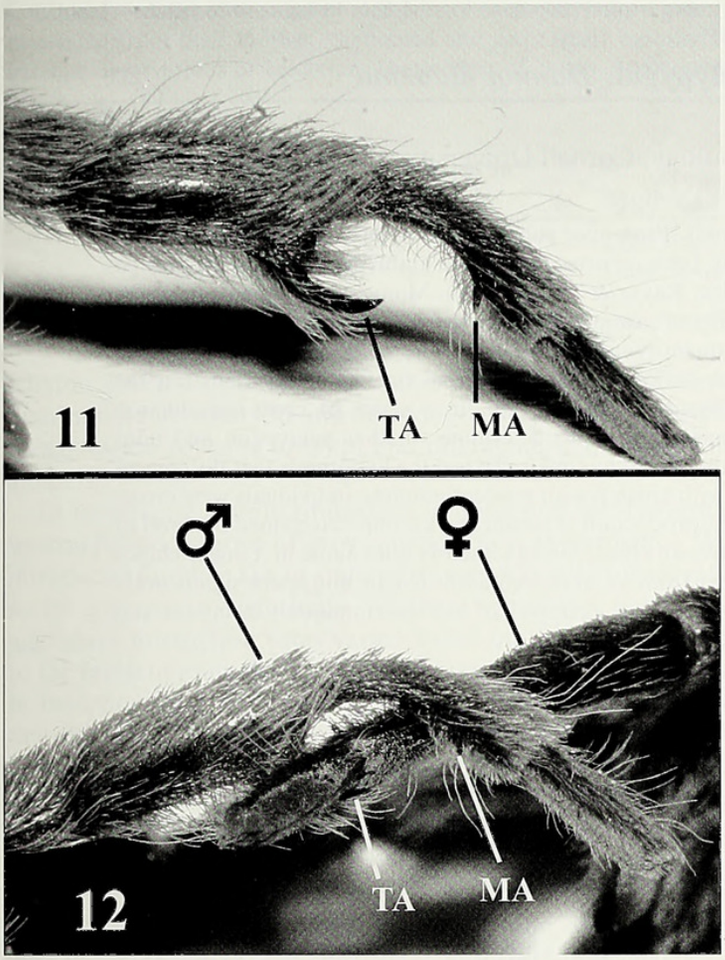
Figures 7–10.—*Sickius longibulbi* mating (continued). 7. Male trying to raise his body. 8. Male balancing himself in the air at an angle of 90° relative to the female body axis. 9. Insertions of male's long slender embolus into the female genital opening. 10. Female lying motionless on the ground after male bites her (pair 4). Photos: R. Bertani.

vibrations (Kumar 2004). Apparently, reproductive behavior of this species was not altered dramatically from the prevalent pattern by absence of the spermathecae.

In *Sickius longibulbi* the male only scratched his palps on the soil and performed inward movements of his leg III. We did not detect the complex movements like those observed by Costa & Pérez-Miles (2002) in *Acanthoscurria suina* and in other Uruguayan theraphosids. The typical pattern for female theraphosids is to tap their front legs in answer to male courtship, but we did not detect this for *Sickius longibulbi* except in one case in which the female was put in a cage with sand and soil many days before the mating attempt (pair 9 in Table 1). This female built a retreat on the soil and when the males approached and touched the retreat door, she answered by making faint tapping movement with her anterior legs. This suggests that in our other observations we did not see females answer male courtship because these females were put in the arena simultaneously and close together with the male.

Another difference when compared to other species was the behavior of the male *S. longibulbi* when approaching the female: he used his leg I tibial apophyses together with the leg I metatarsal apophyses to clasp the female's legs and to bring her close to him. After the male approached the female, he held the female's prosoma tightly with his legs I and II ("hug"). This behavior has not been reported before for any other theraphosid species. Normally, males of other species have legs I clasped, the legs II slightly touching the female and legs III and IV on the substratum (pers. obs). A high level of aggressiveness was evident in the mating behavior of *S. longibulbi*. The male usually bit the female, especially when he was holding her. This aggressive behavior is not commonly reported for mygalomorph spiders (Jackson & Pollard 1990; Shillington & Verrel 1997).

Something else unusual about *S. longibulbi* was that the male seemed to try to knock the female down: he pushed her entire body until she was lying on her back. This is quite different from the loss of equilibrium that has been reported in some Uruguayan species (Costa & Pérez-Miles 2002), as in those species it seems to be related to the spider's adaptation to mating in the entrance to burrows. In *S. longibulbi*, all the males tried to make the female fall over backward so that he could position himself angled up by 90° from the reclining female. The male's behavior in achieving this seems to demand a lot of energy. One of the possibilities of this unusual posture of the male is to make the male more successful at transferring sperm (i.e., in this posture, his extremely long embolus, longer



Figures 11–12.—*Sickius longibulbi* clasping apparatus. 11. Male, leg I. 12. Simulation of a male clasping female leg I. Photos taken from preserved specimens. TA = Male leg I tibial apophysis, MA = Male leg I metatarsal apophysis. Photos: R. Bertani.

than the palpal tibia length (see figs. 1–3 of Bertani & Silva Junior 2002), can deposit more sperm in the female's oviduct, which is where she retains the sperm because she does not have spermathecae). We cannot be certain that the behavior we observed is fully representative of what happens in nature because we did not observe any mating under natural conditions. However, one mating occurred in conditions that were probably quite similar to conditions in nature, with the female having constructed a retreat. In this instance, the male's behavior was comparable to male behavior under more artificial conditions. It has been noted before that spider mating in captivity does not appear usually to be especially distorted when compared to mating behavior in nature (Jackson 1988; Jackson and Pollard 1990), and it seems likely that our observations are, in basic respects, typical of *S. longibulbi*.

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