

Mechanics of copulation in *Lycosa chaperi* Simon (Araneida : Lycosidae)

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The sexual behaviour in spiders has been described by a number of workers (Peckham and Peckham, 1889 and 1890; Montgomery, 1903 and 1910; Petrunkevitch, 1911; Osterloh, 1922; Locket, 1923, and 1927; Bristowe and Locket, 1926; Bristowe, 1926 and 1929; Savory, 1928; Kaston, 1936; Getrsch, 1949; Gering, 1953; Bhatnagar and Sadana, 1966 and Leighton, 1969), but the mechanical aspects of copulation have largely been neglected except by a few workers such as Osterloh (1922), Gering (1953) and Cooke (1965). The functional aspects together with structural variations of different sclerites of the palpal organ have been considered useful criteria in taxonomy by Grasshoff (1968) and Van Helsdingen (1969). Thus, a study on the mechanics of copulation was undertaken on *Lycosa chaperi* Simon and the results are presented herein. This species is found in abundance on the dung heaps around villages in northern India. Reference may be made to Bhatnagar and Sadana (1963) for the structure of male and female genitalia of *L. chaperi*.

In *L. chaperi*, the act of copulation begins immediately after the male mounts the back of the female. The palpal organs of either side are inserted alternately in the female genitalia. The left palp is engaged in the left epigynal opening rhythmically and alternately with the right palp in the right epigynal opening. During these rhythmic insertions the male jerks its abdomen and hind legs with great frequency at the rate of about 60 times a minute, and taps the tip of the abdomen of the female with its fore legs. The copulation time in *L. chaperi* varies from two to forty five minutes and consists of a series of distinct phases, viz. engaging the embolus, inflation of haematodocha, insertion of embolus, coupling of conductor, maximum distention of haematodochae and ejaculation.

Engaging the embolus: The process of engaging the embolus is one of the most critical phases in the mechanics of copulation in *L. chaperi*, in which the male first starts to tap the epigynum gently with its palp. The entire palp is involved in this process and the whole appendage moves in an arc across the face of the epigynum. This follows a definite attempt by the male to insert the embolus into the epigynal opening. The number of attempts made in engaging the embolic terminus are variable. Finally, contact is established by slightly twisting the palp, a slight swelling of the haematodocha and by adjusting the position of its body. During this activity of the male, the female is already in catalepsis and is absolutely motionless. In view of the complexity of both the genitalia and the mechanics of copulation, the cataleptic state of the female *L. chaperi* is of considerable behavioural importance because slight movement of the female during this phase of copulation can effectively obstruct proper union of the sexual structures. As the tip of the embolus is engaged in the epigynal furrow the rest of the process of copulation proceeds in a machine-like fashion.

Inflation of the basal haematodocha: As the embolus establishes contact with the female organs, the basal haematodocha begins to swell by an increased haemolymphatic pressure. Prior to this, there is no evidence of even the slightest haematodochal swelling. Inflation of the basal haematodocha causes the displacement of the genital bulb out of the alveolus. As the genital bulb is extended, it also undergoes slight rotation, which assists in the insertion of the embolic terminus into the epigynal furrow.

Insertion of the embolus: Continued swelling of the haematodochae brings about further rotation of the genital bulb. The embolic terminus (Fig. 1, EMBT) which is already in the epigynal furrow (EF) thus penetrates further. The configuration of the epigynal furrow (EF), the guide (TAG and MAG) and embolus (EMB) are such that during insertion the embolic terminus (EMBT) is directed towards the spermatheca (SP). Further insertion is assisted by a quick thrust of the embolus resulting from the spasmodic pulsations of the basal and distal haematodochae (BHAEM and DHAEM).

In agelenids, Gering (1953) considered the configurations of both the atrium and the embolus responsible for directing the embolus terminus into the bursa, and in *Dysdera*, Cooke (1965) observed a twisted sclerotized strip down the front of the bulb guiding the bulb during insertion. This action is also supplemented by the posterior apophysis in *Dysdera*.

Coupling of the conductor: Rotation of the genital bulb involves displacement and rotation of the main sclerites of the bulb. The tegulum (Fig. 1, TEG) and the conductor (CON) undergo these movements in such a way that the latter (CON) comes to lie in the epigynal furrow (EF). The tooth-like process of the conductor (T) fits into the furrow-sac (FS) at the anterior end of the epigynal furrow (EF). The furrow-sac can be compared with the coupling cavity in agelenid spiders as described by Gering (1953). The conductor (CON) is grooved on its inner side and

forms a firm base to facilitate the insertion of the embolus further into the spermathecal opening. It also prevents any chance slipping of the embolus and disengagement of the palpal organ from the epigynal furrow. The coupling of the conductor is another critical point in the mechanics of copulation in *L. chaperi*. Coupling of the conductor has been reported in other spiders by Osterloh (1922) in *Agelena similis* Keyserling and *Lycosa amentata* Clerck and by Gering (1953) in agelenids. However, Cooke (1965) found that in *Dysdera* the posterior apophysis of the bulb serves to lock the palp and to guide the bulb at the time of copulation.

Maximum distention of haematodochae: The maximum distention of the haematodochae is achieved after the conductor and the embolus have been properly engaged in the epigynum. Haematodochae (Fig. 1, BHAEM and DHAEM) swell to

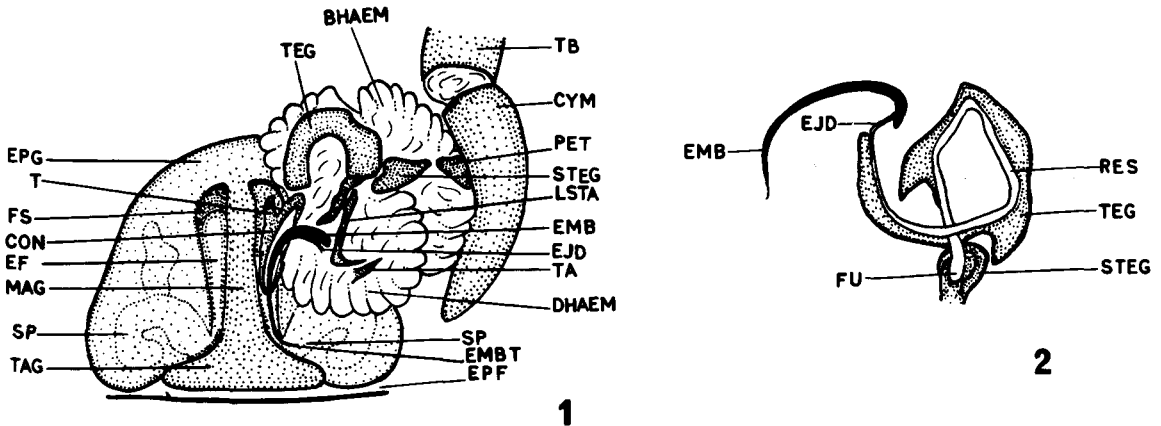


Fig. 1: Male and female genitalia of *L. chaperi* engaged in copulation, showing the Tooth-like process (T) of conductor (CON) engaged in furrow sac (FS) and the embolic terminus (EMBT) reaching the opening of spermatheca (SP). The genital bulb has been shown fully extended.

Fig. 2: Subtegulum showing its articulation with tegulum and the receptaculum seminis showing its relation with these sclerites in *L. chaperi*.

BHAEM = Basal haematodocha; CON = Conductor; CYM = Cymbium DHAEM = Distal haematodocha; EF = Epigynal furrow; EJD = Ejaculatory duct; EMB = Embolus; EMBT = Embolic terminus; EPF = Epigastric furrow; EPG = Epigynal plate; FS = Furrow sac; FU = Fundus; LSTA = Lateral subterminal apophysis; MAG = Median arm of guide; PET = Petiole; RES = Reservoir; SP = Spermatheca; STEG = Subtegulum; T=Tooth-like process of Conductor; TA = Terminal apophysis; TAG = Transverse arm of guide; TB = Tibia; TEG = Tegulum.

their maximum and it is only at the end of copulation that they deflate gradually. Haematodochal swelling also results in erecting the spines on the palp and the legs. The spines become erected to a nearly vertical position with each pulsation of the haematodochae and then drop to a nearly horizontal position as the haematodochae deflate after copulation. As the haematodochae inflate to their maximum capacity, they become transparent losing the textured appearance which otherwise makes them translucent. The haemolymph within the swollen haematodochae also gives them a turbid appearance.

Ejaculation: Ejaculation probably occurs simultaneously with the distention of the haematodochae. The seminal fluid is forced out of the receptaculum seminis on the collapsing of fundus (Fig 2, FU) by an increased haemolymphatic pressure around it. The articulation of the tegulum (TEG) with the subtegulum (STEG) also possibly plays a minor role in collapsing the fundus (FU) when these sclerites rotate over each other during maximum inflation of the genital bulb. Following ejaculation, begins the reversal of all mechanical functions which lead to the maximum distention and the maximum insertion of the embolus. After this, the palpal organ is removed from the epigynal opening of its side and the abdomen of the female is rotated slightly with the help of the first pair of legs and copulation is effected on the other side.

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