

Mating genres in Mecoptera

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All living organisms reproduce to maintain their identity, and each species has its distinctive mating behaviour. Arthropods have developed different mating rituals like the production of serenades (Crickets), performing dances and foreplay (Jumping spider), aphrodisiacs (Moths) *etc.*, to attract the opposite sex. Mecopterans are the ones which are branded for their several genres of mating behaviours. Mecopterans resemble those primitive insects such as mayflies. The abdomen typically curves upwards in the male, superficially resembling the tail of a scorpion, hence called the Scorpionfly. In general, grownup mecopterans are habitually scavengers, devouring the soft bodies of dead invertebrates and decaying vegetation. However, some members of Mecoptera such as Panorpids and Bittacids (hanging flies) are predators and feed on the soft bodied insects. *Panorpa*, raids spider webs to feed on trapped insects and even the spiders themselves, whereas, Bittacids capture flies and moths with their specially modified legs. Mecopterans have adopted different kinds of mating strategies which includes salivary secretions as a nuptial gift, dead arthropod as a nuptial gift, hunted prey as a nuptial gift and sexual coercion. However, the attraction of

the opposite sex and mating success is depending on the type and quantity of food offered.

MATING APPROACHES

Mating tactics are specific to the different mecopteran families. However, depending on the situation, members of a single family can also demonstrate multiple mating strategies

Salivary secretions as the marital donation

Remarkable sexual dimorphism amid the sexes can be seen in salivary glands. These are short and bifurcated in the female, whereas in males these are well developed and multiple-furcated. Here, the male serves the female with a salivary mass that it discharges. In the course of their secretion, these stiff, pillar-shaped aggregates (salivary mass) cling to a leaf. After secreting the saliva mass, males disseminate sex pheromone by an eversible sac present in the genitalia across a long distance. A female magnetized by the pheromone feeds on the saliva. At the same time, the male holds the female forewing with a notal organ (a specialized clamp-like structure produced from parts of the third and fourth abdominal dorsum in the male) and continues to copulate and which may continue for some hours in some species (Kock *et al.*, 2007).

Another similar strategy to attract a promising mate nearby is that male vibrates his wings and swings his abdomen up and down rhythmically and releases sex pheromones from a pouch-like gland located in the genital bulb. After luring a female, the male stops delivering olfactory signals and secretes a drop of liquid salivary secretion that sticks to his mouthparts. When the female tries to feed on the salivary discharge, the male advances to her lateral side and seizes her IXth abdominal segment with his gonostyli. As a result, the male and female take an O-shaped mating stance, with only

their mouthparts and genitalia making contact (Fig. 1). During copulation, the female is continuously supplied with the liquid salivary secretion by the male in a mouth-to-mouth mode. When feeding on salivary secretion, the female frequently cooperates with the male to maintain a firm mating posture and when it stops feeding, the female ends copulation by lashing her abdomen to break off the vaginal connection and departs the male (Zhong *et al.*, 2015). This is the most common sort of mating ritual among Panorpids.

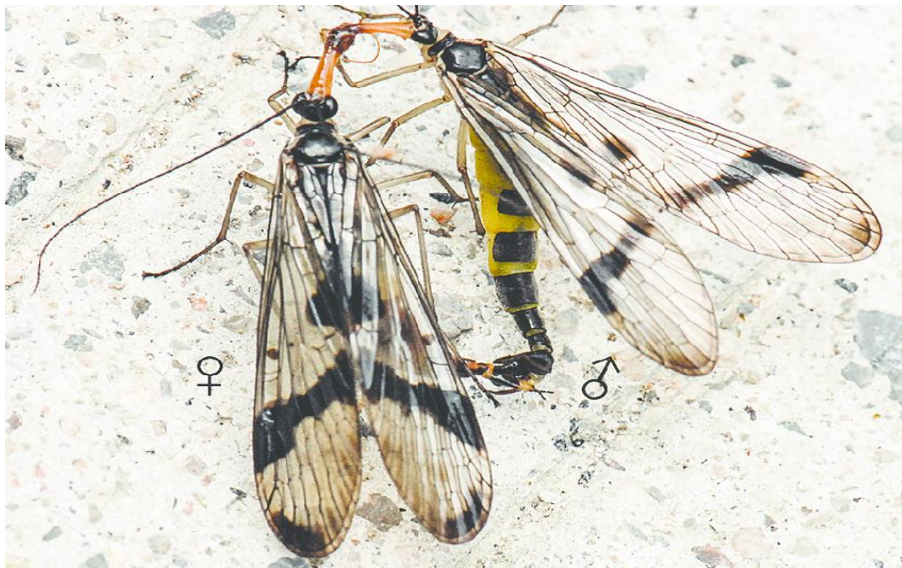


Figure 1: Copulation of *Furcatopanorpa longihypovalva* takes O-shaped stance (Zhong *et al.*, 2015)

Dead arthropod as a nuptial gift

The diet of Panorpidae comprises around 89-97% of deceased insects of which, Dipterans share 47-69% (Thornhill, 1975). Male feeds on dead arthropods and diffuse sex attractant while standing adjacent to the dead arthropod, also parade wing movements and abdominal vibrations to attract females. Males guard nuptial offerings against other males that attempt to seize them through aggression. During hostile interactions, males seldom hook a rival's wing or leg through a pair of sharp claspers formed from the distal end of the genital bulb.

According to laboratory and arena experiments, dead arthropod presentation is preferred over saliva presentation by *Panorpa* males (Fig. 2). Forced copulation is employed by males only after they have exhausted all other options due to resource



Figure 2: *Panorpa communis* with prey (Richard Bartz, Munich aka Makro Freak image; <https://en.wikipedia.org/wiki/Panorpa>

[a_communis#/media/File:Panorpa_communis_with_prey_Diogma_glabrata_glabrata.jpg](#))

scarcity, which might be caused by a lack of absolute resource availability, intensified male-male rivalry, or both. Furthermore, the body weight of males decides their success in the competition for resources. The larger the male the more he engages in discretions ensuing in more relative mating triumph (Thornhill and Gwynne, 1986; Thornhill, 1981).

Prey arthropod being a bridal reward

This kind of mating strategy is most frequent in hanging flies (Bittacids) (Fig. 3). Soft-bodied insects like aphids, tipulids and houseflies are the major prey of Bittacids. They hang on vegetation to quest the target which arrives in their vicinity. After grabbing the prey, the male releases the pheromone, and a female comes near the male and drops her wings. By this moment the female is dangling directly in the obverse of the male. Males use wing-lowering as the cue for the presentation of prey to the female. During prey offering and feeding by the female, the male holds the prey employing both hind legs and one or both middle legs. The male tries to pair his genitalia as the female start feeding on the nuptial reward. Ultimately, the female engages the male's genitalia once she has assessed the excellence of his nuptial offering

(Iwasaki, 1996). These Bittacids can also exhibit transvestism and piracy practices to steal the prey so that, the time to capture prey

is reduced and exposure to predators is also less (Thornhill, 1979).



Figure 3: Hanging scorpionflies (*Bittacus* sp.) with moth prey

(Naskrecki's image from Life in the season of death, 2013;

<https://thesmallermajority.com/2013/07/23/hanging-in-there/>)

Rape / Sexual duress

Rape encompasses a male with no nuptial offering *i.e.*, salivary mass or dead insect, hastening on a passing female along with fixing out his moveable abdomen at her. It is the most common ritual in Panorpid. The abdominal tip is a large and muscular genital bulb accompanied by a terminal duo of genital claspers. The male slowly endeavours to change the position of the female after successfully snatching a leg or wing of the female through his genital claspers. Afterwards, he locks the forward edge of the

female's right forewing inside the notal organ. Females fight briskly to escape as soon as grasped by such a male's genital claspers. The male tries to clinch the genitalia of the female with his genital claspers once the female wings are secured. But the female struggles to retain her abdominal tip away after the male's probing claspers. The male keeps holding the female's wing with the notal organ during copulation and which could remain for a few hours in some species. However, the contribution of rape behaviour to the reproductive success or genetic propagation of the rapist is unclear from

studies to date. Although efficacious rape (*i.e.*, including insemination) might be uncommon this one is usurping behaviour meant for a male to adopt when he is aggressively eliminated from his salivary secreting capacity and the tenure of a dead

insect. The fitness achievement of the *Panorpa* rapist is comprehended when the behaviour of these insects is paired with their ecological scenario (Thornhill, 1980) (Fig. 4).



Figure 4: Sexual coercion in *Boreus brumalis*

(Naskrecki's image from Life in the season of death, 2013;
<https://thesmallermajority.com/2013/01/23/life-in-the-season-of-death/>)

Conclusion

The goal of every single organism resting on this earth is self-perpetuation, which is also true of mecopterans. Mecopterans are habituated to moist environments and also to hotter climates, where they act as scavengers of dead arthropods and predators of moribund organisms. Although mecopterans are of little apparent economic significance, they represent a systematically and biologically important, ancient insect lineage. A wide array of mating-related morphological specializations presumably

reflects more varied historical mating strategies and behaviours in the Panorpoidea group. Mecopterans may have developed a broad array of mating strategies due to a lack of absolute resource availability, increased male-male rivalry, or both. Intense male-male competition in the resource-defense polygynous mating system creates different options for males of different competitive abilities. It is evident that the resource for which males compete is scarce and essential to female reproduction. The preferred mating

genres for both sexes are those that lead to greater fitness, *i.e.*, more copulatory success and survival for males, and greater fertility and survival for females. Mating specialization in mecopterans provides the first insights into the long-term evolution of sexual competition over mating among insects.

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