

BEHAVIOR OF *TITYUS SERRULATUS* (SCORPIONES, BUTHIDAE) IN CAPTIVITY WITH BLOCKED PEDIPALP CHELA

Wesley Dondoni Colombo

PPG-Biologia Animal, Universidade Federal do Espírito Santo, Av. Marechal Campos 1468, 29.040-090, Vitória-ES, Brazil.
— wesleycolombo@gmail.com

Abstract: Scorpions are well-known and well-distributed animals throughout Brazil, in addition to their medical and health importance. This study was aimed at quantifying and qualifying the influence that blocking the chela has on the behavioral repertoire of the scorpion *Tityus serrulatus*. We studied 16 individuals in captivity from October to November 2012. The study had a total duration of 50 hours of observation. Twelve behavioral acts were described and classified into five different behavior categories: foraging, immobility, cleaning, environment exploration, and interaction with conspecifics.

Keys words: Scorpiones, Buthidae, *Tityus serrulatus*, pedipalp chela, ethogram, Brazil.

Comportamiento de *Tityus serrulatus* (Scorpiones, Buthidae) en cautividad con las quelas de los pedipalpos bloqueadas

Resumen: Los escorpiones son animales bien conocidos y distribuidos en todo Brasil y poseen gran importancia médico-sanitaria. Este estudio tiene como objetivo cuantificar y calificar la influencia de las quelas (al ser bloqueadas) sobre el repertorio comportamental del escorpión *Tityus serrulatus*. Se estudiaron 16 individuos en cautiverio entre octubre y noviembre de 2012. El estudio tuvo una duración total de 50 horas de observación. Se describen doce actos de comportamiento y se clasifican en cinco categorías diferentes de comportamiento: búsqueda de alimento, inmovilidad, limpieza, exploración del medio e interacción con sus congéneres.

Palabras clave: Scorpiones, Buthidae, *Tityus serrulatus*, quelas de los pedipalpo, etograma, Brasil.

Introduction

Scorpions have physiological, behavioral and ecological adaptations that have ensured their continued success over the past 450 million years (Polis, 1990). They are best known for their dramatic stinging behavior, but there is also tradition in studies related to sexual behavior (Toscano-Gadea, 2010) and prey capture of these arachnids (Bub & Bowerman, 1979; Rein, 2003; Toscano-Gadea & Costa, 2006; Jiao & Zhu, 2009). Despite having spent much time filled with important geological and evolutionary events, scorpions kept their morphological features well preserved.

Adaptations of scorpions may vary from efficient behavioral repertoire to ultra-sensitive receptors (Polis, 1990). As in other arachnids, they have appendages, used to perform various functions for the organism survival, developed exclusively for their lifestyle. Within the Solifugae and Amblypygi, the first pair of walking legs are secondarily segmented for use as tactile organs, and are not used for locomotion (Savory, 1970). Some Araneae are known to use their first pair of legs for display during courtship, as well as for walking (Bub & Bowerman, 1979).

In Brazil, the most important genus is *Tityus* C. L. Koch, 1836. Among this genus, *Tityus serrulatus* Lutz & Mello, 1922, commonly known as yellow scorpion is one of the most dangerous, able to cause serious injury or death of people and animals. The species gets its name due to the presence of a serration in the third and fourth metasomal segment; it is also characterized by having parthenogenetical reproduction (Matthiesen, 1962; Lourenço, 2002).

According to Meijden *et al.* (2009), the chelae are formed by the last two articles fittings pedipalps, which are the second pair of prosomal appendixes and are composed of



Figure 1. Location of Santa Teresa, Brazil (Wikipedia, 2015).

six segments (the tibia forming still finger and the base chela, while the tarsus forms the movable finger). Among the functions of the chela, we can highlight the handling of prey (Casper, 1985) and defense (Meijden *et al.*, 2009).

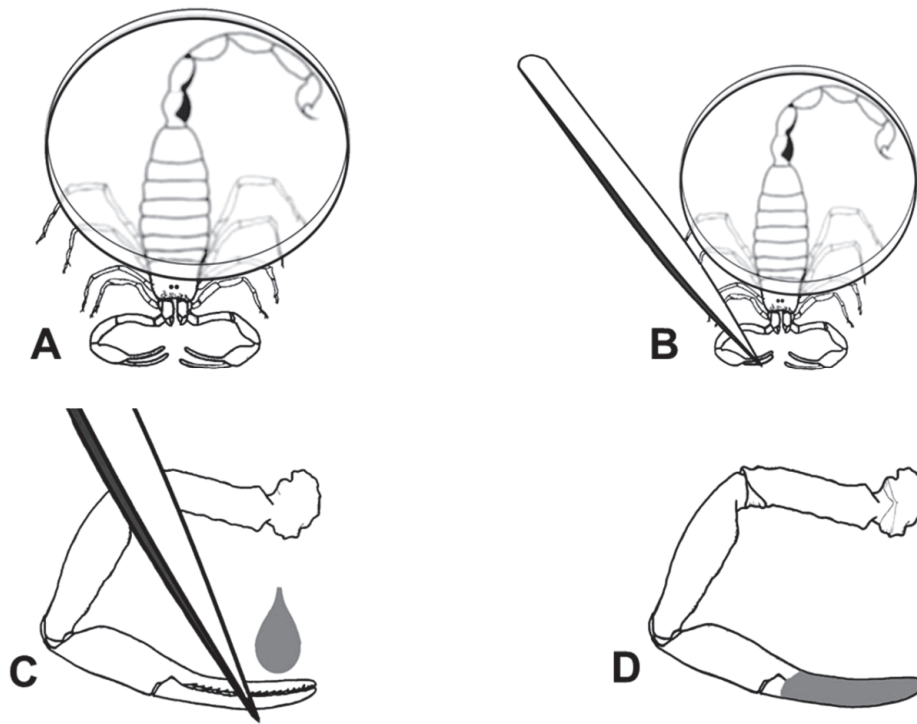


Figure 2. Methodological procedure. (A) Scorpion was immobilized by the researcher (mesosoma and metasoma immobilized), with the help of a Petri dish; (B) it was forced the closure of the tarsal pedipalp; (C) the wax dripped-that; (D) Completely immobilized the movement in this region.

Table I. Description of behavioral acts scorpion *T. serrulatus* (Scorpiones, Buthidae) in captivity for sampling all occurrences (*ad libitum sense*).

Foraging
Standing in alert position: the scorpion realizes the presence of prey, due its movements and directs to it.
Conduct: the scorpion performs fast movements (walk or run) to make physical contact with the prey.
Attack with pedipalps: attack the prey, using their palps. Scorpion tries to catch the prey.
Attack with chelicerae: attack the prey, seeking to hold it to slaughter it.
Nourishment: tear small tangible pieces of prey by using chelicerae and feed.
Immobility
Standing at rest: stand still alone with lowered telson.
Standing in attack position: stand still alone with raised telson.
Cleaning
Rub the forceps in chelicera: rub the forceps of pedipalps between chelicerae, cleaning them.
Rub the telson in chelicera: rub the telson between chelicerae by cleaning it.
Clean up with the second pair of legs: rub the second pair of legs in the previous-ventral and the side part of the body.
Environment exploration
Walking through the room: the specimen walks through the room paused and slowly (trying to climb in the enclosure wall was also considered walking through the room).
Interactions with conspecifics
Agonistic interactions among scorpions: the individual feels threatened by conspecific defending using telson.

Behavioral studies with scorpions (Bub & Bowerman, 1979; Yokota, 1984; Rein, 2003) indicate that just pedipalps are used to manipulate the prey. Currently there are two studies on the behavioral repertoire of *T. serrulatus* (Mineo *et al.*, 2003; Colombo & Alencar, 2014), but they do not account the influence of chela in behavioral diversity. Moreover, studies on natural history and animal behavior, including the native fauna of Brazil's arthropods, are key to the knowledge and conservation of tropical biodiversity (Colombo & Alencar (2014). Therefore, due to lack of behavioral studies on scorpions, I conducted this study aiming to quantify and qualify the influence of chela (to be blocked) in the behavioral reper-toire of *T. serrulatus*.

Material and Methods

The scorpions were collected in a remanescent of Atlantic forest in Santa Teresa, Brazil (Fig. 1). Sixteen adult females of *T. serrulatus* were used and divided into two terrariums (one control and one treatment) with a size of 15 cm X 30 cm X 30 cm, remaining in groups, as generally occurs in nature. All terrariums had sand serving as a substrate. The scorpions received ten cockroaches' adults (*Periplaneta americana* Linnaeus, 1758) every two days as food source. It was provided water in wet cotton in the terrariums during the entire period of the experiment. Temperatures ranged between 17° and 29° C and the humidity was not analyzed.

To annulate the use of chelae by the individuals, the chelae of pedipalps were blocked with paraffin aid. The

Table II. Ethogram scorpion *T. serrulatus* (Scorpiones, Buthidae) captive conditions (n = 2 samples, 50 hours of observation).

Behavioral Categories Behavioral acts	Samples	
	1 (Control)	2 (Chela blocked)
Foraging	9.67	3.85
<i>Standing in alert position</i>	–	–
<i>Conduct</i>	–	–
<i>Attack with pedipalps</i>	3.54	0.54
<i>Attack with the chelicerae</i>	–	3.31
<i>Nourishment</i>	6.13	–
Immobility	55.28	60.67
<i>Standing at rest</i>	29.50	32.27
<i>Standing in attack position</i>	25.78	28.40
Cleaning	14.18	13.45
<i>Rub the forceps in chelicera</i>	6.36	6.30
<i>Rub the telson in chelicera</i>	2.24	2.15
<i>Clean up with the second pair of legs</i>	5.58	5.00
Environment exploration	15.44	16.19
<i>Walking through the room</i>	15.44	16.19
Interactions with conspecifics	5.43	5.84
<i>Agonistic interactions among scorpions</i>	5.43	5.84
Total – 05 Behavioral Categories	100.00	100.00
<i>Total – 12 Behavioral acts</i>	100.00	100.00

blocking enabled tarsus (mobile finger) to move. To block the chela, the scorpion was previously immobilized by the researcher (mesosoma and metasoma immobilized), with the help of a Petri dish, then, with forceps, it was forced the closure of the tarsal pedipalp and them wax dripped-that, which upon drying, completely immobilized the movement in this region (Fig. 2).

The scorpions were observed daily for an hour in the night shift, totaling 50 hours of observation *ad libitum sense* (Del-Claro, 2002) from October to November 2012. The observations were made at 11:00pm to 00:00am) under ultraviolet light. The observation *ad libitum sense* was used by efficiency in recording behavior and because it has been previously used in literature.

Results

I observed 12 behavioral performances, both in the control and treatment groups, divided into five categories: foraging, immobility, cleaning, environment exploration, and interactions with conspecifics (Table I). The behavioral repertoire frequency (%) of each sample was quantified for control and treatment (Table II).

Discussion and Conclusion

The behavioral patterns of foraging were presented for both, the control and the treatment groups. It is noteworthy that the pedipalps are key to forage because they are used in handling the prey (Casper, 1985). This pattern was quantitatively affected in the treatment group, result of the blocking of pedipalps quela, and was recorded a new behavioral act, attacking by using the chelicerae. Bub & Bowerman (1979) observed scorpions using the pedipalps only to redirect prey. However, most fed without the aid of pedipalps. Therefore, I consider that the chelicerae may present a secondary function. They have great mobility, facilitating handling of prey during feeding. The chelicerae are chelated as pedipalps, exhibiting a similar function. It is noteworthy that in the control group foraging, individuals fed; however, in the treatment group this act was not observable because the scorpion could not grasp and handle prey.

Two new behavioral acts were also observed (standing in alert position and conduct) for foraging, but were not quantified, because they were performed timely and briefly. The foraging is the search for food. By minimizing the period of time required outside of the safety of the burrow, scorpions also minimize their exposure to predators, so it would be logical for scorpions to catch and consume prey as quickly as possible (Edmunds & Sibly, 2010). Therefore, scorpions showed a short foraging behavior compared to other behavioral actions. Comparing the behavioral repertoires of previous studies (Mineo *et al.*, 2003; Colombo & Alencar, 2014), my results differ by reporting immobility, which could be caused by the hunting tactic of this species, the "sit and wait" behavior.

The strategy sit and wait is recorded for many scorpions from desert (Stahnke, 1966; Hadley & Williams, 1968; Bub & Bowerman, 1979; Shachak & Brand, 1983).

In the cleaning performance, ordinary behavior were observed, such as rubbing the clamps on chelicerae, rubbing telson in chelicerae and cleaning with the second pair of legs. Importantly, within this standard, the act of rubbing the clamps on chelicera was increased considerably compared to the control group and to previous studies (Mineo *et al.*, 2003; Colombo & Alencar, 2014). I suggest that the cleaning behavior is tightly associated with foraging behavior. Once sensory organs are affected by the presence of dirt as prey bodily fluid, scorpions display a cleaning behavior to reduce or eliminate its influence on their sensory capabilities (Jiao & Zhu, 2010).

On interaction with conspecifics, scorpions are solitary animals, but limited micro-habitats can force them to tolerate other individuals (Brownell & Pollis, 2001). In previous studies (Mineo *et al.*, 2003; Colombo & Alencar, 2014) with *T. serrulatus*, the behavioral pattern of "interaction with conspecifics" was characterized by a single behavioral act, the "walk on others"; these studies however, were run with few individuals. They reported "agonistic interactions among scorpions" in which individuals defended themselves with telson when they felt threatened. Most studies of agonistic behavior have focused in spiders (Schmitt *et al.*, 1990; Faber & Baylis, 1993) and amblypygids (Weygoldt, 1969, 2000; Fowler-Finn & Hebets, 2006). Agonistic behavior is related to animals that

mate, such as whip spiders. *T. serrulatus* reproduces by parthenogenesis (Matthiesen, 1962; Lourenço, 2000). I consider that parthenogenetic scorpions only demonstrate the agonistic behavior for the defense. Another possible explanation for this behavior could be related to the stress of having clamps blocked. Scorpions with blocked chela became more aggressive than the ones with free chela, indicating the defense functions of the pedipalps (Meijden *et al.*, 2009). With the blocked chela, the only form of defense was the telson, justifying the increased frequency of this behavior in the treatment group.

Interaction with conspecifics is common in other arachnids, such as the harvestmen (Machado *et al.*, 2009) and even species of scorpions, for example, *Tityus fasciolatus* (Lourenço, 2002). Because this is a pioneer study for the group (individuals handling) is difficult to establish any detailed comparison with the results obtained here. Importantly, the scorpions of Buthidae, in which the *Tityus* is included, present high rate of adaptation, resulting on uneven ecological and biogeographic patterns in different locations (Secretaria de Vigilância em Saúde, 2009).

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