



## Courtship, copulation, and territorialistic behaviors of *Tropidurus torquatus* (Tropiduridae) in a fragment of Cerrado in Central-West Brazil

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**Resumo** - Este estudo observou e registrou comportamento de corte e cópula e o comportamento territorialista em *Tropidurus torquatus*. Os machos desta espécie usam uma exibição de balanço de cabeça ou “push-up”, que é o principal sinal de comunicação com outros machos. As fêmeas, por sua vez, erguem o rabo, comportamento de estímulo sexual específico que indica a aceitação da cópula. A corte acontecia com movimentos coordenados para machos e fêmeas e podia resultar em cópula eficaz; as fêmeas pareciam preferir machos dominantes durante o período reprodutivo. Os comportamentos territorialistas ocorreram antes e depois da corte, demonstrando os esforços dos machos dominantes de *T. torquatus* em manter seu território durante a estação reprodutiva.

**Palavras-chave:** Machos dominantes. Comunicação de lagartos. Balanço de cabeça. Período reprodutivo. Preferência sexual.

**Abstract** - This study observed and recorded courtship, copulation, and territorialistic behaviors in *Tropidurus torquatus*. Males of this species used a head bobbing or “push-up” display, which is the main communication sign with other males. Females, in turn, performed tail lifting, a specific sexual stimulus behavior indicating acceptance of copulation. Courtship took place with coordinated movements for both males and females and could result in effective copulation; females seemed to prefer dominant males during the reproductive period. Territorialistic behaviors occurred before and after courtship, demonstrating the efforts made by dominant males of *T. torquatus* to maintain their territory during the reproductive season.

**Keywords:** Dominant males. Lizard communication. “Push-up” display. Reproductive period. Sexual preference.



## Introduction

Communication is an important component of social interactions comprising a complex repertoire of specific signs that can be used to establish relations between organisms (RADDER *et al.*, 2006). Among vertebrates, species in the order Squamata display a wide array of visual, auditory, chemical, and tactile signs related to territory maintenance and mate selection (POUGH *et al.*, 2008). In lizards, social communication mostly takes place through discrete, predictive, and sequential motor patterns which are mainly centered on certain movements such as head bobbing or the “push-up” display (ORD; BLUMSTEIN, 2002). This type of movement is important because it allows rivals to compare their status from a distance (ZAHAVI, 1977), avoiding physical combat. But when direct combat cannot be avoided, movements like those are used to recognize the species and differentiate gender during courtship (POUGH *et al.*, 2008).

Lizards in the genus *Tropidurus* occur across much of Brazil, from the southern Amazon River in the Amazon biome to the Pampas in southern Brazil (RODRIGUES, 1987). The species *Tropidurus torquatus* (Wied, 1820) has a wide distribution in South America and prefers open landscapes (RODRIGUES, 1987; CARVALHO, 2013). This species has accentuated sexual dimorphism; males exhibit different coloration, body shape, and body length than females (PINTO *et al.*, 2005). They have a hierarchical social structure, with better territories defended by larger males (KOHLSDORF *et al.*, 2006). *T. torquatus* also exhibits a significant variation in reproductive strategies according to the biome where it is found (WIEDERHECKER *et al.*, 2002; VAN SLUYS *et al.*, 2010; SILVA *et al.*, 2016). Considering the importance of this species’ behavior for reproduction and maintenance of territory, this article describes the movements displayed during the courtship, copulation, and territorial behavior of *T. torquatus*.

## Materials and Methods

This study was performed on the campus of the Federal University of Mato Grosso (15°36’38.31” S, 56°03’57.48” W) in Cuiabá, Mato Grosso, Brazil. This campus has a total area of approximately 147,881.60 m<sup>2</sup> and is comprised of a small fragment of Cerrado in the urban region, cut on the southeast side by the Barbado Stream. The campus consists of several masonry buildings interspersed with areas shaded by trees or covered by herbaceous vegetation.

*Tropidurus torquatus* specimens were observed using the focal-animal method with a total of 38 hours of sample effort (9–11am or 3–5 pm, the times of day when individuals were most active). This time span covered at least two consecutive reproductive periods, according to the reproductive pattern recorded for this species in the Cerrado (WIEDERHECKER *et al.*, 2002; SILVA *et al.*, 2016, 2018). The observed movements were recorded in a field book or photographed when possible.



## Results

We observed a total of four mating and courtship events with successful copulation, while copulation was rejected in one courtship event. Territorial behavior was most frequent, involving sequences of motor and visual patterns.

In courtship, the dominant male approaches the female while pushing its head upward and maintaining its gular region distended. This movement of the head (*i.e.*, head bobbing or “push-up” display) and motor pattern stand out even more due to the conspicuous coloration of the male’s head during the reproductive season, with greenish lip scales and a completely dark gular region. The female is more discreet, with slightly greenish lip scales and some motor movements of the head and limbs.

During courtship, the female moves towards the male in a submissive position with the dorsal region slightly curved towards him and the tail pointed up, possibly signaling that copulation may be effective. At this point, the male may remain in a territorial defense posture, sometimes signaling with his head to keep away other opportunistic males, or he may attempt copulation. The females demonstrated selective interaction with dominant males (larger body lengths) in all the courtship and copulation events observed in this study.

During the one courtship event in which copulation was rejected, a young male performed the motor movements towards a female, but she did not present the accepted posture for copulation. In this case, the female moved her tail horizontally (tail waving) and exhibited an agonistic response to the male; this same female was later observed moving towards another larger male. During the reproductive period, dominant males were seen to be accompanied by more than one female in courtship and/or copulation; but, outside of this period, younger, smaller individuals predominated.

In defending territory, the observed movements varied from head bobbing and distension of the gular region to direct pursuit; when signaling did not keep other males away, direct intraspecific or interspecific combat was observed. The interspecific event observed was between *T. torquatus* and a specimen of *Hemidactylus mabouia* (Gekkonidae); this agonistic encounter consisted of several head movements, approach, and biting by the male *T. torquatus*, which proved to be more aggressive than his opponent.

## Discussion

Studies on *Tropidurus* species have shown that body posture, head movement, and coloring are important to reproduction as well as defense of territory (VAN SLUYS 1993, 2000; ROCHA *et al.*, 2009; RIBEIRO *et al.*, 2010) and comprise most of their behavioral repertoire. In our observation of *T. torquatus* we documented behaviors associated with courtship, copulation, and territorialism, and defending territory was most frequent. Courtship and copulation behavior were restricted to the reproductive period, when dominant males are more active and exposed; this change in male activity and exposure may be related to a greater presence of females, as observed by Baeckens *et al.* (2016).

Sexual dimorphism is evident in *T. torquatus* in differences in body size and color (PINTO *et al.*, 2005). We noted that during the reproductive period, dominant males differed in



color and size from the females and used these attributes in combination with body movements for visual communication. Males of *T. torquatus* also use ventral staining to establish communication regarding sexual identification and social hierarchy (PINTO *et al.*, 2005). The distinctive color patterns in males and females (sexual dichromatism) have also been observed in other lizard species where sexual selection significantly influences male signaling (I-PING *et al.*, 2012).

Body movements, such as head bobbing and “push-up” displays followed by distention of the gular region, constitute a complex form of visual communication in lizards, predominantly in males (RADDER *et al.*, 2006). Tail lifting, however, occurs exclusively in females, as reported in *Psammophilus dorsalis* (RADDER *et al.*, 2006). This same distinctive behavior was observed in this study in specimens of *T. torquatus*.

Studies have also demonstrated the importance of the tail in communication during courtship (FITCH, 2003) and defending territory (SMITH, 1992; MARIAPPAN; BALASUNDARAM, 2003). In social communication, males and females use their tails to defend burrows and ideal environments for thermoregulation, or even to establish hierarchy with co-specific juveniles (*e.g.*, PETERS *et al.*, 2016). For *T. torquatus*, tail lifting seems to be exclusive to females, a fact also observed by Raider *et al.* (2006), although these same authors also observed that tail-raising in females was not specifically related to sexual behavior. In *T. torquatus*, we observed that tail lifting in females was linked to specifically sexual stimulus, indicating acceptance of copulation, and this has also been documented in the co-genus *T. hispidus* (LIMA *et al.*, 2017). Additionally, we observed one female wave her tale in the presence of a co-specific male of shorter body length, which was interpreted as a variation of tail lifting in refusing to copulate.

Females show a preference for larger males during the reproductive season, as reported in several studies with the genus *Tropidurus* (*e.g.*, VAN SLUYS, 1997; KOHLSDORF *et al.*, 2006; RIBEIRO *et al.*, 2010). This result contrasts with work by Olsson (2001), who described females of the species *Ctenophorus fordias* copulating without selection of males, with rejection only occurring outside the reproductive period. One possible explanation for the behavior observed in *T. torquatus* is that because dominant males defend well-defined territories, it would be difficult for young males to access females in these regions (*e.g.*, co-genus *T. itambere*; VAN SLUYS, 1993). These young males consequently occupy adjacent territories and can only expand them when dominant males are absent, so they have a greater possibility of accessing the females. This strategy is characteristic of species with short life cycles, such as *T. torquatus* (WIEDERHECKER *et al.*, 2003; KOHLSDORF *et al.*, 2006).

It should also be mentioned that in polygenic and territorial species such as *Tropidurus* (WIEDERHECKER *et al.*, 2003; RIBEIRO *et al.*, 2009), males can increase their yield by mating with as many females as possible and expanding their living area during the reproductive season. This was also observed in this study, with male individuals of *T. torquatus* defending territory with more than one female during the reproductive season, and this pattern has already been described for *T. itambere* (VAN SLUYS, 2000) and the co-genus *T. oreadicus* in the Cerrado (MEIRA *et al.*, 2007).

In conclusion, we observed that *T. torquatus* exhibited a set of motor and visual movements related to courtship, copulation, and defending territory. Most motor and visual movements were



performed by dominant males; females also used some body postures, with tail lifting signaling willingness to copulate. Territorial behavior was also seen to occur before and after courtship behavior, showing the great effort dominant males of *T. torquatus* put into maintaining their territories during the reproductive season.

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### **Conflict of interest**

The authors did not declare that the work has a conflict of interest.



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