Uma publicação da Sociedade Brasileira de Herpetologia

VOL. 15
SEÇÃO NUM. 03
História Natural e Conservação 2026

Forced copulation in *Tropidurus* aff. *itambere* RODRIGUES, 1987 in the Cerrado of the state of Mato Grosso, Brazil (SQUAMATA: TROPIDURIDAE)

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Editor de Área: Rodrigo Castellari Gonzalez
Submetido em 04/05/2026
Aceito em 18/07/2026

Resumo

Relatamos o primeiro registro aparente de cópula forçada em *Tropidurus* aff. *itambere* no Cerrado de Mato Grosso, Brasil. Duas interações foram observadas em uma população de vida livre no Refúgio do Borá, município de Tesouro, Mato Grosso, Brasil em 9 de novembro de 2023 e 10 de outubro de 2024. No primeiro evento, o macho montou e copulou com a fêmea com sucesso, apesar da luta subsequente e das tentativas de fuga dela. No segundo evento, o macho tentou montar a fêmea, mas ela exibiu comportamento de rejeição e a cópula não ocorreu. Essas observações ampliam o repertório comportamental reprodutivo conhecido para o gênero *Tropidurus*.

Palavras-chave

Cerrado; comportamento; história natural; reprodução.

Abstract

We report the first apparent record of forced copulation in *Tropidurus* aff. *itambere* from the Cerrado of Mato Grosso, Brazil. Two interactions were observed in a free-living population at Refúgio do Borá, municipality of Tesouro, Mato Grosso, Brazil on 9th November 2023 and 10th October 2024. In the first event, the male successfully mounted and copulated with the female despite her struggle and attempts to escape. In the second event, the male attempted to mount the female, but she displayed rejection behaviour and copulation did not occur. These observations expand the known reproductive behavioural repertoire of the genus *Tropidurus*.

Keywords

Behaviour; Cerrado; natural history; reproduction.

Courtship displays are the behaviours exhibited by males during mate-searching and before copulation, and these displays vary widely among different lizard species (Vasconcelos et al., 2019). Behaviours such as these may serve functions beyond merely enhancing success in mate competition (Andersson, 1994). For example, they can reduce escape or aggressive responses from the female, synchronize reproductive endocrine functions, or coordinate the spatial and temporal behaviour of partners for copulation (Andersson, 1994). One of the functions of courtship is to allow the male to signal his good health and physical condition to potential mates (Andersson, 1994; Williams, 1966). If the male is successful, the female tends to remain passive or to move slowly without showing signs of resistance to him (Rodda, 1992).

In contrast, forced copulation is characterized by the female's struggle (including sudden, unusual, rapid, or high-amplitude movements) prevent the male from mounting her (Rodda, 1992). Records of forced copulation have been documented in at least seven lizard species, including *Micrablepharus maximiliani* (Reinhardt & Lütken, 1862), *Iguana iguana* (Linnaeus, 1758), *Conolophus subcristatus* (Gray, 1831), *Microlophus delanonis* (Baur, 1890), *Norops garmani* Stejneger, 1899, *Norops valencienni* Duméril & Bibron, 1837 and *Enyalius perditus* Jackson, 1978 (Trivers, 1976; Werner, 1978; Werner, 1982; Hicks & Trivers, 1983; Rodda, 1992; Lima & Sousa, 2006; Gogliath et al., 2010). Interestingly, except for *M. maximiliani*, all these species belong to Iguania, particularly to the clade Pleurodonta (Zheng and Wiens, 2016).

The family Tropiduridae, widely distributed throughout South America, occurs both east and west of the Andes, including the Galapagos Islands (Rodrigues, 1987; Frost, 1992; Carvalho, 2013). Species of *Tropidurus*, in particular, are abundant in various open formations throughout cis-Andean South America, ranging from Venezuela to Argentina (Rodrigues, 1987). In Brazil, *Tropidurus itambere* Rodrigues, 1987 inhabits Cerrado regions in the states of Minas Gerais, Goiás, Distrito Federal, Mato Grosso, Mato Grosso do Sul, and Tocantins, and is also found in open formations within the Atlantic Forest Domain in the states of São Paulo, Minas Gerais, and Paraná (Rodrigues, 1987; Carvalho, 2013; Guedes et al., 2023). Vasconcelos et al. (2019) described the complete behavioural repertoire (pre-, during, and post-copulation) of *T. hygomi* Reinhardt & Lütken, 1862. Pelegrin (2019) and Souza et al. (2024) also provided additional information on courtship behaviour within the genus *Tropidurus*, specifically for *T. spinulosus* and *T. imbituba*, respectively. In the present study, we report the first apparent record of forced copulation in *T.* aff. *itambere* (Domingos et al., 2017).

MATERIALS AND METHODS

The Refúgio do Borá, located in the municipality of Tesouro, Mato Grosso, Brazil, is a region of Cerrado sensu stricto, predominantly consisting of sparse Cerrado vegetation with multiple palm swamps (veredas) along the Borá stream and some gallery forest formations (Ribeiro & Walter, 1998). This region harbours an abundant population of *T.* aff. *itambere*, and the house where the observations were recorded is frequently visited by individuals of the species that are accustomed to human presence.

On 9th November 2023, at 16:12 h, during an expedition, we observed two individuals of *Tropidurus* aff. *itambere* engaging in sexual behaviour. The observation took place on the porch of a house (-16.106°; -53.821°) at the Refúgio do Borá. The supplementary video associated with this observation (Video S1) is available at Figshare (https://doi.org/10.6084/m9.figshare.32731653). The event was captured by using a smartphone, and during the observation, the observer kept a distance of approximately two metres away from the lizards.During a second expedition, on 10th October 2024, at 10:31 h, another apparent forced copulation attempt was observed at the same location and under the same conditions as the first one. The supplementary video associated with this observation (Video S2) is available at Figshare (https://doi.org/10.6084/m9.figshare.32732313). For the description of behaviours, we adopted the terminology outlined by Carpenter (1977). The individuals observed in both

events were not collected, therefore, no morphometric measurements were obtained. Relative size differences mentioned here are based on visual estimates from the videos and photographs. In the first event, the male appeared substantially more robust than the female, particularly in bulkiness, although not markedly longer in length.

RESULTS

During the first observation (Video S1), prior to the interaction, the female was approximately two metres away from the male's hideout, motionless, near a chair in the outside of the house, while the male remained hidden. No prior interaction was seen between them. Then, the male suddenly ran towards the female, biting her in the neck and performing rapid head-bob movements (approximately four bobs per second) (Fig. 1A). He then adjusted his bite, gripping the upper part of her neck, and repeated the head-bobbing movements twice, with a brief pause between sequences.

After the initial attempt, the male turned toward his observers, still holding the female with his mouth, and repeated the head-bobbing movements. He then dragged her for a short distance, moving in the opposite direction from the observers, paused, and performed two more head-bobs with a pause between them (Fig. 1B). This pattern continued, with the male briefly carrying the female and executing head-bobbing movements at each stop. During these displays, the female responded subtly and slowly, with head bobs significantly more discreet than those of the male.

Following the male's final head-bobbing movements, there was an 11-second pause, during which both individuals remained motionless, with the female occasionally performing subtle head bobs. The male then mounted the female, positioning her body between his forelimbs, arching his body, and executed lateral movements. He aligned his hemipenis with the female's cloaca, positioned his tail beneath hers and arched his body to the left, without releasing his bite on the female's neck. For 18 seconds, the male remained almost motionless, with small, rapid movements at the female cloaca's region. Immediately afterwards, he quickly and forcefully wrapped himself around the female, arching his body even further (Fig. 1C). After about nine seconds in this position, the female tried to move, but she was hampered by the male's weight and began making sudden sideways movements (Fig. 1D). She then managed to free herself, throwing the male backwards. However, because the male's hemipenis was still in her cloaca, she dragged him for a few centimetres until they finally separated. In the end, the male performed head bobs, remained motionless for a few seconds, and eventually moved away.

In the second event (Video S2), the female was lying on a porch, near the grass. The male, similarly to the first observation, emerged from his refuge and quickly charged at the female attempting to mount her. The female reacted immediately, struggling and moving away a few centimetres, adopting a posture of rejection by arching her body and raising her tail (Fig. 1E), as described by Carpenter (1977). After the female assumed this posture, the male made a few head-bob movements and interrupted his approach. Both remained motionless for about seven seconds, with the female maintaining her rejection posture. The male then tried to mount her again, but he was once more repelled by her (Fig. 1F). After this episode, he kept his distance and repeated the head-bobbing movements (about three to four bobs per second). Soon afterwards, the male charged once more, positioning himself behind her, which still maintained the rejection posture (Fig. 1G). A few seconds later, the male appeared to bite or slightly lick the female body near the cloacal region, to which she reacted with a small spasm. The male then moved away, while the female turned her tail towards him in a defensive posture. At the end of the interaction the male gave up. Although the male was leaving, the female still turned her back to him, then she relaxed and returned to her normal posture (Fig. 1H). The male moved back to the grass, but the female stood still for a few minutes, and then also returned to the grass, moving in the opposite direction from him.

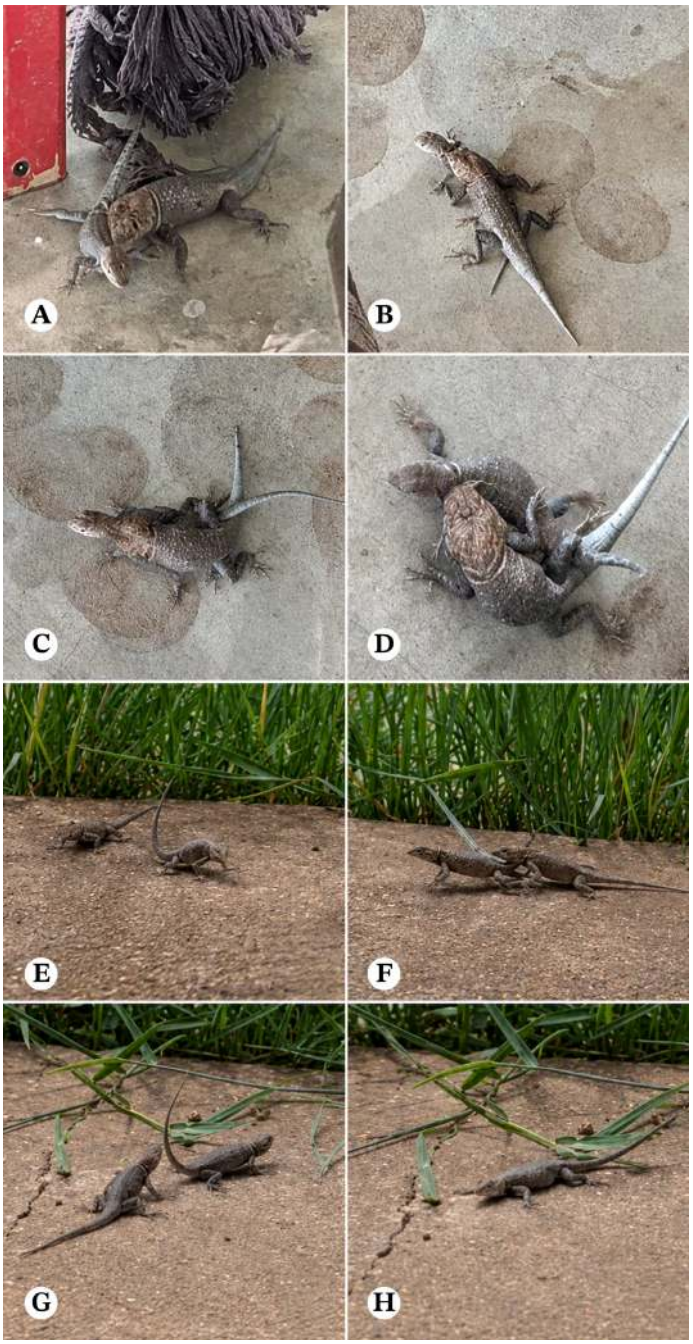


Figure 1. First records of apparent forced copulation in *Tropidurus* aff. *itambere*. The left panel shows the first recorded event: sudden approach of the male towards the female (A); male carries the female away (B); copulation occurs (C); female struggles with sudden lateral movements to escape from the male (D). The right panel shows the second event: male approaches and female displays rejection (E); male pursues fleeing female (F); female maintains rejection posture (G); male gives up, moving away, and female returns to resting position (H).

DISCUSSION

Previous studies have revealed the existence of multiple cryptic lineages under the current nominate species *Tropidurus itambere* (Domingos et al., 2017). The specimens observed in the Borá Refuge probably belong to lineages C or D identified by these authors. Considering that the type locality of *T. itambere* is Sorocaba, São Paulo, we classified the Tesouro population as *Tropidurus* aff. *itambere* (Rodrigues, 1987).

Courtship behaviours in the genus *Tropidurus* include approaches and head-bobbing displays by both males and females, as well as the male licking the the females at the beginning of the interaction (Pelegrin, 2019; Vasconcelos et al., 2019; Souza et al., 2024). These behaviours contrast with forced copulation events, widely reported in lizards (Trivers, 1976; Werner, 1978; Werner, 1982; Hicks & Trivers, 1983; Rodda, 1992; Lima & Sousa, 2006; Gogliath et al., 2010). Although forced copulation may be more difficult for smaller males when attempting to copulate with larger females, since larger females can drag and overpower them, as observed in *Micrablepharus maximiliani*, it can still occur (Trivers, 1976; Werner, 1978; Werner, 1982; Hicks & Trivers, 1983; Rodda, 1992; Lima & Sousa, 2006; Gogliath et al., 2010). In the case of *T.* aff. *itambere*, where males are generally larger than females, body-size differences may influence the success of apparent forced copulation, because larger males may physically control females during the interaction. During our stay at Refúgio do Borá, we observed that females often rejected males, moving away from them and raising their tails, as described by Carpenter (1977). Males of *Tropidurus* aff. *itambere* have also been recorded performing aggressive displays, such as “pushups” and “head-bobbing,” usually from elevated places, and chasing rival males out of their territories (Carpenter, 1977; Werner, 1978, 1982).

Notably, both records reported here were obtained in October and November, which fall within the reproductive season described for *Tropidurus itambere* (Van Sluys, 1993; Van Sluys, 2000; Ferreira et al., 2009).

Although these records are temporally consistent with the reproductive cycle known for the species, the frequency with which this behaviour occurs remains unknown. Werner (1978) documented that about a quarter of the copulations observed in *Microlophus delanonis* were forced, although the author emphasizes the difficulty in differentiating forced events from the voluntary ones. In other species, males may also invade foreign territories to capture females and take them to their own domain (Werner, 1982).

Based on the behavioural evidence observed, we interpret the recorded events as consistent with apparent forced copulation, mainly due to the absence of prior courtship interaction between the individuals and the females' attempts to escape (Rodda, 1992; Pelegrin, 2019; Vasconcelos et al., 2019; Souza et al., 2024). In the first observation (Video S1), a male, substantially larger than the female, was able to capture and move her, possibly towards the central portion of his territory, as reported in some other species of lizards (Werner, 1978; Werner, 1982). In the second observation (Video S2), the male, similar in size to the female, had greater difficulty in capturing her.

Although there are previous records of courtship and forced copulation in the genus *Tropidurus*, little is known about these interactions in *T. itambere*, a species that includes distinct lineages still in the process of formal description (Domingos et al., 2017). Because our report is based on only two observations, these records should be interpreted as an initial natural history contribution rather than a broad characterization of the mating behaviour of this lineage. Future studies and observations are needed to broaden the understanding of the mating behavioural repertoire in the genus.

ACKNOWLEDGMENTS

We thank José Rogério Salles and Álvaro Salles for allowing research expeditions on the Refúgio do Borá. We also thank Johnn Lennon Sarkis Fleiria, our friend and local guide at Refúgio do Borá, for kindly welcoming us and providing invaluable assistance during the field expeditions. His knowledge of the area and continuous support were essential, and these observations would not have been possible without his help.

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