

SHORT COMMUNICATION

## Reproductive behavior of *Tropidurus spinulosus* (Squamata: Tropiduridae) in captivity

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**Keywords:** courtship, multiple copulas, mating, reproduction.

**Palavras-chave:** acasalamento, corte, cópulas múltiplas, reprodução.

*Tropidurus spinulosus* (Cope, 1862) is a medium-sized lizard distributed in north-central Argentina, Paraguay, Bolivia, and Brazil (Carvalho 2013) that inhabits both rocky and forest habitats (Martori and Aúñ 1994, Cruz 1998). Although some facets of the lizard's natural history, such as diet, reproduction, activity, thermal ecology, and habitat use have been studied (e.g., Perez *et al.* 1991, Vitt 1991, Colli *et al.* 1992, Martori and Aúñ 1994, Cruz *et al.* 1997, Cruz 1998, López-Juri *et al.* 2017), little is known about the reproductive behavior of the species. The behaviors associated with courtship and mating in captivity, including information on copulation length, are described below.

Six individuals of *Tropidurus spinulosus* (3 males, SVL: 93.4, 112.7, and 112.0 mm; and 3

females, SVL: 95.2, 94.0, and 96.5 mm), were captured with nooses in rock outcrops in Flor Serrana, Córdoba, Argentina (31°23'31.28" S, 64°35'47.15" W) on 06 September 2009. The lizards were housed together in a 1.0 × 0.4 × 0.5 m (length × width × height) terrarium until 05 November 2009 when they were released at the collection site. Refuges and basking perches were provided with volcanic rocks and logs. They were fed *ad libitum* with crickets and mealworms, and water was provided daily. Two 80-W spotlight reflector light bulbs provided heat and light. Bulbs were connected to a 24-h programmable timer plug to mimic daily light cycles. Air temperature inside the terrarium was about 32°C when the lights were on. Each lizard was marked so that individuals could be identified during mating and courtship events; marks were applied with nail polish on the base of the tail (red for females and white for males). The lizards were observed from 9:00 to 19:00 h; when a reproductive behavior occurred, it was recorded with a Sony DSC-H1 digital camera

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Received 16 August 2018  
Accepted 08 January 2019  
Distributed June 2019

located in front of the terrarium front glass. Videos were analyzed using the program OpenShot for Linux.

In the 44 videos recorded, I observed five complete copulations and two other copulations interrupted by another male in one case and one by the female in another; in addition, two females rejected males attempting to mate. Copulation begins when the hemipenis is inserted into the female's cloaca and ends when hemipenis is extracted; the average duration of copulation is  $43.2 \pm 2.96$  s, ranging from 40–55 s.

The reproductive behavior of these lizards is summarized in a flow chart (Figure 1). Courtship begins with a male licking (i.e., tongue-flick) a female's flank. If receptive, she remains immobile; the male stands over her and biting the skin on the back of her neck. Sometimes, the male bites her flank a couple of times before standing over the female. After a few seconds, the male brings his tail under her tail and positions his hind leg across the female's back to bring the cloacas into contact. Then, one of the hemipenes is inserted into the female's cloaca. No movement occurs during copulation. The male releases the female's neck, dismounts her, and retracts his hemipenis to terminate copulation before leaving. If the female is not receptive, she turns her back to the male and whips her tail to dissuade the male, who eventually leaves. No post-mating behaviors were observed. Three clutches of six eggs were laid during the period of captivity.

Aggressive behavior among males was observed as the lizards established their position in the terrarium hierarchy; this included head bobs, push-ups, chasing, and biting. No agonistic behavior or social hierarchy were observed between females. The dominant male always was the first to mate, but after copulation, other males could engage with the female without having to fight the dominant male. All three males mated at least once.

One female escaped the terrarium and was found within 2 weeks. She seemed receptive but

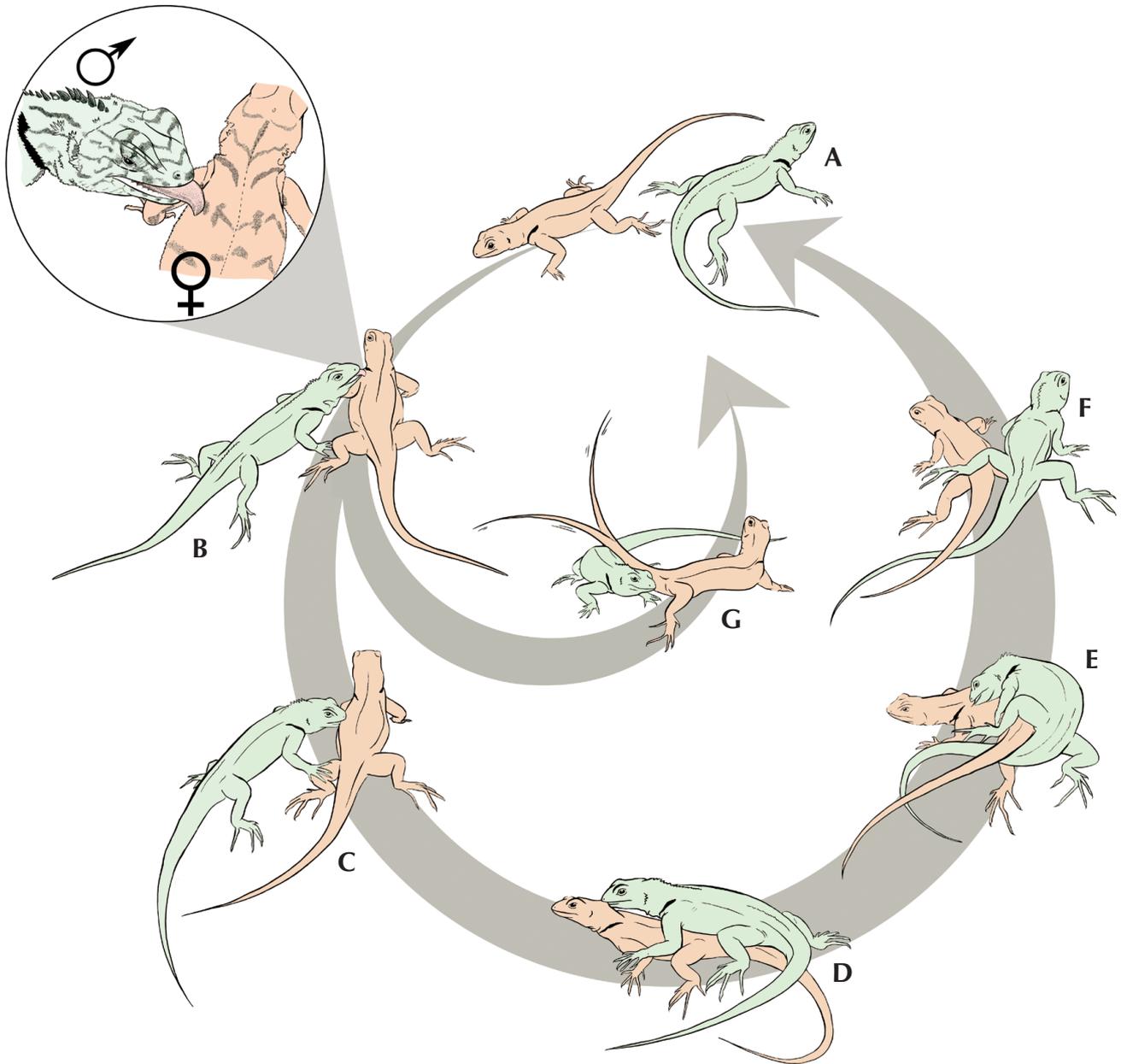
appeared to have lost weight. Males approached the female but left after licking her, despite the female's exhibiting the same behavior as other receptive females.

The observed reproductive behaviors resemble those described for other *Tropidurus* species (Carpenter 1977, Abdala and Ramirez-Pinilla 1990), and for iguanids in general (Noble and Bradley 1933, Carpenter 1967). However, to my knowledge, tongue flicking during courtship was not reported for any species of *Tropidurus*. Lizards use chemical cues to analyze their environment, mark territories, and discriminate prey. They probably also infer some characteristics from other lizards' chemical cues, and thus, scents may be involved in mate selection (Schwenk 1995, Martín and López 2015). Licking seems to be of major importance for mate selection in *T. spinulosus*, given that every courtship recorded began with this behavior. The rejection of the female in poor condition by a male supports the idea of chemical-based mate selection in this species.

I observed multiple mating with the same female in the terrarium. If this behavior occurs in nature, then the species may also be characterized by sperm competition. Sperm competition seems to be associated to prolonged copulations (e.g., Olsson and Madsen 1998). Given that copulation was relatively short in *T. spinulosus*—when compared to that of lizards in general, ranging 0.05–66 min (Olsson and Madsen 1998)—further study is needed to address this supposition.

Observing copulation and reproductive behavior in natural conditions can be challenging. The basic data presented here may help other researchers in designing experiments and generating hypotheses to be tested in the field and laboratory.

*Acknowledgments.*—I would like to thank J. Nori for his help in collecting the specimens used in this work and M. Sosa for his splendid illustrations of behaviors in Figure 1. 



**Figure 1.** Flow chart showing behaviors associated with courtship and mating in *Tropidurus spinulosus* kept in captivity. Images represent lizard postures for main behaviors, as follow: the sequence begins with two non-interacting individuals (A). A male approaches a female and licks her flank (B, and detailed inset picture). If receptive, the female is immobile and the male bites her in the flank (C). Then the male stands over her while biting the back skin of her neck (D). After a few seconds, the male brings his tail under her tail, positioning a hind leg across her back, and bringing the cloacas into contact. One of the hemipenes is then inserted into the female's cloaca (E). When copulation finishes, the male releases the neck of the female, moves off her back, retracts the hemipenis (F), and leaves (A). If not receptive, the female turns her back to the male, and whips her tail to dissuade the male (G), which eventually leaves.

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Editor: Carlos I. Piña