

Novel behavioral observations of the lizard *Tropidurus hispidus* (Squamata: Tropiduridae) in Northeastern Brazil

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ABSTRACT

In this study, we report additional cannibalism and predation events in *Tropidurus hispidus* and, by reviewing our data with that found in the literature, we quantify the relative importance of vertebrate categories as prey for *T. hispidus*. In addition, we provide an ethogram for events related to territoriality, courting and copulation.

Key Words: Copulation; Diet; Ecology; Natural history; Territoriality.

Studies that highlight issues related to diet, habitat use and reproduction are essential for understanding general patterns and processes of populations and help to define conservation strategies based on the knowledge of species (Sawaya *et al.*, 2008). This information can be obtained through observations in the natural environment (Sawaya *et al.*, 2008; Vasconcelos *et al.*, 2019), as well as in the laboratory (Coelho *et al.*, 2018; Pelegrin, 2019).

Tropidurus hispidus (Spix, 1825) (Tropiduridae) is a medium-sized lizard, considered to be the largest species in the genus, with a wide distribution throughout South America in countries like Venezuela (incl. Cojedes), Isla Margarita, Suriname,

French Guiana and Brazil (Ávila-Pires, 1995; Uetz *et al.*, 2020). In Brazil, it is an abundant and generalist species related to use of habitat occurring in different microhabitats in the Caatinga biome being observed mainly on rocks, tree trunks and walls (Rodrigues, 1987; 1988; Ávila-Pires, 1995; Carvalho, 2013). This is a heliophilic and insectivorous lizard (Vitt *et al.*, 1996) that adopts a sit-and-wait foraging strategy (Schoener, 1971) and exhibits territorial behaviors (Ribeiro *et al.*, 2012).

This species has been the subject of several studies, that have addressed aspects of its ecology and natural history (Rodrigues, 1988; Vitt *et al.*, 1996; Teixeira and Giovanelli, 1999; Kolodiuk *et*

al., 2009; Kolodiuk *et al.*, 2010; Ribeiro *et al.*, 2010; Ribeiro and Freire, 2011; Santana *et al.*, 2011; Santana *et al.*, 2014; Gomes *et al.*, 2015; Lima *et al.*, 2017; Melo *et al.*, 2017; Albuquerque *et al.*, 2018), cytogenetics (Kasahara *et al.*, 1987; Frost *et al.*, 2001; Matos *et al.*, 2016) and parasitism (Almeida *et al.*, 2008; Delfino *et al.*, 2011; Brito *et al.*, 2014), although relatively well studied, there are still many aspects of the natural history of this species that remain unknown, especially behavioral aspects related to territoriality, reproduction and predation on vertebrates. Diet-related data can be easily obtained in the laboratory, however, information on behavioral traits is more difficult to observe in captivity, as even in natural environments aggressive encounters and predation events are rarely reported (Passos *et al.*, 2016). In this study, we report novel records of cannibalism and predation in *T. hispidus*, and by incorporating our data with previous literature; we estimate the importance of each category of vertebrate registered as prey of *T. hispidus*. We also present new observations of territoriality, courtship and copulation displays of this lizard. Finally, we provide an ethogram for events related to territoriality, courtship and copulation.

Most of the events ($n=10$) were recorded on a private property, in a rural area, named Sítio Fechado (-7.299166667 S; -37.29777778 W; WSG84; 737 m.a.s.l.; Garmin GPSMAP 64s), an area of Caatinga located in the municipality of Brejinho, state of Pernambuco, Northeastern Brazil. One of the cannibalism events was recorded in an urban area (-7.206388889 S, -36.82361111 W; WSG84; 532 m.a.s.l.; Garmin GPSMAP 64s), in the municipality of Taperoá, in the state of Paraíba, Northeastern Brazil. Two other predation events were also recorded on private properties in Caatinga areas, both in rural areas, one of them named Sítio Clarinha (-7.378333333 S, -37.19027778 W; WSG84; 637 m.a.s.l.; Garmin GPSMAP 64s) and another Sítio Goiana (-7.375555556 S, -37.20638889 W; WSG84; 647 m.a.s.l.; Garmin GPSMAP 64s), both located in the municipality of Itapetim, state of Pernambuco, Northeastern Brazil.

All observations were occasional records and the individuals were not collected. However, all events were photographed, and the images are used here to illustrate the behaviors. Since our study is only descriptive, without the aim of comparing classes of behaviors, individuals or species, we used the *Ad libitum* observation method (Altman, 1974),

that does not require systematic sampling, and where all of an individual's behaviors are recorded in an unlimited period of time.

To describe the *T. hispidus* diet, we performed a bibliographic search in the main online electronic libraries: Web of Science, JSTOR, Scielo, Scopus, Semantic Scholar and Google Scholar, using keywords: "*Tropidurus hispidus*" and a combination of "*Tropidurus hispidus*" and "diet" or "prey" or "sauropagy" or "anuran" or "frog" or "bird" or "mammal". Based on the number of registered events we quantified the relative importance of each category for prey (lizards, anurans, birds and mammals).

Diet

Cannibalism

The first cannibalism event was observed on December 31st, 2016, at 17:27 h, in Sítio Fechado, which lasted 4 min. A *T. hispidus* adult was on the cement wall with the head and tail of a juvenile protruding from its mouth (Fig. 1A). After 3 min, the adult lizard shook its head and completed the ingestion of its prey. The second event of cannibalism was observed on June 11st, 2020, at 14:07 h, in an urban area, lasting 1 min and 15 sec. A *T. hispidus* juvenile climbed onto a rock and soon after was captured by a conspecific adult (Fig. 1B). Then the adult lizard escaped with its prey in its mouth and was no longer visible to record further observations.

Predation

The first predation event occurred on April 30th, 2016, at 10:29 h, in Sítio Clarinha, when a *T. hispidus* adult male was observed trying to prey on a small adult rodent (*Mus musculus*). Both individuals were on the ground close to a house, and the mammal was subjugated by the lizard. The lizard moved across on the ground (~100 cm) keeping the mammal inside its mouth, holding it by the head. Then, the predator stopped for 1 min, so the mammal tried to escape and, quickly, the lizard moved the head in direction to the ground, pressing the prey to immobilize it. The lizard kept still for 10 min, and then, climbed a residence wall and stopped again at 130 cm from the floor for 40 sec still holding the mammal by the head in its mouth (Fig. 1C). At this moment, the lizard noticed the presence of the observer and directed its head to the ground, lifted the tail and bobbed its head four times. Subsequently, the lizard climbed onto the roof of the residence, and it was no longer possible to follow the interaction. The whole event lasted 15 min.

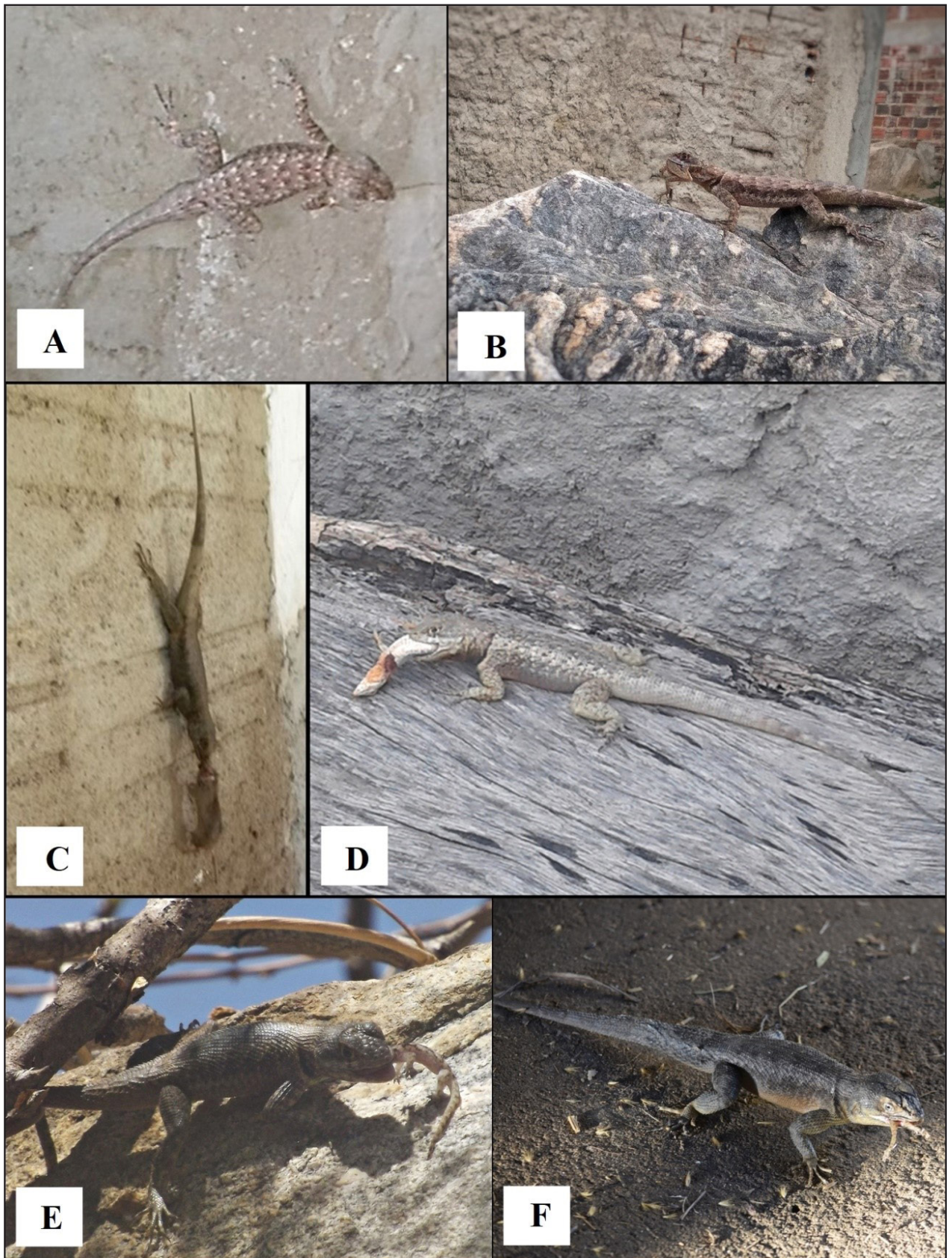


Figure 1. Behavioral events related to the diet of *Tropidurus hispidus*, in Sítio Fechado, Pernambuco, Brazil: A–B- cannibalism; C- predation on *Mus musculus*; D- predation on *Ameivula ocellifera*; E- predation on *Phyllopezus pollicaris*; F- predation on *Scinax x-signatus*

The second predation event was recorded on October 17th, 2017, at 14:22 h, in Sítio Fechado, lasting 30 min. A *T. hispidus* adult was under a tree with a *Ameivula ocellifera* individual in its mouth, having already ingested the tail and part of the limbs. The presence of the observer caused the lizard to move 150 cm, climbed on a trunk and remained still (Fig. 1D), just bobbing its head for 10 min. Later, it moved another 100 cm and climbed onto the wall of a residence, reaching the roof. The individual moved another 75 cm climbing onto the tiles with the prey in its mouth; it then stopped moving and completed the ingestion of the prey in 4 min.

The third predation event occurred on December 29th, 2018, at 11:48 h, in Sítio Goiana, lasting 50 sec. A *T. hispidus* adult was seen chasing a juvenile of the lizard *Phyllopezus pollicaris*, capturing the prey after 5 sec. Soon after, it started eating its prey starting from the head (Fig. 1E) and completing the process in 40 sec.

The fourth predation event was recorded on July 3rd, 2020, at 16:44h, in Sítio Fechado, when a *T. hispidus* adult stood on the wall of a residence and spotted the prey. It quickly reached the ground and captured a tree frog (*Scinax x-signatus*), with only the hindlimbs hanging out of its mouth (Fig. 1F). After 2 min it completed the ingestion of the prey.

According to the literature, invertebrates are the main food items of *T. hispidus* in different biomes (Vitt *et al.*, 1996; Van Sluys *et al.*, 2004; Kolodiuk *et al.*, 2010; Ribeiro and Freire, 2011). Therefore, observations of this species preying on other vertebrates continue to be uncommon. However, the fact that *T. hispidus* preys on vertebrates is not surprising in view of its medium size (68–114 mm; Kolodiuk *et al.*, 2010) and its sit-and-wait foraging strategy which makes the species more opportunistic and less selective (Vitt *et al.*, 1996; Ribeiro and Freire, 2011).

Our records corroborate data already cited in the literature for *T. hispidus* feeding on the amputated tail of a conspecific (Sales *et al.*, 2011), and body parts of a *T. hispidus* juvenile in the stomach contents of an adult (Carneiro *et al.*, 2020). Predation of the lizard *A. ocellifera* has also been reported in the literature (Costa *et al.*, 2010; Zanchi *et al.*, 2012), as well as predation of the lizard *P. pollicaris* (Dubeux *et al.*, 2020), the tree frog *S. x-signatus* (Ribeiro and Freire, 2009; Mendes, 2017), as well as the deadly-fresh rodent *M. musculus* (Virginio *et al.*, 2017).

T. hispidus is a sit-and-wait predator (Rodrigues, 1987), consuming a wide range of prey, including insects, plant parts and small vertebrates (Table 1), which suggests that this species is opportunistic in the trophic aspect. Furthermore, it is also known

Table 1. List of vertebrate prey species reported for *Tropidurus hispidus* in Brazil. * = field record.

Prey categories	Species	Source
ANURANS		
<i>Microhylidae</i>	<i>Elachistocleis ovalis</i> (Schneider, 1799)	Vitt <i>et al.</i> , 1996
<i>Hylidae</i>	<i>Scinax x-signatus</i> (Spix, 1824)	Ribeiro and Freire, 2009; Mendes, 2017*; This study*
BIRDS		
<i>Rhynchocyclidae</i>	<i>Todirostrum cinereum</i> (Linnaeus, 1766)	Guedes <i>et al.</i> , 2017*
<i>Trochilidae</i>	<i>Eupetomena macroura</i> (Gmelin, 1788)	Guedes <i>et al.</i> , 2017*
	<i>Chlorostilbon lucidus</i> (Shaw, 1812)	Fernandes <i>et al.</i> , 2020*
LIZARDS		
<i>Gymnophthalmidae</i>	<i>Colobosaura modesta</i> (Reinhardt and Lutken, 1862)	Costa <i>et al.</i> , 2010
	<i>Vanzosaura multiscutata</i> (Amaral, 1933)	Oliveira <i>et al.</i> , 2020
<i>Tropiduridae</i>	<i>Tropidurus</i> sp. (tail*)	Van Sluys <i>et al.</i> , 2004
	<i>Tropidurus hispidus</i> (Spix, 1825)	Sales <i>et al.</i> , 2011*; Carneiro <i>et al.</i> , 2020; This study*
	<i>Tropidurus jaguaribanus</i> (Passos <i>et al.</i> , 2011)	Passos <i>et al.</i> , 2016*
<i>Gekkonidae</i>	<i>Hemidactylus mabouia</i> (Moreau de Jonès, 1818)	Silva <i>et al.</i> , 2012*; Pagel <i>et al.</i> , 2020*
<i>Teiidae</i>	<i>Ameiva ameiva</i> (Linnaeus, 1758)	Rodrigues <i>et al.</i> , 2015*
	<i>Ameivula ocellifera</i> (Spix, 1825)	Costa <i>et al.</i> , 2010; Zanchi <i>et al.</i> , 2012*; This study*
<i>Phyllodactylidae</i>	<i>Gymnodactylus geckoides</i> (Spix, 1825)	Pergentino <i>et al.</i> , 2017*
	<i>Phyllopezus pollicaris</i> (Spix, 1825)	Dubeux <i>et al.</i> , 2020*; This study*
<i>Dactyloidae</i>	<i>Norops auratus</i> (Daudin, 1802)	Costa-Campos and Souza, 2013
MAMMALS		
<i>Muridae</i>	<i>Mus musculus</i> (Linnaeus, 1758)	Virginio <i>et al.</i> , 2017* This study*

Table 2. List of predator species reported for *Tropidurus hispidus* in Brazil.

Predator categories	Species	Source
ANURANS		
<i>Leptodactylidae</i>	<i>Leptodactylus troglodytes</i> (A. Lutz, 1926)	Alcantara <i>et al.</i> , 2014
BIRDS		
<i>Cathartidae</i>	<i>Cathartes burrovianus</i> (Cassin, 1845)	Aragão <i>et al.</i> , 2020
<i>Accipitridae</i>	<i>Rupornis magnirostris</i> (Gmelin, 1788)	De-Carvalho <i>et al.</i> , 2011
SNAKES		
<i>Dipsadidae</i>	<i>Oxyrhopus trigeminus</i> (Duméril <i>et al.</i> , 1854)	Alencar <i>et al.</i> , 2012; Mikalauskas <i>et al.</i> , 2017
	<i>Philodryas nattereri</i> (Steindachner, 1870)	Vitt and Vangilder, 1983; Mesquita <i>et al.</i> , 2011; Menezes <i>et al.</i> , 2013
<i>Colubridae</i>	<i>Boiruna sertaneja</i> (Zaher, 1996)	Vitt and Vangilder, 1983
	<i>Siphlophis leucocephalus</i> (Gunther, 1863)	Maia-Carneiro <i>et al.</i> , 2016
	<i>Oxybelis aeneus</i> (Wagler, 1824)	Mesquita <i>et al.</i> , 2012; Sousa <i>et al.</i> , 2020; Santana and Teixeira, 2020
<i>Viperidae</i>	<i>Crotalus durissus ruruima</i> (Hoge, 1965)	Farias and Primeiro, 2020
LIZARDS		
<i>Teiidae</i>	<i>Salvator merianae</i> (Duméril and Bibron, 1839)	Silva <i>et al.</i> , 2013
	<i>Ameivula ocellifera</i> (Spix, 1825)	Tavares <i>et al.</i> , 2017
<i>Tropiduridae</i>	<i>Tropidurus hispidus</i> (Spix, 1825)	Sales <i>et al.</i> , 2011; Carneiro <i>et al.</i> , 2020; This study*
SPIDERS		
<i>Theraphosidae</i>	<i>Lasiodora klugi</i> (C.L. Koch, 1841)	Vieira <i>et al.</i> , 2012
MAMMALS		
<i>Callithrichidae</i>	<i>Callithrix jacchus</i> (Linnaeus, 1758)	Melo <i>et al.</i> , 2018

to be a species consumed by a variety of animal species (Table 2), making this species a significant link in the food chain of its habitat.

Among the categories of vertebrates recorded as prey of *T. hispidus* in the literature and in the present study, lizards are the most frequent item, followed by birds, anurans and mammals (Fig. 2). The lizard species mentioned as prey of *T. hispidus* are abundant, demonstrate diurnal activity and have saxicolous habits, a combination of factors that make them more available in relation to other groups of vertebrates. The only vertebrates found in the diet of the congener *Tropidurus torquatus*, in Restinga environments (Siqueira *et al.*, 2013), were lizards and anurans, with the former being the most frequent category, which may indicate a possible preference for eating lizards or that this is a more accessible item according to the time of year.

Territoriality

Territorial behavior was observed twice (n=2), in Sítio Fechado. The first observation occurred on October 31st, 2018, at 10:28 h, between two *T. hispidus* males, and consisted of a physical confrontation under a tree, which presented a crack on its trunk that sheltered a couple of this species. The resident male, visibly larger, performed head bobbing movements

and then attacked the other male (invader), who entered his territory and approached the tree. The fight took place with an altercation between bites on the mouth (Fig. 3A) and head (Fig. 3B), with staring (direct eye contact) and head bobbing movements, in addition to 360° circular movements on the body's own axis (Fig. 3C). This interaction was completed after 1 min and 23 sec, when the invader ran away.

The second observation of territorial behavior occurred on December 12th, 2018, at 11:12 h, lasting 2 min and 03 sec. Two males, apparently of the same size, were observed in a confrontation, in which one male bit the mouth of the other (Fig. 3D). The

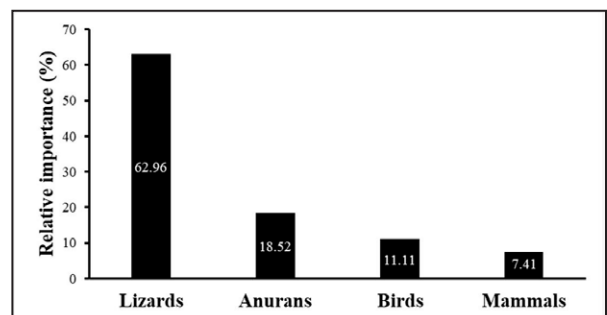


Figure 2. Relative frequency of the vertebrate prey categories that make up the diet of *T. hispidus* in Brazil. * = field record.

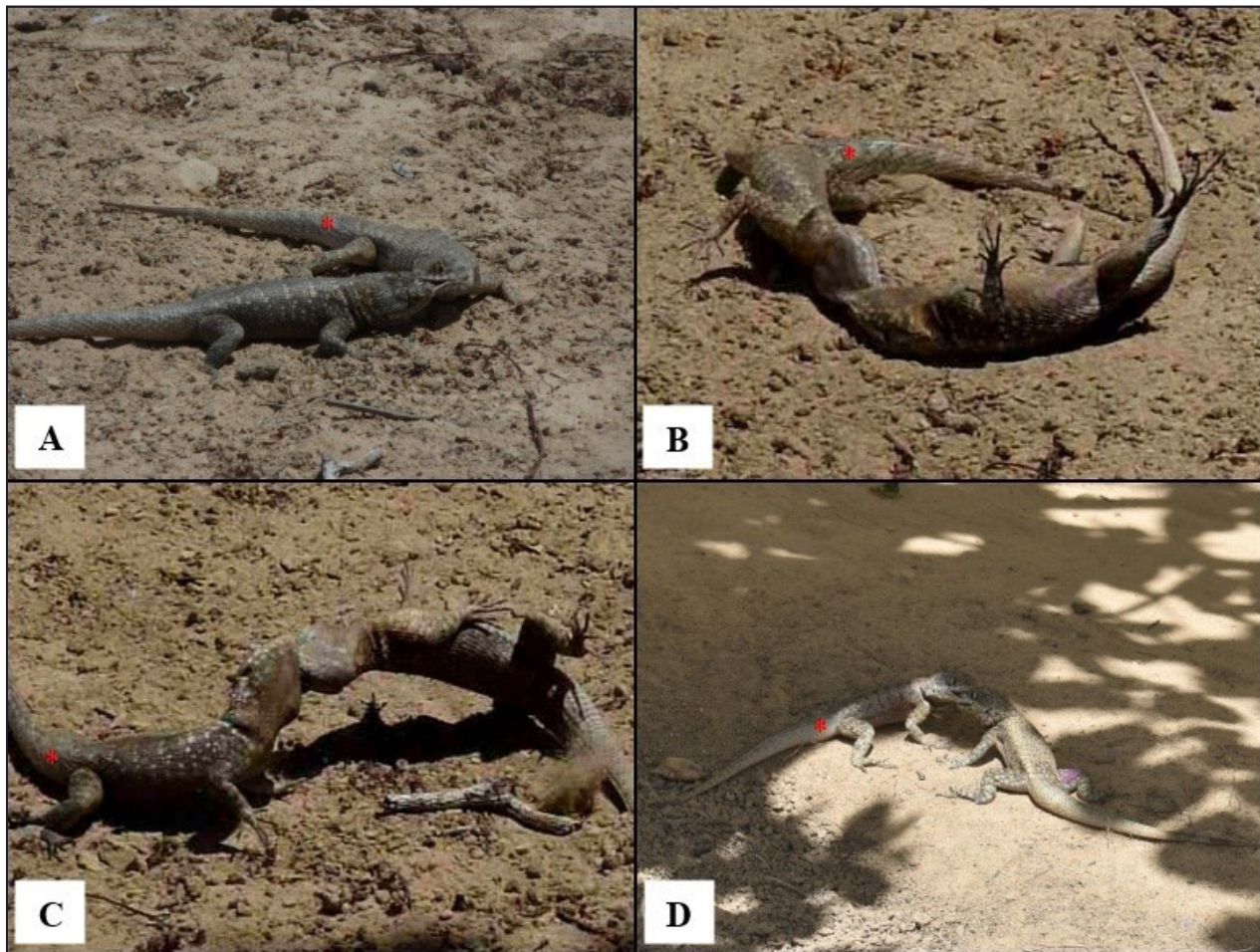


Figure 3. Behavioral events related to territoriality in males of *Tropidurus hispidus*, in Sítio Fechado, Pernambuco, Brazil: A- mouth bites; B- head bites; C- 360° circular movements on the body's own axis; D- male biting the mouth of another. Red asterisk = resident male.

presence of the observer caused the lizards to escape in different directions.

Territoriality in lizards may be related to ecological factors, such as the availability of food resources, female defense, breeding sites and/or thermoregulation sites (Ferguson *et al.*, 1983). Lizards such as *T. hispidus* present evident territorial behavior, with aggressive and confrontational modes. These aggressive behaviors performed by males involve chases and bites and are observed, mainly, when an invader male approaches the female or simply when a male enters the territory of others (Carpenter, 1977). Records in the literature corroborate what was recorded here for *T. hispidus*, indicating that territoriality is a striking characteristic of this species, consisting in behaviors with aggressive displays, chases and bites (Carpenter, 1977; Pinto, 1999). However, the combination of biting, holding and the performance of 360° circular movements has not yet been reported.

Courtship and copulation

The courtship and copulation behaviors were observed five ($n=5$) times, in Sítio Fechado. The first observation was on January 15th, 2019, at 12:09 h, where a *T. hispidus* couple was on stony soil, when the male was observed biting the female's neck (Fig. 4A) and, after 38 sec, it shook its head up and down, bobbed its head and positioned his whole body on the female. Subsequently, the male held his hindlimbs to the pelvic region of the female immobilizing her for copulation, which lasted 25 sec (Fig. 4B). Finally, the male released the female and they separated, moving in opposite directions, with no post-copulation interaction, with this event lasting 3 min.

The second courtship and copulation events were observed on September 24th, 2019, at 11:50 h, with a total duration of 2 min 16 sec. A *T. hispidus* couple stood under the wall of a residence (Fig. 4C),



Figure 4. Courtship and copulation behavioral events in *Tropidurus hispidus*, in Sítio Fechado, Pernambuco, Brazil: first event: **A**- male biting female's neck; **B**- copulation; second event: **C**- male approaching female; **D**-copulation; third event: **E**- lifting tail female, male positioning the posterior limb under the pelvic region of the female and beginning of copulation; **F**- end of copulation and distancing to both; **G**- male bleeding to cloaca; **H**- male biting the female's neck with another lizard nearby, but with no interaction.

when the male bit the female near the pelvic region and, after 15 sec, bit her neck and both moved 45 cm. When they stopped, the male positioned its body on the female who raised her tail, bents its body and performed the copulation, lasting 21 sec (Fig. 4D). When the event finished, the female and male stayed close to each other (~10 cm) but with no interaction.

The third courtship and copulation event was observed on July 19th, 2020, at 14:45 h, when a male was biting a female's neck under compacted clay soil. After 46 sec, the female moved about 300 cm with the male on her back, stopped and, after 42 sec, the female lifted her tail and began copulation, which lasted 1 min (Fig. 4E). At the end of the copulation, the male stopped biting the female's neck and both began to drift away (Fig. 4F) bobbing their heads. The entire event lasted 2 min and 47 sec. When the female completely moved away, it was possible to notice the presence of blood coming out of the male's cloaca (Fig. 4G), who still stood for 6 min, doing bobbing its head.

The fourth courtship and copulation event was observed on July 30th, 2020, at 10:46 h, in which a male was biting a female's neck and there was another lizard (sex not determined) near (~20 cm) to the couple (Fig. 4H) but with no interaction. After 1 min 12 sec, the female lifted its tail, the male bent his body and began copulation, which lasted 13 sec. At the end of the copulation event, the male stopped biting the female's neck, the couple was close (~5 cm), both bobbing their heads. The entire event lasted 2 min and 10 sec.

On August 21st, 2020, at 15:08 h, there was a fifth event related to courtship and copulation with a total duration of 3 min and 18 sec. A male was biting a female's neck, so it moved about 400 cm with the male on her back, stopped and, after 23 sec, moved from side to side, then the male let go of the female's neck and continued on her back. Both performed head bobbing and the male licked the female's neck three times (Fig. 5A), she then moved another 80 cm and stopped, the male approached and also licked three times near the female's cloaca (Fig. 5B). After the licks, the male climbed again on the back of the female and bit her neck, tried to copulate, but the female came out and climbed onto the wall of a residence, soon after the male also left.

In the literature there are some studies that describe aspects related to the reproductive behavior of the *Tropidurus* genus. Carpenter (1977) reported that *T. hispidus*, *T. torquatus* and *T. occipitalis* females displayed the typical rejection posture of the Iguanidae female to the approaching or courting males. It has also been reported that *T. hispidus* and *T. torquatus* males present similar performances, however, with aggressive inclinations of the head, in contrast to the flexions with longer dewlap and accentuated lateral compression observed in *T. occipitalis* (Carpenter, 1977). Ávila and Cunha-Avellar (2006) observed in *Tropidurus etheridgei* that the female stood on four legs, arched her back and showed herself to the male while raising her tail. The male, in turn, bit the female's neck twice and the base of her tail once (Ávila and Cunha-Avellar 2006). Vaz-Nunes *et al.* (2008)

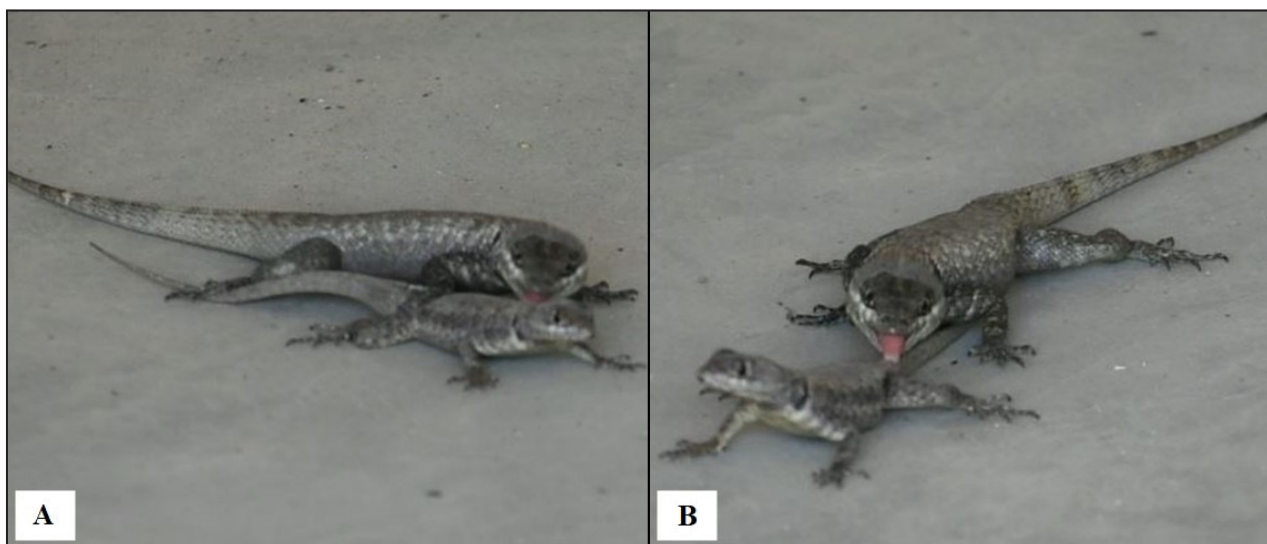


Figure 5. *Tropidurus hispidus* male licking the neck (A) and the cloaca of a female (B), in Sítio Fechado, Pernambuco, Brazil.

reported that in *Tropidurus itambere* the female stands on all four legs, arches the back and raises the tail up while the male approaches performing head movements with the inflated gular region. In addition, the male bit the female's neck and pushed her cloacal region with his nose (Vaz -Nunes *et al.* 2008).

Vasconcelos *et al.* (2013) and Vasconcelos *et al.* (2019) observed that in *Tropidurus hygomi* the male approached the female during locomotion, then the male stopped wagging his tail and shaking his head with its body positioned laterally towards the female. The female then lifted her body off the ground, keeping her limbs firm and lifted her tail, allowing the male to assume the copulation position. After separating from the female, the male moved slowly in circles around the female until she was gone (Vasconcelos *et al.*, 2013; Vasconcelos *et al.*, 2019). Pelegrin (2019) observed that in *Tropidurus spinulosus* the male approaches a female and licks her neck, if she is receptive, she remains immobile and the male bites her on the neck, then the male stays on top while biting the skin of her neck. After a few seconds, the male brings his tail under her tail, placing a hind leg on his back and putting the cloaca in contact. One of the hemipenis is then inserted into the female's cloaca and when the copulation ends, the male releases the female's neck, comes off her back, retracts the hemipenis and leaves. If the female is not receptive, she whips her tail to fend off the male who ends up going away. Comparing our records with what is in the literature, it is evident that most courting and copulation behaviors are common to species of the *Tropidurus* genus.

Displays during reproduction vary widely among lizard species, playing a key role in mating success, because in addition to being specific to each species, it also signals and informs the individual quality of males and females (Miles *et al.*, 2007). Before copulation, male tropidurids perform head bobs and bite females' necks during copulation (Carpenter, 1966; Lima *et al.*, 2017; Vasconcelos *et al.*, 2019). Neck licking behavior has been reported for *T. spinulosus* (Pelegrin, 2019) and cloaca licking behavior in *T. torquatus* (Scandelai, 2005). Licking behavior has been highlighted as a way of recognizing and selecting the appropriate reproductive partner (Schwenk, 1995; Martín and López, 2015; Pelegrin, 2019).

The consummation of copulation occurs when the hemipenis is inserted into the female's cloacae and closes at the time it is removed (Pelegrin, 2019).

The duration of this behavior varies in tropidurids. Here, copulation events lasted from 13 sec to 1 min, therefore, providing the longest recorded copulation time for this genus, compared to *T. spinulosus* (40 a 55 sec) (Pelegrin, 2019), *T. itambere* (Vaz-Nunes *et al.*, 2008) and *T. hygomi* (Vasconcelos *et al.*, 2019) (20 sec in both species).

The post-copula bleeding of the male in the third copulation event described here is not represented in literature, especially for the Tropiduridae family. However, this copulation event lasted for the longest amount of time (1 min), and this may have been the reason for the bleeding.

Ethogram

The ethogram or behavioral repertoire is a basic tool for better understanding the biology, ecology and behavior of an animal species, in captive or natural environmental conditions (Altman, 1974; Alcock, 1997; Del-Claro, 2004). This tool consists of a list of behaviors related to a category or several behavioral categories, and may encompass behaviors related to reproduction, rest, defense or locomotion, including behavioral acts and their descriptions (Grier, 1984; Yamamoto and Volpato, 2011). Considering that the events presented here can serve as the basis for future work involving the behavioral ecology of tropidurids, we developed two ethograms for behaviors related to territoriality (Table 3) and courtship and copulation (Table 4).

The observation of behavioral events in nature are fortuitous however, they can provide important information about the life history and trophic relationships of a species (Valdujo *et al.*, 2002; Hartmann *et al.*, 2003; Turci *et al.*, 2009; Guedes *et al.*, 2017). These records are important in confirming diet data obtained from stomach content analysis, as well as providing, in detail, the sequence of behavioral acts, and their duration. There is great difficulty in registering and/or trying to quantify these events in nature, since not all behaviors are common and these could have been easily affected by the presence of the observer. Visual records of these behaviors, although infrequent, provide a detailed view of behavioral acts and supply information about the use of environments, microhabitats, daily activities and feeding behavior (Teixeira and Giovanelli, 1999; Nogueira *et al.*, 2003; Hartmann *et al.*, 2005; Turci *et al.*, 2009).

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Table 3. Ethogram of the behaviors exhibited by *Tropidurus hispidus* during territoriality events in Sítio Fechado, Pernambuco, Brazil.

Behavior	Description
Warning displays	Lizards make direct eye contact while head bobbing. Head bobbing: fast vertical movements with head, carried out to ward off other males from their territory.
Confrontation	Bites on the mouth. Bites on the head. If the confrontation is long, in addition to the bites, the lizard rotates the body on its own axis (360 ° rotation movement) in a clockwise and counter-clockwise direction, causing the other to also rotate.
Flight	After the 360°circular movements one of the lizards (invader) manages to detach and quickly escapes from the other individual (resident).

Table 4. Ethogram of the behaviors exhibited for *Tropidurus hispidus* during courtship and copulation in Sítio Fechado, Pernambuco, Brazil.

Behavior	Description
Bite	The male holds the female biting the neck skin. The male immobilizes the female by placing the forelimbs and posterior limbs on it.
Lift the tail	The female raises the tail, allowing the male to insert the hemipenis into the cloacal opening, initiating copulation. The male releases the female's neck and then removes the hemipenis from her cloaca.
Neck's Licking	Vertical rapid movements with the head performed by males and females before and/or after copulation. The male licks the female's neck.
Cloaca's licking	The males lick the female's cloaca.
Drag the cloaca	The male moves with the cloacal region being pressed against the substrate, right after copulation.
Move away	The male and female slowly move away from each other bobbing their heads.

second cannibalism event. José Henrique thanks the residents of RVS Matas do Siriji for their great support. Juliana Delfino thanks the UFCG for the incentive with a research initiation grant (PIBIC 2019-2020).

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