Predation on the tiger rat snake *Spilotes pullatus* (Serpentes: Colubridae) by the southern black-eared opossum *Didelphis aurita* (Mammalia: Didelphimorphia), with a review of known predators

Anderson Lozorio Canal Filho[1*], Isabella Marçal Silva[2], Beatriz Medeiros Brandão[3], Iasmin Macedo[4], Thiago Silva-Soares[5]

1 Programa de Pós Graduação em Ciências de Floretas Tropicais, Instituto Nacional de Pesquisas da Amazônia, 69060-001 Manaus, AM, Brazil
2 Universidade Federal do Espírito Santo, 29500-000 Alegre, ES, Brazil
3 Rua Francisco Xavier 144, casa 4, Morro das Pedras, 88066-027 Florianópolis, SC, Brazil
4 Instituto Últimos Refúgios, Rua Amarílio Lunz 16, República, 29070-030 Vitória, ES, Brazil
5 Herpeto Capixaba project, Instituto Biodiversidade Neotropical, Rua Sanhaço 562, Nova Guarapari, 29206-400 Guarapari, ES, Brazil

**Corresponding author: andersonlozorioo@gmail.com*
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The snake genus *Spilotes* Wagler, 1830 (Colubridae) is currently composed of two species: *Spilotes pullatus* (Linnaeus, 1758) and *Spilotes sulphureus* (Wagler, 1824) (Jadin, 2013). *Spilotes pullatus* is popularly known in Brazil as "caninana", which in Tupi language means "that has small head" (Amaral, 1929). This vernacular name refers to the diminutive head size in relation to the large sizes that adult individuals can attain – up to 270 mm total length – as one of the largest colubrids in South America (Savage, 2002; Marques et al., 2014). One of the main characteristics of *S. pullatus* is its fascinating ability to expand the neck region, due to the elasticity and great extension capacity of a membrane that connects the ends of tracheal rings, which allows the species to appear larger in a threatening situation (Amaral, 1929).

This species, listed as Least Concern in the IUCN Red List (Arzamendia et al., 2019), is widely distributed in Central and South America, from southern Mexico to northern Argentina (Savage, 2002). It is widespread in Brazil, present in all biomes (Vanzolini et al., 1980; Mendonça et al., 2011; Nogueira et al., 2019). It is an arboreal and diurnal species, non-venomous and with a generalist diet, swallowing prey alive or killing them by constriction (Martins et al., 2008; Marques et al., 2014; Castro & Silva-Soares, 2016).

The southern black-eared opossum *Didelphis aurita* Wied, 1826 (Didelphimorphia, Didelphidae) is one of the most common marsupial species in the eastern Neotropical region, occurring from northeastern Brazil to northeastern Argentina, inhabiting mainly primary and secondary forests at lower elevations (Astúa, 2015). It is a scansorial, solitary and nocturnal marsupial inhabiting a wide range of habitats in the Atlantic Forest, including urban and rural areas (Cerqueira et al., 1990; Vieira & Monteiro-Filho, 2003). The characteristics associated with its generalist food habits (opportunistic/omnivorous) make this species largely abundant, with high population densities, especially in areas close to human habitations, hence, a sylvatic-synanthropic species (Olifiers et al., 2005; Junior & Leite 2007).

On 20 February 2022 at 1912h, an adult *Spilotes pullatus* was filmed in an attempted predation by an adult *D. aurita*. The interaction was recorded at Ilhabela, an archipelago off the northern coast of the state of São Paulo, southeastern Brazil (23°49′14.43″ S 45°21′17.58″ W, datum WGS84; 26 m elev. a.s.l.), adjacent to an urban area near Ilhabela State Park, a 27,025 hectare "archipelago-park" covered by Atlantic Ombrophilous Dense Forest.

The interaction occurred as follows: BMD heard a loud crawling sound in leaf litter. The *S. pullatus* emerged from the forest, pursued five seconds later by the *Didelphis aurita*. The observer began videotaping the scene (Figure 1). The opossum rapidly attacked the snake, which tried to strike and bite the marsupial once or twice. The snake also attempted to coil its body around the opossum, but the marsupial shook off the snake. The opossum did not immobilize the snake on its first attack, but bit the snake behind the head, immobilizing it and carrying it, still alive, in its mouth back towards the forest. The video is 21 seconds in length, but the total interaction, from the first noise to the animals' disappearance, lasted about 35 seconds. The video may be accessed at *herpetocapixaba.com.br/herpetovideos*.

Didelphis aurita locates food items mainly through auditory and olfactory

stimuli, usually grasping the food with its mouth directly from the ground (Hunsaker, 1977; Streilein, 1982). The opossum and the caninana are sympatric throughout their distributions and most species of *Didelphis* are known to prey upon snakes (Cordero & Nicolas, 1986; Santori et al., 1995; Astúa, 2015). Since *S. pullatus* is diurnal and *D. aurita* is nocturnal, we believe that the opossum probably encountered the snake while it was resting in a nocturnal shelter. Since snake predators typically consume prey that are smaller than the predator (Schalk & Cove, 2018), it is remarkable that the opossum attacked and subdued the snake, which measured approximately 200 cm. Despite these records, *D. aurita* is apparently not a specialized snake predator, and the action of attacking a snake by a strong bite at the base of the head followed by shaking it from side to side, is apparently a conservative behavior in mammals (Oliveira & Santori, 1999).

To search for records of *Didelphis aurita* preying on *S. pullatus,* we performed a literature review through the Web of Science, Scopus and Google Scholar online platforms. We incorporated search terms to cover literature published in English, Portuguese, and Spanish, followed OR by "*Spilotes pullatus*" or "*Didelphis aurita*". In addition, a search was made for all available issues of the journal Herpetological Review (1967-2022). Finally, we searched for photographic snake feeding records on the Wiki Aves platform on 26 March 2023 with the help of the online material available by Souza et al., (2022) in attempt to add more records. Although documented predation records for *S. pullatus* are scarce, the species has been reported as prey of reptiles, birds, and mammals (Tab. 1).

Most studies on the interaction of *Didelphis* opossums and snakes have focused on venomous snakes, since it is documented that at least four species of *Didelphis* are tolerant to snake venom (Vellard, 1945; Perales et al., 1986; Oliveira & Santori, 1999; Astúa, 2015). We found records of *S. pullatus* being preyed by raptors such as the Great Black Hawk – *Urubitinga urubitinga* (Gmelin, 1788), the Roadside Hawk – *Rupornis magnirostris* (Gmelin, 1788) and by the specialized snake-eater, the Laughing-Falcon – *Herpetotheres cachinnans* (Linnaeus, 1758) (Gerhardt et al., 1993; Costa et al., 2014; Oakley et al., 2021). Furthermore, a predation attempt by the Central American Indigo Snake *Drymarchon melanurus* (Duméril, Bibron & Duméril, 1854) was also reported (Oakley & Theodorou, 2020) and previously, Hernández-Ríos et al., (2013) observed a *D. melanurus* in the process of consuming a *S. pullatus* in Mexico; however, because the initial capture of the prey was not observed, it is unknown if the *S. pullatus* was preyed or scavenged. More recent-

ly, Peláez-Cruz et al. (2022) reported a potential predation event on *S. pullatus* by the gray fox *Urocyon cinereoargenteus* (Schreber, 1775) recorded in northern Yucatán, Mexico, although there is no evidence that the fox consumed the snake.

After searching these sources, we conclude that predators of *S. pullatus* are poorly documented. The predator-prey interaction between *D. aurita* and *S. pullatus* has not been previously reported, so this is the first record of such predation, with the description of their struggle. Our record adds one more potential prey of *Didelphis aurita*, as well as one more predator of *Spilotes pullatus,* showing the likely opportunistic behavior of the marsupial. This new record broadens our knowledge about the natural history of the species, and we suggest considering the tiger rat snake as a component of the opossum diet.

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Table 1. Predators previously reported for the Tiger Rat Snake *Spilotes pullatus*.

(*) Photo Web Link. Velame (2013). Observation code:*WA1122818*.

PREDATOR	LOCALITY	REFERENCES
SQUAMATA		
Lizards		
Teiidae		
Salvator merianae (Duméril & Bibron, 1839)	Ceara, Brazil	Silva et al., (2014)
Serpentes		
Colubridae		
Drymarchon melanurus (Duméril, Bibron & Duméril, 1854)	Tamaulipas, Mexico	Hernández-Ríos et al., (2013)
	Campeche, Mexico	Oakley & Theodorou (2020)
Dipsadidae		
Clelia clelia (Daudin, 1803)	Tambopata, Peru	Champagne (2021)
AVES		
Accipitriformes		
Accipitridae		
Rupornis magnirostris (Gmelin, 1788)	Campeche, Mexico	Oakley et al., (2021)
Urubitinga solitaria (Vieillot, 1817)	Cayo District, Belize	Novy & Van Putte (2016)
Urubitinga urubitinga (Gmelin, 1788)	Flores, Guatemala	Gerhardt et al., (1993)
Falconiformes		
Falconidae		
Caracara plancus (Miller, 1777)	Bahia, Brazil	*https://www.wikiaves.com.br/1122818**
Herpetotheres cachinnans (Linnaeus, 1758)	Costa Rica	Costa et al., (2014)
MAMMALIA		
Carnivora		
Canidae		
Urocyon cinereoargenteus (Schreber, 1775)	Yucatán, Mexico	Peláez-Cruz et al., (2022)
Didelphimorphia		
Didelphidae		
Didelphis aurita (Wied, 1826)	São Paulo, Brazil	This study



Figure 1. Southern black-eared opossum (*Didelphis aurita*) preying on a tiger rat snake (*Spilotes pullatus*), in Ilhabela, state of São Paulo, Brazil: (A-B) Opossum attempts to kill the snake; (C) snake tries to strike and coil its body around the marsupial; (D) the snake is finally immobilized with a bite behind the head. Photos: BMD.