
First record of pseudoautotomy in the genus *Echinanthera* (Serpentes: Colubridae)

Urotomy (tail breakage) is a singular defensive strategy in lepidosaurian reptiles, allowing an individual to lose portions or the entirety of its tail during a predator attack, increasing its chances of escape (Arnold 1984). Its more commonly known variation is autotomy, which occurs in the tuatara (Sphenodontidae) and in several lineages of lizards; it is characterized by the intravertebral rupture in specialized planes of the tail, with the capacity of spontaneous fracture and partial regeneration by the development of a cartilaginous rod in the area previously occupied by the osseous tissue (Slowinski & Savage 1995, Savage & Slowinski 1996, Jagnandan et al. 2014). Another form, termed pseudoautotomy by Slowinski & Savage (1995), is diagnosed by the intervertebral fracture in random portions of the tail, without the capacity for spontaneous rupture or regeneration, and present in some snakes and lizards (Etheridge 1967, Arnold 1984, Slowinski & Savage 1995). In this case, since the tail rupture is not spontaneous, it depends on external stimuli in order to occur (Savage & Slowinski, 1996).

Accordingly to Arnold (1984) and Bateman & Fleming (2009), pseudoautotomy is a derived character, present in taxons that lost their capacity to realize autotomy. In snakes, two distinct forms of this behavior are known: specialized pseudoautotomy, in which the rupture is facilitated by the presence of a long, thick and fragile tail, and non-specialized

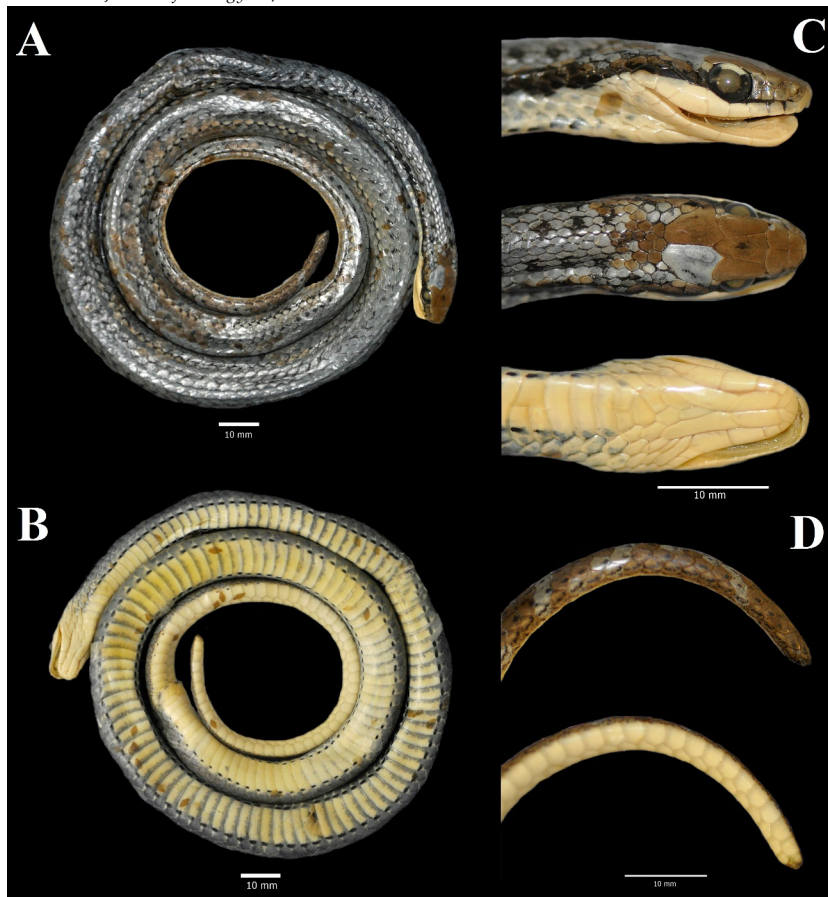


Figure 1. Specimen of *Echinanthera cephalostriata* (MZUSP 21.246) in which the tail breakage was observed. A: Dorsal surface; B: Ventral surface; C: Head views; D: Tail views. Photograph credits: Daniella Pereira Fagundes de França.

pseudoautotomy, in which the snakes have a moderately long or even long tail (>35% of total length in adults), but without observed modifications for tail breakage (Savage & Slowinski 1996).

Even though the anatomical mechanism of the fracture is still poorly known in snakes, there are urotomy records in several snake families (Hoogmoed & Ávila-Pires 2011, Dourado et al. 2013, Costa et al. 2014, Padilla-Pérez et al. 2015, Crnobrnja-Isailović et al. 2016, Strugariu et al. 2018).

The genus *Echinanthera* Cope, 1894 belongs to colubrid snakes (Pyron et al. 2013, Figueroa et al. 2016), comprising six species distributed across the oriental Atlantic region of Brazil (Di-Bernardo 1992). These species are characterized by their terrestrial and cryptozoic habits, slender bodies and long tails reaching up to 47% of the total body size in some species (Gomes & Marques 2012). Marques & Sazima (2004) raised the hypothesis that *E. cyanopleura* (Cope, 1885) and *E. undulata* (Wied, 1824) use their tails as defensive mechanisms, based on the number of specimens with damaged tails examined in collections. Zanella & Cechin (2010) and Gomes & Marques (2012) also provided brief mentions over the tail damage of *E. cyanopleura* and *E. undulata* specimens, respectively. Still, urotomy records for neotropical snakes are rare (Costa et al. 2014) and this behavior was never observed within the genus *Echinanthera*.

During fieldwork conducted in the Estação Ambiental São Camilo (Coordinates: -24.1827°, -46.7888°, Datum WGS 84), municipality of Itanhaém, São Paulo state, in an afternoon in September 2012, an individual of *E. cephalostriata* Di-Bernardo 1996 was observed still under the leaf litter, having

only its head partially exposed. The specimen was thereafter captured with a snake hook, and to our surprise, surfaced amongst the leaf litter with a ruptured tail, while its amputated portion presented minimal bleeding and abrupt movements. The adult female (rostrum-cloacal length of 434 mm, tail length 140 mm + n) was collected (under collecting permit SISBIO 31557) and deposited in the Herpetological Collection of the Museu de Zoologia da Universidade de São Paulo (MZUSP 21.246).

Several authors have reported cases in which pseudoautotomy occurs in situations that the tail is grabbed and the snake twists its body across its longitudinal axis, until the tail is detached (e.g Cooper & Alfieri 1993, Savage & Slowinski 1996, Marco 2002, Crnobrnja-Isailović et al. 2016, Strugariu et al. 2018), although there is a record of a snake able to rupture its tail while twisting it across its body (Hoogmoed & Ávila-Pires 2011). Unfortunately, due to the dense leaf litter in which the snake was encountered, we were unable to observe how the tail breakage occurred in this case.

Our record possibly corroborates the hypothesis raised by Marques & Sazima (2004), although the species mentioned by these authors were not directly examined in this study. Accordingly to Martins (1994), terrestrial species with long tails possibly use them for specific means, such as urotomy, since long tails are usually observed in arboreal, and rarely in terrestrial taxa. In the case of *Echinanthera*, this could also be the norm, although a genus-wide analysis needs to be undertaken.

Absent or reduced bleeding after tail breakage in snakes

has been reported by other authors (Dourado et al. 2013, Ribeiro & Mesquita 2014, Padilla-Pérez et al. 2015). This could indicate the presence of sphincters within the veins and arteries located in the tail of *E. cephalostriata*, in order to stop blood loss during urotomy, as recorded for some lizard species (Arnold 1984).

The first confirmed record of urotomy for *E. cephalostriata* corroborates the speculations that *Echinanthera* species may use their tails as a defensive mechanism. However, this observation suggests further studies regarding urotomy within the genus: (1) evaluate the presence/absence of sphincters used to stop blood loss within *Echinanthera* spp.; (2) assess if there is a breakage plane or specialized musculature that assists in tail breakage; (3) analyze if there is urotomy within other closely related genera and evaluate if there are geographical or sexual variations or trends within interspecific tail breakage frequencies. These, and several other themes, are still unanswered questions within a new and enigmatic defensive behavior in genus *Echinanthera*.

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Arthur Diesel ABEGG^{1,*},
Raissa Marina Silva SIQUEIRA²,
Flora Roncolato ORTIZ¹
and Omar Machado ENTIAUSPE-NETO³

1. Instituto Butantan, Laboratório Especial de Coleções Zoológicas, Avenida Vital Brasil, 1.500, Butantã, CEP 05503-900 São Paulo, SP, Brazil.
2. Laboratório de Herpetologia, Museu de Zoologia da Universidade de São Paulo - Avenida Nazaré, 481, Ipiranga, CEP 04263-000, São Paulo, SP, Brazil.
3. Universidade Federal do Rio Grande, Instituto de Ciências Biológicas, Laboratório de Vertebrados. Av. Itália km 8, CEP 96203-900, Rio Grande, RS, Brazil.

*Corresponding author, A.D., Abegg, E-mail: arthur_abegg@hotmail.com