

First record of tail bifurcation in *Lygodactylus klugei* (Smith, Martin & Swain, 1977) (Sauria: Gekkonidae), with comments on caudal adhesive pads

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Resumo

Primeiro registro de bifurcação da cauda em *Lygodactylus klugei* (Smith, Martin & Swain, 1977) (Sauria: Gekkonidae) com comentários sobre as almofadas adesivas caudais. O processo de regeneração caudal em lagartos nem sempre ocorre perfeitamente, podendo ocasionar algumas anormalidades como o surgimento de caudas empenadas ou supranumerárias. Aqui relatamos os primeiros casos de bifurcação da cauda na lagartixa anã *Lygodactylus klugei* e trazemos observações sobre as almofadas adesivas caudais nos indivíduos com cauda bifurcada. Nossos registros representam um novo caso de bifurcação caudal em espécies de lagartos que apresentam caudas com especializações funcionais e estruturas morfológicas elaboradas, sendo os primeiros registros desse tipo de anomalia para o gênero *Lygodactylus*.

Palavras-chave: Anomalias da cauda; Autotomia; Lagartos; Regeneração da cauda

Abstract

The process of caudal regeneration in lizards does not always occur perfectly, which can cause some abnormalities, such as the appearance of warped or supernumerary tails. Here we report the first cases of tail bifurcation in the Dwarf Gecko, *Lygodactylus klugei*, and observations about the caudal adhesive pads in individuals with bifurcated tails. Our observations represent a new case of caudal bifurcation for lizard species that have tails with functional specializations and elaborate morphological structures and are the first records of this type of anomaly for the genus *Lygodactylus*.

Key words: Autotomy; Lizards; Tail anomalies; Tail regeneration



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Lizards have the noteworthy ability to regenerate their broken tails, which involves repairing several damaged tissues, including muscular, osteological, and neuronal (ALIBARDI, 2010). This regeneration is essential to ensure the survival of lizards, since individuals without regenerated tails may experience a reduction in individual fitness for some behavioral aspects, such as habitat selection, foraging, anti-predatory behavior, and social and reproductive issues (see review in BATEMAN; FLEMING, 2009). However, the regeneration is not always perfect and there are many records of tail abnormalities, such as the appearance of warped, curly, or supernumerary tails (MEYER et al., 2002; PASSOS et al., 2016). Incomplete autotomy or tail injuries can stimulate the regeneration of additional tails (DUDEK; EKNER-GRZYB, 2014; KOLENDA et al., 2017; RAMADANOVIC; ZIMIC, 2019) and have been reported in different lizard families, for example, Dactyloidae (e.g., TIPANTIZA-TUGUMINAGO et al., 2019), Gekkonidae (e.g., GARCÍA-VINALAY, 2017), Iguanidae (e.g., ARIANO-SÁNCHEZ; GIL-ESCOBEDO, 2016), Lacertidae (e.g., KOLENDA et

al., 2017), Phyllodactylidae (e.g., FILADELFO et al., 2017), Scincidae (e.g., MAGALHÃES et al., 2015), Teiidae (e.g., SALES; FREIRE, 2019), Tropiduridae (e.g., BRASILEIRO, 2021), Sphaerodactylidae (e.g., MOUADI et al., 2021) and others (see review in HENLE; GRIMM-SEYFARTH, 2020). Here we report the first cases of tail bifurcation in *Lygodactylus klugei*, which were recorded in two areas of the Caatinga domain in northeastern Brazil.

During studies carried out with the species, we recorded two cases of an individual with a bifid tail. The first specimen was an adult female (CHUFCL 7260; SVL = 27.9 mm, Figure 1A, 1B) collected on July 6, 2018, in the municipality of Pentecoste (-3.81843 S, -39.33923 W; 65 m a.s.l.), Ceará, Brazil. The bifurcation occurred 19.37 mm posterior to the cloaca. The first branch was 5.1 mm long and a second branch was 3.57 mm long. Both branches were uniform in color, with no apparent differentiation of the scales. The second specimen was an adult male (CHUFCL 7319; SVL = 25.55 mm, Figure 1C) collected on July 18, 2018, in the municipality of Patos (-7.05974 S, -37.27507 W; 251 m

FIGURE 1: Individuals of *L. klugei* with tail bifurcations. Female captured in Pentecoste, Ceará (A, B). Male captured in Patos, Paraíba (with autotomized tail during capture) (C).



a.s.l), Paraíba, Brazil. In this case, the bifurcation was very inconspicuous and located in the terminal portion of the tail, 17.52 mm posterior to the cloaca. The longest branch was 2.06 mm, and the second branch was 1.16 mm and darker.

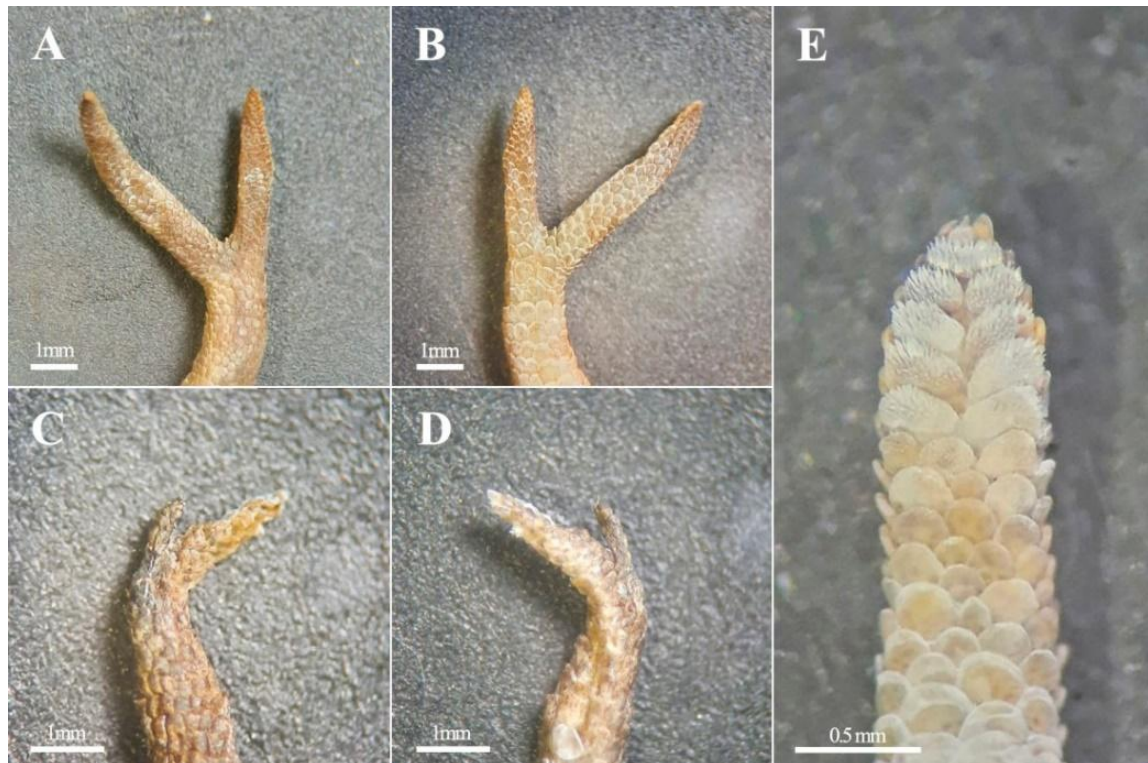
According to Alibardi (2010), these deformities can be caused by incomplete caudal autotomy, as well as by a crushed spinal cord and ependymal within the tail. Although it is not possible to confirm this with our data, we suggest that both cases of bifurcation were derived from previous injuries where there was incomplete autotomy, but the damage was sufficient to start the process of regeneration and growth of a new tail in the affected places (DUDEK; EKNER-GRZYB, 2014), which resulted in a supernumerary tail in each individual.

The tip of the tail of *L. klugei* has specialized glandular structures similar to the adhesive pads found on the fingers (SMITH et al., 1977). Studies using scanning electron micrographs report that the regenerated tail in this species has the same

structures and performs the same functions as the original tail, although there are imperfections (VITT; BALLINGER, 1982). Although we did not investigate the ultrastructure of the region, we did not observe adhesive pads on any of the caudal branches of both individuals at macroscopic levels (Figure 2A-D). The visual absence of these structures compared to the original tails in other individuals (Figure 2E) leads us to believe that the bifurcation processes described here occurred in previously regenerated tails.

Although there are no studies on the effects caused by supernumerary tails, occasional reports suggest that the presence of these anomalies can negatively affect the fitness of individuals, but without apparent changes in survival rates (see HENLE; GRIMM-SEYFARTH, 2020). Visually, we did not observe any type of locomotor deficiency or difficulty in escaping during the capture process of both individuals compared to other *L. klugei* specimens with non-bifurcated tails. Although tail loss can impair the ability to escape on vertical surfaces

FIGURE 2: Details of bifurcations. Dorsal (A) and ventral (B) view of the female (CHUFCL7260). Dorsal (C) and ventral (D) view of the male (CHUFCL7319). Dorsal view of the tail of a third individual with intact tail (without previous autotomies), with emphasis on the caudal adhesive pads (E).



in *Lygodactylus* (VITT; BALLINGER, 1982; MEDGER et al., 2008), the effects of multiple tails with additional adhesive structures, and whether these are functional in the natural environment, are still unknown.

During our studies developed over a year in 12 populations of *L. klugei*, 249 individuals were captured. The findings of bifurcated tails described here represent an occurrence of 0.8%, a value similar to those found for some lizard populations, such as *Ophisops elegans* Ménétries, 1832 (TAMAR et al., 2013), *Lacerta agilis* Linnaeus, 1758 (KOLENDA et al., 2017), *Ablepharus kitaibelii* Bibron & Bory St-Vincent, 1833 (VERGILOV; NATCHEV, 2017), *Ameivula ocellifera* (Spix, 1825) (SALES; FREIRE, 2019), *Psychosaura macrorhyncha* (Hoge, 1946) (VRCIBRADIC; NIEMEYER, 2013), and others (see HENLE; GRIMM-SEYFARTH, 2020). When we analyze the populations of *L. klugei* from this research independently, the total number of individuals sampled in each location corresponds to 23 and 21 for the Patos and Pentecoste populations, respectively. In addition to the results obtained by Henle and Grimm-Seyfarth (2020), the cases described here are a new record of tail bifurcation for lizard species that have tails with functional specializations and elaborate morphological structures and are also the first reports of this type of anomaly for the genus *Lygodactylus*.

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