Herpetology Notes, Volume 18: 467–470 (published online on 27 June 2025)

Third case of tail bifurcation in Cope's Mabuya, *Notomabuya frenata* (Cope, 1863), in Mato Grosso do Sul, Brazil

Nelson R. de Albuquerque[1,*], Luciana M. Valério[2], and Roullien H. Martins[1]

Several animals have the ability to detach part of their body as a predator-escape strategy. This behaviour is common among groups of both invertebrates and vertebrates (Maginnis, 2006; Fleming et al., 2007; Emberts et al., 2019). Among reptiles, a multitude of lizards, some snakes, and the tuatara are capable of breaking their tails (e.g., Hickman, 1960; Bustard, 1968; Greene, 1973; Broadley, 1987; Cooper and Alfieri, 1993; Seligmann et al., 2008; Hoogmoed and Ávila-Pires, 2011; Costa et al., 2014). When this happens, two types of breaks can be distinguished (Savage and Slowinski, 1996): autotomy (intravertebral breakage and regeneration of the lost part) and pseudo-autotomy (intervertebral breakage without regeneration).

Recently, a series of publications has brought significant advances in the study of tail furcations in lizards (e.g., Arango-Lozano and Patiño-Siro, 2020; Bülbül and Sarikurt, 2022; Cazanove et al., 2023; Baum and Kaiser, 2024; Liang et al., 2024; Albuquerque et al., 2025). We highlight the contribution of Baum and Kaiser (2024), who provided an updated list of all available data on tail furcation in lizards. These authors also listed the species and the type(s) of furcations (e.g., bifurcations, duplications, trifurcations) found within lizard families. Later, Baum et al. (2024) reported the first case of a tail bifurcation for the family Xantusiidae and Albuquerque et al. (2025) published the first case of tail duplication in the teiid *Salvator merianae*, bringing the total number of known lizard specimens with a forked tail to 543 and the total number of known lizard species with a forked tail to 251 (and not 252 as cited by Albuquerque et al., 2025).

Among the species listed by Baum and Kaiser (2024) was the report by Vrcibradic and Niemeyer (2013) of two cases of bifurcation and one case of trifurcation in the tails of three specimens of Cope's Mabuya (*Notomabuya frenata*) collected in Valinhos, São Paulo State, Brazil. Herein, we present a new case of tail furcation in *N. frenata*, with information on its external morphology. Following the terminology proposed by Henle and Grimm-Seyfarth (2020), since the split in this individual occurred distal to the mid-length of the longest point of the tail, we describe this as a bifurcation.

The specimen has been deposited in the Coleção Zoológica de Vertebrados of the Universidade Federal de Mato Grosso do Sul (ZUFMS-REP 05341). It was collected on 10 January 2024 at Fazenda Anahi, Porto Murtinho, Mato Grosso do Sul, Brazil (21.6465°S, 57.7354°W; WGS 84). We measured head length (from the quadrate-articular jaw joint to the tip of the snout), snout length (from the tip of snout to the anterior margin of the orbit), snout–vent length (SVL), tail length (TL) (from the cloacal scale to the point of furcation), and the length of each regenerated tail. We made all measurements to the nearest 0.1 mm using digital callipers except SVL and TL, which we made with a flexible ruler to the nearest 1 mm. We determined the sex of specimen based on the presence-absence of hemipenes verified through a ventral incision at the base of the tail.

The specimen is a female with head length of 16.9 mm (27.1% of SVL), snout length 6.1 mm, SVL 62 mm, TL 35 mm (55.9% of SVL) plus 2.8 mm/8.5 mm to the tip of right/left tail, respectively (Fig. 1A, B). Each regenerated tail ends in a rounded, scaleless, blunt tip (Fig. 1C, D). The longest regenerated tail is 13.5% of SVL. ZUFMS-REP 05341 is the third case of tail bifurcation in *N. frenata*.

[1] Laboratório de Zoologia, Instituto de Biociências, Universidade Federal de Mato Grosso do Sul, Avenida Costa e Silva, Campo Grande, Mato Grosso do Sul 79070-900, Brazil.

[2] Instituto de Biociências, Letras e Ciências Exatas, Universidade Estadual Paulista, São José do Rio Preto, São Paulo 15054-000, Brazil.

[*] Corresponding author. E-mail: nelson.rufino@ufms.br

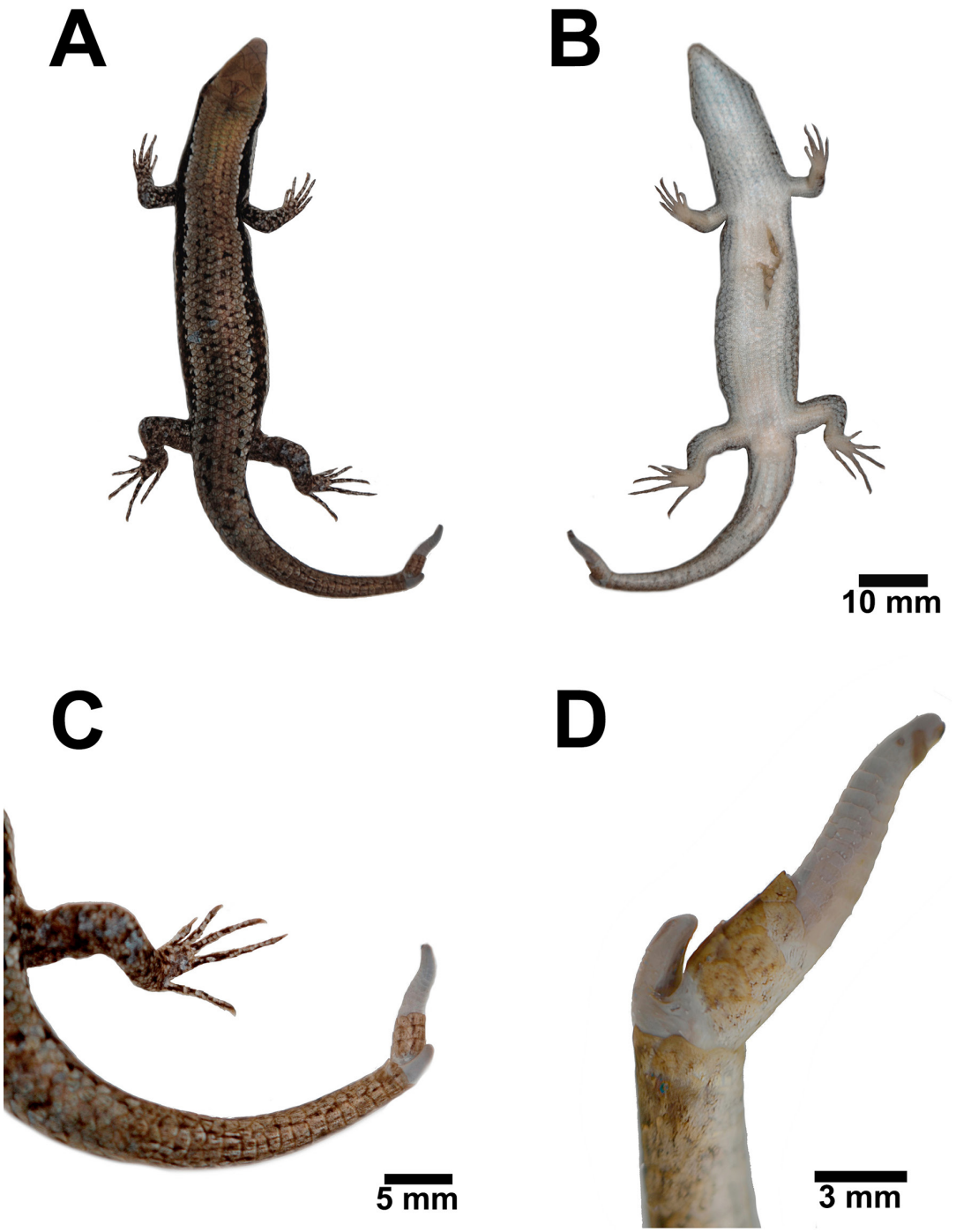

Figure 1. *Notomabuya frenata* (ZUFMS-REP 05341) with a bifurcated tail from Mato Grosso do Sul, Brazil. (A) Dorsal and (B) ventral views. (C) Right and (D) left views of the tail. Note that each regenerated tail ends in a rounded, scaleless, blunt tip.

Tail furcation in lizards, although relatively common, can have important biological implications. Such anomalies are typically associated with previous autotomy events, where the regeneration process deviates from the typical pattern, leading to abnormal morphologies like bifurcations or trifurcations (e.g., Koleska and Jablonski, 2015; Cotoras and Vidal, 2023; Liang et al., 2024). These atypical regenerations may compromise the tail's original functionality, reducing its effectiveness in predator escape due to altered movement or breakage dynamics (e.g., Hsieh et al., 2016; Barr et al., 2020). Additionally, maintaining and regenerating multiple tail tips can increase energetic costs, which may impact growth, reproduction, or survival (Doughty et al., 2003; Barr et al., 2021). Thus, while regenerative capacity offers survival advantages, aberrant tail morphologies may impose physiological and ecological trade-offs, which should be addressed in future studies.

Acknowledgements. We thank Diego J. Santana for his earlier review of the manuscript and Timothy J. Baum for providing the pre-peer review. CNPq provided LMV with a fellowship during his time as a graduate student. This study was financed in part by the Universidade Federal de Mato Grosso do Sul, Ministério da Educação, Brazil.

References

Albuquerque, N.R., Martins, R.H., Freire, D.H., Batista, F.A. (2025): The first report of tail duplication in the black-and-white Tegu *Salvator merianae* (Squamata, Teiidae). Ecologica Montenegrina **82**: 64–68.

Arango-Lozano, J., Patiño-Siro, D. (2020): Regenerate tail bifurcation in the Green Iguana (*Iguana iguana* Linnaeus, 1758). Herpetology Notes **13**: 483–484.

Barr, J.I., Somaweera, R., Godfrey, S.S., Gardner, M.G., Bateman, P.W. (2020): When one tail isn't enough: abnormal caudal regeneration in lepidosaurs and its potential ecological impacts. Biological Reviews **95**: 1479–1496.

Barr, J.I., Boisvert, C.A., Bateman, P.W. (2021): At what cost? Trade-offs and influences on energetic investment in tail regeneration in lizards following autotomy. Journal of Developmental Biology **9**: 1–21.

Baum, T.J., Kaiser, H. (2024): Tail furcations in lizards: a revised summary and the second report of tail duplication in the Western Fence Lizard, *Sceloporus occidentalis* Baird & Girard, 1852. Herpetology Notes **17**: 459–475.

Baum, T.J., Barrio-Amorós, C.L., Kaiser, H. (2024): A reptile dysfunction: tail bifurcation in the Costa Rican Tropical Night Lizard, *Lepidophyma reticulatum* Taylor, 1955, a first for the family Xantusiidae. Herpetology Notes **17**: 815–816.

Broadley, D.G. (1987): Caudal autotomy in African snakes of the genera *Natriciteres* Loveridge and *Psammophis* Boie. African Journal of Herpetology **33**: 18–19.

Bülbül, U., Sarikurt, S. (2022): First observation of tail bifurcation in the Clark's Lizard, *Darevskia clarkorum* (Darevsky & Vedmederja, 1977) and the Spiny-Tailed Lizard, *Darevskia rudis* (Bedriaga, 1886) (Squamata: Lacertidae). Commagene Journal of Biology **6**: 119–121.

Bustard, H.R. (1968): Temperature dependent tail autotomy mechanism in gekkonid lizards. Herpetologica **24**: 127–130.

Cazanove, G., Sbrovazzo, B., Sanchez, M. (2023): Tail bifurcation and trifurcation in *Phelsuma* species on Reunion Island (Squamata: Gekkonidae). Cahiers Scientifiques de l'Océan Indien Occidental **13**: 1–3.

Cooper, W.E., Alfieri, K.J. (1993): Caudal autotomy in the eastern garter snake, *Thamnophis s. sirtalis*. Amphibia-Reptilia **14**: 86–89.

Costa, H.C., Moura, M.R., Feio, R.N. (2014): A tale of lost tails: pseudoautotomy in the neotropical snake genus *Drymoluber* (Serpentes: Colubridae). Canadian Journal of Zoology **92**: 811–816.

Cotoras, D.D., Vidal, M.A. (2023): Tail bifurcation incidence in *Liolaemus* lizards assessed through citizen science and naturalist notes. South American Journal of Herpetology **26**: 29–36.

Doughty, P., Shine, R., Lee, M.S. (2003): Energetic costs of tail loss in a montane scincid lizard. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology **135**: 215–219.

Emberts, Z., Escalante, I., Bateman, P.W. (2019): The ecology and evolution of autotomy. Biological Reviews **94**: 1881–1896.

Fleming, P.A., Muller, D., Bateman, P.W. (2007): Leave it all behind: a taxonomic perspective of autotomy in invertebrates. Biological Reviews **82**: 481–510.

Greene, H.W. (1973): Defensive tail display by snakes and amphisbaenians. Journal of Herpetology **7**: 143–161.

Henle, K., Grimm-Seyfarth, A. (2020): Exceptional occurrences of double, triple and quintuple tails in an Australian lizard community, with a review of supernumerary tails in natural populations of reptiles. Salamandra **56**: 373–391.

Hickman, J.L. (1960): Observations on the skink lizard *Egernia whitii* (Lacepede). Papers and Proceedings of the Royal Society of Tasmania **94**: 111–118.

Hoogmoed, M.S., Avila-Pires, T.C.S. (2011): A case of voluntary tail autotomy in the snake *Dendrophidion dendrophis* (Schlegel, 1837) (Reptilia: Squamata: Colubridae). Boletim do Museu Paraense Emílio Goeldi. Ciências Naturais **6**: 113–117.

Hsieh, S.T.T. (2016): Tail loss and narrow surfaces decrease locomotor stability in the arboreal green anole lizard (*Anolis carolinensis*). Journal of Experimental Biology **219**: 364–373.

Koleska, D., Jablonski, D. (2015): Tail trifurcation recorded in *Algyroides nigropunctatus* (Duméril & Bibron, 1839). Ecologica Montenegrina **3**: 26–28.

Liang, T., Ran, J.M., Liang, Q.R., Leng, L., Du, J.H., Wang, J., Shi, L. (2024): Report of abnormal tail regeneration of *Eremias yarkandensis* (Sauria: Lacertidae) and its locomotor performance. Ecology and Evolution **14**: e11074.

Maginnis, T.L. (2006): The costs of autotomy and regeneration in animals: a review and framework for future research. Behavioral Ecology **17**: 857–872.

Savage, J.M., Slowinski, J.B. (1996): Evolution of coloration, urotomy and coral snake mimicry in the snake genus *Scaphiodontophis* (Serpentes: Colubridae). Biological Journal of the Linnean Society **57**: 129–194.

Seligmann, H., Moravec, J., Werner, Y.L. (2008): Morphological, functional and evolutionary aspects of tail autotomy and regeneration in the 'living fossil' *Sphenodon* (Reptilia: Rhynchocephalia). Biological Journal of the Linnean Society **93**: 721–743.

Vrcibradic, D., Niemeyer, J. (2013): Natural history notes. *Mabuya frenata*, *M. macrorhyncha*. Tail bifurcation. Herpetological Review **44**: 510–511.

Accepted by Hinrich Kaiser