

Simultaneous feeding and copulation in *Xenodon merremii* (Wagler, 1824) during predation on *Rhinella diptycha* (Cope, 1862) in northeastern Brazil

Ricardo Santos Magalhães¹ and Seté Payayá²

The predation of frogs by vertebrates is common among reptiles, birds, fishes, and mammals across different life stages (Mesquita, 2009; Cabrera-Guzmán et al., 2015; Peixoto-Couto et al., 2020). Snakes are among the main predators of anurans within trophic webs, with many species specialising in anuran predation through different strategies used to subdue their prey (Costa and Trevelin, 2020).

Records of snake copulation in the wild remain poorly documented due to the difficulty of detecting these animals as a consequence of their cryptic behaviour (Clark et al., 2014; Travaglia-Cardoso et al., 2021). Male snakes are known to exhibit opportunistic behaviour during reproductive periods (Ross and Crews, 1978; Shine, 2003), displaying a wide range of behavioural strategies and prioritising reproduction over other activities (Krohmer, 2004). Reports of cannibalism among snake species during copulation are known in the scientific literature (Falcão et al., 2025); however, simultaneous feeding and copulatory behaviours are rarely documented in snakes.

Rhinella diptycha (Cope, 1862) is a bufonid widely distributed throughout South America, occurring in Argentina, Bolivia, Brazil, Paraguay, and Uruguay. It is found in the Chaco, Atlantic Forest, Pantanal, Caatinga, and Cerrado biomes and, as a cosmopolitan species, is mainly associated with open and peri-domestic areas (Uetanabaro et al., 2008; Oliveira et al., 2025). Like most bufonids, this species is capable of secreting toxins through its parotoid glands as a defensive mechanism against predators such as snakes. Its toxins are highly resistant and exhibit cardiotoxic properties (Mailho-

Fontana et al., 2018; Shibao et al., 2018). Nevertheless, some snake species are immune to the toxins present in its skin, such as *Xenodon merremii* (Wagler, 1824), which preferentially preys upon toads of the genus *Rhinella* and possesses adaptations for exploiting this prey type, including opisthoglyphous dentition capable of deflating the anuran through perforation and envenoming (Freiberg, 1982; Meira and Freire, 2012; Gendler et al., 2021).

Xenodon merremii is a large and robust dipsadid snake widely distributed throughout South America, occurring in the Guianas, Bolivia, Paraguay, Argentina, Ecuador, Venezuela and Uruguay (Peters and Orejas-Miranda, 1970; Carreira and Achaval, 2007; Cacciali, 2010; Uetz et al., 2025). In Brazil, the species occurs in all major terrestrial biomes, including the Caatinga, Cerrado, Atlantic Forest, Pantanal, Pampas and Amazon Forest (Moura-Leite and Bernarde, 1999; França et al., 2006). Individuals may reach between 1–2 m in total length (Freiberg, 1982; Gonçalves, 2025) and the largest specimen registered was a female (snout-vent length = 1855 mm; Pizzatto et al., 2008). The species is terrestrial and primarily diurnal and exhibits marked colour polymorphism, with distinct morphological patterns, including size and colouration throughout its distributional range (Andrade et al., 2020; Gonçalves, 2025). Knowledge regarding the reproductive cycle of *X. merremii* remains scarce, particularly for males, whose reproductive biology is considerably less understood than that of females. Female reproductive cycles are described as strongly seasonal and regionally variable, lasting from 8–10 months, whereas males appear to exhibit a continuous reproductive cycle that is not constrained by seasonal factors (Pizzatto et al., 2008).

During the rainy season, on 13 May 2026 at 11:04 h, we observed two *X. merremii* copulating in the Payayá Indigenous Reserve, municipality of Utinga, State of Bahia, northeastern Brazil (12.02891°S 41.06277°W;

¹ Universidade Federal da Bahia, Av. Milton Santos s/nº, Ondina, Salvador, Bahia 40170-110, Brazil.

² Independent Researcher, Utinga, Bahia 46810-000, Brazil.

* Corresponding author. E-mail: ricardosm@ufba.br

elevation 600 m). While the male was attempting to copulate, the female was focused on obtaining energy probable for the gestation period, attempting to consume an individual of *R. diptycha* (Fig 1.). The individuals of *X. merremii* were found together, the predation was initiated by the female, which attempted to ingest the individual of *R. diptycha* headfirst. The toad was completely immobilised and bleeding, although still inflated in an apparent attempt to discourage predation. Simultaneously, the male *Xenodon merremii*, which was considerably smaller than the female, remained coiled around the female throughout the feeding event (Fig. 1). After approximately 20 minutes of observation, another male *X. merremii*, apparently larger than the male in copula, appeared, possibly attracted by pheromones; however, no agonistic interaction between the males was observed, and the second male soon left the area. Meanwhile, the female continued repeatedly biting the individual of *R. diptycha* in an attempt to reposition

her posterior teeth to reduce the body volume of the still-inflated toad. After 30 minutes of observation, the female snake moved away from the initial site carrying the toad in its mouth while the male remained on her dorsum, whereafter we could no longer observe them. Based on the 30 minutes of continuous observation, we cannot confirm whether copulation continued after the pair of serpents left the observation site. However, the male remained mounted on the female while she carried the prey away.

It is important to emphasise that the observed individuals were not collected. The predation and copulatory events were documented through photographs and video recordings, which are respectively available on the HerpMapper platform (<https://www.herpmapper.org/record/560337>) and YouTube (<https://youtube.com/playlist?list=PLfzSXFOUHMVGfGM-xH3NYA0rUySHJV6d4&si=961FCgmYzb8rtjJB>). The observation was conducted with authorisation of the Payayá



Figure 1. Predation attempt by the female *Xenodon merremii* on a *Rhinella diptycha* while the male attempts to initiate copulation. (A) and (B) general view of the female *X. merremii* with *R. diptycha* in its mouth and the *X. merremii* male coiled around the female's body; (C) Close-up view of the female *X. merremii* with *R. diptycha* in its mouth; (D) Close-up view of the male *X. merremii* on the female's dorsum. Photos by Seté Payayá.

Indigenous community and in collaboration with Indigenous researchers.

The persistence of reproductive behaviour during a prolonged feeding event involving a large toxic anuran suggests that mating activity in male *X. merremii* may take precedence over other energetically demanding behaviours. This record contributes to the understanding of rarely observed interspecific interactions, helping to fill gaps in the ecology and natural history of these species. Observations of this nature reinforce the importance of documenting behavioural, trophic, and reproductive interactions to achieve a broader understanding of species' ecological niches and natural histories.

Acknowledgments. We extend our gratitude to the Payayá Indigenous Community for allowing for the utilisation and dissemination of the presented data and for their participation on this extraordinary observation. And we also thank to Alexandre Missassi to the pre-peer review of the manuscript and Luisa M. Diele-Viegas for her encouragement and support during our early scientific careers.

References

- Andrade, H., Oliveira, A.G., Santana, D.J., Garda, A.A. (2020): First record of leucism in *Xenodon merremii* (Wagler, 1824) in Brazil. *Herpetology Notes* **13**: 297–299.
- Cabrera-Guzmán, E., Crossland, M.R., Brown, G.P., Shine, R. (2015): Predation on invasive cane toads (*Rhinella marina*) by native Australian rodents. *Journal of Pest Science* **88**(1): 143–153.
- Cacciali, P. (2010): Chromatic variation in populations of *Xenodon merremii* (Serpentes: Dipsadidae) in Paraguay. *Acta Herpetologica* **5**: 107–112.
- Carreira, S., Achaval, F. (2007): Sobre la presencia de *Xenodon merremii* (Wagler, 1824) en Uruguay (Reptilia: Squamata). *Boletín de la Sociedad Zoológica del Uruguay* **16**: 32–35.
- Clark, R.W., Brown, W.S., Stechert, R., Zamudio, K.R. (2014): Mating systems, reproductive success, and sexual selection in secretive species: a case study of the western diamond-backed rattlesnake, *Crotalus atrox*. *PLoS ONE* **9**(3): e90616.
- Costa, W.P., Trevelin, C.C. (2020): Unsuccessful predation attempts by snakes on anuran amphibians: how successful are snakes? *Herpetology Notes* **13**: 649–660.
- Falcão, B.B., São Pedro, V.A., Entiauspe-Neto, O.M. (2025): Occurrence and evolution of cannibal behaviour in extant snakes. *Biological Reviews* **101**(2): 644–664.
- França, F.G.R., Mesquita, D.O., Colli, G.R. (2006): A checklist of snakes from Amazonian savannas in Brazil, housed in the Coleção Herpetológica da Universidade de Brasília, with new distribution records. *Occasional Papers* **17**: 1–13.
- Freiberg, M.A. (1982): *Snakes of South America*. Hong Kong, T.F.H. Publications.
- Gendler, J.L.P.L., Salles, R.O.L., Puerto, G., Nishimura, E.K., Sant'Anna, S.S., Oliveira, I.S., França, F.O.S. (2021): Bites by *Xenodon merremii* (Wagler, 1824) and *Xenodon newwiedii* (Günther, 1863) (Dipsadidae: Xenodontini) in São Paulo, Brazil: a retrospective observational study of 163 cases. *Toxicon* **198**: 24–31.
- Gonçalves, G.S. (2025): Variação morfológica de *Xenodon merremii* (Wagler, 1824): impacto de fatores geográficos, ontogenéticos e sexuais. Dissertação de Mestrado, Universidade Federal do Mato Grosso do Sul.
- Guedes, T.B., Nogueira, C., Marques, O.A.V. (2014): Diversity, natural history, and geographic distribution of snakes in the Caatinga, northeastern Brazil. *Zootaxa* **3836**: 1–93.
- Krohmer, R.W. (2004): The male red-sided garter snake (*Thamnophis sirtalis parietalis*): reproductive pattern and behavior. *ILAR Journal* **45**(1): 65–74.
- Mailho-Fontana, P.L., Antoniazzi, M.M., Toledo, L.F., Verdade, V.K., Sciani, J.M., Barbaro, K.C., Jared, C. (2018): Morphological and biochemical characterization of the cutaneous poison glands in toads (*Rhinella marina* group) from different environments. *Frontiers in Zoology* **15**(1): 46.
- Meira, R.M., Freire, E.M.X. (2012): *Rhinella granulosa* (Common Lesser Toad), *Xenodon merremii*. *Herpetological Review* **43**: 3.
- Moura-Leite, J.C., Bernarde, P.S. (1999): *Xenodon merremii*. Brazil: Rondônia. *Herpetological Review* **30**: 1.
- Oliveira, G.C.S., Souza, M.B., Silva, A.A., et al. (2025): Record of predation of the Brazilian yellow scorpion *Tityus serrulatus* (Buthidae) by the toad *Rhinella diptycha* (Bufonidae) in an urban area in southeastern Brazil. *Acta Biológica Colombiana* **30**(3): 170.
- Peixoto-Couto, R.M., Cabrera-Miguel, M., Ortega, Z. (2020): First record of predation on *Rhinella diptycha* (Anura, Bufonidae) by *Caiman latirostris* (Crocodylia, Alligatoridae). *Actualidades Biológicas* **42**(112): 1–5.
- Peters, J.A., Orejas-Miranda, B. (1970): Catalogue of the Neotropical Squamata. Part I. Snakes. *Bulletin of the United States National Museum* **297**: 1–347.
- Pizzatto, L., Jordão, R.S., Marques, O.A.V. (2008): Overview of reproductive strategies in Xenodontini (Serpentes: Colubridae: Xenodontinae) with new data for *Xenodon newwiedii* and *Xenodon merremii*. *Journal of Herpetology* **42**(1): 153–162.
- Shibao, P.Y.T., Tashima, A.K., Sanz, L., Camargo, A.C.M., Serrano, S.M.T., Calvete, J.J., Antoniazzi, M.M., Jared, C. (2018): Deep sequencing analysis of toad *Rhinella schneideri* skin glands and partial biochemical characterization of its cutaneous secretion. *Journal of Venomous Animals and Toxins Including Tropical Diseases* **24**(1): 36.
- Uetanabaro, M., Souza, F.L., Landgraf-Filho, P., Beda, A.F., Brandão, R.A. (2008): Guia de Campo de Anuros do Pantanal Sul e Planaltos de Entorno. Campo Grande, Mato Grosso do Sul, Brazil, Editora UFMS/UFMT.
- Uetz, P., Freed, P., Aguilar, R., Hošek, J., Eds. (2025): The Reptile Database. Available at: <https://reptile-database.reptarium.cz/Xenodon/merremii>. Accessed on 13 May 2026.