




First record of *Xenodon nattereri* (Steindachner, 1869) (Reptilia, Squamata, Dipsadidae) from Paraguay

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Abstract. *Xenodon nattereri* (Steindachner, 1869) is a diurnal snake primarily associated with the Cerrado ecoregion in South America, and it is considered endemic to Brazil. Here, we report a record of this species from Cerro Corá National Park (Amambay, Paraguay), extending the geographic range of this species by approximately 30 km to the southwest.

Keywords. Geographic range extension, Neotropics, Parque Nacional Cerro Corá, snakes

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Introduction

The Neotropical snake genus *Xenodon* H. Boie, 1826 consists of medium-sized species with terrestrial or fossorial habits, in addition to species that mimic coral snakes (genus *Micrurus* Wagler, 1824) and pitvipers (genus *Bothrops* Wagler, 1824) (Yanosky and Chani 1988; Cabral et al. 2022). The morphology of these snakes varies, with some having a rounded rostral scale, while others present a modified keeled rostral scale (Grazziotin et al. 2012). A modified rostral scale developed twice independently in a clade containing coral snakes mimics, such as *X. matogrossensis* (Scrocchi & Cruz, 1993), *X. pulcher* (Jan, 1863), and *X. semicinctus* (Duméril, Bibron & Duméril, 1854), and in a clade containing species closely related to either coral snake or pitviper mimics, such as *X. nattereri*, *X. dorbignyi* (Bibron, 1854), and *X. histricus* (Jan, 1863) (Cabral et al. 2022). Of these species, *X. pulcher*, *X. dorbignyi*, and *X. histricus* occur in Paraguay (Cacciali et al. 2016).

Some *Xenodon* species are widely distributed (Nogueira et al. 2019; Cabral et al. 2022) and polychromatic (Cacciali 2010), as is the case with *X. merremii*

(Wagler, 1824), while others have restricted distributions and are chromatically homogeneous such as *X. wernerii* (Eiselt, 1963), *X. guentheri* (Boulenger, 1894), and *X. matogrossensis*. *Xenodon nattereri* (Steindachner, 1869), in particular, occupies a wide area in Brazil and has an Extent of Occurrence (convex hull) of 1,974,843 km². It is a semi-fossorial Neotropical snake typical of open habitats (Cabral et al. 2022). In the latest compilation of the geographic ranges of Brazilian snakes, *X. nattereri* accounted for 130 records from several states, in areas specially associated with the Cerrado ecoregion and adjacent areas of the Atlantic Forest and Chiquitano Dry Forest (Nogueira et al. 2019). Paraguay currently has a diversity of 120 snake species, of which 50 are present in the Cerrado and seven are found exclusively in this ecoregion in Paraguay (Cacciali et al. 2016). *Xenodon nattereri* has not been recorded in Paraguay to date, having been considered endemic to Brazil (Nogueira et al. 2019). Here, we provide the first record of *X. nattereri* from Paraguay, extending the known distribution of this species by approximately 30 km to the southwest.

Methods

Field surveys were conducted in the Cerro Corá National Park (CCNP; Parque Nacional Cerro Corá in Spanish), as part of routine activities led by forest guards. During surveys, personnel searched for animals and evidence of their occurrence (e.g. feces, footprints, and food remains). Specifically for snakes, searches were conducted by active survey sampling methods that included walks along trails while inspecting beneath logs, rocks, tree bark, etc. (Cacciali 2013; Simmons 2015). The individual of *X. nattereri* documented here was found at 8:41 am during a morning walk within the limits of the CCNP.

The CCNP covers 5,538 ha dominated by Cerrado grasslands mixed with subtropical subhumid semi-deciduous forests and gallery forests along the several natural streams, on an uneven surface with some rocky outcrops and hills (Martínez et al. 2016). Elevation information was obtained from the Consortium for Spatial Information (CSI 2008) available at <http://www.diva-gis.org/gdata>, using SRTM30 (30 seconds resolution) datasets.

Results

Xenodon nattereri (Steindachner, 1869)

Figure 1

New record. PARAGUAY – Amambay • Cerro Corá National Park, Picada Lorito, 22°38'33"S, 056°00'19"W; 285 m elev.; date: 17.XII.2022; Carlos Ortega; individual recorded crossing the trail in a gallery forest, sex unidentified.

Identification. The specimen, with a snout–vent length

of about 20 cm (estimated by eye), escaped and could not be collected, and this record is based solely on a photograph (Fig. 1). However, the characteristics shown in the photograph (Fig. 1) allow for the identification of the species. Additional photographs are available at the figshare web repository (<https://doi.org/10.6084/m9.figshare.c.6454849.v1>). The genus *Xenodon* contains six rostral-keeled species. Three of these species (*X. matogrossensis*, *X. pulcher*, and *X. semicinctus*) have wide black, white, or red dorsal rings, resembling the coloration patterns of coral snakes, which do not match the coloration of the photographed individual. *Xenodon nattereri* differs from *X. dorbignyi* because the latter species has black round dorsal spots edged by a white ring, and smaller black spots on both flanks, below each dorsal spot. The individual of *X. nattereri* recorded by us has dark and light brown dorsal bands with irregular edges and separated by white rings. This color pattern is shared by *X. nattereri* and *X. histricus*, although *X. histricus* has red and black bands. We note that this species pair cannot be differentiated using pholidosis, and body color is the major diagnostic character to differentiate them. Therefore, the coloration of our recorded individual matches the description of *X. nattereri* by Scrocchi and Cruz (1993) and photographs of this species by Marques et al. (2009), Fiorillo et al. (2021), and Cabral et al. (2022).

Discussion

The individual of *Xenodon nattereri* recorded by us was found at approximately 30 km from the Paraguayan border with Brazil (Fig. 2) and same distance from the closest known occurrence of this species in Brazil: Ponta Porã municipality, Mato Grosso do Sul (voucher



Figure 1. Individual of *Xenodon nattereri* recorded at the Cerro Corá National Park, Paraguay (not collected).



Figure 2. Geographic location of the Paraguayan record of *Xenodon nattereri* in relation with the closer Brazilian records.

specimen deposited in Instituto Butantan, São Paulo, Brazil: IB 16475). With this new record of *X. nattereri* from Paraguay, the diversity of snake species known from the country increases to 121, with eight species endemic to the Cerrado. We highlight the value of the two most important protected areas in the Paraguayan Cerrado: Laguna Blanca and Cerro Corá National Park. Laguna Blanca had been a protected area for five years (2010–2014), but it is no longer. However, it still has high conservation value in containing an impressive number of reptiles endemic to the Cerrado (Smith et al. 2016). It was considered the first important area for the conservation of amphibians and reptiles from the Paraguayan Cerrado (Smith et al. 2016), and the second important area is the CCNP, from where there are also many records of species endemic to this ecoregion (Cacciali et al. 2015, 2016). Our record of a newly discovered snake from the Cerrado in Paraguay highlights the importance of maintaining and increasing conservation of this threatened ecoregion in this country.

According to Cacciali et al. (2015), the CCNP is a well-sampled area compared with other Paraguayan protected areas, and it contains 37 reptile species. Our record of *X. nattereri* raises the number of reptile species protected in this area to 38. It is noteworthy that this species is currently considered as Least Concern globally by the International Union for the Conservation of Nature (IUCN; Silveira et al. 2012). However, further field surveys are required to better understand its geographic distribution in Paraguay and therefore its national conservation status. Most of the natural Cerrado vegetation has been dramatically altered in the eastern region of the country.

Some authors suggest that taxonomic aspects of *X. nattereri* are unresolved, as it has been considered as a synonym of *X. histricus* (Peters and Orejas-Miranda; Cei 1993). Hoge et al. (1976) separated these species on the basis of color patterns, although they are the most similar species pair among *Xenodon* and phylogenetically closely related (Grazziotin et al. 2012).

Nevertheless, even with their similar color, genetic differentiation between *X. histricus* and *X. nattereri* is greater than among *X. pulcher*, *X. semicinctus*, and *X. matogrossensis* (Cabral et al. 2022). If *X. nattereri* is treated as a synonym of *X. histricus*, our record is still of great importance given that the distribution of *X. histricus* in Paraguay is not accurate (Cacciali et al. 2016).

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Author Contributions

Conceptualization: PC, CO. Investigation: PC. Methodology: CO. Visualization: CO, PC. Writing – original draft: PC. Writing – review and editing: CO.

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