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PENSOFT

Mussurana bicolor (Peracca, 1904) (Squamata, Colubridae): additional country records and first list of voucher specimens from Bolivia

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Abstract. We present country records and a list of voucher specimens for *Mussurana bicolor* (Peracca, 1904) (Serpentes, Colubridae) from Bolivia. There is scarce information on museum specimens and locality data from Bolivia for this species in the scientific literature. Additionally, we discuss two newly collected specimens from the Llanos de Moxos, a floodplain in the Beni Department. This account contributes to the knowledge of the northwestern distributional status of *M. bicolor* and summarizes available data for Bolivia.

Keywords. Beni, Neotropics, Primary rainforest, snake

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Introduction

The genus *Mussurana* Zaher, Grazziotin, Cadle, Murphy, Moura-Leite & Bonatto, 2009 (Serpentes, Colubridae) comprises three species: *Mussurana bicolor* (Peracca, 1904), *M. montana* (Franco, Marques & Puorto, 1997), and *M. quimi* (Franco, Marques & Puorto, 1997). These are terrestrial, possibly semifossorial, snakes known to inhabit open savannahs, wetlands, gallery forests, Pantanal, Chiquitano dry forest, and Chaco (Cei 1993; Strussmann and Sazima 1993; Couturier and Faivovich 1996; Franco et al. 1997; Morato et al. 2003; Álvarez et al. 2009; Cabral and Weiler 2014; Cano et al. 2015; Cacciali et al. 2016; Nogueira et al. 2019). Morphologically these species are characterized as being smaller-bodied, having fewer ventral scales, and with unique coloration as compared to species of *Boiruna* Zaher, 1996, *Clelia* Fitzinger, 1826, and *Pseudoboa* Schneider, 1801 (Zaher 1996; Franco et al. 1997; Morato et al. 2003; Zaher et al. 2009). Additionally, Zaher (1994, 1999) and Zaher at al. (2009) described this genus as undergoing ontogenetic changes in color and pattern. Juveniles are brick red with a black longitudinal vertebral band and a uniformly creamish venter. Adults are entirely black on the dorsum. The hemipenis has a unique row of larger papillae on the internal face of the lobes, the postero-ventral tip of the nasal gland is longer than wide, and the dorsal wall of the Duvernoy gland is reduced throughout its length.

Mussurana bicolor (Peracca, 1904) was originally described based on a male specimen (MHNG 677.47) from northern Santa Fé province, Argentina (Peracca

1904), and it has since been documented in southern Brazil and across most parts of Paraguay (Scrocchi and Viñas 1990; Cei 1993; Strussmann and Sazima 1993; Couturier and Faivovich 1996; Franco et al. 1997; Morato et al. 2003; Scrocchi et al. 2006; Scott et al. 2006; Álvarez et al. 2009; Giraudo et al. 2012; Cabral and Weiler 2014; Cano et al. 2015; Cacciali et al. 2016; Nogueira et al. 2019). However, to our knowledge there is no existing information available other than the occurrence of this species in Bolivia, but which was first documented there by Jansen (2008) in the Santa Cruz Department.

Here we report two specimens of *M. bicolor* recently collected from the Beni Department (Centro de Investigación de Recursos Acuáticos, CIRA-946; Colección Boliviana de Fauna, CBF-4645) and present a list of 13 specimens, including the new specimens, collected from Bolivia and deposited in museum collections and for which we were able to access associated data.

Methods

Scale counts, scutellation, and terminology follows Dowling (1951) and Peters (1964). Paired subcaudals were counted on one side only. Dorsal scale row counts were taken at three standardized locations; these counts are separated by a slash (/): head length behind occiput, midbody, and head length anterior to cloaca. An Olympus SZX10 DF PL 0.5x stereo microscope with a MikrOkular Full HD digital camera was used to photograph and identify apical pits on dorsal scales. Live measurements were taken immediately upon capture with a flexible ruler to the nearest millimeter. Live weight (g) of each specimen was determined using an Ohaus model HH 320 electronic balance. Sex was determined by the probe method following McDiarmid et al. (2012) and confirmed by injection following Simmons (2002). Specimen identification was determined by comparing and analyzing meristic data, morphometrics, and coloration, as well as figures, drawings, and photographs from the original description (Peracca, 1904) and taxonomic information by Cei (1993), Couturier and Faivovich (1996), Zaher (1996), Franco et al. (1997), Morato et al. (2003), and Scott et al. (2006). The specimens were fixed in a formalin solution and preserved in a 70% ethanol solution. Geographic coordinates in decimal degrees were obtained with a Garmin eTrex GPS receiver and using the WGS84 datum. All specimens are associated with specific geographic coordinates. The map was prepared using ArcGIS Pro v. 3.0.

Abbreviations for museum collections are as follows: Museo Nacional de Historia Natural, Colección Boliviana de Fauna (CBF), Forschungsinstitut und NaturMuseum Senckenberg (SMF), Museo de Historia Natural "Noel Kempff Mercado" (MNKR), Colección de Historia Natural de Herpetología, Centro de Investigación de Recursos Acuáticos, Universidad Autónoma del Beni José Ballivián (CIRA), Smithsonian National Museum of Natural History (USNM), American Museum of Natural History (AMNH), and the University of Florida, Florida Museum of Natural History (UF). A comprehensive search for voucher specimen information consisted of reviewing published scientific papers, journals, books, and government reports. Four online databases (VertNet, https://vertnet.org; ARCTOS, https://arctosdb.org/; Global Biodiversity Information Facility (GBIF), https://www.gbif.org/; SpeciesLink, https://splink.cria.org.br/) were also searched. We only verified identification and reviewed material from the new specimens reported herein. For voucher specimens reported via online databases and publications, we only reviewed and assessed associated available data.

The newly collected specimens were deposited in the herpetology collection of Museo Nacional de Historia Natural, Colección Boliviana de Fauna (CBF-4645) in La Paz, Bolivia and Centro de Investigación de Recursos Acuáticos (CIRA-946) in Trinidad, Beni, Bolivia. Specimen collection was approved by the Texas A&M University–Kingsville (#2018-05-22) Animal Care and Use Committees and permitted by the Dirección General de Biodiversidad y Áreas Protegidas Bolivia (permits #0120/2022 and #0128/2019).

Results

***Mussurana bicolor* (Peracca, 1904)**

Figures 1–3

New records (Fig. 1). BOLIVIA – Beni • José Ballivián, Llanos de Moxos, near the Yacuma River; 14.1049°S, 066.8019°W; on the bank of a roadside pool during a herpetological survey of the area; G. Callapa & R. Hurtado leg., 16 June 2022; 1 adult ♂ (CBF-4645); Figure 2 • Cercado, on the Hernán Melgar Justiniano University Campus of the Universidad Autónoma del Beni José Ballivián, in the offices of the Centro de Investigación de Recursos Acuáticos; 14.8117°S, 064.8961°W; found opportunistically; L.R. Rivas, C.B. Eversole & R.L. Powell leg., 4 July 2022; 1 adult ♂ (CIRA-946); Figure 3.

Identification. The specimens (Figs. 2, 3) were identified following relevant literature based on the following diagnostic characters: smaller than the other two species of the genus, generally not exceeding 80 cm in total length (CBF-4645: snout to vent length, 36.6 cm; tail

Table 1. Meristic data from the two specimens of *Mussurana bicolor* from Beni, Bolivia (CBF-4645 and CIRA-946).

Code	Dorsal scales	Apical pits	Ventral scales	Subcaudal scales	Cloacal scale	Supralabials	Supralabials in contact with orbit
CBF-4645	19-19-17	2	171	72 (pair)	Single	8/8	4-5/4-5
CIRA-946	19-19-17	2	169	70 (pair)	Single	8/9	4-5/5-6

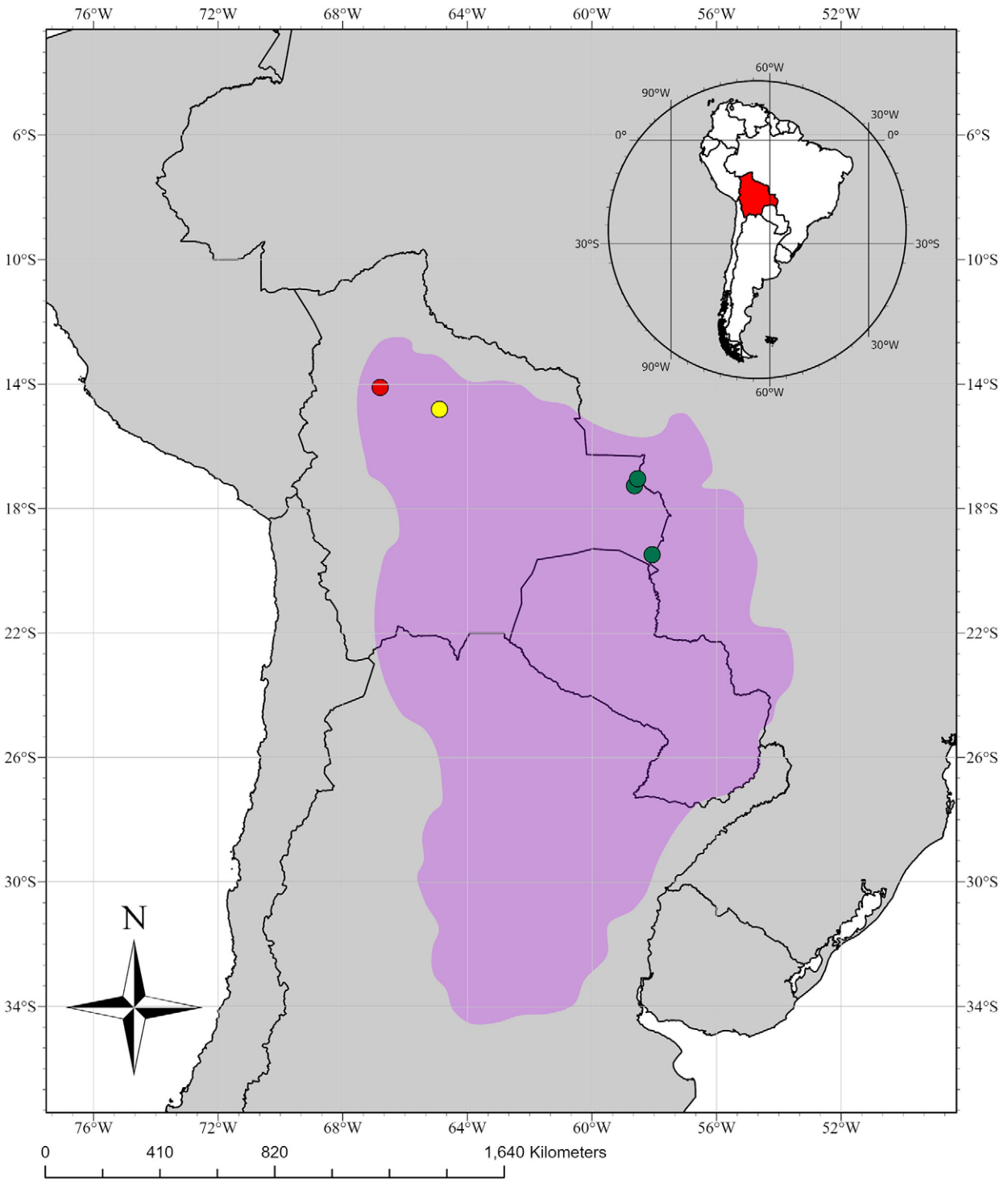

Figure 1. New records of *Mussurana bicolor* from the Department of Beni, Bolivia (CBF-4645, red circle; CIRA-946, yellow circle), additional voucher specimens collected in Bolivia that include precise locality data (green circles), and estimated range (based on previously reported specimens) in South America (magenta area).

length, 10.2 cm; live weight, 22.3 g; CIRA-946: snout to vent length, 40.0 cm; tail length, 11.9 cm; live weight, 26.4 g). See Table 1 for meristic data.

Color and pattern: specimens with a wide (10–12 scales) dark brown or greyish black vertebral stripe and a lighter (tan, dark yellow, or dark orange) flank region (Figs. 2, 3). The dorsal vertebral stripe displays much less contrast in older adults due to darkening of the flank region (Zaher et al. 2009). Dorsal scales with apical pits (two) and dorsum with varying degrees of iridescence. Dorsal head color dark brown to black with supralabial scales ivory. Ventral color ivory and immaculate.

Other Bolivian specimens. In addition to the novel collected specimens (CBF-4645, CIRA-946), we located 11 specimens of *M. bicolor* deposited in six collections. These additional Bolivian specimens were collected from across the departments of Santa Cruz and Beni (Fig. 1; Table 2).

Figure 2. *Mussurana bicolor* specimen (CBF-4645) from near the Yacuma River, Santa Rosa, Beni, Bolivia.

Figure 3. *Mussurana bicolor* specimen (CIRA-946) from the Hernán Melgar Justiniano University Campus, city of Trinidad, Beni, Bolivia.

Table 2. Voucher specimens of *Mussurana bicolor* collected from Bolivia based on literature and museum data (including new records from Beni, Bolivia).

Specimen	Date collected	Department	Province	Locality	Latitude	Longitude
CBF-2105	3 May 1993	Santa Cruz	Ángel Sandóval	San Fernando	−17.2600	−058.6380
CBF-4645	16 June 2022	Beni	José Ballivián	Santa Rosa municipality, near the Yacuma River	−14.1049	−066.8018
USNM-281001	17 Dec 1979	Beni	Cercado	Trinidad	No data	
USNM-280969	2 July 1982	Beni	Vaca Diez	Guayaramerín	No data	
AMNH R-101823		Beni	No additional data			
AMNH R-104559		Beni	No additional data			
AMNH R-101822		Beni	No additional data			
SMF-86639	15 April 2004	Santa Cruz	Ángel Sandóval	Hacienda El Espinal, Pantanal, San Matias	−17.0372	−058.5305
MNKR-4255	23 January 2005	Santa Cruz	Ángel Sandóval		−17.0372	−058.5305
MNKR-19953	11 April 2013	Santa Cruz	Ángel Sandóval	Área Natural de Manejo Integrado San Matías	−17.0372	−058.5339
MNKR-19954	11 April 2013	Santa Cruz	Germán Busch	Parque Nacional y Área Natural de Manejo Integrado Otuquis	−19.4872	−058.0686
UF Herp-68524	21 August 1986	Beni	Iténez	1 km south of Magdalena	No data	
CIRA-946	4 July 2022	Beni	Cercado	Trinidad, Hernán Melgar Justiniano University Campus	−14.8117	−064.8958

Discussion

The distribution of *Mussurana bicolor* appears to be wider than that of the other two *Mussurana* species, *M. montana* and *M. quimi*, and extends from northern Argentina, across Paraguay to southern Brazil (Peracca 1904; Scrocchi and Vinas 1990; Strussmann and Sazima 1993; Couturier and Faivovich 1996; Scrocchi et al. 2006; Scott et al. 2006, Giraudo et al. 2012, Cano et al. 2015, Nogueira et al. 2019). Nogueira et al. (2019) included Bolivia in the distributional range of this species. However, they did not reference specific specimens or provide detailed geographic information from Bolivia as the basis for this inclusion. As mentioned by Powell et al. (2021), the information presented by Nogueira et al. (2019) is problematic, as several specimens do not have reference voucher numbers and there are numerous errors and duplications. Therefore, information from Nogueira et al.'s publication and associated data should first be verified and referenced with caution.

The two recently collected specimens of *M. bicolor* constitute important new records for Bolivia and the Beni Department. The combination of these and other *M. bicolor* specimens housed in various collections (Table 2), represent the first verified and georeferenced occurrence records of this species from Bolivia as a whole. The distribution of *M. bicolor* extends towards the Llanos de Moxos, a plain which is characterized by tropical savanna and mixed riverine forest near Santa Rosa and palm groves-grasslands in the surroundings of Trinidad (Navarro 2011). The new records from the Beni Department extend the known geographical distribution by approximately 399 km (CIRA-946) and 572 km (CBF-4645) in a straight line to northwestern Bolivia from the nearest previously known occurrence Angostura, Santa Cruz, Bolivia (Jansen 2008). Coupled with other, mostly unreported occurrences based on previously collected specimens, the new and old records a distributional gap in the northwestern portion of the species' range in Bolivia. These findings underline the need for further herpetological surveys in the vast and poorly understood Llanos de Moxos—the largest wetland in the Amazon basin.

More data are needed to fully delimit the distribution of *M. bicolor* in Bolivia and throughout its range in South America, and will aid in a better understanding of the occurrence and occupancy of this species in the neotropics. Additional data will also improve our knowledge of the ecology and natural history of *M. bicolor*, which is severely limited throughout the entirety of its range (Santana et al. 2019; Silva and Couto 2021). Additionally, although the IUCN conservation status of this species is currently categorized as Least Concern, improved delineation of the true distributional range of *M. bicolor* will aid in future assessments of its conservation status (IUCN 2022).

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Author Contributions

Conceptualization: LRR, CBE, RLP, GC. Data curation: RLP, CBE, LRR, GC. Formal analysis: CBE, GC, RLP. Funding acquisition: RW, CBE, RLP. Investigation: CBE, RLP, RW, LRR, GC. Methodology: RLP, GC. Project administration: RLP. Supervision: RW, CBE, LRR, RLP. Validation: CBE. Visualization: CBE, RLP. Writing – original draft: CBE, RLP, GC, LRR. Writing – review and editing: RLP, GC, LRR, CBE, RW.

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