

Snakes of Juazeiro, Bahia, Middle of São Francisco River, Brazil

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RESUMO: (Serpentes de Juazeiro, Bahia, Médio Rio São Francisco, Brasil). Apresentamos aqui um inventário de serpentes do município de Juazeiro, na Bahia, Brasil, uma região semiárida do médio Rio São Francisco. Foram registradas 25 espécies entre os 45 espécimes de serpentes coletadas, por meio de coleta por terceiros, na fitofisionomia arbustiva da Caatinga. Esta pesquisa representa um trabalho inédito sobre diversidade de uma região pouco conhecida, com comentários em outros estudos no Bioma Caatinga.

Palavras-chave: Répteis, Squamata, inventário, semiárido.

ABSTRACT: We present an inventory of snakes from the municipality of Juazeiro, state of Bahia, Brazil, a semi-arid region in the middle São Francisco River. Forty-five individuals from 25 species were recorded, based on specimens collected by third parties, in the phytophysiognomy of Caatinga scrubs. This research represents a novel study on the diversity of a poorly known region, and includes comments on other studies in the Caatinga biome.

Key words: Reptiles, Squamata, inventory, semiarid.

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Introduction

Inventories of herpetofauna for environmental licensing of hydroelectric projects have increased significantly in Brazil over the last 10 years, mainly in the north and central-west regions (Pavan & Dixo, 2004; Vaz-Silva *et al.*, 2007; Cintra *et al.*, 2009; Silva Jr *et al.*, 2009; Ilha & Dixo, 2010; Ávila & Kawashita-Ribeiro, 2011).

In the Atlantic Forest, Cerrado, and Caatinga domains, inventories involving amphibians and reptiles have also been intensified because of the environmental licensing process. However, these have not occurred as a direct result of the energy demand, as is the case in the central-west and northern regions of Brazil (Silva Jr *et al.*, 2009; Ilha & Dixo, 2010; Avila & Kawashita-Ribeiro, 2011). These inventories are a consequence of smaller licensing projects added to independent academic research (Feio & Caramaschi, 2002; Argôlo, 2004; Carvalho *et al.*, 2005; Dixo & Verdade, 2006; Recoder & Nogueira, 2007; Ribeiro *et al.*, 2008; Juncá & Lima, 2008; Santana *et al.*, 2008; Sawaya *et al.*, 2008; Costa *et al.*, 2009; Ghizoni-Jr *et al.*, 2009; Valdujo *et al.*, 2009; Forlani *et al.*, 2010; Salles *et al.* 2010; Tonini *et al.*, 2010; Morato *et al.*, 2011; Recoder *et al.*, 2011; Vrcibradic *et al.*, 2011; Castro *et al.*, 2012; Freitas *et al.*, 2012; Ribeiro *et al.*, 2012; Souza Filho & Verrastro, 2012; Hamdan & Lira-da-Silva, 2012).

Local snake inventories in the semi-arid domain are very rare, being considered one of the least sampled Brazilian biomes regarding list of species and inventories. Some studies (e.g. Juncá, 2005; Freitas *et al.*, 2012; Ribeiro *et al.*, 2012; Benício *et al.*, 2012 a and b; Mesquita *et al.*, 2013) have reported the occurrence of squamate reptiles in areas of the Caatinga in northeastern Brazil. However, the areas sampled in these studies are altitude enclaves amidst the Caatinga Biome with several vegetation types including forests, cerrados and savannas, being usually more diverse ecosystems harboring species from more humid environments.

Inventories exclusive to the Caatinga's interplanaltic depressions (Ab `Saber, 1977) are very rare and poorly known (Vanzolini *et al.*, 1980; Vitt & Vangilder, 1983; Rodrigues, 2003; Rodrigues, 1996; Cavalcanti *et al.*, 2014; Guedes *et al.*, 2014). Based on the lack of studies in the Central Caatinga area, we gathered a significant sample of specimens, aiming to increase awareness and present an inventory of the snake fauna of the municipality of Juazeiro, in the middle Rio São Francisco, central region of Caatinga biome in the state of Bahia.

Material and methods

The study area is located in Juazeiro (09°25'34''S, 40°30'30''W, WGS84), state of Bahia, northeastern Brazil and characterized by semi-arid climate, arboreal Caatinga vegetation, grazing fields, planting of tropical fruits and urban expansion (Alvarez *et al.*, 2010).

Data was collected from 1993 to 2015, while collected specimens were only acquired from 1997 to 2001; specimens were either observed or photographed, while the ones collected for this study were obtained by third-party collector donations made to Cobra-Viva Wild Animal Sanctuary, or from road cruising for run-over or live individuals on the BR-324 and 407 highway (which crosses the city of Juazeiro). Many of the specimens delivered to Cobra Viva came from apprehensions by the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), the Military Police and firemen of the municipality of Juazeiro. The vast majority of specimens collected were stored in a freezer after arriving dead and, at least twice a year, were taken to the Zoological Collection of the State University of Feira de Santana, Bahia, Brazil. Specimens after death were stored in a freezer and subsequently preserved in

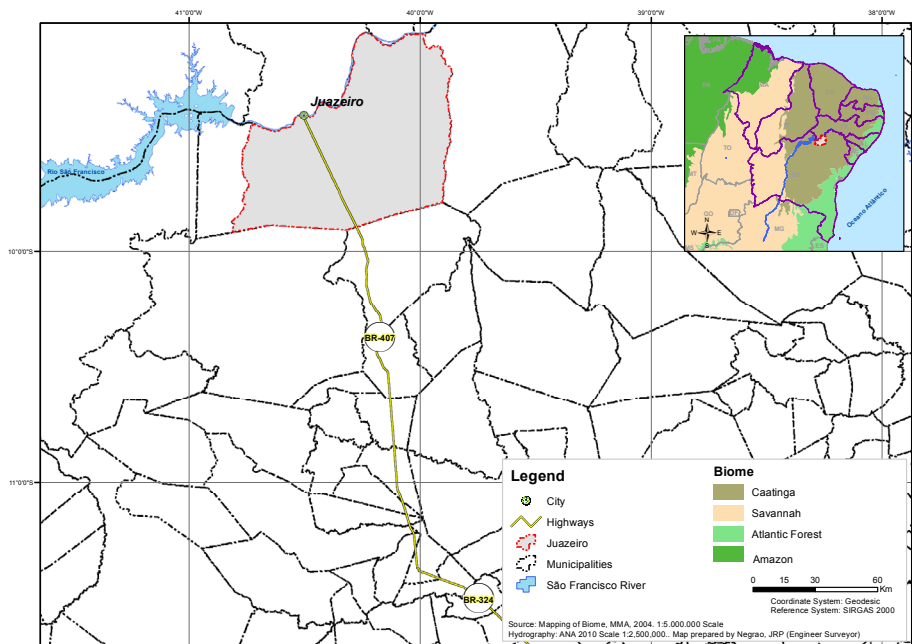


Figure 1. Map of Juazeiro in Bahia, Brazil and its central location in the Caatinga Biome.

70% ethanol. Taxonomic nomenclature follows Costa & Bérnils (2015) and the voucher specimen numbers can be found in Appendix 1. After thawing, the specimens were fixed in 10% formalin and subsequently deposited in the reference collection of the Museum of Zoology of the State University of Feira de Santana (MZUEFS, Feira de Santana, Bahia), and Zoology Museum of the Santa Cruz State University (MZUESC, Ilhéus, Bahia), Brazil.

Permits issued for collections over this long period of study were IBAMA/SUPES/BA/2006 Wild Animal Sanctuary Cobra Viva. Collections were also granted in Articles 26 of IBAMA's Normative Instruction 119/2006 and Article 26 of IN 154/2007 of ICMBio for collecting animal carcasses on federal and state highways.

Results

Due to the extensive nature of this study (22 years' worth of observations and 5 years of collections), we could not present a detailed account of our collecting efforts and methods. However, from the described collections by third parties, we present 45 individuals representing 25 snake species belonging to six families (Table 1; Figures 2, 3 and 4) observed within the city limits of Juazeiro, state of Bahia, northeastern Brazil (Figure 1).

Discussion

The inventories of snakes in the Caatinga that are closest to the municipality of Juazeiro were carried out in Xique-Xique, about 300 kilometers south of Juazeiro (Rodrigues, 1996; Rodrigues & Juncá, 2002), recording 26 species of snakes from seven families. There is some similarity in the species found between the Xique-Xique and Juazeiro collection sites of at least 15 species. However, the study by Rodrigues (1996) in Xique-Xique was conducted in a region of paleodunes that is represented by a strong presence of endemic species of snakes, such as *Amerotyphlops amoipira* (Rodrigues & Juncá, 2002) *Amerotyphlops yonenagae* (Rodrigues, 1991), *Apostolepis arenaria* Rodrigues, 1992, *Apostolepis gaboi* Rodrigues, 1992, *Rodriguesophis chui* (Rodrigues, 1993) and *Rodriguesophis scriptorcibatus* (Rodrigues, 1993). Based on Rodrigues (1996) and Brito & Freire (2012) it may be possible to find *Typhlops yonenagae* Rodrigues, 1991 in Juazeiro since this species inhabits sandy soils on the right bank of the São Francisco River. *Mastigodryas bifossatus* (Raddi, 1820), may also be found in Juazeiro

Table 1. Species registered in Juazeiro, Bahia, Brazil.

Serpentes	
Family	Species
Leptotyphlopidae	<i>Trilepida brasiliensis</i> (Laurent, 1949)(Figure 2A)
Boidae	<i>Boa constrictor</i> Linnaeus, 1758 (Figure 3J)
	<i>Epicrates assisi</i> Machado, 1945 (Figure 3K)
Colubridae	<i>Spilotes pullatus</i> (Linnaeus, 1758) (Figure 3L)
	<i>Leptophis ahaethulla</i> (Linnaeus, 1758) (Figure 4Z)
	<i>Chironius exoletus</i> (Linnaeus, 1758) (Figure 3M)
	<i>Oxybelis aeneus</i> (Wagler, 1824) (Figure 3N)
Dipsadidae	<i>Erythrolamprus poecilogyrus</i> (Wied, 825) (Figure 3O)
	<i>Erythrolamprus mossoroensis</i> (Hoge & Lima-Verde, 1973) (Figure 2C)
	<i>Erythrolamprus viridis</i> (Günther, 1862) (Figure 3P)
	<i>Lygophis dilepis</i> (Cope, 1862) (Figure 2D)
	<i>Leptodeira annulata</i> (Linnaeus, 1758) (Figure 4Q)
	<i>Boiruna sertaneja</i> Zaher, 1996 (Figure 2E)
	<i>Rodriguesophis iglesiassi</i> (Gomes, 1915) (Figure 2B)
	<i>Helicops leopardinus</i> (Schlegel, 1837) (Figure 4R)
	<i>Oxyrhopus trigeminus</i> Duméril, Bibron and Dumeril, 1854 (Figure 4S)
	<i>Philodryas olfersii</i> (Lichtenstein, 1823) (Figure 4T)
	<i>Philodryas nattereri</i> (Lichtenstein, 1823) (Figure 4U)
	<i>Pseudoboa nigra</i> (Duméril, Bibron and Dumeril, 1854) (Figure 4V)
	<i>Xenodon merremii</i> (Wagler, 1824) (Figure 4W)
	<i>Thamnodynastes sertanejo</i> Bailey, Thomas & Silva-Jr, 2005 (Figure 2F)
	<i>Thamnodynastes</i> sp. (Figure 2G)
Elapidae	<i>Micrurus</i> sp. (Figure 3I)
Viperidae	<i>Bothrops erythromelas</i> (Amaral, 1923) (Figure 2H)
	<i>Crotalus durissus</i> Linnaeus, 1758 (Figure 4X)

(A) *Trilepida brasiliensis*(B) *Rodriguesophis iglesiassi*(C) *Erythrolamprus mossoroensis*(D) *Lygophis dilepis*(E) *Boiruna sertaneja*(F) *Thamnodynastes sertanejo*(G) *Thamnodynastes* sp.(H) *Bothrops erythromelas*

Figure 2. Snakes collected in Juazeiro, Bahia, Brazil; (A) *Trilepida brasiliensis*; (B) *Rodriguesophis iglesiassi*; (C) *Erythrolamprus mossoroensis*; (D) *Lygophis dilepis*; (E) *Boiruna sertaneja*; (F) *Thamnodynastes sertanejo*; (G) *Thamnodynastes* sp.; (H) *Bothrops erythromelas*.



(I) *Micrurus* sp



(J) *Boa constrictor* - specimen measuring 3.52 meters



(K) *Epicrates assisi*



(L) *Spilotes pullatus*



(M) *Chironius exoletus*



(N) *Oxybelis aeneus*



(O) *Erythrolamprus poecilogyrus*



(P) *Erythrolamprus viridis*

Figure 3. Snakes collected in Juazeiro, Bahia, Brazil; (I) *Micrurus* sp; (J) *Boa constrictor*; (K) *Epicrates assisi*; (L) *Spilotes pullatus*; (M) *Chironius exoletus*; (N) *Oxybelis aeneus*; (O) *Erythrolamprus poecilogyrus*; (P) *Erythrolamprus viridis*.

(Q) *Leptodeira annulata*(R) *Helicops leopardinus*(S) *Oxyrhopus trigeminus*(T) *Philodryas olfersii*(U) *Philodryas nattereri*(V) *Pseudoboa nigra*(W) *Xenodon merremii*(X) *Crotalus durissus*(Z) *Leptophis ahaethulla*

Figure 4. Snakes collected in Juazeiro, Bahia, Brazil; (Q) *Leptodeira annulata*; (R) *Helicops leopardinus*; (S) *Oxyrhopus trigeminus*; (T) *Philodryas olfersii*; (U) *Philodryas nattereri*; (V) *Pseudoboa nigra*; (W) *Xenodon merremii*; (X) *Crotalus durissus*; (Z) *Leptophis ahaethulla*.

for having a wide distribution in various biomes of Brazil (Freitas, 2003). Further studies are needed in order to assess the occurrence of these and other putative species in the study area.

Ribeiro *et al.*, (2012) recorded 43 snake species in the Chapada do Araripe, southern Ceará. Ribeiro *et al.*, (2013) found 15 species of snakes on the left bank of the São Francisco River in the city of Petrolina, state of Pernambuco, and out of these only *Lygophis paucidens* Hoge, 1953 was not recorded in Juazeiro. Mesquita *et al.*, (2013) found 22 species of snakes for the semi-arid region in the state of Ceará, of which only *Apostolepis cearensis* Gomes, 1915, *Mastigodryas bifossatus*, *Psomophis joberti* (Sauvage, 1884) and *Tantilla melanocephala* (Linnaeus, 1758) were not found in Juazeiro.

In the National Park of Serra da Capivara, Piauí, eleven species were found, and only *Corallus hortulanus* (Linnaeus, 1758) and *Bothrops lutzi* (Miranda-Ribeiro, 1915) were not recorded in Juazeiro (Cavalcanti *et al.*, 2014). In the National Park of Catimbau, Pernambuco, eleven species were found, of which only *Tantilla melanocephala*, *Apostolepis cearensis* Gomes, 1915 and *Taeniophallus affinis* (Gunther, 1858) were not recorded in Juazeiro (Pedrosa *et al.*, 2014). Benício *et al.*, (2015) found 12 species of snakes in the central region of Piauí, all also found in Juazeiro. In both regions from other states of Brazil, there are forests, cerrados and caatingas, a mosaic of ecosystems that foster greater species diversity. In the northern state of Piauí, 14 species of snakes were found in a transition area between the semi-arid region and the Cerrado, eight species occurring in both areas (Silva *et al.*, 2015).

Other surveys performed in the Caatinga found a higher number of species of snakes, such as the inventories of amphibians and reptiles in the Chapada Diamantina Central, Bahia, which recorded 44 snake species (25 snake species in Juncá, 2005; 35 species in Freitas *et al.*, 2012; 23 species in Magalhães *et al.*, 2015).

A total of 112 snake species have been found in the Caatinga biome, 25 of which are endemic. The tropical and subtropical grasslands, savannas and shrublands have several enclaves of other vegetations such as savanna, forests and transitional environments, with a large number of species that only occur at specific points within the entire Caatinga (Guedes *et al.*, 2014).

In the middle São Francisco River region, in Juazeiro, Bahia, the 25 species recorded in this study have a wide geographical distribution in the Caatinga biome. This is especially true for *Trilepida brasiliensis* (Figure 2 A) because this species is recorded in the Cerrado Biome or its enclaves (Rodrigues & Puerto, 1994; Ribeiro *et al.*, 2012), and this is the first record of this species for typical Caatinga depressions. *Rodriguesophis iglesiasi* (Figure 2 B) is also

a species known only from the Cerrado Biome in sandy soils. According to Guedes *et al.*, (2014), only seven species found in Juazeiro are endemic to the Caatinga biome, *Epicrates assisi* (Figure 3 K), *Erythrolamprus mossoroensis* (Figure 2 C), *Boiruna sertaneja*, (Figure 2 E), *Thamnodynastes sertanejo* (Figure 2 F), *Thamndynastes* sp., (Figure 2 G), *Bothrops erythromelas* (Figure 2 H), and *Micrurus* sp., (Figure 3 I), being *Thamnodynastes sp* and *Micrurus sp* undescribed species, endemic to the Caatinga, according to Franco & Ferreira (2002) and Guedes *et al.*, (2014), respectively. According to Freitas (2003), *Crotalus durissus* (Figure 4X) and *Philodryas nattereri* (Figure 4U), are widely distributed through open vegetation environments in the Cerrado and Caatinga biomes. *Leptodeira annulata* (Figure 4Q), is always associated with ciliary forests (Freitas, 2003), and *Leptophis ahaethulla* (Figure 4Z), is always associated with tree life (Freitas, 2003), and only a single individual was recorded in 27 Years of this species. The other species recorded in this study have wide distribution in other regions of Brazil and neighboring countries. We suggest that the use of other collection methods or larger sampling periods could be used to increase the knowledge and quantitative lists of the regional taxa. Inventories of snakes in the Caatinga Biome are essential for the basic knowledge of snakes found in this biome; it is very important that basic inventories be published more often in order to provide a base for future studies, considering that inventories can provide useful data for further ecological or taxonomic works regarding the sampled taxa. We highlight the importance of the educational work conducted by the Wild Animal Sanctuary “Cobra Viva” in Juazeiro, considering its significant contributions of collected specimens to our work, as well as environmental education regarding the conservation of snakes

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Appendix 1. Voucher specimens deposited at the Museum of Zoology of the State University of Feira de Santana (MZUEFS) and Zoology Museum of the Santa Cruz State University (MZUESC):

Trilepida brasiliensis (MZUEFS 677, 1127 - 1129) *Boa constrictor* (MZUEFS 647; MZUESC 8162) *Epicrates assisi* (MZUEFS 1285-87) *Spilotes pullatus* (MZUEFS 1448) *Chironius exoletus* (MZUEFS 1279) *Oxybelis aeneus* (MZUEFS, 1388) *Oxyrhopus trigeminus* (MZUEFS 1126, 1288, 1455) *Pseudoboa nigra* (MZUEFS 1130, 1289) *Philodryas nattereri* (MZUEFS 1280, 1389-90, 1409, 1452-54) *Philodryas olfersii* (MZUEFS 1455) *Helicops leopardinus* (MZUEFS 1282-83, 1386-87) *Xenodon merremii* (MZUEFS 1284, 1457) *Boiruna sertaneja* (MZUEFS 1407) *Erythrolamprus viridis* (MZUEFS 1456) *Erythrolamprus mossoroensis* (MZUEFS 1391) *Erythrolamprus poecilogyrus* (MZUEFS 1392) *Lygophis dilepis* (MZUEFS 1458) *Rodriguesophis iglesiassi* (MZUEFS 1393) *Thamnodynastes* sp. (MZUEFS 1281) *Thamnodynastes sertanejo* (MZUEFS 1462) *Micrurus* sp. (MZUEFS 1460) *Bothrops erythromelas* (MZUEFS 685, 1285, 1449-51) *Crotalus durissus* (MZUEFS 1459).