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The Herpetofauna of Boqueirão da Onça: an Important Natural Heritage Site in the Caatinga of Brazil

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***Abstract.*—The conservation units of Boqueirão da Onça, Brazil, a mosaic of protected areas located in the sub-middle of the São Francisco River, host the largest continuum of preserved Caatinga vegetation in the world. Although the region represents a biodiversity hotspot in the Caatinga domain, many relevant areas remain unsampled for amphibians and reptiles. To fill important knowledge gaps about the distribution, ecology, and diversity of herpetofauna from Caatinga, we present here a list of amphibian and reptile species of the Boqueirão da Onça, in Bahia state, northeastern Brazil. We conducted field expeditions between August 2019 and May 2021, totaling 64 sampling days using six sampling methods. We recorded 76 species, including 24 amphibians, one chelonian, 19 lizards, 27 snakes, and five amphisbaenians. This result represents the highest diversity reported in the Caatinga to date, compared to studies conducted in other locations throughout the domain. Additionally, we extended the geographic distribution of three species, and identified a frog and a lizard as potentially new species. The diversity of mammals, birds, and now amphibians and reptiles found in the area highlights the importance of Boqueirão da Onça as a priority area for conservation programs in the Caatinga domain.**

Key Words.—amphibians; conservation; inventory; reptiles; species richness

Introduction

The Caatinga has long been misconceived as a domain with low diversity and endemism rates (Garda et al. 2018); however, its high biodiversity has become more recognized over the last decade due to numerous studies conducted, mainly in protected areas (e.g., Pedrosa et al. 2014; Magalhães et al. 2015; Campos et al. 2019; de Castro et al. 2019). This seasonally dry tropical forest of South America (SDTF) covers 912.529 km², which is 10.7% of Brazil's territory (da Silva et al. 2017). Among the important areas for conservation in the Caatinga, the mosaic of protected areas of Boqueirão da Onça in Brazil is essential to protecting biodiversity of this biome (Tabarelli and da Silva 2003; Antongiovanni et al. 2018). This mosaic is in the sub-middle of the São Francisco River, the most economically and biologically important river in northeastern Brazil (da Silva et al. 2005). Established in 2018 (decree-laws 9,336/18 and 9,337/18), the mosaic comprises the Boqueirão da Onça National Park, covering 346,000 ha, and the Boqueirão da Onça Environmental Protection Area (EPA), covering 505,000 ha. Collectively, these two protected areas form a biodiversity conservation hotspot within the Caatinga, encompassing over 850,000 ha. Studies conducted in the region have found high mammal and bird diversity (Schunck et al. 2012; Campos et al. 2019), as well as new species of plants, reptiles, and amphibians that are endemic to the region (e.g., Pereira et al. 2016; Siniscalchi et al. 2019; Ribeiro et al. 2020; Mângia et al. 2022). In addition, the region harbors endangered flagship species including the Jaguar (*Panthera onca*) and Three-banded Armadillo (*Tolypeutes tricinctus*), as well as the Lear's Macaw (*Anodorhynchus leari*), all of which are protected in this area (Ministério do Meio Ambiente [MMA] 2022). Despite the relevance of the Boqueirão da Onça mosaic, most conservation units encompass the Environmental Protection Area, which is less restrictive in terms of land use and allows sustainable activities, which corresponds to the International Union for Conservation of Nature and Natural

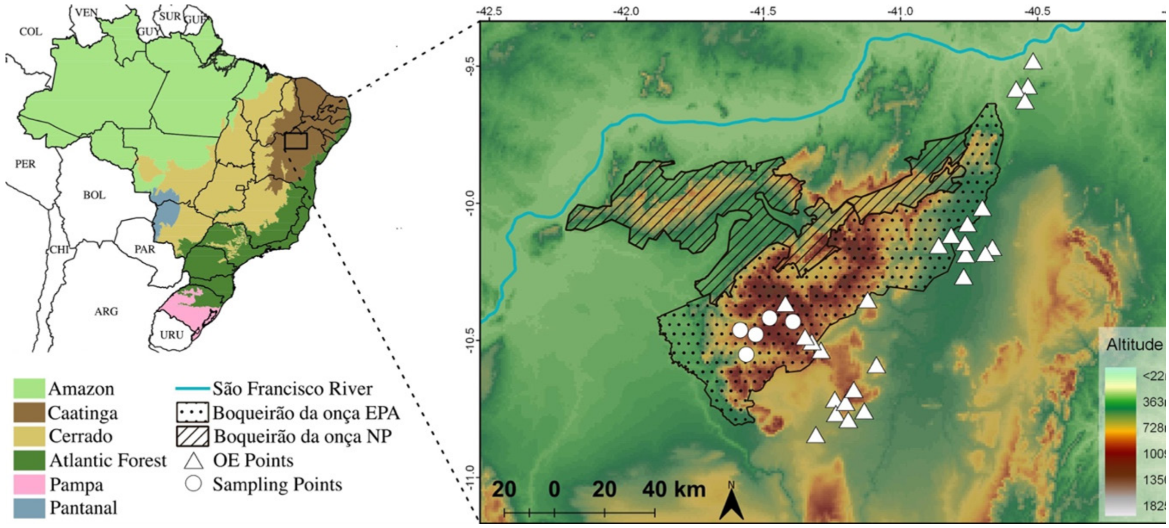

Figure 1. Brazilian map with morphoclimatic domains (left), and close up (right), with elevational shape of the region of Boqueirão da Onça Mosaic, state of Bahia, Brazil. Sampling points are shown in Table 1. Dots represent sampling points using the following methods: pitfall traps (PT), Visual Encounter Surveys (VES), Acoustic Encounter Surveys (AES), road encounters (RE), and the Fauna-Rescue program (FRP). Triangles represent opportunistic encounters (OE).

Resources (IUCN) protected areas categories IV, V and VI (IUCN 1994).

The number of identified vertebrate species associated with the Caatinga has increased substantially, as has the endemism rate, mainly for herpetofauna (Garda et al. 2018). Currently, Caatinga harbors at least 99 species of amphibians and 200 species of reptiles, with a considerable number of species being typical of this domain (20 amphibians and 71 reptiles; Guedes et al. 2014; Garda et al. 2017; Mesquita et al. 2017; Mângia et al. 2022).

Despite the many studies conducted in Caatinga in the last decade and the recognition that this domain harbors a variety of endemic herpetofauna (e.g., Garda et al. 2013; Cavalcanti et al. 2014; Caldas et al. 2016; de Castro et al. 2019), there are important areas that remain unsampled (e.g., the Boqueirão da Onça mosaic). Conducting inventories in these unexplored areas helps fill important knowledge gaps about the distribution, ecology, and diversity of the herpetofauna, including the discovery of possibly new taxa (Dal Vechio et al. 2013). Because the Boqueirão da Onça is extremely relevant for biodiversity conservation, and because there are no data on the local herpetofauna, we present here an inventory of amphibians and reptiles of this region, with information on taxonomic diversity.

Materials and Methods

Study area.—The study was conducted in the Boqueirão da Onça Environmental Protection Area (EPA) and adjacent areas. Situated in the northeastern region of Brazil, in the northern portion of Bahia State, this region encompasses the municipalities of Sento Sé, Umburanas, Campo Formoso, Sobradinho, and Juazeiro (Fig. 1). The elevation in the region varies from 400 to 1,200 m above sea level and encompasses different vegetation types (Fig. 2), including prickly shrubs, rock fields (*campos rupestres*) and deciduous woody vegetation (Prado 2003). The climate of Boqueirão da Onça is predominantly semiarid (Bsh type in the Koppen classification system), with mean temperatures of 30° C and mean annual precipitation of 693 mm (Alvares et al. 2013a, b).

Data sample.—We obtained data through a herpetofauna monitoring and fauna rescue program for a wind farm. For the monitoring program, we conducted eight field expeditions between August 2019 and May 2021, each lasting eight consecutive days, for a total of 64 sampling days. We employed four sampling methods: (1) pitfall traps (PT); (2) Visual Encounter Surveys (VES); (3) Acoustic Encounter Surveys (AES); and (4) encounters on road (ER; Crump and Scott 1994; Martins and Oliveira 1998; Cechin and Martins 2000). The PT method

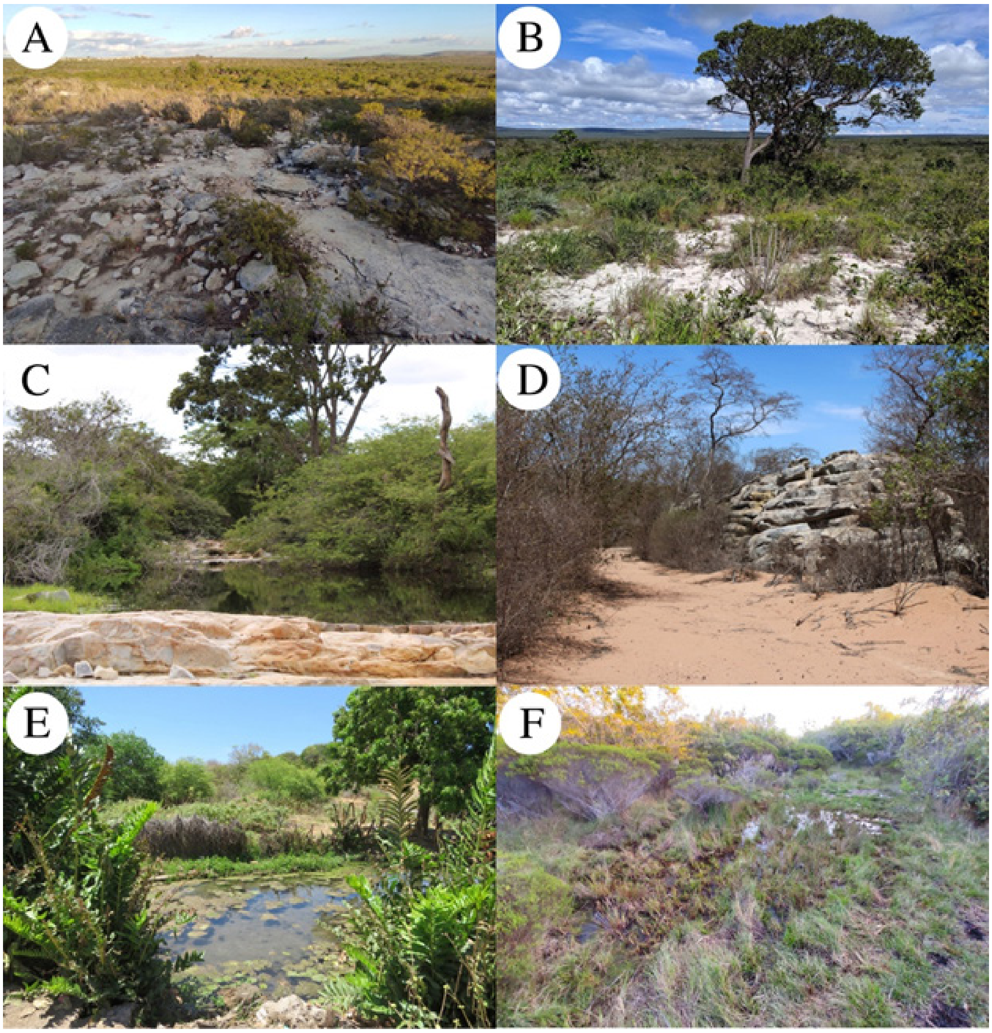

Figure 2. Some of the environments sampled in Boqueirão da Onça, Brazil: (A) rocky outcrop; (B) sandy soil with undergrowth; (C) temporary pond on rocky outcrop; (D) Caatinga during dry season; (E) spring in area disturbed by humans; (F) temporary marsh in clayey soil with grass vegetation. (All photographs by Diego G. Cavalheri except E, by Sarah Mângia).

was employed at five sampling points (Fig. 1), each composed of two lines of pitfalls located at least 1,000 m apart. Each station consisted of 20 buried buckets of 60 L in volume, set 5 m apart and connected by drift fences (50 cm tall). We checked the buckets daily and kept them open for 8 d per expedition (200 buckets × 8 d × eight expeditions = 12,800 bucket days). The VES were carried out for 1 h during the night and 1 h during the day at each of the five sampling points, always by two people (for a total of 160 h). This method consists of walking slowly along a transect to search for reptiles and amphibians. We conducted the AES method only at night, sampling for 1 h per breeding site once per expedition (total of 80 h). This method involves detecting male amphibians that emit advertisement calls; however, we also tallied visual encounters. To access the five sampling points, we used the same routes (about 200 km per sampling day) during the eight expeditions, controlling the speed at 40 km/h. Therefore, we categorized all individuals we opportunistically observed along the roads as ER finds.

In addition to the aforementioned methods (PT, VES, AES, and ER), we also included species found during the Fauna-rescue Program (FRP). This method involves rescuing animals and plants that appear during the process of vegetation clearing, which is typically conducted for development purposes by third parties. Our role was to follow this clearing process and ensure the safety of the wildlife. We collected specimens that suffered significant injuries or which we found dead during this process, while

Table 1. Sampling points in the Boqueirão da Onça EPA, state of Bahia, Brazil. Sampling method are AES = Acoustic Encounter Survey, PT = pitfall traps, and VES = Visual Encounter Survey.

Methods	Longitude (W)	Latitude (S)	Phytophysiognomy (modified from Prado 2003)
PT 01	41°33’34.10”	10°33’1.97”	Medium Caatinga Forest
PT 02	41°32’49.04”	10°32’47.56”	Medium Caatinga Forest
PT 03	41°31’37.70”	10°28’40.49”	Open or Dense Shrubby Caatinga
PT 04	41°31’39.35”	10°29’28.00”	Open or Dense Shrubby Caatinga
PT 05	41°34’55.02”	10°27’43.85”	Open or Dense Shrubby Caatinga
PT 06	41°34’51.55”	10°28’22.87”	Open or Dense Shrubby Caatinga
PT 07	41°28’36.31”	10°24’58.00”	Open or Dense Shrubby Caatinga
PT 08	41°26’43.44”	10°23’22.45”	Open or Dense Shrubby Caatinga
PT 09	41°23’21.03”	10°25’50.31”	Low Open Shrubby Caatinga
PT 10	41°23’45.28”	10°26’20.31”	Caatinga/Cerrado transition
VES 01	41°29’31.52”	10°30’3.82”	Open or Dense Shrubby Caatinga
VES 02	41°30’36.12”	10°31’56.94”	Medium Caatinga Forest
VES 03	41°31’45.30”	10°29’8.17”	Open or Dense Shrubby Caatinga
VES 04	41°23’29.15”	10°25’59.68”	Caatinga/Cerrado transition
VES 05	41°34’51.68”	10°28’33.72”	Open or Dense Shrubby Caatinga
VES 06	41°28’29.38”	10°24’58.06”	Gallery Forest
VES 07	41°34’11.09”	10°33’3.07”	Medium Caatinga Forest
VES 08	41°33’13.91”	10°32’52.36”	Medium Caatinga Forest
VES 09	41°32’25.11”	10°32’56.28”	Medium Caatinga Forest
AES 01	41°23’16.29”	10°27’32.37”	Caatinga/Cerrado transition; lentic temporary environment
AES 02	41°23’26.65”	10°27’52.72”	Caatinga/Cerrado transition; lentic permanent environment
AES 03	41°28’3.75”	10°25’7.04”	Gallery Forest; lotic temporary environment
AES 04	41°32’23.61”	10°25’34.12”	Gallery Forest; lotic permanent environment
AES 05	41°30’40.84”	10°33’8.76”	Medium Caatinga Forest; lentic temporary environment

those in good condition or with treatable injuries were reintroduced in nearby areas with no clearing activity, typically within the same protected areas. The FPR occurred continuously during the other sampling (PT, VES, AES, and ER). Furthermore, to encompass all vegetation types present in the surroundings area of EPA Boqueirão da Onça and to improve the list of species, we conducted diurnal and nocturnal active searches at an additional 21 points (Fig. 1; Table 1). We categorized this approach as opportunistic encounters (OE) because we collected these data during point-to-point displacement in a non-systematic manner.

Nomenclature follows Segalla et al. (2021) for amphibians and Burbrink et al. (2020) and Uetz et al. (The Reptile Database. Available from http://www.reptile-database.org [Accessed 20 January 2024]) for family and species category of reptiles, respectively. To determine the level of threat, we followed lists of global (IUCN 2024), national (MMA 2022), and state (Secretaria do Meio Ambiente [SEMA] 2017) levels of endangered species. To determine the endemism of species in the Caatinga, we followed Nogueira et al. (2019) for snakes, Uchôa et al. (2022) for lizards, and Garda et al. (2017) for amphibians. For species not included in these references, we used additional sources to determine endemism (Azevedo et al. 2021; de Albuquerque et al. 2022).

***Analysis*.**—We conducted an abundance-based dataset Rarefaction Curve Analysis (Gotelli and Colwell 2001) by 1,000 randomizations using iNEXT package (Hsieh and Chao 2016). This analysis uses the Hill numbers to calculate taxonomic diversity in the follow parameters: the species richness (q = 0), Shannon Diversity (q = 1) and Simpson Diversity (q

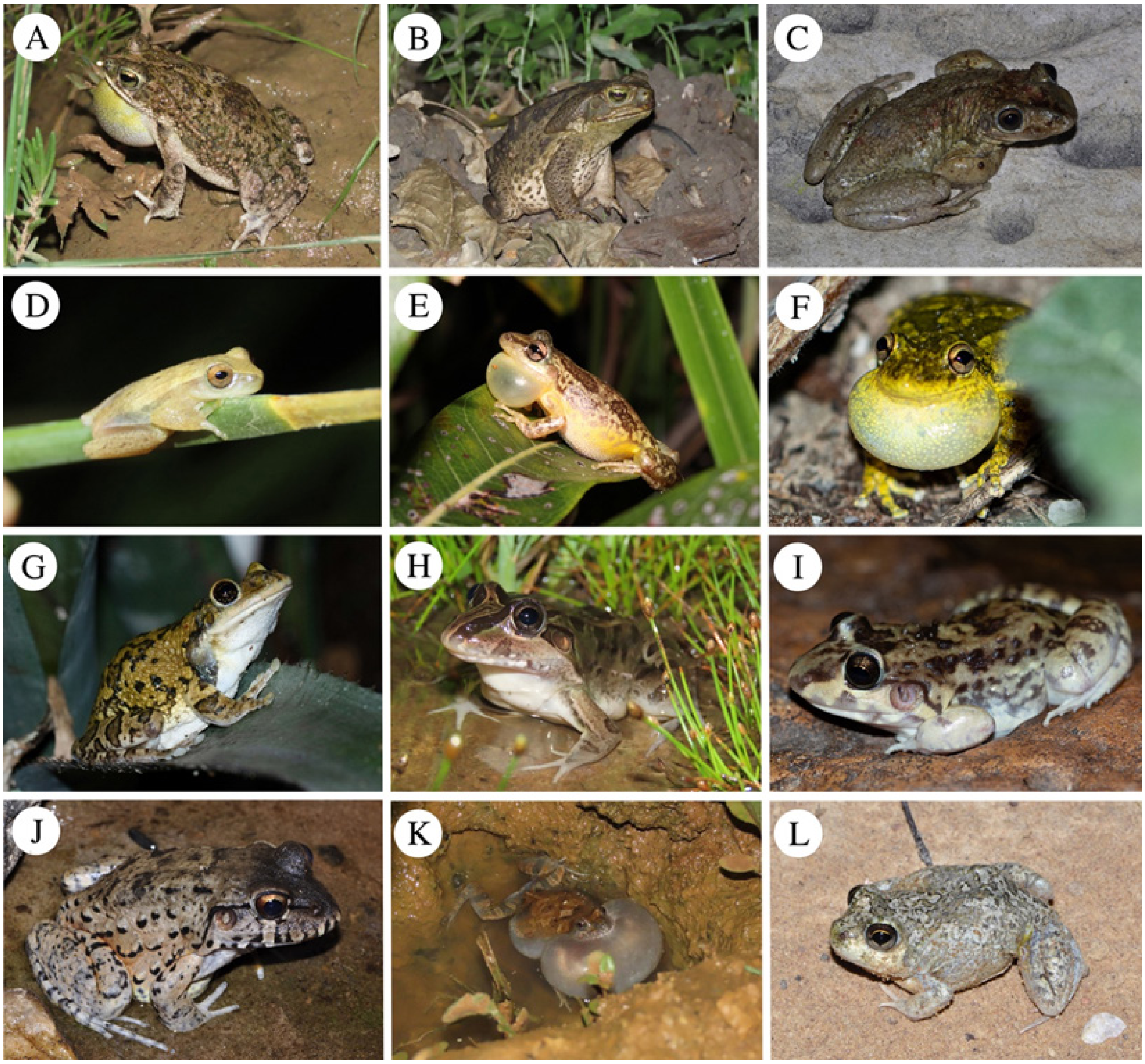

Figure 3. Some of the herpetofauna sampled in Boqueirão da Onça, Bahia, Brazil: (A) Sapinho-cururu (*Rhinella granulosa*); (B) Sapo-cururu-da-Caatinga (*Rhinella jimi*); (C) Perereca-de-capacete-da-Caatinga (*Corythomantis greeningi*); (D) Pererequinha-nanica-comum (*Dendropsophus nanus*); (E) Perereca (*Scinax* sp.); (F) Perereca-de-banheiro (*Scinax x-signatus*); (G) Perereca-grudenta-da-Caatinga (*Trachycephalus atlas*); (H) Rã-manteiga-da-savana (*Leptodactylus macrosternum*); (I) Rã-cavadeira (*Leptodactylus troglodytes*); (J) Rã-pimenta-da-Caatinga (*Leptodactylus vastus*); (K) Rãzinha-cigarra (*Physalaemus cicada*); (L) Sapinho-goré (*Pleurodema diplolister*). (A, B, D, H, K photographed by Sarah Mângia; C, L by Danilo Capela; E by Lucas Marioto; F, G, I, J by Diego Cavalheri).

= 2; Chao et al. 2014). The observed and expected diversity are calculate by rarefaction curves, where the expected diversity is calculated by the double of sampling effort (standard parameter of iNEXT function; Hsieh and Chao 2016). We estimated the taxonomic diversity of the total sampling effort of combined methods for amphibians (AES) and for snakes, and lizards (plus amphisbaenians; PT, VES, and OE). We also estimated the taxonomic diversity for each sampled area for each sampling method (PT, VES, and AES; Table 1).

We generated a dendrogram using the Paired Group Cluster Algorithm and Jaccard Similarity Measure, considering only the presence and absence of species, with the program PAST v. 2.17c (Hammer et al. 2001). We compared our results with inventories conducted in other areas of the Caatinga, exclusively including studies that sampled both amphibians and reptiles (Supplemental Information Table S1), through a cluster analysis in this domain and its ecoregions (*sensu* Velloso et al. 2002; with modifications by da Silva et al. 2017). We analyzed amphibians, snakes, and lizards (including amphisbaenians) separately, and only considered species level identifications

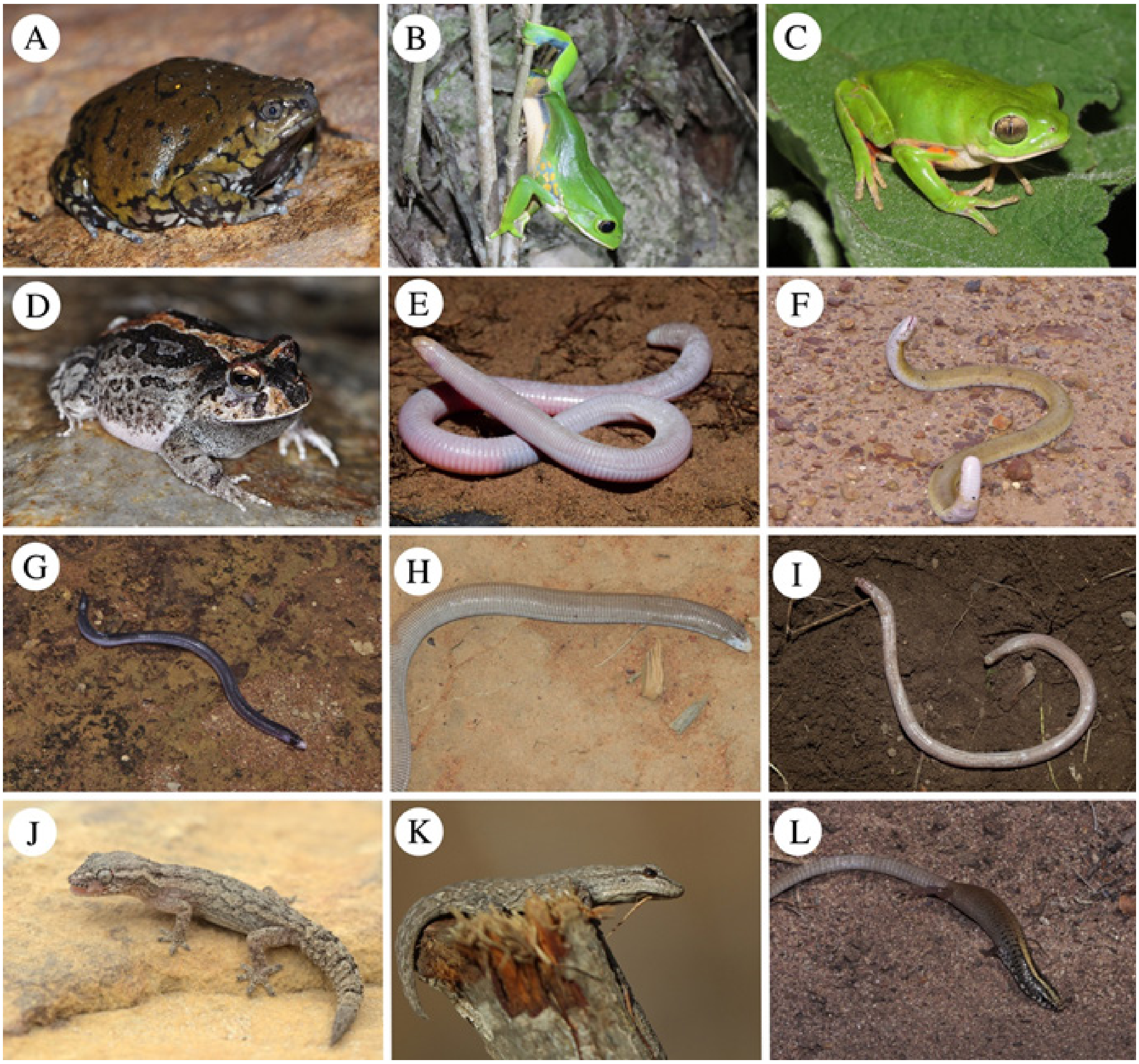

Figure 4. Some herpetofauna sampled in Boqueirão da Onça, Bahia, Brazil. (A) Sapo-bode (*Dermatonotus muelleri*); (B) Perereca-bandeira-da-Bahia (*Phyllomedusa bahiana*); (C) Perereca-da-folhagem-Nordestina (*Pithecopus nordestinus*); (D) Sapo-velhochico (*Proceratophrys velhochico*); (E) Anfisbena-de-capacete (*Amphisbaena acangaoba*); (F) Anfisbena-grande (*Amphisbaena alba*); (G) Anfisbena-kiriri (*Amphisbaena kiriri*); (H) Anfisbena-marrom-do-nordeste (*Amphisbaena pretrei*); (I) Anfisbena-marrom-comum (*Amphisbaena vermicularis*); (J) Briba-de-rabo-gordo (*Hemidactylus brasilianus*); (K) Briba-diurna-do-nordeste (*Lygodactylus klugei*); (L) Lagartinho-puro-comum (*Acratosaura mentalis*). (B, C photographed by Sarah Mângia; D, G, L by Danilo Capela; E, I by Thiago da Silveira; A, F, H, J, K by Diego Cavalheri).

(we did not include amphisbaenians due to the low number of records). To determine the correlation between similarity and linear distance, we performed Mantel tests (999 Monte Carlo randomization) to test the null hypothesis that faunal dissimilarity is not associated with the distance between localities.

Results

We found 76 herpetofauna species (Appendix 1), including 24 amphibians (Figs. 3 and 4), one chelonian, five amphisbaenians (Fig. 4), 19 lizards (Figs. 4, 5, and 6), and 27 snakes (Figs. 6 and 7). The taxonomic diversity analysis revealed that the abundance-based rarefaction and extrapolation sampling curves for order diversity ($q = 1$ and $q = 2$) stabilized for amphibians, lizards, and snakes. The species richness ($q = 0$) for amphibians also reached stability (Supplemental Information Fig. S1, Table S2). The asymptotic diversity analysis indicated that the true diversities were inferred for the mentioned parameters and assemblages. The species richness ($q = 0$) for lizards and snakes did not reach stability, however, suggesting that more species are expected

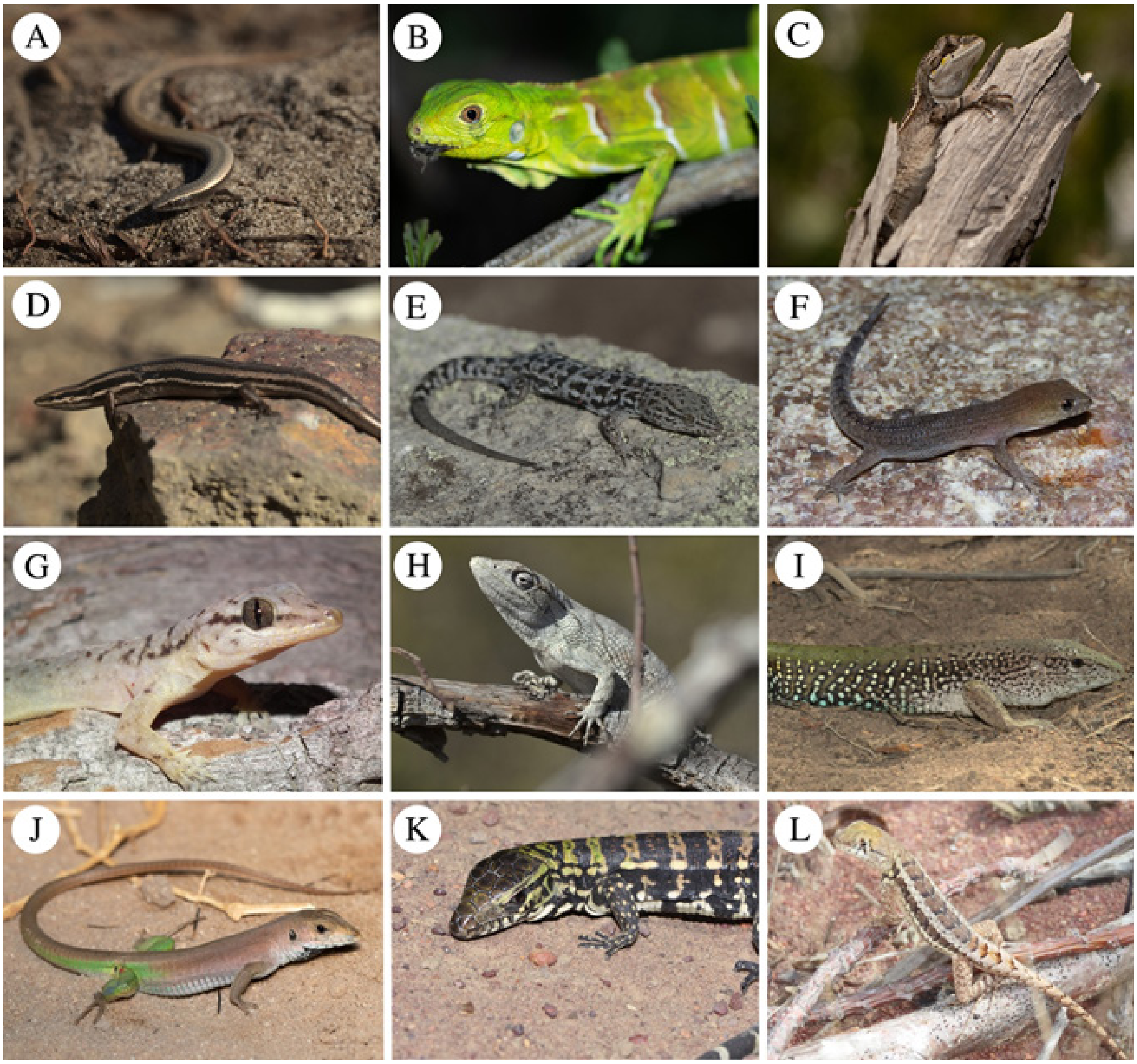

Figure 5. Some lizards sampled in Boqueirão da Onça, Bahia, Brazil. (A) Microteiú-áspero (*Psilops paeminosus*); (B) Iguana-verde (*Iguana iguana*); (C) Camaleãozinho-da-Caatinga (*Enyalius bibronii*); (D) Mabuia-da-Caatinga (*Brasiliscincus heathi*); (E) Geco-de-mucugê (*Gymnodactylus vanzolinii*); (F) Geco-da-Caatinga (*Gymnodactylus geckoides*); (G) Lagartixa-dos-lajedos (*Phyllopezus pollicaris*); (H) Lagarto-preguiça-cinza (*Polychrus acutirostris*); (I) Ameiva-comum (*Ameiva ameiva*); (J) Amêivula-da-garganta-negra (*Ameivula nigrigula*); (K) Teiú-açu (*Salvator merianae*); (L) *Tropidurus* sp. (F, G, L photographed by Sarah Mângia; K by Danilo Capela; A, B, C, D, E, H, I, J by Diego Cavalheri).

in these assemblages (Supplemental Information Fig. S1, Table S2). In the case of the AES method, which only included amphibians, the taxonomic diversity analysis for each sampled area also revealed the true diversity, except for diversity of orders (q = 1 and q = 2) in the AES 5 area (Supplemental Information Fig. S2, Table S3). The same pattern was observed for the PT and VES methods, which included only lizards, amphisbaenians, and snakes. The diversity of orders (q = 1 and q = 2) stabilized and reached an asymptotic state (Supplemental Information Fig. S4 and S5, Tables S4 and S5). For PT 1, 3, 5, 7 and 10, however, as well as VES 1, 2, 3, 6 and 8, more species are expected (q = 0).

Amphibians were represented by six families: Bufonidae (n = 2 species), Hylidae (n = 9), Leptodactylidae (n = 8), Microhylidae (n = 1), Phyllomedusidae (n = 2), and Odontophrynidae (n = 2). The most common species was *Scinax* sp. (n = 77) in AES 1, 2, and 5, followed by Rã-pimenta-da-Caatinga (*Leptodactylus vastus*; n = 45) in AES 4; Sapo-cururu-da-Caatinga (*Rhinella jimi*; n = 20) in

Figure 6. Some lizards and snakes sampled in Boqueirão da Onça, Bahia, Brazil. (A) Calango-do-cocorobó (*Tropidurus cocorobensis*); (B) Calango-áspero (*Tropidurus hispidus*); (C) Calango-chato-das-pedras (*Tropidurus semitaeniatus*); (D) Cobra-fio-nordestina (*Epictia borapeliotes*); (E) Jiboia (*Boa constrictor*); (F) Salamanta-da-Caatinga (*Epicrates assisi*); (G) Azulão-boia (*Leptophis dibernadoi*); (H) Bicuda-cinza (*Oxybelis aeneus*); (I) Caninana-comum (*Spilotes pullatus*); (J) Papa-lacraia-vermelha (*Tantilla boipiranga*); (K) Fura-terra-cearense (*Apostolepis cearensis*); (L) Muçurana-sertaneja (*Boiruna sertaneja*). (J, K, L photographed by Danilo Capela; A-I by Diego Cavalheri).

AES 3; and Rã-cavadeira (*L. troglodytes*; n = 6) in AES 01 to 05 (Supplemental Information Fig. S5). The sampling points AES 01 and AES 05 lacked intermediary species, with high dominance for a few species (Supplemental Information Fig. S5). The other sampling points had more intermediary species, but AES 2 and AES 4 also showed high dominance (Supplemental Information Fig. S5).

Among reptiles, we recorded 16 families: Amphisbaenidae (n = 5 species); Gekkonidae (n = 2); Gymnophtalmidae (n = 3); Iguanidae (n = 1); Leiosauridae (n = 1); Mabuyidae (n = 1); Phyllodactylidae (n = 3); Polychrotidae (n = 1); Teiidae (n = 3); Tropiduridae (n = 4); Leptothyphlopidae (n = 2); Boidae (n = 2); Colubridae (n = 5); Dipsadidae (n = 15); Elapidae (n = 1); and Viperidae (n = 2). The most common species, captured using the PT method (Supplemental Information Fig. S6), was Amêivula-da-garganta-negra (*Ameivula nigrigula*; n = 1,563) in all sampled areas, except by Calango-do-cocorobó (*Tropidurus cocorobensis*; n = 135) in PT 09. For the VES method (Supplemental Information Fig. S7), the most common species were *Ameivula nigrigula* (n = 51) in VES 01, 02, 07, 08, and 09, Lagartixa-dos-

Figure 7. Some snakes sampled in Boqueirão da Onça, Bahia, Brazil. (A) Arbusteira-do-Butantan (*Dryophylax phoenyx*); (B) Olho-de-gato (*Leptodeira annulata*); (C) Falsa-coral-de-boca-branca (*Oxyrhopus trigeminus*); (D) Cobra-cipó-do-sertão (*Philodryas nattereri*); (E) Cobra-cipó-verde (*Philodryas olfersii*); (F) Muçurana-malhada (*Pseudoboa nigra*); (G) Muçurana-vermelha-da-Caatinga (*Rodriguesophis iglesiasi*); (H) Cobra-do-folhiço (*Taeniophallus occipitalis*); (I) Nariguda-do-Cerrado (*Xenodon nattereri*); (J) Ibiboboca (*Micrurus ibiboboca*); (K) Jararaca-da-seca (*Bothrops erythromelas*); (L) Cascavel (*Crotalus durissus*). (B, C, F, H, I, J photographed by Danilo Capela; A, D, E, G, K, L by Diego Cavalheri).

lajedos (*Phyllopezus pollicaris*; n = 7) in VES 03, *T. cocorobensis* (n = 4) in VES 04, Geco-da-Caatinga (*Gymnodactylus geckoides*; n = 8) in VES 05, and Calango-chato-das-pedras (*T. semitaeniatus*; n = 21) in VES 06. For both methods, we observed in all sampled areas a high dominance of lizard species, especially *A. nigrigula* and *T. cocorobensis*. The snakes and amphisbaenians species were the least commonly recorded species. The cluster analysis did not identify any ecoregion groups for analyzed taxa (Fig. 8); however, the Mantel test indicated that dissimilarity in amphibians (r = 0.430; P = 0.005) increase with geographical distance, but not for snakes (r = -0.016; P = 0.470) and lizards (r = 0.207; P = 0.207; Fig. 9).

Discussion

Boqueirão da Onça harbors the third highest herpetofauna diversity in the Caatinga, highlighting new occurrences and the potential for new species. Our work also extends the known distribution of some species, such as Perereca-bandeira-da-Bahia (*Phyllomedusa bahiana*) and Papa-lacraia-vermelha

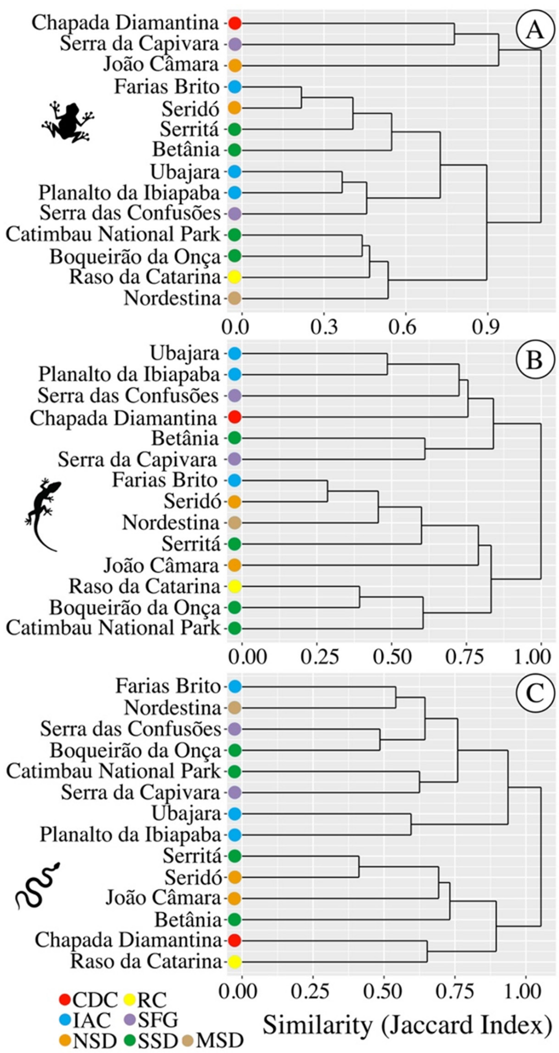

FIGURE 8. Dendrogram from cluster analysis of the list of anurans, snakes, and lizards (including amphisbaenians) conducted in different Caatinga localities. (A) Anurans, (B) Lizards, (C) Snakes. List of inventories in Table S1 Abbreviations are CDC: Chapada Diamantina Complex; IAC: Ibiapaba-Araripe Complex; NSD: Northern Sertaneja Depression; RC: Raso da Catarina; SFG: São Francisco-Gurguéia; SSD: Southern Sertaneja Depression; MSD: Meridional Serteneja Depression.

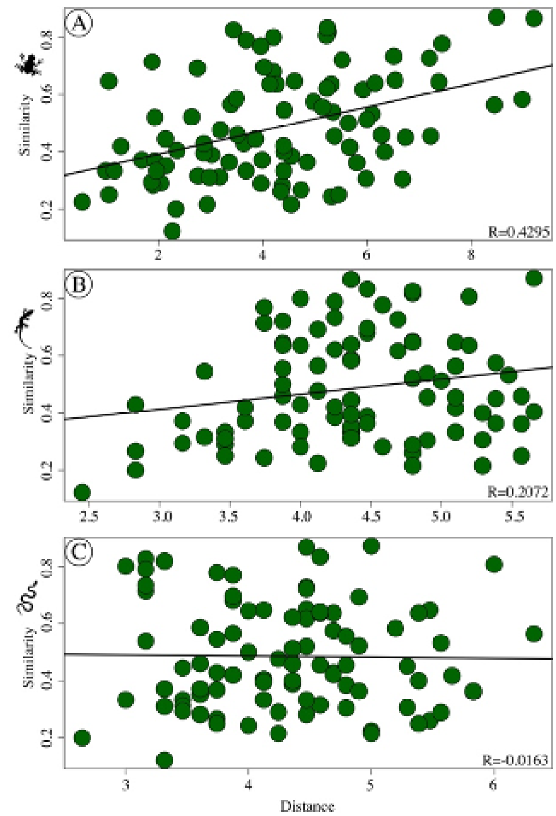

FIGURE 9. Results of the Mantel test for (A) amphibians, (B) lizards and amphisbaenians, and (C) snakes

(*Tantilla boipiranga*). Additionally, the region shows high diversity of lizards and amphisbaenians, attributed to detailed sampling methods. Our results underscore the importance of Boqueirão da Onça as a priority area for herpetofauna conservation in the Caatinga.

The herpetofauna richness in Boqueirão da Onça (n = 76 species) is surpassed only by Planalto de Ibiapaba (n = 121 species; Loebmann and Haddad 2010) and Serra das Confusões (n = 94 species; Marques et al. 2023) in the Caatinga. The high diversity observed in Planalto de Ibiapaba can be attributed to several factors, including the size and the presence of distinct ecological domains in the region, which contribute to the occurrence of species typical of the Cerrado, Atlantic Forest, and Amazon biomes. Regarding the greater diversity observed in the Serra das Confusões, the study incorporated, in addition to standard sampling methods for herpetofauna, a compilation of data obtained from two previous studies (Dal Vechio et al. 2016; Madella-Auricchio et al. 2017). Thus, it is important to highlight those other factors, such as data sampling methods and sampling time, may influence the observed richness in the studied region (Protázio et al. 2022). The richness of anurans found in Boqueirão da Onça is expected if compared with other inventories in Caatinga (Supplemental Information Table S1). Nevertheless, lists of anuran species from Caatinga that include influence from rain forest enclaves (called *Brejos de Altitude* in northeastern Brazil) or transition zones might show higher richness, with more than 30 species (Loebmann and Haddad

2010; Magalhães et al. 2015). Species such as Sapo-velhochico (*Proceratophrys velhochico*) were registered only after a torrential rainy day, between November and February, during explosive breeding (see Mângia et al. 2022). Therefore, other species with similar behavior may not be sampled due to the absence of their reproductive period, and inventories of anurans in Caatinga appear to be directly correlated with climatic conditions (e.g., Cavalcanti et al. 2014). The low number of anurans recorded in ER might be due to fact that the number of vehicles passing through the area at night is much lower than during the day (pers. obs.), and because anurans in Caatinga are known for their nocturnal activities (Navas et al. 2004), fewer roadkill animals are expected.

Pitfall traps and encounters on road were the least effective methods for inventorying amphibians in our study, recording only five and three individuals, respectively. The few specimens that we recorded in PT were captured on the day after a rain, specifically in the sole PT site situated near the stream (100 m). None of the other PT stations captured anurans during our sampling. The sampling areas AES 02, 03, and 04 showed high taxonomic diversity, with highest diversity of orders q = 0, 1, and 2. These areas have distinctly phytophysionomies, but all areas have permanent lentic and lotic water bodies. This could be the major factor that increases the diversity of an area, as water is a scarce resource in dry seasonal environments. These three areas also showed more evenness and less dominance of species abundance, due the presence of intermediary species (Magurran 2011).

None of the amphibians inventoried here are listed as protected and only *Proceratophrys velhochico* is endemic to the Caatinga. *Phyllomedusa bahiana* and Perereca-da-folhagem-Nordestina (*Pithecopus nordestinus*) are categorized as Data Deficient (DD) in the IUCN Red list, which indicates that appropriate information about abundance or distribution of these species is lacking to assess their risk of extinction (IUCN 2024). Some species recorded during our fieldwork are noteworthy. We expanded the distribution range of *Phyllomedusa bahiana* distribution by 150 km to the northwest from previously known localities (see Brunes et al. 2014). In addition, Boqueirão da Onça may harbor at least one more undescribed species of Anura, the *Scinax* sp., which we were unable to identify at the species level and may represent a new species. This species may belong to the group of *Scinax ruber*, but based on its advertisement call and morphological aspects, we were not able to associate it with any known species in the region (Pombal et al. 1995).

The number of lizard and amphisbaenian species was high when compared to other inventories in the Caatinga domain (Supplemental Information Table S1). The richness in the Boqueirão da Onça Mosaic (n = 24) was second only to that of Serra das Confusões National Park (n = 31; Marques et al. 2023), Catimbau National Park (n = 25; Pedrosa et al. 2014), and Planalto da Ibiapaba (n = 33; Loebmann and Haddad 2010). Except for Catimbau National Park, both inventories are in areas with a strong influence of other domains, such as Cerrado (in both), and Atlantic Forest and Amazon (in Planalto de Ibiapaba), resulting in species from different domains coexisting in the area (Dal Vechio et al. 2016; Loebmann and Haddad 2010). The richness of lizards in the Boqueirão da Onça Mosaic was third only to that of Catimbau National Park, Pernambuco state, and Serra das Confusões, Piauí state, in inventories conducted within the Caatinga domain (Pedrosa et al. 2014; Marques et al. 2023). When considering only amphisbaenians, the richness in the Boqueirão da Onça Mosaic (n = 5) was considerably higher than that of other localities in the Caatinga, except for Serra das Confusões (n = 6; Marques et al. 2023), and the same number of species was recorded in regions with influence from different morphoclimatic domains (e.g., Planalto de Ibiapaba, Loebmann and Haddad 2010). This result might be due to the FRP method applied in the present study, which turns the soil and exposes this fossorial group (pers. obs.). Such methodology is not normally used in herpetofauna inventory studies due to its significant impact on the biota.

Pitfall traps 7 and 10 are expected to have a higher number of species for lizards, amphisbaenians, and snakes, with 26 and 16 species, respectively. This could be attributed to specific environment characteristics of these areas. Pitfall trap 7 is near a permanent water source, which provides water spots along the river even during the dry season. On the other hand, PT 10 exhibits a transitional phytophysiognomy between the Caatinga and Cerrado domains. These areas also exhibited the highest diversity of amphibians and high abundance of lizards, particularly *A. nigrigula* and *T. cocorobensis*. Approximately one quarter of the diet of snakes in the Caatinga consists of amphibians, while caecilians and amphisbaenians contribute 7.8% and lizards make up 6.7% (Guedes et al. 2014). Among the snakes, 56.6% are generalists, 80.4% feed on vertebrates, and 18.7% prey on invertebrates (Guedes et al. 2014). As for lizards, 65% of species consume invertebrates (Uchôa et al. 2022). Caatinga highlands, such as the PT 10 area (at 1,031 m elevation), are known for harboring a high richness of snake species (Guedes et al. 2014). In both methods, the low evenness of reptile assemblages can be attributed to the absence of intermediary species and the dominance of a few lizard species (Magurran 2011).

Snakes exhibited high diversity when compared to other Caatinga inventories, even when considering transitional areas (Supplemental Information Table S1). This result can be attributed to a combination of factors: (1) a considerable large effort, with more pitfall traps, field-days, and the inclusion of more sampling methods; (2) the elevational range of the sampling points that encompassed areas between 400 and 1,100 m; and (3) the heterogeneity of the study area. This group requires a significant effort to be adequately sampled (Bernarde 2012), and in the Caatinga domain the timeframe of the fieldwork appears to be a critical factor in snake inventories (e.g., Freire et al. 2009; Caldas et al. 2016). In addition, some reptiles have secretive habits, and many species rely on chance encounters (Steen 2010; Oda et al. 2017), which could explain why we recorded only one specimen of some species during the entire study period (e.g., the snakes Falsa-cipó-do-campo, *Drymoluber brazili*, and Muçurana-vermelha-da-Caatinga, *Rodriguesophis iglesiasi*).

Among the 51 species of reptiles sampled in Boqueirão da Onça, nine (18.3% of the total) are endemic to the Caatinga. Four species are categorized at some level of protection: Microteiú-áspero (*Psilops paeminosus*, Vulnerable [VU], Near Threatened [NT], Endangered [EN], in the IUCN, Instituto Chico Mendes de Conservação da Biodiversidade [ICMBio], and SEMA, respectively); Geco-de-mucugê (*Gymnodactylus vanzolini*, Data Deficient [DD], DD, EN); *Drymoluber brazili* (Least Concern [LC], LC, EN); and *Tantilla boipiranga* (VU, No Information [NI], NI). There are several reptile species of note in this study. We have extended the known distribution range of *Tantilla boipiranga* by approximately 600 km, representing the first record of this species for Bahia state and for the Caatinga (Azevedo et al. 2021; Guedes et al. 2023). Additionally, we have extended the range of the poorly known *Gymnodactylus vanzolini* by approximately 300 km to the north, previously only known from Mucugê municipality (Cassimiro and Rodrigues 2009; Freitas et al. 2012; Uchôa et al. 2022). Interestingly, we only found *G. vanzolini* in rock fields (*Campos rupestres*), which is consistent with its description paper (Cassimiro and Rodrigues 2009). In other areas with different vegetation types, we commonly found *Gymnodactylus geckoides* in Boqueirão da Onça Mosaic. Even though these species occur in the same region, they appear to occupy different environments in Boqueirão da Onça. The morphological characteristics of *Tropidurus* sp. differ from other species of the genus in the region, suggesting that this population may represent an undescribed species.

Although cluster analyses have been used to compare species composition between domains and recover geographical groups for amphibians and lizards (e.g., Dal Vechio et al. 2013, 2016), we were not able to do this within the Caatinga ecoregions in our study. Instead of ecoregions, our analyses indicated that distance might be a better indicator of the similarity or dissimilarity for amphibian species composition: the closer one area to another, the more similar they are. Although not tested in this study, the elevational gradient is another important feature to consider when comparing different areas because regionalization between highlands and lowlands in the Caatinga has been proposed for amphibians and reptiles (Camardelli and Napoli 2012; Guedes et al. 2014). Accurately assessing this variable in inventory papers is difficult, however, because this information is usually presented only with the variation within the sampled area, which does not include the elevation for each sampled point (Dal Vechio et al. 2016; de Castro et al. 2019).

The Boqueirão da Onça Mosaic region has been identified as a priority area for conservation of biodiversity in the Caatinga domain (MMA 2018). Recent studies conducted in the region corroborate this statement, with evidence of high bird diversity (Schunck et al. 2012) and mammal diversity (Campos et al. 2019). Our study, which employed a range of methods and significant effort, produced a robust list of herpetofauna species, placing Boqueirão da Onça in a prominent position in the Caatinga domain. The potential for discovering new species (e.g., Ribeiro et al. 2018, 2020; Mângia et al. 2022), the high richness of snake, lizard, and amphisbaenian species compared to other areas in the Caatinga, and the discovery of new occurrence points for anurans and reptiles, all reinforce this region as a priority for herpetofauna conservation in the Caatinga.

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APPENDICES

Appendix Table 1 List of herpetofauna species recorded for the Boqueirão da Onça Mosaic, state of Bahia, northeastern Brazil showing number of individuals of each species found, sample method, Caatinga endemism, and level of threat in global (IUCN 2024), national (MMA 2022) and state (SEMA 2017) lists. Caatinga endemic species are indicated with an X. Sample method are AES = acoustic encounter survey, ER = encounters on road, FRP = fauna-rescue program, OE = Occasional encounters, PT = pitfall traps, VES = Visual encounter survey. Threat levels are NI = no information, DD = data deficient, LC = least concern, NT = near threatened, VU = vulnerable, EN = Endangered.

Taxa	Number	Methodology	IUCN	ICMBio	SEMA	Endemic
Order Anura						
Bufonidae						
Sapinho-cururu (*Rhinella granulosa*)	26	AES, OE	LC	LC	NI	
Sapo-cururu-da-Caatinga (*Rhinella jimi*)	155	AES, OE, FRP	LC	NI	NI	
Hylidae						
Perereca-da-Caatinga (*Boana crepitans*)	5	OE	LC	LC	NI	
Perereca-quarenta-e-três (*Boana raniceps*)	19	OE	LC	LC	NI	
Perereca-de-capacete-da-Caatinga (*Corythomantis greeningi*)	47	AES, OE	LC	LC	NI	
Pererequinha-ampulheta (*Dendropsophus minutus*)	5	OE	LC	LC	NI	
Pererequinha-nanica-comum (*Dendropsophus nanus*)	130	OE	LC	LC	NI	
Perereca-mascarada-do-nordeste (*Scinax pachycrus*)	26	OE	LC	LC	NI	
Perereca (*Scinax* sp.)	254	AES	NI	NI	NI	
Perereca-de-banheiro (*Scinax x-signatus*)	119	AES, OE	LC	LC	NI	
Perereca-grudenta-da-Caatinga (*Trachycephalus atlas*)	6	AES, OE	LC	LC	NI	
Leptodactylidae						
Rã-assobiadeira-comum (*Leptodactylus fuscus*)	21	OE	LC	LC	NI	
Rã-manteiga-da-savana (*L. macrosternum*)	153	AES, OE	LC	LC	NI	
Rã-cavadeira (*Leptodactylus troglodytes*)	145	AES, OE, PF	LC	LC	NI	
Rã-pimenta-da-Caatinga (*Leptodactylus vastus*)	205	AES, OE	LC	LC	NI	
Rãzinha-cigarra (*Physalaemus cicada*)	66	AES, OE	LC	LC	NI	
Rã-cachorro (*Physalaemus cuvieri*)	12	AES, OE	LC	LC	NI	
Sapinho-goré (*Pleurodema diplolister*)	18	AES, OE, PF	LC	LC	NI	
Rãzinha-pocotó (*Pseudopaludicola pocoto*)	277	OE	NI	LC	NI	
Microhylidae						
Sapo-bode (*Dermatonotus muelleri*)	7	AES, PF	LC	LC	NI	
Phyllomedusidae						
Perereca-bandeira-da-Bahia (*Phyllomedusa bahiana*)	105	AES, OE	DD	LC	NI	
Perereca-da-folhagem-Nordestina (*Pithecopus nordestinus*)	40	OE	DD	LC	NI	
Odontophrynidae						
Sapo-berimbau (*Proceratophrys cristiceps*)	14	OE	LC	LC	NI	
Sapo-velho-chico (*Proceratophrys velhochico*)	33	AES, FRP	NI	NI	NI	X
Order Testudines						
Chelidae						
Cágado-do-São-Francisco (*Mesoclemmys tuberculata*)	1	OE	NI	LC	NI	

Appendix Table 1, cont

Taxa	Number	Methodology	IUCN	ICMBio	SEMA	Endemic
Anfisbena-de-capacete (*Amphisbaena acangaoba*)	14	PT, FRP	NI	NI	NI	X
Anfisbea-grande (*Amphisbaena alba*)	11	PT, ER, OE, FRP	LC	LC	NI	
Anfisbena-kiriri (*Amphisbaena kiriri*)	1	PT, OE, FRP	NI	NI	NI	X
Anfisbena-marrom-do-Nordeste (*Amphisbaena pretrei*)	1	OE, ER, FRP	LC	LC	NI	
Anfisbena-marrom-comum (*Amphisbaena vermicularis*)	41	FRP	NI	LC	NI	
Gekkonidae						
Briba-de-rabo-gordo (*Hemidactylus brasilianus*)	37	PT, VES, FRP	LC	LC	NI	
Briba-diurna-do-nordeste (*Lygodactylus klugei*)	1	OE, FRP	LC	LC	NI	
Gymnophthalmidae						
Lagartinho-puro-comum (*Acratosaura mentalis*)	41	PT	LC	LC	NI	X
Micro-teiú-áspero (*Psilops paeminosus*)	12	PT, FRP	VU	NT	EN	X
Rabo-vermelho-da-Caatinga (*Vanzosaura multiscutata*)	2	OE	LC	LC	NI	X
Iguanidae						
Iguana-verde (*Iguana iguana*)	1	VES	LC	LC	NI	
Leiosauridae						
Camaleãozinho-da-Caatinga (*Enyalius bibronii*)	8	PT, FRP	LC	LC	NI	
Mabuyidae						
Mabuia-da-Caatinga (*Brasiliscincus heathi*)	7	PT, VES, FRP	LC	LC	NI	
Phyllodactylidae						
Geco-de-Mucugê (*Gymnodactylus vanzolinii*)	52	PT, VES, FRP	DD	DD	EN	X
Geco-da-Caatinga (*Gymnodactylus geckoides*)	30	OE	LC	LC	NI	
Lagartixa-dos-lajedos (*Phyllopezus pollicaris*)	112	VES, FRP	LC	LC	NI	
Polychrotidae						
Lagarto-preguiça-cinza (*Polychrus acutirostris*)	2	ER, OE, FRP	LC	LC	NI	
Teiidae						
Ameiva-comum (*Ameiva ameiva*)	7	PT, ER, FRP	LC	LC	NI	
Amêivula-da-garganta-negra (*Ameivula nigrigula*)	1864	PT, VES, FRP	NI	DD	NI	X
Teiú-açu (*Salvator merianae*)	14	PT, VES, ER, FRP	LC	LC	NI	
Tropiduridae						
Calango (*Tropidurus* sp.)	8	OE	NI	NI	NI	
Calango-do-cocorobó (*Tropidurus cocorobensis*)	664	PT, VES, FRP	LC	LC	NI	X
Calango-áspero (*Tropidurus hispidus*)	257	PT, VES, ER, FRP	LC	LC	NI	
Calango-chato-das-pedras (*Tropidurus semitaeniatus*)	187	PT, VES, FRP	LC	LC	NI	X
Leptotyphlopidae						
Cobra-fio-nordestina (*Epictia borapeliotes*)	1	FRP	LC	LC	NI	X

Appendix Table 1, cont

Taxa	Number	Methodology	IUCN	ICMBio	SEMA	Endemic
Cobra-fio-brasileira (*Trilepida brasiliensis*)	4	PT, FRP	LC	LC	NI	
Boidae						
Jiboia (*Boa constrictor*)	1	FRP	LC	LC	NI	
Salamanta-da-Caatinga (*Epicrates assisi*)	5	PT, ER, OE, FRP	LC	LC	NI	
Colubridae						
Falsa-cipó-do-campo (*Drymoluber brazili*)	1	ER	LC	LC	EN	
Azulão-boia (*Leptophis dibernadoi*)	1	ER, OE, FRP	LC	LC	NI	X
Bicuda-cinza (*Oxybelis aeneus*)	9	VES, ER, OE, FRP	LC	LC	NI	
Caninana-comum (*Spilotes pullatus*)	3	ER, OE, FRP	LC	LC	NI	
Papa-lacraia-vermelha (*Tantilla boipiranga*)	3	PT, FRP	VU	NI	NI	
Dipsadidae						
Fura-terra-cearence (*Apostolepis cearensis*)	3	PT, ER, FRP	LC	LC	NI	
Muçurana-sertaneja (*Boiruna sertaneja*)	4	VES, ER, FRP	NI	LC	NI	
Arbusteira-do-Butantan (*Dryophylaxs phoenix*)	6	PT, ER, FRP	NI	NI	NI	
Cobra-d'água-leopardo (*Helicops leopardinus*)	1	OE	LC	LC	NI	
Olho-de-gato (*Leptodeira annulata*)	4	VES, ER, FRP	LC	LC	NI	
Falsa-coral-de-boca-preta (*Oxyrhopus guibei*)	2	OE	LC	LC	NI	
Falsa-coral-de-boca-branca (*Oxyrhopus trigeminus*)	11	PT, VES, ER, FRP	LC	LC	NI	
Cobra-cipó-do-sertão (*Philodryas nattereri*)	7	ER, FRP	LC	LC	NI	
Cobra-cipó-verde (*Philodryas olfersii*)	6	ER, FRP	LC	LC	NI	
Muçurana-malhada (*Pseudoboa nigra*)	8	VES, ER, FRP	LC	LC	NI	
Muçurana-vermelha-da-Caatinga (*Rodriguesophis iglesiasi*)	1	PT	LC	LC	NI	
Cobra-do-folhiço (*Taeniophallus occipitalis*)	1	PT, FRP	LC	LC	NI	
Arbusteira-sertaneja (*Thamnodynastes sertanejo*)	1	ER	LC	LC	NI	
Boipeva-do-campo (*Xenodon merremii*)	1	FRP	NI	LC	NI	
Nariguda-do-Cerrado (*Xenodon nattereri*)	3	PT, ER	LC	LC	NI	
Elapidae						
Ibiboboca (*Micrurus ibiboboca*)	2	PT, VES	NI	DD	NI	
Viperidae						
Jararaca-da-seca (*Bothrops erythromelas*)	15	PT, VES, ER, FRP	LC	LC	NI	
Cascavel (*Crotalus durissus*)	3	ER, OE, FRP	LC	LC	NI	

Appendix Table 2. Specimens of amphibians and reptiles collected at Boqueirão da Onça, state of Bahia, Brazil.

Rhinella jimi – ZUFMS-AMP14899; *Scinax* sp. MAP7382; *Scinax x-signatus* – ZUFMS–AMP14900; *Leptodactylus troglodytes* – ZUFMS-AMP14893; *Leptodactylus vastus* – ZUFMS–AMP14894; *Pleurodema diplolister* - ZUFMS-AMP14895-14898; *Dermatonotus muelleri* – ZUFMS-AMP14892; *Proceratophrys velhochico* – ZUFMS-AMP13652, ZUFMS-AMP 13949; *Amphisbaena acangaoba* - ZUFMS-REP04181-4186; *Amphisbaena alba* - ZUFMS-REP04187–4192; *Amphisbaena kiriri* - ZUFMS-REP04193–4195, ZUFMS-REP04197–4199; *Amphisbaena pretrei* - ZUFMS-REP04287; *Hemidactylus brasilianus* - ZUFMS-REP04290; *Acratosaura mentalis* - ZUFMS-REP04201–4203; *Psilops paeminosusi* - ZUFMS-REP04294–4295; *Enyalius bibronii* - ZUFMS-REP04284–4286; *Gymnodactylus vanzolinii* - ZUFMS-REP04288–4289; *Phyllopezus pollicaris* - ZUFMS-REP04291–4292; *Polychrus acutirostris* - ZUFMS-REP04293; *Ameivula nigrigula* - ZUFMS-REP04204–4283; *Salvator merianae* ZUFMS-REP04296; *Tropidurus cocorobensis* - ZUFMS-REP04297– 4305; *Tropidurus hispidus* - ZUFMS-REP04306; *Epictia borapeliotes* - MAP7424; *Trilepida brasiliensis* - ZUFMS-REP04154; *Boa constrictor* - ZUFMS-REP04307; *Epicrates assisi* - ZUFMS-REP04310; *Drymoluber brazili* - ZUFMS-REP04153; *Oxybelis aeneus* - ZUFMS-REP04156–4161; *Spilotes pullatus* – ZUFMS-REP04146–4147; *Tantilla boipiranga* – MAP6959; *Apostolepis cearensis* – ZUFMS-REP04151–4152; *Boiruna sertaneja* – ZUFMS-REP04308–4309; *Dryophylax phoenix* – ZUFMS-REP04177–4178; *Oxyrhopus trigeminus* – ZUFMS-REP04149; *Philodryas nattereri* – ZUFMS-REP04162–4163; *Philodryas olfersii* – ZUFMS-REP04166–4171; *Pseudoboa nigra* – ZUFMS-REP04172–4175; *Rodriguesophis iglesiasi* – ZUFMS-REP04155; *Taeniophallus occipitalis* – ZUFMS-REP04176; *Thamnodynastes sertanejo* – ZUFMS-REP04179; *Xenodon merremii* – ZUFMS-REP04150; *Micrurus ibiboboca* – ZUFMS-REP04148; *Bothrops erythromelas* – ZUFMS-REP04164–4165.