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Inventory

Herpetofauna of Matas de Água Azul, an Atlantic Forest remnant in Serra do Mascarenhas, Pernambuco state, Brazil

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Abstract: The northern most portion of Atlantic Forest is currently considered as the most vulnerable and threatened in this ecoregion, while also harboring the ecoregion's least studied biota. Herein we present results of a herpetofaunistic survey in Refúgio de Vida Silvestre (Wildlife Refuge) Matas de Água Azul (RVSMAA), in the mountain range Serra do Mascarenhas, northeastern state of Pernambuco, Brazil, one of the largest forest remnants in the northern Atlantic Forest. The sampling was carried out in four expeditions using methods of visual searching and pitfall traps. A total of 43 species of amphibians and 40 species of reptiles were registered, including anurans, caecilians, lizards, snakes and chelonians. The richness recorded represented 56% of amphibians and 20% of reptiles registered in the Atlantic Forest north of the São Francisco River. The RVSMAA holds a high diversity of amphibians and reptiles, representing one of the highest levels of richness in the northern Atlantic Forest. The record of seven species included in some of the threatened species lists reinforces the importance of the area for the conservation of the Atlantic Forest herpetofauna and adds relevant information to our knowledge of northern Atlantic Forest biodiversity and aids in its assessment of conservation.
Keywords: *Amphibians; Hotspot; Inventory; Conservation; Reptiles.*

Herpetofauna das Matas de Água Azul, um remanescente de Mata Atlântica na Serra do Mascarenhas, estado de Pernambuco, Brasil

Resumo: Atualmente, a porção norte da Mata Atlântica é considerada a mais vulnerável, ameaçada e com menos estudos sobre a biota em toda sua extensão. Apresentamos aqui os resultados do inventário herpetofaunístico realizado no Refúgio de Vida Silvestre Matas de Água Azul (RVSMAA), localizada na cadeia de montanhas da Serra do Mascarenhas, estado de Pernambuco, Brasil, um dos maiores remanescentes florestais da porção norte da Mata Atlântica. A amostragem da área foi realizada em quatro expedições onde foram utilizados os métodos de busca visual e estações de armadilhas de interceptação e queda. Um total de 43 espécies de anfíbios e 40 de répteis foram registradas, incluindo anuros, cecílias, lagartos, serpentes e quelônios. A riqueza registrada representa 56% dos anfíbios e 20% dos répteis registrados para a Mata Atlântica ao norte do Rio São Francisco. O RVSMAA possui elevada diversidade de anfíbios e répteis, representando uma das maiores riquezas do norte da Mata Atlântica. O registro de sete espécies incluídas em alguma das listas de espécies ameaçadas para a região reforça a importância da área para a conservação da herpetofauna do Nordeste e acrescenta informações relevantes ao conhecimento e conservação da biodiversidade da Mata Atlântica ao norte do Rio São Francisco.
Palavras-chave: *Anfíbios; Hotspot; Inventário; Conservação; Répteis.*

Introduction

The Atlantic Forest ecoregion represents the second largest forest block in the Neotropical region, originally occupying an extensive area along the eastern coast of South America, from Argentina to the northeastern region of Brazil (Galindo-Leal & Câmara 2003, Ribeiro et al. 2009). The heterogeneity of phytophysiognomies, together with historical and geographical factors, have been determinant in establishing a unique biodiversity (Moura et al. 2016), with this ecoregion demonstrating high richness and endemism (Myers et al. 2000, Roll et al. 2017).

The Atlantic Forest presents an extensive latitudinal amplitude, which generates a considerable variation in temperature, precipitation and humidity, resulting in broad climatic heterogeneity throughout its territory (Ribeiro et al. 2009, Alvares et al. 2013). Topographic variation (0-2700 meters) together with vegetation composition (Pinto & Brito 2003), have played a fundamental role in the diversification of Neotropical biota, resulting in very distinctive biotas throughout its area, demonstrating a noticeable break in fauna and flora compositions when comparing northern and southern portions of the Atlantic Forest (Costa 2003, Carnaval et al. 2014).

Nevertheless, the Atlantic Forest has been severely threatened since the start of the European colonization in Brazil, accelerating the anthropogenic pressure during the last century mainly due to deforestation and the conversion of natural environments into plantations and cattle farming areas. This anthropogenic disruption is mainly caused by the advance of agricultural frontiers, resulting in its current highly relictual coverage, covering no more than 11% of its original area (Ribeiro et al. 2009). The high richness, endemism and the strong threats this area suffers, confer to the Atlantic Forest the status of a worldwide hotspot for biological diversity (*sensu* Myers et al. 2000), and it is therefore, considered as a priority area for the conservation of neotropical biota (Rossa-Feres et al. 2017).

The Atlantic Forest may be divided into eight biogeographical subregions based on endemism areas and transitional regions (Silva & Casteleti 2003, Ribeiro et al. 2011). The northernmost subregion is the Pernambuco Biogeographic Sub-Region (BSR Pernambuco; *sensu* Ribeiro et al. 2009), extending latitudinally from the far north of Rio Grande do Norte state to Alagoas state (05º15'S - 10º30'S), whose southern limit is defined by the São Francisco River, and is currently the most vulnerable and threatened subregion. The BSR Pernambuco is, currently, a mosaic of a few isolated forest remnants within large areas of sugarcane monocultures and pastures (Tabarelli et al. 2006).

As a result, this subregion is classified as the least protected by official conservation units (less than 1% of the existing remnants) and is home to the lowest number of studies on biodiversity in the Atlantic Forest (Ribeiro et al. 2009). Studies that aim to catalog the diversity and distribution of amphibian and reptile species in the BSR Pernambuco are restricted to punctual and short-term inventories, mostly in forest remnants close to urbanized areas (e.g., Santana et al. 2004, Roberto et al. 2017, Melo et al. 2018, Dubeux et al. 2020a). Despite this, 79 species of amphibians and 196 species of reptiles are currently registered for the BSR Pernambuco, of which 23 are endemic (Moura et al. 2016, Almeida et al. 2016, Costa & Bérnils 2018, Mesquita et al. 2018, Dubeux et al. 2020b).

The Serra do Mascarenhas mountain range is one of the largest continuous remnants of Atlantic Forest in the BSR Pernambuco. Located in Pernambuco state, it includes two main forest fragments, "Matas de Água Azul" and "Mata de Xixá", an area of high biological importance for biodiversity conservation in the northern Atlantic Forest and also represents one of the most preserved and least altered forested areas in the state (Pietrobom & Barros 2007, SEMAS 2014). Nevertheless, as with other regions in the northern Atlantic Forest, this area is undergoing an intense process of fragmentation due to the advance of plantations (sugar cane) and other strong anthropogenic pressures (SEMAS 2014).

Aiming to preserve the forest remnants in the northern Atlantic Forest of Pernambuco state, in 2014 a state conservation unit of integral protection was created within the areas of "Matas de Água Azul" and "Mata de Xixá", the second largest continuous remnants of Atlantic Forest in Pernambuco state (Pernambuco 2014), with an area of approximately 3800 ha: the Refúgio de Vida Silvestre (Wildlife Refuge) Matas de Água Azul (RVSMAA) (SEMAS 2014). Despite the importance of RVSMAA as a protected area in the northern Atlantic Forest, there are few studies on its biota which are mostly restricted to an inventory of Pteridophytes and technical reports on birds and plants (Pietrobom & Barros 2007, Lucena 2009, Pereira 2009). Information involving the herpetofauna of the region is limited to a preliminary list of amphibians presented by Santos & Carnaval (2002), which recorded 18 anuran species.

Thus, herein we present the results of a herpetofaunistic inventory in the Serra do Mascarenhas mountain range, specifically within the limits of the conservation unit Refugio de Vida Silvestre Matas de Água Azul, aiming to fill important gaps in the poorly known fauna of the BSR Pernambuco and in particular, of the virtually unknown herpetofauna of Serra do Mascarenhas. As such, we expect that the records reported herein can be used to provide information to supply biogeographical studies and to elaborate conservation strategies for this highly threatened environment.

Material and Methods

1. Study area

The forest remnants present in the Serra do Mascarenhas mountain range are mainly concentrated in the area currently defined as the integral conservation unit, Refúgio de Vida Silvestre Matas de Água Azul. The area of the unit covers 3800 ha in the municipalities of Vicência, Timbaúba and Macaparana, in northeastern Pernambuco state, Brazil (Figure 1- 2). The area is characterized by the presence of a series of hills, with altitudes varying from 150 to 500 meters a.s.l. within ridges and valleys that stand out within the Borborema Plateau (SEMAS 2014). The majority of Serra do Mascarenhas is drained by abundant springs that flow into the main tributaries of the left bank of Siriji River, and large dams such as the one in the Engenho Água Azul (Figure 2F) and the Mascarenhas reservoir (SEMAS 2014). The vegetation is characterized by subdeciduous and deciduous forests, varying up to dense Ombrophilous and mountainous rainforest, featuring large forest blocks and series of smaller surrounding fragments (Figure 1C) (Pietrobom & Barros 2003, Lucena 2009).

The sampling of amphibians and reptiles was conducted during four expeditions that explored different areas in two distinct seasons. The data on average rainfall and temperature, considered to characterize each season, are for the *Zona da Mata* mesoregion in Pernambuco state, where the Serra do Mascarenhas is located. The climatic data encompass

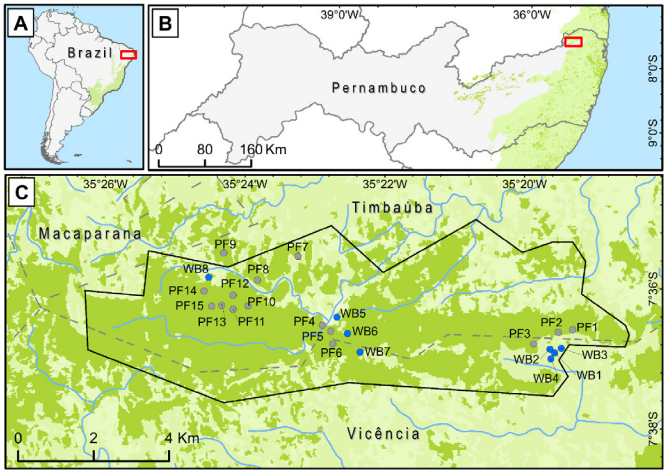

Figure 1. **A** = Location of Pernambuco state within South America (red rectangle). **B** = Location of the area including Serra do Mascarenhas within Pernambuco state (red rectangle). **C** = Serra do Mascarenhas area; black line corresponds to the limits of Refúgio de Vida Silvestre Matas de Água Azul (RVSMAA). Gray circles correspond to Pitfall Traps (**PF**); blue circles correspond to visited water bodies (**WB**); blue lines correspond to hydrography of the area. Light green = original covering of the Atlantic Forest; dark green = remaining Atlantic Forest.

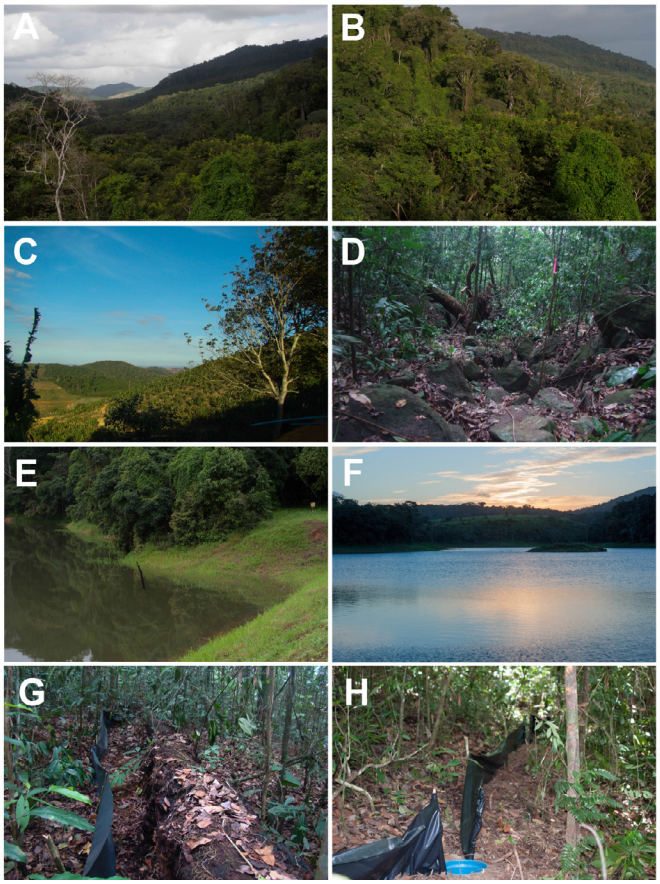

Figure 2. Landscapes and sampling sites in the Refúgio de Vida Silvestre Matas de Água Azul, Serra do Mascarenhas, Pernambuco state, Brazil. A-D = Vegetation in study areas. E-F = Examples of water bodies. G-H = Examples of pitfall traps.

the time of expeditions and was provided by the state climatic agency (APAC 2020). The region presents a tropical Atlantic (As) climate, with a dry season during the summer, according to Koppen's climate classification (Alvares et al. 2014), and two marked seasons defined by rainfall pattern: dry season (October-March) and rainy season (April-September). The first and third expeditions were carried out during the dry season from February 7th to 22th 2017 (average monthly rainfall of ~78.2 mm and temperatures ranging from 20.5°C to 34.6 °C), and from January 8th to February 19th 2018 (average monthly rainfall 53.4 mm, and temperatures ranging from 20.3°C to 31.7°C), respectively. The second and fourth expeditions were carried out during the rainy season from July 10th to 19th 2017 (average monthly rainfall of ~133.5 mm, and temperatures ranging from 19.1°C to 26.4°C), and from July 26th to August 21th 2018 (average monthly rainfall of 152.7 mm, and temperatures ranging from 18.8°C to 29.9°C), respectively.

The first expedition was conducted at the eastern portion of RVSMAA (7°36'S 35°19'W, elevation ~300-400 m) (all coordinates were taken under DATUM WGS84). Four water bodies (WB) were sampled: three small human-built water reservoirs with water at low levels (maximum depths less one meter) and with areas of 366 m² (WB1), 695 m² (WB3) and 560 m² (WB4); all were located in open areas with herbaceous vegetation around their edges (see Table 1 for coordinates). Water body 2 is a dam, with an area of 3,727 m² and a maximum depth of three meters, also located in an open area and with herbaceous vegetation around its edges. Three pitfall traps (PFs) were installed (see sampling methods below). PF1 and PF2 were installed in areas of secondary forest, in a steep area with tall trees (~22-30 m) and some rocky outcrops in the forest; PF3 was installed in a flat area with spaced out trees and ground covered by a dense layer of leaf litter, without rocky outcrops.

The second expedition was carried out in a locality known as Mata do Engenho Água Azul (7°36'S 35°22'W, elevation ~300-400 m) in the central portion of RVSMAA. Three water bodies were sampled: WB5 (reservoir of Engenho Água Azul) had an area of 400 m² and a maximum depth of six meters, with part of its shores connected to the forest and other parts to areas with tall grass, accumulated fallen tree trunks and areas with herbaceous vegetation. The WB6 has an area of 1,140 m² with a maximum depth of two meters and tall grasses inside and some scattered fallen tree trunks at its shores. Water body 7 is a swamp, with an area of approximately 7,600 m² and a maximum depth of two meters, full of tall grasses and aquatic plants. Three pitfall traps were installed: PF4, parallel, and PF6, perpendicular, to a stream that flows into the WB5, ~100 meters inside the forest from the nearest border, in an area presenting dense vegetation and where the ground was covered by a dense layer of leaflitter. Pitfall trap 5 was installed in a steep area, 470 meters inside the forest from the closest border, in an area presenting dense vegetation and where the ground was covered by a dense layer of leaflitter.

The third and fourth expeditions were carried out in a locality know as Mata de Xixá (7°36'S 35°24'W, elevation ~300-500 m) in the western portion of RVSMAA. Only one water body was sampled. The WB8 is a small human-built water reservoir, with an area of approximately 79 m² and a maximum depth of two meters, located in an open area and presenting herbaceous vegetation around its edges. Nine Pitfall traps were installed: PF10-15 were installed inside the continuous fragment of Mata do Xixá; PF10, PF12 and PF14 were installed ~200 meters inside the forest from the closest edge of fragment, and P11, PF13 and PF15 were installed ~400 meters inside the forest from the edge of the fragment. All areas have dense vegetation composed mainly of primary vegetation with large trees, and where the ground is covered with a dense

Table 1. List of sampling points with geographical coordinates and the locality names in the Refúgio de Vida Silvestre Matas de Água Azul, Serra do Mascarenhas, Pernambuco state, Brazil. Pitfall Trap (PF) and Water Bodies (WB).

Abbreviation	Coordinates	Locality	
PF1	7º36'35"S 35º19'19"W	Mata do Engenho Água Azul, Timbaúba Mata do Engenho Água Azul, Vicência Vicência	First campaign
PF2	7º36'37"S 35º19'31"W		
PF3	7º36'47"S 35º19'52"W		
WB1	7º36'55"S 35º19'34"W		
WB2	7º36'52"S 35º19'38"W		
WB3	7º36'51"S 35º19'29"W		
WB4	7º37'00"S 35º19'38"W		
PF4	7º36'31"S 35º22'54"W	Mata do Engenho Água Azul, Timbaúba Mata do Engenho Água Azul, Vicência	Second campaign
PF5	7º36'36"S 35º22'47"W		
PF6	7º36'47"S 35º22'45"W		
WB5	7º36'24"S 35º22'41"W		
WB6	7º36'38"S 35º22'32"W		
WB7	7º36'54"S 35º22'21"W		
PF7	7º35'32"S 35º23'15"W	Mata de Xixá, Timbaúba	Third and fourthcampaigns
PF8	7º35'52"S 35º23'50"W		
PF9	7º35'29"S 35º24'18"W		
PF10	7º36'14"S 35º23'57"W		
PF11	7º36'17"S 35º24'10"W		
PF12	7º36'05"S 35º24'10"W		
PF13	7º36'14"S 35º24'20"W		
PF14	7º36'02"S 35º24'35"W		
PF15	7º36'15"S 35º24'29"W		
WB8	7º35'50"S 35º24'31"W		

layer of leaflitter, although also presenting sparse clearings. The areas where PF14-15 were installed, presented some rocky outcrops in the forest. Pitfall traps 7-9 were installed inside of three different, smaller and isolated fragments from the largest forest fragments. In these three fragments the vegetation was drier and more open when compared to the continuous forest in Mata do Xixá fragment.

2. *Sampling methods*

Two different and complementary sampling methods were used. Visual encounter surveys without time constraints (VES) were used to sample areas where no pitfall traps were placed, inside the forest and close to water bodies (Figure 1) aiming to cover the largest area possible (Foster 2012). All pitfall traps were installed in straight line with buckets of 30 liter and five-meter drift fences between each bucket, at specific sites (Foster 2012). Sampling efforts were distinct in each expedition. The number of buckets and pitfalls changed in each expedition and area. Logistical issues such as locations with rocky soil, uneven terrain or areas with reduced access were determinant in the choice for the amount of buckets. In the first expedition, effort for VES without time constraints was 11 people/day with diurnal and nocturnal searches for 15 days and three pitfall traps were installed, two with 19 buckets each and one with 34 buckets, that remained active for 14 days, totaling a sampling effort of five buckets/day. In the second expedition, the VES effort consisted of seven people/day with diurnal and nocturnal searches for nine days; we also used three pitfall traps, this time with 30 buckets each, which remained active for 10 days with a sampling effort of nine buckets/day. During the third and fourth expeditions the VES consisted of eight people/day with diurnal and nocturnal searches for 28 days; nine pitfall traps with 11 buckets each were installed and remained active for 30 days, with a sampling effort of three buckets/day.

3. *Data collection and analysis*

The specimens collected were euthanized using lidocaine 2% and a sample of liver or muscle tissue was collected from each specimen and stored in alcohol. The specimens were fixed in formaldehyde 10% in accordance with the permits emitted by environmental agencies (ICMBio permit nº 46368; CPRH process nº 03840/2016) and the authorization of the Ethics Committee for the Use of Animals of the Federal University of Pernambuco (CEUA-UFPE nº 0006/2017). All specimens and tissues samples collected were or will be incorporated into the Herpetological Collection of the Federal University of Pernambuco (CHUFPE) under the acronyms CHUFPE and PMSN and PDM (CHUFPE field numbers). Due to closures of the Universities during the COVID-19 pandemic, some specimens have still to be incorporated into the collection and have kept their field numbers associated with their collection numbers, allowing for the correct identification of each individual specimen. The complete voucher list is available in Supplementary Material 1. The taxonomic nomenclature followed Frost (2020) and Uetz et al. (2019).

Values of relative abundance were not obtained for any of the expeditions, however, for several species, mainly reptiles, samples were composed of singletons or doubletons (Table 2 and 3). Estimates of the effectiveness of sampling effort for amphibians and lizards were performed for the complete data set. Snakes and chelonians were not included in this analysis due to the low rate of capture. As encounters with these animals were occasional, the resulting list may be underestimated, which may compromise the results. The data matrices were constructed based on individuals per species (Gotelli & Colwell 2001), including VES and PF data. Species accumulation curves were generated through 1000 randomizations without substitution using only taxa recorded with collected specimens (taxa sampled by auditory or visual records were not included). Additionally, for the same datasets, species richness was estimated using non-parametric tests of Chao 1, since this estimator uses abundance data considering the presence of species represented by only one individual (singletons) or two individuals (doubletons) in the sample. All the analyzes were performed using the EstimateS 9.1.0 software (Colwell et al. 2012).

4. Conservation status

The conservation status of each species followed global, national and local assessments. The Red Book of Endangered Species of the International Union for the Conservation of Nature and Natural Resources (IUCN 2020) was used for the global assessment, the *Livro Vermelho da Fauna Brasileira Ameaçada de Extinção* of *Instituto Chico Mendes de Conservação da Biodiversidade* (ICMBio 2018) was used for the national assessment, and the *Lista Estadual Oficial de Espécies da Fauna Ameaçada de Extinção – Anfíbios* (SEMAS, 2015) and *Lista Estadual Oficial de Espécies da Fauna Ameaçada de Extinção – Répteis* (SEMAS, 2017) were used for the local assessment (Pernambuco state) of the conservation status of each species.

Results

A total of 708 specimens were sampled during the four field expeditions, 43 amphibian and 40 reptile species. The amphibian species belongs to 22 genera and 10 families of anurans and one family of Gymnophiona. The family Hylidae was the richest with 17 species (40%

Table 2. List of amphibian species recorded in the Refúgio de Vida Silvestre Matas de Água Azul, Serra do Mascarenhas, Pernambuco state, Brazil. **C1** = 1st Campaign; **C2** = 2nd Campaign; **C3-4:** 3rd and 4th Campaigns; the numbers in these columns correspond to specimens collected in each campaign. Specimens recorded by Santos & Carnaval (2002) are discriminated in the fifth column. Sampling methods abbreviations: **AS** = Active Search; **PF** = Pitfall Traps; **AR** = Auditory Records; **VR** = Visual Records. Conservation status abbreviations: **VU** = Vulnerable; **LC** = Least Concern; **DD** = Data Deficient; **EN** = Endangered; **NA** = Not Available; (-) Recorded species with no individuals collected.

AMPHIBIAN SPECIES	C1	C2	C3-4	Santos & Carnaval (2002)	Sampling methods	Conservation status		
						IUCN	ICMBio	State list
ANURA								
Aromobatidae								
Allobates olfersioides (Lutz, 1925)			2		AS, PF	VU	VU	EN
Bufonidae								
Rhinella crucifer (Wied-Neuwied, 1821)	5	8	14	x	AS, PF	LC	LC	LC
Rhinella granulosa (Spix, 1824)	6	4	2	x	AS	LC	LC	LC
Rhinella jimi (Stevaux, 2002)	5	1	-		AS, VR	LC	LC	LC
Craugastoridae								
Pristimantis sp.	9	8	18		AS, PF	LC	LC	LC
Eleutherodactylidae								
Adelophryne baturitensis Hoogmoed, Borges & Cascon, 1994	5		6		PF	VU	LC	NA
Hylidae								
Boana albomarginata (Spix, 1824)	12	5		x	AS	LC	LC	LC
Boana crepitans (Wied-Neuwied, 1824)	8				AS	LC	LC	LC
Boana exastis (Caramaschi & Rodrigues, 2003)		-	1		AS, VR	DD	LC	EN
Boana faber (Wied-Neuwied, 1821)	9		2		AS	LC	LC	LC
Boana raniceps (Cope, 1862)	5	1	1	x	AS	LC	LC	LC
Boana semilineata (Spix, 1824)		15	1	x	AS, AR	LC	LC	LC
Corythomantis greeningi Boulenger, 1896			2		AS	LC	LC	LC
Dendropsophus branneri (Cochran, 1948)	4	8	1	x	AS	LC	LC	LC
Dendropsophus elegans (Wied-Neuwied, 1824)		5	-	x	AS, VR	LC	LC	LC
Dendropsophus minutus (Peters, 1872)	1	5		x	AS	LC	LC	LC
Dendropsophus oliveirai (Bokermann, 1963)		9	1	x	AS	LC	LC	LC
Dendropsophus soaresi (Caramaschi & Jim, 1983)	1				AS	LC	LC	LC
Scinax auratus (Wied-Neuwied, 1821)		5			AS	LC	LC	LC

Continue...

Continuation...

Scinax eurydice (Bokermann, 1968)	1	4	3		AS	LC	LC	LC
Scinax gr. *ruber* (Laurenti, 1768)	7	1	3		AS	LC	LC	LC
Scinax nebulosus (Spix, 1824)		4		x	AS	LC	LC	LC
Trachycephalus mesophaeus (Hensel, 1867)			5		AS	LC	LC	LC
Leptodactylidae								
Adenomera aff. *hylaedactyla* (Cope, 1868)		1	1		AS, PF	NA	NA	NA
Leptodactylus fuscus (Schneider, 1799)	3		1	x	AS, PF	LC	LC	LC
Leptodactylus macrosternum Ribeiro, 1926	11	3	1		AS, PF	LC	LC	LC
Leptodactylus cf. *mystaceu*s (Spix, 1824)	1	1			AS	LC	LC	LC
Leptodactylus natalensis A. Lutz, 1930	1	6			AS, PF	LC	LC	LC
Leptodactylus troglodytes A. Lutz, 1926	7	1	3	x	AS, PF	LC	LC	LC
*Leptodactylus vastu*s A. Lutz, 1930	4	3	2		AS, PF	LC	LC	LC
Physalaemus cuvieri Fitzinger, 1826	5	1	11	x	AS, PF	LC	LC	LC
Pseudopaludicola mystacalis (Cope, 1887)			-		VR	LC	LC	DD
Microhylidae								
Chiasmocleis alagoana Cruz, Caramaschi & Freire,1999	2		3		AS, PF	DD	EN	DD
Dermatonotus muelleri (Boettger, 1885)	1		1		AS	LC	LC	LC
Elachistocleis cesarii (Miranda-Ribeiro, 1920)				x	-	NA	LC	LC
Stereocyclops incrassatus Cope, 1870		2	11		AS, PF	LC	LC	LC
Odontophrynidae								
Macrogenioglottus alipioi Carvalho, 1946			14		PF	LC	LC	NA
Proceratophrys cristiceps (Müller, 1883)			1			LC	LC	LC
*Proceratophrys renalis (*Miranda-Ribeiro, 1920*)*	2	1	26		AS, PF	NA	LC	LC
Phyllomedusidae								
Hylomantis granulosa (Cruz, 1989)		1	4	x	AS	LC	VU	VU
Pithecopus gonzagai Andrade, Haga, Ferreira, Recco-Pimentel, Toledo & Bruschi, 2020	12	9	1	x	AS	NA	NA	NA
Ranidae								
Lithobates palmipes (Spix, 1824)	21	1	1	x	AS	LC	LC	LC
GYMNOPHIONA								
Siphonopidae								
Siphonops sp.			-		VR	NA	NA	NA

of total richness), followed by Leptodactylidae (9 spp.), Microhylidae (4 spp.), Bufonidae and Odontophrynidae (3 spp. each), Phyllomedusidae (2 spp.), and Aromobatidae, Craugastoridae, Eleutherodactylidae, Ranidae and Siphonopidae (1 species each) (Figures 3-5). The species list of the anurans recorded at each site, including number of collected specimens, information about collection method and global, national and local conservation status is provided in Table 2.

Forty species of reptiles, within 35 genera and 19 families of Squamata and one genus of Testudines, were recorded. Within the Squamata, 18 species of lizards were collected, with Teiidae being the most diverse family with three species recorded, followed by Dactyloidae, Polychrotidae, Scincidae and Tropiduridae (2 spp. each), Diploglossidae, Gekkonidae, Gymnophthalmidae, Iguanidae, +, Phyllodactylidae and Sphaerodactylidae (1 species each) (Figure 6). Twenty-one snake species were recorded, with Dipsadidae being the most diverse family with nine species, followed by Colubridae (5 spp.), Typhlopidae and Viperidae (2 spp. each), Boidae, Elapidae, and Leptotyphlopidae (1 species each) (Figure 7). Within the Testudines, only one species was recorded, belonging to the family Chelidae (Figure 6A). The species list of reptiles recorded at each site, including number of collected specimens, information about collection method and global, national and local conservation status is provided in Table 3. The accumulation curves for Anura and for the pooled herpetofauna datasets reach an asymptote and are close (pooled Herpetofauna) (N = 56; Chao 1 = 57.43 ± 5.14) or meet (Anura) (N = 41; Chao 1 = 41.20 ± 3.56) the curve of Chao 1 estimator, whereas the lizard's curve does not reach an asymptote or reach the estimator curve (N = 15; Chao 1 = 15.99 ± 2.87) (Figure 8).

Discussion

The virtually unknown herpetofauna from Serra do Mascarenhas is composed of 43 species of amphibians and 40 species of reptiles. In addition, Serra do Mascarenhas has five species of herpetofauna considered as threatened according to local lists. The species list elaborated herein reveals a rich fauna corresponding to 56% of amphibians and 20% of all reptile species (36% of lizard and 26% of snake species) reported for the BSR Pernambuco (Costa & Bérnils 2018, Mesquita et al. 2018, Dubeux et al. 2020b). The richness recorded herein, represents 44% of the herpetofauna known for Pernambuco state,

Table 3. List of reptile species recorded in the Refúgio de Vida Silvestre Matas de Água Azul, Serra do Mascarenhas, Pernambuco state, Brazil. **C1** = 1st Campaign; **C2** = 2nd Campaign; **C3-4** = 3rd and 4th Campaigns; the numbers in these columns correspond to specimens collected in each campaign. Sampling Methods: **AS** = Active Search; **PF** = Pitfall Traps; **VR** = Visual Record. Conservation status: **VU** = Vulnerable; **LC** = Least Concern; **DD** = Data Deficient; **NA** = Not Available; (-) Recorded species with no individuals collected.

REPTILE SPECIES	C1	C2	C3-4	Sampling methods	Conservation status		
					IUCN	ICMBio	State list
TESTUDINATA							
Chelidae							
Phrynops geoffroanus (Schweigger, 1812)		1		AS	NA	LC	LC
SQUAMATA							
Dactyloidae							
Dactyloa punctata (Daudin, 1802)	5	5	7	AS, PF	NA	LC	LC
Norops fuscoauratus (D'Orbigny, 1837)	11		4	AS	NA	LC	LC
Diploglossidae							
Diploglossus lessonae Peracca, 1890			1		LC	NA	LC
Gekkonidae							
Hemidactylus mabouia (Moreau de Jonnès, 1818)	6	-	-	AS	NA	NA	NA
Gymnophthalmidae							
Dryadosaura nordestina Rodrigues, Freire, Pellegrino & Sites, 2005	2			PF	LC	LC	LC
Iguanidae							
Iguana iguana (Linnaeus, 1758)		1	-	AS, VR	LC	LC	LC
Leiosauridae							
Enyalius aff. *catenatus* (Wied, 1821)	26	2	24	AS, PF	LC	LC	LC
Phyllodactylidae							
Gymnodactylus darwinii (Gray, 1845)	7	1	10	AS, PF	LC	LC	LC
Polychrotidae							
Polychrus acutirostris Spix, 1825		2		AS	LC	LC	LC
Polychrus marmoratus (Linnaeus, 1758)		7	2	AS	LC	LC	LC
Scincidae							
Psychosaura agmosticha (Rodrigues, 2000)			1	PF	LC	LC	LC
Psychosaura macrorhyncha (Hoge, 1946)			1	PF	LC	LC	NA
Sphaerodactylidae							
Coleodactylus meridionalis (Boulenger, 1888)	5	9	13	AS, PF	LC	LC	LC
Teiidae							
Ameiva ameiva (Linnaeus, 1758)			1	PF	LC	LC	LC
Kentropyx calcarata Spix, 1825			6	PF	LC	LC	LC
Salvator merianae Duméril & Bibron, 1839			-	VR	LC	LC	LC
Tropiduridae							
Strobilurus torquatus Wiegmann, 1834	2		3	PF	LC	LC	VU
Tropidurus hispidus (Spix, 1825)	2	1		AS	LC	LC	LC
Boidae							
Corallus hortulana (Linnaeus, 1758)		1		AS	LC	LC	LC
Colubridae							
Chironius flavolineatus Jan, 1863	1	6		AS	LC	LC	LC
Dendrophidion atlantica Freire, Caramaschi & Gonçalves, 2010	1			AS	NA	DD	DD
Oxybelis aeneus (Wagler in Spix, 1824)		1		AS	LC	LC	LC
Tantilla melanocephala (Linnaeus, 1758)	1		3	AS	NA	LC	LC
Spilotes pullatus (Linnaeus, 1758)	-			VR	LC	LC	LC
Dipsadidae							
Dipsas neuwiedi (Ihering, 1911)	1			AS	LC	LC	LC
Helicops angulatus (Linnaeus, 1758)			4	AS	LC	LC	LC
Imantodes cenchoa Linnaeus, 1758	5			AS	LC	LC	LC

Continue...

Continuation...

Oxyrhopus trigeminus Duméril, Bibron & Duméril, 1854	1	1	AS	LC	LC	LC
Pseudoboa nigra (Duméril, Bibron & Duméril, 1854)	1		AS	LC	LC	LC
Taeniophallus affinis (Günther, 1858)	2		AS	LC	LC	NA
Thamnodynastes pallidus (Linnaeus, 1758)	1	1	AS	LC	LC	LC
Xenodon merremi (Wagler in Spix, 1824)	1	1	AS	LC	LC	LC
Xenodon rabdocephalus (Wied-Neuwied, 1824)	2	2	AS	LC	LC	LC
Elapidae						
Micrurus aff. *ibiboboca* (Merrem, 1820)		1	AS	NA	DD	DD
Leptotyphlopidae						
Epictia borapeliotes (Vanzolini, 1996)		1	PF	NA	LC	LC
Typhlopidae						
Amerotyphlops arenensis Graboski, Pereira-Filho, Silva, Prudente & Zaher, 2015	2	2	PF	LC	LC	LC
Amerotyphlops brongersmianus (Vanzolini, 1976)	1	1	PF	LC	LC	LC
Viperidae						
Bothrops leucurus Wagler, 1824		2	AS	NA	LC	LC
Lachesis muta (Linnaeus, 1766)		1	AS	NA	LC	VU

Figure 3. Amphibians of Refúgio de Vida Silvestre Matas de Água Azul, Serra do Mascarenhas, Pernambuco state, Brazil. **A -** *Allobates olfersioides* (CHUFPE-A 1103, adult male, SVL 13.74 mm)*;* **B** - *Rhinella crucifer* (CHUFPE-A 0969, adult male, SVL 55.80 mm)*;* **C** - *R. granulosa* (PMSN 333, adult male, SVL 53.54 mm); **D** - *R. jimi* (CHUFPE-A 0656, adult male, SVL 279.60 mm); **E** - *Pristimantis* sp. (unvouchered specimen); **F** - *Adelophryne baturitensis* (unvouchered specimen); **G** - *Boana albomarginata* (PMSN 579, adult male, SVL 46.24 mm); **H** - *B. crepitans* (PMSN 344, adult female, SVL 58.80 mm); **I** - *B. exastis* (PDM 05, adult male, SVL 70.50 mm); **J** - *B. faber* (CHUFPE-A 0746, adult female, SVL 89.27 mm); **K** - *B. raniceps* (PMSN 542, adult male, SVL 69.70 mm); **L** - *B. semilineata* (CHUFPE-A 0959, adult male, SVL 64.76 mm); **M** - *Corythomantis greeningi* (CHUFPE-A 1041, adult male, SVL 72.83 mm); **N** - *Dendropsophus branneri* (unvouchered specimen); **O** - *D. elegans* (unvouchered specimen).

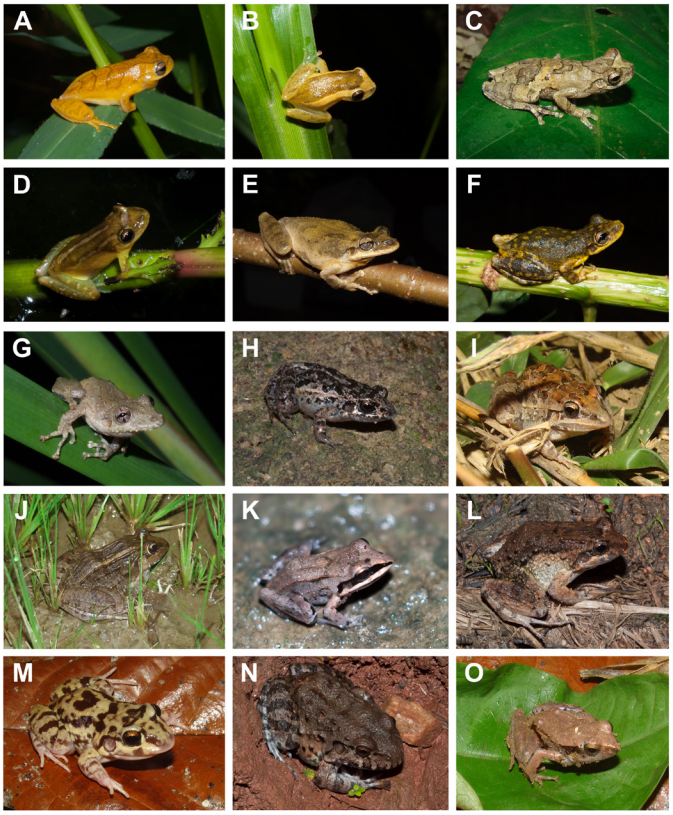

Figure 4. Amphibians of Refúgio de Vida Silvestre Matas de Água Azul, Serra do Mascarenhas, Pernambuco state, Brazil. **A -** *Dendropsophus minutus* (unvouchered specimen); **B -** *D. oliveirai* (PMSN 315, adult male, SVL 17.51 mm); **C -** *D. soaresi* (CHUFPE-A 0769, adult male, SVL 34.65 mm); **D -** *Scinax auratus* (unvouchered specimen); **E -** *S. eurydice* (PMSN 687, adult male, SVL 52.72 mm); **F** - *Scinax* gr. *ruber* (unvouchered specimen); **G** - *S. nebulosus* (unvouchered specimen); **H** - *Adenomera* aff. *hylaedactyla* (unvouchered specimen); **I** - *Leptodactylus fuscus* (CHUFPE-A 0728, adult male, SVL 44.50 mm); **J** - *L. macrosternum* (unvouchered specimen); **K** - *Leptodactylus* aff. *mystaceus* (PMSN 411, adult male, SVL 27.30 mm); **L** - *L. natalensis* (unvouchered specimen); **M** - *L. troglodytes* (CHUFPE-A 0756, adult male, SVL 46.38 mm); **N** - *L. vastus* (PMSN 264, adult male, SVL 25.73 mm); **O** - *Physalaemus cuvieri* (PMSN 234, adult female, SVL 26.70 mm).

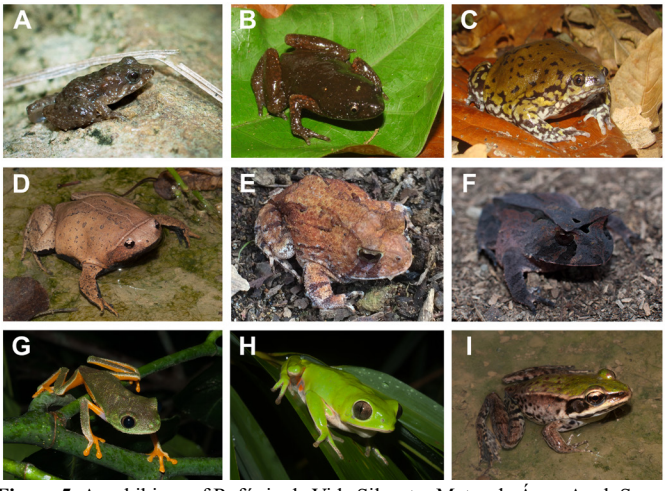

Figure 5. Amphibians of Refúgio de Vida Silvestre Matas de Água Azul, Serra do Mascarenhas, Pernambuco state, Brazil. **A -** *Pseudopaludicola mystacalis* (unvouchered specimen); **B -** *Chiasmocleis alagoana* (PMSN 329, adult male, SVL 21.66 mm); **C -** *Dermatonotus muelleri* (PMSN 371, adult female, SVL 67.28 mm); **D -** *Stereocyclops incrassatus* (CHUFPE-A 1038, adult male, SVL 54.57 mm); **E -** *Proceratophrys cristiceps* (unvouchered specimen); **F -** *P. renalis* (CHUFPE-A 767, adult male, SVL 42.93 mm); **G -** *Hylomantis granulosa* (CHUFPE-A 1093, adult male, SVL 36.20 mm); **H -** *Pithecopus gonzagai* (PMSN 462, adult male, SVL 31.60 mm); **I -** *Lithobates palmipes* (CHUFPE-A 0952, adult female, SVL 46.32 mm).

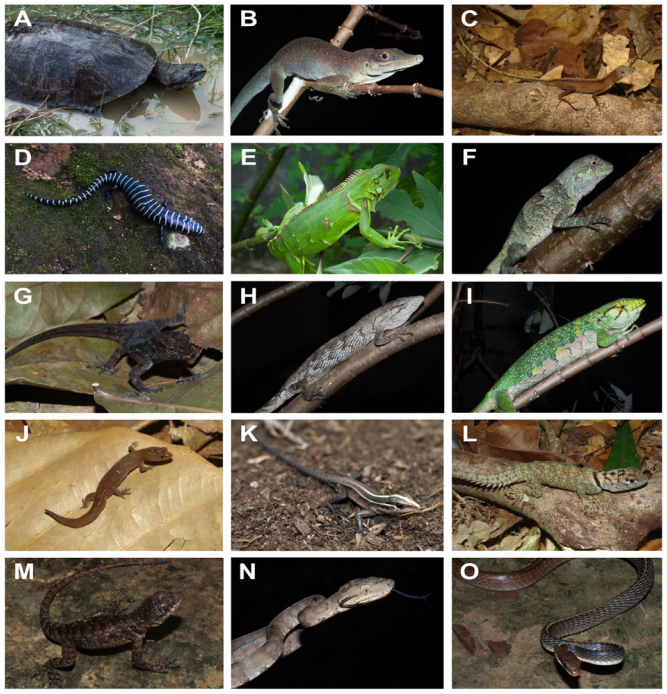

Figure 6. Reptiles of Refúgio de Vida Silvestre Matas de Água Azul, Serra do Mascarenhas, Pernambuco state, Brazil. **A -** *Phrynops geoffroanus* (PMSN 634, adult female, SVL 309 mm); **B -** *Dactyloa punctata* (PMSN 401, adult male, SVL 77.2 mm); **C -** *Norops fuscoauratus* (PDM 49, adult male, SVL 49.2 mm); **D -** *Diploglossus lessonae* (PDM 136, adult male, SVL 56.11 mm); **E -** *Iguana iguana* (PMSN 632, juvenile male, SVL 171.53 mm); **F -** *Enyalius* aff. *catenatus* (unvouchered specimen); **G -** *Gymnodactylus darwinii* (PMSN 261, adult male, SVL 43.70 mm); **H -** *Polychrus acutirostris* (CHUFPE-R 0945, adult female, SVL 171.53 mm); **I -** *P. marmoratus* (CHUFPE-R 0937, adult female, SVL 136.22 mm); **J -** *Coleodactylus meridionalis* (PMSN 349, adult male, SVL 20.9 mm); **K -** *Kentropyx calcarata* (PDM 159, adult male, SVL 57.82 mm); **L -** *Strobilurus torquatus* (PMSN 453, adult female, SVL 61.22 mm); **M -** *Tropidurus hispidus* (PMSN 415, adult female, SVL 55.52 mm); **N -** *Corallus hortulana* (PMSN 689, adult female, SVL 580 mm); **O -** *Chironius flavolineatus* (PMSN 474, adult male, SVL 940 mm).

including at least 64% of amphibian and 32% of reptile species, one of the largest assemblages of amphibians and reptiles ever registered for the state (e.g., Santos & Carnaval 2002, Moura et al. 2010, Roberto et al. 2017). When exclusively considering the richness reported for the Atlantic Forest of Pernambuco, the assemblage reported here comprises approximately 41% of the snake, 69% of the lizard and 67% of the amphibian species registered for this ecoregion.

In comparison with the herpetofauna recorded in adjacent Atlantic Forest fragments in Pernambuco state, the richness found in RVSMAA is the fourth largest in the state, only falling behind that recorded for the *Estação Ecológica de Tapacurá* (36 species of amphibians and 56 of reptiles; Moura et al. 2010), the Serra do Urubu mountain range (46 species of amphibians and 42 reptiles; Roberto et al. 2017) and the *Reserva Biológica Guaribas* (34 species of amphibians and 72 reptiles; Mesquita et al. 2018). Thus, RVSMAA has a greater richness than that found in other important remnants within the state, such as the *Refúgio de Vida Silvestre Matas do Sistema Gurjaú* (24 species of amphibians and 43 of reptiles; Moura et al.2010) and the Dois Irmãos State Park (34 species of amphibians and 21 of reptiles; Melo et al. 2018).

The accumulation curves and richness estimate for RVSMAA revealed that our sampling is close to representing the total diversity of the herpetofauna (collected lizards and anurans) present in the area (N = 56; Chao 1 = 57.43 ± 5.14; Figure 8), mainly regarding the amphibians (N = 41; Chao 1 = 41.20 ± 3.56; Figure 8). The accumulation curve of lizards approaches but not reaches an asymptote (N = 15; Chao 1 = 15.99 ± 2.87; Figure 8), what may be a result of the limiting factor of sampling efforts being divided into three different locations in the RVSMAA, two of which were visited only once and for short periods of time (9-25 days). Although we attempted to sample a wide area of RVSMAA, the great heterogeneity of habitats probably contributes to the occurrence of an even richer and more diverse herpetofauna that has not yet been assessed. Some species widely distributed across the state (Moura et al. 2010) and with probable occurrence in the area, have not been registered, such as amphisbaenids and crocodilians. This reinforces the need for new long-term studies in the region.

Most of the species registered are classified as Least Concern (LC) in the global, national and local conservation red lists. However, two species are categorized as being threatened at some level according to the IUCN (IUCN 2020), three according to the Brazilian national list (ICMBio 2018), and five according to local lists (SEMAS 2015, 2017) (Tables 2 and 3). All these threatened species were registered exclusively in the largest block of continuous forest (Mata de Xixá and Mata do Engenho Água Azul) and all were recorded as single individuals. The collection sites for all these species are highly conserved when compared to adjacent areas and present springs and/or streams that keep the area constantly and highly moist.

All the threatened species in the area are endemic to the Atlantic Forest and dependent on preserved forests for their survival. *Allobates olfersioides* (Table 2, Figure 3A), although widely distributed in the Atlantic Forest, is dependent on areas with clean water sources and moist soils and is usually found near watercourses (Verdade & Rodrigues 2007). This species has suffered severe population declines in many regions of Brazil (Eterovick et al. 2005, Silvano & Segalla 2005), with fragmentation and habitat loss,

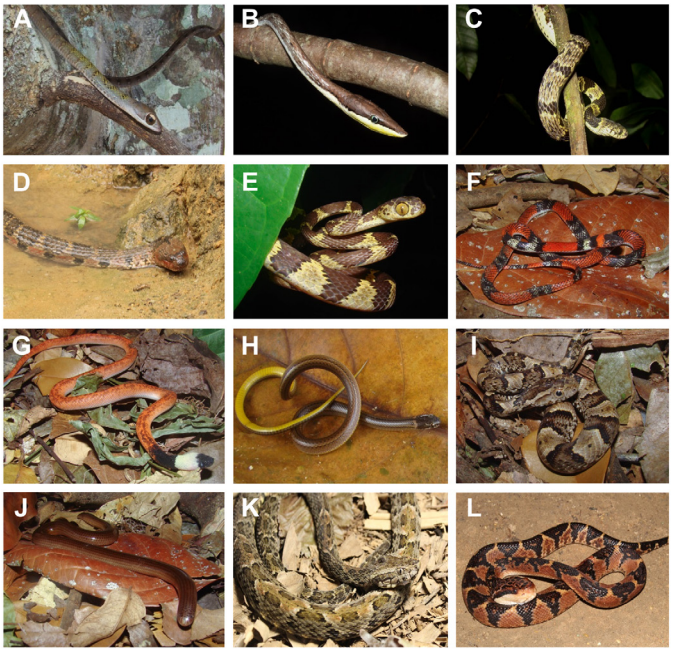

Figure 7. Reptiles of Refúgio de Vida Silvestre Matas de Água Azul, Serra do Mascarenhas, Pernambuco state, Brazil. **A** - *Dendrophidion atlantica* (CHUFPE-R 393, adult male, SVL 840 mm); **B** - *Oxybelis aeneus* (PMSN 690, adult male, SVL 991 mm); **C** - *Dipsas neuwiedi* (PMSN 506, adult male, SVL 428 mm); **D** - *Helicops angulatus* (CHUFPE-R 602, adult female, SVL 515 mm); **E** - *Imantodes cenchoa* (unvouchered specimen); **F** - *Oxyrhopus trigeminus* (PMSN 400, adult female, SVL 330 mm); **G** - *Pseudoboa nigra* (PMSN 482, juvenile, SVL 365 mm); **H** - *Taeniophallus affinis* (PMSN 404, adult male, SVL 273 mm); **I** - *Xenodon rabdocephalus* (CHUFPE-R 0590, adult female, SVL 271 mm); **J** - *Amerotyphlops brongersmianus* (CHUFPE-R 0962, adult female, SVL 301 mm); **K** - *Bothrops leucurus* (PMSN 1739, adult female, SVL 805 mm); **L** - *Lachesis muta* (PMSN 1757, adult male, SVL 515 mm).

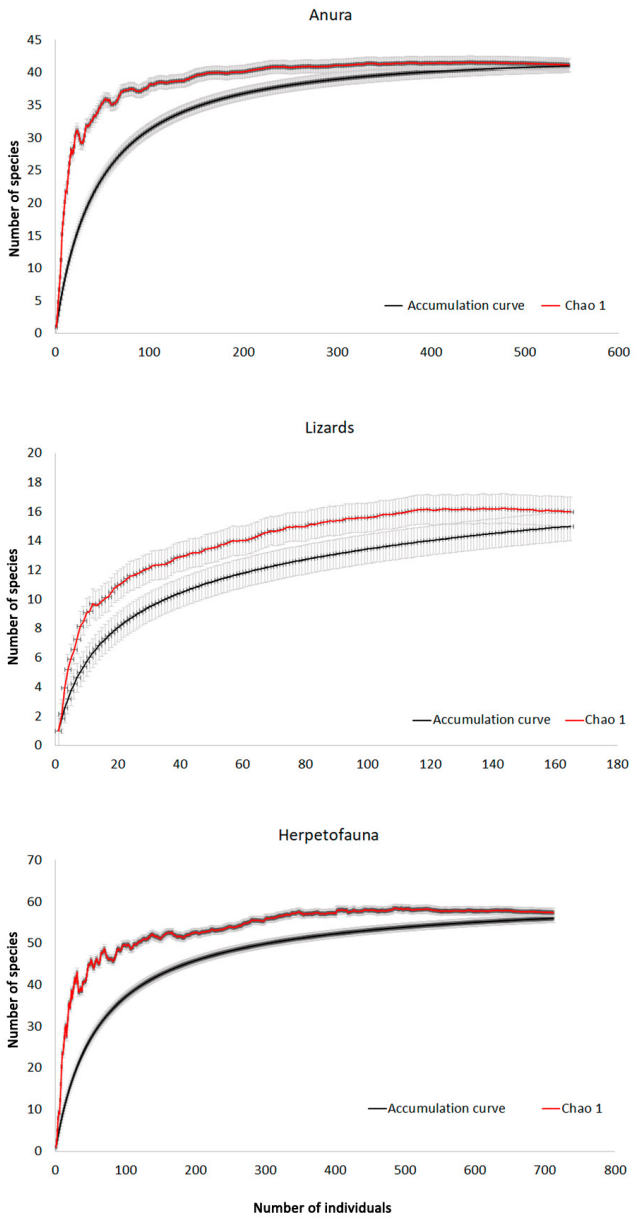

Figure 8. Accumulation curves based on individuals for anurans, lizards and pooled herpetofauna to all combined campaigns in Refúgio de Vida Silvestre Matas de Água Azul, Serra do Mascarenhas, Pernambuco state, Brazil. Black line represents collected individuals and red line the estimated species richness based on Chao 1 estimator.

resulting from deforestation, posing the greatest threats to this species (Campos et al. 2013). It has also been affected by chytridiomycosis caused by the keratinophilic fungus *Batrachochytrium dendrobatidis* (Bd) (Carnaval et al. 2006). In the RVSMAA, *Allobates olfersioides* was collected in the wet leaflitter next to a clean water stream inside the forest (near PF13). Another threatened species that was diagnosed with a Bd infection was *Hylomantis granulosa* (Table 2, Figure 5G) (Valencia-Aguilar et al. 2016). This species is restricted to the Atlantic Forest in Alagoas and Pernambuco states (Moura et al. 2010, Almeida et al. 2016), and occurs in isolated populations (ICMBio 2018). It is a forest species not commonly observed in degraded environments, whose occurrence is restricted to the interior and, occasionally, the edges of large forest remnants (Vilela et al. 2015). In RVSMAA, the specimen of *H. granulosa* was collected near WB7 and inside the forest about 600 meters from the nearest edge, close to PF13.

A similar situation was observed for *Chiasmocleis alagoana* (Table 2, Figure 5B), which is distributed across a few remnants of Atlantic Forest in Alagoas, Pernambuco and Paraíba states (Santana et al. 2004, Moura et al. 2010, Almeida et al. 2016). There are no studies indicating the presence of Bd in this species, and little is known about the conservation of this species (Nascimento & Skuk 2006, Nascimento et al. 2020). *Adelophyne baturitensis* (Table 2, Figure 3F), was considered endemic to two "brejos de altitude" (highland humid forest remnants scattered throughout the semiarid lowlands) in Ceará state (Loebmann & Haddad 2010). It was also posteriorly registered in a "brejo de altitude" in the state of Pernambuco (Loebmann et al. 2011), always above 600 meters of elevation. The record of *A. baturitensis* in Serra do Mascarenhas is the first finding of this species outside the "brejos de altitude", representing its record at the lowest altitude (~ 300 m elevation) and expanding the known distribution of the species 95 km northeast of the nearest recorded locations in the municipality of Caruaru, state of Pernambuco (Loebmann et al. 2011).

Among the threatened reptiles, the "bushmaster" *Lachesis muta* (Table 3, Figure 7L) in RVSMAA was observed in dense and primary forests, as is usually the case for the species (Campbell & Lamar 2004). In this study, it was recorded in the largest forest fragment (Mata do Xixá). Records in disturbed forests are rare (Rodrigues et al. 2013a), revealing its fidelity to densely forested areas, making it highly

susceptible to habitat loss. In addition, the tropidurid lizard *Strobilurus torquatus* (Table 3, Figure 6L) also has a high association with forested habitats, with reports placing the species in the Atlantic Forest in nine Brazilian states (Rodrigues et al. 2013b) and in forest enclaves in Ceará state (Borges Nojosa & Caramaschi 2003). Additionally, four species are classified as Data Deficient (DD) in the local and/or national evaluation of threats (Tables 2 and 3). The lack of knowledge on their ecological and environmental needs, their geographical distribution and population sizes are some of the factors that complicate the assessment of their statuses (ICMBio 2018). The evaluation of these taxa is even more complicated because some are considered to be complexes of species, such as *Pseudopaludicola mystacalis* (Roberto et al. 2013). This species currently has a wide geographical distribution across Brazilian ecoregions (Frost 2020) but it is likely to harbor a great cryptic diversity not yet described and species that are possibly already threatened with extinction without our knowledge.

Some species have not been identified to a specific level, either because they escaped during collection, with no precise identification (*Siphonops* sp.), represent complexes of species with poorly defined lineage limits (e.g., *Scinax* gr. *ruber*) or can represent lineages not formally described or lacking clear diagnostic characters (*Pristimantis* sp.). In this last instance, according to Trevisan et al. (2020) three lineages of *Pristimantis* are currently found in the state of Pernambuco, two of which are not formally described (*P. ramagii*, "São Francisco River clade" and "Pseudoramagii clade). Although the type locality of *P. ramagii* (Boulenger, 1888) (municipality of Igarassu, state of Pernambuco) is 50 km from the study area, the lack of diagnostic characteristics in its original description, added to the high polymorphism present in the genus, makes it difficult to accurately identify the specimens sampled. Therefore, we preferred to keep the specimen identification restricted to the generic level until the other lineages of the genus are described and the diagnostic morphological characters are clearly proposed for them.

Our results indicate that the forest remnants of Serra do Mascarenhas house one of the greatest recorded diversities of amphibians and reptiles in the northern Atlantic Forest. The record of seven threatened species reinforces the relevance of the area for the conservation of herpetofauna in the BSR Pernambuco and northern Atlantic Forest. Similarly, the record of five Data Deficient species in this assessment lists provide important information to clarify the threatened statuses and distributions of these species. Finally, we expect that the diversity data we provide will be relevant to draw a more complete picture of local biodiversity and for conservation assessments, reinforcing the importance of this region as a significant biodiversity reservoir for the state and for northeastern Brazil.

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Author Contributions

Patricia Marques do Amaral Oliveira: Substantial contribution in the concept and design of the study, data collection, data analysis and interpretation and manuscript preparation.

Anna V. Albano de Mello: Substantial contribution in the concept and design of the study, data collection, data analysis and interpretation and manuscript preparation.

Marcos J. Matias Dubeux: Substantial contribution in the concept and design of the study, data collection, data analysis and interpretation and manuscript preparation.

Sérgio Bruno de Assis Oliveira: Contribution to data collection and critical revision, adding intelectual content.

Gabrielly Félix Lourenço: Contribution to data collection, data analysis and interpretation and manuscript preparation.

Pedro M. Sales Nunes: Substantial contribution in the concept and design of the study, data collection, data analysis and interpretation and manuscript preparation.

Conflicts of Interest

The authors declare that they have no conflict of interest related to the publication of this work.

References

ALMEIDA, J.P.F.A., NASCIMENTO, F.A.C., TORQUATO, S., LISBOA, B.S., TIBÚRCIO, I.C.S., PALMEIRA, C.N.S., LIMA, M.G. & MOTT, T. 2016. Amphibians of Alagoas State, northeastern Brazil. Herpetol Notes 9:123-140.

ALVARES, A.C., STAPE, J.L., SENTELHAS, P.C., GONCALVES, J.L. & SPAROVEK, G. 2013. Köppen's climate classification map for Brazil. Meteorol. Zeitschrift 22:711-728.

APAC. 2020. Boletim Pluviométrico. http://www.apac.pe.gov.br/ (last access on 22/mar/2020).

BORGES-NOJOSA, D.M. & CARAMASCHI, U. 2003. Composição e análise comparativa da diversidade e das afinidades biogeográficas dos lagartos e anfisbenídeos (Squamata) dos brejos nordestinos. In Ecologia e conservação da Caatinga (I. Leal, J.M.C. Silva & M. Tabarelli, eds) Editora UFPE, Recife, p.489-540.

CAMPBELL, J.A. & LAMAR, W.W. 2004. The venomous reptiles of the western hemisphere. Volume 1. Cornell University Press, Ithaca.

CAMPOS, F.S., BRITO, D. & SOLÉ, M. 2013. Threatened amphibians and their conservation status within the protected area network in Northeastern Brazil. J Herpetol 47(2):277-285.

CARNAVAL, A.C.O.Q., PUSCHENDORF, R., PEIXOTO, O.L., VERDADE, V.K. & RODRIGUES, M.T. 2006. Amphibian chytrid fungus broadly distributed in the Brazilian Atlantic Rain Forest. EcoHealth 3(1): 41-48.

CARNAVAL, A.C., WALTARI, E., RODRIGUES, M.T., ROSAUER, D., VANDERWAL, J., DAMASCENO, R., PRATES, I., STRANGAS, M., SPANOS, Z., RIVERA, D., PIE, M.R., FIRKOWSKI, C.R., BORNSCHEIN, M.R., RIBEIRO, L.F. & MORITZ, C. 2014. Prediction of phylogeographic endemism in an environmentally complex biome. Proc. Royal Soc. B 281(1792):1-8.

CNUC/MMA. 2019.Cadastro Nacional de Unidades de Conservação. Tabela consolidada das Unidades de Conservação, Ministério do Meio Ambiente, 2016. http://www.mma.gov.br/cadastro_uc (last access on 04/apr/2020).

COLWELL, R.K., CHAO, A., GOTELLI, N.J., LIN, S.-Y, MAO, C.X., CHAZDON, R.L. & LONGINO, J.T. 2012. Models and estimators linking individual-based and sample-based rarefaction, extrapolation, and comparison of assemblages. J Plant Ecol. 5:3-21.

COSTA, L.P. 2003. The historical bridge between the Amazon and the Atlantic Forest of Brazil: a study of molecular phylogeography with small mammals. J. Biogeogr. 30(1):71-86.

COSTA, H.C. & BÉRNILS, R.S. 2018. Répteis do Brasil e suas Unidades Federativas: Lista de espécies. Herpetol Brasil 7(1):11-57.

DUBEUX, M.J.M., GONÇALVES, U., DO NASCIMENTO, F.A.C. & MOTT, T. 2020a. Anuran amphibians of a protected area in the northern Atlantic Forest with comments on topotypic and endangered populations. Herpetol Notes 13:61-74.

DUBEUX, M.J.M., NASCIMENTO, F.A.C., LIMA, L.R., MAGALHÃES, F.M., SILVA, I.R.S., GONÇALVES, U., ALMEIDA, J.P.F., CORREIA, L.L., GARDA, A.A., MESQUITA, D.O., ROSSA-FERES, D.C. & MOTT, T. 2020b. Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest. Biota Neotropica 20(2):e20180718. https://doi.org/10.1590/1676-0611-BN-2018-0718 (last access on 16/jan/2021).

ETEROVICK, P.C., CARNAVAL, A.C., BORGES-NOJOSA, D.M., SILVANO, D.L., SEGALLA, M.V. & SAZIMA, I. 2005. Amphibian declines in Brazil: an overview. Biotropica 37:166-179.

FOSTER, M.S. 2012. Standard techniques for inventory and monitoring. In Reptile biodiversity: standard methods for inventory and monitoring (R.W. McDiarmid, M.S. Foster, C. Guyer, N. Chernoff & J.W. Gibbons, eds.). University of California Press, Los Angeles, p.205-240.

FROST, D.R. 2020. Amphibian Species of the World. Version 6.0. http://research.amnh.org/herpetology/amphibia/index.php (last access on 22/mar/2020).

GALINDO-LEAL, C. & CÂMARA, I.D.G. 2003. Atlantic Forest hotspot status: an overview. In The Atlantic Forest of South America: biodiversity status, threats, and outlook (C. Galindo-Leal & I.G. Câmara, eds). Island Press, Washington, D.C, p.3-11.

GOTELLI, N.J. & COLWELL, R.K. 2001. Quantifying biodiversity: procedures and pitfalls in the measurement and comparison of species richness. Ecol. Lett. 4(4):379-391.

ICMBIO. 2018. Fauna Brasileira Ameaçada de Extinção. Fundação Biodiversitas para a Conservação da Diversidade Biológica, Brasília.

IUCN. 2020. The IUCN Red List of Threatened Species. Version 2020-1, International Union for Conservation of Nature and Natural Resources. http://www.iucnredlist.org (last access on 22/mar/2020).

LOEBMANN, D. & HADDAD, C.F.B. 2010. Amphibians and reptiles from a highly diverse area of the Caatinga domain: composition and conservation implications. Biota Neotropica 10: 227-256. https://doi.org/10.1590/S1676-06032010000300026 (last access on 16/jan/2021).

LOEBMANN, D., ORRICO, V.G.D. & HADDAD, C.F. 2011. First record of Adelophryne baturitensis Hoogmoed, Borges & Cascon, 1994 for the state of Pernambuco, northeastern Brazil (Anura, Eleutherodactylidae, Phyzelaphryninae). Herpetol Notes 4:75-77.

LUCENA, M.D.F.A. 2009. Flora do Engenho Água Azul, Timbaúba, Pernambuco, Brasil. Relatório Técnico. CEPAN, Recife.

MAGURRAN, A.E. 2004. How many species? In Measuring Biological Diversity (Magurran, A.E.) Wiley-Blackwell, New Jersey, p.1-132.

MELO, I.V., MOURA, G.J.B., FREITAS, M.A., ANDRADE, E.V.E., CASAL, C., ABEGG, A.D. & KOKUBUM, M.N.C. 2018. New additions to herpetofauna of the Parque Estadual Dois Irmãos, an urban Atlantic Rainforest Fragment, Recife municipality, Pernambuco state, northeastern Brazil. Herpetol Notes 11:245-254.

MESQUITA, D.O., ALVES, B.C.F., PEDRO, C.K.B., LARANJEIRAS, D.O., CALDAS, F.L.S., PEDROSA, I.M.M.C. & NOGUEIRA-COSTA, P. 2018. Herpetofauna in two habitat types (tabuleiros and Stational Semidecidual Forest) in the Reserva Biológica Guaribas, northeastern Brazil. Herpetol Notes 11:455-474.

MOURA, G.J.B., SANTOS, E.M., OLIVEIRA, M.A.B. & CABRAL, M.C.C. 2010. Herpetofauna no estado de Pernambuco. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, Brasília.

MOURA, M.R., VILLA-LOBOS, F., COSTA, G.C. & GARCIA, P.C. 2016. Disentangling the role of climate, topography and vegetation in species richness gradients. Plos One 11(3):1-16.

MYERS, N., MITTERMEIER, R.A., MITTERMEIER, C.G., FONSECA, G.A. & KENT, J. 2000. Biodiversity hotspots for conservation priorities. Nature 403(6772):853-858.

NASCIMENTO, F.A.C. & SKUK, G.O. 2006. O girino de Chiasmocleis alagoanus Cruz, Caramaschi & Freire, 1999 (Anura: Microhylidae). Biota Neotropica 6(3). http://www.biotaneotropica.org.br/v6n3/pt/abstract?shortcommunication+bn02506032006 ISSN 1676-0603 (last access on 16/jan/2021).

NASCIMENTO, F.A.C.D., VILELA, B., DUBEUX, M.J.M., GALDINO, J.Y.A., ARAÚJO-NETO, J.V., LEAL, F., DE SÁ, R. 2020. Reproductive biology and sexual dimorphism of the poorly known frog Chiasmocleis alagoana (Microhylidae, Gastrophryninae), with an updated diagnosis for the species. Stud. Neotrop. Environ. 55:1-15.

PEREIRA, G.A. 2009. Aves do Engenho Água Azul, Timbaúba, Pernambuco, Brasil. Relatório Técnico. CEPAN, Recife.

PERNAMBUCO. 2014. Decreto nº 40.551, de 28 de março de 2014. Cria o Refúgio de Vida Silvestre Matas de Água Azul, localizado nos Municípios de Timbaúba, Vicência e Macaparana, neste Estado. Diário Oficial do Estado de Pernambuco, Recife.

PIETROBOM, M.R. & BARROS, I.C.L. 2003. Pteridófitas de um fragmento florestal na Serra do Mascarenhas, estado de Pernambuco, Brasil. INSULA Revista de Botânica 32:73-118.

PIETROBOM, M.R.& BARROS, I.C.L. 2007. Pteridophytes of Engenho Água Azul, municipality of Timbaúba, Pernambuco, Brazil. Rodriguésia 58(1):85-94.

PINTO, L.P. & BRITO, M.C.W. 2003. Dynamics of biodiversity loss in the Brazilian Atlantic Forest: an introduction. In The Atlantic Forest of South America: biodiversity status, trends, and outlook (C.G. Leal & I.G. Câmara, eds). Island Press, Washington, D.C., p.27-30.

RIBEIRO, M.C., METZGER, J.P., MARTENSEN, A.C., PONZONI, F.J. & HIROTA, M.M. 2009. The Brazilian Atlantic Forest: How much is left, and how is the remaining forest distributed? Implications for conservation. Biol. Conserv. 142(6):1141-1153.

RIBEIRO, M.C., MARTENSEN, A.C., METZGER, J.P., TABARELLI, M., SCARANO, F. & FORTIN, M.J. 2011. The Brazilian Atlantic Forest: A shrinking biodiversity hotspot. In Biodiversity hotspots (F. Zachos & J. Habel, eds). Springer, Berlin, p. 405-434.

ROBERTO, I.J., CARDOZO, D. & ÁVILA, R.W. 2013. A new species of Pseudopaludicola (Anura, Leiuperidae) from western Piauí state, northeast Brazil. Zootaxa 3636(2):348-360.

ROBERTO, I.J., OLIVEIRA, C.R., ARAÚJO-FILHO, J.A., OLIVEIRA, H.F. & ÁVILA, R.W. 2017. The herpetofauna of the Serra do Urubu mountain range: a key biodiversity area for conservation in the Brazilian Atlantic Forest. Pap Avulsos Zool. 57(27):347-373.

RODRIGUES, R., ALBUQUERQUE, R.L., SANTANA, D.J., LARANJEIRAS, D.O., PRÓTAZIO, A.S., FRANÇA, F.G.R. & MESQUITA, D.O. 2013a. Record of the occurrence of Lachesis muta (Serpentes, Viperidae) in an Atlantic Forest fragment in Paraíba, Brazil, with comments on the species' preservation status. Biotemas 26(2):283-286.

RODRIGUES, K.C., DELFIM, F.R., DE CASTRO, C.S.S., FRANÇA, F.G.R., LEITE FILHO, E., MESQUITA, D.O., ARAÚJO DE OLIVEIRA, F., DOS SANTOS, A.C.A, FERRARI, S.F & VALENÇA-MONTENEGRO, M.M. 2013b. Strobilurus torquatus Wiegmann, 1834 (Squamata: Tropiduridae): New records from the Brazilian state of Paraíba and a geographic distribution map. Check list 9(3):614-617.

ROLL, U., FELDMAN, A., NOVOSOLOV, M., ALLISON, A., BAUER, A.M., BERNARD, R., BÖHM, M., CASTRO-HERRERA, F., CHIRIO, L., COLLEN, B., COLLI, G.R., DABOOL, L., DAS, I., DOAN, T.M., GRISMER, L.L., HOOGMOED, M., ITESCU, Y., KRAUS, F., LEBRETON, M., LEWIN, A., MARTINS, M., MAZA, E., MEIRTE, D., NAGY, Z.T., NOGUEIRA, C.C., PAUWELS, O.S.G., PINCHEIRA-DONOSO, D., POWNEY, G.D., SINDACO, R., TALLOWIN, O.J.S., TORRES-CARVAJAL, O., TRAPE, J.F., VIDAN, E., UETZ, P., WAGNER, P., WANG, Y., ORME, C.D.L., GRENYER, R. & MEIRI, S. 2017. The global distribution of tetrapods reveals a need for targeted reptile conservation. Nat. Ecol. Evol. 1(11):1677-1682.

ROSSA-FERES, D. C., GAREY, M.V., CARAMASCHI, U., NAPOLI, M.F., NOMURA, F., BISPO, A. A., BRASILEIRO, CR.A., THOMÉ, M.T.C., SAWAYA, R.J., CONTE, C.E., CRUZ, C.A.G., NASCIMENTO, L.B., GASPARINI, J.L., ALMEIDA, A.P. & HADDAD, C.F.B. 2017. Anfíbios da Mata Atlântica: lista de espécies, histórico dos estudos, biologia e conservação. In Revisões em Zoologia: Mata Atlântica (E.L.A. Monteiro-Filho & C.E. Conte, orgs). Editora UFPR, Curitiba, p.237-314.

SANTANA, G.G., VIEIRA, W.L.S., PEREIRA-FILHO, A., DELFIM, F.R., LIMA, Y.C.C. & VIEIRA, K. 2004. Herpetofauna em um fragmento de Floresta Atlântica no Estado da Paraíba, Região Nordeste do Brasil. Biotemas 21(1):75-84.

SANTOS, E.M. & CARNAVAL, A.C.O.Q. 2002. Anfíbios anuros do Estado de Pernambuco. In Diagnóstico da Biodiversidade de Pernambuco (M. Tabarelli & J.M.C. Silva, eds). SECTMA/Massangana, Recife, p.529-536.

SEMAS. 2014. Proposta para criação de Unidade de Conservação na Mata de Água Azul - Timbaúba, Vicência e Macaparana – Pernambuco. http://www.semas.pe.gov.br/web/semas (last access on 22/mar/2020).

SEMAS. 2015. Resolução SEMAS Nº 1 de 09 de janeiro de 2015. Reconhece como espécies de anfíbios da fauna pernambucana ameaçadas de extinção aquelas constantes da lista oficial e dá outras providências. Diário Oficial do Estado de Pernambuco, Jan/09/2015.

SEMAS. 2017. Resolução SEMAS Nº 1 de 25 de maio de 2017. Reconhece como espécies de répteis da fauna pernambucana ameaçadas de extinção aquelas constantes da lista oficial e dá outras providências. Diário Oficial do Estado de Pernambuco, May/15/2017.

SILVA, J.M.C. & CASTELETI, C.H.M. 2003. Status of the biodiversity of the Atlantic Forest of Brazil. In The Atlantic Forest of South America: Biodiversity status, threats, and outlook (C. G. Leal & I. G. Câmara, eds). CABS and Island Press, Washington, p.43-59.

SILVANO, D.L. & SEGALLA, M.V. 2005. Conservation of Brazilian amphibians. Conserv. Biol. 19:653-658.

TABARELLI, M., SIQUEIRA-FILHO, J.A. & SANTOS, A.M.M. 2006. Conservação da Floresta Atlântica ao norte do Rio São Francisco. In Biodiversidade Biológica e Conservação da Floresta Atlântica ao norte do Rio São Francisco (K.C. Pôrto, J.S. Almeida-Cortezand & M. Tabarelli, eds). Ministério do Meio Ambiente, Brasília, p.41-48.

TREVISAN, C.C., BATALHA-FILHO, H., GARDA, A.A., MENEZES, L., DIAS, I.R., SOLÉ, M., CANEDO, C., JUNCÁ, F.A. & NAPOLI, M.F. 2020. Cryptic diversity and ancient diversification in the northern Atlantic Forest Pristimantis (Amphibia, Anura, Craugastoridae). Mol. Phylogenet. Evol. 148:106811.

UETZ, P., CHERIKH, S., SHEA, G., INEICH, I., CAMPBELL, P. D., DORONIN, I.V., ROSADO, J., WYNN, A., TIGHE, K. A., MCDIARMID, R., LEE, J.L., KÖHLER, G., ELLIS, R., DOUGHTY, P., RAXWORTHY, C.J., SCHEINBERG, L., RESETAR, A., SABAJ, M., SCHNEIDER, G., FRANZEN, M., GLAW, F., BÖHME, W., SCHWEIGER, S., GEMEL, R., COUPER, P., AMEY, A., DONDORP, E., OFER, G., MEIRI, S. & WALLACH, V. 2019. A global catalog of primary reptile type specimens. Zootaxa 4695(5):438-450.

VALENCIA-AGUILAR, A., TOLEDO, L.F., VITAL, M.V. & MOTT, T. 2016. Seasonality, environmental factors, and host behavior linked to disease risk in stream-dwelling tadpoles. Herpetologica 72(2):98-106.

VERDADE, V.K. & RODRIGUES, M.T. 2007. Taxonomic review of Allobates (Anura, Aromobatidae) from the Atlantic Forest, Brazil. J Herpetol 41(4):566-580.

VILELA, B., LISBOA, B.S. & NASCIMENTO, F.A.C. 2015. Reproduction of Agalychnis granulosa Cruz, 1989 (Anura: Hylidae). Journal Natural History 49(11-12):709-717.

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