



Anurans of the Caparaó National Park and surroundings, southeast Brazil

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ZORNOSA-TORRES, C., AUGUSTO-ALVES, G., LYRA, M.L., SILVA JÚNIOR, J.C., GARCIA, P.C.A., LEITE, F., VERDADE, V., RODRIGUES, M.T., GASPARINI, J.L., HADDAD, C.F.B., TOLEDO, L.F. **Anurans of the Caparaó National Park and surroundings, southeast Brazil.** *Biota Neotropica* 20(3): e20190882. <https://doi.org/10.1590/1676-0611-BN-2019-0882>.

Abstract: The Atlantic Forest (AF) is one of the biodiversity hotspots of the world, and the most fragmented biome of Brazil. This biome includes different phytophysiognomies, as riparian, slope, cloudy forests, and grasslands. Such complexity, allied to huge latitudinal and high elevational range, provides diverse habitats and conditions for amphibian speciation. As a result, there are over 600 amphibian species known to occur in the AF. Within this biome the Caparaó National Park (CNP) is relevant, as it includes the highest peak of the biome, the *Pico da Bandeira* at almost 3,000 m above sea level, as well as different phytophysiognomies as rocky fields and humid forests. In spite of that, its amphibian fauna is still poorly described. We inventoried amphibians at the CNP and surrounding areas from 2016 to 2018 and recorded 47 anuran species, of which two are locally endemic and at least six have not been described yet. Additionally, we compiled data from previous surveys (2004 to 2008) and secondary data from scientific collections. All together, we registered a total of 61 anuran species from 12 families for the CNP and surroundings, placing this area among the 10 amphibian richest sites in the AF. Some of these species are represented by only one or two collected specimens and have not been registered in the CNP since the 1980's, such as *Thoropa lutzi* and *Hylodes vanzolinii*. These species could be examples of population declines or even past local extinctions, highlighting the need of further sampling efforts in that highly biodiverse site.

Keywords: *Amphibia; frogs; toads; Atlantic Forest; species composition; species lists.*

Anuros do Parque Nacional do Caparaó e arredores, sudeste brasileiro

Resumo: A Mata Atlântica (MA) é considerada um dos *hotspots* de biodiversidade do mundo, sendo o bioma mais degradado no Brasil. Este bioma compreende muitas fitofisionomias, como floresta ombrófila, semidecidual, e campos de altitude. Esta complexidade, aliada à enorme variação latitudinal e altitudinal, disponibiliza habitats e condições diversas à especiação dos anfíbios. Como resultado, atualmente são conhecidas mais de 600 espécies de anfíbios que ocorrem na MA. Dentro deste bioma o Parque Nacional do Caparaó (PNC) é relevante, pois inclui o ponto mais alto da Mata Atlântica, o Pico da Bandeira com cerca de 3000 m de elevação, assim como diferentes fitofisionomias, como campos rupestres e florestas úmidas. Apesar disso, sua fauna de anfíbios é ainda pobremente descrita. Realizamos inventários de anfíbios no PNC e entorno de 2016 a 2018 e registramos 47 espécies de anuros, das quais duas são endêmicas e pelo menos seis ainda não foram descritas. Adicionalmente, compilamos dados de coletas anteriores (2004 a 2008) e dados secundários de coleções científicas. Ao juntar todos os dados registramos um total de 61 espécies de anuros de 12 famílias para o PNC e arredores, colocando esta área entre as 10 áreas mais ricas em anfíbios da MA. Algumas destas espécies estão representadas apenas por um ou dois exemplares em coleções e não foram registradas no PNC desde a década de 1980, como *Thoropa lutzi* e *Hylodes vanzolinii*. Estas espécies podem ser exemplos de declínios populacionais ou mesmo de extinções locais, destacando a necessidade de maiores esforços amostrais neste local altamente biodiverso.

Palavras-chave: *Amphibia*; composição de espécies; lista de espécies; Mata Atlântica; rãs; sapos.

Introduction

The Atlantic Forest (AF) is one of the most degraded biomes of Brazil, with less than 16% of its original extension, due to severe anthropic pressure over the past couple centuries (Ribeiro et al. 2011, Rossa-Feres et al. 2018). This biome is characterized by having different phytophysionomies as evergreen, deciduous and semi-deciduous forest, mangroves, swamps, dunes and high-altitude grasslands (Ribeiro et al. 2011), high latitudinal variation (almost from the equator line, down to subtropical regions), and high topographic complexity (Morellato & Haddad 2000, Toledo et al. 2014). Due to the high number of endemic species and the huge habitat loss it has been considered one of the 35 biodiversity hotspots of the world (Mittermeier et al. 2011), and therefore, conservation of this biome is a priority.

The AF amphibians are also diverse and represented by more than 600 species, of which about 75% are endemic, and several species yet to describe (Haddad et al. 2013, Rossa-Feres et al. 2018). In the AF, humidity and vegetation cover are determinants of amphibian species diversity, which are related to altitudinal variation (Vasconcelos et al. 2014). Some of the AF mountains are traditional centers of endemism, due to their elevation, climatic variation and biogeographic history (Guarnizo & Cannatella 2013, Vasconcelos et al. 2014).

The mountain region of the Caparaó National Park (CNP) in the border of the states of Minas Gerais and Espírito Santo, southeastern Brazil, includes the highest peak of the Atlantic Forest, reaching almost 3,000 m above sea level. The area is covered by different phytophysionomies (e.g., riparian, slope and cloudy forests; grasslands), and houses a diverse amphibian biota (Ferreira et al. 2015), including micro endemic species, as *Cycloramphus bandeirensis* (Heyer 1983). In spite of the potential relevance of the area for amphibian diversity, the single amphibian species list available was based on a 20 days survey and reported only 21 anuran species (Ferreira et al. 2015).

Here, we present an improved list of the anuran species of the Caparaó National Park and surroundings based on a period of almost seven years of fieldwork in the region and accessing information from scientific collections, including sound recordings and vouchered specimens.

Material and Methods

1. Study site

We searched for amphibians in the Caparaó National Park (CNP) and surroundings (Figure 1A). The Caparaó National Park is located between the states of Minas Gerais and Espírito Santo, southeastern Brazil, and belongs to the massif of Caparaó, which is part of the north region of the Serra da Mantiqueira (a mountain range) in the Atlantic Forest. Seasons in the CNP region are divided in a rainy summer (from November to March) and a wet winter (from April to October). The CNP has a huge elevational variation, from 859 to 2,892 m above sea level (a.s.l.), and the predominant phytophysionomies are ombrophilous rainforests and high-altitude grasslands (above 1,900 m a.s.l.) (Machado et al. 2016).

2. Field and scientific collections samplings

We conducted field surveys from 2016 to 2018 in the Caparaó National Park and surroundings. We sampled 62 sample sites/units (SUs) (Figure 1A, Table S1), mainly during rainy season (see above), totaling 63 sampling days, as follows: 29 January to 03 February 2016, 27 July to 01 August 2016, 19–25 October 2016, 02–12 December 2016, 06–15 January 2017, 05–12 October 2017, 06–12 December 2017, 16–25 January 2018 and 22 November to 04 December 2018.

During these surveys we actively and acoustically searched for amphibians in possible breeding sites (Figure 2) inside and outside the park, both in its East and West slopes. These slopes were delimited by the downstream direction of the rivers. We also search in specific localities where rare species were registered in the past. Adult anurans were collected, anesthetized, and killed with lidocaine 5%, fixed in 10% formalin, and stored in 70% ethanol. Tadpoles were fixed and stored in 7% formalin. For all individuals we collected muscle tissue samples before fixing the specimens and stored at 100% ethanol. Voucher specimens were deposited at the Museu de Zoologia “Prof. Adão José Cardoso” (ZUEC), Universidade Estadual de Campinas (Unicamp), according to the ICMBio (#58836-1) permit, SISGen (#A8A7729) protocol, and ethics committee (#4827-1/2018) approval.

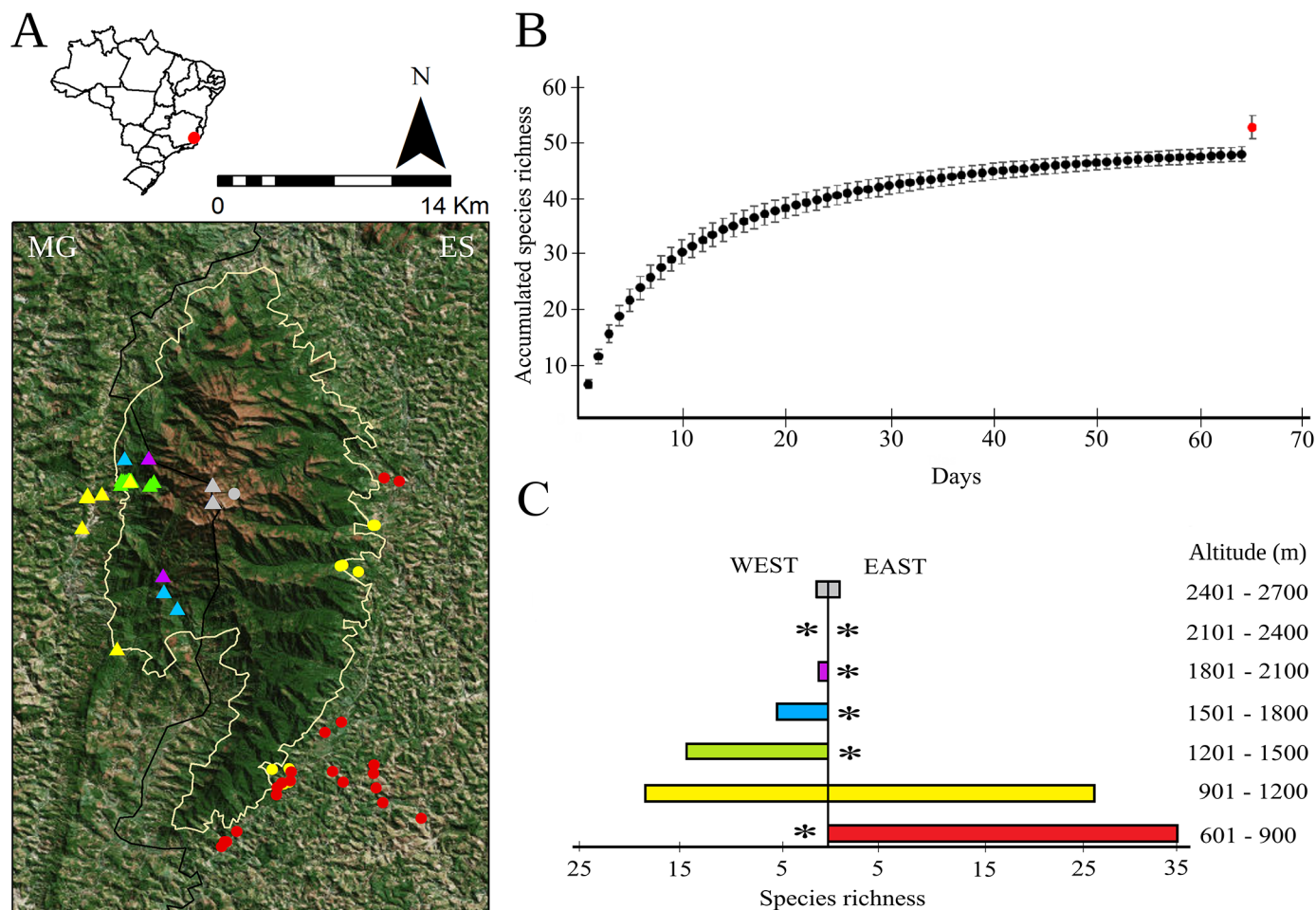


Figure 1. (A) Distribution of anuran species in the Caparaó National Park (CNP): yellow line determines the limits of the CNP, triangles correspond to registers in the west slope, dots in the east slope, and colors correspond to altitudinal ranges; black line represents the boundaries between states of Minas Gerais (MG) and Espírito Santo (ES). (B) Accumulated species richness during 63 days of survey; red dot corresponds to the jackknife 1 estimator for species richness. (C) Number of species registered in each altitudinal range; asterisks indicate areas not sampled. Geographical coordinates of all sample units are in Table S1. Diversity index values (ACE, ICE, Chao 1, Chao 2, Jackknife 1, Jackknife 2, Bootstrap) are in Table S2.

Anuran calls were recorded using digital recorders (TASCAM DR-40, Marantz PMD 661, Sony PCM-M10, Zoom H4n, and Zoom H4n Pro) and were deposited at the Fonoteca Neotropical Jacques Vielliard (FNJV), ZUEC, Universidade Estadual de Campinas (Unicamp). Based on these samples we estimated diversity indexes (ACE, ICE, Chao 1, Chao 2, Jackknife 1, Jackknife 2, and Bootstrap) and constructed a sample-based accumulation curve with 1,000 randomizations using the software EstimateS 9.1.0 (Colwell 2013). We decided to show only the Jackknife 1 index as it is the best fitting index and the most used diversity index in species list studies.

Additionally, we combined this dataset with data from previous surveys carried out from 2004 to 2008, and with data from specimens deposited in the following Brazilian scientific collections: Museu de Zoologia da Universidade de São Paulo (MZUSP), São Paulo, São Paulo; Centro de coleções taxonômicas, Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, Minas Gerais; Coleção Célio F. B. Haddad (CFBH), Universidade Estadual Paulista “Júlio de Mesquita

Filho”, Rio Claro, São Paulo; Museu Nacional (MNRJ), Rio de Janeiro, Rio de Janeiro; and sound recordings from the Fonoteca Neotropical Jacques Vielliard (FNJV), ZUEC, Universidade Estadual de Campinas, Campinas, São Paulo.

Taxonomic nomenclature follows Frost (2020). Species identification was done by comparisons with previously collected individuals in scientific collections (Appendix I), species descriptions, sound recordings from individuals and additional DNA analyses for the ones we needed extra identification (e.g., tadpoles, juveniles or species complexes). For the molecular analyses we extracted total DNA and amplified a fragment of 16S ribosomal DNA, following methods in Lyra et al. (2017). Purified fragments were sent to Macrogen, Republic of Korea for sequencing. We then used the blast tool (BLAST+ application, Camacho et al. 2009) to assign individuals to species. We assigned a species identification if similarity between sequences was higher than 98%. The newly generated sequences were submitted to GenBank (accession numbers: MN450227–MN450262).

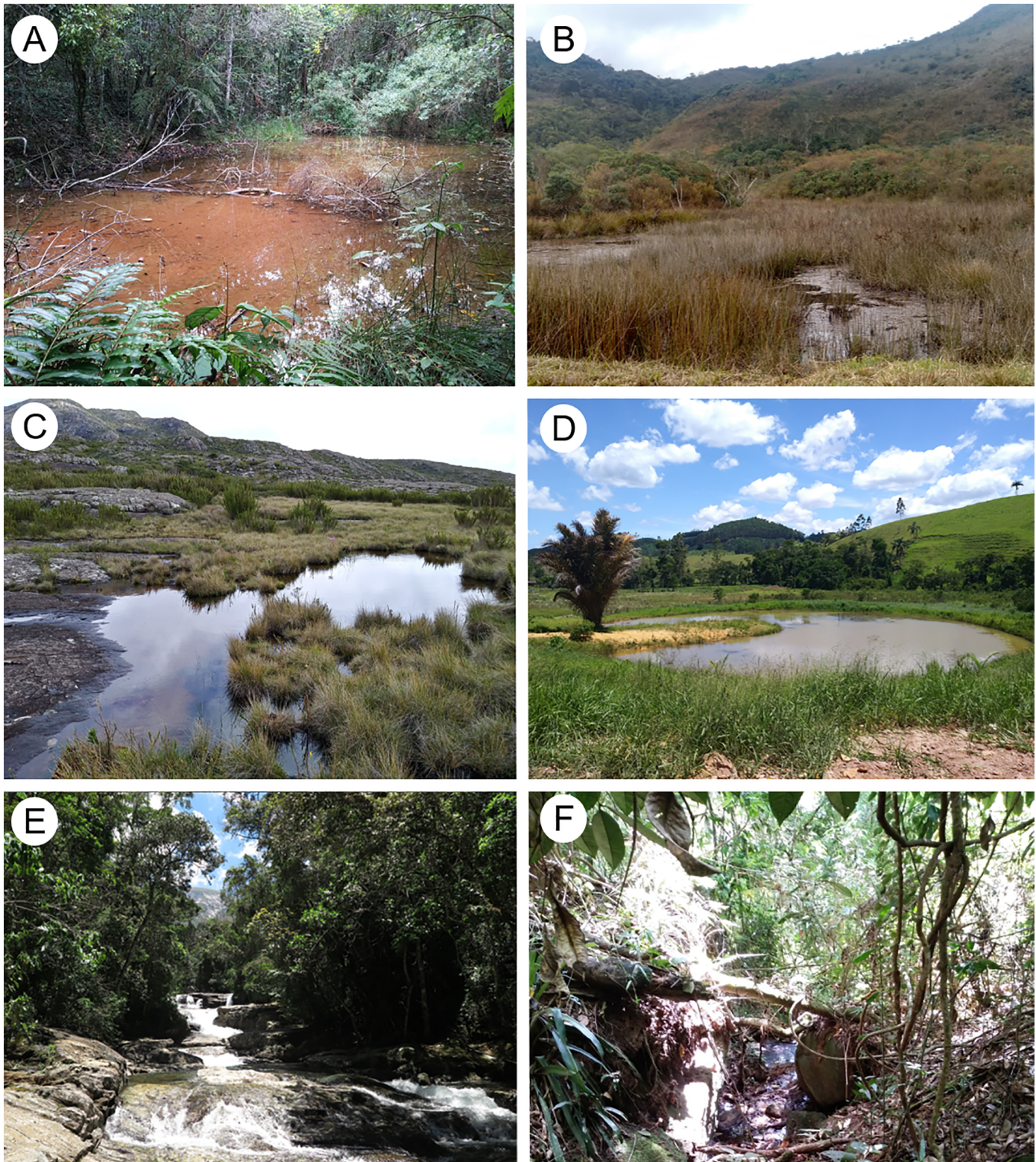


Figure 2. Anuran breeding sites at the Caparaó National Park (CNP) and surrounding areas. (A) swamp in forest areas, (B) swamp in open areas, (C) altitude lagoons, (D) artificial lagoons, (E) rivers and streams, (F) deciduous forest.

Results

We registered 47 species of anurans, from 11 families: Brachycephalidae (7 spp.), Bufonidae (2 spp.), Centrolenidae (2 spp.), Craugastoridae (1 sp.), Cycloramphidae (2 spp.), Hylidae (18 spp.),

Hylodidae (1 sp.), Leptodactylidae (9 spp.), Microhylidae (2 spp.), Odontophrynidae (1 sp.), and Phyllomedusidae (2 spp.). Two of the species are endemic for the CNP [*Cycloramphus bandeirensis* and *Physalaemus* sp. (aff. *maculiventris*)] and at least six of those species

[*Aplastodiscus* sp. (possible *Aplastodiscus* sp. 6 of Berneck et al. 2016), *Physalaemus* sp. (aff. *maculiventris*), *Ischnocnema* spp. (three species), and *Brachycephalus* sp.] have not been described yet. From these not described species, *Physalaemus* sp. (aff. *maculiventris*) is abundant in the mountaintop but has extremely restricted distribution. On the other hand, the other five species [*Aplastodiscus* sp., *Brachycephalus* sp., and *Ischnocnema* spp. (three species)] are less abundant and were registered in forested microhabitats.

Gathering with the information from our previous surveys and secondary data from scientific collections, we compiled a list of 61 anuran species comprised in 12 families (Table 1; Figure 3 – 8; Appendix I), placing the Caparaó National Park (CPN) among the 10 amphibian richest sites in the AF (Table 2). The Jackknife 1 index estimated that we registered 93% of the species during the most recent two years of fieldwork (Figure 1B; Table S2).

However, these species corresponded to about 75% of the total species richness we were able to list. Species richness differed between both East and West slopes and among altitudinal ranges (Figure 1A, C). The site with the highest species richness was located in the East side from 600 to 900 m, where we registered 34 species (Figure 1C). Although higher altitudes have less species, it is where the endemic ones were found, *Cycloramphus bandeirensis* and *Physalaemus* sp. (aff. *maculiventris*).

Two species present in scientific collections (*Hylodes vanzolinii* and *Thoropa lutzi*) were not sampled in the study area in recent times, even after directed efforts in their specific microhabitats. As an example, *H. vanzolinii* is known only by the holotype and one paratype, both collected in 1980 (Heyer 1982), and *T. lutzi*, which was collected in the CNP only in November 1980 and has never been registered again.

Table 1. Anuran species list from the Caparaó National Park (CNP) and surrounding areas. An asterisk * represents species that has the CNP as type locality; a hashtag # indicates an undescribed species; a cross † indicates a species that is not collected since the 1980s in the CNP. Slopes are west (W) and east (E). Data is classified as secondary (S), collected/primary (C), sound recorded (R) and identification confirmed by molecular analyses (M). Sample sites: Table S1.

Species	Altitude	Slope	Data	Sample site
Brachycephalidae				
<i>Brachycephalus</i> sp. #	-	-	S	-
<i>Ischnocnema izecksohni</i> (Caramaschi & Kisteumacher, 1989)	851-1350	W, E	C, S	17, 34, 38, 41, 47, 49, 50
<i>Ischnocnema</i> sp. (aff. <i>guentheri</i> / CS3) #	1000	E	C, S, M	27
<i>Ischnocnema feioi</i> Taucce, Canedo & Haddad, 2018	1200	W	C, S	38
<i>Ischnocnema abdita</i> Canedo & Pimenta, 2010	1006	E	C, R, S, M	32
<i>Ischnocnema</i> sp. (aff. <i>lactea</i>) #	-	-	S	-
<i>Ischnocnema</i> sp. (gr. <i>parva</i>) #	1000	E	C, S, M	27
<i>Ischnocnema parva</i> (Girard, 1853)	1000	E	C, S, M	27
<i>Ischnocnema verrucosa</i> (Reinhardt & Lütken, 1862)	-	-	S	-
<i>Ischnocnema octavioi</i> (Bokermann, 1965)	1215	W	C, M	54
Bufonidae				
<i>Dendrophryniscus carvalhoi</i> Izecksohn, 1994	-	-	S	-
<i>Rhinella crucifer</i> (Wied-Neuwied, 1821)	758-1591	W, E	C, R, S, M	2, 11, 13, 17, 20, 22-24, 36, 38, 41, 43, 53
<i>Rhinella granulosa</i> (Spix, 1824)	843	E	C, R	18
Centrolenidae				
<i>Vitreorana eurygnatha</i> (Lutz, 1925)	1572	W	C, R, S	55
<i>Vitreorana uranoscopa</i> (Müller, 1924)	1000-1200	W, E	C, R, S	27, 41
Craugastoridae				
<i>Haddadus binotatus</i> (Spix, 1824)	990-1307	W, E	C, R, S	18, 33, 38, 41, 45, 47, 50, 52
Cycloramphidae				
<i>Cycloramphus bandeirensis</i> Heyer, 1983 *	2405	E	C, R, S	60
<i>Thoropa lutzi</i> Cochran, 1938†	-	-	S	-
<i>Thoropa miliaris</i> (Spix, 1824)	829-1259	W, E	C, S	13, 33, 38
<i>Zachaenus carvalhoi</i> Izecksohn, 1983	-	-	S	-
Hemiphractidae				
<i>Fritziana ohausi</i> (Wandolleck, 1907)	-	-	S, M	-

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Hylidae

<i>Aplastodiscus arildae</i> (Cruz & Peixoto, 1987)	-	-	S, M	-
<i>Aplastodiscus cavicola</i> (Cruz & Peixoto, 1985)	851	E	C, R, M	17
<i>Aplastodiscus</i> sp. #	-	-	S	-
<i>Boana albopunctata</i> (Spix, 1824)	796-1005	W, E	C, R, S	4, 12, 19, 21, 22, 31
<i>Boana albomarginata</i> (Spix, 1824)	758-922	E	C, R, S	2, 3, 10, 15
<i>Boana crepitans</i> (Wied-Neuwied, 1824)	796-826	E	C, R, S, M	3, 4, 10
<i>Boana faber</i> (Wied-Neuwied, 1821)	806-1282	W, E	C, R, S	4, 11, 12, 17, 18, 22, 37, 38, 42, 45, 46, 49, 50
<i>Boana pardalis</i> (Spix, 1824)	781-1259	W, E	C, R, S, M	4, 5, 9, 13, 17, 21, 26, 31, 34, 38, 44
<i>Boana polytaenia</i> (Cope, 1870)	815-1746	W, E	C, R, S	4, 12, 13, 22, 47, 49, 57
<i>Boana semilineata</i> (Spix, 1824)	698	E	C, R	1
<i>Bokermannohyla caramaschii</i> (Napoli, 2005)	815-1200	W, E	C, S	9, 18, 27, 34, 37, 40, 41, 50, 54
<i>Dendropsophus elegans</i> (Wied-Neuwied, 1824)	758-922	E	C, R, S	2, 4, 10, 12, 13, 15, 17, 20, 22,
<i>Dendropsophus branneri</i> (Cochran, 1948)	-	-	S	-
<i>Dendropsophus haddadi</i> (Bastos & Pombal, 1996)	806-843	E	C, M	16
<i>Dendropsophus pseudomeridianus</i> (Cruz, Caramaschi & Dias, 2000)	698-922	E	C, R, S	1, 2, 10, 22
<i>Dendropsophus minutus</i> (Peters, 1872)	758-1215	W, E	C, R, S	2, 4, 12, 13, 15, 17, 20, 36, 49
<i>Itapotihyla langsdorffii</i> (Duméril & Bibron, 1841)	-	-	S	-
<i>Oloolygon tripui</i> (Lourenço, Nascimento & Pires, 2010)	1179-1872	W	C, R, S, M	35, 38 - 41, 48, 51, 58, 59
<i>Scinax alter</i> (Lutz, 1973)	698-1282	W, E	C, R	1, 2, 6, 12, 13, 15, 16, 20, 22, 23, 27, 34, 36, 49
<i>Scinax eurydice</i> (Bokermann, 1968)	758-922	E	C, R, S, M	2, 10, 12, 16, 18, 22
<i>Scinax</i> cf. <i>hayii</i> (Barbour, 1909)	872-990	E	C, R, S, M	19
<i>Scinax fuscovarius</i> (Lutz, 1925)	796-886	E	C, R, S, M	2, 3, 16, 18, 20, 21

Hylodidae

<i>Hylodes babax</i> Heyer, 1982	-	-	S	-
<i>Hylodes vanzolinii</i> Heyer, 1982 * †	-	-	S	-
<i>Megaelosia apuana</i> Pombal, Prado & Canedo, 2003	1200	W	C, S	38

Leptodactylidae

<i>Pseudopaludicola restinga</i> Cardozo, Baldo, Pupin, Gasparini & Haddad, 2018	796-843	E	C, R, M	3
<i>Physalaemus cuvieri</i> Fitzinger, 1826	796-1005	W, E	C, R	3, 10, 21, 25, 31
<i>Physalaemus feioi</i> Cassini, Cruz & Caramaschi, 2010	824-886	E	C, R	12, 20
<i>Physalaemus</i> sp. (aff. <i>maculiventris</i>) * #	2425-2656	W	C, R, S	61, 62
<i>Adenomera thomei</i> (Almeida & Ângulo, 2006)	-	E	NC	-
<i>Leptodactylus fuscus</i> (Schneider, 1799)	698-1005	W, E	C, R, S	1, 3, 8, 22, 24, 31
<i>Leptodactylus mystacinus</i> (Burmeister, 1861)	758-933	W, E	C, S	18
<i>Leptodactylus spixi</i> Heyer, 1983	796-1040	E	C, S	3, 4, 35
<i>Leptodactylus latrans</i> (Steffen, 1815)	696-1005	W, E	C, S	1, 7, 12, 22, 28-31

Microhylidae

<i>Chiasmocleis</i> sp.	-	E	R	-
<i>Elachistocleis</i> cf. <i>cesarii</i> (Miranda-Ribeiro, 1920)	820	E	C, R	10
<i>Myersiella microps</i> (Duméril & Bibron, 1841)	-	-	S	-

Odontophrynidae

<i>Proceratophrys boiei</i> (Wied-Neuwied, 1824)	986-1294	W, E	C, R, S	35, 41, 47, 49
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Phyllomedusidae

<i>Phyllomedusa burmeisteri</i> Boulenger, 1882	820-886	E	C, R, S	10, 12, 15, 17, 18, 20
<i>Pithecopus rohdei</i> (Mertens, 1926)	758	E	C	2

Anurans of the Caparaó region



Figure 3. Anuran species found in the Caparaó National Park (CNP) and surrounding areas (SVL, snout-vent length, in millimeters). (A) *Ischnocnema izecksohni* (ZUEC 24371, SVL = 28.1); (B) *I. feioi* (not vouchered); (C) *Ischnocnema* sp. (gr. *parva*) (ZUEC 24365, SVL = 17.2); (D) *I. parva* (ZUEC 24352, SVL = 17.9); (E) *I. verrucosa* (UFMG 17230); (F) *Dendrophryniscus carvalhoi* (not vouchered); (G) *Rhinella crucifer* (not vouchered); (H) *R. granulosa* (ZUEC 23631, SVL = 50.3; ZUEC 23632, SVL = 62.2).

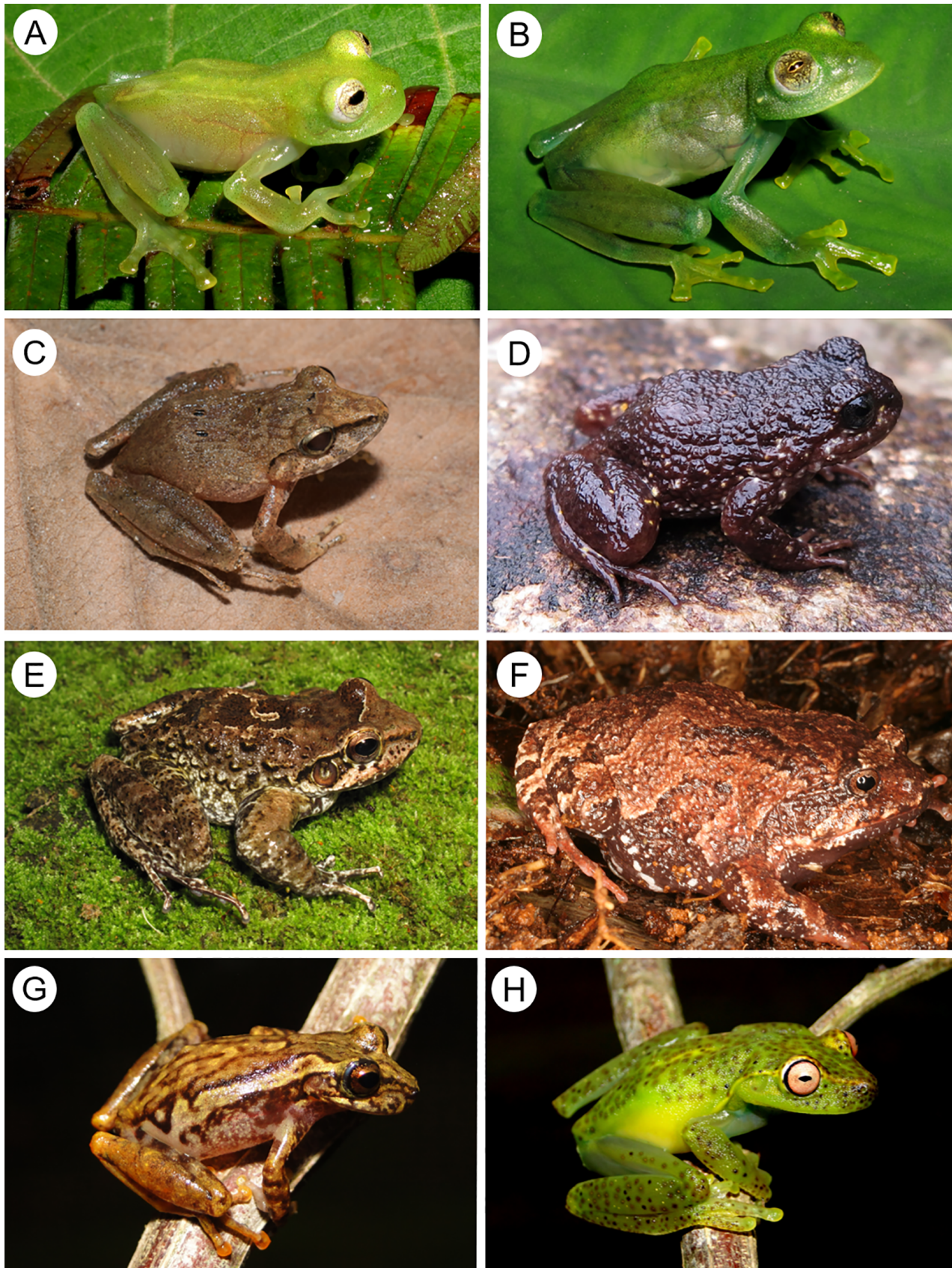


Figure 4. Anuran species found in the Caparaó National Park (CNP) and surrounding areas (SVL, snout-vent length, in millimeters). (A) *Vitreorana eurygnatha* (ZUEC 24380, SVL = 16.8); (B) *V. uranoscopa* (ZUEC 24376, SVL = 25.2); (C) *Haddadus binotatus* (not vouchered); (D) *Cycloramphus bandeirensis* (not vouchered); (E) *Thoropa miliaris* (not vouchered); (F) *Zachaenus carvalhoi* (not vouchered); (G) *Fritziaria ohausi* (UFMG 17263); (H) *Aplastodiscus arildae* (UFMG 17259). Photograph C by Victor Fávoro Augusto.

Anurans of the Caparaó region

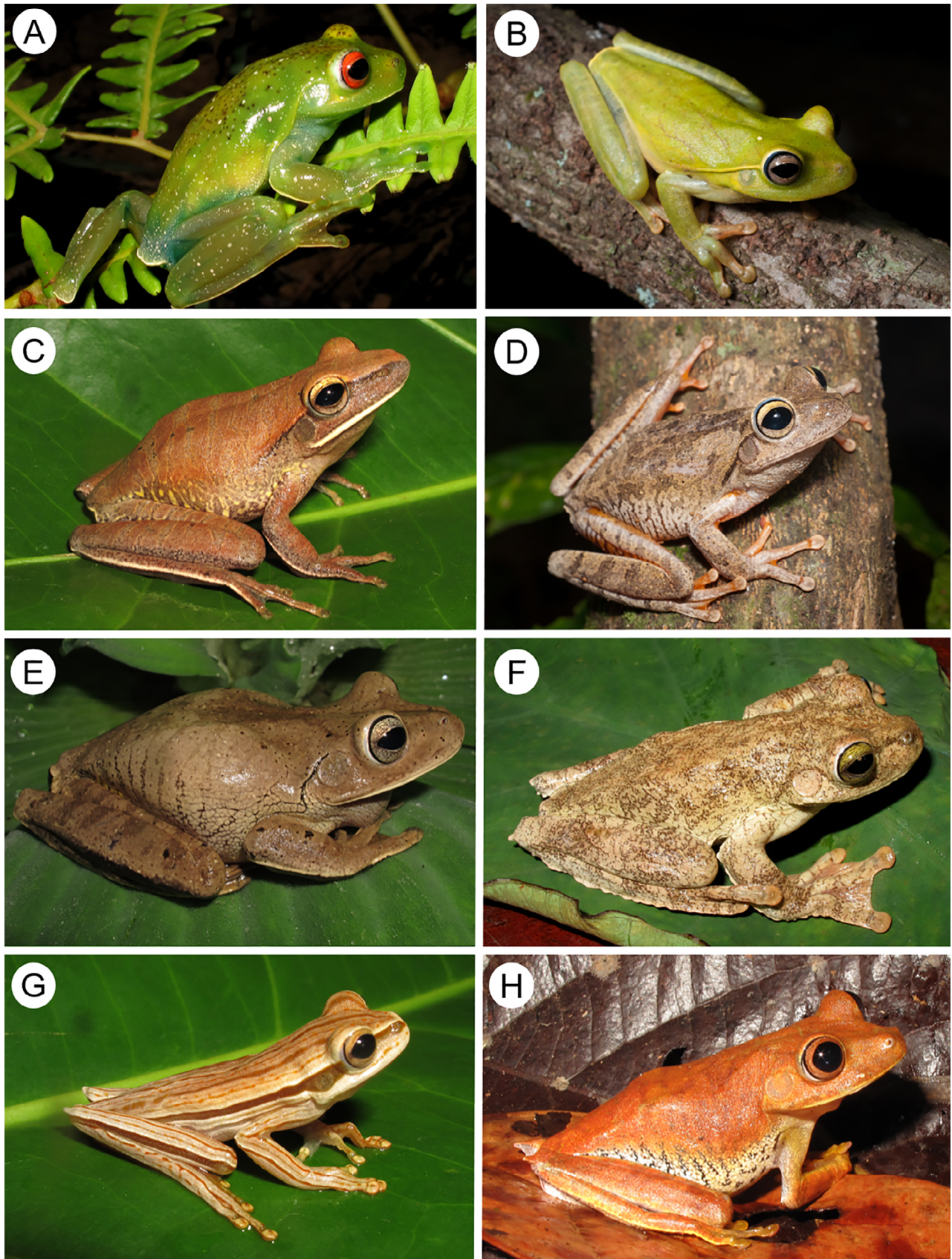


Figure 5. Anuran species found in the Caparaó National Park (CNP) and surrounding areas (SVL, snout-vent length, in millimeters). (A) *Aplastodiscus cavicola* (ZUEC 24368, SVL = 32.0); (B) *Boana albomarginata* (not vouchered); (C) *B. albopunctata* (ZUEC 23597, SVL = 48.5); (D) *B. crepitans* (ZUEC 24578, SVL = 55.1); (E) *B. faber* (ZUEC 23582, SVL = 77.9); (F) *B. pardalis* (not vouchered); (G) *B. polytaenia* (ZUEC 23617, SVL = 26.4); (H) *B. semilineata* (ZUEC 24364, SVL = 43.0). Photograph B, C, and D by Victor Fávoro Augusto.



Figure 6. Anuran species found in the Caparaó National Park (CNP) and surrounding areas (SVL, snout-vent length, in millimeters). (A) *Bokermannohyla caramaschii* (ZUEC 24351, SVL = 64.4); (B) *Dendropsophus elegans* (ZUEC 23616, SVL = 25.7); (C) *D. haddadi* (ZUEC 23629, SVL = 17.3); (D) *D. pseudomeridianus* (not vouchered); (E) *D. minutus* (not vouchered); (F) *Olotrygon tripui* (ZUEC 23628, SVL = 28.4); (G) *Scinax alter* (not vouchered); (H) *S. eurydice* (not vouchered). Photograph H by Víctor Fávoro Augusto.

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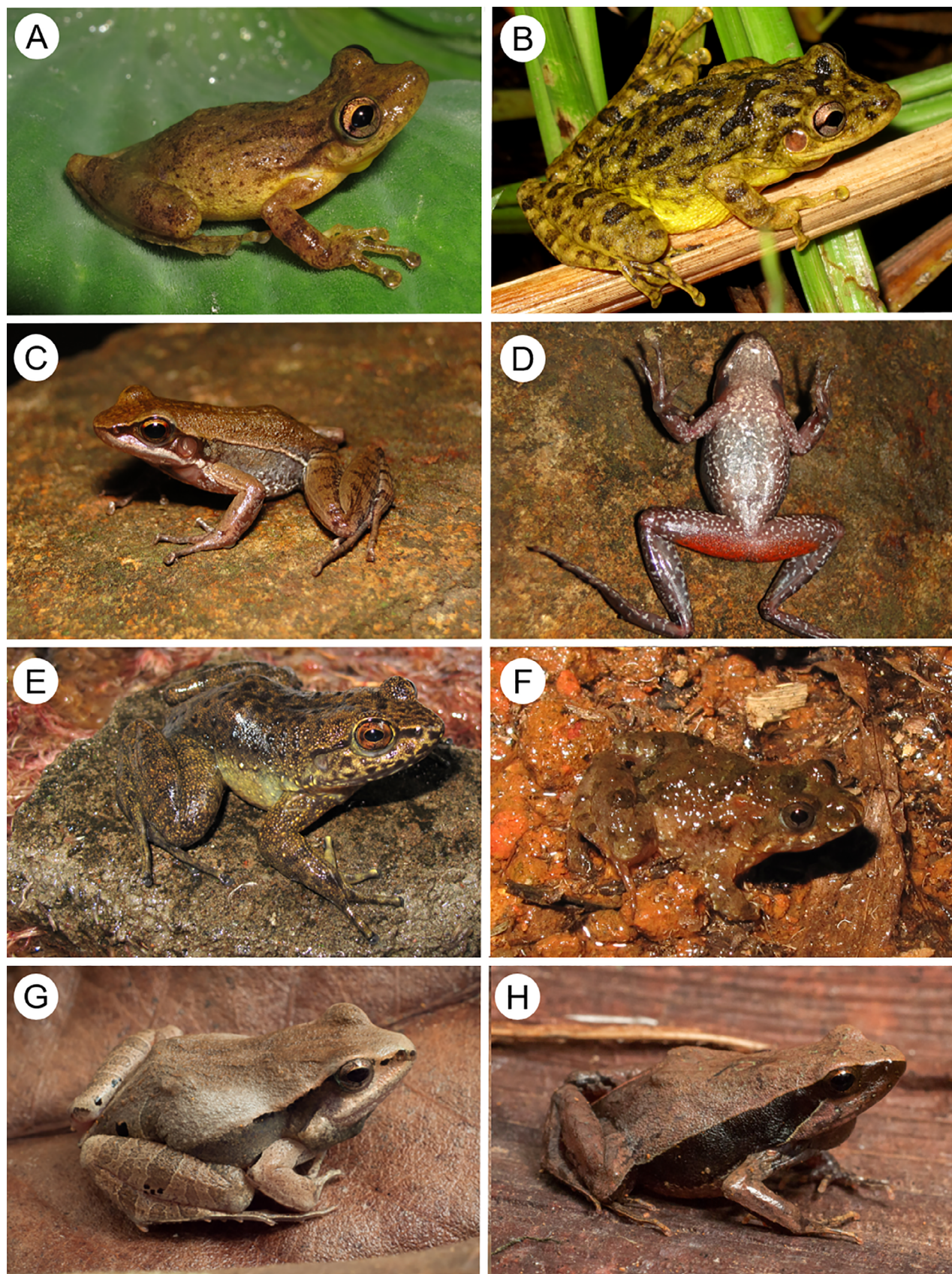


Figure 7. Anuran species found in the Caparaó National Park (CNP) and surrounding areas (SVL, snout-vent length, in millimeters). (A) *Scinax* cf. *hayii* (ZUEC 23598, SVL = 34.4); (B) *S. fuscovarius* (not vouchered); (C) *Hylodes babax* (UFMG 17258); (D) *H. babax* ventral view (UFMG 17258); (E) *Megaelasia apuana* (ZUEC 23497); (F) *Pseudopaludicola restinga* (not vouchered); (G) *Physalaemus cuvieri* (ZUEC 24566, SVL = 28.7); (H) *P. feioi* (ZUEC 24557, SVL = 20.3). Photographs G and H by Victor Fávoro Augusto.

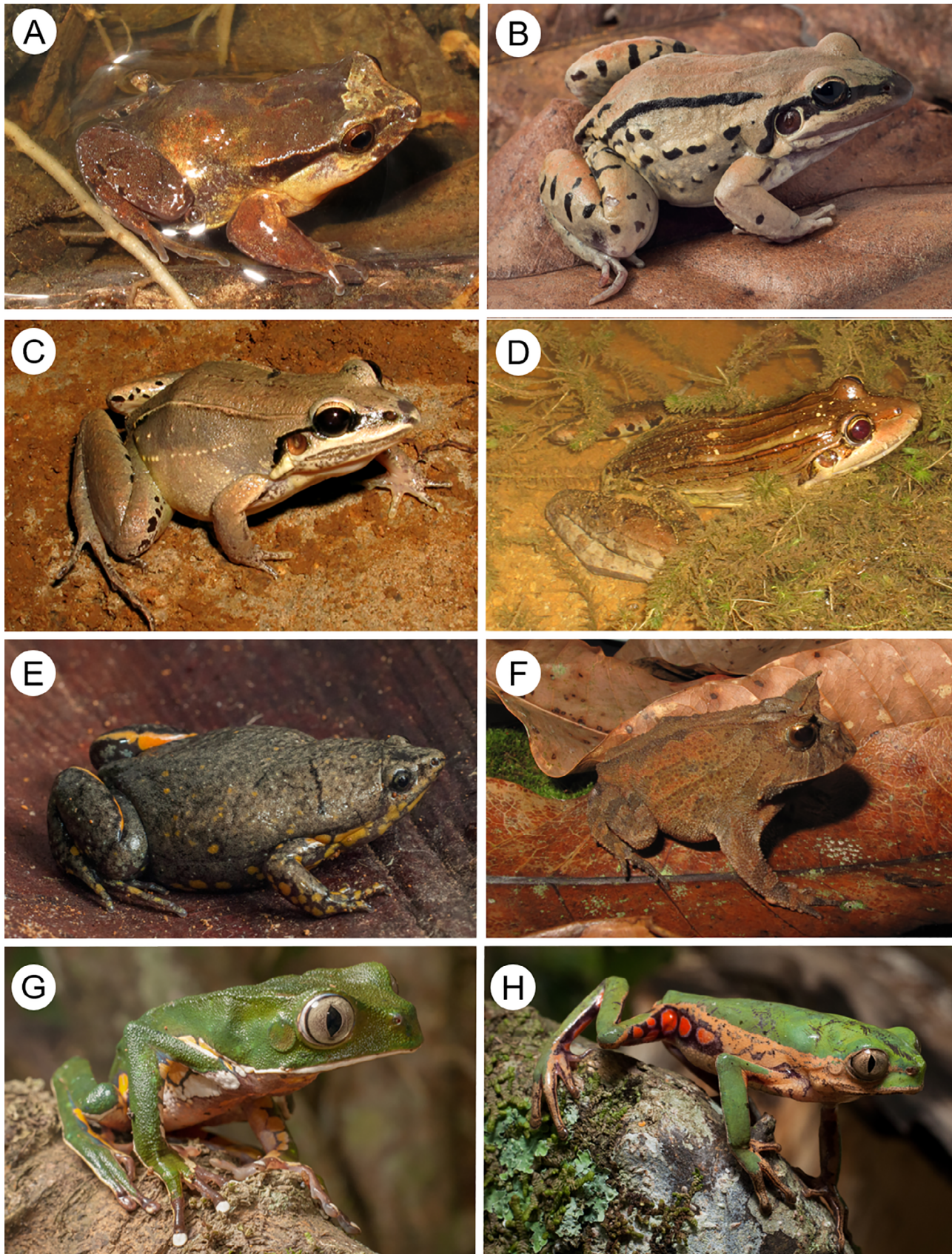


Figure 8. Anuran species found in the Caparaó National Park (CNP) and surrounding areas (SVL, snout-vent length, in millimeters). (A) *Physalaemus* sp. (aff. *maculiventris*) (not vouchered); (B) *Leptodactylus mystacinus* (ZUEC 24573, SVL = 53.1); (C) *L. spixi* (ZUEC 23627, SVL = 43.9); (D) *L. latrans* (not vouchered); (E) *Elachistocleis* cf. *cesarii* (ZUEC 24579, SVL = 30.5); (F) *Proceratophrys boiei* (ZUEC 23621, SVL = 51.2); (G) *Phyllomedusa burmeisteri* (not vouchered); (H) *Pithecopus rohdei* (ZUEC 24570, SVL = 37.4). Photographs B, E, G and H by Victor Fávoro Augusto.

Table 2. Amphibian most rich localities in the Atlantic Forest. Time sampled (†) in a site refers to time reported in the literature and does not include historical samplings that can be retrieved in museum records. One asterisk (*) refer that values were rounded to integer numbers. Two asterisks (**) symbolize that the area used was the area of the Tijuca National Park. Three asterisks (***) refer to an area unable to calculate. Brazilian states: (BA) Bahia, (ES) Espírito Santo, (MG) Minas Gerais, (RJ) Rio de Janeiro, (SP) São Paulo. RPPN, Reserva Particular do Patrimônio Natural (Private Reserve of Natural Heritage).

Locality	Species richness	Time sampled†	Area (km ²)*	Species richness/ km ²	Reference
Municipality of Santa Teresa (ES)	108	≈ 10 years	683	0.16	Ferreira et al. (2019); Moura et al. (2012)
RPPN Serra Bonita (BA)	80	88 days	20	4.00	Dias et al. (2014)
Reserva Ecológica de Guapiaçu (RJ)	73	≈ 7 years	13	5.62	Almeida-Gomes et al. (2014)
Maciço da Tijuca (RJ)	69	-	40**	1.73	Vacine et al. (2018)
Reserva Biológica de Paranapiacaba and surroundings (SP)	69	-	***	-	Verdade et al. (2009)
Estação Biológica da Boracéia (SP)	67	≈ 5 years	165	0.41	Heyer et al. (1990)
Parque Estadual da Serra do Mar - Núcleos Curucutu, Santa Virgínia and São Sebastião (SP)	65	81 days	558	0.12	Silva et al. (2017)
Parque Estadual Carlos Botelho (SP)	65	76 days	378	0.17	Forlani et al. (2010)
Caparaó National Park (MG, ES)	61	63 days	318	0.19	Present study
Parque Estadual Turístico do Alto Ribeira (SP)	60	15 days	357	0.17	Araujo et al. (2010)

Discussion

This is a first comprehensive list of anurans for the Caparaó National Park (CNP) and surroundings. This update adds 40 anuran species to the list used for the park management plan (21 species) and place the CNP among the 10 amphibian richest sites in the Atlantic Forest (Table 2). Considering the size of the CNP and the other areas in the AF, the CNP is the 4th richest site, even we did not have access to all the areas of the park. Many of the species that were registered outside the limits of the CNP may also occur inside its boundaries. The CNP shares 40 species with the municipality of Santa Teresa (Ferreira et al. 2019) and 33 species with the Serra do Brigadeiro State Park (SBST) (Moura et al. 2012). The shared species are mainly abundant and widely distributed species, such as *Rhinella crucifer*, *Boana albomarginata*, *B. albopunctata*, *B. faber*, *B. pardalis*, *B. polytaenia*, *B. semilineata*, and *Dendropsophus minutus*. Resemblance in their amphibian species composition could be due the similar biogeographic origins, as these three localities belongs to the northern sector of the Mantiqueira mountain range (Gontijo-Pascutti et al. 2012), and also could be due to the proximity (140 km and 74 km straight-line distance, respectively), environmental and elevational similarities (Moura et al. 2012, Ferreira et al. 2019). Additionally, rare species, such as *Hylodes babax*, has been rediscovered in the past 10 years outside the CNP boundaries at Serra do Brigadeiro State Park and at Uaimiú State Forest, both in the state of Minas Gerais, near the type locality (CNP) where the last record was in 2008 with a single specimen (Pirani et al. 2010, Verdade et al. 2011).

The two endemic species found in this area are restricted to high-altitude grasslands (above 2,000 m). *Physalaemus* sp. (aff. *maculiventris*) is an abundant species with restricted distribution to altitude lagoons inside the CNP (Lagoa da sombra and Três lagoas) and has explosive reproduction. *Cycloramphus bandeirensis* can be found in high-altitude habitats at CNP and has a characteristic semiterrestrial reproductive mode (Verdade et al. 2019). High-altitude grasslands in the CNP undergo extreme temperature oscillations that could impact local amphibian populations (Veríssimo et al. 2012).

For example, the minimum temperature recorded in July 2017 was -14 °C (Oliveira 2017) and there are recent reports of fires in CNP (G1 Minas 2019), which leads to local high temperatures and habitat loss, as observed in other high-altitude localities (Aximoff 2011). The undescribed species *Ischnocnema* spp. (three species), *Brachycephalus* sp. and *Aplastodiscus* sp. are less abundant, and although they inhabit decidual forests, a common environment in this area, we do not have specific information of their distribution range.

The lack of records of *Hylodes vanzolinii* and *Thoropa lutzii* in the Caparaó National Park could be related with local population declines or extinctions (see Verdade et al. 2011 for review of potential factors leading to amphibian declines in Brazil). If that is the case, a plausible cause would be the chytrid fungus, which spiked in the AF during the 1980's and was related to several amphibian extinctions in that decade (see Carvalho et al. 2017). We therefore indicate the need of higher sampling efforts and specific searches for those species. Furthermore, as this area has some species that were not described yet, it is even possible that some other not described species have vanished before our knowledge of their existence.

The publication of species lists is mandatory for the understanding of the regional biodiversity and is the basis for local wildlife conservation efforts. In this case, the current survey highlights one of the most amphibian diverse regions in the Atlantic Forest and reveals several species that should be described in the following years.

Supplementary Material

The following online material is available for this article:

Appendix I - Specimens or sound recordings examined and vouchered.

Table S1 - Sample sites/units (SUs) used in the anuran survey from Caparaó National Park and surrounding areas.

Table S2 - Diversity index values estimated for the amphibian assemblage of the Caparaó National Park.

Acknowledgments

We thank C. Lambertini, L. Tacioli, C. Nunes-de-Almeida, R. Santos, M. Pontes, S. Dena, V. Augusto, M. Freitas, B. Dias, L. Ribeiro, A. Bertolazzi, D. Pavan, F. F. Curcio, L. D. Matos, M. Teixeira Jr., and R. S. Recoder for helping during fieldwork; all residents of the surroundings of the CNP which allowed our research in their properties; Caparaó National Park for logistic support during research; CZ-T, GA-A, LFT, CFBH, MTR, VKV, PCAG, and JLG are grateful to the São Paulo Research Foundation (FAPESP #2001/05470-8, #2003/10335-8, #2011/50146-6, #2013/50741-7, #2014/23388-7, #2016/25358-3, and #2019/03170-0), the National Council for Scientific and Technological Development (CNPq #300896/2016-6, #140874/2019-4, #306623/2018-8, and #310301/2018-1), and the Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES #001). We also thank Biota Neotropica editors Marcelo Felgueiras Napoli and Carlos Joly for the constructive feedback and revisions on our manuscript.

Author Contributions

Camila Zornosa-Torres: Substantial contribution in the concept and design of the study; Contribution to data collection; Contribution to data analysis and interpretation; Contribution to manuscript preparation; Contribution to critical revision, adding intellectual content.

Guilherme Augusto-Alves: Contribution to data collection; Contribution to manuscript preparation; Contribution to critical revision, adding intellectual content.

Mariana L. Lyra: Contribution to data analysis and interpretation; Contribution to critical revision, adding intellectual content.

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Felipe Leite: Contribution to data collection.

Vanessa Verdade: Contribution to data collection; Contribution to critical revision, adding intellectual content.

Miguel T. Rodrigues: Contribution to data collection; Contribution to critical revision, adding intellectual content.

João Luiz Gasparini: Contribution to data collection; Contribution to critical revision, adding intellectual content.

Célio F. B. Haddad: Contribution to data collection; Contribution to critical revision, adding intellectual content.

Luís Felipe Toledo: Substantial contribution in the concept and design of the study; Contribution to data collection; Contribution to data analysis and interpretation; Contribution to manuscript preparation; Contribution to critical revision, adding intellectual content.

Conflicts of Interest

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

Ethics

Ethics committee approval #4827-1/2018 stated in the Material and Methods section.

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Received: 11/09/2019

Revised: 15/06/2020

Accepted: 26/06/2020

Published online: 20/07/2020