



Reptiles of the Serra das Torres Natural Monument: using the Rapid Assessment method to fill a knowledge gap in the Atlantic Forest of southeastern Brazil

Jane C. F. Oliveira¹*, Rafael dos Santos², Mateus Leite Lopes-Silva², Lorena da Penha Vasconcelos Barros³, Bárbara Risse-Quaioto², Cátia Moura Militão¹, Pedro Fatorelli¹, Flávia A. L. Belmoch², Thiago Marcial de Castro² and Carlos Frederico Duarte Rocha¹

¹Universidade do Estado do Rio de Janeiro, Departamento de Ecologia, Instituto de Biologia Roberto de Alcântara Gomes, Rua São Francisco Xavier 524, CEP 20550-019, Maracanã, Rio de Janeiro, RJ, Brasil

²Centro Universitário São Camilo, Rua São Camilo de Lellis, 1, CEP 29304-910, Paraíso, Cachoeiro de Itapemirim, ES, Brazil

³Faculdades Integradas São Pedro – FAESA, Centro Universitário, Avenida Vitória 2220, CEP 29053360, Monte Belo, Vitória, ES, Brazil

*Corresponding author: Jane C. F. Oliveira, e-mail: janeherpeto@gmail.com

OLIVEIRA, J.C.F., SANTOS, R., LOPES-SILVA, M.L., BARROS, L.P.V., RISSE-QUAIOTO, B., MILITÃO C.M., FATORELLI, P., BELMOCH, F.A.L., CASTRO, T. M., ROCHA, C.F.D. **Reptiles of the Serra das Torres Natural Monument: using the Rapid Assessment method to fill a knowledge gap in the Atlantic Forest of southeastern Brazil.** *Biota Neotropica*. 20(2): e20190726. <https://doi.org/10.1590/1676-0611-BN-2019-0726>

Abstract: Data on the composition of local reptile assemblages in several Brazilian ecosystems can still be considered relatively restricted in scope in most cases. In this study, we conducted surveys in the Serra das Torres Natural Monument, located in the municipalities of Atílio Vivacqua, Muqui, and Mimoso do Sul, using the Rapid Assessments method (RAP) during 30 days in the rainy season of 2018. We sampled actively for approximately 1320 hours with a 6–10 person crew, supplemented by 720 hours of passive sampling (30 bucket-days) using pitfall traps with drift fences. We recorded 34 reptile species during our sampling method (2 amphisbaenid, 11 lizards, and 21 snakes) and an occasional encounter, after the end of sampling, that added a chelonian species to the list, *Hydromedusa maximiliani*, totaling 35 reptile species. The Dipsadidae was the family with the greatest snake species richness and, the Gymnophthalmidae had the greatest lizard species richness. The species richness recorded in the Serra das Torres Natural Monument (Ntotal = 35) represents ca. 27% of all reptile species found in the state of Espírito Santo (N = 130). The most abundant lizard species was *Leposoma scincoides* followed by *Eupleopus gaudichaudii* and, the most abundant snake species was *Bothrops jararaca* being markedly higher than that recorded in similar studies. Twenty-seven percent of the reptile species recorded in our study are endemic to the Atlantic Forest and 30% (N = 10) have been recorded less than five times previously in the Brazilian state of Espírito Santo. Our study reinforces the need for the conservation of the Serra das Torres Natural Monument because of its importance as a reservoir of a considerable portion of the reptile biodiversity of Espírito Santo state, and of the Atlantic Forest biome as a whole.

Keywords: *Amphisbaenia*; Brazilian state of Espírito Santo; Community; Herpetofauna; Lizards; Snakes; Squamata.

Répteis do Monumento Natural Serra das Torres: usando o método de avaliação rápida para preencher uma lacuna de conhecimento na mata atlântica do sudeste do Brasil

Resumo: O conhecimento das assembleias de répteis para muitos ecossistemas no Brasil pode ser considerado ainda relativamente restrito. Neste estudo, nós realizamos amostragens no Monumento Natural Serra das Torres, localizado nos municípios de Atílio Vivacqua, Muqui e Mimoso do Sul, no estado do Espírito Santo, utilizando o método de avaliação rápida (RAP) durante 30 dias na estação chuvosa de 2018. Amostramos cerca de 1320 horas de busca ativa durante os períodos diurno e noturno, com uma equipe de 6 a 10 pessoas, suplementada por 720 horas de amostragem com armadilhas de queda com cercas guia (30 dias-balde). Registramos 34 espécies de répteis squamatas durante as amostragens (2 anfisbenídeo, 11 lagartos e 21 serpentes) e um encontro ocasional posterior que acrescentou uma espécie de quelônio à lista, *Hydromedusa maximiliani*, totalizando 35 espécies de répteis. Dipsadidae foi a família com a maior riqueza de serpentes, e Gymnophthalmidae foi a família com maior riqueza de lagartos.

A riqueza de espécies que registramos no Monumento Natural Serra das Torres (Ntotal = 35) representa ca. 27% de todas as espécies de répteis encontradas no estado do Espírito Santo (N = 130). A espécie de lagarto mais abundante foi *Leposoma scincoides* seguido por *Ecleopopus gaudichaudii*, enquanto a espécie mais abundante de serpente foi a *Bothrops jararaca*, sendo marcadamente maior do aquela registradas em estudos similares. Vinte e sete por cento das espécies de registradas em nosso estudo são endêmicas da Mata Atlântica e trinta por cento das espécies (N = 10) tinham menos de cinco indivíduos registrados anteriormente no estado do Espírito Santo. Nosso estudo reforça a necessidade de conservação do Monumento Natural Serra das Torres devido à sua importância como reservatório de uma considerável parcela da biodiversidade de répteis do estado do Espírito Santo, bem como do bioma Mata Atlântica.

Palavras-chave: *Amphisbaenia; Comunidade; estado do Espírito Santo; Herpetofauna; Lagartos; Serpentes; Squamata.*

Introduction

Data on the composition of local reptile assemblages in Brazilian ecosystems can still be considered relatively restricted in most cases. Although there is a reasonable number of studies on the reptile assemblages of some Brazilian forest remnants, most do not address the community as a whole, but rather, focus on a specific group, such as the snakes (Strüssmann & Sazima, 1993; Argôlo, 2004; Rocha et al. 2008; Pontes & Rocha 2008; Sawaya, 2008; Pontes et al. 2009;), lizards (e.g. Martins, 1991, Oliveira et al. 2019), or provide a compilation of the records available for an area, combining personal data with records obtained in previous studies (e.g. Vitt et al. 2008, Dias & Rocha 2014). However, comprehensive checklists of the reptile assemblage of a given ecosystem, based on a single, consolidated field inventory, are relatively rare, and most have focused on the rainforests of southeastern Brazil (Rocha, 1998; Almeida-Gomes et al., 2008; Vrcibradic et al., 2011; 2014; Rocha et al, 2018), although some important efforts are available for gallery forests in Central Brazil (e.g. Brandão & Araújo, 2001), and for the vast Lençóis Maranhenses region of northeastern Brazil (e.g. Miranda et al. 2012).

Understanding species composition, richness and abundance is a fundamental issue for countless conservation actions (Sutherland et al. 2013) and many ecological and taxonomic questions can be explored from this data set from a given area. Inventories of the reptile assemblages of the ombrophilous forest of Espírito Santo state, in southeastern Brazil, are restricted to a single introductory checklist of the reptiles of the Duas Bocas Biological Reserve (Tonini et al. 2010), in the municipality of Cariacica. Although there is an important set of specimens collected throughout the state, deposited in herpetological collections (e.g. Instituto Nacional da Mata Atlântica) efforts to discover the reptile fauna of the ombrophilous forest in Espírito Santo state remain as occasional collections, without short or long-term studies and either without information about the abundance of species.

The Serra das Torres Natural Monument, situated in southern Espírito Santo state (referred to here as the MONAST: Monumento Natural Serra das Torres) encompasses an array of upland environments characterized by high levels of biodiversity in some groups of fauna and flora (IPEMA 2010), but surprisingly there are no data available on its reptile assemblage. In this study, we inventoried the forests of MONAST through intensive sampling over a three-month period and we present the results here as the first comprehensive reptile checklist for the region of this pristine remnant of forest in the Brazilian state of Espírito Santo.

Material and Methods

1. Study site

The MONAST is located in southern Espírito Santo state, and includes parts of the municipalities of Atilio Vivacqua, Mimoso do Sul, and Muqui, in southeastern Brazil (-21.0209, -41.2378) (Figure 1). The MONAST encompasses the largest complex of forest remnants in southern Espírito Santo, with approximately 10,450 hectares of Atlantic rainforest. This forest remnant includes mountains that reach 1100 m a.s.l. at their highest point (Oliveira et al. 2013) and the vegetation types are composed of semideciduous seasonal forest, submontane dense ombrophilous forest, and dense ombrophilous forest, all at varying levels of conservation (Magnago et al. 2008). The mean annual temperature is approximately 24.5°C and mean rainfall is around 1290 mm (Oliveira et al. 2013).

2. Surveys of reptiles

We used the Rapid Assessment (RA) method to assess the species richness and abundance of reptiles in the MONAST during January, February, and March 2018. The RA method provides an efficient approach for the collection of reliable and replicable data in a short period of time (Patrick et al. 2014).

The RA method we employed in the present study consisted of intensive sampling over ten consecutive days at each of the three study sites located within the MONAST (a total of 30 field days) with a field team between six and 10 members, at 18 different locations. We conducted time-limited active searches (Crump & Scott Jr. 1994) between 0900 and 1200 hours for the daytime period, and between 1800 and 2200 hours for the crepuscular/nighttime period, with a total of approximately 1320 hours of sampling effort. We conducted the active searches in preserved forest fragments located as far as possible from areas of anthropogenic impact, including areas at altitudes ranging from ca. 600 m to 1100 m a.s.l. To guarantee the best possible estimate of local species richness, we also recorded the reptile species found in the habitats in the vicinity of the MONAST, including human habitations, pasture, and plantations. We did not conduct an active search more than once at the same geographic coordinate.

We also collected reptiles using four systems of pitfall traps with drift fences (Corn 1994) installed in different forest fragments, in particular the best-preserved habitats, and at different altitudes. Each system consisted of 40 buckets (of 20 L), which were arranged in a straight line at each study site.

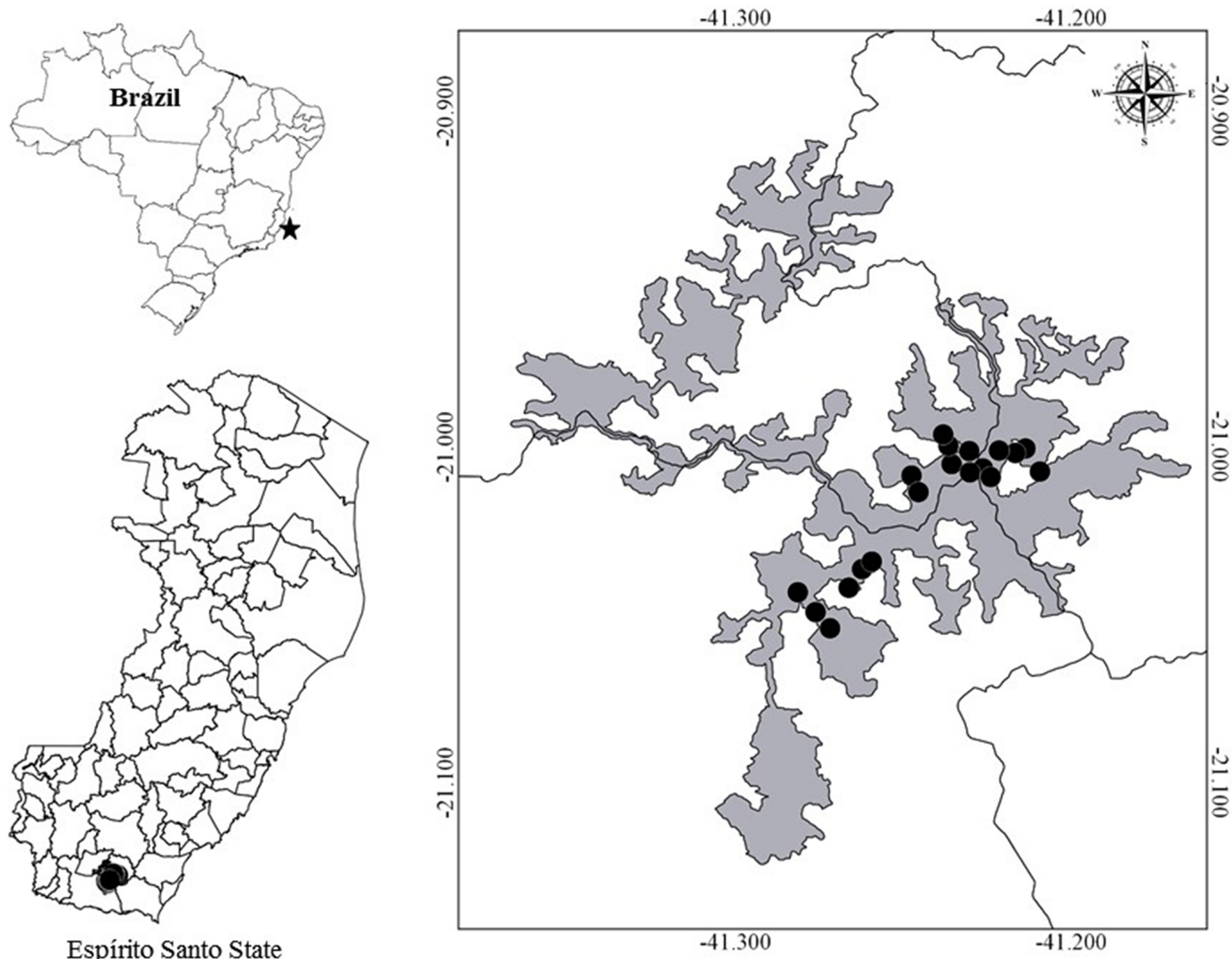


Figure 1. Points sampled in the Serra das Torres Natural Monument in the Brazilian state of Espírito Santo (black dots). The enlarged figure on the right shows the limits of the Natural Monument in relation to the three municipalities (Atilio Vivacqua, Mimoso do Sul, and Muqui) in which it is located.

We installed the traps three days prior to the sampling period at each of the three sites, with all buckets remaining active until the 10th consecutive day of sampling. We removed all the buckets and fences at the end of the sampling period at each site and then moved them to the next sampling area. The overall sampling effort of the pitfall traps was approximately 720 hours. At the end of the survey, we removed all the pitfall systems from the MONAST.

We identified the reptile species using specific references (e.g., Ávila-Pires 1995; Marques et al. 2001; Silva Jr et al. 2016) with confirmation by specialists, whenever necessary. The taxonomic identity of the species known to occur in Espírito Santo was confirmed through consultations at the herpetological collections of the National Atlantic Forest Institute (INMA: Instituto Nacional da Mata Atlântica), in Santa Teresa, Espírito Santo state, and the Museu Nacional (NMRJ) in Rio de Janeiro state, in order to minimize possible errors with regard to species occurrence. We considered these two collections to represent accurately the herpetofauna known to occur in the Brazilian state of Espírito Santo.

We constructed a species accumulation curve based on the cumulative number of species recorded during the RA (S) as a function of sampling effort (n). We estimated species richness by the Bootstrap method, which we considered to be the diversity index best suited to our data (Magurran 2004). We also classified species occurrence as “rare” or “common” based on the number of previous records from Espírito Santo, using the data available in online databases (Species Link 2018). Based on these previous records from Espírito Santo state, we classified species in four classes of occurrence: (i) 1–5 occurrences, (ii) 6–10 occurrences, (iii) 11–20 occurrences, and (iv) more than 20 occurrences. We considered species in the (i) 1-5 occurrences category to be “rare” in the state of Espírito Santo.

The collection of voucher specimens was authorized by Sisbio/RAN Nº 57085-6 and the Espírito Santo for the Environment (IEMA) Nº 033-2017. The vouchers were deposited at the MNRJ, in Rio de Janeiro and INMA, in Espírito Santo state. We did not collect specimens of some easily-recognized species (e.g., *Salvator merianae*, and *Boa constrictor*) due to their large body size, which would require additional resources for specimen collection.

Results

We obtained 257 specimens of 35 reptile species representing 15 families distributed in two orders, Chelonia (N = 1) and Squamata

(N = 34) during our inventory of the Serra das Torres Natural Monument (Table 1, Figure 2 and 3). The Squamata species recorded were represented by two amphisbaenids, 11 lizards, and 21 snakes.

Table 1. Reptile species recorded in the Serra das Torres Natural Monument in Espírito Santo, southeastern Brazil, showing the abundance (number of records), sampling method, and endemism in the Brazilian Atlantic Forest. OE: occasional encounter; AS: Active search; PT: pitfall trap; END/AF: Endemic to the Brazilian Atlantic Forest. * = recorded after the end of the sampling method. ** = non-indigenous species.

Species	Abundance	Method	END/AF
TESTUDINES			
Chelidae			
<i>Hydromedusa maximiliani</i> (Mikan, 1820)*	1	OE	x
SQUAMATA: Amphisbaenia			
<i>Amphisbaena alba</i> Linnaeus, 1758	1	OE	—
<i>Leposternon microcephalum</i> Wagler, 1824	1	OE	—
SQUAMATA: Lacertilia			
Diploglossidae			
<i>Ophides fragilis</i> (Spix, 1825)	2	OE/AS	—
Gekkonidae			
<i>Hemidactylus mabouia</i> (Moreau de Jonnés, 1818)**	1	AS	—
Phyllodactylidae			
<i>Gymnodactylus darwini</i> (Gray, 1845)	16		x
Gymnophthalmidae			
<i>Ecleopopus gaudichaudii</i> Duméril & Bibron, 1839	38	PT	x
<i>Heterodactylus imbricatus</i> Spix, 1825	2	PT	x
<i>Leposoma scincoides</i> Spix, 1825	54	AS/PT	x
<i>Placosoma glabellum</i> (Peters, 1870)	1	PT	x
Leiosauridae			
<i>Enyalius boulengeri</i> Etheridge, 1969	27	AS/PT	—
Mabuyidae			
<i>Brasiliscincus agilis</i> (Raddi, 1823)	11	AS	x
Teiidae			
<i>Salvator merianae</i> Duméril & Bibron, 1839	5	AS	—
Tropiduridae			
<i>Tropidurus torquatus</i> (Wied, 1820)	7	AS	—
SQUAMATAS: Serpentes			
Boidae			
<i>Boa constrictor</i> Linnaeus, 1758	1	AS	—
Colubridae			
<i>Chironius bicarinatus</i> (Wied, 1820)	2	AS	x
<i>Spilotes pullatus pullatus</i> (Linnaeus, 1758)	1	OE	—
Dipsadidae			
<i>Dipsas variegata</i> (Duméril, Bibron & Duméril, 1854)	3	AS	—
<i>Elapomorphus quinquelineatus</i> (Raddi, 1820)	2	AS/PT	—
<i>Erythrolamprus miliaris miliaris</i> (Linnaeus, 1758)	4	OE/AS	—
<i>Erythrolamprus reginae</i> (Wagler in Spix, 1824)	1	PT	—
<i>Imantodes cenchoa</i> (Linnaeus, 1758)	3	AS	—
<i>Leptodeira annulata annulata</i> (Linnaeus, 1758)	3	AS	—
<i>Oxyrhopus clathratus</i> Duméril, Bibron & Duméril, 1854	2	AS	—
<i>Oxyrhopus petolaris digitalis</i> (Reuss, 1834)	2	AS	—
<i>Philodryas patagoniensis</i> (Girard, 1858)	1	OE	—
<i>Dipsas newwiedi</i> (Ihering, 1911)	2	AS	—
<i>Siphlophis longicaudatus</i> (Andersson, 1901)	1	AS	—
<i>Taeniophallus affinis</i> (Günther, 1858)	5	AS/PT	—
<i>Thamnodynastes nattereri</i> (Mikan, 1828)	2	AS	—
<i>Xenodon newwiedi</i> Günther, 1863	3	AS	—

Species	Abundance	Method	END/AF
Elapidae			
<i>Micrurus corallinus</i> (Merrem, 1820)	2	AS	x
<i>Micrurus lemniscatus carvalhoi</i> Roze, 1967	1	AS	—
Tropidophiidae			
<i>Tropidophis paucisquamis</i> (Müller in Schenkel, 1901)	2	AS	x
Viperidae			
<i>Bothrops jararaca</i> (Wied, 1824)	47	AS/OE	—



Figure 2. Examples of the reptile species recorded in the Serra das Torres Natural Monument in Espírito Santo state, southeastern Brazil. (A): *Imantodes cenchoa*; (B) *Chironius bicarinatus*; (C) *Oxyrhopus petolarius digitalis*; (D) *Dipsas variegata*; (E) *Tropidophis paucisquamis*; (F) *Taeniophalus affinis*; (G) *Oxyrhopus clathratus*; (H) *Erythrolamprus reginae*.



Figure 3. Examples of the reptile species recorded in the Serra das Torres Natural Monument in Espírito Santo state, southeastern Brazil. (A) *Heterodactylus imbricatus*; (B) *Brasiliscincus agilis*; (C) *Enyalius boulengeri*; (D) *Placosoma glabellum*; (E) *Leposoma scincoides*; (F) *Ecleopopus gaudichaudii*; (G) *Gymnodactylus darwini*; (H) *Amphisbaena alba*.

The snake family with the largest number of species was the Dipsadidae (N = 13 species), while in the case of the lizards, the most diverse family was the Gymnophthalmidae (N = 4 species). The most abundant lizard species in our inventory were *Leposoma scincoides* (N = 54) and *Ecleopopus gaudichaudii* (N = 38), followed by *Enyalius boulengeri* (N = 27) (Figure 4). The rarest lizard species were *Heterodactylus imbricatus* and *Ophiodes fragilis*, both recorded only twice and

Placosoma glabellum and the exotic, invasive gekko *Hemidactylus mabouia*, which were both recorded only once (Figure 4). The most abundant snake species was *Bothrops jararaca* (N = 47 specimens), while the other 21 snake species were all recorded less than five times during the study (Figure 5). We recorded two species of Amphisbaenia, *Amphisbaena alba* (N = 1) and one *Leposternon microcephalum*. We also recorded one *Hydromedusa maximiliani* after the end of the RA sampling.

Reptiles of Serra das Torres

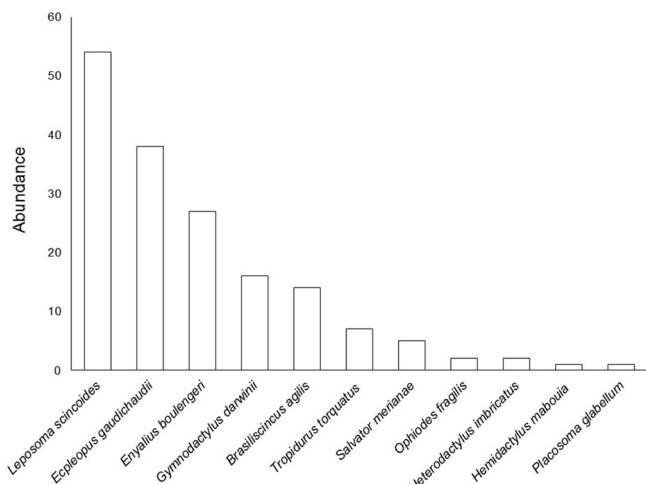


Figure 4. Lizard species richness and abundance recorded in the Serra das Torres Natural Monument in Espírito Santo state, southeastern Brazil.

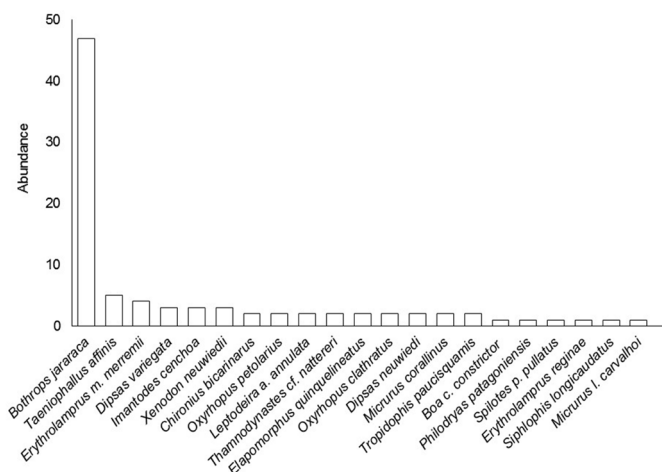


Figure 5. Snake species richness and abundance recorded in the Serra das Torres Natural Monument in Espírito Santo state, southeastern Brazil

This chelonian was included in the MONAST species list and richness but was not included in the analyses. Additionally, we did not collect a voucher specimen of *H. maximiliani* due to the threatened status (vulnerable) of the species in Espírito Santo state (IPEMA 2007; Bérnils et al. *no prelo*).

The species accumulation curve did not reach the asymptote, although the total species richness estimated for the MONAST based on the Bootstrap index was 36, only slightly above the actual species richness recorded in our study (34 species) (Figure 6). The largest number of species was recorded by active searching (N = 24 species), whereas only eight species were collected in the pitfall traps (Table 1). Four species (three lizards and one snake) were recorded exclusively by the pitfall traps.

Eight of the 11 lizard species (72%) recorded in the MONAST are endemic to the Atlantic Forest biome and two of the snakes are also endemic to this biome (Table 1). Ten (30%) of the reptiles recorded in the present study had less than five previous records from the state of Espírito Santo, and were thus classified as “rare”, and the same number (10 species, 30%) had been recorded more than 20 times, and were thus classified as “common” (Figure 7).

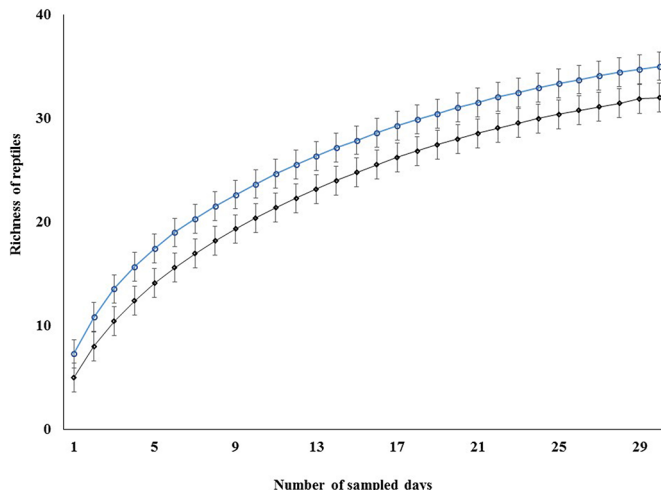


Figure 6. Accumulation (black line) and rarefaction curves (blue line) of the reptile species recorded during the 30 days of the sampling period in the Serra das Torres Natural Monument in Espírito Santo state, southeastern Brazil.

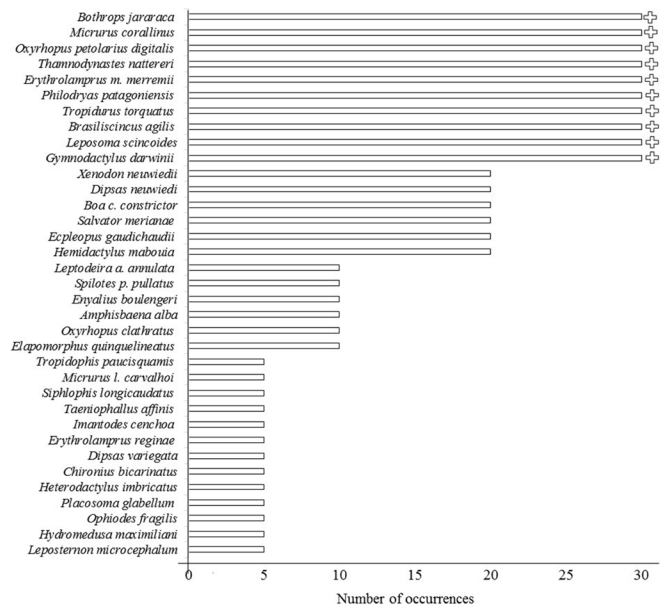


Figure 7. Number of previous records, according to data on herpetological collections in the state of Espírito Santo, of the reptile species occurring in the Serra das Torres Natural Monument.

Discussion

The reptile species richness recorded in the MONAST ($N_{total} = 35$) represents ca. 30% of all the squamates found in the Brazilian state of Espírito Santo ($N = 117$, see Costa & Bérnils 2018). This indicates that the MONAST protects a large proportion of the overall reptile biodiversity of Espírito Santo and, in turn, of the Atlantic Forest biome. The species richness of Serra das Torres is also similar to other remnants ombrophilous forest in southeastern Brazil where reptile surveys have been conducted. For example, Moura et al. (2012) recorded 40 reptile species (1 amphisbaenid, 9 lizards, and 29 snakes) in Serra do Brigadeiro, in the Brazilian state of Minas Gerais, while Almeida-Gomes et al. (2014) recorded 37 species

(one chelonian, one crocodylian, 10 lizards, and 24 snakes) in the Guapiaçu Ecological Reserve, in Rio de Janeiro. It is important to note that our inventory recorded 34 species (excluding *H. maximiliani*, found after the end of sampling), while the predicted species richness was only a little higher (36 species), despite the fact that the accumulative species curve did not reach the asymptote. These findings support the reclassification of the MONAST remnants as a more restrictive category of conservation unit, such as a state park, to better guarantee the protection of the reptile diversity of this important Atlantic Forest complex.

Hemidactylus mabouia, a non-indigenous lizard, was recorded in a forest fragment next to a banana plantation at the borders of the MONAST. This gekko is native to Africa, and has invaded a number of different natural environments in Brazil (Rocha et al. 2011, Telles et al. 2015, Oliveira et al. 2016), including many ombrophilous forest remnants (Rocha et al. 2011; Telles et al. 2015). The occurrence of *H. mabouia* in the MONAST is consistent with the dispersal of the species in other regions, where it is associated with open areas impacted by human activities (Rocha et al. 2011; Oliveira et al. 2016). The record of *H. mabouia* collected in the present study suggests that this species may begin to invade MONAST's natural environments.

The dominance of the family Dipsadidae in the present study is consistent with the pattern found in other areas of the Atlantic Forest (e.g. Hartmann et al. 2009, Freitas 2014). The Dipsadidae includes most tropical snakes, with more than 700 species (Vidal et al. 2010, Uetz et al. 2019), and the predominance of dipsadids recorded in the present study indicates a conservative snake community structure in Serra das Torres. Gymnophthalmidae was the most diverse lizard family ($N = 4$ species) in MONAST. This family as composed of small lizards, typically semi-fossorial, which forage in the leaf-litter (Dixo and Verdade 2006). In our samplings, gymnophthalmids were captured mainly in the pitfall traps, what is in accordance with the habitats of most species.

The most abundant lizards in our study were *Leposoma scincoides* and *Eclepopus gaudichaudii*, whereas *Heterodactylus imbricatus* and *Placosoma glabellum* were the least abundant in the community. This result is comparable with other studies in Atlantic Forest remnants where the species of the Gymnophthalmidae family are major components of local leaf-litter reptile communities (e.g. Maia et al. 2011, Cruz et al. 2014). For example, *E. gaudichaudii* represented a large proportion of the leaf-litter reptile community in the Morro Grande Forest Reserve, in São Paulo state (54%), whereas *Heterodactylus imbricatus* was the least abundant lizard (3%) (Dixo and Verdade 2006). In the MONAST, 32% of the lizards recorded during the survey were *Leposoma scincoides*, and 23% were *E. gaudichaudii* while *H. imbricatus* represented only 1.2% and *Placosoma glabellum* only 0.6% of the lizard's abundance. These four lizard species are endemic to the Atlantic Forest of southern and southeastern Brazil (Tozetti et al. 2017) and are considered species dependent on forested areas (Dixo and Verdade 2006). Since these species depend on preserved areas, local changes in the environment, even on a small scale, can result in changes in the composition or even the local extinction of these species (Román-Cuesta and Martínez-Vivalta 2006).

The most abundant snake was *Bothrops jararaca*. This pitviper has a wide distribution in the Atlantic Forest, occupying well-preserved, impacted, and anthropogenic areas (Sazima 1988, 1992, Campbell and Lamar 1989). Although *B. jararaca* is a common snake in the communities in which it occurs, its abundance varies considerably among localities.

In Serra do Mendanha, in Rio de Janeiro state, for example, *B. jararaca* is relatively rare, with only 10 records being obtained in a 62-month study (Pontes and Rocha 2009), whereas in the Juréia-Itatins Ecological Station, in São Paulo state, the species was relatively abundant, with 60 records being collected during a 15-month study (Marques and Sazima 2004). In the MONAST, *Bothrops jararaca* was more abundant ($N = 47$ records in 30 days of sampling) than all the other snake species combined ($N_{\text{total}} = 42$). Although it is important to consider the differences in the methods adopted in the different studies, the abundance of *B. jararaca* in Serra das Torres indicates that this forest remnant is a potentially important site for the conservation of this pitviper species.

We also recorded nine reptile species (27% of the total) that are endemic to the Atlantic Forest in our study at MONAST (Table 1). Overall, approximately 100 species are endemic to this biome (Tozetti et al. 2017). The Atlantic Forest is one of the world's most biodiverse biomes, although it is also one of the most threatened, reinforcing its status as a conservation hotspot (Myers et al. 2000, Ribeiro et al. 2009, Colombo and Joly 2010). Additionally, one chelonian (*Hydromedusa maximiliani*) and one snake (*Tropidophis paucisquamis*) are considered as vulnerable (VU) in the red list of threatened species in the state of Espírito Santo (Bérnils et al. *no prelo*). *Hydromedusa maximiliani* is endemic to the Atlantic Forest domain, where it inhabits streams at high altitudes (above 600 m a.s.l.) in the states of Bahia, Espírito Santo, Minas Gerais, São Paulo, and Rio de Janeiro (Argôlo & Freitas 2002). The main threat to the conservation of *H. maximiliani* is the alteration of the vegetation cover, which modifies the species' natural habitat and provokes shifts in the temperature beyond the optimum it requires to survive (Almeida et al. 2007). *Hydromedusa maximiliani* is also listed as Vulnerable in the IUCN Red List (IUCN 2019). *Tropidophis paucisquamis* is endemic to Atlantic Forest, occurring in the states of Espírito Santo, Rio de Janeiro, São Paulo, Paraná and Minas Gerais (Oliveira et al. 2019) and are mainly associated with the Serra do Mar and Serra da Mantiqueira mountain chains at an altitudinal range from 500 to 1261 m. (Curcio et al. 2012). The dwarf boa *T. paucisquamis* is rare in inventory studies and there are only four records of the species in Espírito Santo state (this study) and only 50 specimens from 26 localities are deposited in scientific collections of the entire Brazil (Oliveira et al. 2019). This species has among its antipredator mechanisms the cephalic autohemorrhage which has been described for species of the *Tropidophis* genus as a physiological product of increased blood pressure associated with a behavioral response caused by stress or fright (Smith et al. 1993). However, information about the biology and natural history of *Tropidophis paucisquamis* are poorly known. The presence of a high number of endemic species, habitat-dependent species and endangered species make MONAST an important refuge for the reptile fauna of the Atlantic forest.

In addition, 10 (30%) of the reptiles recorded in our study have less than five previous records in Espírito Santo (Figure 7). The rarity of these species in the state probably reflects in many cases the lack of studies in this region of southeastern Brazil. For example, *Micrurus lemniscatus carvalhoi*, is known to occur in western Argentina and eastern Paraguay, and is widespread in most Brazilian biomes, although only two previous records were available from Espírito Santo (Castro et al. 2017). This is typical of most of the rare species recorded in the present study and, considering the ongoing deforestation in Espírito Santo, we would strongly recommend that further studies of the state's herpetofauna be carried out.

The importance of the MONAST for the protection of the region's herpetofauna only began to be revealed in the past decade (e.g. Oliveira et al. 2009, 2012, 2013), and the new data presented here further reinforce the importance of this Atlantic Forest remnant for the conservation of the Atlantic Forest herpetofauna. The present study is the first inventory for southern Espírito Santo and it has been fundamental to the filling of a large knowledge gap in this portion of Atlantic Forest. Finally, we would recommend that the local environmental authorities focus on the need to maintain the integrity of the habitat structure of the entire remnant that harbors the Monumento Natural Serra das Torres.

Acknowledgments

This study is part of the results of the "Atlantic Forest Biodiversity Research Program" (PPBio Mata Atlântica Program) of the Brazilian Ministry of Science, Technology, Innovation, and Communication (MCTIC) and was supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) (Process No. 457458/2012-7) to HGB. This study is also part of the "Biodiversity Research Program of the State of Rio de Janeiro" (BIOTARio), supported by Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro – FAPERJ (Process No. E-26_010.001639_2014) to CFD Rocha. The authors also benefitted from grants provided to HGB (process 307781/2014-3) and to CFDR (302974/2015-6 and 424473/2016-0) by CNPq, and the FAPERJ "Scientists of Our State" Program to CFDR (E-26/202.920.2015) and HGB (process E-26/201.267.2014). JCFO thanks FAPERJ for a postdoctoral fellowship (Process E-26/202.388/2017). CMM thanks FAPERJ for a fellowship, E-26/202.163/2016. We thank João Kloss Degen, Evanderson Conceição, Maurício Milanezi and Bruno Barboza for helping in part of the fieldwork and Paulo Passos for the snake identification. We thank all the local residents at MONAST, in particular, João Marcos Dir, Benedito Sales Martins, Gilson Martins, Jorge Duarte, Ricardo and Eloá Perriraz Silva, Isaías Gregório and Maria Aparecida Correia, Renato Betero, Angelo Gasparello and family, Claudia Altoé, Cristiano Oliveira and Juci P. Almeida. We also thank Márcio Meneguissi Menon, José R. L. Vasconcelos, and IEMA for logistic support. JCFO extends special thanks to Valentin Colli, Avelino Lacerda, and Antônio Carlos Balbino, and their families, for more than 10 years of support for her herpetological studies in Serra das Torres.

Author contributions

Jane C. F. Oliveira: Substantial contribution to the conception and design of the work; Contribution in the acquisition of the data; Contribution in the analysis and interpretation of the data; Contribution in the writing of the work; Contribution in the critical review appending intellectual content.

Rafael dos Santos: Contribution to data collection.

Mateus Leite Lopes-Silva: Contribution to data collection.

Lorena P. Vasconcelos Barros: Contribution to data collection.

Bárbara Risse-Quaioto: Contribution to data collection.

Cátia Moura Militão: Contribution to data collection; Contribution to critical revision, adding intellectual content.

Pedro Fatorelli: Contribution to data collection; Contribution to critical revision, adding intellectual content.

Flávia A. L. Belmoch: Contribution to data collection.

Thiago Marcial Castro: Contribution to species identification in the herpetological collection.

Carlos Frederico Duarte Rocha: Substantial contribution to the conception and design of the work; contribution in the acquisition of the data; contribution in the analysis and interpretation of the data; contribution in the writing of the work; contribution in the critical review appending intellectual content.

Conflicts of interest

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

References

- ARGÔLO, A.J.S. & FREITAS, M.A. 2002. *Hydromedusa maximiliani*. Herpetological Review 33:147.
- ARGÔLO, A.J.S. 2004. As Serpentes dos Cacaiais do Sudeste da Bahia. Ilhéus: EDITUS. 259 pp.
- ÁVILA-PIRES, T.C. 1995. Lizards of Brazilian Amazonia (Reptilia: Squamata). Zoologische Verhandlungen Leiden 299: 1-706.
- ALMEIDA, A.P., GASPARINI, J.L., ABE, A.S., ARGÔLO, A.J.S., BATISTOTTE, C., FERNANDES, R., ROCHA, C.F.D., AND VAN SLUYS, M. 2007. Os répteis ameaçados de extinção no Estado do Espírito Santo. In: Passamani, M. and Mendes, S.L. (Eds.). Espécies da Fauna Ameaçadas de Extinção no Estado do Espírito Santo. Vitória, Brazil: Instituto de Pesquisas da Mata Atlântica, pp. 65–7
- ALMEIDA-GOMES, M., VRCIBRADIC, D., SIQUEIRA, C.C., KIEFER, M.C., KLAION, T., ALMEIDA-SANTOS, P., NASCIMENTO, D., ARIANI, C.V., BORGES-JUNIOR, V.N.T., FREITAS-FILHO, R.F., VAN SLUYS, M. & ROCHA, C.F.D. 2008. Herpetofauna of an Atlantic rainforest area (Morro São João) in Rio de Janeiro State, Brazil. Anais da Academia Brasileira de Ciências 80: 291300.
- ALMEIDA-GOMES, M., SIQUEIRA, C.C., BORGES-JUNIOR, V.N.T., VRCIBRADIC, D., FUSINATTO, L.A. & ROCHA, C.F.D. 2014. Herpetofauna da Reserva Ecológica de Guapiaçu (REGUA) e das áreas do entorno, no estado do Rio de Janeiro, Brasil. Biota Neotropica 14(3):1-15.
- BÉRNILS, R.S., CASTRO, T.M., ALMEIDA, A.P., ARGÔLO, A.J., COSTA, H.C., OLIVEIRA, J.C.F., SILVA-SOARES, T., NOBREGA, Y.C., CUNHA, C.J. *no prelo*. Répteis ameaçados de extinção no estado do Espírito Santo. In Fauna e Flora ameaçadas de extinção no estado do Espírito Santo (Fraga, C.N.F., Formigoni, M.H., Chaves, F.F., eds.). 1ed. Santa Teresa: Instituto Nacional da Mata Atlântica, p. 270-293.
- BRANDÃO, R.A. & ARAÚJO, A.F.B. 2001. A herpetofauna associada às matas de galeria do Distrito Federal. In Cerrado: Caracterização e -Recuperação de Matas de Galeria (Ribeiro, J.F., Fonseca, C.E.L. & Sousa-Silva, J.C., eds.). Embrapa Cerrados, Planaltina, p. 561-604.
- CAMPBELL, J.A. W. LAMAR. 1989. The venomous reptiles of Latim América. Ithaca. Cornell University Press.
- CASTRO, T.M., OLIVEIRA, J.C.F., GONZALEZ, R.C., CURCIO, F.F. & FEITOSA, D.T. 2017. First Record of *Micrurus lemniscatus carvalhoi* Roze, 1967 (Serpentes: Elapidae) from Espírito Santo. Herpetology Notes, volume 10: 391-393.
- COSTA, H.C. & BÉRNILS, R.S. 2018. Répteis do Brasil e suas Unidades Federativas: Lista de espécies. Herpetologia Brasileira 7(1): 11-57.
- CORN, P.S. 1994. Straight-line drift fences and pitfall. In Measuring and monitoring biological diversity: standard methods for amphibians (R.W. Heyer, M.A. Donnelly, R.A. McDiarmind, L.C. Heyek & M.S. Foster, eds.). Smithsonian Institution Press, Washington DC, 109-117.
- COLOMBO, A.F. & JOLY, C.A., 2010. Brazilian Atlantic Forest lato sensu: the most ancient Brazilian forest, and a biodiversity hotspot, is highly threatened by climate change. Brazilian Journal of Biology, 70(3), pp.697-708.

- CURCIO, F.F., NUNES, P.M.S., ARGÔLO, A.J.S., SKUK G., RODRIGUES, M.T. 2012. Taxonomy of the South American dwarf boas of the genus *Tropidophis* bibron, 1840, with the description of two new species from the Atlantic Forest (Serpentes: Tropidophiidae). *Herpetological Monographs* 26(1): 80–121.
- CRUMP, M.L. & SCOTT JR., N.J. 1994. Visual Encounter Surveys. Measuring and Monitoring Biodiversity: Standard Methods for Amphibians. In: W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L.-A. C. Hayek and M. S. Foster. Washington, Smithsonian Institution Press.
- CRUZ, A.J.R.; DUMMOND, L.O.; LUCENA, V.D.; MAGALHÃES A.D.; BRAGA, C.A.C.; ROLIN, J.M. & PIRES, M.R.S. 2014. Lizard fauna (Squamata, Sauria) from Serra do Ouro Branco, southern Espinhaço Range, Minas Gerais, Brazil. *Check List* 10(6):1290-1299.
- DIXO, M. & VERDADE, V.K. 2006. Herpetofauna de serrapilheira da Reserva Florestal de Morro Grande, Cotia (SP). *Biota Neotrop.* (6)2: 11-20
- DÍAS, E.J.R. & ROCHA, C.F.D. 2014. Habitat structural effect on Squamata fauna of the Restinga ecosystem in northeastern Brazil. *Anais da Academia Brasileira de Ciências* 86(1): 359–37
- FREITAS, MA. 2014. Squamate reptiles of the Atlantic Forest of northern Bahia, Brazil
- HARTMANN, P.A., HARTMANN, M.T. & MARTINS, M. 2009. Ecologia e história natural de uma taxocenose de serpentes no Núcleo Santa Virgínia do Parque Estadual da Serra do Mar, no sudeste do Brasil. *Biota Neotrop.* 9(3): <http://www.biotaneotropica.org.br/v9n3/en/abstract?article+BN03609032009>
- IPEMA - INSTITUTO DE PESQUISA DA MATA ATLÂNTICA. 2007. Espécies da fauna ameaçadas de extinção no Estado do Espírito Santo. Marcelo Passamani, Sérgio Lucena Mendes, organizadores. - Vitória: IPEMA. 140 p.
- IPEMA - INSTITUTO DE PESQUISA DA MATA ATLÂNTICA. 2010. Saberes da Mata: Um jeito participativo de cuidar da mata atlântica. Instituto de Pesquisas da Mata Atlântica – Vitória: IPEMA. 72 p.
- MAIA, T.; ALMEIDA-GOMES M.; SIQUEIRA C.C.; VRCIBRADIC D.; KIEFER M.C.; ROCHA C.F.D. 2011. Diet of the lizard *Eublepharis macularius* (Gymnophthalmidae). *Zoologia* 28(5): 587-592.
- MAGURRAN, E. 2004. Measuring biological diversity. Oxford, UK: Blackwell.
- MARQUES, O.A.V., ETEROVIC, A. & SAZIMA, I. 2001. Serpentes da Mata Atlântica. Guia ilustrado para a Serra do Mar. Holos, Ribeirão Preto.
- MAGNAGO, L.F.S., SIMONELLI, M., FONTANA, A.A.P., KOLLMANN, L.J.C., MATOS, F.A.R. 2008. Aspectos Fitogeográficos, Vegetacionais e Estado de Conservação da Região de Serra das Torres, Espírito Santo, Brasil. *Revista Científica Faesa*. 41:33–38.
- MARTINS, M. 1991. The lizards of Balbina, Central Amazonia, Brazil. *Stud. Neotrop. Fauna Environ.* 26:179–190.
- MARQUES, O.A.V. & SAZIMA, I. 2004. História natural dos répteis da Estação Ecológica Juréia-Itatins. Pp 386 in: MARQUES, O.A.V. & DULEBA, W. (Eds). Estação Ecológica Juréia-Itatins. Ambiente físico, flora e fauna. Ribeirão Preto, Holos Editora, 386 p.
- MIRANDA, J.P., COSTA, J.C.L. & ROCHA, C.F.D. 2012. Reptiles from Lençóis Maranhenses National Park, Maranhão, northeastern Brazil. *ZooKeys* 246: 51–68.
- MOURA, M.R., MOTTA, A.P., FERNANDES, V.D. & FEIO, R.N. 2012. Herpetofauna da Serra do Brigadeiro, um remanescente da Mata Atlântica, em Minas Gerais, Sudeste do Brasil. *Biota Neotropica* 12(1): 209–235
- MYERS, N., MITTERMEIER, R.A., MITTERMEIER, C.G., DA FONSECA, G.A. AND KENT, J., 2000. Biodiversity hotspots for conservation priorities. *Nature*, 403(6772), p.853.
- OLIVEIRA, J.C.F., COCO, L., DE DEUS, F.F., PAGOTTO, R.V., SOARES, E.S., ROCHA, C.F.D. & VRCIBRADIC, D. 2009. *Phasmahyla guttata* geographic distribution. *Herpetological Review* 40(4): 446.
- OLIVEIRA, J.C.F., CÔCO, L., PAGOTTO, R.V., PRALON, E., VRCIBRADIC, D., POMBAL JR. J.P. & ROCHA, C.F.D. 2012. Amphibia, Anura, *Brachycephalus didactylus* (Izecksohn, 1971) and *Zachiaenus parvulus* (Girard, 1853): Distribution extension. *Check List* 8(2): 242-244.
- OLIVEIRA, J.C.F., PRALON, E., COCO, L., PAGOTTO, R.V., & ROCHA, C.F.D. 2013. Environmental humidity and leaf-litter depth affecting ecological parameters of a leaf-litter frog community in an Atlantic Rainforest area. *Journal of Natural History* 47: 1-10.
- OLIVEIRA, J.C.F., WINCK, G.R., RIBEIRO, J.P., ROCHA, C.F.D. 2016. Antropogenic or niche preference: contributions on the knowledge of *Hemidactylus mabouia* invasion in South America. *North-Western Journal of Zoology* 12: 389-292.
- OLIVEIRA, J.C.F., PEREIRA-RIBEIRO, J., WINCK, G.R. & ROCHA, C.F.D. 2019. Lizard assemblages on sandy coastal plains in southeastern Brazil: An analysis of occurrence and composition, and the role of habitat structure. *Anais da Academia Brasileira de Ciências*.
- OLIVEIRA, L.A., ROCHA, P.C.R., MORAIS, J.F. & FEIO, R.N. 2019. Range extension of the Brazilian dwarf boa *Tropidophis paucisquamis* (Müller, 1901) (Serpentes, Tropidophiidae) and first record in the state of Minas Gerais, Brazil.
- PATRICK et al. 2014. Guidelines for undertaking rapid biodiversity assessments in terrestrial and marine environments in the Pacific / Brian Patrick – Apia, Samoa: SPREP, Wildlands.
- PONTES, J.A.L. & C.F.D. ROCHA. 2008. Serpentes da Serra do Mendanha, Rio de Janeiro, RJ: Ecologia e conservação. Rio de Janeiro, Technical Books Editora, 147p.
- PONTES, J.A.L., Pontes, R.C., ROCHA, C.F.D. 2009. The snake community of Serra do Mendanha, in Rio de Janeiro State, Southeastern Brazil: composition, abundance, richness and diversity in areas with different conservation degrees. *Brazilian Journal of Biology* 69: 631-637.
- SAWAYA, R.J., Marques, O.A.V. & Martins, M. 2008. Composição e história natural das serpentes de Cerrado de Itirapina, São Paulo, sudeste do Brasil. *Biota Neotropica* 8(2): 127-149.
- SMITH, D.D., PFLANZ, D.J., POWELL, R. 1993. Observations of Autohemorrhaging in *Tropidophis haetianus*, *Rhinocheilus lecontei*, *Heterodon platyrhinos* and *Nerodia erythrogaster*. *Herpetological Review* 24: 130-131.
- STRÜSSMANN, C. & SAZIMA I. 1993. The snake assemblage of the Pantanal at Poconé, western Brazil: faunal composition and ecological summary. *Studies on Neotropical Fauna and Environment*. 28:157-168.
- TELLES, F.B.S., MILITÃO, C.M., BERGALLO, H.G., ROCHA, C.F.D. 2015. Invasion of the alien gecko *Hemidactylus mabouia* (Moureaux de Jonnés, 1818) in a natural habitat at Praia do Sul Biological Reserve, Ilha Grande, RJ, Brazil. *Brazilian Journal of Biology (Online)* 2:1-3.
- TOZETTI, A.M., SAWAYA, R.J., MOLINA, F.B., BERNILS, R.S., BARBO, F.E., LEITE, J.C.M., BORGES-MARTINS, M., RECODER, R., TEIXEIRA JUNIOR, M., ARGÔLO, A.J.S., MORATO, S.A.A., RODRIGUES, M.T. 2017. Revisões em zoologia: Mata Atlântica / Emygdio Leite de Araujo Monteiro- Filho, Carlos Eduardo Conte (orgs.). – 1. ed. – Curitiba: Ed. UFPR, 2017. 490 p.: il. (algumas color.) (Série Pesquisa, 310).
- 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. *Biological Conservation* 142: 1141-1153.
- ROCHA, C.F.D. 1998. Composição e organização da comunidade de répteis da área de Mata Atlântica da região de Linhares, Espírito Santo. ANAIS DO VIII SEMINÁRIO REGIONAL DE ECOLOGIA. Volume VIII. P 869-881;
- ROCHA, C.F.D., BERGALLO, H.G., VERA Y CONDE, C.F., BITTENCOURT, E.B., SANTOS, H.C. 2008. Richness, abundance, and mass in snake assemblages from two Atlantic Rainforest sites (Ilha do Cardoso, São Paulo) with differences in environmental productivity. *Biota Neotropica* (Ed. Portuguesa), 8:117-122.
- ROCHA, C.F.D., ANJOS, L.A., & BERGALLO, H.G. 2011. Conquering Brazil: the invasion by the exotic gekkonid lizard *Hemidactylus mabouia* (Squamata) in Brazilian natural environments. *Zoologia* 28(6): 747-754.
- ROCHA, C.F.D., TELLES, F.B.S., VRCIBRADIC, D., NOGUEIRA-COSTA, P. 2018. The Herpetofauna from Ilha Grande (Angra dos Reis, Rio de Janeiro, Brazil): updating species composition, richness, distribution and endemisms. *Papéis Avulsos de Zoologia (online)* 58: 25-36.
- ROMÁN-CUESTA, R.M & MARTÍNEZ-VILALTA, J. 2006. Effectiveness of protected areas in mitigating fire within their boundaries: case study of Chiapas, Mexico. *Conservation Biology* 20:1074–1086.
- SAZIMA, I. 1992. Natural History of the jararaca pitviper, *Bothrops jararaca* in southeastern Brazil. Pp 199-216 in Campbell & E. D. Brodie Jr. (eds), *Biology of the pitvipers*, Tyler (Texas). Selva.

- SAZIMA, I. 1988. Um estudo de biologia comportamental de jararaca, *Bothrops jararaca* com uso de marcas naturais. Memórias do Instituto Butantan 50:83-90.
- SILVA JR., PIRES, N.J., FEITOSA, D.T. 2016. Diversidade das cobras-coraís do Brasil. In: As cobras-coraís do Brasil – Biologia, Taxonomia, Venenos e Envenenamentos, p. 80–167. Silva Jr., J., Ed., Goiás, BR, Editora da PUC.
- SPECIES LINK, visit on October 2018 in <http://smlink.cria.org.br>
- SUTHERLAND ET AL. 2013. Identification of 100 fundamental ecological questions. *Journal of Ecology* 101: 58-67.
- TONINI, J.F.R. CARÃO, L.M., PINTO, I.S., GASPARINI, J.L., LEITE, Y.L.R. & COSTA, L.P. 2010. Non-volant tetrapods from Reserva Biológica de Duas Bocas, State of Espírito Santo, Southeastern Brazil. *Biota Neotropica* 10(3):1-13.
- VIDAL N, DEWYNTER, M. & GOWER, D.J. Dissecting the major American snake radiation: A molecular phylogeny of the Dipsadidae Bonaparte (Serpentes, Caenophidia). 2010. *Comptes Rendus Biologies* 333: 48–55.
- VITT, L.J., MAGNUSSON, W.E., ÁVILA-PIRES, T.C.S. & LIMA, A.P. 2008. Guia de Lagartos da Reserva Adolpho Ducke, Amazônia Central. Manaus, Áttema Design, 175p
- VRCIBRADIC, D., ROCHA, C.F.D, KIEFER, M.C., HATANO, F.H., FONTES, A.F., ALMEIDA-GOMES, M., SIQUEIRA, C.C., PONTES, J.A.L., BORGES-JUNIOR, V.N.T., GIL, L.O., KLAION, T., Rubião, E.C.N. VAN SLUYS, M. 2011. Herpetofauna, Estação Ecológica Estadual do Paraíso, state of Rio de Janeiro, southeastern Brazil. *Check List (São Paulo. Online)* 7: 745-749.
- UETZ, P. & J. HALLERMANN. 2019. The TIGR Reptile Database. Rockville, JCVI, Available online at: <http://www.reptiledatabase.org> [Accessed: 12/12/2018]

Received: 17/01/2019

Revised: 22/02/2020

Accepted: 01/03/2020

Published online: 17/04/2020