Lizards and snakes of Refúgio de Vida Silvestre Matas do Siriji, an Atlantic Forest hotspot of the Pernambuco Endemism Center, Northeastern Brazil

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Abstract: The Atlantic Forest north of the São Francisco River, known as the Pernambuco Endemism Center (PEC), comprises small, poorly-known and, consequently, highly threatened forest remnants, such as Refúgio de Vida Silvestre (RVS) Matas do Siriji, a montane forest located in the municipality of São Vicente Férrer, state of Pernambuco, Northeast Brazil. We provide the results of the first inventory of the squamate fauna of the region with comments on the conservation status of some species, comparisons with other locations in Northeast Brazil and a brief discussion of biogeography. Time-constrained transects, pit-fall traps, occasional encounters and third-party records registered 18 lizard species and 25 snake species, with the rarefaction curve of the former tending to stability. The RVS Matas do Siriji possesses 39.81 % of the lizard and snake species known for the state of de Pernambuco, being the third richest area in species in the State, with a composition similar to that of other areas within PEC. Based on the lists of SEMAS, ICMBio and IUCN, some of the registered species are considered vulnerable to extinction while others have yet to be evaluated. The RVS Matas do Siriji includes a rich, threatened and underestimated fauna of squamate reptiles, indicating that more restrictive protection measures must be adopted in this Conservation Unit.

Keywords: Northeastern Atlantic Forest; state of Pernambuco; Squamata; Endangered species.

Lagartos e serpentes do Refúgio de Vida Silvestre Matas do Siriji, um hotspot da Mata Atlântica do Centro de Endemismo Pernambuco, Nordeste do Brasil

Resumo: A Mata Atlântica ao norte do Rio São Francisco, conhecida como Centro de Endemismo Pernambuco (CEP), é composta pelos menores, menos conhecidos e, consequentemente, mais ameaçados remanescentes florestais, como o Refúgio de Vida Silvestre (RVS) Matas do Siriji, uma floresta serrana localizada no município
de São Vicente Férrer, Pernambuco, Nordeste do Brasil. Aqui apresentamos o primeiro inventário sobre a fauna de Squamata dessa região, com comentários sobre o status de conservação de algumas espécies, similaridade na composição com outras localidades do Nordeste do Brasil e uma breve discussão biogeográfica. Foram utilizados transectos limitados por tempo, armadilhas de queda, encontros ocasionais e registro por terceiros. Registramos 18 espécies de lagartos e 25 de serpentes com a curva de rarefação de lagartos próxima da estabilidade. O RVS Matas do Siriji possui 39,81% das espécies de lagartos e serpentes do Estado de Pernambuco, ocupando o terceiro lugar em número de espécies no Estado e apresentando uma composição similar a de outras áreas do CEP. Além disso, com base nas listas da SEMAS, ICMBio e IUCN, algumas das espécies registradas encontram-se em estado vulnerável à extinção e outras não possuem avaliação. Portanto, o RVS Matas do Siriji comporta uma rica, ameaçada e subestimada fauna de répteis Squamata e medidas de proteção mais restritivas devem ser adotadas nessa Unidade de Conservação.

**Palavras-chave:** Mata Atlântica nordestina; Estado de Pernambuco; Squamata; Espécies ameaçadas.

**Introduction**

Centuries of successive economic cycles and constant occupation of Atlantic Forest environments has seriously compromised the ecological balance of the unique ecosystems of the domain (Silva & Casteleti 2005). The Atlantic Forest originally covered an area of 1,480,000 km², which corresponds to 17% of the national territory (Freitas et al. 2019). Today, only 160,000 km² (12.4%) of the coverage of the Atlantic Forest domain remains (SOS Mata Atlântica & INPE 2019), which houses at least 1% to 8% of the world’s biodiversity (Silva & Casteleti 2005), earning it recognition as a global biodiversity hotspot (Myers et al. 2000).

Northeast Brazil has the lowest coverage of remaining of Atlantic Forest and the lowest amount of protected areas (Lobo-Araújo et al. 2013, Vale et al. 2018), even though it has great biological importance due to high endemism, especially north of the São Francisco River. Among the biogeographic subunits that make up the Northeastern Atlantic Forest is the Pernambuco Endemism Center (PEC) (Rizzini 1997, Cavalcanti & Tabarelli 2004), a region that extends from the state of Alagoas to the state of Rio Grande do Norte (Prance 1982, Santos et al. 2007). The region possesses high endemism, with emphasis on plants (Prance 1982, Santos et al. 2007), butterflies (Brown 1979, Tyler et al. 1994) and birds (Silva et al. 2004, Lobo-Araújo et al. 2013, Vale et al. 2018), and is considered to have been an important refuge for Atlantic Forest species north of the São Francisco River during Quaternary climate changes (see Carnaval et al. 2009, Porto et al. 2013, Costa et al. 2017).

Thus far, a total of 84 lizard species (Tozetti et al. 2017) and 142 snake species (Marques et al. 2019) have been documented for the Atlantic Forest and although such estimates have yet to be made for PEC, some works have already contributed to the knowledge of its reptile fauna (Silva et al. 2006, Santana et al. 2008, Moura et al. 2012, Moura et al. 2015, Roberto et al. 2015, Oliveira et al. 2016, Roberto et al. 2017, Melo et al. 2018, Mesquita et al. 2018). Nonetheless, the herpetofauna of many areas remains to be sampled and evaluated, especially with regard to conservation (Roberto et al. 2017). Thus, it is extremely necessary and urgent that the herpetofauna of remnants that make up the PEC be surveyed, as the results of such studies are essential to better target conservation action plans (Margules & Pressey 2000). At least 15 species of squamate reptiles present in PEC were contemplated to better target conservation action plans (Margules & Pressey 2000). At the RVS Matas do Siriji, in the state of Pernambuco (A; dark grey), municipality of São Vicente Férrer (B), Northeastern Brazil. The numbered circles (I, II and III) represent the sampled subareas. (C) Landscape of an environment found in the area.
Three subareas were selected for sampling (Figure 1B) and assessed for their structure and environmental conditions:

— Subarea I (07°37’00.4”S, 035°30’17.3”W, 575 m). With a history of growing manioc 50 years ago, and its subsequent abandonment, Subarea I currently possesses a shrub-tree stratum with little open space and is marked by a large number of young A. Banana (Musa spp.) monoculture surrounds the subarea almost completely and human presence is more frequent in this subarea than in the others. The terrain has little declivity (8.2%) and is considered undulating. It has, on average: 74% canopy coverage; 6.03 cm litter height; five trees per every 16 m² of 15 m in height and 31.20 cm circumference at breast height (CBH); air and soil temperature of 22.5°C and 24°C, and air and soil humidity of 81% and 85%, respectively.

— Subarea II (07°36’36.9’’S, 035°30’25.9”W, 566 m). Marked by great declivity (40.1%), this subarea area was classified as strongly undulating. It is composed of a predominantly arboreal stratum that is slightly more spaced than in subareas I and III. No livestock or agriculture areas have been developed in the subarea but there are some trails. There is a source of water and an artificial pond at the beginning of the path of this subarea, while at the halfway mark there is a marked presence of rocks of varying sizes and many jackfruit (Artocarpus heterophyllus) from seedlings to large individuals of 15 m. The subarea has, on average: 80% canopy cover; 5.92 cm litter height; four trees per every 16 m² of 14 m in height and 27.98 cm CBH; air and soil temperature both 25.5°C; air and soil humidity of 78% and 83%, respectively.

— Subarea III (07°36’58.0”S, 035°30’37.1”W, 537 m). This subarea is more heterogeneous because it is markedly arbooreal, including the presence of trees with tabular roots. It has a part with “bare” soil and a 20 m² rocky outcrop while the end of the path has a dense forest in better condition of preservation with natural streams, presenting gently undulating declivity (7.4%). This subarea has, on average: 85% canopy coverage; 6.24 cm litter height; four trees per every 16 m² of 15 m in height and 34.61 cm CBH; air and soil temperature of 24.5°C and 23.7°C; and air and soil humidity of 79% and 82%, respectively.

2. Sampling

Data collection was performed monthly from April 2018 to September 2019 (with the exception of May, June, August and September 2018), during field expeditions of seven or eight consecutive days (total of 102 days in the field).

Time-constrained visual searches of 1 hr 30 min were performed systematically along transects in each subarea (Crump & Scott Jr. 1994) by five observers each period (morning, afternoon and night) of the day for a total of 2,205 hours (1,530 during the day / 675 at night; 441 hours/ by five observers each period (morning, afternoon and night) of the day

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Collected specimens (Appendix) were identified using Freitas et al. 2018), Pernambuco state, Área de Preservação Permanent Mata

and in the Coleção Paleoherpetológica e Herpetológica da Universidade Federal Rural de Pernambuco (CFH-UFRPE) and in the Coleção de Zoologia Didática da Universidade Federal Rural de Pernambuco (CZD-UFRPE), in the municipality of Recife, state of Pernambuco, Brazil. All procedures were carried out under permanent licenses for the collection of zoological material (SISBIO number. 11218-1 and 66285-1), as well as authorization from Secretaria de Meio Ambiente e Sustentabilidade (CPRH) management (process number 014349/2018).

3. Data analysis

In describing the taxocenosis, the number of sightings of a species was considered equivalent to its abundance since abundance itself was not assessed. Dominance (d) (Berger-Parker index), equitability (J) (Pielou index) and diversity of the taxocenosis were obtained through the Shannon-Wiener index (H’) (Magurran 1988) using PAST 3.25 software (Hammer et al. 2001). An abundance distribution diagram was created and tested using relative frequency [(number of samples with a record of a species/total number of samples) x 100] and relative abundance [(number of individuals of the same species/total number of individuals collected in the area) x 100] of each species (Dajoz 2005), based on the adequacy of theoretical models of distribution and abundance (broken-stick, geometric, log-series or log-normal) (Melo 2008, Mesquita et al. 2013).

Values for the species rarefaction curves were obtained with PAST 3.25 (Hammer et al. 2001) using the rarefaction system with 10,000 randomizations (using sampling days as sample units). The values were then transferred to Microsoft Excel (2016), where graphs more representative of the curves’ behavior were produced to evaluate the efficiency of the sampling effort (Gotelli & Colwell 2001). Species richness for lizards and snakes were estimated using the non-parametric estimators ICE and Jacknife II (Colwell & Coddington 1994) in Estimates 9.1.0 software (Colwell & Eenslohn 2014).

Classical cluster analyses were performed for lizards (79 spp.) and snakes (122 spp.) separately using the Jaccard Index (presence (1) / absence (0)) (Magurran 2004) in PAST 3.25 (Hammer et al. 2001). Records of squamate species at 36 locations in the Northeastern Atlantic Forest and associated ecosystems, including RVS Matas do Siriju, were used: 19 montane forests, including forest enclaves in the semiarid region — Serra do Urubu (Moura et al. 2011, Roberto et al. 2017), municipalities of Arcosverde, Belo Jardim and Sertãnia (Freitas et al. 2019a), in Pernambuco state; Agrestina, Arara, Bananeiras, Bezerros, Brejo dos Cavais, Brejo de Madre de Deus and Mata do Pau-Ferro (Pereira-Filho & Montingelli 2011; Pereira-Filho et al. 2020), in Pernambuco and Paraíba states; Reserva Biológica Pedra Tallada (Roberto et al. 2015), Pernambuco state; Chapada do Araripe (Borges-Nojosa & Caramaschi 2003, Ribeiro et al. 2008, Ribeiro et al. 2012), Ceará state; Parque Estadual Pico do Jable (Pereira-Filho & Montingelli 2011, Arruda 2017), Paraíba state; and Planalto do Ibiapaba (including Parque Nacional do Ubajara) and (Borges-Nojosa & Caramaschi 2003, Loebmann & Haddad 2010, Castro et al. 2019) Serra do Maranguape, Serra da Aratanga and Maciço do Baturité (Borges-Nojosa & Caramaschi 2003, Borges-Nojosa 2007), Ceará state; 14 low altitude fragments of Atlantic Forest near the coast — Estação Ecológica do Tapacurá (Moura et al. 2012), rainforest fragment Tejipió (Oliveira et al. 2016) and Parque Estadual Dois Irmãos (Santos et al. 2017, Melo et al. 2018), Pernambuco state, Área de Preservação Permanente Mata
Among the lizards, *Enyalius aff. catenatus* and *Gymnodactylus darwini* were the most frequently seen, representing 17% (n=41) and 12% (n=28) of the total number of sightings (n=239) of the entire taxocenosis. Among snakes, *Dipsas variegata* and *Lachesis muta* were most recorded, representing 4% (n=10) and 3% (n=8) of the total number of sightings of the whole taxocenosis (Table 1).

The reptile taxocenosis showed low dominance (d= 0.139) and high equitability (J= 0.824), indicating that it is stable (H= 3.080). It fit the log-normal model (Figure 9), as there was no significant difference between the distribution of abundances of the taxocenosis and the model (X²= 2.907; p= 0.234).

Among the species found in RVS Matas do Siriji, three had a conservation status of Vulnerable (*Strobilurus torquatus, Dipsas sazimai* and *Lachesis muta*), according to at least one of the three lists consulted (Table 1). *Dendrophidion atlantica* is considered Data Deficient (DD) by ICMBio (2018) and was not evaluated by the other lists (SEMAS 2017 and IUCN 2020), whereas only *Amerotyphlops arenensis* was not evaluated by any of the lists (Table 1).

The similarity dendrogram for lizards (Figure 10A) formed two large groups, represented by different phytosociologically, with Group I (upper part) comprising 12 areas with a predominance of mesic caatinga with small remnants of seasonal Atlantic Forest, and Group II (bottom part) comprising 15 areas of Atlantic Forest, with montane or lowland, dense or open ombrophilous forest. In this dendrogram, RVS Matas do Siriji is inserted in Group II, sharing greater composition (59%) with Estação Ecológica do Tapacurá (47.22%) (Moura et al. 2017 and IUCN 2020), whereas only *Amerotyphlops arenensis* was not evaluated by any of the lists (Table 1).

The similarity dendrogram for snakes (Figure 10B) revealed that RVS Matas do Siriji shared a maximum of 40% of its composition with RPPN Pedra D’antas and RPPN Frei Caneca (2017 2016), Reserva Particular Usina Porto Rico (RPUPR-AL), Reserva Madeiras (RM-AL) and Mata do Engenho Coimbra (MEC-AL).

The similarity dendrogram for RVS Matas do Siriji showed a maximum of 40% of its composition with Serra do Urubu (SU-PE) and 30% with other montane areas, and between 10% of the areas of montane or plain, dense or open ombrophilous forest. Groupings with considerable similarity with RVS Matas do Siriji and other areas were not observed. A grouping of montane forests located more centrally and northwest of the Caatinga, including Reserva Estadual Pico do Jabre (PEPJ-PE), Arcoverde (AV-PE), Sertânia (SE-PE), Belo Jardim (BJ-PE) and Chapada do Araripe (CA-CE), remained in both dendrograms, sharing 34% of their compositions in the snake dendrogram and 54% in the lizard dendrogram (Figure 10).

**Discussion**

To date, there is an estimated 41 species of lizards and 67 species of snakes in the state of Pernambuco (SEMAS 2017). Thus, RVS Matas do Siriji possesses 39.81% of the lizard and snake species of the state, with more species than RPPN Pedra D’antas and RPPN Frei Caneca (which make up Serra do Urubu) with 37.04% (Roberto et al. 2017) and fewer than Estação Ecológica do Tapacurá (47.22%) (Moura et al. 2012) and Parque Estadual de Dois Irmãos (48.15%) (Santos et al. 2017, Melo et al. 2018), all of which are areas of extreme importance for the state of Pernambuco and for PEC as a whole.

Most species had a similar number of sightings, and thus the taxocenose had high equitability and low dominance and did not differ significantly from the log-normal model (Figure 9). According to Dajoz (2005), a fit to this model is common for communities controlled by
### Table 1. List of lizard and snake species recorded in Refúgio de Vida Silvestre Matas do Siriji, municipality of São Vicente Férrer, state of Pernambuco, Northeastern Brazil, between April 2018 and September 2019, with respective collection methods, relative frequency, conservation status (according SEMAS, ICMBio and IUCN) and record type. TCVS = time-constrained visual search, OE = occasional encounter, PT= pitfall trap, TPR = third-party records, TPR* = third-party records after study, LC= Least Concern, DD= Data Deficient, VU= Vulnerable, AF= restricted to the Atlantic Forest, PEC= restricted to the Atlantic Forest and endemic to PEC.

| Family/Species | Collection method | Relative frequency (%) | SEMAS 2017/ICMBio 2018/IUCN 2019 | Record type |
|----------------|-------------------|------------------------|-----------------------------------|-------------|
| **Lagartos**   |                   |                        |                                   |             |
| **Dactyloidae**|                   |                        |                                   |             |
| *Dactyloa punctata* (Daudin, 1802) | TCVS | 9.54 | LC/LC/not evaluated | Collected |
| *Norops fuscoauratus* (D’Orbigny, 1837 in Duméril & Bibron, 1837) | TCVS | 7.05 | LC/LC/ not evaluated | Collected |
| *Norops ortontii* (Cope, 1868) | TCVS/OE | 1.24 | not evaluated /LC/ not evaluated | Collected |
| **Gekkonidae** |                   |                        |                                   |             |
| *Hemidactylus agrius* Vanzolini, 1978 | OE | 2.07 | LC/LC/LC | Collected |
| *Hemidactylus mabouia* (Moreau de Jonnès, 1818) | TCVS/OE | 0.83 | - | Collected |
| **Gymnophthalmidae** |                   |                        |                                   |             |
| *Dryadosaura nordestina* Rodrigues, Freire, Pellegrino & Sites Jr., 2005 ^AF | PT | 1.24 | LC/LC/LC | Collected |
| **Leiosauridae** |                   |                        |                                   |             |
| *Enyalius aff. catenatus* ^AF | TCVS/PT | 17.01 | LC/LC/LC | Collected |
| **Phyllodactylidae** |                   |                        |                                   |             |
| *Gymnodactylus darwini* (Gray, 1845) ^AF | TCVS/PT | 11.62 | LC/LC/LC | Collected |
| **Polychrotidae** |                   |                        |                                   |             |
| *Polychrus marmoratus* (Linnaeus, 1758) | OE | 1.66 | LC/LC/LC | Collected |
| *Polychrus acutirostris* Spix, 1825 | TCVS | 0.83 | LC/LC/LC | Photographic record |
| **Scincidae** |                   |                        |                                   |             |
| *Copeoglossum nigropunctatum* (Spix, 1825) | OE | 3.32 | LC/LC/LC | Collected |
| *Brasiliscincus heathi* (Schmidt & Inger, 1951) | OE | 0.83 | LC/LC/LC | Photographic record |
| **Sphaerodactylidae** |                   |                        |                                   |             |
| *Coleodactylus meridionalis* (Boulenger, 1888) | TCVS | 2.49 | LC/LC/LC | Photographic record |
| **Teiidae** |                   |                        |                                   |             |
| *Ameiva ameiva ameiva* (Linnaeus, 1758) | TCVS | 2.49 | LC/LC/LC | Photographic record |
| *Salvator merianae* Duméril & Bibron, 1839 | OE | 1.24 | LC/LC/LC | Photographic record |
| *Kentropyx calcarata* Spix, 1825 | TCVS/OE | 0.41 | LC/LC/LC | Photographic record |
| **Tropiduridae** |                   |                        |                                   |             |
| *Strobilurus torquatus* Wiegmann, 1834 ^AF | OE | 1.24 | VU/LC/LC | Collected |
| *Tropidurus hispidus* (Spix, 1825) | TCVS | 7.47 | LC/LC/LC | Collected |
| **Serpentes** |                   |                        |                                   |             |
| **Boidae** |                   |                        |                                   |             |
| *Boa constrictor* Linnaeus, 1758 | TPR | - | LC/LC/ not evaluated | Photographic record |
| *Epicrates assisi* Machado, 1945 | OE | 0.83 | LC/LC/ not evaluated | Photographic record |
| **Colubridae** |                   |                        |                                   |             |
| *Chironius flavolineatus* Jan, 1863 | OE | 0.41 | LC/LC/LC | Photographic record |
| *Dendrophidion atlantica* Freire, Caramaschi & Gonçalves, 2010 ^PEC | OE/TCVS | 1.66 | DD/DD/ not evaluated | Collected |
| *Echinanthera cephalomaculata* Di Bernardo, 1994 ^PEC | TPR | - | not evaluated /VU/ not evaluated | Photographic record |

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several ecological factors, which leads to a balance in the sharing of available resources or, in other words, less competition, which is a commonly observed pattern for tropical forests.

The richness estimators ICE and Jacknife II indicated that, in 102 days of sampling, we recorded between 90% and 96% of the maximum expected lizard richness and 53% of the maximum expected snake richness (without considering the three snake species obtained by third-party records). Curves that do not reach an asymptote (Figure 8) demonstrate a need for continued sampling (Gotelli & Colwell 2001), which is reinforced by the species recorded by the third-party records during and after the study. In addition, species richness is proportional to sampling effort (Melo et al. 2003), and so it would take a greater sampling effort to record the rest of the species, especially the snakes. Thus, the present list of species is an initial milestone in the study of reptiles of RVS Matas do Siriji.

The methods that contributed the most to determining richness and abundance in the present study were, respectively, occasional encounters and time-constrained visual searches (Table 1). The efficiency of these methods for registering reptiles has been reported in many studies in different biomes (Carvalho et al. 2005, Freitas & Silva 2007, Quintela et al. 2010, Roberto et al. 2017), including Pedrosa et al. (2014) who reported that such methods are better for sampling snakes. On the other hand, pitfall traps represented a less efficient method, especially for snakes. According to Cechin & Martins (2000), pitfall traps are less efficient in environments with high vertical structure, that is, forest environments in which many species have an arboreal habit. However, the importance of this method (How & Shine 1999, Henderson et al. 2016) in recording fossorial species, such as *Amerotyphlops arenensis* and *Dryadosaura nordestina* (Roberto et al. 2017), and especially lizards and snakes with active foraging, is undeniable.

The third-party records are also of paramount importance, as has been seen in the literature for snake inventories, due to its fortuitous character (Cunha & Nascimento 1978, Cechin & Martins 2000). Indeed, the voluntary contribution of residents of RVS Matas do Siriji to the present study led to the inclusion of three additional species of snakes (*Boa constrictor*, *Echinanthera cephalomaculata* and *Oxyrhopus petolarius digitalis*), one of which is considered VU according to ICMBio. These findings confirm the efficiency of using a combination of different methods to optimize the sampling of snakes (Caldas et al. 2016).

Although most of the species observed in the present study are considered Least Concern (LC) by SEMAS (2017) (27 species), ICMBio
(2018) (34 species) and IUCN (2020) (26 species), some considerations are needed with regard to species in the VU and DD categories, as well as the lack of evaluation for some species (Table 1):

The snake *Echinatephytus cephalomaculatus* is an endemic species of PEC, with its first record being at its type locality in the state of Alagoas (Di-Bernardo 1994, Roberto et al. 2015) and recent records for three locations in the state of Pernambuco (Freitas et al. 2019b). Its registration in RVS Matos do Siriri, therefore, expands its distribution 74 km to the north of its nearest record (municipality of Gravatá, state of Pernambuco). Since the expansion of its distribution to the state of Pernambuco was done after the publication of the SEMAS list, the absence of its ranking is justifiable; nonetheless it is in urgent need of evaluation, such as by IUCN. The other species of the genus, *E. cephalostriatata*, also recently had its distribution expanded in the state of Pernambuco (Dias et al. 2019), which was also its second record for PEC – the first record was made by Roberto et al. (2015), and was also not evaluated by SEMAS.

The snake species *Taeniophallus affinis* is also not listed by SEMAS due to the fact that its two records in the state of Pernambuco (Roberto et al. 2017) were published after (September and December, respectively) the list (May 2017). The snake *Xenodon rhabdocephalus rhabdocephalus* was not evaluated by SEMAS, although it had already been registered in Reserva Biológica Pedra Talhada (Roberto et al. 2015) located on the border between the states of Pernambuco and Alagoas. The recent expansion of its distribution to PEC (Andrade Lima et al. 2020) reveals sampling gaps in that region and makes the assessment of its extinction risk more accurate. Therefore, these two species need urgent evaluation by SEMAS. The arboreal lizard *Norops ortonii* was registered by Oliveira et al. (2016) in the state of Pernambuco prior to the publication of the SEMAS list but was not evaluated.

Although Fernandes et al. (2004), considered that there are no subspecies of *Lachesis muta* (*L. m. muta* and *L. m. rhombeata*), both the IUCN and SEMAS categorized *L. m. rhombeata* as VU, considering only the populations of the Atlantic Forest distributed from the state of Ceará to the south of the state of Rio de Janeiro (Campbell & Lamar 2004). Interestingly, this was the second most sighted species of snake within RVS Matos do Siriri, as it was for another location in the state of Pernambuco (Serra do Urubu; Roberto et al. 2017). The main reason for its classification as VU is habitat loss due to intense destruction of the Atlantic Forest (Alves et al. 2014), which is the reality for almost all fragments of the biome in Brazil, but especially those of PEC. Even if they are not considered subspecies, evaluation of the populations of the Atlantic Forest and the Amazon separately by ICMBio would more accurately represent the conservation status of the populations.

The snake *Amerotyphlops arenensis*, which only occurs in the states of Paraíba, Alagoas and Pernambuco (Graboski et al. 2015, Roberto et al. 2015, 2017), was recently described. This species has not been evaluated by any of the three consulted lists and needs to be urgently. The species was probably not on the SEMAS list because its first record for the state of Pernambuco (Roberto et al. 2017) was published four months after the publication of the list, although there was already a
record on the border between the states of Pernambuco and Alagoas.

It should be noted that the classification of DD (e.g. *Dendrophidion atlantica* and *Micrurus lemniscatus carvalhoi*) should not be taken as any less of a concern since little-known species may be at a higher degree of threat than VU or Endangered (EN) species. This is especially true for species with disjunct distributions and low densities and that are restricted to only one region, such as PEC, which, according to Ribeiro et al. (2009), retains about 12.1% of its original coverage, of which only 1% is protected.

The clear formation of two groups in the lizard dendrogram (Figure 10A) seems to reflect the phytophysiognomies of the localities: Group I with seasonal (dry) forests west of Planalto da Borborema, which, despite some of them having remnants of Atlantic Forest (montane forests), are inserted in the Caatinga biome and, thus, are strongly influenced by it; and Group II (in which RVS Matas do Siriji is inserted) with predominantly ombrophilous (humid) forests east of Planalto da Borborema, typical of Atlantic Forest, including other montane forests. Some studies involving plants (Santos et al. 2007, Rodal & Sales 2008, Rodal et al. 2008) and snakes (Pereira-Filho et al. 2020) as models, have demonstrated the division of montane forests into “wet” and “dry”, with Planalto da Borborema being indicated as responsible for the division.

We emphasize that the lizard composition of localities was more efficient at showing the formation of these groups of “wet” and “dry” forests than snake composition. This finding probably does not reflect a true random distribution of snakes, but instead the difficulty in their sampling.

In general, the lizard and snake composition of RVS Matas do Siriji was found to be similar to six other Atlantic Forest fragments of PEC (PEDI-PE, APPMB-PB, RM-AL, RPUPR-AL, MEC-AL and SU-PE), which are all east of Planalto da Borborema and share species frequently recorded in Atlantic Forest environments, such as *Dryodora occidentalis*, *Dactyloa punctata*, *Enyalius catenatus*, *Gymnodactylus darwini*, *Norops fascoua*, *Norops ortoni*, *Polychrus marmoratus*, *Strobilurus torquatus*, *Bothrops leucurus*, *Dendrophidion atlantica* and *Lachesis muta*. This finding may be a reflection of the proximity of RVS Matas do Siriji to these locations, as well as its phytophysiognomic similarity with the dense ombrophilous forests of these areas. On the other hand, the presence of seasonal montane forest (located in the center and northwest of the Caatinga; west of Planalto da Borborema) (AV-PE, SE-PE, BJ-PE, PEPJ-PB and CA-CE) in the two dendrograms, even while maintaining a lizard fauna more similar to those of the three areas of Caatinga (PNSC-PI, PNSCO-PI and PNCD-BA), demonstrates that the lizard and snake fauna of this type of montane forest (e.g., *Gymnodactylus geckoides*, *Spix, 1825*, *Hemidactylus brasilianus*, *Strobilurus nordestina*, *Dactyloa punctata*, *Enyalius catenatus*, *Gymnodactylus darwini*, *Norops fuscous*, *Norops oroton*, *Polychrus marmoratus*, *Strobilurus torquatus*, *Bothrops leucurus*, *Dendrophidion atlantica* and *Lachesis muta*). This finding may be a reflection of the proximity of RVS Matas do Siriji to these locations, as well as its phytophysiognomic similarity with the dense ombrophilous forests of these areas. On the other hand, the presence of seasonal montane forest (located in the center and northwest of the Caatinga; west of Planalto da Borborema) (AV-PE, SE-PE, BJ-PE, PEPJ-PB and CA-CE) in the two dendrograms, even while maintaining a lizard fauna more similar to those of the three areas of Caatinga (PNSC-PI, PNSCO-PI and PNCD-BA), demonstrates that the lizard and snake fauna of this type of montane forest (e.g., *Gymnodactylus geckoides*, *Spix, 1825*, *Hemidactylus brasilianus* (Amaral, 1935), *Lygodactylus klugei* (Smith, Martin & Swain, 1977), *Ameiva ocellifera* (Spix, 1825), *Phyllopezus politcaris* (Spix, 1825), *Psychosaura agmosticha* (Rodrigues, 2000), *Tropidurus semitaeniatus* (Spix, 1825), *Vanzosaura multiscutata* (Amaral, 1933), *Apostolepis cearensis* Gomes, 1915, *Boiruna sertaneja* Zaher, 1996, *Bothrops erythromelas* Amaral, 1923, *Epictia borapeliotes* (Vanzolini, 1996), *Thamnodynastes almacae* Franco & Ferreira, 2003 and *T. sertanejo* Bailey, Thomas & Silva-Jr, 2005) is strongly influenced by the Caatinga.
Figure 6. Snake species registered in Refúgio de Vida Silvestre Matas do Siriji, municipality of São Vicente Férrer, state of Pernambuco, Northeastern Brazil, between April 2018 and September 2019. (A) Philodryas olfersii (unvouchered), (B) Imantodes cenchous (unvouchered), (C) Oxyrhopus guibei (LHUFCG 2286, juvenile), (D) Oxyrhopus petularius digitalis (unvouchered), (E) Oxyrhopus trigeminus (CPH-UFRPE 5275), (F) Pseudoboa nigra (unvouchered), (G) Taeniocephalus affinis (LHUFCG 2271), (H) Xenodon rabdocephalus rabdocephalus (unvouchered).

Figure 7. Snake species registered in Refúgio de Vida Silvestre Matas do Siriji, municipality of São Vicente Férrer, state of Pernambuco, Northeastern Brazil, between April 2018 and September 2019. (A) Micrurus lemniscatus carvalhoi (unvouchered), (B) Amerotyphlops arenensis (LHUFCG 2265), (C) Bothrops leucurus (LHUFCG 2368), (D) Lachesis muta (unvouchered).

Figure 8. Rarefaction curves (red) with its standard deviation (dashed lines) and ICE (light grey) and Jacknife II (dark grey) curves for lizards (A) and snakes (B) registered in Refúgio de Vida Silvestre Matas do Siriji, municipality of São Vicente Férrer, state of Pernambuco, Northeastern Brazil, between April 2018 and September 2019.

Figure 9. Abundance distribution for species of lizards and snakes registered in Refúgio de Vida Silvestre Matas do Siriji, municipality of São Vicente Ferrer, state of Pernambuco, Northeastern Brazil, between April 2018 and September 2019. Bars = relative frequency, line = relative abundance. The diagram fits the log-normal model ($X^2 = 2.907; p = 0.234$).

Although it is part of PEC, some authors (Pôrto et al. 2004, Ferraz & Rodal 2006, Santos et al. 2007) consider RVS Matas do Siriji to be a “Brejo de Altitude” (“Brejo Nordestino”) — another biogeographic subunit of the Atlantic Forest located north of Rio São Francisco — being a mosaic of phytosociomomies with minimal influence from the Caatinga biome on its northwest side and stronger influence by the Atlantic Forest to the south-southeast, including being considered a “área de tensão ecológica” (Caatinga – Atlantic Forest ecotone) (Santos & Tabarelli 2004). The literature argues that “Brejos de Altitude” are places where fauna from the Caatinga and Atlantic Forest can coexist (e.g., Borges-Nojosa & Caramaschi 2003, Pereira-Filho & Montingelli 2011, Ribeiro et al. 2012, Castro et al. 2019, Freitas et al. 2019). Only four (9.30%) typical Caatinga species (Brasiliscincus heathi, Hemidactylus agrius, Polychrus acutirostris and Philodryas nattereri) were recorded in RVS Matas do Siriji demonstrating that “Brejos de Altitude” possess different compositions throughout their distribution (e. g. Ribeiro et al. 2012, Roberto et al. 2015, Roberto et al. 2017; Castro et al. 2019, Freitas et al. 2019), with strong or weak influences from the Caatinga.
models for understanding the remote relationships between the Amazon and Atlantic Forest and, more recently, between the Atlantic Forest and the Caatinga in the biogeographic regions of PEC and “Brejos de Altitude” (montane forests) (e.g. Rodrigues et al. 2014; Prates et al. 2018). However, it is known that many areas in these regions have yet to be sampled (Borges-Nojosa & Arzabe 2005, Roberto et al. 2017), making the need to inventory these places urgent, not only for biogeographic reasons but especially for the conservation of existing biodiversity.

In general, the squamate fauna of RVS Matas do Siriji possesses typical elements of the Northeastern Atlantic Forest, with species that only occur in the PEC, and is even similar to Parque Estadual de Dois Irmãos (Santos et al. 2017). Thus, RVS Matas do Siriji reaffirms the capacity of PEC to harbor high endemism of several groups, with Squamata being no exception. Additionally, RVS Matas do Siriji possesses endangered species (Lima et al. 2020) and species with few recent records for Pernambuco (Dias et al. 2019a, 2019b; Freitas et al. 2019b), including five species that are not included in the list of species for the state (SEMAS 2017), highlighting the need to update the list to include such species mainly for the assessment of their conservation status. Although RVS Matas do Siriji has been a full protection Conservation Unit since 2014 and identified as a priority conservation area in PEC for 20 years (MMA 2000), it still suffers from the removal of vegetation, giving way to vast monocultures of sugarcane and bananas. Therefore, RVS Matas do Siriji is home to a rich, threatened and underestimated reptile fauna, and still contributes abundantly to the maintenance of biodiversity, not only of PEC, but the Atlantic Forest as a whole, reasons that call for the protection of this neglected Conservation Unit.

Supplementary Material

The following online material is available for this article:
Appendix

Acknowledgments

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Author Contributions

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Emerson Gonçalves Dias: data acquisition and the design of the manuscript.
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Erica Suzan Martins Lima: data acquisition and the design of the manuscript.
Edmilza Maranhão dos Santos: data analysis and interpretation, writing the manuscript, and critical review with the addition of intellectual content; data acquisition and the design of the manuscript.
Marcelo Nogueira de Carvalho Kokubum: data analysis and interpretation, writing the manuscript, and critical review with the addition of intellectual content; data acquisition and the design of the manuscript.

Conflicts of Interest

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

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