ETHNOBIOLOGY AND CONSERVATION

RESEARCH ARTICLE

Ethnobiology and Conservation, 10:38 (23 November 2021)
doi:10.15451/ec2021-11-10.38-1-48
ISSN 2238-4782 ethnobioconservation.com

The snake fauna of the most threatened region of the Atlantic Forest: natural history, distribution, species richness and a complement to the Atlas of Brazilian Snakes

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ABSTRACT

The Atlantic Forest is one of the richest tropical forests in the world, with a high endemism rate of vertebrates, including several snakes. The snake fauna of the Atlantic Forest is rich and complex, presenting differences in fauna composition along its extension. The existence of at least four endemism centers along this forest is well documented and supported by data of vertebrates, invertebrates and plants. The Pernambuco Endemism Center (PEC) is the most septentrional region of the Atlantic Forest, and it contacts areas with transitional forests and arid landscapes (Caatinga) which along with altitudinal variation enable a unique snake fauna for this region. In this study we provide: (i) an updated list of species, detailed information about natural history, as well as a detailed geographic distribution for all species recorded in the PEC; (ii) a comparison between the snake fauna of the PEC with other regions of the Atlantic Forest. The snake fauna of the PEC is composed by 86 species of 8 families. The results showed that most of the species recorded in the PEC are distributed close to the coast, probably due to the proximity of the research centers, but also due to the present distribution of the remnants close to the coast. The forest remnants in the highlands (*Brejos de Altitude*) harbors a high diversity of species with high similarity with the coastal forests. We found a strong separation between the snake fauna of assemblages located in southwestern and northeastern Brazil, indicating clear characteristics of the snake fauna of the PEC.

Keywords: Conservation; Diversity; Pernambuco Endemism Center; Ophidians; NMDS.

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SIGNIFICANCE STATEMENT

We highlight the distribution, natural history and fauna composition of the most threatened portion of the Atlantic Forest. We provide original data about distribution and natural history of many species, and finally we emphasize the singular characteristics of the snake fauna of the Pernambuco Endemism Center.

INTRODUCTION

The Atlantic Forest (AF) is one of the world biodiversity hotspots extending over 1.5 million km^2 from northeastern to south Brazil, from the states of Rio Grande do Norte to Rio Grande do Sul (Coimbra-Filho and Câmara 1996). It presents heterogeneous physiognomies in which ca. 20,000 species of plants, 2,420 species of terrestrial vertebrates and thousands of invertebrate species inhabit, many of them locally or regionally endemic (Myers et al. 2000). Since Brazil was colonized, the Atlantic Forest has become home for more than 125 million Brazilians, including the largest urban centers of South America (Coimbra-Filho and Câmara 1996). The urbanization, industrialization, and agricultural expansion during the last five centuries led to a loss of more than 93% of the original AF vegetation (Tabarelli et al. 2005), which is now reduced to archipelagos of small forest fragments surrounded by open areas (Joly et al. 2014; Morellato and Haddad 2000). As a consequence of this destruction, about 60% of the threatened species of both flora and fauna of Brazil dwell in this region (Martinelli and Morais 2013). Thus, efforts to better know the biodiversity and to maximize conservation strategies in the AF are crucial to safeguard its unique biodiversity and evolutionary history among tropical forests (Joly et al. 2014).

Understanding which mechanisms explain the high diversity and endemism found in the high diverse areas, such as AF, is a challenge for many researchers and has been a target until nowadays. Taxonomic studies and species distribution data enable identifying distribution patterns of species and to infer historical processes which determined the distribution patterns found, as well as to raise hypotheses about the evolutionary history of this important tropical forest (Pinto-da-Rocha et al. 2005). However, gaps in the basic knowledge about species composition and geographic distribution of several groups hamper the progress to answer important issues about origin and diversification of the AF biota.

Snakes are poorly known among the terrestrial vertebrates of the Atlantic Forest (Pereira-Filho et al. 2017), and the lack of data increases in north direction to northern portion (Pereira-Filho et al. 2017; Guedes et al. 2018) even despite recent studies (Pires et al. 2014; Graboski et al. 2015; Rodrigues et al. 2015; Pereira-Filho et al. 2017; Pereira-Filho et al. 2020; França et al. 2020). The data available to these northern areas of the AF show that the snake fauna is not similar to south areas of the AF. It is composed by species shared with Cerrado and Caatinga, forested species presenting disjoint distribution between Atlantic and Amazon forests, and by some endemic species exclusive to this portion (Marques et al. 2001; Guedes et al. 2011, 2014; Pereira-Filho et al. 2017). The distinctiveness of the snake fauna of the north portion of the AF is supported by biogeographical studies of birds, haverstmens, and bamboos that recognize this portion as the Pernambuco Endemism Center (PEC; Silva et al. 2004; Pinto-da-Rocha et al. 2005), or even a distinct ecoregion of the Atlantic Forest (Olson et al. 2001).

Studies on fauna composition are urgent due to habitat losses and climate change (Antonelli et al. 2018). Areas identified as centers of endemism hold biota which tell us about their complex evolutionary history that explain such extraordinary biodiversity (Guedes et al. 2020). In this study, we provide: (i) an updated list of species, detailed information about natural history as well as a detailed geographic distribution for all species recorded in the PEC; and (ii) a comparison between the snake fauna of the PEC with other regions of the Atlantic Forest.

MATERIAL AND METHODS

Study area

The Pernambuco Endemism Center (PEC) is located in the north of the Atlantic Forest (5°00'00" and 10°30'00"S and 34°5'00" and 37°12'00"W), extending from the states of Alagoas to Rio Grande do Norte, encompassing lowland forests and also inland altitudinal forests known as "*Brejos de Altitude*" or "*Brejos Nordestinos*" (Andrade-Lima 1982; Santos et al. 2007; Pereira-Filho and Montingelli 2011; Pereira-Filho et al. 2020) (Figure 1). This specific portion of the AF presents special characteristics such as an evident contact zone with the Caatinga (seasonal semi-arid dry forest) and the presence of altitudinal

moist forests (Brejos de Altitude). The PEC currently presents five types of lowland forest: Restinga, divided in open Restinga and Restinga Forest; Tabuleiros, specifically Tabuleiro Forests; Submontane Tropical Moist Forests; and Montane Tropical Moist Forests (Thomas and Barbosa 2008) (Figure 2). We also added data from transitional forests between Atlantic Forest and Caatinga, since these areas are related to *brejos de altitude*.

Despite discussions about a subdivision of the PEC in lowland forest (coastal forests) and altitudinal forests (*Brejos de Altitude*) are still undergoing (Santos et al. 2007), we opted to add the inland altitudinal forests since these areas present typical Atlantic Forest vegetation and harbor a very similar snake fauna to the coastal fragments (Pereira-Filho et al. 2020).

The climate is tropical moist with the rainy season from March to August and the dry season to September to February in the coastal zones; the rainy season in some inland forests (the ones located west of the Borborema plateau) is from January to May, with all other months representing the dry season (typical hydric system of the Caatinga) (RadamBrasil 1983).

Data source

We created a database composed of 729 snake specimens housed in three herpetological collections: the Herpetological Collection of Universidade Federal da Paraíba (*CHUFPB*), the Coleção Herpetológica e Paleoherpetológica da UFRPE (*CHP-UFRPE*) and the Herpetological Collection of the Zoology Museum of the Universidade de São Paulo (*MZUSP*). Although the material housed in these three collections were the main sources of our database, we complemented it with data from the herpetological collection of the Universidade Federal de Alagoas (*MUFAL*) and from literature (Pereira-Filho and Montingelli 2011 Guedes et al. 2014; Roberto et al. 2015 Roberto et al. 2017; Pereira-Filho et al. 2017; Mesquita et al. 2018; Freitas et al. 2019; Pereira-Filho et al. 2020; França et al. 2020). We also added information of exemplars observed in nature but not collected. Despite the numerous literature records used in our data base, the main source was the Atlas of Brazilian Snakes, as this study approaches all the snakes found in the PEC, thus almost all the black points in Figure 1 were extracted from this research source (Nogueira et al. 2019).

Geographic distribution

We obtained data on geographic distribution by georeferencing locality data associated with each specimen verified in the herpetological collections and mentioned in the literature from published gazetteers (i.e. NGA 2019). Georeferencing locality data was also obtained for each specimen observed and photographed in the field (exact observation point). Additionally, original locality data mentioned in the literature were maintained in order to draw the distribution maps (e.g., from Guedes et al. 2014; Freitas et al. 2019; Nogueira et al. 2019; Lima et al. 2021) for each species. All maps were drawn using the QGIS version 2.18.19 software program (QGIS Core Team 2018).

Non-Metric Multidimensional Scaling (NMDS)

We performed a Non-Metric Multidimensional Scaling (NMDS) analysis with data from a reliable species list of 31 snakes assemblages in order to evaluate the relationship of the PEC snake fauna with the different regions of the Atlantic Forest, as follows: Vera Cruz (Franco et al. 1998), São Francisco de Paula (Di-Bernardo 1998), Santa Maria (Cechin 1999), Tapirai (Condez et al. 2009), Murici (Freire 2001), Ilhéus (Argôlo 2004), Passo Fundo (Zanela and Cechin 2006), Ouro Branco (Pedro and Pires 2009), Serra do Mendanha (Pontes and Rocha 2008), Picinguaba (Hartmann et al. 2009), Santa Virginia (Hartmann et al. 2009), Sete Barras (Fiorillo et al. 2020), Duque de Caxias (Salles and Silva 2010), Viçosa (Costa et al. 2010), Juréia (Marques and Sazima 2004), Carlos Botelho (Forlani et al. 2010), Vitoria (Silva-Soares et al. 2011), Paranapiacaba (Trevini et al. 2014), Pedra Talhada (Roberto et al. 2015), Serra do Urubu (Roberto et al. 2017), João Pessoa, Guaribas, Santa Rita, Cruz do Espirito Santo and Areia (Pereira-Filho et al. 2017), ArcoVerde, Sertânea, Belo Jardim (Freitas et al. 2019) Alagoa Grande, Alagoinha, Serra dos Cavalos (unpublished data). Taxonomic arrangements followed Costa and Bernils (2018); Zaher et al. (2009) and Grazziotin et al. (2012). We used the metaMDS function (arguments k=1, distance="bray", trymax=1000) of the Vegan package in the R v3.6.3 software program.

RESULTS AND DISCUSSION

Natural History

The information presented in this section comes from literature and field observations in many forest remnants in the PEC. Some observations for many species are punctual and describe some events rarely seen in nature. We also present some of the environments where some species are found (Figures 3, 4 and 5). In the end of the section we present plates of 83 species of the 86 recorded from the PEC with specific localities in parentheses (Figures 6 – 16).

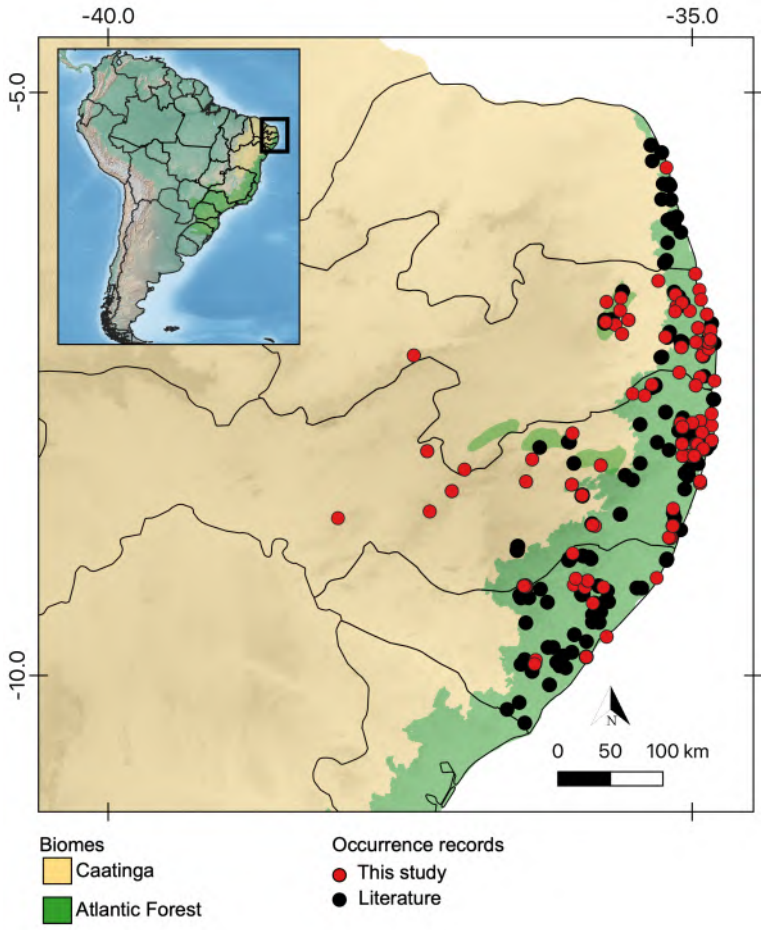

Figure 1. Map showing aspects of the Pernambuco Endemism Center with the occurrence records of snake species. (A) The total area compassing the states of Alagoas, Pernambuco, Paraíba and Rio Grande do Norte, showing the point records of snakes in the study area. (B) The distribution of protected areas. (C) The Atlantic Forest remnants (MapBiomas 2011-2012).

Typhlopidae Merrem, 1820

Amerotyphlops amoipira Rodrigues & Juncá, 2002

The only record of *A. amoipira* in the PEC area is from the Restinga of Barra de São Miguel, a coastal ecosystem in state of Alagoas. Restingas are ecosystems associated to the Atlantic Forest, thus the inclusion of this record is correct and very important, since according to Rodrigues and Juncá (2003), this species was considered endemic to a specific region of the Caatinga (sandy dunes of Middle São Francisco River, northeastern Brazil). According to Guedes et al. (2014), this species is nocturnal and fossorial, feeding on insects. There are two other records of *A. amoipira* for the coastal sandy dunes of Rio Grande do Norte, although we were not able to confirm the identification of the record and thus we did not consider this record in our database.

Amerotypholps arenensis Graboski, Pereira-Filho, Silva, Prudente & Zaher, 2015

Originally described in a *Brejo de Altitude* in Areia, Paraíba (Pau Ferro state park) (Graboski et al. 2015), there is a second record of the Pedra Talhada Biological Reserve (between Pernambuco and Alagoas states) (Roberto et al. 2015). The species was also recorded in the Atlantic Forest of Brejo dos Cavalos, 850 m above sea level in Caruaru (Pernambuco). Furthermore, one last citing was recorded for the municipality of Alagoa Grande (another Brejo de Altitude), close to the type locality. This species was also recently recorded in Caatinga dry areas (Graboski et al. 2018). *A. arenensis* is a common species in the type locality, with more than 19 exemplars collected.

Almost all individuals were collected by pitfall traps, although one individual was seen active during the day on the forest floor after heavy rains (pers. obs).

Amerotyphlops brogersmianus (Vanzolini, 1976)

This species is widely distributed in the Pernambuco Endemism Center, with records in the Atlantic Forest of Alagoas, Pernambuco and Paraíba; however, it was not recorded in the *Brejos de Altitude* of the PEC (Pereira-Filho et al. 2020). It is a very common species in some Atlantic Forest fragments in Paraíba such as, Usina São João Forest, Gargau Forest and Guaribas Biological Reserve (Pereira-Filho et al. 2017; Mesquita et al. 2018). Little data about natural history are available for *A. brongersmianus*, and the species was observed active during the day on the forest floor in an Atlantic Forest fragment (Buraquinho Forest, João Pessoa, Paraíba state), while a second exemplar was found buried in a sandy soil in the same locality.

Amerotyphlops paucisquamus (Dixon & Hendricks, 1979)

A. paucisquamus is an endemic species of the Atlantic Forest. According to Graboski et al. (2015) and Pereira-Filho et al. (2017), this species is distributed in the states of Alagoas, Pernambuco, Paraíba, and Rio Grande do Norte. Like the other Scolecophidians recorded in the PEC, there is little information about the natural history of *A. paucisquamus*. This species is sympatric with *A. brongersmianus* in all its distribution in the PEC, although it is not sympatric with *A. arenensis* in some fragments.

Leptotyphlopidae Stejneger, 1892

Epictia borapeliotes (Vanzolini, 1996)

Epictia borapeliotes is a fossorial species, commonly found in Atlantic Forest areas in the Pernambuco Endemism Center and even in the dry Caatinga (Pereira-Filho et al. 2017). However, there is little

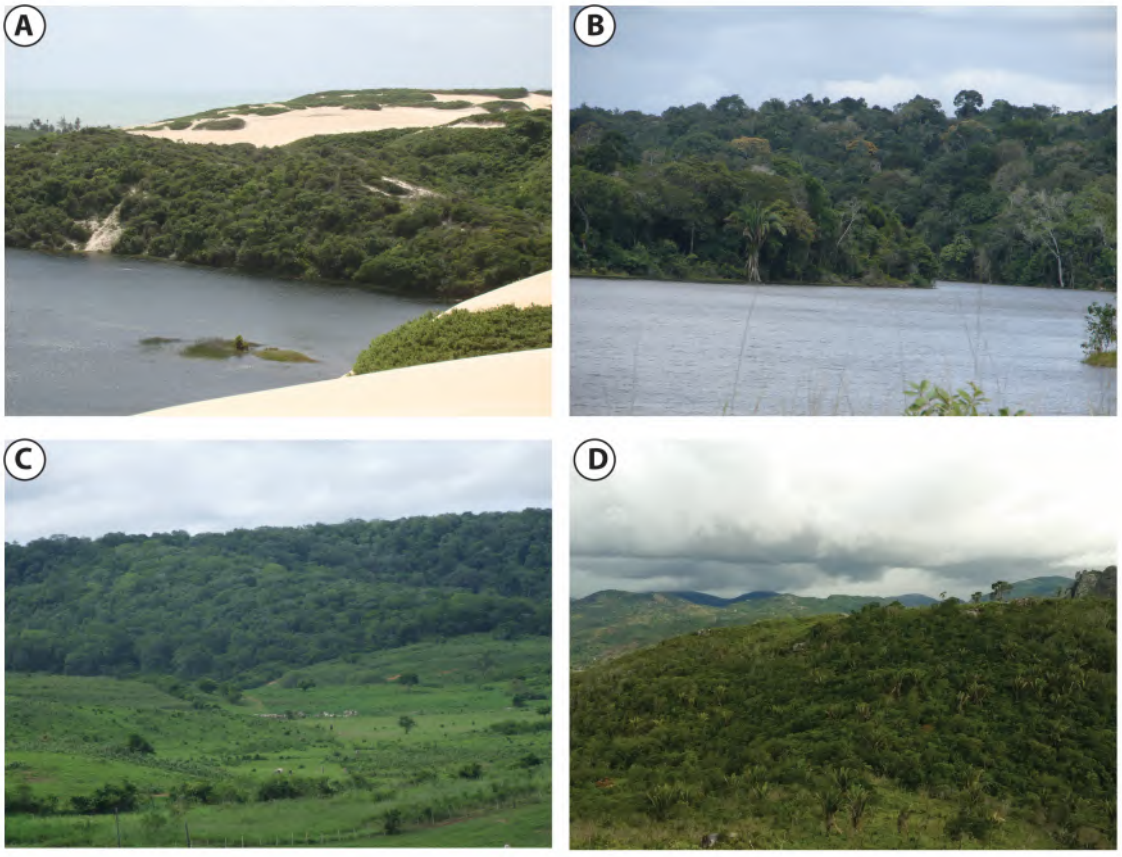

Figure 2. Phytophysiognomies of the Pernambuco Endemism Center: (A) Restinga (Genipabu, Rio Grande do Norte); (B) Coastal Tabuleiro Forest (Cruz do Espírito Santo, Paraíba); (C) Transitional Forest between Atlantic Forest and Caatinga (Alagoinha, Paraíba); and (C) Montane Forest (Belo Jardim, Pernambuco). Photos: A and D (Marco Freitas), B and C (Gentil Filho).

information about its natural history. According to Guedes et al. (2014), it is a nocturnal species which feeds on arthropods. This species can be found within forest fragments, but also in urban areas. Pereira-Filho et al. (2017) found specimens in the city of João Pessoa, Paraíba state. Two specimens were recorded in the city of Caruaru, Pernambuco state.

Trilepida salgueiroi (Amaral, 1955)

There is only one record of *T. salgueiroi* in the Pernambuco Endemism Center. One specimen was found dead being eating by ants in a well-preserved Atlantic Forest fragment above 500 meters (Murici Ecological State, state of Alagoas). There is no information about the natural history of *T. salgueiroi*, although according to Marques et al. (2017), other species of the genus such as *T. brasiliensis* and *T. koppesi* present nocturnal activity, fossorial habits and feed on arthropods. These are probably the same habits of *T. salgueiroi*.

Anomalepididae Taylor, 1939

Liotyphlops trefauti Freire, Caramaschi & Argôlo, 2007

Little information is available about this rare species. L. trefauti is originally known to the states of Bahia and Alagoas (Freire et al. 2007), and after 10 years, new records were obtained for areas in Pernambuco state (Abegg et al. 2017). The only data about the natural history of *L. trefauti* are related to habitat and activity. The holotype was collected at 12:30 inside thick and moist litter around the trunk of a large tree in the forest. The paratype was collected at 10:00 also in thick and moist litter (Freire et al. 2007). A third specimen was seen inside an ant nest of the genus *Acromyrmex* (Hymenoptera, Formicidae) (Freire et al. 2007).

Boidae Gray, 1825

Boa constrictor Linnaeus, 1758

Boa constrictor presents wide distribution in the PEC. It has records in Alagoas, Pernambuco, Paraíba and Rio Grande do Norte (Nogueira et al. 2019). This species can apparently be found in well preserved forests, secondary forests, pastures and even in urban areas of large cities like Recife and João Pessoa (Pernambuco and Paraíba states respectively).

Corallus hortulanus (linnaeus, 1758)

C. hortulanus has been recorded in Alagoas, Pernambuco, Paraíba and Rio Grande do Norte (Nogueira et al. 2019), despite its wide distribution in the PEC, there are few records in this large area. The only record available in Paraíba state is for the Gargau Forest, Santa Rita Municipality. In Pernambuco state there are records for Gurjau, Tapacurá, Caete and Frei Caneca. One individual was found dead in Ibateguara in Alagoas state at 500 meters above sea level.

Epicrates assisi Machado, 1945

This species presents high adaptability to several environments. Our records show specimens found in altitudes from sea level to above 850m (Bezerros municipality, Pernambuco state). *E. assisi* can inhabit pastures, secondary forests, and also urban areas of large cities such as Recife and João Pessoa. This species is terrestrial/arboreal and feeds on small mammals and birds. Our records indicate diurnal/nocturnal activity (Pereira-Filho et al. 2017; Guedes et al. 2014).

Epicrates cenchria (Linnaeus, 1758)

This is a rare species with disjunct distribution between the Amazon and Atlantic Forests. There are only few records in the PEC in Pernambuco and Alagoas. We do not have data about the natural history of *E. cenchria*, although according to Marques et al. (2019), this species is nocturnal and terrestrial with a diet based on vertebrates like rodents and birds. The records in Pernambuco (Ipojuca, Recife and Nazaré da Mata) are the northernmost records in the Atlantic Forest.

Viperidae Oppel, 1811

Bothrops bilineata (Wiedi-Neuwiedi, 1821)

There are few records of *B. bilineata* in the PEC forests. Most of them come from Murici Ecological Station in Alagoas. Four individuals were observed in small shrubs within well preserved forest. Others records come from Pernambuco state in coastal forest fragments such as Água Azul and Frei Caneca forests (Timbauba and Jaqueira municipalities respectively). The records from Pernambuco state are the northernmost in the Atlantic Forest. This species is nocturnal, arboreal and feeds on small vertebrates like rodents and frogs (Marques et al. 2004). This species occurs in forest environments within well preserved

forest remnants and is probably a forest dependent species.

Bothrops erythromelas Amaral, 1923

According to Guedes et al. (2014), this species is endemic to the Caatinga biome. However, Freitas et al. (2019) and Pereira-Filho et al. (2020) recorded this snake in the *Brejos de Altitude* in Pernambuco state. The presence of *B. erythromelas* in *Brejos de Altitude* areas is probably due to the proximity of the *Brejos* to the Caatinga. This species is nocturnal and terrestrial, feeding on lizards and frogs (Guedes et al. 2014).

Bothrops leucurus Wagler in Spix, 1824

This the most common species of the genus Botrops in the PEC forests. *B. leucurus* can be found in a variety of environments such as well-preserved forests, secondary forests, agricultural landscapes or even within large cities (Pereira-Filho et al. 2017). This species is endemic to the Atlantic Forest with distribution from Espirito Santo to Rio Grande do Norte state (Campbell and Lamar 2004) in coastal and inland fragments with altitude varying from sea level to 900 meters. This species presents nocturnal activity, feeding on small vertebrates (Marques et al. 2019).

Bothrops muriciensis Ferrarezzi & Freire, 2001

This species is only known in the Murici Ecological Station in Alagoas (type locality). According to Freitas et al. (2012), this species requires well-preserved forests and inhabits the forest leaf litter. Two juveniles were found closer to a stream inside the forest, two adult females were found resting in the leaf litter, and one of these females remained in the same place for 22 days. One adult male was found coiled on a trail during the day. According to Campbell and Lamar (2004) and Marques et al. (2019), this species is terrestrial with diurnal/nocturnal activity feeding on small vertebrates.

Crotalus durissus (Linnaeus, 1758)

C. durissus is widely distributed in the PEC, with records in the coastal fragments, but also in *Brejos de Altitude* (Pereira Filho et al. 2017; Pereira Filho et al. 2020). Our primary data shows that this species inhabits the Atlantic Forest at sea level up to 900 meters of altitude, but also occurs in pastures or even in urban areas of large cities. Our records show nocturnal activity and rodents as prey, confirming the information of Guedes et al. (2014).

Lachesis muta (Linnaeus, 1758)

Lachesis muta is well distributed in the PEC forests, although there are no records for this species in the state of Rio Grande do Norte (Pereira-Filho et al. 2020) despite Campbell and Lamar (2004) confirming the species to the state. Pereira-Filho et al. (2020) present 22 records for *L. muta* in PEC, specifically 6 records to Paraíba state, 9 to Pernambuco and 7 to Alagoas. Herein we present another 5 records for Pernambuco (Figure 19). Our records indicate nocturnal activity with one adult female activity at night in the city of Ibateguara (Alagoas state) after heavy rains in a forest at 400 meters above sea level.

Elapidae Boie, 1827

Micrurus aff. *ibiboboca*

This is the most common Coral Snake in the Atlantic Forest of CEP. This species presents wide distribution, inhabits coastal forests and also inland forests (*Brejos de Altitude*), with altitudes varying from 550 to 630 meters above sea level (Pereira-Filho et al. 2020). This species presents diurnal/nocturnal activity and feeds on snakes and amphisbaenians. This is species is apparently not found in the semi-arid region (Caatinga dry forest), but the exceptions are the contact zones between the Atlantic Forest and the Caatinga.

Micrurus corallinus (Merrem, 1820)

We do not have any primary data about the natural history of *M. corallines*; actually, this species is only mentioned for the PEC region by Freire (2001), who recorded the species in the state of Rio Grande do Norte, and by Silva Jr. et al. (2016), who also mention the species being found in Rio Grande do Norte, but also provide a record for Alagoas. According to Silva Jr. et al. (2016), this species is widely distributed in the Atlantic Forest from Santa Catarina to Rio Grande do Norte state. According to Marques et al. (2019), this species is diurnal, subterraneous and feeds on snakes and amphisbaenians.

Micrurus ibiboboca (Merrem, 1820)

This species and *Micrurus* aff. *ibiboboca* present a complex taxonomic status, with *Micrurus* aff. *ibiboboca* commonly named *Micrurus ibiboboca* in most of its distribution. However, *Micrurus ibiboboca* described by Merrem in 1820 was not recorded in the Atlantic Forest of the PEC, even with the examination of

Figure 3. Well-preserved primary forest in Murici Ecological Station in Alagoas State. Habitat of the species *Bothrops muriciensis*, *Bothrops bilineata* and *Lachesis muta*.

a large number of *Micrurus* sp. in our database. The distribution map of Nogueira et al. (2019) presents many records of *Micrurus ibiboboca* for Pernambuco and Paraíba states, but from our viewpoint those records should be assigned to *Micrurus* aff. *ibiboboca* on the coast and to *Micrurus* sp. in the semi-arid region. According to Pereira-Filho et al. (2017), this species is nocturnal/diurnal and feeds on amphisbaenians.

Micrurus lemniscatus (Linnaeus, 1758)

This species is mentioned in the PEC by Silva Jr. et al. (2016), with records in Paraíba, Pernambuco and Alagoas states. However, we were not able to confirm all of the mentioned records. We recorded *M. lemniscatus* in the PEC region recently in January 2019, with one individual recorded in the city of Maragogi in Alagoas state. All the other records made by Silva Jr. et al. (2016) and Nogueira et al. (2019) deserve special attention due to possible iden-

tification problems. This is certainly the rarest Coral snake found in the PEC and no data about its natural history is available in this region.

Micrurus potyguara Pires, Silva -Jr., Feitosa, Prudente, Pereira-Filho & Zaher, 2014

This species is endemic to the PEC, with records in Rio Grande do Norte, Paraíba and Pernambuco states (Pires et al. 2014). This coral snake inhabits coastal fragments and was not recorded in inland forests. *M. potyguara* presents diurnal/nocturnal activity and fossorial habits (Pereira-Filho et al. 2017).

Micrurus sp.

This species inhabits the Caatinga dry forest in most of its distribution, although it can also be found in the *Brejos de Altitude* forests (Pereira-Filho et al. 2017; Pereira-Filho et al. 2020). Like the other species of Coral snakes, it also presents diurnal/nocturnal activity and feeds on snakes and amphisbaenians (Pereira-Filho et al. 2017). This species is probably endemic to the Caatinga dry forests (Guedes et al. 2014).

Colubridae Opell, 1811

Chironius bicarinatus (Wied-Neuwiedi, 1820)

There are only two records of *C. bicarinatus* in the PEC region. According to Nogueira et al. (2019), the species occurs in Paraíba state, and according to Roberto et al. (2015), it also occurs in the Pedra Talhada Biological Reserve (Pernambuco/Alagoas states). We were not able to find any other record of this species for the PEC forests. According to Marques et al. (2004), it is arboreal and terrestrial, with diurnal activity and a diet based on frogs.

Chironius carinatus (Linnaeus, 1758)

There are few published records of *C. carinatus* in the PEC forests. According to Araujo et al. (2019) and Nogueira et al. (2019), there are only 7 records of this species in the whole PEC. The northernmost point is one recorded by Araujo et al. (2019) for the municipality of Santa Rita in Paraíba state. According to our primary data, this species can inhabit dense forests and pastures. It apparently prefers to inhabit areas with water bodies like small rivers and streams. An adult female in Murici Ecological Station remained in the same place for one week. Marques et al. (2019) presented some defensive behaviors of *C. carinatus* such as expanding its gular region and biting. On two occasions our data show that this species seems to utilize small streams and rivers to avoid predators, diving directly into these water bodies when disturbed. Both records were made in the Murici Ecological Station during the day with individuals found within dense forest. This species is diurnal, arboreal and terrestrial and primarily feeds on frogs (Marques et al. 2019).

Chironius exoletus (Linnaeus, 1758)

According to Dixon et al. (1993), Pereira-Filho et al. (2017) and Nogueira et al. (2019), this species has its distribution associated with forests. *C. exoletus* is not common in the Atlantic Forest of the PEC, and there are few records for the area (only five) (Nogueira et al. 2019). Primary data show that *C. exoletus* inhabits forests at sea level until 850 meters of altitude (Serra dos Cavalos, Pernambuco state). According to Pereira-Filho et al. (2017), this species is diurnal, arboreal and terrestrial, and feeds on frogs.

Chironius flavolineatus (Jan, 1836)

This is the most common species of the genus in the entire PEC, inhabiting coastal and inland fragments, transitional zones between Atlantic Forest and Caatinga and even urban areas (Pereira-Filho et al. 2017; Pereira-Filho et al. 2020). Nogueira et al. (2019) presented only 7 records for the PEC region, although this species is widely distributed in the area (see map). This species inhabits dense forests but also regions with pastures. *C. flavolineatus* presents diurnal activity and a diet based on lizards and frogs (Marques et al. 2019)

Dendrophidion atlantica Freire, Caramaschi & Gonçalves, 2010

Dendrophidion atlantica is a rare snake in the PEC forests with only seven records for the whole area. Our primary data shows another three occurrence points in Paraíba and Pernambuco states (see map). Two individuals were observed in Murici Ecological Station, in the dense forest during the day. Both were on the forest floor and remained immobile when they were seen. According to Marques et al. (2019), this species is diurnal and terrestrial with a diet based on frogs.

Drymarchon corais (Boie, 1827)

This species is widely distributed in the PEC with many records in Alagoas, Pernambuco, Paraíba and

Rio Grande do Norte (Nogueira et al. 2019). Our primary data indicates that this species is diurnal and terrestrial, with observations of two individuals in Atlantic Forest fragments in Paraíba state. According to Marques et al. (2019), this species is terrestrial, feeding small vertebrates like frogs and lizards.

Drymoluber brazili (Gomes, 1918)

The inclusion of *Drymoluber brazili* in our database was due to an exemplar collected from Pico do Jabre, a *Brejo de Altitude* in the municipality of Matureia in 1978. A new exemplar has recently been recorded in the same region, although the exemplar from Pico do Jabre is the only one known for the Brejos de Altitude. There are also records of *D. brazili* in the municipality of Cajazeiras (pers. obs) in the Caatinga biome. This species is rare in nature and little data about its natural history is available. According to Marques et al. (2017), this species is diurnal feeding on lizards and frogs.

Drymoluber dichrous (Peters, 1863)

This species is found in coastal Atlantic Forest, but also in the *Brejos de Altitude*, with records at sea level up to 850 meters of altitude (Brejo of Serra dos Cavalos, Pernambuco state). Nogueira et al. (2019) presented only four records for the whole PEC region, although *Drymoluber dichrous* is widely distributed in the forest fragments of the region (Pereira-Filho et al. 2017). This species is diurnal and terrestrial, feeding on frogs and lizards (Pereira-Filho et al. 2017; Marques et al. 2019).

Leptophis ahaetulla (Linnaeus, 1758)

This snake is widely distributed in the PEC forests, with some records in Paraíba and Pernambuco. Nogueira et al. (2019) only presented a few records for the region. *L. ahaetulla* is diurnal, terrestrial and arboreal, with a diet based on small vertebrates (Marques et al. 2005; Pereira-Filho et al. 2017; Marques et al. 2020).

Oxybelis aeneus (Wagler, 1824)

This species is distributed in the whole region of the PEC, but most of the records in northeastern Brazil are in the Caatinga (Nogueira et al., 2019). However, it is a common species in coastal fragments and also in the *Brejos de Altitude* (Pereira-Filho et al. 2017). Our primary data indicates diurnal activity and utilization of arboreal stratus with 2 meters of altitude (Murici Ecological Station). This species is diurnal and arboreal, feeding on lizards, birds and frogs (Marques et al. 2005; Marques et al. 2019).

Paluspohis bifossatus (Raddi, 1820)

There are only five records for *P. bifossatus* in the PEC region. Most of the records are for coastal Atlantic Forest in Paraíba state. Some of the records were made in transitional forests between Atlantic Forest and Caatinga (Agreste region). This species also inhabits coastal fragments. All records made in Paraíba state were more than 20 years ago. There are no recent records for this species in the whole PEC. This species is diurnal and terrestrial with a diet based on rodents and frogs (Guedes et al. 2014).

Spilotes pullatus (Linnaeus, 1758)

Our primary data show that *S. pullatus* is widely distributed in the PEC, with records in Alagoas, Pernambuco and Paraíba, in coastal fragments, but also in the *Brejos de Altitude*. Primary data also indicate diurnal activity and arboreal habits (Saltinho Biological Reserve in Pernambuco state and Murici Ecological Station). Despite its large distribution in the PEC, Nogueira et al. (2019) only provided four records for the entire area. According to Vanzolini et al. (1980), Argôlo (2004) and Marques et al. (2004), this species is diurnal, terrestrial and arboreal, with a diet based on rodents, birds, lizards and frogs.

Spilotes sulphureus (Wagler, 1824)

This species presents low abundance in the PEC forests, although primary data indicate at least four localities in Paraíba state (Mata do Buraquinho, Guaribas Biological Reserve, Gargau Forest and Usina São João Forest) and one in Murici Ecological Station. Nogueira et al. (2019) only provided two records in the whole PEC for Alagoas and Paraíba, respectively. A young individual was observed in Murici Ecological Station on a tree at 2 meters above the ground during the day, and remained immobilie during the observation. A second individual (adult female) was also observed during the day, but on the forest floor. According to Pereira-Filho et al. (2017), this species presents a disjoint distribution between the Amazon and Atlantic Forest. *S. sulphureus* is diurnal and arborial/terrestrial with a diet based on small mammals and birds (Marques et al. 2004; Marques et al. 2019).

Tantilla melanocephala (Linnaeus, 1758)

This species is common in all PEC forests, and inhabits coastal and inland fragments. It has been recorded in Alagoas, Pernambuco and Paraíba states. It is a fossorial snake with diurnal and nocturnal

habits, and a diet based on centipedes (Marques et al. 2019).

Dipsadidae Bonaparte, 1838

Atractus caete Passos, Fernandes, Bernils & Moura Leite, 2010

Atractus caete is a rare species with records known for Quebrangulo and Chã Preta in Alagoas state. There are no other records for the entire PEC. According to Passos et al. (2010), this species inhabits Atlantic Forest remnants in elevation between 300 and 500 meters of altitude. According to Guedes et al. (2014), this species is nocturnal, fossorial and feeds on earthworms.

Atractus maculatus (Gunther, 1858)

Most of the records for *Atractus maculatus* are in the Alagoas state, only recently Abegg et al. (2017) confirmed the presence of this species in Pernambuco state. Our primary data are based on two records in Alagoas state. The first was in September of 2016, when a female was seen crossing a road at night in an area with extensive pastures. This female contained five well developed eggs. The second was recorded in April of 2020, when an adult exemplar was seen moving at night in a pasture area. The records in the PEC area are still restricted to Alagoas and Pernambuco states (Nogueira et al. 2019).

Atractus potschi Fernandes, 1995

Atractus potschi is a rare species within the PEC area. There is currently only one record for the city of Maceio in Alagoas state. All other records are for Sergipe and Bahia states which are not part of the PEC. According to Marques et al. (2019), this species is nocturnal and fossorial, with a diet based on earthworms.

Dipsas aff. *neuwiedii*

The distribution of *Dipsas* aff. *neuwiedi* is restricted to the PEC forests. This species is under description (Francisco Franco pers. com) and its distribution is restricted to the *Brejos de Altitude* and inland forests of Alagoas, Paraíba and Pernambuco (Nogueira et al. 2019; Pereira-Filho et al. 2020). We recorded nocturnal activity in Murici Ecological Station in dense forest areas, but also in secondary forest.

Dipsas mikanii (Schlegel, 1837)

There are only three records of *D. mikanii* in the whole PEC, specifically to the coastal Atlantic Forest of Paraíba state (Nogueira et al. 2019). We added four new records for this species on the coast of Paraíba state (map). According to Guedes et al. (2014), this species is nocturnal and arboreal/terrestrial with a diet based on snails.

Dipsas sazimai Fernandes, Marques, Argôlo, 2010

There are only two records of *D. sazimai* in the entire PEC. Fernandes et al. (2010) recorded the species in Murici Ecological Station and Roberto et al. (2014) recorded the species in Pedra D'Anta in Pernambuco state. *D. sazimai* can be considered rare in the PEC Atlantic Forest, as well as in the entire Atlantic Forest (Fernandes et al. 2010). This species is nocturnal, predominantly arboreal, but also found on the forest floor, with a diet based on snails (Fernandes et al. 2010; Marques et al. 2019).

Dipsas variegata Duméril, Bibron & Duméril, 1854

Dipsas variegata has been recorded for the states of Alagoas and Pernambuco with only three records (Nogueira et al. 2019), and can be considered a rare species in the PEC Atlantic Forest. An adult female was found in activity on the forest floor during the night in Murici Ecological Station in March of 2010. The species is nocturnal terrestrial/arboreal and feeds on snails (Guedes et al. 2014).

Sibon nebulatus (Linnaeus, 1758)

There are records of *S. nebulata* for the states of Alagoas, Pernambuco and Paraíba (Nogueira et al. 2019), all in coastal Atlantic Forest. This species can be considered rare in the PEC, even with additional research in two herpetological collections (*CHUFPB, CHP-UFRPE*). We added three more localities in Paraíba state (see map). This species is nocturnal and arboreal/terrestrial with a diet based on snails (Marques et al. 2019).

Imantodes cenchoa (Linnaeus, 1758)

According to Nogueira et al. (2019), there are only three records of *I. cenchoa* for the PEC Atlantic Forest. All records are from inland forests: Garanhuns and Serra dos Cavalos in Pernambuco and one for the Pedra Talhada Biological Reserve. However, this species is common in coastal forest fragments as stated by Pereira-Filho et al. (2017). *Imantodes cenchoa* is a nocturnal species, with arboreal habits and a diet based on lizards and frogs (Marques et al. 2019).

Leptodeira annulata (Linnaeus, 1758)

Leptodeira annulata presents most of its distribution in inland PEC Atlantic Forest. There is only one record for the coastal Atlantic Forest in the municipality of Recife, Pernambuco state. This species is widely distributed in the Caatinga biome and can be found in many *Brejos de Altitude* regions (Pereira-Filho et al. 2020). An adult was observed in activity (moving on the forest floor) during the night in Murici Ecological Station. This species is nocturnal terrestrial/arboreal with a diet based on frogs (Marques et al. 2019).

Caaeteboia gaeli Montingelli, Barbo, Pereira-Filho, Santana, França, Grazziotin & Zaher, 2020

Caeteboia gaeli is a rare species exclusively distributed in the PEC Atlantic Forest (Pereira-Filho et al. 2017; Montingelli et al. 2020). This species was previously mentioned by Pereira-Filho et al. (2017) when a single specimen had been captured in the municipality of Cruz do Espírito Santo, Paraíba state. Montingelli et al. (2020) recorded two other exemplars, one for the municipality of Pedras de Fogo also in Paraíba, and a third one in the municipality of Saloa, Pernambuco state. There is little primary data about its natural history. The exemplar of Pedras de Fogo was captured during the day on the forest floor, while the exemplar of Saloá was also found during the day coiled on a bromeliad (Montingelli et al. 2020).

Echinanthera cephalomaculata Di-Bernardo, 1994

This species has only been recorded in Alagoas and Pernambuco states (Di-Bernardo 1994; Freitas et al. 2020). The records made by Freitas et al. (2020) were made 25 years after the original description. One individual was recorded in the Municipality of Gravatá in Pernambuco state in February of 2020, while a second one was found in Chã Grande in July of 2020, and an adult female was found on the forest floor in the Serra dos Cavalos in Caruaru municipality. These are the only records known for the type locality (Quebrangulo Biological Reserve, Alagoas state) (Freitas et al. 2020). Roberto et al. (2015) stated that *E. cephalomaculata* is rare in the type locality and presented nocturnal/diurnal activity, being found on the forest floor. The species was found in altitude varying from 560 to 850 meters above sea level. Despite the rarity of this species in the whole PEC, Marques et al. (2019) considered this species diurnal, terrestrial and with a diet based on frogs.

Echinanthera cephalostriata Di-Bernardo, 1996

This is probably the rarest snake found in the PEC, with only one record and only one exemplar collected in the area. This species was recorded by Roberto et al. (2015) in the PEC Atlantic Forest for the Pedra Talhada Biological Reserve in Alagoas state. The authors stated that *E. cephalostriata* is rarer than *E. cephalomaculata*. This was the first record for Alagoas state, as well as for the PEC Atlantic Forest. This species is diurnal, terrestrial and feeds on frogs (Marques et al. 2019).

Taeniophallus affinis (Gunther, 1858)

T. affinis is distributed in the sates of Alagoas, Pernambuco and Paraíba, in coastal fragments, but also in *Brejos de Altitude* (Nogueira et al. 2019; Pereira-Filho et al. 2020). This species is apparently associated to well preserved fragments. We added four new localities in the state of Paraíba, three in the coastal fragments and one in a *Brejos de Altitude* (see map). This species is diurnal and terrestrial, feeding on frogs and lizards (Marques et al. 2019).

Taeniophallus occipitalis (Jan, 1863)

Despite its wide distribution this species presents few records in the PEC Atlantic Forest. The records are in Paraíba and Pernambuco, although Freire (2001) and Roberto et al. (2015) recorded this species in the Murici Ecological Station and Pedra Talhada Biological Reserve in Alagoas. Three individuals were seen in Murici, active during the day moving on the floor in a secondary forest. According to Marques et al. (2019), this species is diurnal and feeds on lizards and frogs.

Apostolepis cearensis Gomes, 1915

A. cearensis has been recorded in Caatinga, coastal Atlantic Forest and *Brejos de Altitude* (Pereira-Filho et al. 2017; Pereira-Filho et al. 2020; Nogueira et al. 2019) with confirmed records in Paraíba, Rio Grande do Norte and Pernambuco. According to Nogueira et al. (2019), there are only three records in the PEC Atlantic Forest, although our primary data indicates at least three other localities in Paraíba state (see map). We have little data about its natural history, but according to Guedes et al. (2014), this species is diurnal and fossorial with a diet based on small snakes.

Figure 4. Typical coastal Tabuleiro Forest in Santa Rita, Paraíba state. Habitat of *Caaeteboia gaeli*, *Micrurus* aff. *ibiboboca*, *Tantilla melanocephala* and *Epictia borapeliotes*.

Apostolepis longicaudata Gomes in Amaral, 1921

This species is rare in the PEC Atlantic Forest, with records restricted to the Guaribas Biological in Reserve in Paraíba state (Pereira-Filho et al. 2020). There are two other records in Paraíba, but in the Caatinga domain (Cabaceiras and Maturéia municipalities). We do not have information about the natural history of the specimens collected, although Marques et al. (2019) report diurnal activity, fossorial habits and a diet based on small snakes.

Hydrodynastes gigas (Duméril, Bibron and Duméril, 1854)

This is a rare species in the PEC area, with only two records. The first one was made by Pereira-Filho and Montingelli (2006) for the municipality of João Pessoa in Paraíba state, the second record was made by Junior et al. (2020) for the municipality of Extremoz in Rio Grande do Norte state. According to Pereira-Filho et al. (2017), this species is diurnal, aquatic, and feeds on frogs and fish.

Helicops angulatus (Linnaeus, 1758)

This species is widely distributed in the whole PEC, in the coastal Atlantic Forest and inland forests (Nogueira et al. 2019). Primary data on its natural history are available for an adult female found at night, moving on the ground close to two small lakes in the Murici Ecological Station in August of 2018. Three adult individuals were found at night in small ponds hunting tadpoles during the rainy season in Paraíba state, precisely in June of 2008, in an urban fragment of Atlantic Forest in João Pessoa municipality (Mata do Buraquinho). This species is aquatic, with diurnal/nocturnal activity, and feeds on fish, frogs and tadpoles (Pereira-Filho et al. 2017; Marques et al. 2019).

Helicops leopardinus (Schlegel, 1837)

Helicops leopardinus is distributed in the coastal Atlantic Forest in the states of Alagoas, Pernambuco and Rio Grande do Norte (Nogueira et al., 2019). Roberto et al. (2015) recorded the species in the inland forest of the Pedra Talhada Biological Reserve. Despite all of the records presented by Nogueira et al.

(2019) for the PEC Atlantic Forest, *H. leopardinus* is not found frequently. There are no records for the Atlantic Forest of Paraíba and there is only one for Pernambuco. This species is aquatic, with nocturnal/diurnal activity, and feeds on frogs and fish (Marques et al. 2019).

Philodryas nattereri Steindachner, 1870

This species is widely distributed in the whole PEC Atlantic Forest, inhabiting fragments at sea level up to 900 meters of altitude. Most of the records are in the coastal Atlantic Forest, but this species is easily found in *Brejos de Altitude* and in the Caatinga dry forest (Nogueira et al. 2017; Pereira-Filho et al. 2020). This species is diurnal and terrestrial with a diet based on lizards, small mammals and birds (Guedes et al. 2014).

Philodryas olfersii (Linchtenstein, 1823)

This species is distributed in the whole PEC, including *Brejos de Altitude* (Nogueira et al. 2019; Pereira-Filho et al. 2020). According to our primary data, *P. olfersii* can inhabit forests, pasture and even urban areas. There are three records of predation on the lizards *Ameiva ameiva* and *Tropidurus hispidus* and on the frog *Leptodactylus macrosternum*. This species is diurnal, arboreal/terrestrial, and feeds on a large variety of prey such as birds, lizards, frogs and small mammals (Marques et al. 2017).

Pseudablabes patagoniensis (Girard, 1858)

There are only three records of *P. patagonienesis* in the PEC Atlantic Forest (Nogueira et al. 2019), although we were able to add 9 new localities in Paraíba state (see map). This species is apparently associated with the coastal fragments in the PEC, but there is only one record for *Brejos de Altitude*, precisely in an altitudinal forest in Alagoinha municipality (Paraíba State). This species is diurnal and terrestrial, and feeds on lizards and frogs (Marques et al. 2019).

Boiruna sertaneja Zaher, 1996

Boiruna sertaneja is considered endemic of the Caatinga domain (Guedes et al. 2014), although there are many records in the PEC Atlantic Forest. Pereira-Filho et al. (2017) examined two exemplars from Atlantic Forest areas of Paraíba state, from Santa Rita and Alagoinha municipalities. Mesquita et al. (2018) also recorded this species in the Guaribas Biological Station in Mamanguape municipality, also in Paraíba. Another exemplar (roadkilled) was recorded 2017 in Taquaritinga do Norte, Pernambuco state. Zaher (1996) examined one exemplar from Timbauba municipality, also in Pernambuco state. This species inhabits coastal fragments as well as *Brejos de Altitude*, and is widely distributed in the Caatinga domain (Pereira-Filho et al. 2020; Guedes et al. 2014). This species is nocturnal and mainly feeds on snakes, but can also consume lizards (Pereira-Filho et al. 2017; Guedes et al. 2014).

Clelia plumbea (Wiedi-Neuwiedi, 1820)

There are only two records for *Clelia plumbea* in the whole PEC. Zaher (1996) examined an exemplar from Maceio in Alagoas state. Roberto et al. (2015) recorded the species in the Pedra Talhada Biological Reserve in the municipality of Quebrangulo, also in Alagoas state. Nogueira et al. (2019) presented the same record provided by Zaher (1996) for Maceio in Alagoas. According to Marques et al. (2019), this species is nocturnal and terrestrial with a diet based on lizards and snakes.

Oxyrhopus guibei Hoge & Romano, 1978

This species was recorded in the PEC for the first time in Murici forest in 1999 (Freire 1999). After this record, Santana et al. (2008) recorded this species in the Atlantic Forest of Paraíba state, with the northernmost point of its distribution being in the coastal Atlantic Forest. According to Nogueira et al. (2019), there are records only in Alagoas and Paraíba. However, Pereira-Filho et al. (2017) provided records for more areas in Paraíba, including a *Brejo de Altitude*. This species can be found in the Atlantic Forest at sea level up to 800m altitude. One adult was collected during the night in Murici Ecological Station. Another record was made in the Brejo dos Cavalos, Caruaru municipality, Pernambuco state when an adult individual was seen moving on the forest floor in a dense area of Atlantic Forest at 800 meters of altitude. According to Marques et al. (2019), this species nocturnal, terrestrial and feeds on lizards and small rodents.

Oxyrhopus petolarius (Linnaeus, 1758)

There are records of this species in Alagoas, Paraíba and Pernambuco, in coastal and inland Atlantic Forest. Nogueira et al. (2019) presented only two records in the whole PEC, for Pernambuco and Paraíba states. Two individuals were seen active in the night in Murici Ecological Station moving on the forest floor and also crossing roads. Another record

Figure 5. Coastal Restinga in Genipapu, Rio Grande do Norte State. The Restinga forests with natural lagoons are the habitat for *Hydrodynastes gigas*, *Helicops angulatus*, Philodryas nattereri and *Pseudablabes patagoniensis*.

was made in Pedra Talhada Biological Reserve (Pernambuco/Alagoas states), when an adult was seen at night crossing a road. This species is nocturnal and terrestrial, and consumes lizards and rodents (Pereira-Filho et al. 2017).

Oxyrhopus trigeminus Duméril, Bibron & Duméril, 1854

This is a widely distributed species in the PEC inhabiting coastal forests and Brejos de Altitude, in altitudes varying from sea level up to 900 meters above sea level. Our primary data show that *O. trigeminus* can be found in well preserved forests, secondary forest pastures, and even urban environments. The data also indicate nocturnal activity, with individuals sheltered in hollow logs. According to Nogueira et al. (2019), this species can be found in the whole PEC.

Phimophis guerini (Duméril, Bibron & Duméril, 1854)

According to Nogueira et al. (2019), there are only four records of *P. guerini* in the PEC. The northernmost record in the Atlantic Forest is in the coast of Paraíba and Rio Grande do Norte, with the latter not presenting a precise location (Pereira-Filho et al. 2012; Marques et al. 2012). We added four new records for the Atlantic Forest of Paraíba state (map). This species is terrestrial/fossorial, nocturnal, and feeds on lizards (Guedes et al. 2014).

Pseudoboa nigra (Duméril, Bibron & Duméril, 1854)

This species is distributed in coastal Atlantic Forest as well as in *Brejos de Altitude* of the PEC (Pereira-Filho et al. 2017; Pereira-Filho et al. 2020). It can be found within forest fragments, in the edge of forested areas and in pasture areas. There are records for Alagoas, Pernambuco, Paraíba and Rio Grande do Norte (Guedes et al. 2014). According to Marques et al. (2019), this species is nocturnal and terrestrial, and feeds on lizards.

Siphlophis compressus (Daudin, 1803)

This species has been recorded for the states of Alagoas and Paraíba (Nogueira et al. 2019). We added information for one more coastal forest in Paraíba and Pernambuco (see map). Despite the distribution in Alagoas, Paraíba and Pernambuco, *S. compressus* can be considered rare in the PEC since there are only two localities in Paraíba, Pernambuco and Alagoas with confirmed occurrence. Two active individuals were seen on the forest floor in Murici Ecological Station in March 2010. This species is nocturnal, arboreal/terrestrial with a diet based on lizards (Marques et al. 2017).

Psomophis joberti (Sauvage, 1884)

P. joberti can be considered a rare species in the PEC. There are only two records in the coastal forests of Paraíba and Rio Grande do Norte (Nogueira et al. 2019). We added four new localities in Paraíba state, all on the coast (see map). Pereira-Filho et al. (2020) recorded this species in the *Brejos de Altitude* of Alagoinha in the municipality of Alagoinha. This species is diurnal and terrestrial, and feeds on lizards and frogs (Guedes et al. 2014).

Thamnodynastes almae Franco & Ferreira, 2003

The first records of *Thamnodynastes almae* in the Atlantic Forest were made by Pereira-Filho et al. (2020) with records in five *Brejos de Altitude* of Pernambuco. This species can be found in the most inland forests with great proximity to the Caatinga dry forest, although it is absent in coastal Atlantic Forest. One individual was recorded in Serra Negra, municipality of Bezerros at 850 meters above sea level. According to Guedes et al. (2014), this species is nocturnal, arboreal/terrestrial with a diet based on frogs and lizards.

Thamnodynastes hypoconia (Cope, 1860)

According to Nogueira et al. (2019), *Thamnodynastes hypoconia* does not occur in the PEC Atlantic Forest. However, Pereira-Filho et al. (2020) recorded this species in the *Brejos de Altitude* of Paraíba and Pernambuco. According to Marques et al. (2019), this species is diurnal, terrestrial with a diet based on frogs and lizards.

Thamnodynastes pallidus (Linnaeus, 1758)

This snake is widely distributed in the PEC, although only in forest habitat. It is very common in the coastal fragments and rare in *Brejos de Altitude*. According to our database, *T. pallidus* only occurs in the Brejos of Pedra Talhada and Serra dos Cavalos. This species presents a disjunct distribution between the Amazon and Atlantic Forest. *T. pallidus* is nocturnal semi-arboreal with a diet based on small frogs (Pereira-Filho et al. 2017).

Thamnodynastes phoenix Franco, Trevine, Montingelli & Zaher, 2017

Thamnodynastes phoenix is found in the most inland *Brejos de Altitude* with a strong influence of Caatinga dry forest and is absent from coastal Atlantic Forest fragments (Pereira-Filho et al. 2020). This species is abundant in Caatinga (Guedes et al. 2014), but it is not common in *Brejos de Altitude*. This species feeds on lizards and frogs, is terrestrial and nocturnal (Guedes et al. 2014).

Thamnodynastes sertanejo Bailey, Thomas & Silva-Jr. 2005

This species is absent from the coastal PEC Atlantic Forest, but can be found in *Brejos de Altitude* (Pereira-Filho et al. 2020). This is probably due to the proximity of the *Brejos* with the surrounding Caatinga. This species can be considered rare even in Caatinga areas. *T. sertanejo* is nocturnal, semi-arboreal and feeds on small frogs (Guedes et al. 2014).

Erythrolamprus aesculapii (Linnaeus, 1758)

This species has been recorded for the states of Alagoas (Murici Ecological Station) and Pernambuco (Municipality of Aldeia), and these are the only records for the whole PEC. An individual was found in Murici during the day in July 2019, moving on the forest floor on a secondary forest. Freire (2001) also recorded the species in Murici. These are the first records for the PEC region. This species is diurnal, terrestrial with a diet based on snakes (Guedes et al. 2014; Marques et al. 2019).

Erythrolamprus almadensis (Wagler, 1824)

This species is recorded in the PEC for the states of Pernambuco and Paraíba, with only two records,

one in each state. Pereira-Filho et al. (2017) mentioned this species in areas of coastal Atlantic Forest, and Pereira-Filho et al. (2020) made records in the *Brejos de Altitude* region. According to Marques et al. (2019), this species is diurnal, terrestrial and semi-aquatic, and feeds on frogs.

Erythrolamprus miliaris (Linnaeus, 1758)

According to Nogueira et al. (2020), *E. miliaris* is recorded in the Atlantic Forest of Alagoas, Pernambuco and Paraíba. Pereira-Filho et al. (2020) recorded this species in the Brejo de Altitude Mata do Pau Ferro, in Areia municipality, Paraíba state. All the records made by Nogueira et al. (2020) are in inland forests. Primary data is based on individuals found in inland forests. An adult was found in March 2015 moving on the forest floor close to a stream in Tamandaré, Pernambuco municipality. An adult was found in October 2017 moving on the forest floor close to a stream during the night in Caruaru municipality in Pernambuco, at 850 meters above sea level. A third exemplar was found in Murici, Alagoas state in October 2020. The individual was moving on the forest floor in the later afternoon close to a small stream. According to Guedes et al. (2014), this species is diurnal/nocturnal, terrestrial/semi-aquatic and feeds on fish and frogs.

Erythrolamprus mossoroensis (Hoge & Lima-Verde, 1973)

This is a rare species in the PEC forests. The inclusion of this species in our list is due to a record in Agrestina (Pernambuco state). Despite Nogueira et al. (2019) not providing a precise location of the record, it is possible that *E. mossoroensis* can be found in the *Brejos de Altitude* of the region, like many other species such as *Thamnodynastes sertanejo*, *Thamnodynastes phoenix* and *Bothrops erythromelas*. According to Guedes et al. (2014), this species presents diurnal/nocturnal activity, terrestrial and semi-aquatic habits and a diet based on frogs and fish.

Erythrolamprus poecilogyrus (Wiedi-Neuwiedi, 1825)

This is a widely distributed species in northeastern Brazil, with records in the Atlantic Forest and Caatinga in all states of the PEC region (Guedes et al. 2014, Nogueira et al. 2019). Two records were made for the Murici Ecological Station; one individual was found in October of 2018 moving on the forest floor at night close to a small stream. Another record was made in February of 2020 of another individual also moving at night close to a small stream. A third individual was recorded in Brejo dos Cavalos, Caruaru municipality in Pernambuco state at 850m above sea level. The exemplar was moving at night close to small streams. This species is considered diurnal/nocturnal, terrestrial/semi-aquatic with a diet based on small frogs (Guedes et al. 2014; Vieira et al. 2020).

Erythrolamprus reginae (Linnaeus, 1758)

E. reginae is a rare species in the PEC with only two known records for the municipalities of Mangabeiras and Maceio, both in Alagoas state. A third record was made in Murici Ecological Station, also in Alagoas. The specimen was active during the day close to a stream in a forest area. According to Marques et al. (2017), this species is diurnal, terrestrial/semi-aquatic, and feeds on frogs and lizards.

Erythrolamprus taeniogaster (Jan, 1863)

This species is recorded in Alagoas (three records) and Pernambuco (one record) states, although there are published records for Paraíba state (França and Bezerra 2010). The few records in the PEC region show the rarity of the species. Three records were made for the Murici Ecological Station. An adult individual was seen in May 2017 crossing a lake in the morning. Another individual was seen in August 2017 during the night close to small streams in a dense forested area. An adult female was recorded in the morning in a degraded swampy area in July 2020. This species is diurnal, terrestrial/semi-aquatic with a diet based on fishes (Marques et al. 2019).

Erythrolamprus viridis (Gunther, 1862)

E. viridis is widely distributed in the PEC area, with records in the Atlantic Forest and in the dry areas of Caatinga (Guedes et al. 2014). One individual was found in activity in a pasture area during the day. A second individual was found in thermoregulation process during the morning in a pasture area, both records were made in the Murici Ecological Station. This species is diurnal, terrestrial with a diet based on small frogs (Guedes et al. 2014, Marques et al. 2017, 2019)

Lygophis dilepis (Cope, 1862)

Lygophis dilepis is not a common species in the PEC Atlantic Forest. There is only one record of this

species for the municipality of João Pessoa, Paraíba state (Guedes et al. 2014). Other records in Paraíba come from Santa Rita, Alagoa Grande and Areia municipalities (inland Atlantic Forest). This species is common in many areas of the Caatinga biome (Guedes et al. 2014).

Xenodon merremii (Wagler in Spix, 1824)

This species is widely distributed in the PEC and inhabits the forests of the coast to the inland altitudinal forests. There are records for Alagoas, Pernambuco, Paraíba and Rio Grande do Norte states. *X. merremii* can be found in the forest edges and in the interior, but also inhabits agricultural environments and even pastures.

Xenodon rabdocephalus (Wied-Neuwiedi, 1824)

Xenodon rabdocephalus was only recently recorded in the PEC forests for the states of Alagoas and Pernambuco (Lima et al. 2020), inhabiting forests in the coast and also *Brejos de Altitude*. This species shares it is distribution with *X. merremii*, although *X. rabdocephalus* presents disjunct distribution between the Amazon and Atlantic Forest (Nogueira et al. 2019).

Xenopholis scalaris (Wucherer, 1861)

This species is rare in the PEC forests, with few records in Alagoas and Pernambuco (França et al. 2019; Nogueira et al. 2019). *X. scalaris* presents disjunct distribution between Amazon and Atlantic Forest. One exemplar was recorded in activity at night in Murici Ecological Station (Alagoas state). The records for the Atlantic Forest are concentrated in southeastern Brazil and in Bahia state.

Xenopholis undulatus (Jensen, 1900)

Xenopholis undulatus is a species related to open areas like the Cerrado Biome, although it generally presents few records in the Atlantic Forest. This species can be considered rare in the PEC, since their single records to Alagoas, Pernambuco and Paraíba. This species can inhabit the coastal forests, but also *Brejos de Altitude* (Pereira-Filho et al. 2017).

Lioheterophis hieringi Amaral, 1936

This is a very rare species of the PEC. *Lioheterophis hieringi* is known from the type locality (Campina Grande municipality, Paraíba state) and was described in 1936; since then, no other exemplars have been known or collected. Campina Grande presents most of its area covered by xeric Caatinga vegetation, but presents some transitional forests with Atlantic elements; thus, we decided to include this species due to the possibility of its occurrence in such transitional forests.

Species richness and sampling bias

The Atlantic Forest shows different sampling efforts in all of its range, with well-known regions, but also with gaps, mainly in the northernmost portion. Specifically regarding the Pernambuco Endemism Center, knowledge about the snake fauna is under constant improvement, with an increase in information in the last years (Pereira Filho et al. 2017; Nogueira et al. 2019; França et al. 2020). Our results show that most of the richest points in the PEC are located near the coast and also near urban centers with established research institutions (Figure 17). The general increase in knowledge about the snake fauna of northeastern Brazil, including the Atlantic Forest and also the Caatinga, came with the presence of professional herpetologists in all Federal Universities in all the region, which is a completely different panorama from a few years ago.

Even with new research centers, many areas remain faunistically unknown, and not only for snakes, but for vertebrate fauna in general. The PEC area is one of the lesser known regions in terms of fauna and flora (Rodal et al. 2008; Pereira-Filho et al. 2020), and the most threatened region of the Atlantic Forest (Tabarelli and Santos 2004) with many areas having been strongly reduced to small and extremely fragmented areas (Coimbra-Filho and Câmara 1996). The biggest forest remnants in this region are the Murici Ecological Station with 6,131 hectares (Alagoas state) and the Pedra Talhada Biological Reserve with 4,469 hectares (Alagoas/Pernambuco states). Other remnants strongly vary in size from 200 to 3500 hectares. The *Brejos de Altitude* probably present the most concerning situation, with most of the areas reduced to fragments with 600 or less hectares and suffering strong deforestation processes (Pereira-Filho and Montingelli 2011; Pereira-Filho et al. 2020).

Despite the degradation of the Atlantic Forest in the PEC, many areas are not known and represent significant gaps in the biodiversity knowledge in the region; remnants in the extreme of this situation are located in Rio Grande do Norte state. The little available data about the snake fauna of the Atlantic Forest of Rio Grande do Norte are in specific herpetological collections (MZUSP, UFPB and UFRN), but without any published comprehensive list of species for the forest areas.

The best known areas are located in the coast of Paraíba, Pernambuco and Alagoas states, with richness varying from 22 to 45 species. The Murici Ecological Station is the richest area in the PEC with 45 snake species (unpublished data), followed by the Guaribas Biological Reserve (Mesquita et al. 2018) in Paraíba state with 42, and the Pedra Talhada Biological Reserve on the border of Pernambuco and Alagoas states, also with 42 species (Roberto et al. 2015). Our data about snake richness in the PEC presents small differences from the one provided by Nogueira et al. (2019). According to the Atlas of Brazilian Snakes, the PEC area presents richness from 1 to 25 species in most of the area, with some specific areas with 50 species. There are no localities with 50 species in our database, although many areas on the coast can potentially reach 50 species or even more.

All the values presented herein can be changed once new sample efforts are implemented in the PEC, and studies are conducted in key fragments with extensive potential for biodiversity surveys.

Nogueira et al. (2019) provided the geographic distribution for all 86 species found in the PEC with refined information about altitude and Biomes. However, the PEC region presented many gaps for many species of the area, some of them with published information were not included in the Atlas. With our database, species such as *Trilepida salgueiroi, Amerotyphlops brongersmianus, Epicrates cenchria, Bothrops bilineata, Bothrops leucurus, Micrurus potyguara*, and *Chironius bicarinatus* (among others) had their distributions expanded herein. In fact, we were able to improve the geographic distribution for 53 species out of the 86 found in the PEC.

The distribution maps (Figure 18-23) show important sharing of species among the coastal fragments, the *Brejos de Altitude* and also with the Caatinga, with many species being found in all phytophysiognomies, clearly demonstrating the proximity of the snake fauna of the Caatinga and the PEC (Table 1).

Figure 6. 1- *Amerotyphlops amoipira* (Ibiraba, Bahia), 2- *Amertyphlops arenensis* (Areia, Paraíba), 3- *Liotyphlops trefauti* (Maceio, Alagoas), 4- *Amerotyphlops brongersmianus* (Santa Rita, Paraíba), 5- *Amerotyphlops paucisquamus* (Mamanguape, Paraíba), 6- *Epictia borapeliotes* (João Pessoa, Paraíba), 7- *Trilepida salgueiroi* (Murici, Alagoas), 8- *Boa constrictor* (Maceio, Alagoas). Photos: 1 (Miguel Rodrigues), 2, 4, 6 (Gentil Filho), 5 (Frederico França), 7, 8 (Marco Freitas), 3 (Ubirantan Gonçalves).

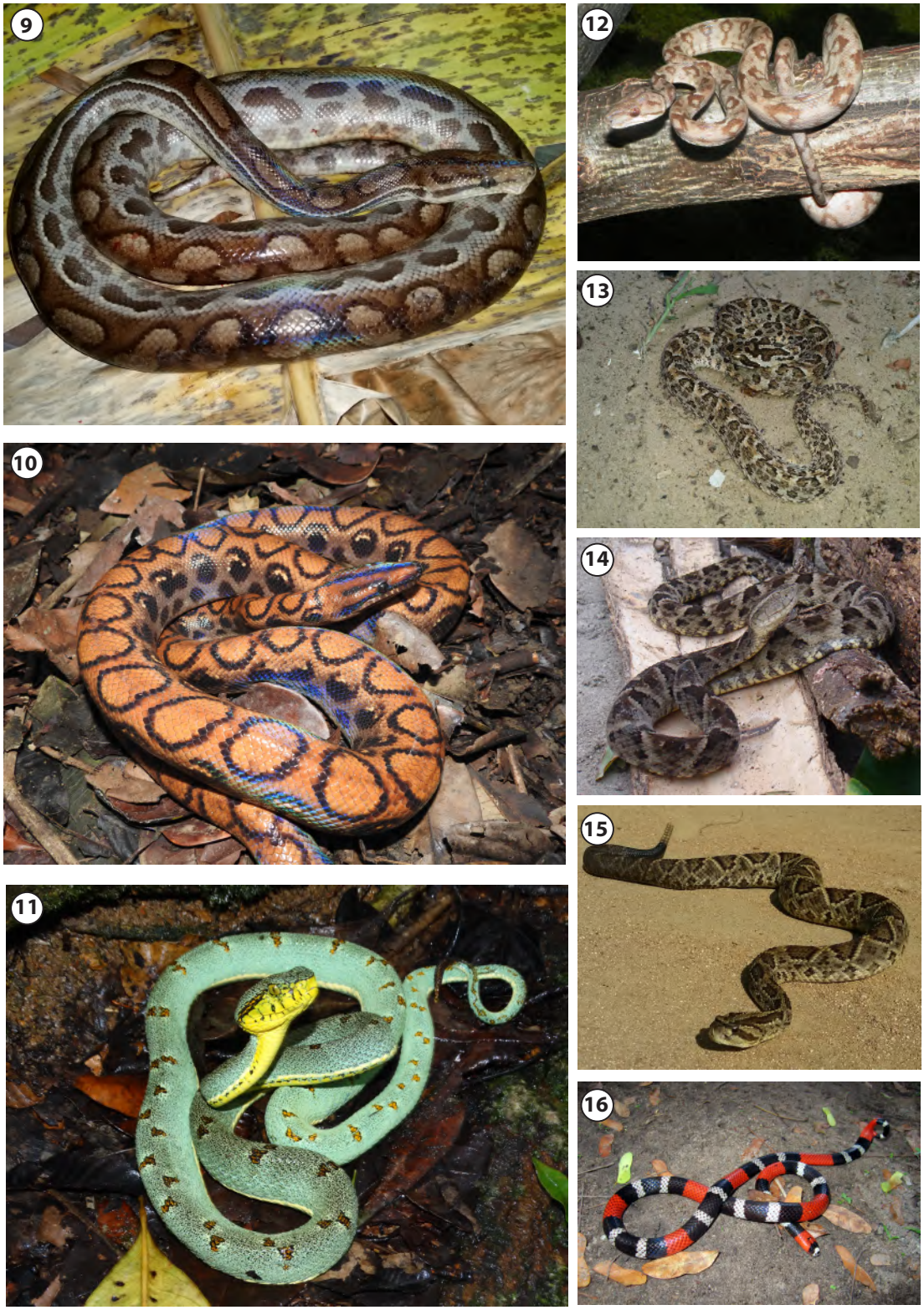

Figure 7. *Epicrates assisi* (Caruaru, Pernambuco), 10- *Epicrates cenchria* (Maceio, Alagoas), 11- *Bothrops bilineata* (Murici, Alagoas), 12- *Corallus hortulana* (Santa Rita, Paraíba), 13- *Bothrops erythromelas* (Garanhuns, Pernambuco), 14- *Bothrops leucurus* (Mamanguape, Paraíba), 15- *Crotalus durissus* (Murici, Alagoas), 16- *Micrurus* aff. *ibiboboca* (João Pessoa, Paraíba). Photos: 9, 10, 11, 13 ,15 (Marco Freitas), 12 (Jefter Rodrigues), 14 (Frederico França), 16 (Claudio Sampaio).

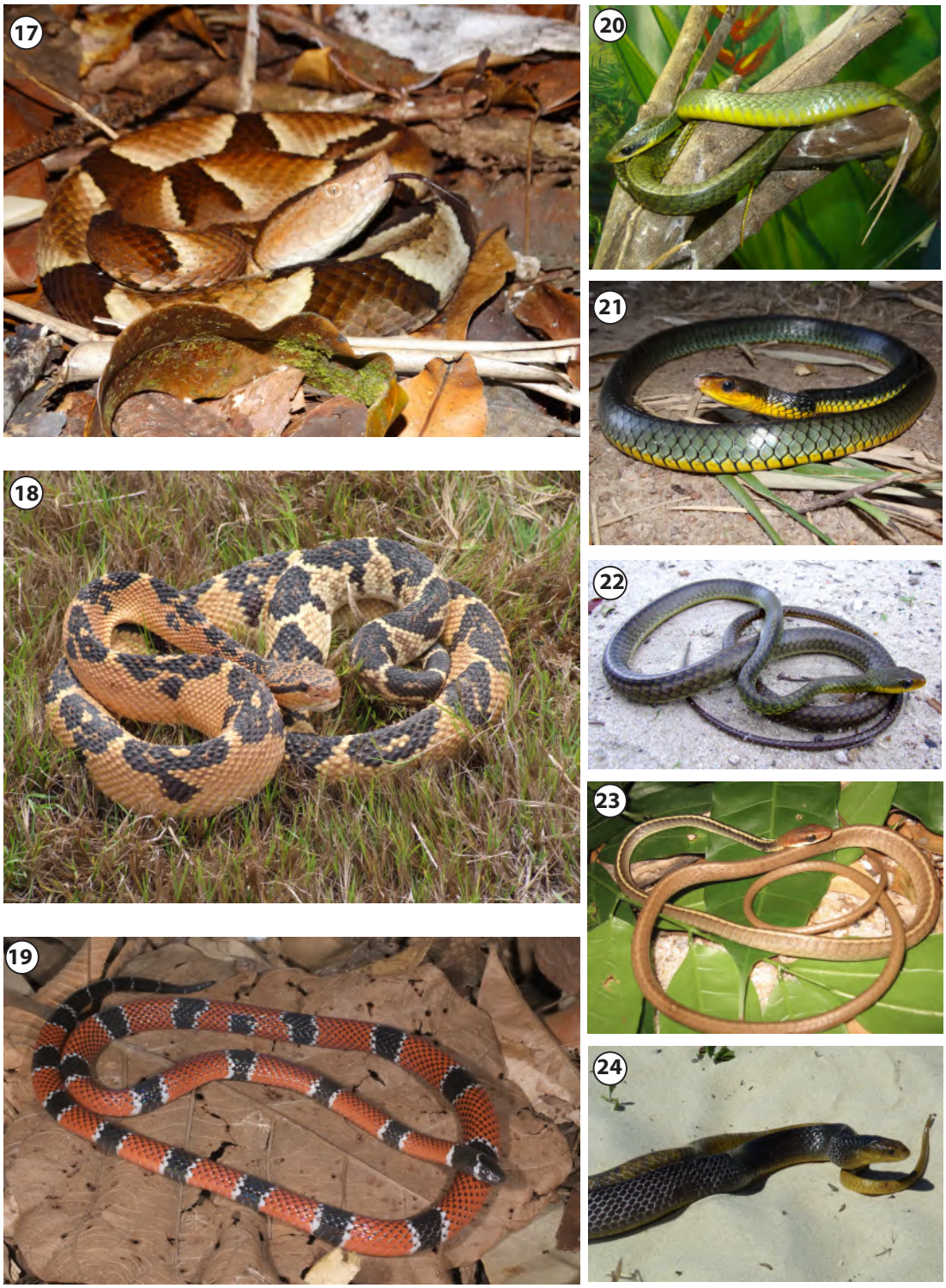

Figure 8. 17- *Bothrops muriciensis* (Murici, Alagoas), 18- *Lachesis muta* (Cruz do Espírito Santo, Paraíba), 19- *Micrurus corallinus* (Goianinha, Rio Grande do Norte), 20- *Chironius bicarinatus* (São Paulo), 21- *Chironius carinatus* (Murici, Alagoas), 22- *Chironius exoletus* (Areia, Paraíba) 23- *Chironius flavolineatus* (João Pessoa, Paraíba), 24- *Drymarchon corais* (Barra de Cunhau, Rio Grande do Norte). Photos: 17, 21, (Marco Freitas), 19 (Adrian Garda), 18, 22, 23 (Gentil Filho), 24 (Frederico França).

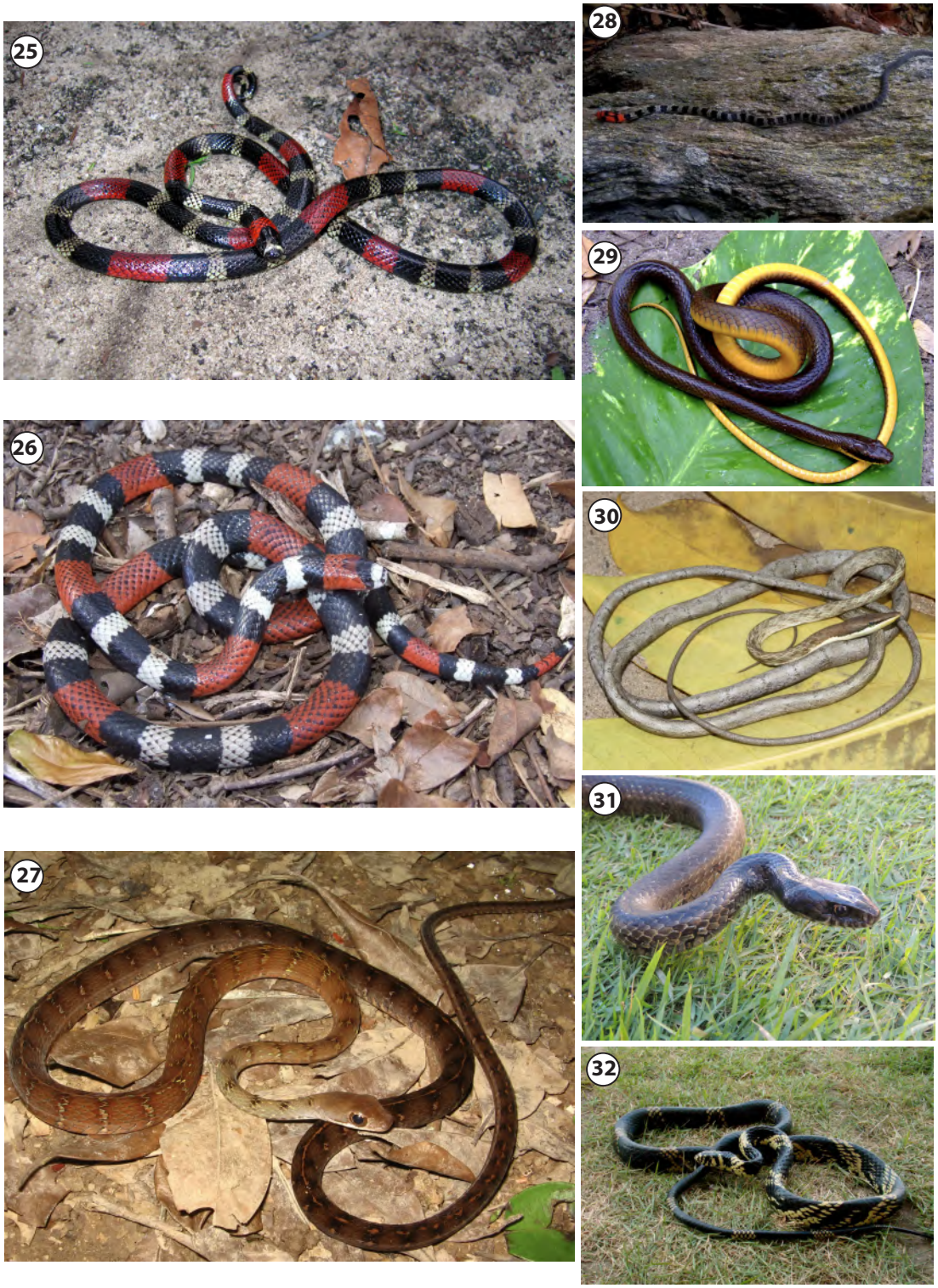

Figure 9. 25- *Micrurus potyguara* (João Pessoa, Paraíba), 26- *Micrurus* sp. (Areia, Paraíba), 27- *Dendophidion atlantica* (Murici, Alagoas), 28- Drymoluber brazili (Salgadinho, Paraíba), 29- *Drymoluber dichrous* (Areia, Paraíba), 30- *Oxybelis aeneus* (Santa Rita, Paraíba), 31- *Palusophis bifossatus* (Trairi, Ceará), 32- i (Santa Rita, Paraíba). Photos: 25, 26, 29, 30 (Gentil Filho), 27 (Marco Freitas), 28 (Juliana Alves), 31 (Hugo Ferreira), 32 (Frederico França).

Figure 10. 33- *Leptophis ahaetulla* (Santa Rita, Paraíba), 34- *Atractus maculatus* (Murici, Alagoas), 35- *Dipsas sazimai* (Murici, Alagoas), 36- *Spilotes sulphureus* (João Pessoa, Paraíba), 37- *Tantilla melanocephala* (Santa Rita, Paraíba), 38- *Atractus postchi* (Feira de Santana, Bahia), 39- *Dipsas* aff. *neuwiedi* (Areia, Paraíba), 40- *Dipsas mikanii* (Rio Tinto, Paraíba). Photos: 33, 36, 27, 39, 40 (Gentil Filho), 34, 35, 38 (Marco Freitas).

Figure 11. 41- *Caaeteboia gaeli* (Pedras de Fogo, Paraíba), 42- *Echinanthera cephalomaculata* (Caruaru, Pernambuco), 43- *Echinanthera cephalostriata* (Quebrangulo, Alagoas), 44- *Dipsas variegata* (Murici, Alagoas), 45- *Sibon nebulata* (Mamanguape, Paraíba), 46- *Imantodes cenchoa* (Mamanguape, Paraíba), 47- *Leptodeira annulata* (Maceio, Alagoas), 48- *Taeniophallus affinis* (Mamanguape. Paraíba). Photos: 41 (Gentil Filho), 42, 44, 47 (Marco Freitas), 43 (Igor Joventino), 45, 46, 48 (Frederico França).

Figure 12. 49- *Apostolepis cearensis* (Cruz do Espírito Santo, Paraíba), 50- *Apostolepis longicaudata* (Mamanguape, Paraíba), 51- *Hydrodynastes gigas* (João Pessoa, Paraíba), 52- *Taeniophallus occipitalis* (Santa Rita, Paraíba), 53- *Helicops angulatus* (Santa Rita, Paraíba), 54- *Helicops leopardinus* (Floresta, Pernambuco), 55- *Philodryas nattereri* (João Pessoa, Paraíba), 56- *Philodryas olfersii* (João Pessoa, Paraíba). Photos: 49, 51 (Claudio Sampaio), 50 (Frederico França), 52, 53, 55, 56 (Gentil Filho), 54 (Ivan Sazima).

Figure 13. 57- *Boiruna sertaneja* (Alagoinha, Paraíba), 58- *Oxyrhopus guibei* (Tamandaré, Pernambuco), 59- *Siphlophis compressus* (Murici, Alagoas), 60- *Pseudablabes patagoniensis* (João Pessoa, Paraíba), 61- *Oxyrhopus petolarius* (João Pessoa, Paraíba), 62- *Oxyrhopus trigeminus* (Tamandaré, Pernambuco), 63- *Phimophis guerini* (Conde, Paraíba), 64- *Pseudoboa nigra* (Santa Rita, Paraíba). Photos: 57, 58, 60, 61, 62, 63 (Gentil Filho), 59 (Marco Freitas), 64 (Jefter Rodrigues).

Figure 14. 65- *Thamnodynastes almae* (Bezerros, Pernambuco), 66- *Thamnodynastes sertanejo* (São José dos Cordeiros, Paraíba), 67- *Erythrolamprus aesculapii* (Murici, Alagoas), 68- *Psomophis joberti* (Mamanguape, Paraíba), 69- *Thamnodynastes hypoconia* (Maturéia, Paraíba), 70- *Thamnodynastes pallidus* (São Lourenço da Mata, Pernambuco), 71- *Thamnodynastes phoenix* (Arcoverde, Pernambuco), 72- *Erythrolamprus almadensis* (João Pessoa, Paraíba). Photos: 65, 67, 70, 71 (Marco Freitas), 66, 68, 72 (Gentil Filho).

Figure 15. 73- *Xenodon rhabdocephalus* (Murici, Alagoas), 74- *Xenopholis scalaris* (Murici, Alagoas), 75- *Xenopholis undulatus* (Camarajibe, Pernambuco), 76- *Erythrolapmrus miliaris*, (Caruaru, Pernambuco), 77- *Erythrolamprus mossoroensis* (Floresta, Pernambuco), 78- *Erythrolamprus poecilogyrus* (Murici, Alagoas), 79- *Erythrolamprus reginae* (Murici, Alagoas), 80- *Erythrolamprus taeniogaster* (Santa Rita, Paraíba). Photos: 73, 74, 75, 76, 78, 79 (Marco Freitas), 77 (Ivan Sazima), (80 Frederico França).

Figure 16. 81- *Erythrolamprus viridis* (Murici, Alagoas), 82- *Xenodon merremii* (Maceió, Alagoas), 83- *Lygophis dilepis* (Rio Tinto, Paraíba). Photos: 81, 82 (Marco Freitas), 83 (Frederico França).

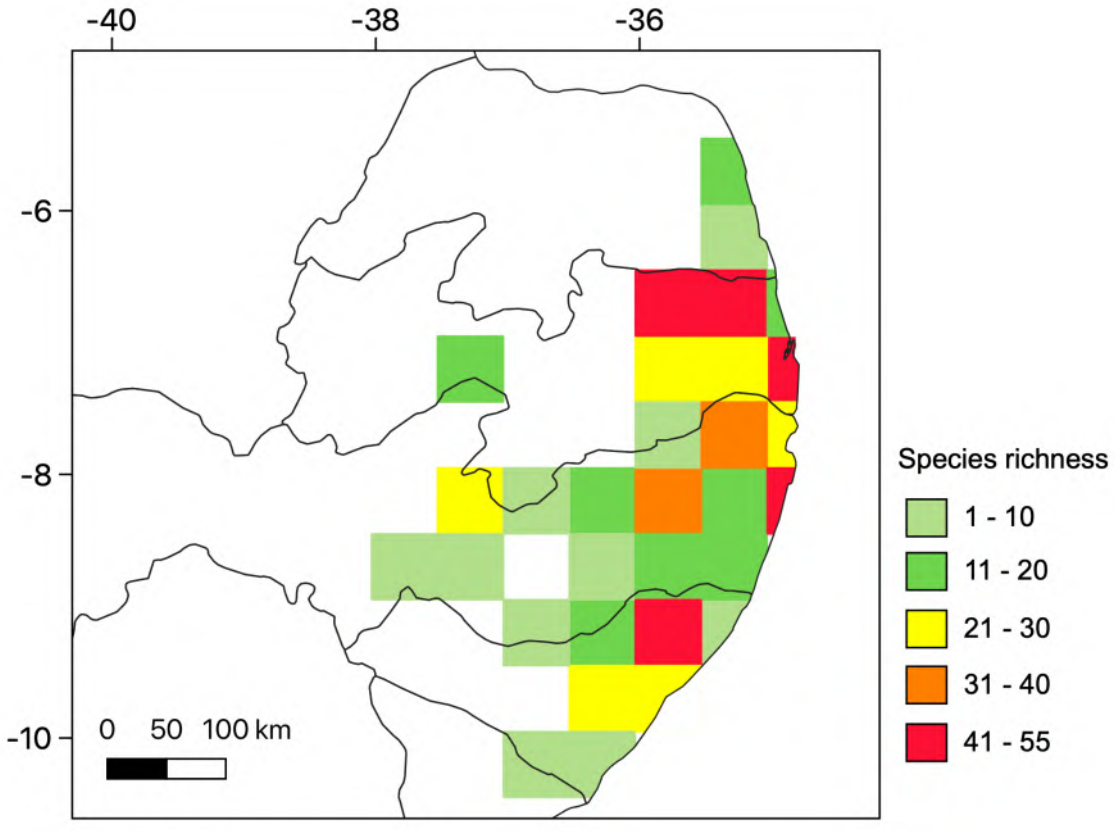

Figure 17. Map of species richness for snakes in the Pernambuco Endemism Center.

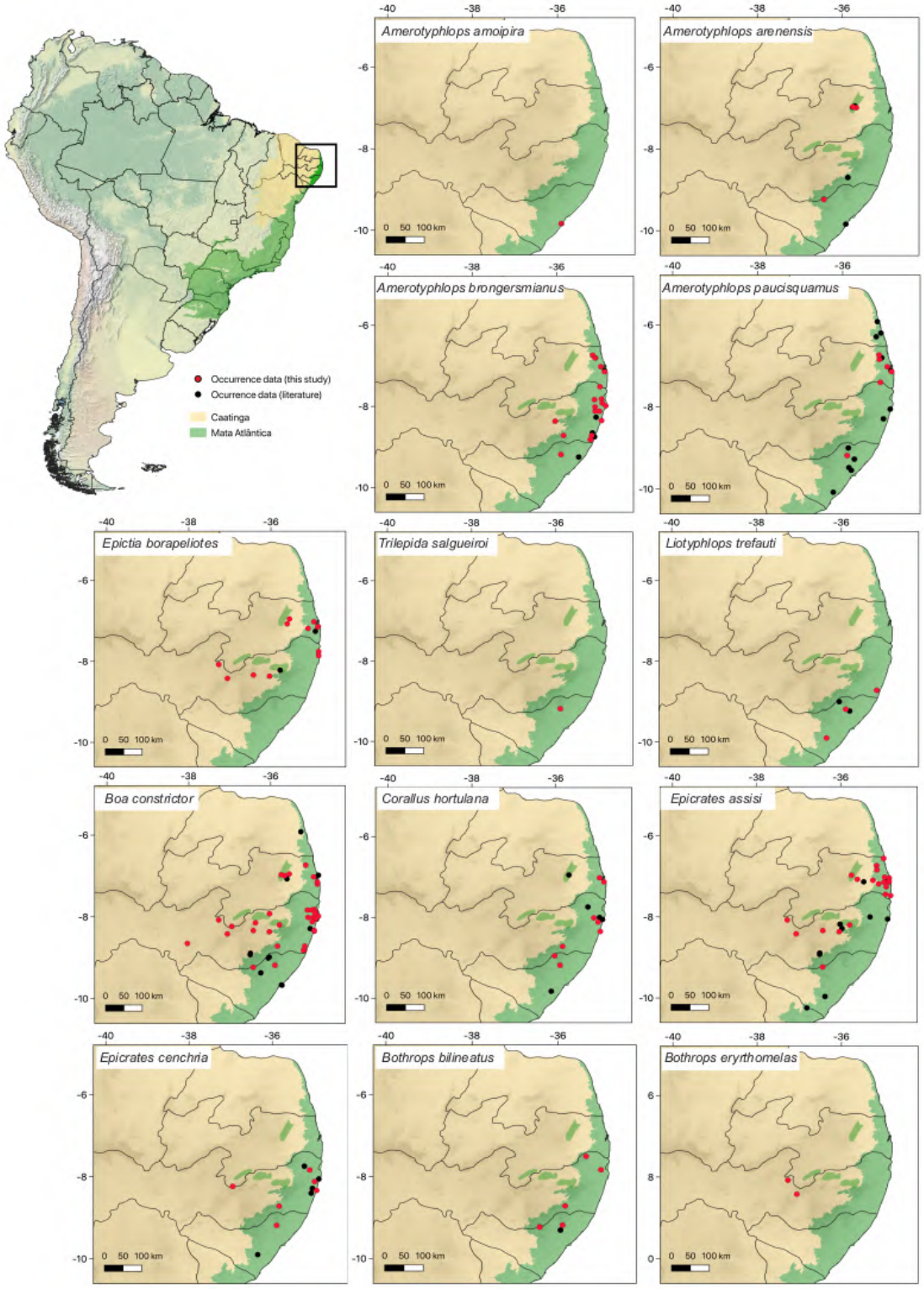

Figure 18. Distribution maps of the snakes of the PEC: *Amerotyphlops amoipira, Amerotyphlops arenensis, Amerotyphlops brongersmianus, Amerotyphlops paucisquammus, Epictia borapeliotes, Trilepida salgueiroi, Liotyphlops trefauti, Boa constrictor, Corallus hortulana, Epicrates assisi, Epicrates cenchria, Bothrops bilineatus* and *Bothrops erythromelas.*

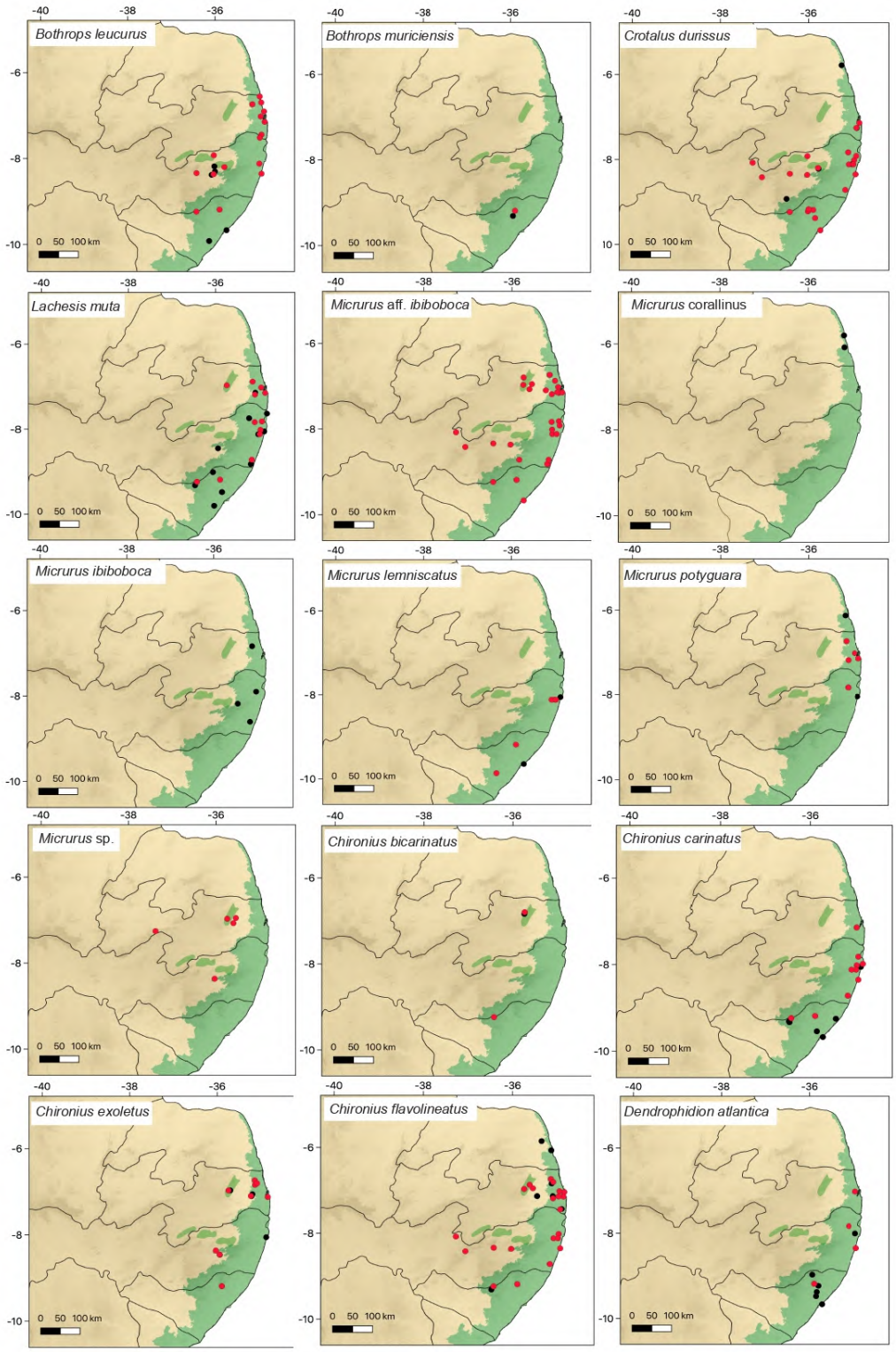

Figure 19. Distribution maps of the snakes of the PEC: *Bothrops leucurus, Bothrops muriciensis, Crotalus durissus, Lachesis muta, Micrurus aff. ibiboboca, Micrurus corallinus, Micrurus ibiboboca, Micrurus lemniscatus, Micrurus potyguara, Micrurus sp. Chironius bicarinatus, Chironius carinatus, Chironius exoletus, Chironius flavolineatus* and *Dendrophidion atlantica.*

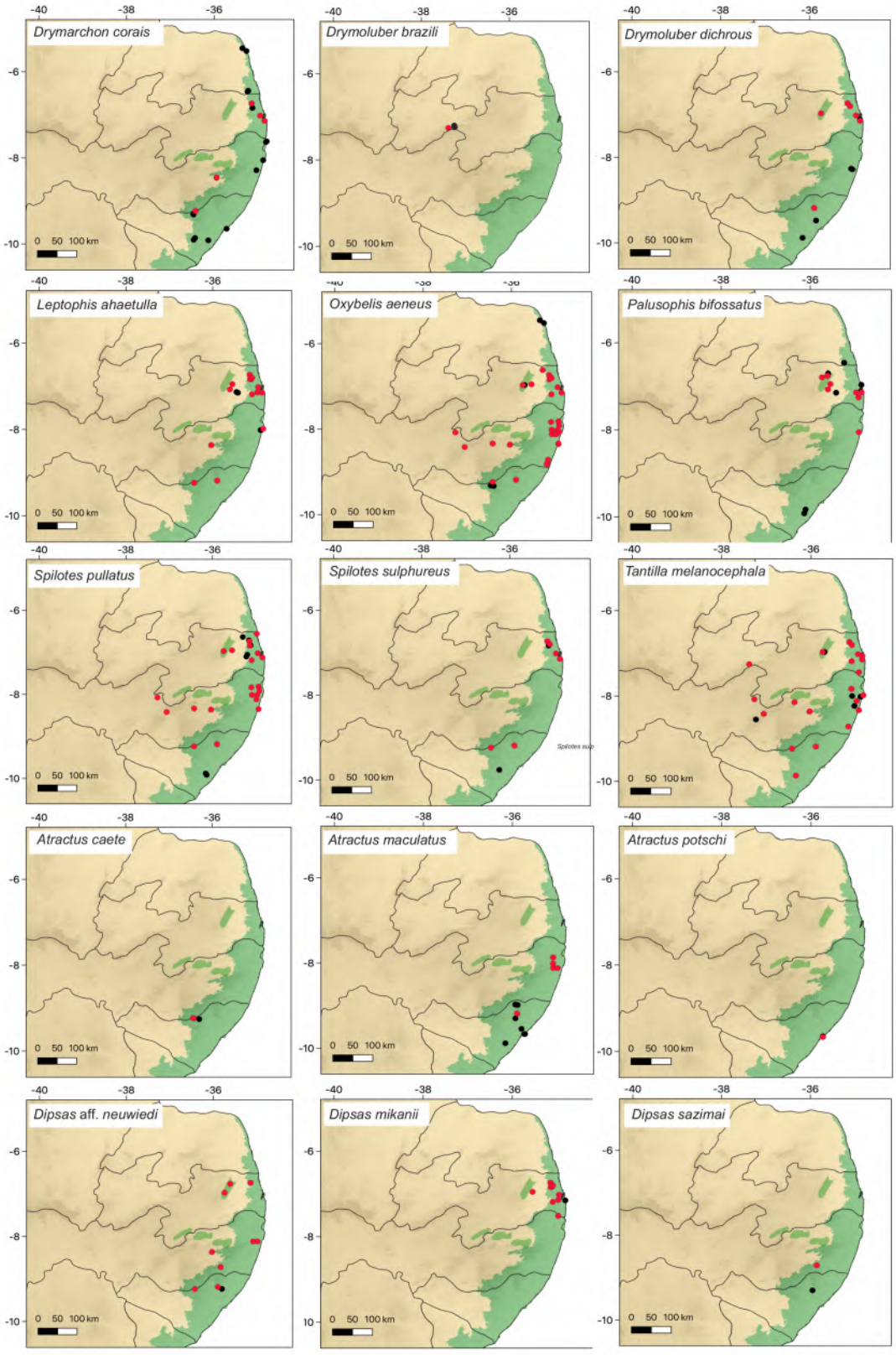

Figure 20. Distribution maps of the snakes of the PEC: *Drymarchon corais, Drymoluber brazili, Drymoluber dichrous, Leptophis ahaetulla, Oxybelis aeneus, Palusophis bifossatus, Spilotes pullatus, Spilotes sulphureus, Tantilla melanocephala, Atractus caete, Atractus maculatus, Atractus potschi, Dipsas aff. neuwiedi, Dipsas mikania* and *Dipsas sazimai.*

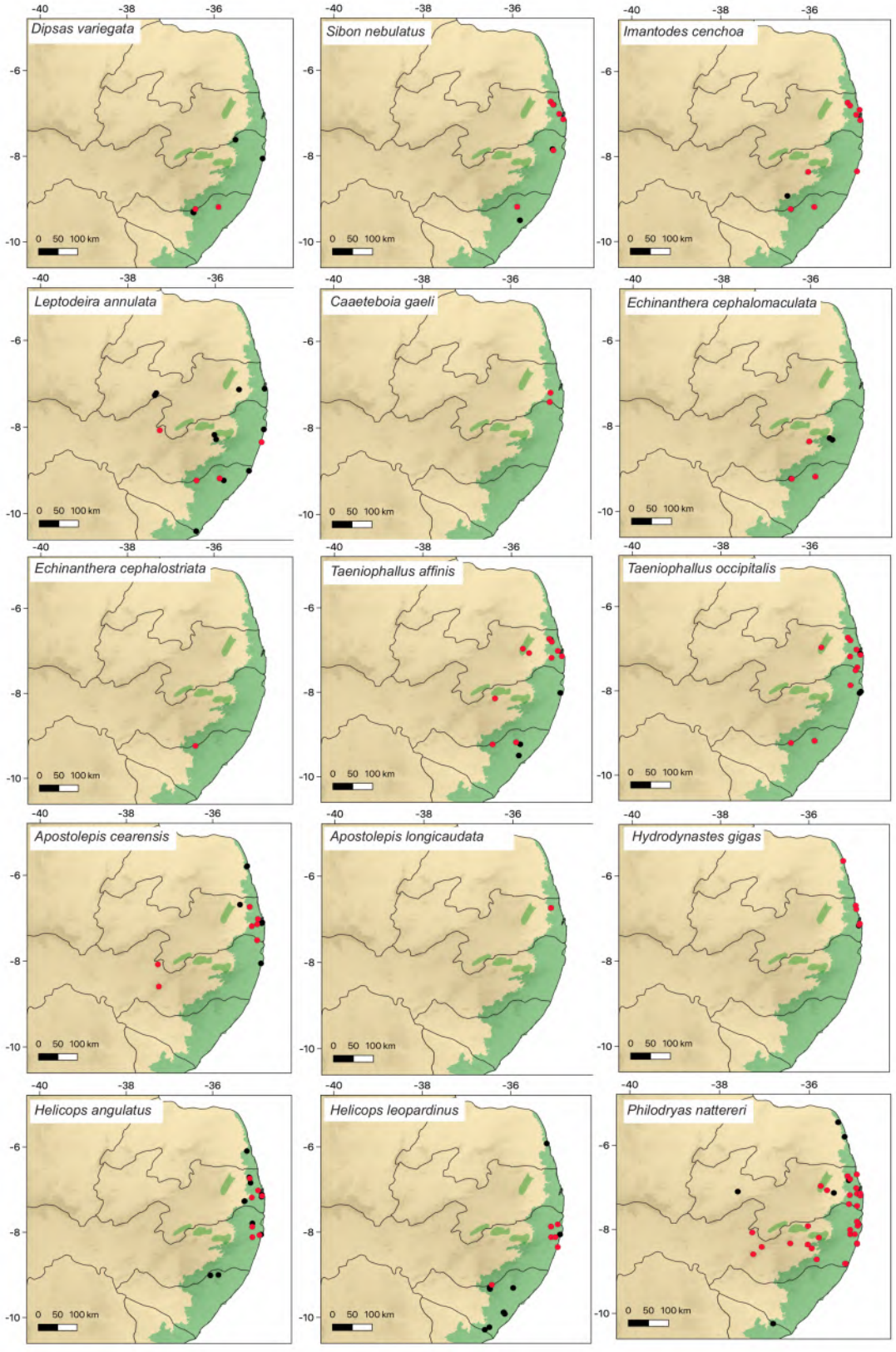

Figure 21. Distribution maps of the snakes of the PEC: *Dipsas variegata, Sibon nebulatus, Imantodes cenchoa, Leptodeira annulata Caaeteboia gaeli, Echinanthera cephalomaculata, Echinanthera cephalostriata, Taeniophallus affinis, Taeniophallus occipitalis, Apostolepis cearensis, Apostolepis longicaudata, Hydrodynastes gigas, Helicops angulatus, Helicops leopardinus* and *Philodryas nattereri.*

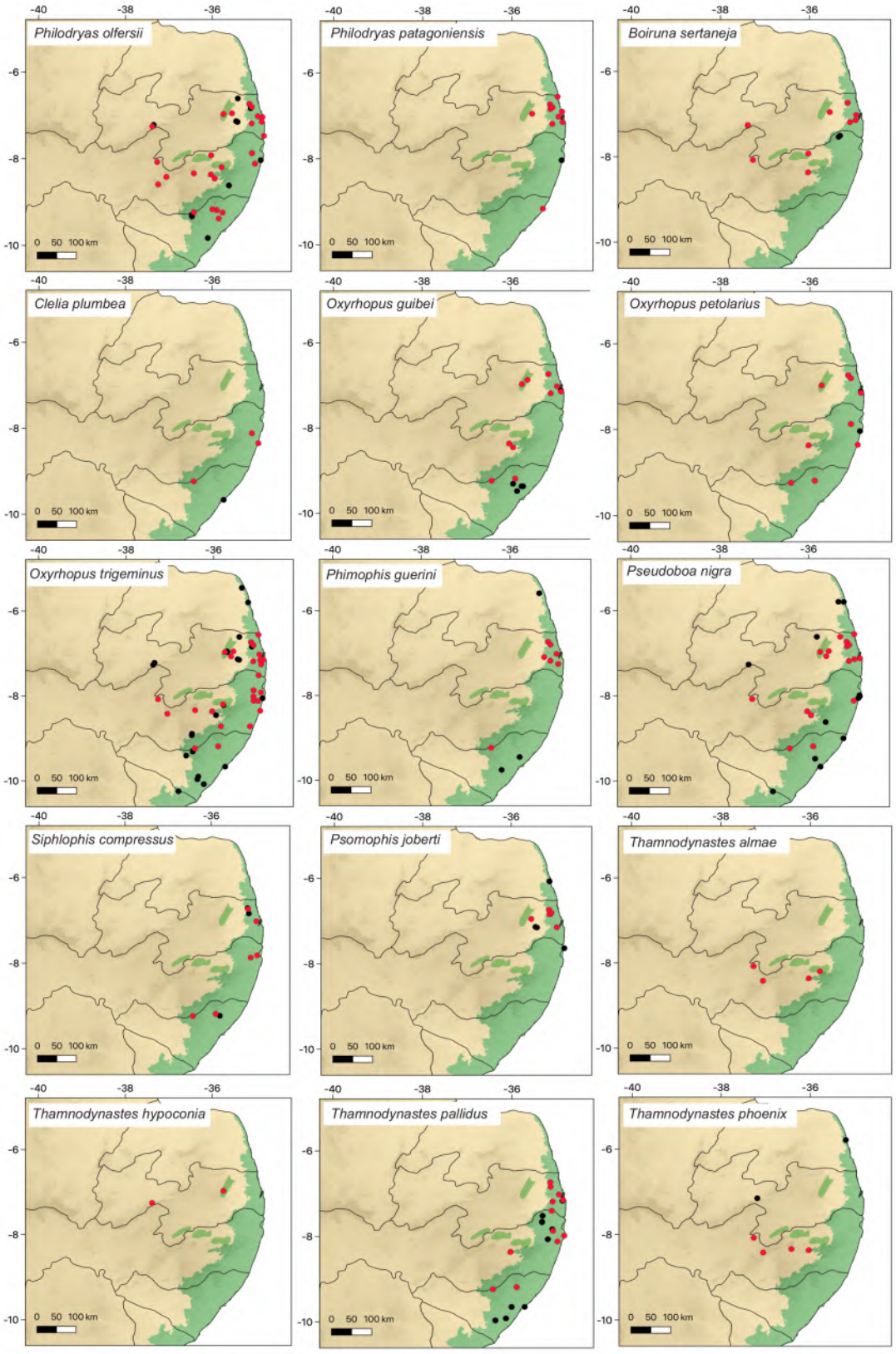

Figure 22. Distribution maps of the snakes of the PEC: *Philodryas olfersii, Pseudablabes patagoniensis, Boiruna sertaneja, Clelia plumbea, Oxyrhopus guibei, Oxyrhopus petolarius, Oxyrhopus trigeminus, Phimophis guerini, Pseudoboa nigra, Siphlophis compressus, Psomophis joberti, Thamnodynastes almae, Thamnodynastes hypoconia, Thamnodynastes pallidus* and *Thamnodynastes phoenix*.

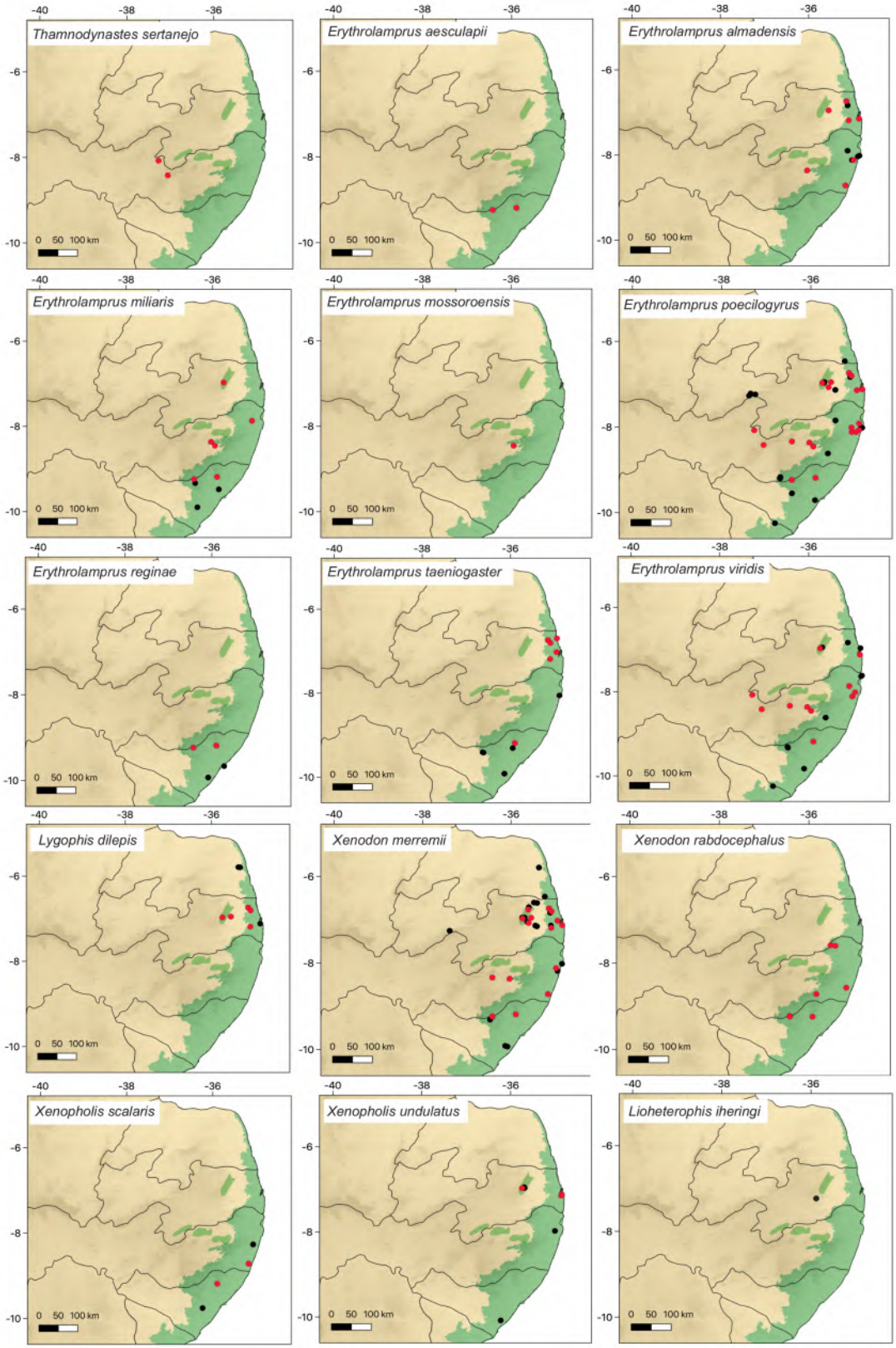

Figure 23. Distribution maps of the snakes of the PEC: *Thamnodynastes sertanejo, Erythrolamprus aesculapii, Erythrolamprus almadensis, Erythrolamprus miliaris, Erythrolamprus mossoroensis, Erythrolamprus poecilogyrus, Erythrolamprus reginae, Erythrolamprus taeniogaster, Erythrolamprus viridis, Lygophis dilepis, Xenodon merremii, Xenodon rhabdocephalus, Xenopholis scalaris, Xenopholis undulatus* and *Lioheterophis iheringi.*

Table 1. List of snake species recorded for the Pernambuco Endemism Center. DAF: Distribution in the Atlantic Forest, Endemic of The Atlantic Forest*, Endemic of the PEC **; DDAAF: Disjunct Distribution between Amazon and Atlantic Forest; DBA: Distribution in *Brejos de Altitude.*

Snake species	DAF	DDAAF	DBA
Typhlopidae			
Amerotyphlops amoipira	X		
Amerotyphlops arenensis			X
Amerotyphlops brongersmianus	X		
Amerotyphlops paucisquamus	X		
Leptotyphlopidae			
Epictia borapeliotes	X		X
Trilepida salgueiroi	X*		
Anomalepididae			
Liotyphlops trefauti	X*		
Boidae			
Boa constrictor	X		X
Corallus hortulanus	X		
Epicrates assisi	X		X
Epicrates cenchria		X	
Viperidae			
Bothrops bilineata		X	X
Bothrops erythromelas			X
Bothrops leucurus	X*		X
Bothrops muriciensis	X**		
Crotalus durissus	X		X
Lachesis muta		X	X
Elapidae			
Micrurus aff. ibiboboca	X		X
Micrurus corallinus	X*		
Micrurus ibiboboca	X		
Micrurus lemniscatus	X		
Micrurus potyguara	X**		
Micrurus sp.			X
Colubridae			
Chironius bicarinatus	X		X
Chironius carinatus		X	X
Chironius exoletus	X		X
Chironius flavolineatus	X		X
Dendrophidion atlantica	X**		
Drymarchon corais	X		X

Drymoluber brazili			X
Drymoluber dichrous		X	X
Leptophis ahaetulla	X		X
Oxybelis aeneus	X		X
Palusophis bifossatus	X		X
Spilotes pullatus	X		X
Spilotes sulphureus		X	X
Tantilla melanocephala	X		X
Dipsadidae			
Atractus caete	X**		X
Atractus maculatus	X**		
Atractus potschi	X*		
Dipsas aff. neuwiedii	X*		X
Dipsas mikanii	X		X
Dipsas sazimai	X*		
Dipsas variegata		X	X
Sibon nebulata		X	
Imantodes cenchoa	X		X
Leptodeira annulata	X		X
Caaeteboia gaeli	X**		
Echinanthera cephalomaculata	X**		X
Echinanthera cephalostriata	X*		X
Taeniophallus affinis	X*		X
Taeniophallus occipitalis	X		X
Apostolepis cearensis	X		X
Apostolepis longicaudata	X		
Hydrodynastes gigas	X		
Helicops angulatus	X		
Helicops leopardinus	X		X
Philodryas nattereri	X		X
Philodryas olfersii	X		X
Pseubablabes patagoniensis	X		X
Boiruna sertaneja	X		X
Clelia plumbea		X	X
Oxyrhopus guibei	X		X
Oxyrhopus petolarius	X		X
Oxyrhopus trigeminus	X		X
Phimophis guerini	X		X
Pseudoboa nigra	X		X
Siphlophis compressus		X	X

Psomophis joberti	X		X
Thamnodynastes almae			X
Thamnodynastes hypoconia	X		X
Thamnodynastes pallidus		X	X
Thamnodynastes phoenix	X		X
Thamnodynastes sertanejo	X		X
Erythrolamprus aesculapii	X		X
Erythrolamprus almadensis	X		X
Erythrolamprus miliaris	X		X
Erythrolamprus mossoroensis	X		
Erythrolamprus poecilogyrus	X		X
Erythrolamprus reginae		X	X
Erythrolamprus taeniogaster		X	
Erythrolamprus viridis	X		X
Lygophis dilepis	X		X
Xenodon merremii	X		X
Xenodon rhabdocephalus		X	X
Xenopholis scalaris		X	
Xenopholis undulatus	X		X
Lioheterophis iheringi			?

There is no consensus if *Brejos de Altitude* or *Brejos Nordestinos* must be considered in the PEC Atlantic Forest or part of the Caatinga dominion (Pereira-Filho and Montingelli 2011; Guedes et al. 2014; Pereira-Filho et al. 2020). These forests harbor Amazon and Atlantic Forest species, as well as endemic species to the Caatinga, and represent isolated moist areas in the semi-arid Caatinga (Guedes et al. 2014; Pereira-Filho et al. 2020). These areas are very similar to the Atlantic Forest in fauna and flora, although each of them represents a singular area with specific sets of fauna and flora (Barbosa et al. 2004; Pereira-Filho and Montingelli 2011). According to Pereira-Filho et al. (2020), 63 species of snakes are recorded in the *Brejos de Altitude* located in the PEC, and this number is probably an underestimation due to the lack of extensive sample efforts. This specific region of the PEC Atlantic Forest gives a singular identity for the PEC forests, increasing its complexity and diversity.

Six centers of endemism or biogeographic subregions are currently known for snakes in the Atlantic Forest (Moura et al. 2017; Barbo et al. 2021), and the PEC is always recovered even with different methodologies. The PEC forests represent the northernmost center of endemism and the only one with a strong connection and geographical proximity with the Caatinga (Pereira-Filho et al. 2020; França et al. 2020), assigning a very particular snake fauna to this region. As stated by Pereira-Filho et al. (2017) and França et al. (2020), the high number of snakes in open areas and with wide distribution probably is the main difference among the PEC and the other biogeographic subregions of the Atlantic Forest. The proximity of the Caatinga and the *Tabuleiros* patches (savanna-like formations) in the forests must ensure the presence of non-typical Atlantic Forest snakes.

The spatial distribution of the 31 snake assemblages along two NMDS axes (Bray-Curtis matrix) showed clear separation of the PEC assemblages in relation to the others in the Atlantic Forest, and even with different methodologies (biogeographical or statistical), the singularity of the snake assemblages of the PEC is confirmed (Figure 24).

According to Nogueira et al. (2019), there are 415 species of snakes in Brazil, and approximately 220 in the Atlantic Forest, representing 54.32% of all species (Moura et al. 2017; Barbo et al. 2021). A total of 86 species are recorded in the PEC, representing 43.09% of all species recorded in the Atlantic Forest. Considering the endemicity of the species, there are 79 endemic species in the whole biome, and 7 are endemic to the PEC forests: *Micrurus potyguara, Bothrops muriciensis, Caaeteboia gaeli, Atractus caete, Atractus maculatus, Echinanthera cephalomaculata* and *Dendrophidion atlantica* (Barbo et al. 2021). These seven species are known from a few records in the PEC. *Micrurus potyguara* is recorded in Rio Grande do Norte, Paraíba and Pernambuco states, but only with one locality in each state; *Bothrops muriciensis* is only known for the Murici Ecological Station with a few records in a very small area (Freitas et al. 2012); *Caaeteboia gaeli* was described with only three exemplars, two of them recorded in Paraíba state and one from Pernambuco (Montingelli et al. 2020); *Atractus caete* is only known in two localities in Pernambuco and Alagoas; and finally, *Atractus maculatus* and *Dendrophidion atlantica* are the most common endemic species of the PEC, both with 6 known localities in Alagoas and Pernambuco and Alagoas, Pernambuco and Paraíba, respectively, and both species are found in very low densities.

Despite the increasing amount of information in the last few years, the study of the PEC snake fauna and other groups of vertebrates cannot be considered appropriate, with many areas without any sampling effort, and the elevated rate of recently described new species corroborates this panorama. Some vertebrates have been described for the PEC in recent years. Silva et al. (2002) described a new species of Pygmy-Owl (*Glaucidium mooreorum*), then two new frog species of the genus *Phyllodytes* were described (Peixoto et al. 2003), and two new species of medium sized mammals, *Dasyprocta iacki* and *Coendu speratus* (Feijó and Langutth 2013; Mendes Pontes et al. 2013) were also described in 2013. In addition, seven snake species (*Echinanthera cephalomaculata, Bothrops muriciensis, Atractus caete, Dendrophidion atlantica, Micrurus potyguara, Amerotyphlops arenensis* and *Caaeteboia gaeli*) were described in the last decades (Di-Bernardo 1994; Ferrarezzi and Freire 2001; Passos et al. 2010; Freire et al. 2010; Pires et al. 2014; Graboski et al. 2015; Montingelli et al. 2020). These new descriptions clearly highlight the importance of the PEC forests and the urgent need to study the fauna of this region of the Atlantic Forest.

There is no way to know the extinction rates faced by the PEC remnants and the real richness of these forests is forever lost. The whole region faces strong degradation processes through direct deforestation and the irresponsible expansion of cities. In a general view, the sugar cane monoculture widely implemented by power plants strongly reduced the original area of the Atlantic Forest, and ironically the power plants nowadays maintain the largest remnants in the area, and despite the huge importance of these fragments, they represent only a glimpse of what the northern Atlantic Forest was in its prime. Studying the PEC forests is imperative in order to comprehend how to preserve these forests and assure viable populations

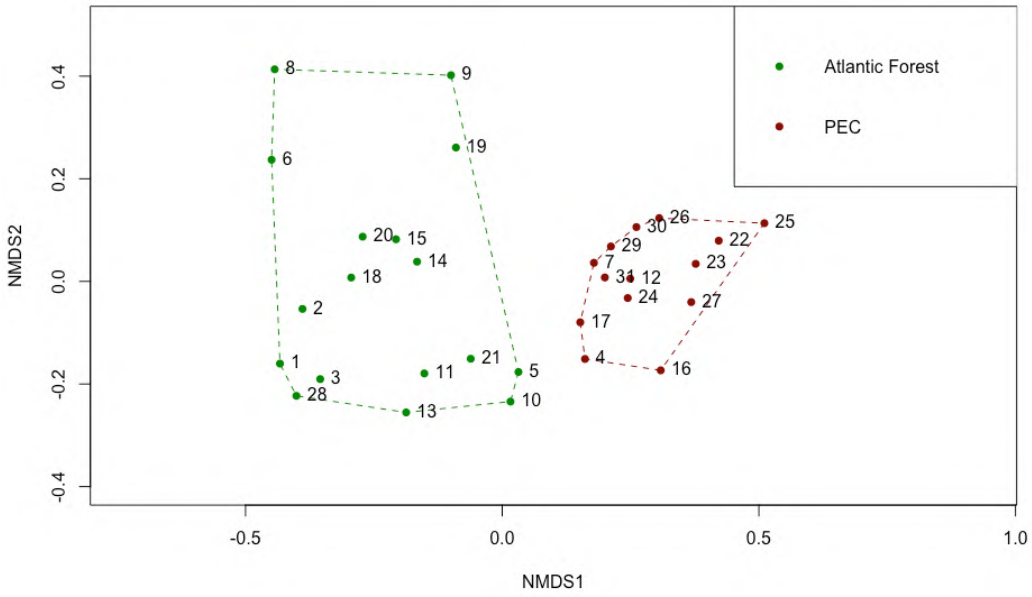

Figure 24. NMDS result showing the separation of the snake assemblages of the PEC in comparison to the others along the Atlantic Forest. Stress value S= 01049. The numbers are: 1- Jureia (SP), 2- Santa Virginia (SP), 3- Picinguaba (SP), 4 Murici (AL), 5- Ilheus (BA), 6- S.F. de Paula (RS), 7- João Pessoa (PB), 8-Passo Fundo (RS), 9- Santa Maria (RS), 10- Vera Cruz (BA), 11- S. Mendanha (RJ), 12- Areia (PB), 13- D. Caxias (RJ), 14-Viçosa (MG), 15- C. Botelho (SP), 16- Serra do Urubu (PE), 17- Pedra Talhada (PE/AL), 18- Paranapiacaba (SP), 19- Ouro Branco (MG), 20- Tipirai (SP), 21- Vitoria (ES), 22- Arcoverde (PE), 23- Sertânea (PE), 24- Brejo dos Cavalos (PE), 25- Belo Jardim (PE), 26- Alagoinha (PB), 27- Alagoa Grande (PB), 28- Sete Barras (SP), 29- Mamanguape (PB), 30- Espirito Santo (PB), 31- Santa Rita (PB).

of plants and animals living in a singular area of an extremely threatened biome.

ACKNOWLEDGEMENTS

The authors are grateful to Hussam Zaher from the Zoology Museum of the Universidade de São Paulo (MZUSP) and to Gustavo Calazans from the Universidade Federal da Paraíba (CHUFPB) for permission to examine the specimens under their care. TBG thanks to Universidade Estadual do Maranhao for the Senior Researcher fellowship.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Study conception: GAPF, MAF, TBG, FGRF
Data analysis: GAPF, FGRF, TBG
Wrote the first draft of the manuscript: GAPF, TBG
Wrote the final version of the manuscript: GAPF, MAF, GJBM, WLSV,FGRF, TBG
Supervision: GAPF, TBG, FGRF, WLSV, MAF, GJBM

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Received: 20 July 2021
Accepted: 05 November 2021
Published: 23 November 2021

Editor: Rômulo Alves

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Trilepida salgueiroi- Alagoas: Murici: CHP-UFRPE 4957; *Amerotyphlops arenensis*- Paraiba: Areia: Mata do Pau Ferro: Mzusp 20037- 20047, Caruaru, Brejo dos Cavalos CHP-UFPRE 6022; *Amerotyphlops brongersmianus*- Paraiba: Mamanguape: Reserva Biologica Guaribas: Mzusp 20247-52; Cruz do Espírito Santo: Mata do Açude do Cafundo: MZUSP 20248-20252; Pernambuco: Saltinho: CHP-UFRPE 0648; Caruaru: Parque Municipal João Vasconcelos Sobrinho CHP-UFRPE 0914; *Amerotyphlops paucisquamus*- Paraiba: Mamanguape: Reserva Biologica Guaribas: CHUFPB 11096-106; *Epictia borapeliotes*- Paraiba: Cruz do Espirito Santo: Mata do Açude do Cafundo: MZUSP 20336-20343; Alagoa Grande: Mata de Pitombeira: MZUSP 23061, 23064; Pernambuco: Igarassu CH-UFRPE 0582,0583; Ilha de Itamaraca CHP-UFRPE 1062; *Boa constrictor*- Paraiba: Alagoinha: MZUSP 22996; João Pessoa CHUFPB 4463; Pernambuco: Tapacura CHP-UFRPE 0731, Dois Irmãos CHP-UFRPE 0911; *Corallus hortulana*- Paraiba: Santa Rita: MZUSP 23070, Araruna MZUSP 20262;Epicrates assisi- Paraiba: Areia: Mata do Pau Ferro: MZUSP 20379-20382; Alagoa Grande: MZUSP 22982-22984; João Pessoa: CHP-UFPB 4464; Alagoas: Ibateguara: CHP-UFRPE 6019; *Epicrates cenchria*: Pernambuco: Ccminic CHP-UFRPE 0709, Aliança CHP-UFRPE 0846; Alagoas: CHP-UFRPE 2970; *Bothrops bilineata*: Pernambuco: Timbauba: MNRJ 9016; *Bothrops erythromelas*: Pernambuco: Caruaru: Brejo dos Cavalos: CHP-UFRPE 6033; Bothrops leucurus: Paraiba: João Pessoa: CHUFPB 4475; Pernambuco: Tapacura: CHP-UFRPE 4517, Caruaru: Brejos dos Cavalos CHP-UFPB 1067, 1068; *Bothrops muriciensis*: Alagoas: Murici: MNRJ 7036, 7037; UFAL 379; *Crotalus durissus*: Paraiba: Conde CHUFPB 424; Pernambuco: Cciminic CHP-UFRPE 0558, 0718, Aldeia CHP-UFRPE 0668; *Lachesis muta*: Paraiba: Cruz do Espirito Santo: CHUFPB 00001, Santa Rita: MZUSP 23079; Pernambuco: Ccminic: CHP-UFRPE 0559; *Micrurus* aff. *ibiboboca*: Paraiba: Cruz do espírito Santo: MZUSP 20437, 20438, 204392; João Pessoa: CHUFPB 4360; Pernambuco: Recife: CHP-UFRPE 3204 *Micrurus* sp: Paraiba: Areia: Mata do Pau Ferro: MZUSP 20428, 20429 *Micrurus lemniscatus*: Alagoas: Maragogi: CHP-UFRPE 6032; *Micrurus potyguara*: Paraiba: João Pessoa: CHUFPB 4355, 4358, 4359, 4361; *Chironius carinatus*: Pernambuco: Recife: Parque Dois Irmãos: CHP-UFRPE 1014; Alagoas: Murici CHP-UFRPE 6010, 6011,6012; Chironius exoletus: Paraiba: Areia: Mata do Pau Ferro MZUSP 20414, 20414, 20416, 20417; *Chironius falvolineatus*: Paraiba: Santa Rita: MZUSP 23077, 23086, 23087, João Pessoa CHUFPB 4493; *Dendrophidion atlantica*: Paraiba: Santa Rita: MZUSP 22830; Pernambuco: CHP-UFRPE 0546; *Drymarchon corais*: Paraiba: João Pessoa: CHUFPB 1102; *Drymoluber brazili*: Paraiba: Matureia: Pico do Jabre: MZUSP 7562; *Drymoluber dichrous*: Paraiba: João Pessoa: CHUFPB 4484; Pernambuco: Caruaru: Brejo dos Cavalos CHP-UFRPE 6024; *Leptophis ahaetulla*: Paraiba: Alagoinha MZUSP 23030, João Pessoa CHUFPB 4443; Pernambuco: Recife: Parque Dois Irmãos CHP-UFRPE 3007, *Oxybelis aeneus*: Paraiba: João Pessoa CHUFPB 4481; Pernambuco: Cminic CHP-UFRPE 0710, Tapacura CHP-UFRPE 3040, 3149; *Palusophis bifossatus*: Paraiba: João Pessoa CHUFPB 2431; *Spilotes pullatus*: Paraiba: Mamanguape MZUSP 20383, Areia: Mata do Pau Ferro MZUSP 20384, 20385. Pernambuco: Cminic CHP-UFRPE 0554, 0717, Tapacura CH-UFRPE 0830; *Spilotes sulphureus*: Paraiba: João Pessoa: MZUSP 20369, CHUFPB 4331; *Tantilla melanocephala*: Paraiba: João Pessoa: CHUFPB 4326, Cruz do Espírito Santo MZUSP 20321, 20322; Pernambuco: Caruaru: Brejo dos Cavalos CHP-UFRPE 0854, 1030, 1074, Recife CHP-UFRPE 0539; *Atractus maculatus*: Pernambuco: Cminic CH-UFRPE 0720, 0721; Dipsas aff. neuwiedi: Paraiba: Areia: Mata do Pau Ferro MZUSP 20418-20424; *Dipsas mikanii*: Paraiba: Paraiba: João Pessoa CHUFPB 169, Cruz do Espirito Santo MZUSP 20270; *Sibon nebulata*: Paraiba: Paraiba: João Pessoa CHUFPB 4327; Pernambuco: Cminic CHP-UFRPE 553; *Imantodes cenchoa*: Paraiba: João Pessoa: CHUFPB 4440; *Leptodeira annulata*: Pernambuco: Caruaru: Brejo dos Cavalos MZUSP 9016; *Caaeteboia gaeli*: Paraiba: Cruz do Espirito Santo MZUSP 19559, Pedras de Fogo CHUFPB ; 24395; *Taeniophallus affinis*: Paraiba: João Pessoa CHUFPB 4439, Cruz do Espirito Santo MZUSP 20266; Pernambuco: Caruaru: Brejo dos Cavalos CHP-UFRPE 6031; *Taeniophallus occipitalis*: Paraiba: João Pessoa CHUFPB 4503, Cruz do Espirito Santo MZUSP 20267, 20268; Pernambuco: Cminic 0551, Caruaru, Brejos dos Cavalos CHP-UFRPE 6030; *Apostolepis cearensis*: Paraiba: Cruz do Espirito Santo MZUSP 20345, 20346, 20347; *Apostolepis longicaudata*: Paraiba: Mamanguape: Reserva Biologica Guaribas CHUFPB 308; *Hydrodynastes gigas*: Paraiba: João Pessoa CHUFPB 4317; Helicops angulatus: Paraiba: Cruz do Espirito Santo MZUSP 20357, 20358, 20359, Santa Rita MZUSP 23072, 23073, 22074; *Philodryas nattereri*: Paraiba: João Pessoa CHUFPB 4468, Cruz do Espirito Santo MZUSP 20408, 20409; *Philodryas olfersii*: João Pessoa CHUFPB 4446, Alagoinha MZUSP 23068,; Pernambuco: Ciminic CHP-UFRPE

0719; Alagoas, Murici: CHP-UFRPE 6011, 6012; *Pseudablabes patagoniensis*: Paraiba: João Pessoa CHUFPB 4442; Alagoas: Porto de Pedra: CHP-UFRPE 6021; *Boiruna sertaneja*: Paraiba: Cruz do Espirito Santo MZUSP 20371; *Oxyrhopus guibei*: Paraiba: João Pessoa CHUFPB 4511, Cruz do Espirito Santo MZUSP 20372, 20373, 20374, Areia: Mata do Pau Ferro MZUSP 20290, 20291; *Oxyrhopus petolarius*: Paraiba: João Pessoa CHUFPB 4449, Areia: Mata do Pau Ferro MZUSP 20281; Pernambuco: Cminic CHP-UFRPE 0716; *Oxyrhopus trigeminus*: Paraiba: João Pessoa CHUFPB 4450, Cruz do espirito Santo MZUSP 20302, 20303, Areia: Mata do Pau Ferro MZUSP 20274, 20275; Pernambuco: Caruaru: Brejo dos cavalos CHP-UFRPE 6062, 0913, 1066; *Phimophis guerini*: Paraiba: Conde MZUSP 20360; *Pseudoboa nigra*: Paraiba: João Pessoa CHUFPB 962, Cruz do Espirito Santo MZUSP 20364, 20365, 20366, Pernambuco: Tapacura CHP-UFRPE 0934; Alagoas: Murici CHP-UFRPE 6016; *Siphlophis compressus*: Paraiba: Mamanguape: Reserva Biologica Guaribas CHUFPB 15987,; Pernambuco: Cminic CHP-UFRPE 0565; *Psomophis joberti*: Paraiba: Santa Rita CHUFPB 4319, Alagoinha MZUSP 23031, 23033; *Thamnodynastes hypoconia*: Paraiba: Mamtureia: Pico do Jabre MZUSP 20375; *Thamnodynastes pallidus*: Paraiba: João Pessoa 4366, Santa Rita: Mata da Usina São João MZUSP 20355, 20356; Pernambuco: Cminic CHP-UFRPE 0548, 0646; *Thamnodynastes Phoenix*: Pernambuco: Caruaru: Brejo dos Cavalos CHP-UFRPE 6025; *Erythrolamprus aesculapii*: Pernambuco: Aldeia CHP-UFRPE 0670; *Erythrolamprus almadensis*: Paraiba: João Pessoa CHUFPB 4454; Pernambuco: Caruaru: Brejo dos Cavalos CHP-UFRPE 0693; *Erythrolamprus miliaris*: Paraiba: Areia: Mata do Pau Ferro MZUSP 20334; Erythrolamprus poecilogyrus: Paraiba: Areia: Mata do Pau Ferro MZUSP 20360, Alagoinha MZUSP 23013; *Erythrolamprus viridis*: Paraiba: Areia: Mata do Pau Ferro MZUSP 20317; Pernambuco: Caruaru: Brejo dos Cavalos CHP-UFRPE 6029; Alagoas: Murici CHP-UFRPE 6018; *Lygophis dilepis*: Paraiba: Santa Rita: Mata da Usina São João MZUSP 20348, Alagoinha MZUSP 22990; *Xenodon merremii*: Paraiba: Santa Rita: Mata da Usina São João MZUSP 20284; Pernambuco: Cminic CHP-UFRPE 0555; *Xenopholis scalaris*: Pernambuco: Reserva Saltinho CHP-UFRPE 0623, 0633; *Xenopholis undulatus*: Paraiba: Areia: Mata do Pau Ferro: MZUSP 9100