



Original Paper

Synopsis of Loganiaceae in Pernambuco, Brazil

Arthur Macedo^{1,5}, Edlley Pessoa^{2,3} & Marccus Alves⁴

Abstract

Loganiaceae is a member of the Gentianales order and comprises about 460 species in 16 genera, being mainly distributed in the tropical regions of the world. The Brazilian Neotropical region is one of the centers of diversity for two of the richest genera of Loganiaceae, *Spigelia* and *Strychnos*, justifying floristic efforts to better understand family diversity in this region. This study aims to update the taxonomic knowledge about the Loganiaceae of the state of Pernambuco, Northeastern Brazil, providing an identification key, diagnostic characters of the species emphasizing vegetative features, illustrations and photos, distribution maps, and occurrence within Conservation Units. We analyzed collections from 18 local herbaria and conducted field expeditions to strategical locations of the state between 2017 to 2019. In total, we identified 16 species belonging to three genera: *Mitreola* (1), *Spigelia* (8) and *Strychnos* (7). As shown in previous studies, the morphology of the carpoatlas was determinant in the recognition of *Spigelia* species. In Pernambuco, *Mitreola petiolata*, *Spigelia flemmingiana*, *S. laurina*, *S. scabra*, *Strychnos atlantica*, *S. divaricans*, *S. mattogrossensis*, and *S. trinervis* were found only in the Atlantic Forest, while *Spigelia alborubra*, *S. linarioides*, *S. pernambucensis*, *Strychnos gardneri*, and *S. rubiginosa* were found only in the Caatinga domain. *Spigelia anthelmia*, *S. polystachya*, and *Strychnos parvifolia* have continuous distribution between both phytogeographic domains, presenting high morphological variability in these areas. Among the 16 loganiaceous species, 13 belong to 20 different Conservation Units spread over the two phytogeographic domains, highlighting the importance of maintaining these areas for the conservation of biodiversity in the state.

Key words: Asterids, Atlantic Forest, Caatinga, carpoatlas, Gentianales.

Resumo

Loganiaceae é membro da ordem Gentianales e compreende cerca de 460 espécies em 16 gêneros, sendo principalmente distribuída nas regiões tropicais do mundo. A região Neotropical do Brasil é um dos centros de diversidade para dois dos gêneros mais ricos de Loganiaceae, *Spigelia* e *Strychnos*, justificando esforços florísticos para melhor compreensão da diversidade da família nesta região. Este trabalho tem como objetivo atualizar o conhecimento taxonômico sobre Loganiaceae no estado de Pernambuco, Região Nordeste do Brasil, provendo chave de identificação, características diagnósticas dos táxons com ênfase em aspectos vegetativos, ilustrações e fotografias, mapas de distribuição e suas ocorrências em Unidades de Conservação. Foram analisadas coleções botânicas de 18 herbários locais e conduzidas expedições de coleta em locais estratégicos do estado. No total, foram identificadas 16 espécies pertencentes a três gêneros: *Mitreola* (1), *Spigelia* (8) e *Strychnos* (7). Como proposto em estudos prévios, também foi identificado que a morfologia do carpoatlas é determinante no reconhecimento das espécies de *Spigelia*. Em Pernambuco, *Mitreola petiolata*, *Spigelia flemmingiana*, *S. laurina*, *S. scabra*, *Strychnos atlantica*, *S. divaricans*, *S. mattogrossensis* e *S. trinervis* foram encontradas exclusivamente na Mata Atlântica, enquanto *Spigelia alborubra*, *S. linarioides*, *S. pernambucensis*, *Strychnos gardneri* e *S. rubiginosa* foram encontradas apenas na Caatinga. *Spigelia anthelmia*, *S. polystachya* e *Strychnos parvifolia* possuem distribuição contínua entre os dois domínios fitogeográficos, apresentando alta

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variabilidade morfológica nestas áreas. Entre as 16 espécies de Loganiaceae, 13 pertencem a 20 Unidades de Conservação diferentes espalhadas nos dois domínios fitogeográficos, destacando a importância da manutenção destas áreas para a preservação da biodiversidade no estado.

Palavras-chave: Asterídeas, Floresta Atlântica, Caatinga, Carpoatlas, Gentianales.

Introduction

Loganiaceae is a member of the Gentianales (Asterids; APG IV 2016) and comprises about 460 species in 16 genera distributed in four tribes: Antonieae, Loganieae, Spigeliaceae and Strychnaceae (Struwe *et al.* 2018). The family has pantropical distribution and a few temperate representatives in North America, Asia and in Australasia (Christenhusz *et al.* 2017). The Neotropical region is one of the centers of diversity for two of the richest genera of the family, *Spigelia* and *Strychnos*, with two other genera, *Antonia* and *Bonyunia*, endemic to this area (Struwe *et al.* 2018).

The family is represented by five genera (*Antonia*, *Bonyunia*, *Mitreola*, *Spigelia*, and *Strychnos*) and 131 species (approximately a third of the global diversity) distributed throughout Brazilian territory (BFG 2015, 2018). In the Northeast region, Loganiaceae is represented by four genera and ca. 50 species, being three genera and 17 species recorded so far for the state of Pernambuco, distributed through the Caatinga and Atlantic Forest domains (Chiappeta 1985; BFG 2015, 2018).

Members of Loganiaceae are characterized by an herbaceous to lianescent habit, opposite or/to pseudo-verticillate leaves, interpetiolate stipules (reduced to a stipular line in *Strychnos*), and eucamptodromous, pinnipalmate, pinnate, or acrodromous venation. The flowers are actinomorphic, with a sympetalous corolla composed of four to five petals, four to five stamens attached to the corolla tube, and usually presenting a syncarpous gynoecium with a superior ovary. The fruits can be berries, capsules, or drupes (Struwe *et al.* 2018).

The family is globally known for the metabolism of deadly poisonous substances (complex indole alkaloids) produced by several genera and species, especially in *Strychnos* and *Spigelia* (Struwe *et al.* 2018). American species of *Strychnos* present at least 44 alkaloids, including strychnine, brucine and diaboline (Silva *et al.* 2005). At least 18 *Strychnos* species are used by South American native communities as ingredients to produce the dart poison curare, being *S. toxifera*

one of its main components (Krukoff 1965; Bisset 1992; Schultes & Raffauf 1990; Silva *et al.* 2005). *Spigelia* is also represented by poisonous plants, due to the presence of spiganthine, ryanodine, isoquinoline, and flavonoids (Hübner *et al.* 2001; Santos 2002; Camurça-Vasconcelos *et al.* 2004), with a historical use by traditional communities as an anti-helminthic treatment (Struwe *et al.* 2018).

Taxonomic studies in Loganiaceae performed in the Northeast Region of Brazil have suggested this area as an important hotspot for family diversification (Chiappeta 1985; Nurit *et al.* 2005; Melo *et al.* 2009; Brandão & Rapini 2018; Macedo *et al.* 2020) due to the presence of several endemic species, including the recent description of new and rare taxa (Fernández Casas 2008; Popovkin *et al.* 2011; Brandão & Rapini 2017; Macedo *et al.* 2019). However, the recognition of some loganiaceous species in this area is still challenging as so far there are few taxonomic studies available including the species rich state of Pernambuco.

Therefore, this study aims to provide new floristic efforts to better understand the family diversity in this region through a taxonomic synopsis of the species of Loganiaceae occurring in the state of Pernambuco providing an identification key, diagnostic characters of the species emphasizing vegetative features, illustrations, and photos, distribution maps, and occurrence within Conservation Units of the state.

Material and Methods

The study area comprises the state of Pernambuco, which is part of the Northeast Region of Brazil, having an extension of 98,068,021 km² (1.15% of the national territory) (IBGE 2015). The geomorphology of the state includes coastal plains located along the Atlantic Coast, highlands in the Borborema and Araripe Plateaus (from 450 to about 1,100 m elevation), and intracontinental lowland areas such as the Sertaneja-São Francisco Depression (Andrade 2007; Ferreira *et al.* 2014). Pernambuco also comprises the archipelago of Fernando de Noronha, constituted of about 20 islands distributed in the Atlantic Ocean (Araujo Filho *et al.* 2014). The archipelago is located

350 km off the Brazilian coast, with ca. 26 km² of extension and presents vegetation very compromised by human activity (Araújo Filho *et al.* 2014).

The state includes portions of two phytogeographic domains: the Atlantic Forest, covering about 17% of its territory (ca. 17,652 km²) and present in the eastern portion of the state, and the Caatinga domain, covering 83% of the territory (ca. 81,396 km²) and distributed through the central and western portions (IBGE 2004; Coutinho 2006). The Atlantic Forest is characterized by a tropical wet climate with high annual precipitation, between 1,400–2,200 mm (Andrade 2007; Ferreira *et al.* 2014). It includes coastal and dune forest vegetation (locally called *Restingas*), semideciduous and ombrophilous forests, ranging from lowland (ca. 100 to 500 m) to montane (500 to 1,300 m) elevation (Andrade 2007; Ferreira *et al.* 2014) (Fig. 1a-c). Besides that, enclaves of sub-montane to montane semideciduous forest, locally called “Brejos de Altitude”, are located among the Caatinga domain (Andrade 2007; Ferreira *et al.* 2014) (Fig. 1d-e). The Caatinga *s.s.* is characterized by a xeric, seasonally dry tropical forest vegetation (Fig. 1f-h) with a semiarid climate, annual precipitation between 400–700 mm, concentrated in a short rainy season followed by prolonged droughts (Ferreira *et al.* 2014). Granitic-gneiss rock outcrops are fairly common in this domain (Fig. 1g-h) (adapted from IBGE 2012; Zelenski & Louzada 2019).

Specimens from the following herbaria were analyzed: EAC, IPA, PEUFR, SPF, and UFP. Specimen photographs from these herbaria were also analyzed: ALCB, ASE, CEPEC, HCDAL, HUEFS, HUESB, HURB, HVASF, IAC, MO, NY, and UB. Herbaria acronyms follows Thiers (continuously updated). Additionally, the following recently created and non-indexed herbaria were visited: Herbário do Projeto de Integração do São Francisco (Petrolina, Pernambuco), Herbário Sérgio Tavares (Recife, Pernambuco), Herbário do Trópico do Semi-árido (Petrolina, Pernambuco). Fieldwork was carried out between 2017 and 2019 in nine localities (Cabo de Santo Agostinho, Ipojuca, Recife, São Lourenço da Mata and Sirinhaém in the Atlantic Forest, and Bezerros, Buique, Gravatá, and Petrolina in the Caatinga), totaling 20 expeditions to different ecosystems and Conservation Units (CUs) in Pernambuco.

All collected samples were treated following herborization techniques (Peixoto & Maia 2013) and deposited in the UFP herbarium. The specimens

were analyzed under a stereomicroscope, following the terminology of Radford *et al.* (1974) and Harris & Harris (2001) for a general morphological description of the material examined. For *Spigelia*, the morphology of the corolla (distal and proximal portion of the tube) follows Macedo *et al.* (2019), and morphology of the carpologic structures (carpoatlas, metastyle and epistyle) follows Fernández Casas (2003).

The selected examined material includes specimens that cover most of the morphologic and geographic variability within the study area. Genera and species descriptions were based only on specimens from the studied area. Geographic distribution maps and the heatmap, showing the density of specimens collected across the state of Pernambuco, were produced using the software QGIS 3.18 (2020) according to the original geographic coordinates available on specimen labels or using the geographic coordinates of the municipalities when the data were absent. The heatmap was created based on Kernel density estimation using 35 km diameter ray of each collection. The names of the Conservation Units (CUs) and respectively abbreviations follow CNUC (2020).

Results and Discussion

The family Loganiaceae, in Pernambuco, can be recognized by its herbaceous to lianescent habit, round or squared stems, opposite to pseudo-verticillate leaves, and monochasial, dichasial or thyrsoid inflorescences. Calyx (4–)5-merous, gamosepalous, corolla (4–)5-merous, gamopetalous, androecium isomerous, gynoecium semiapocarpic to syncarpic, ovary half inferior or superior, globose or 2-lobbed. Fruits capsules or berries.

We confirmed 16 taxa distributed in three genera of the 17 species of Loganiaceae previously cited for Pernambuco (Chiappeta 1985; BFG 2018): *Mitreola* (1), *Spigelia* (8), and *Strychnos* (7). Eight species were found exclusively in the Atlantic Forest, five were found only in the Caatinga, and three exhibited continuous distribution between both phytogeographic domains presenting a high morphological variability probably related to the different climate conditions of each region. *Spigelia gracilis* A. de Candolle (1845: 6) was previously recorded for Pernambuco (BFG 2018), however, the specimen that was used as a state record is an isotype of *Spigelia pernambucensis* Fernández Casas (2013: 317). In comparison with

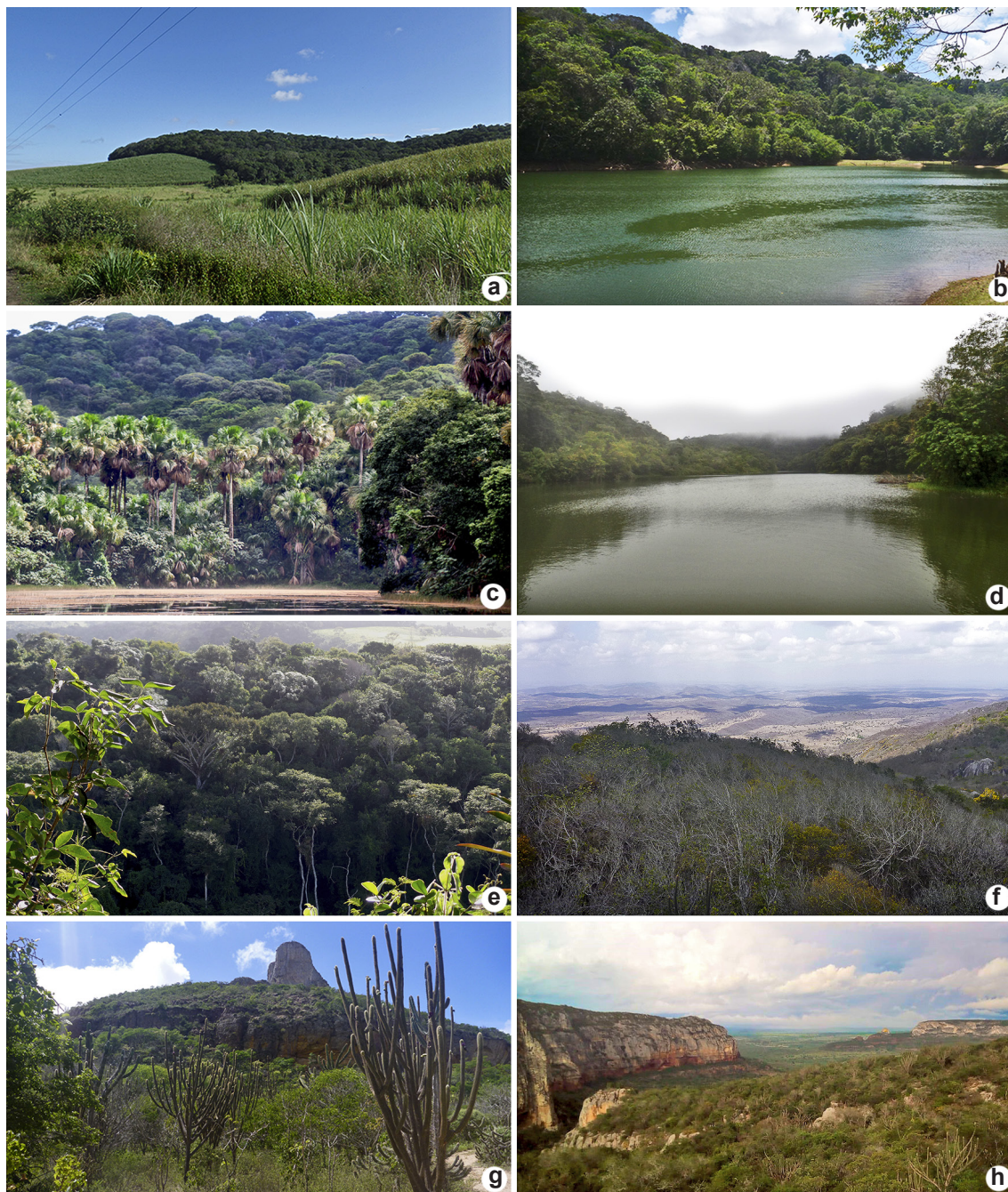


Figure 1 – a-h. Phytophysiognomies of the two phytogeographic domains in Pernambuco (Atlantic Forest and Caatinga) – a-c. lowland Atlantic Forest fragments – a. Mata das Cobras, Usina Trapiche, Sirinhaém; b. Piedade fragment, Usina São José, Igarassu; c. Parque Estadual de Dois Irmãos, Recife; d. submontane Atlantic Forest fragment - Reserva Particular do Patrimônio Natural Pedra D'anta, Jaqueira, Lagoa dos Gatos; e-h. Caatinga phytophysiognomies – e. submontane Semideciduous Seasonal Forest enclaves (brejo de altitude), in the Reserva Particular do Patrimônio Natural Serra do Contente; f. shrubby vegetation area in the Parque Ecológico de Serra Negra, Bezerros; g. tree-shrub vegetation in Parque Nacional do Catimbau, Buíque; h. rocky outcrop vegetation in Parque Nacional do Catimbau, Buíque.

the previous treatment of Chiappeta (1985), six new taxa were recorded to the state, four species of *Spigelia* [*S. alborubra* A. Macedo & E. Pessoa (2019: 148), *S. linarioides* A. de Candolle (1845: 6), *S. pernambucensis* and *S. polystachya* Klotzsch ex Progel (1868: 265)] and two of *Strychnos* [*S. gardneri* A. de Candolle (1845: 14) and *S. mattogrossensis* S. Moore (1895: 392)]. Most of the new taxa were recorded in the Caatinga, confirming that more studies were carried out in this domain in the last decades effecting the documentation of the regional biodiversity.

It was not possible to confirm the occurrence of *Strychnos bahiensis* Krukoff & Barneby (1969: 29) and *Strychnos pseudoquina* A. Saint-Hilaire (1822: 340) in Pernambuco. Although being recorded in the state by the BFG (2015, 2018), none of the analyzed specimens showed vegetative and/or floral morphology compatible with the type specimens, respectively. Therefore, the occurrence of these species in the state were excluded from this study. Nevertheless, it is still possible the existence of specimen of these taxa in unstudied herbaria collections.

According to Krukoff & Monachino (1942), the biology of some *Strychnos* species, especially the canopy-dwelling lianas occurring in tropical forests as the Amazon and Atlantic Forest, with short flowering periods, could probably be the reason why several samples were found only in the vegetative stage in the visited collections, contributing to the misidentifications of sterile specimens. According to Ducke (1955), the species of *Strychnos* from the Northeastern Atlantic Forest of Brazil are flowering in summer (December to March) and fruiting in winter (July to September). Concerning *Strychnos*, extensive fieldwork effort is still needed to support a complete taxonomic revision of the genus seeking a better understanding of its diversity in Brazil.

On the contrary, probably due to its life cycle as herbs, all *Spigelia* species are very usually found with flowers and fruits. Also, carpologic features, as the carpoatlas morphology (size, shape, foramen, and extremities), were proved to be useful characters for identification in the species level for *Spigelia* (Tab. S1, available on supplementary material <<https://doi.org/10.6084/m9.figshare.19609968.v1>>; Figs. 2-3). Fernández Casas (2003) and Manoel *et al.* (2017) also noted that carpologic structures (carpoatlas, metastyle, and epistyle) can be extremely useful to circumscribe species in the genus.

According to the heatmap of the density of specimens collected across the state, the taxonomic knowledge of Loganiaceae in Pernambuco is centered in areas close to the metropolitan region of the state capital, Recife, along the coastal Atlantic Forest, and in the vicinity of Parque Nacional do Catimbau in the Caatinga domain (Fig. 4); both regions that have been studied in detail in the last years (Buril *et al.* 2013; Delgado-Júnior *et al.* 2014; Ferreira *et al.* 2016; Melo *et al.* 2016; Delgado-Júnior & Alves 2017; Athiê-Souza *et al.* 2019). On the other hand, areas such as the transition zone between the Atlantic Forest and the Caatinga, as well as the extreme western portion of the state continued to be very poorly sampled, due to low historical fieldwork carried out in the Caatinga in comparison with the Atlantic Forest and the lower number of research institutions placed in this area.

Most of the loganiaceous species in Pernambuco have wide distribution ranges, some ranging from North (*Mitreola petiolata* (Walter ex J.F Gmel.) Torrey & A. Gray (1841: 45) and *Spigelia anthelmia* L. (1753: 149) or Central (*Spigelia scabra* Chamisso & Schlechtendal (1826: 202), *Spigelia polystachya*) to South America, whereas others are widely distributed only in South America (*S. gardneri*, *S. mattogrossensis*, and *S. rubiginosa* A. de Candolle (1845: 16). Furthermore, some species present disjunct distributions between the Atlantic and Amazon Forest [*Spigelia flemmingiana* Chamisso & Schlechtendal (1826: 203) and *Strychnos divaricans* Ducke (1932: 746)]. Other species, however, have restricted distributions to one domain: *Strychnos trinervis* (Vell.) Martius (1843: 121) and *Spigelia laurina* Chamisso & Schlechtendal (1826: 204) both endemic to the Atlantic Forest in Brazil; or to restricted areas *Strychnos atlantica* Krukoff & Barneby (1969: 61) which is endemic to the Atlantic Forest of Northeastern Brazil; and *Spigelia alborubra*, *S. linarioides*, and *S. pernambucensis* all endemic to the Caatinga and/or the Brazilian Cerrado (Krukoff & Monachino 1942; BFG 2015, 2018; Fernández Casas 2016; Zappi 2016). Unfortunately, only *Spigelia alborubra* was evaluated according to the IUCN guidelines for conservation status, being considered Endangered (EN) (IUCN 2022; Macedo *et al.* 2019).

Some species of the herbaceous genera, *Mitreola* and *Spigelia*, are observed in roadsides in urban centers (*e.g.*, *S. anthelmia*) or, more often, in forest fragment margins, sometimes with

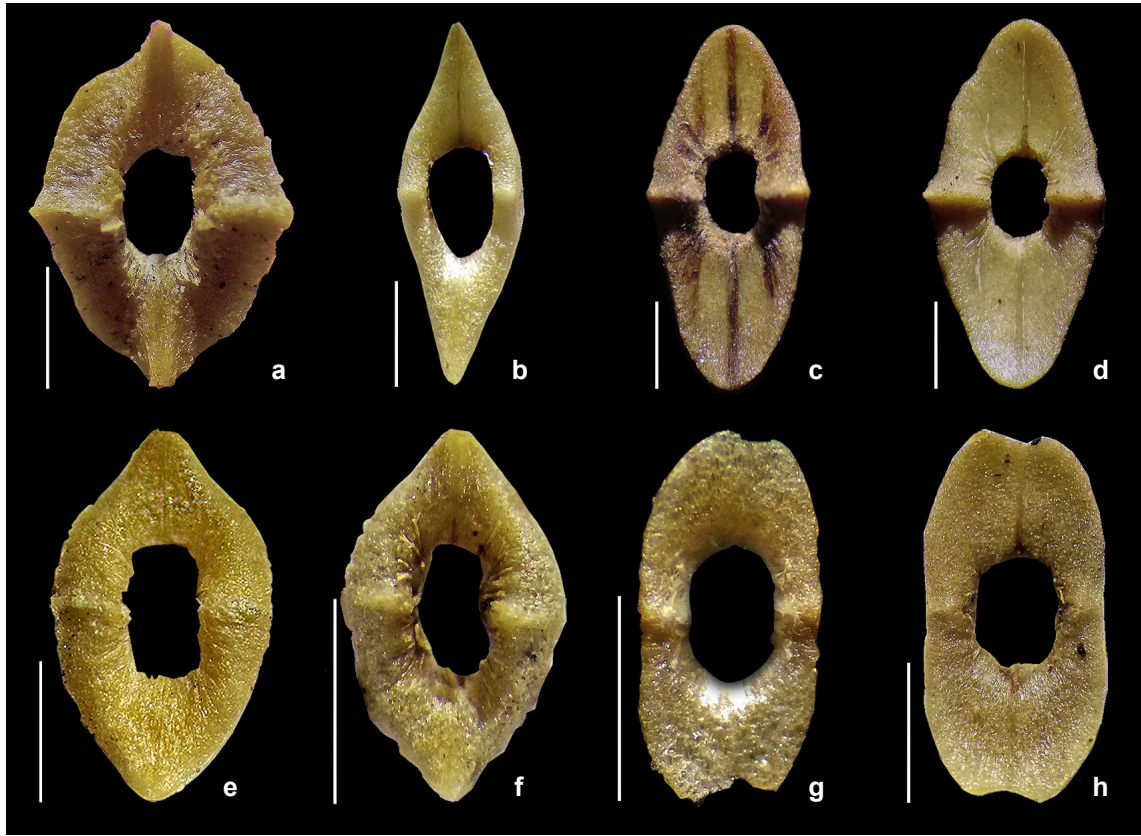


Figure 2 – a-h. Morphology of the carpoatlas of *Spigelia* in Pernambuco – a. *Spigelia alborubra*; b. *S. anthelmia*; c-d. *S. laurina*; e. *S. linarioides*; f. *S. flemmingiana*; g. *S. polystachya*; h. *S. scabra*. (a. J.L.S. Lima 374; b. A. Macedo 147; c-d. M.L. Bazante et al. 996; e. S.A. Lima 06; f. A. Macedo 59; g. G.I.L. Fotius 3446; h. A. Macedo 96). *S. pernambucensis* without data. Bars = 1 mm.

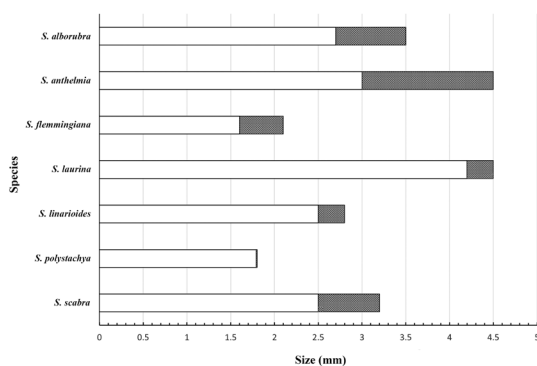


Figure 3 – Diagram showing the morphological variation on carpoatlas size in species of *Spigelia* from the state of Pernambuco, Brazil (*S. pernambucensis* without data). The whole bar represents the full size of a single carpoatlas for each species and the grey fraction corresponds to intraspecific variation.

high anthropic activity in both Atlantic Forest and Caatinga. Less frequently, some species are found in rock outcrops in both domains, such as *S. flemmingiana* and *S. linarioides*, while temporary water bodies are the habitat of *S. polystachya*.

An important ecological feature observed in many of the *Spigelia* species is that they are rare, *i.e.* form small populations, and were generally represented by few specimens in herbaria. However, *S. anthelmia* presents wide geographic distribution and its colonization success can be explained by self-pollination (Erbar & Leins 1999) and the adaptation for surviving exclusively under anthropic action, occupying poor and degraded soils, and by a presumed dispersion by humans. In *Strychnos* some species seem to be more common than others, such as *S. parvifolia* A. de Candolle (1845: 16) present in the Atlantic Forest and *S. rubiginosa* in the Caatinga. In the

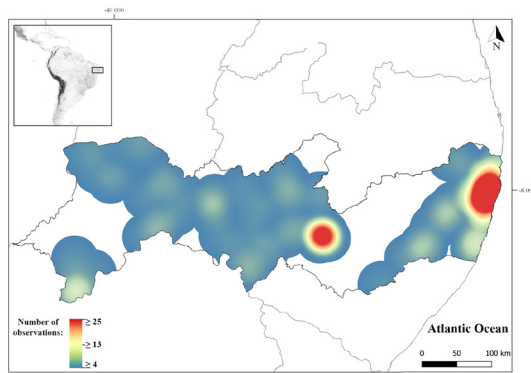


Figure 4 – Heatmap based on the number of collections of Loganiaceae in Pernambuco.

Atlantic Forest, the species of *Strychnos* were collected more frequently at the edge of forest fragments, probably due to easier access to those environments that favors the visualization of the canopy individuals, as the species are mostly lianescent. In the Caatinga, the species are usually shrubby-like, being observed in the open areas

as small-sized plants, such as *S. parvifolia* and *S. rubiginosa*, growing in sandy soils and rock outcrops.

Thirteen species (82%) were found in 20 CUs in the state (Tab. S2, available on supplementary material <<https://doi.org/10.6084/m9.figshare.19609968.v1>>), while three grow in unprotected areas - *Spigelia alborubra* (a Northeastern endemic species considered endangered of extinction), *S. polystachya*, and *Strychnos mattogrossensis* (Figs. 5-8). Three species are only known in Pernambuco from PARNA Catimbau, one of the few patches of preserved sedimentary Caatinga in Pernambuco (Moro *et al.* 2014), where several other angiosperms have been recorded so far only in this area of the state (Siqueira-Filho & Leme 2006; Hind & Bautista 2009; Souza-Silva *et al.* 2010; Athiê-Souza *et al.* 2019). Some authors suggest a strong influence of the geomorphology and paleoclimate in the local flora (Ab'Saber 1974; Athiê-Souza *et al.* 2019), stressing the CU as an important resource for conservation of the Caatinga biodiversity in Northeastern Brazil.

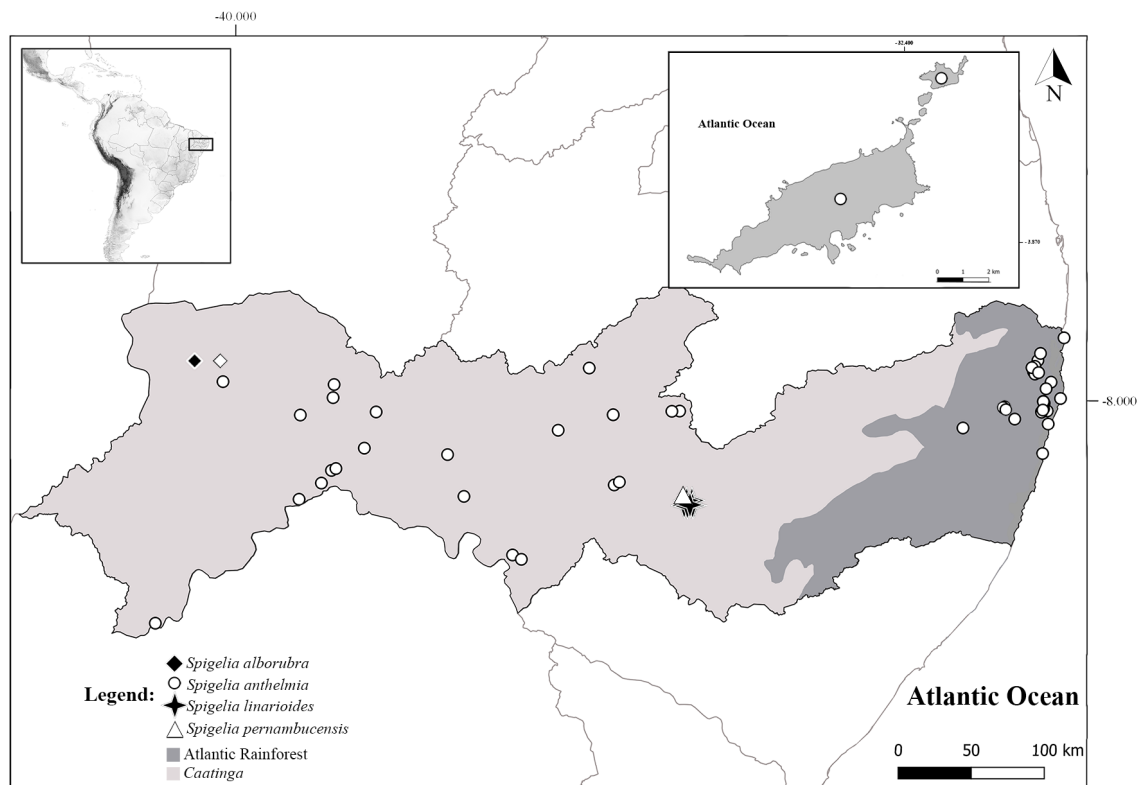


Figure 5 – Distribution map of *Spigelia alborubra*, *S. anthelmia*, *S. linarioides* and *S. pernambucensis* in Pernambuco, with detail of the Fernando de Noronha archipelago.

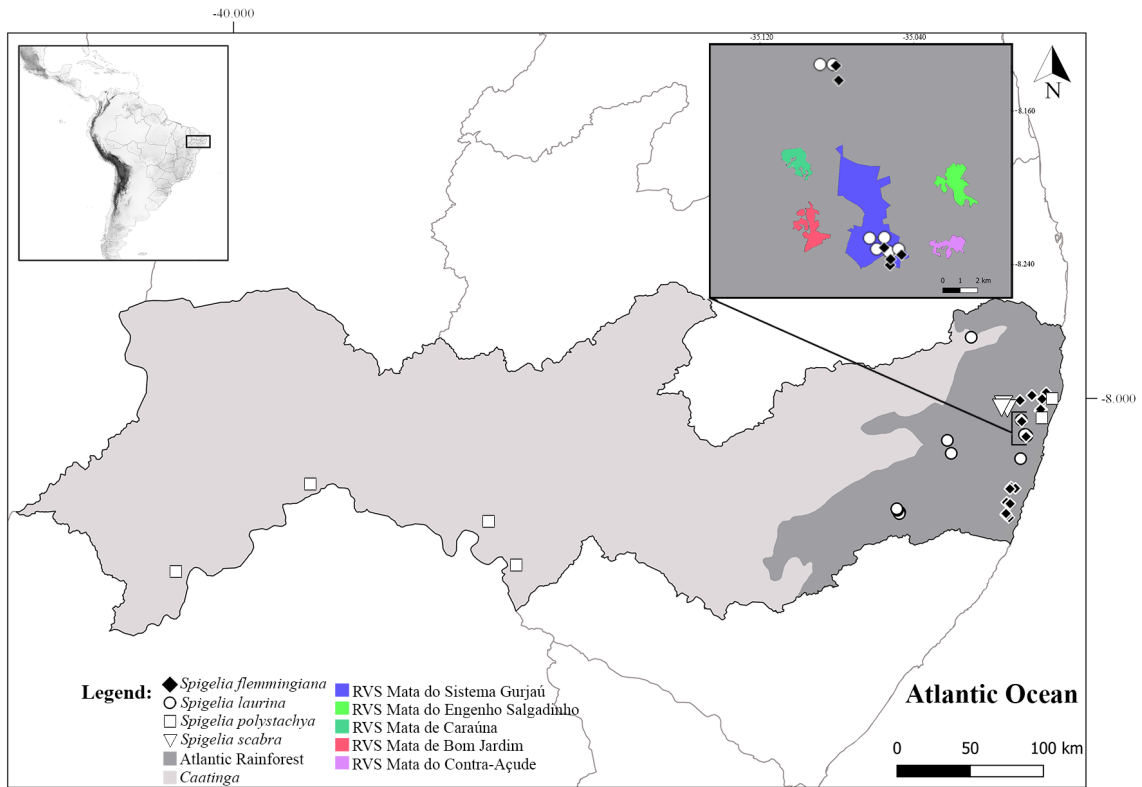


Figure 6 – Distribution map of *Spigelia flemmingiana*, *S. laurina*, *S. polystachya* and *S. scabra* in Pernambuco.

Likewise, we consider some CUs in the Atlantic Forest as also relevant for conservation, such as APA Aldeia-Beberibe, containing other four Conservation Units within its limits (RVS Mata do Quizanga, RVS

Mata da Usina São José, RVS Mata de Miritiba and PE Dois Irmãos). Seven species of Loganiaceae were registered in APA Aldeia-Beberibe, being this CU the most diverse area for Loganiaceae in Pernambuco.

Identification key for the species of Loganiaceae occurring in Pernambuco

1. Herbs; leaf venation eucamptodromous or pinnipalmate, sometimes with a single midvein; capsules 2
2. Inflorescences a dichasium; fruits apically 2-horned..... 1.1. *Mitreola petiolata*
- 2'. Inflorescences a scorpioid monochasium; fruits apically 2-rounded 3
3. Stems cylindrical; fruits with muricate surface..... 2.2. *Spigelia anthelmia*
- 3'. Stems quadrangular throughout or only at the apex; fruits with a smooth surface..... 4
4. Leaves linear 5
5. Interangular veins absent along the stem; corolla urceolate; metastyle absent..... 2.7. *Spigelia polystachya*
- 5'. Interangular veins present along the stem; corolla infundibuliform or salverform; metastyle present 6
6. Corolla salverform with constriction at the apex of the tube, red and white; exerted stigma hidden among corolla lobes..... 2.1. *Spigelia alborubra*
- 6'. Corolla infundibuliform without constrictions, white and greenish to white and purple/pink; included stigma 7

- 7. Inflorescences > 7 cm long; calyx lobes greenish; corolla < 1.2 cm long, upper tube < 0.19 cm wide 2.6. *Spigelia pernambucensis*
- 7'. Inflorescences ≤ 7 cm long; calyx lobes green and purple; corolla > 1.22 cm long, upper tube > 0.3 cm wide 2.5. *Spigelia linarioides*
- 4'. Leaves elliptical to ovate 8
- 8. Inflorescences sessile; calyx lobes > 0.3 cm long 2.8. *Spigelia scabra*
- 8'. Inflorescences pedunculated; calyx lobes < 0.25 cm long 9
- 9. Leaves ≥ 6.0 cm long; inflorescence peduncle ≥ 1.3 cm long, 8–15 flowers; calyx lobes 0.23–0.25 cm long; corolla 1.5–1.6 cm long 2.4. *Spigelia laurina*
- 9'. Leaves ≤ 5.5 cm long; inflorescence peduncle ≤ 1.2 cm long, 16–20 flowers; calyx lobes 0.12–0.15 cm long, corolla 1.3–1.35 cm long 2.3. *Spigelia flemmingiana*
- 1'. Shrubs, small trees to lianas; leaf venation acrodromous; berries 10
- 10. Leaves velutinous 3.6. *Strychnos rubiginosa*
- 10'. Leaves glabrous to pubescent 11
- 11. Leaves pubescent only on the axils of the abaxial veins, glabrous on the rest of the blade; inflorescences axillary 3.3. *Strychnos gardneri*
- 11'. Leaves totally glabrous or indument not concentrated on the axils of the abaxial veins; inflorescences terminal 12
- 12. Leaves pubescent along the entire abaxial veins, margin ciliate; fruits with membranaceous epicarp 3.5. *Strychnos parvifolia*
- 12'. Leaves glabrous or glabrescent along abaxial veins; fruits with woody epicarp 13
- 13. Leaf apex acute to obtuse; calyx lobes narrowly triangular 14
- 14. Adaxial surface of the leaves lustrous; calyx lobes > 2.6 mm long 3.7. *Strychnos trinervis*
- 14'. Adaxial surface of the leaves opaque; calyx lobes < 2.2 mm long 3.1. *Strychnos atlantica*
- 13'. Leaf apex acuminate; calyx lobes deltate 15
- 15. Calyx lobes < 0.9 mm long; corolla < 1.37 cm long 3.2. *Strychnos divaricans*
- 15'. Calyx lobes > 1 mm long; corolla > 3 mm long 3.4. *Strychnos mattogrossensis*

1.1. *Mitreola petiolata* (Walter ex J.F Gmel.) Torrey & A. Gray, Fl. N. Amer. 2(1): 45. 1841.

Figs. 7; 9a

Herbs. Leaves opposite, venation eucamptodromous; stipules reduced. Inflorescences pedunculate, profusely branched dichasium. Corolla 5-merous and urceolate, 0.13–0.15 cm long; stamen included; gynoeceium semi-apocarpic, ovary half-inferior, 2-lobate at the apex, each lobe with one style and stigma. Fruit capsules, 2-lobed, lobes hornlike, slightly muricate surface, green when mature.

Material examined: Igarassu, Usina São José, Fragmento Piedade, 5.IX.2007, fr., *A. Alves-Araújo et al.* 139 (UFP). São Lourenço da Mata, 1.I.1920, fr., *B. Pickel* 665 (IPA); 30.X.1931, fr., *B. Pickel* 2833 (IPA); 13.VIII.1934, fr., *B. Pickel* 3621 (IPA).

Additional material examined: BRAZIL. PIAUÍ: Floriano, 17.V.1997, fl. and fr., *L.P. Felix* (HST 15968).

Uruçuí, Barra da Volta, 12.V.2009, fl. and fr., *A.M. Miranda et al.* 5899 (HST).

In Brazil it is found in the Northern (only Pará and Tocantins), Northeastern (all states except for Alagoas and Sergipe), Central-Western (except for Mato Grosso do Sul) and Southeastern (except for Espírito Santo) regions (BFG 2018).

Mitreola comprises six species, some endemic to Asia and others with wide continental distribution in Africa, Asia, and America (Islas-Hernández *et al.* 2019). It is reported as a weedy species in Pernambuco, inhabiting sugarcane plantations in the Atlantic Forest domain (Chiappeta 1985). However, few specimens of *M. petiolata* have been collected in the state. It was rediscovered in 2009 after seventy-five years from the last collection record (Macedo *et al.* 2020), probably due to being ignored by collectors during fieldwork for having

a weedy ecological role. It was found with flowers and fruits throughout the year.

2. *Spigelia* L., Sp. Pl. 1: 149. 1753.

Herbs. Leaves opposite to pseudo-verticillate, venation pinnipalmate or only with one midvein; stipules usually reduced. Inflorescences sessile or pedunculate in a scorpioid monochasium, usually not branched. Corolla 5-merous, infundibuliform or salverform; stamen included or exerted; gynoecium syncarpous, ovary superior, globose, 1 style and stigma and pluriovulate. Fruit capsules 2-lobed, lobes rounded, smooth to muricate surface, green to orange when mature.

The total number of species is estimated to 65–90 species, the variation being due to the absence of a recent taxonomic revision (Struwe *et al.* 2018) and the description of some new taxa from Brazil and Mexico in recent years (Popovkin *et al.* 2011; Islas-Hernández *et al.* 2017a, b; Macedo *et al.* 2019).

2.1. *Spigelia alborubra* A.R. Macedo & E. Pessoa, Phytotaxa 404(4): 146–154. 2019. Figs. 5; 9b

Corolla 1.2–2 cm long, salverform, tube red and lobes white, constricted at the apex of the tube, lobes erect; stigma exerted, metastyle 2–2.2 cm long.

Material examined: Trindade, a 3 km a leste da cidade, 20.III.1982, fl. and fr., *L. Lima 374* (UFP-holotype, HTSA-isotype, INPA-isotype).

Additional material examined: BRAZIL. BAHIA: Jacobina, 13.VII.1998, fl. and fr., *L.P. Felix & G. Trajano 8502* (HST); *L.P. Felix & G. Trajano 8522* (HST). Miguel Calmon, 14.VII.1991, fl. and fr., *A.M. Miranda & F. Esteves 332* (HST).

This species is endemic to Northeastern Region of Brazil, occurring in Caatinga in the states of Bahia and Pernambuco (Macedo *et al.* 2019).

Apparently, its morphology is adapted to semi-arid conditions (thin stems and reduced or absent leaves), making it difficult to differentiate from related species using vegetative features alone. It can be distinguished from *Spigelia pernambucensis* and *S. linarioides* by its corolla shape (salverform vs. infundibuliform) and color (red with white vs. white with/or pink). According to Macedo *et al.* (2019), it is found with flowers and fruits throughout the year.

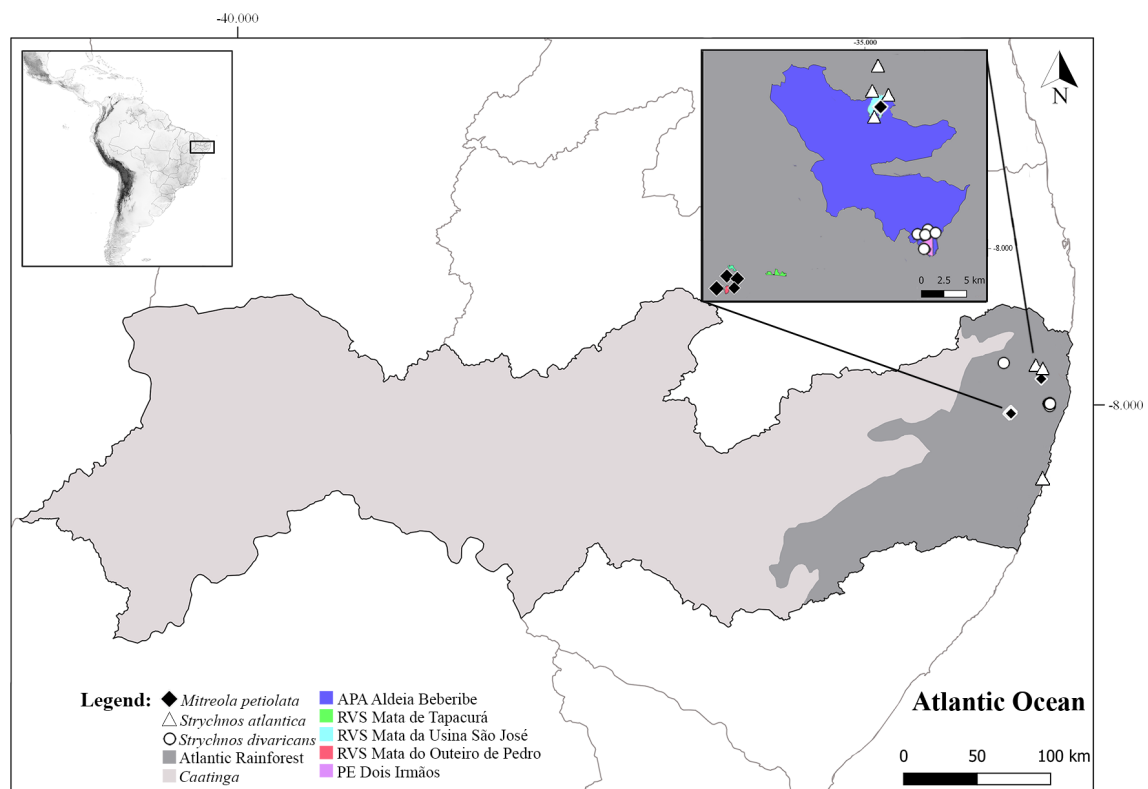


Figure 7 – Distribution map of *Mitreola petiolata*, *Strychnos atlantica* and *S. divaricans* in Pernambuco.

2.2. *Spigelia anthelmia* L., Sp. Pl. 1: 149. 1753.

Figs. 5; 10a-c

Stems cylindrical. Leaves one to two pairs opposite and reduced at the base, two pairs pseudo-verticillate at the apex of the stems. Corolla infundibuliform, 0.8–0.9 cm long, lower tube covered by the calyx lobes; metastyle 0.25–0.27 cm long. Capsules surface muriccate.

Selected material examined: Cabo de Santo Agostinho, Enseada dos Corais, 15.XII.2017, fl. and fr., *A. Macedo 13* (UFP). Carnaubeira da Penha, 25.V.2017, fl. and fr., *K. Pinheiro 2021* (UFP). Fernando de Noronha, 1.VI.1993, fl. and fr., *A.M. Miranda et al. 838* (PEUFR). Goiana, RPPN Fazenda Tabatinga 27.I.2010, fl. and fr., *D. Cavalcante & B.S. Amorim 78* (UFP). Igarassu, 6.IV.1983, fl. and fr., *A. Chiappeta CFPE 490* (IPA, PEUFR). Petrolina, área da CODEVASF, 22.XII.1982, fl. and fr., *G. Fotius 3255* (HTSA). Sertânia, Estação do IPA, 24.VII.2013, *M.C. Silva* (IPA 88480). Recife, Campus da UFPE, 19.III.1985, fl. and fr., *S.I. Silva* (UFP 4301).

The species is distributed from Florida (USA) to Southeastern Brazil (Guimarães & Pereira 1969; Fernández Casas 2016; BFG 2018). Nowadays, is naturalized in Tropical Africa and Asia, with a

recent first record in China (Liang *et al.* 2019). It is widely distributed in Brazil, except for the southern region (BFG 2018).

It grows in various environmental conditions and is the most common species and has the wider known distribution in the genus (Fernández Casas 2016). It is associated with urban zones and human occupation and is found in sidewalks and wastelands. In Pernambuco, it is found in the Atlantic Forest and Caatinga domains, and in Fernando de Noronha Island has become an invasive species. *Spigelia anthelmia* resembles *S. scabra*, but it differs from this latter species by its phyllotaxy (opposite and pseudo-verticillate *vs.* only pseudo-verticillate in *S. scabra*), sessile leaves (*vs.* petiolate leaves in *S. scabra*), and muriccate capsules (*vs.* smooth capsules in *S. scabra*). It is found with flowers and fruits throughout the year.

2.3. *Spigelia flemmingiana* Cham. & Schldtl., Linnaea 1(2): 203. 1826.

Figs. 6; 10d-f

Stems slightly quadrangular. Leaves petiolate, opposite to pseudo-verticillate close to

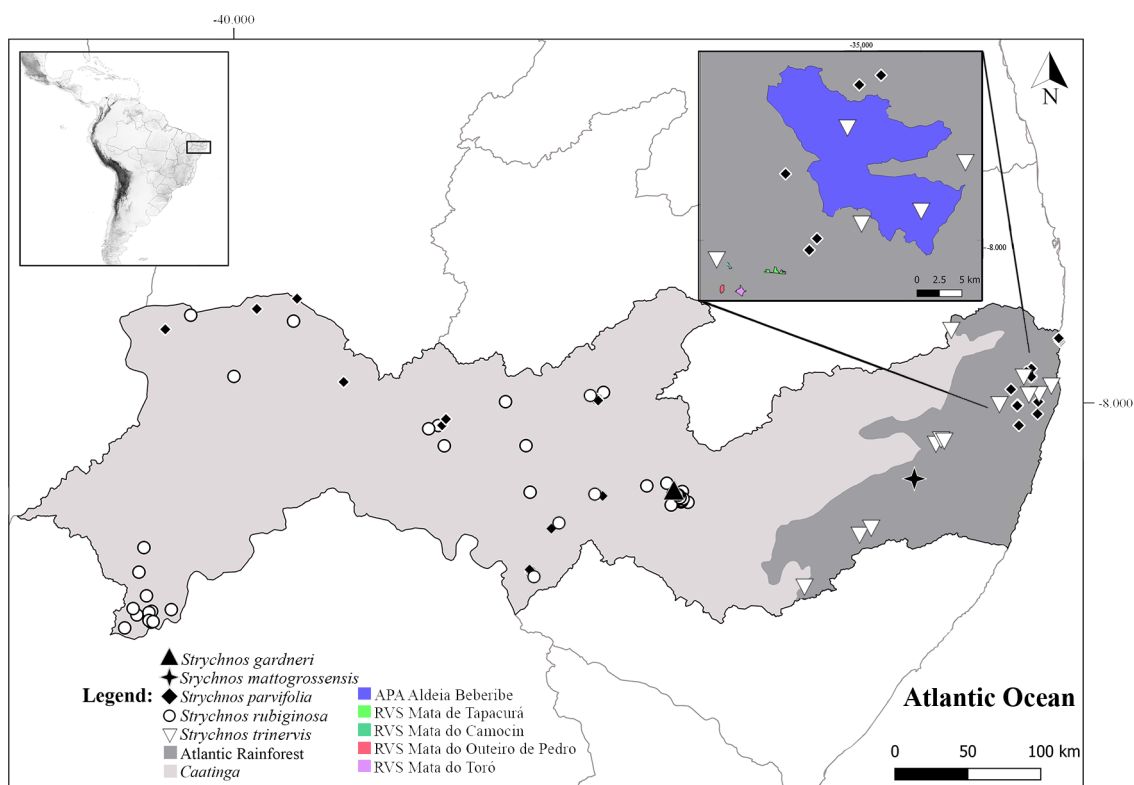


Figure 8 – Distribution map of *Strychnos gardneri*, *S. mattogrossensis*, *S. parvifolia*, *S. rubiginosa* and *S. trinervis* in Pernambuco.

the inflorescences. Inflorescences pedunculated. Calyx lobes 0.12–0.15 cm; corolla infundibuliform, 1.3–1.35 cm long, lower tube 0.58–0.6 cm long, upper tube 0.48–0.5 cm long; metastyle 0.15–0.17 cm long. Capsules smooth.

Selected material examined: Cabo de Santo Agostinho, Gurjaú, Reserva da Compesa, 7.VI.1983, fl. and fr., *A. Chiappeta CFPE 580* (PEUFR). Moreno, Reserva Ecológica de Carnijó, 3.IV.2003, fl. and fr., *R. Pereira 20* (IPA). Recife, Jardim Botânico do Recife, 30.XIX.2011, fl. and fr., *J.R. Maciel et al. 1497* (UFP); 8.XIX.2011, fl. and fr., *B.S. Amorim et al. 1222*; Mata do Curado, 15.V.2017, fl. and fr., *A. Macedo et al. 60* (UFP); Mata de Dois Irmãos, 16.III.2017, fl. and fr., *A. Macedo et al. 41* (UFP). Rio Formoso, Reserva Florestal de Saltinho, 4.IX.1984, fl. and fr., *F. Galindo* (IPA 49730). São Lourenço da Mata, Estação Ecológica de Tapacurá, Mata do Toró, 27.IX.2017, fl. and fr., *A. Macedo 97* (UFP).

This is a South American species (Fernández Casas 2016) distributed in Venezuela, Guyana, and French Guiana and along the Brazilian Atlantic Forest from Pernambuco to Paraná (Fernández Casas 2016; BFG 2018).

It is found in lowland ombrophilous forest and rock outcrops with low anthropic activity. It resembles *Spigelia laurina* but differs by its smaller inflorescence peduncles (< 1.2 cm vs. > 1.3 cm long in *S. laurina*), smaller corolla (1.3–1.35 cm vs. 1.5–1.6 cm long), and longer metastyle (0.15–0.17 cm vs. 0.11–0.12 cm long). It is found with flowers and fruits throughout the year.

2.4. *Spigelia laurina* Cham. & Schltld., *Linnaea* 1(2): 204–205. 1826. Figs. 6; 10g

Stems brownish to purplish, cylindrical and slightly quadrangular only at the apex. Leaves elliptical, coriaceous. Inflorescence axis quadrangular. Calyx lobes 0.23–0.25 cm long; corolla infundibuliform, white, 1.5–1.6 cm long. Capsules smooth.

Selected material examined: Amarají, Engenho Trindade, Mata da Encrenca, 7.XII.1983, fl. and fr., *A. Chiappeta et al. CFPE 846* (PEUFR). Cabo de Santo Agostinho, Reserva de Gurjaú, 8.VIII.1983, fr., *A. Chiappeta 320* (IPA); fl. and fr., *A. Chiappeta 5494* (IPA). Gravata, Fazenda Harmonia, 6.IX.1970, fl. and fr., *Andrade-Lima 70-5999* (IPA). Ipojuca, PE-42, 24.I.2014, fl. and fr., *A. Melo & B.S. Amorim 1216* (UFP). Lagoa dos Gatos, Mata do Jasmin, 21.IX.2017, fl. and fr., *M.L. Bazante et al. 996* (UFP); RPPN Pedra d'Anta, 22.XI.2011, fl. and fr., *D. Araújo et al. 22* (UFP). Timbaúba, Engenho Água Azul, 6.III.1998, fr., *A. Laurêncio et al. 783* (PEUFR).

This species is endemic to the Brazilian Atlantic Forest (Fernández Casas 2016; BFG

2018), occurring in Northeastern (Bahia and Pernambuco), Southeastern (Espírito Santo, Minas Gerais, Rio de Janeiro and São Paulo) and Southern (Paraná) regions (Chiappeta 1985; Fernández Casas 2016; BFG 2018).

It occurs in lowland to submontane ombrophilous forest with low anthropic activity. It differs from *Spigelia flemmingiana* by its longer inflorescence peduncle (> 1.3 cm vs. < 1.2 cm long), larger leaves (≥ 6.0 cm long vs. ≤ 5.5 cm long), and longer calyx lobes (0.23–0.25 vs. 0.12–0.15 cm long). It is found with flowers and fruits throughout the year.

2.5. *Spigelia linarioides* A. DC. *Prod.* 9: 6. 1845. Figs. 5; 10h

Stems quadrangular, 1–3 interangular ribs. Leaves 0.7–2 cm long, linear. Inflorescences up to 7 cm long. Calyx lobes green and purple; corolla infundibuliform, 1.22–1.4 cm long, white to pink or purple and greenish at the base, lower tube 0.55–0.7 \times 0.2–0.22 cm long, upper tube 0.28–0.3 \times 0.3–0.35 cm long. Capsules smooth.

Material examined: Buíque, Parque Nacional do Catimbau, estrada Buíque-Catimbau, 7.III.1996, fr., *A. Laurêncio et al. 317* (PEUFR); 11.VII.1997, fl. and fr., *A.M. Miranda et al. 2746* (HST); 1.III.2001, fl., *R. Pereira 2123* (IPA); 13.III.2008, fl., *O. Cano et al. 168* (IPA); Estrada do Furtuoso, 13.II.2008, fl., *G.D. Alcântara et al. 49* (HST); Serra de Jerusalém, 20.III.2017, fl. and fr., *S.A. Lima 06* (UFP); trilha das Torres, 11.I.1996, fl. and fr., *E. Freire et al. 32* (PEUFR); trilha para Serra de Jerusalém, 25.III.2018, fl. and fr., *A. Macedo et al. 135* (UFP).

This species is endemic to Brazil (BFG 2018) and found in the highland rocky fields in the Southeastern (Minas Gerais) and Northeastern (Bahia and Pernambuco) regions, and the Caatinga (Fernández Casas 2016).

In Pernambuco it is found only at PARNA Catimbau in the Caatinga vegetation, and in fragmented populations at Serra de Jerusalém. This fragmentation may be a consequence of the suppression of herbaceous and shrubby vegetation by the intense goat farming in the region (Parente & Parente 2010). It is morphologically similar to other species of *Spigelia* sect. *Graciles*, forming a species complex with *S. gracilis* and *S. pernambucensis*. The identities of these taxa are not fully understood (Brandão & Rapini 2018). *Spigelia linarioides* differs from *S. pernambucensis* by the larger corolla (1.22–1.4 cm vs. 1.1–1.2 cm). It is found with flowers and fruits from January to July.



Figure 9 – a-x. Diagnostic characters of the species of Loganiaceae in Pernambuco – a. *Mitreola petiolata* – floral and vegetative branches; b. *Spigelia alborubra* – floral branch; c. *Spigelia polystachya* – inflorescence section; d-e. *Spigelia pernambucensis* – d. floral and vegetative branches; e. flower; f. *Spigelia scabra* – habit; g-i. *Strychnos atlantica* – g. branch; h. inflorescence; i. calyx lobe; j-k. *Strychnos trinervis* – j. calyx lobe; k. flower; l-n. *Strychnos divaricans* – l. branch; m. flower; n. calyx lobe; o-p. *Strychnos gardneri* – o. branch; p. view of the axils of the abaxial nerves of the leaves; q-s. *Strychnos mattogrossensis* – q. branches with inflorescences; r. flower; s. calyx lobe; t-w. *Strychnos parvifolia* – t. morphotype with large leaves; u. morphotype with small leaves (Caatinga); v. indumentum on the axils of the abaxial surface (present on both morphotype leaves); w. calyx lobe. x. *Strychnos rubiginosa* – calyx lobe. (a. B. Pickel 665; b. J.L.S. Lima 374; c. G.I.L. Fotius 3446; d-e. A.M. Miranda et al. 1727; f. A. Macedo 96; g-i. Andrade-Lima 70-5718; j-k. B. Pickel 1213; l-n. A. Ducke 2309; o-p. G.C. Delgado-Júnior 413; q-s. A. Lima 70-5681A; t. Andrade-Lima 49-332; u-v. K. Pinheiro 1316; w. D. Cavalcanti et al. 579; x. A. Laurêncio et al. 330).

2.6. *Spigelia pernambucensis* Fern.Casas, Fontqueria 56(34): 317-318. 2013. Figs. 5; 9d-e

Stems strongly branched, quadrangular, 1–3 interangular ribs. Leaves linear. Inflorescences usually exceeding 7 cm long. Calyx lobes greenish; corolla infundibuliform, 1.1–1.2 cm long, pinkish, lower tube 0.5–0.52 × 0.1–0.12 cm, upper tube 0.3–0.35 × 0.17–0.19 cm.

Material examined: Buíque, Parque Nacional do Catimbau, estrada Buíque-Catimbau, 19.VI.1994, *A.M. Miranda et al.* 1727 (ALCB-holotype, HST-isotype, PEUFR-isotype).

This species is endemic to Brazil (Fernández Casas 2013), occurring only in Pernambuco (Fernández Casas 2013).

It is known only by the type specimen, collected at PARNA Catimbau in the Caatinga, in sympatry with *Spigelia linarioides*, which is morphologically similar, growing on sandy soils at 800 m elevation. It shows slightly smaller and narrower corolla in comparison to *Spigelia linarioides* (1.1–1.2 cm vs. 1.2–1.4 cm long) and larger inflorescences (> 7 cm vs. ≤ 7 cm long). The examined specimens do not provide enough data to describe the carpel morphology. Brandão & Rapini (2018) stressed out how difficult the delimitation in *S. sect. Graciles* is, especially due to the large morphological overlap between these two species. More studies are still needed to understand the taxonomic relationships between these two species, especially the possibility of synonymizing *S. pernambucensis* and *S. linarioides*. It is found with flowers and fruits in June.

2.7. *Spigelia polystachya* Klotzsch *ex* Progel, *Fl. bras.* 6(1): 265. 1868. Figs. 6; 9c

Up to 20 cm tall. quadrangular stems, interangular ribs absent. Leaves linear. Inflorescences pedunculated. Calyx lobes ca. 0.5 mm long; corolla 0.11–0.13 cm long, urceolate, white; metastyle absent.

Selected material examined: Cabrobó, lagoa temporária, 16.II.2012, fl. and fr., *V.M. Cotarelli et al.* 1346 (HVASF). Floresta, 27 km ao sul da cidade, 5.III.2009, fl. and fr., *J.G. Carvalho-Sobrinho* 2031 (HVASF). Petrolândia, Lagoa Itaparica, 18.I.2012, fl. and fr., *V.M. Cotarelli et al.* 1182 (HVASF). Olinda, Casa Caiada, 27.VI.1961, fl. and fr., *S. Tavares* 625 (IPA). Petrolina, 3 km sul do CPATSA, 20.IV.1983, fl. and fr., *G.I.L. Fotius* 3446 (HTSA). Recife, Bongí, gramado da Divisão de Pesquisa do IPA, 6.IV.1964, fl. and fr., *Andrade-Lima* 64-4246 (IPA).

Additional material examined: BRAZIL. BAHIA: Juazeiro, estrada para Sobradinho, 7.VII.2009, fl. and fr., *J. Paula-Souza* 9923 (SPF).

The species occurs in Central and South America (Fernández Casas 2016), occurring in the Brazilian Northeastern region (Bahia, Pernambuco, Piauí and Rio Grande do Norte) (BFG 2018).

According to herbarium labels, it is recorded in the Atlantic Forest and Caatinga in Pernambuco, always associated with water bodies (river margins, rainwater ponds and temporary ponds after rains in the Caatinga) and urban occupation. Despite its wide distribution throughout Pernambuco, not many specimens were found in herbarium collections, probably due to its small size and/or its annual habit. This can also explain its absence in previous studies (Chiappeta 1985). It differs from *S. anthelmia* by its size (up to 20 cm tall) with linear (vs. lanceolate to elliptic) and opposite leaves (vs. opposite and pseudo-verticillate). Also, *S. polystachya* can be confused with *S. gracilis*, but the former has urceolate corolla (vs. infundibuliform corolla in *S. gracilis*). It is found with flowers and fruits from January to April.

2.8. *Spigelia scabra* Cham. & Schldl., *Linnaea* 1(2): 202-203. 1826. Figs. 6; 9f; 10i

Stems quadrangular, interangular ribs absent. Leaves petiolate and always pseudo-verticillate. Corolla 0.85–0.86 cm long, white with apex lobes pink-purple; metastyle 0.17–0.18 cm. Smooth capsules, orangish when mature.

Material examined: São Lourenço da Mata, ESEC Tapacurá, Mata do Camocim, 15.V.1933, fl. and fr., *B. Pickel* 3275 (IPA); 27.IX.2017, fl. and fr., *A. Macedo* 96 (UFP); Mata de Cueira, 10.X.1984, fl. and fr., *V.C. Lima* (HUEFS 111798).

The species is widespread throughout Central and South America, except for Guyana, Chile, and Suriname (Fernández Casas 2007; Fernández Casas 2016). In Brazil, it occurs in South, Southeastern, Central-Western (except Distrito Federal), Northeastern (only Bahia and Pernambuco), and Northern (only Amazonas) regions (BFG 2018).

It is widely distributed in tropical forests and savannas in South America, being also found in areas that suffered anthropic action (BFG 2018). In Pernambuco, it is found only in lowland ombrophilous forest at RVS Mata do Toró, a fragment of Atlantic Forest at an elevation of ca. 100 m. It is a very polymorphic species (Fernández Casas 2007) and differs from *S. anthelmia* by its quadrangular stem (vs. cylindrical), always pseudo-verticillate (vs. opposite to pseudo-verticillate) and petiolate leaves (vs. sessile). It is found with flowers and fruits from September to October.

3. *Strychnos* L., Sp. Pl. 1: 189. 1753.

Lianas to climbing shrubs or small trees, armed or not, sometimes with woody tendrils. Leaves opposite, venation acrodromous. Stipules reduced. Inflorescences axillary or terminal, sessile or pedunculate in dichasium or thyrsoids.

Corolla (4–)5-merous, rotate or salverform; stamen included; gynoecium syncarpous, ovary superior, globose, 1 style and stigma and one to pluriovulate. Fruits berries, yellow, orange, or brown, epicarp membranaceous or woody, glabrous.

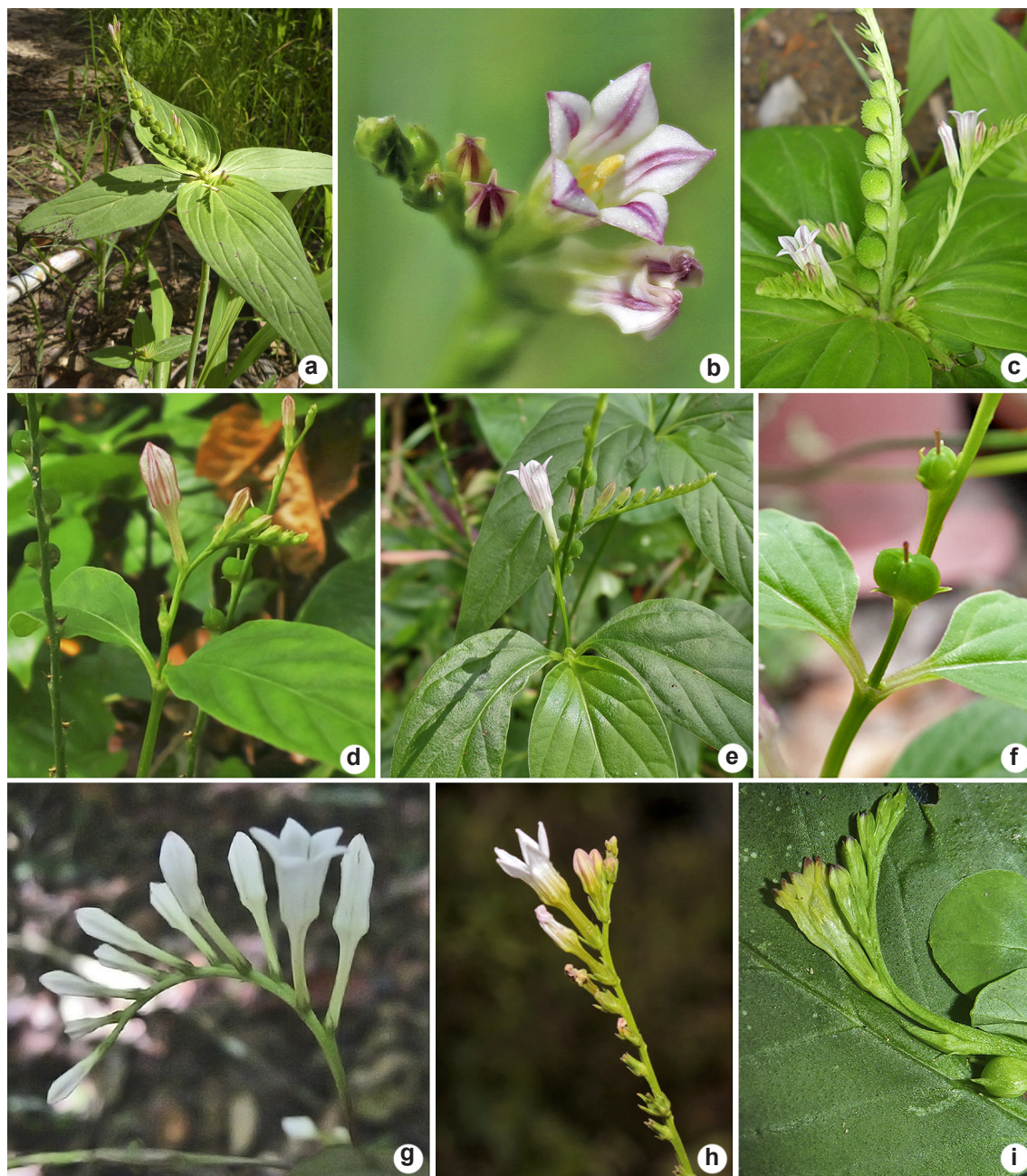


Figure 10 – a-i. Diagnostic characters of *Spigelia* in Pernambuco – a-c. *Spigelia anthelmia* – a. phyllotaxy; b. flower; c. inflorescences and fruits; d-f. *S. flemmingiana* – d. floral buds; e. open flower; f. fruits and metastyle; g. *S. laurina* – inflorescence; h. *S. linarioides* – inflorescence; i. *S. scabra* – inflorescence. (a-c. A. Macedo et al. 18; d-f. A. Macedo et al. 41; g. M.L. Bazante et al. 996).

The genus has ca. 200 species worldwide and is monophyletic (Struwe *et al.* 2018). New species were recently described for Brazil by Manoel & Guimarães (2011), Manoel *et al.* (2013) and Brandão & Rapini (2017).

3.1. *Strychnos atlantica* Krukoff & Barneby, Mem. New York Bot. Gard. 20(1): 61. 1969.

Fig. 7, Fig. 9g-i

Habit lianescent to shrubby or small tree, tendrils present, spines present. Petiole 0.5–0.8 cm long, leaf blade 14–19.8 × 4.7–7.5 cm, narrow ovate to elliptic, acute to obtuse at apex, cuneate to attenuate at base, coriaceous and olive-green with both surfaces glabrous and opaque. Inflorescences with peduncles up to 1 cm long. Calyx lobes 0.2–0.22 cm long, narrowly triangular and corolla about 0.2 cm long (Brandão & Rapini 2017). Fruits up to 3 cm diam, woody.

Material examined: Igarassu, Usina São José, H.C.H. Silva *et al.* 147 (PEUFR); 1.VI.2002, H.C.H. Silva & K.D. Rocha 288 (PEUFR); 27.XI.2007, J.S. Gomes *et al.* 316 (UFP); 18.VIII.2009, J.D. Garcia 1132 (UFP); 1.II.2010, J.D. Garcia 1412 (UFP). Rio Formoso, Cupe, Praia de Muro Alto, 6.II.1970, fl. and fr., Andrade-Lima 70-5718 (IPA).

Additional material examined: BRAZIL. ESPÍRITO SANTO: km 22 da rodovia Linhares para Bananal, fl., 24.XI.1973, fl., R.S. Pinheiro & T.C. Santos 2281 (CEPEC-epitype).

This species is endemic to Brazil (Krukoff & Barneby 1969; BFG 2018), and it has been recorded for the Atlantic Forest in Bahia, Espírito Santo and Pernambuco (BFG 2018).

It is present in gallery forests, ombrophilous forests and dunes forest vegetation of the Brazilian Northeastern (BFG 2018). Many specimens in the material examined were in the vegetative stage, except for Andrade-Lima 70-5718 which has an old inflorescence that had preserved the calyx and was previously identified by B.A. Krukoff in 1971. This specimen was used to identify several sterile samples, based on vegetative characters. *Strychnos atlantica* is easily distinguished from other species of the genus that occur in Pernambuco by its proportionally elongated leaves (14–19 cm long in *S. atlantica* vs. 4–12 cm in all other species) and by the calyx lobes 0.2–0.22 cm long, narrowly triangular-shaped. It was found with flowers and fruits in February.

3.2. *Strychnos divaricans* Ducke, Bull. Mus. Hist. Nat. 2(6): 746. 1932.

Figs. 7; 9l-n

Habit lianescent, tendrils present, spines absent. Leaf blade 3.5–12.2 cm long, elliptic,

acuminate at apex and glabrous or glabrescent with olive-green to grey-green color surfaces when dry. Calyx lobes 0.8–0.9 mm long, deltate; corolla 1.35–1.37 cm long, white and greenish, internal and external surface glabrous. Fruits 4.8–5.6 cm diam., darkish and woody epicarp.

Selected material examined: Nazaré da Mata, Mata da Alcaparra, 29.V.2010, M.J. Silva (IPA 85259). Recife, Mata de Dois Irmãos, 20.X.1949, fr., Andrade-Lima 49-377 (IPA); 30.XIX.1951, Ducke & Andrade-Lima (IPA 2203); 9.III.1984, A. Chiappeta (IPA 42348); 15.X.1985, C. Araujo 5 (IPA); Brejo dos Macacos, 25.I.1952, fl., A. Ducke 2309 (IPA); 15.V.2017, A. Macedo *et al.* 83 (UFP).

This species is endemic to Brazil presenting a disjunct distribution between the Northern (Amapá, Amazonas, and Pará) and Northeastern (not confirmed only in the states of Alagoas and Sergipe) regions (BFG 2018).

It is found in gallery forests, inundated forests (várzeas), and ombrophilous forests in the Brazilian Atlantic and Amazon Forest (BFG 2018). In Pernambuco, the species occurs in lowland ombrophilous forest and can be distinguished from other species of *Strychnos* based on its proportionally small leaves, acuminate at the apex, and the blade surfaces colored olive-green to grey-green when dried. It differs from *S. mattogrossensis*, the most similar species, only in floral morphology, such as the smaller calyx lobes (0.8–0.9 vs. 1–1.2 mm long), larger corolla (1.35–1.37 vs. 0.3–0.33 cm long) and larger and woody fruits (4.8–5.5 cm vs. 1.8–2 cm diam.). It is found with flowers and fruits from October to January.

3.3. *Strychnos gardneri* A.DC., Prod. 9: 14. 1845.

Figs. 8; 9o-p; 11d

Habit lianescent, tendrils present, spines present. Leaves coriaceous, glabrous and lustrous on the adaxial surface, abaxially pubescent only on the axils of the primary veins. Calyx lobes 0.1–0.12 cm long; corolla 0.7–0.75 cm long, external surface glabrous to slightly papillate and lobes tomentose on the inner basal surface. Fruits 1.8–2.0 cm diam., epicarp membranaceous.

Material examined: Buíque, Parque Nacional do Catimbau, Casa de Farinha, 9.VIII.2012, fl., G.C. Delgado-Júnior & S.O. Santos 413 (UFP).

Additional material examined: BRAZIL. CEARÁ: Serra do Besouro, sítio Serrinha, 26.I.1958, fl., T.N. Guedes 495 (UB). Crato, Chapada do Araripe, 17.V.1966, fl. and fr., J.S. Sobrinho 273 (HST).

The species is endemic to Brazil (BFG 2018) being distributed in the Central-Western (not recorded in Distrito Federal and Mato Grosso

do Sul), Northeastern (occurring in Bahia, Ceará, Maranhão, and Pernambuco), Northern (occurring only in Pará and Tocantins), and Southeastern regions (BFG 2018). It is recorded in the Amazon Forest, Caatinga, Cerrado, and Atlantic Forest domains (BFG 2018).

In Pernambuco, *S. gardneri* is known by only a single specimen collected in the Parque Nacional do Catimbau. It differs from others species of *Strychnos* of Pernambuco by its glabrous and lustrous adaxial leaf surface, abaxially pubescent primary vein axils and for being the only species in the state with axillary inflorescences. The flowering period is estimated to be between November or December in Pernambuco based on the only specimen collected.

3.4. *Strychnos mattogrossensis* S. Moore, Trans. Linn. Soc. London, Bot. 4: 392. 1895.

Figs. 8; 9q-s

Habit lianescent, tendrils and spines present. Leaves 4.8–7 × 2.6–3.8 cm, membranaceous, elliptical, acuminate at apex, dark olive-green after dried. Calyx lobes deltate, 0.1–0.12 cm; corolla 0.3–0.33 cm long, lanate on the inner surface of the corolla lobes. Fruits 1.8–2 cm diam., orange, epicarp membranaceous to slightly woody.

Material examined: Bonito, 29.I.1970, fl., *Andrade-Lima 70-5681A* (IPA).

Additional material examined: BRAZIL. AMAZONAS: São Paulo de Olivença, 24.XII.1948, fr., *R. de Lemos Frôes 23769* (NY). TOCANTINS: Almas, 22.VIII.2012, fr., *G.C.T. Ceccantini 3802* (SPF).

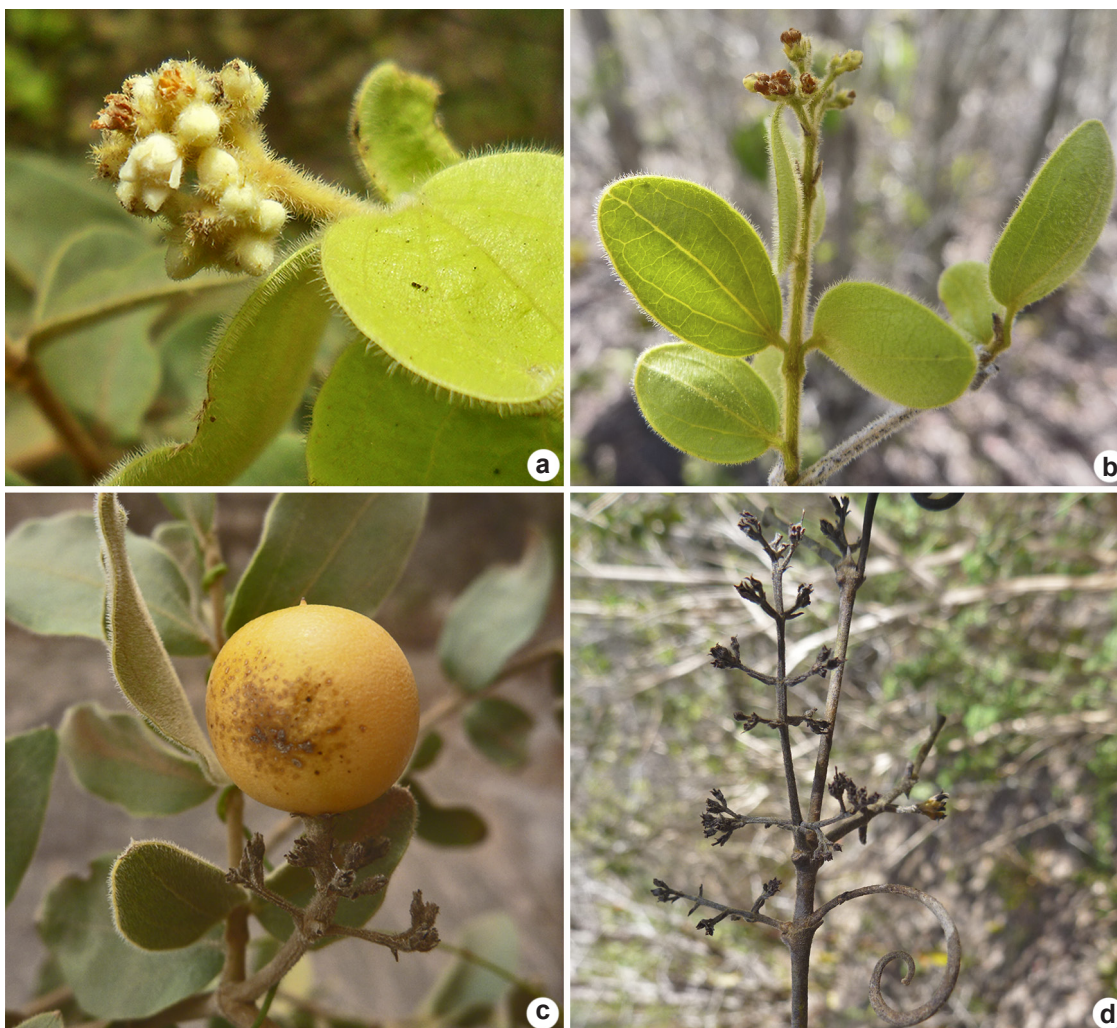


Figure 11 – a-d. Diagnostic characters of *Strychnos* in Pernambuco – a-c. *Strychnos rubiginosa* – a. flowers; b. velutinous indument on the stems, leaves and inflorescences; c. fruit; d. *S. gardneri* – inflorescence. (a-c. *A. Macedo et al. 128*; d. *C.G. Delgado-Júnior & S.O. Santos 413*). Photo: d. Geadelande Delgado.

Endemic to Brazil (BFG 2018), the species is distributed in the Central-Western (except Distrito Federal and Goiás), Northeastern (except Alagoas, Piauí, and Sergipe), and Northern (only in Acre, Amazonas, and Pará) regions (BFG 2018).

It is a liana or scandent shrub living in tropical inundated forests (igapós and várzeas), gallery, and ombrophilous forest in the Amazon, Atlantic Forest, Caatinga and Cerrado domains in Brazil (BFG 2018). In Pernambuco, *S. mattogrossensis* is known from a single collection from a submontane ombrophilous forest fragment. It is morphologically similar to *S. divaricans* by leaf morphology but differs from it by its larger calyx lobes (0.1–0.12 cm vs. 0.8–0.9 mm long), smaller corolla (0.3–0.33 vs. 1.35–1.37 cm long), and smaller, membranaceous fruits (1.8–2 cm vs. 4.8–5.6 cm diam.).

3.5. *Strychnos parvifolia* A. DC., Prod. 9: 16. 1845. Figs. 8; 9t-w

Spines and tendrils instead of leaves in some points along the branches. Leaves elliptic, sometimes subcordate or orbicular, pubescent only along primary veins in the abaxial surface and at the margin of the leaves, usually glabrous to glabrescent adaxially. Calyx lobes glabrous, except for midline of hairs and ciliate margins; corolla 0.2–0.35 cm long, 4–5 lobed; anthers pilose at the base. Fruits 2.3–2.4 cm diam., epicarp membranaceous to slightly woody.

Selected material examined: Araripina, Serra do Araripe, 27.IV.1983, fr., *A. Chiappeta et al. CFPE 543* (PEUFR). Goiana, RPPN Fazenda Tabatinga, 9.IX.2011, fl., *D. Cavalcanti et al. 579* (UFP). Igarassu, Mata de Piedade, 11.IV.2007, fr., *J.S. Marques & N.A. Albuquerque 16* (IPA). Mirandiba, 13.II.2009, fl., *K. Pinheiro 1350* (UFP); *K. Pinheiro 1316* (UFP). Palmares, próximo a Pirangi, 11.II.1948, *A. Ducke* (NY 590530). Recife, Mata de Dois Irmãos/Brejo dos Macacos, 19.II.1948, *A. Ducke 2117* (IAC, NY); 4.X.1949, *Andrade-Lima 49-332* (IPA). Tacaratu, Serra de Tacaratu, 18.X.2016, fl., *A.P. Fontana & J.R. Silva 9696* (HPISF).

The species is present in Bolivia, Brazil, and Paraguay (Krukoff & Monachino 1942). In Brazil, it is found in Central-Western, Northeastern, Northern, and Southeastern regions (BFG 2018).

This species is very polymorphic due to its wide geographic distribution in several Brazilian phytogeographic domains (Amazon Rainforest, Caatinga, Cerrado and Atlantic Forest) (Krukoff & Monachino 1942). In Pernambuco, it is found both in the Caatinga and lowland ombrophilous forest

in the Atlantic Forest, presenting conspicuous morphological variation between these domains (Caatinga vs. Atlantic Forest), including habit (subshrubs vs. lianas), leaf size (smaller vs. ordinary size), the density of hairs in surfaces (denser vs. sparse), corolla size (shorter vs. ordinary size) and the number of corolla lobes and anthers [4 (–5) vs. 5]. In the Caatinga, *S. parvifolia* can be confused with *S. rubiginosa*, but the former can be identified based on the indument distribution in leaves (pubescent along abaxial and adaxial veins and at leaf margins vs. completely velutinous) and in the calyx lobes (pubescent only over the midvein vs. completely pubescent). It is found with flowers and fruits from September to April.

3.6. *Strychnos rubiginosa* A. DC., Prod. 9: 16. 1845. Figs. 8; 9x; 11a-c

Habit shrubby, rarely with tendrils, spines absent, velutinous indument covering stems. Leaf surfaces velutinous, blade 0.7–5 × 0.6–2.8 cm. Calyx pubescent; corolla 0.3 cm long; anthers pilose at the base. Fruits 1.3–1.7 cm diam., orange when mature, membranaceous to slightly woody.

Selected material examined: Araripina, Serra do Araripe-Serrolândia, 27.IV.1983, *A. Chiappeta et al. CFPE 534* (IPA). Buíque, estrada Buíque-Catimbau, 7.III.1996, fl. and fr., *A. Laurêncio et al. 330* (PEUFR). Carnaíba, Sítio Carnaubinha, 15.IV.2015, fr., *M. Oliveira 2771* (HTSA). Chapada do Araripe, 1.II.1982, fl. and fr., *G. Fotius 3731* (IPA). Mirandiba, Fazenda São Gonçalo, 2.V.2008, fr., *K. Pinheiro 566* (UFP). Petrolina, Fazenda Lagoinha, 11.III.1982, fl. and fr., *A. Chiappeta 116* (IPA); Cohab III, 1.VIII.1986, fl., *G. Freire 24* (IPA). Serra Talhada, Fazenda Tiburana, 1.X.2007, fl., *M. Oliveira & F. Roque 3111* (ASE).

Species endemic to Brazil (Krukoff & Monachino 1942; BFG 2018). It is found in the Central-Western, Northeastern, and Southeastern regions (BFG 2018).

It is one of the few species of *Strychnos* endemic to the Brazilian Caatinga and Cerrado domains (BFG 2018). In Pernambuco, it is found only in the Caatinga, occupying rocky to sandy soils. It differs from the other species of the genus, especially the morphologically related *S. parvifolia*, by its shrubby habit (vs. mostly lianescent), vegetative surfaces velutinous (vs. abaxially pubescent only along primary veins and at leaf margins), and by the external surface of the calyx lobes completely pubescent (vs. pubescent only over the midvein). It is found with flowers and fruits from September to March.

3.7. *Strychnos trinervis* (Vell.) Mart., Syst. Mat. Med. Veg. Bras.: 121. 1843. Figs. 8; 9k-j

Habit climbing shrubby to lianescent, up to 10 meters tall, with woody tendrils, spines absent. Leaves coriaceous, when dry present dark brown and lustrous adaxial surface and light brown and opaque abaxial surface. Calyx lobes lanceolate to narrowly triangular, pubescent in the outer surface, 0.26–0.3 cm long; corolla 0.9–1.8 cm long. Fruits 5.6–5.8 cm diam., epicarp woody, dark brown when mature.

Selected material examined: Abreu e Lima, 25.X.1983, fl., *A. Chiappeta* (IPA 45274). Gravatá, Serra do Contente, 29.II.2016, fl. and fr., *M.L. Bazante et al.* 477 (UFP); 22.II.2017, fr., *A. Macedo et al.* 39 (UFP). Quipapá, Engenho Brejinho, 15.IX.1972, fr., *Andrade-Lima 72-7006* (IPA). Recife, Brejo dos Macacos, 25.I.1952, *A. Ducke 2308* (IPA). São Lourenço da Mata, fl., *B. Pickel 1137* (IPA); Estação Ecológica de Tapacurá, 3.V.2001, fr., *K. Almeida 130* (PEUFR).

Additional material examined: BRAZIL. ALAGOAS: Quebrangulo, REBIO Pedra Talhada, 1.XII.2012, fr., *B.S. Amorim et al.* 1724 (UFP).

This species is endemic to Brazil (BFG 2018) and recorded in the Northeastern (From Rio Grande do Norte to Bahia), Southeastern (all states), and Southern (all states) regions (BFG 2018).

It is widely distributed in the Brazilian Atlantic Forest (BFG 2018). In Pernambuco, it is recorded from sub-montane seasonally semideciduous forest enclaves (brejos de altitude), present scandent habit and growing over surrounding trees. It resembles *S. atlantica* but differs by its lustrous adaxial surface and opaque abaxial surface of the leaves (*vs.* both surfaces opaque), calyx lobes 0.26–0.3 cm (*vs.* 0.2–0.22 cm) and corolla 0.9–1.8 cm long (*vs.* about 0.2 cm long). It is found with flowers and fruits from October to May.

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List of exsiccatae

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