



## Original Paper

# Seasonal Semideciduous Forest and Cerrado Floristic composition of fragments in Serra das Flores, Ibiapaba Plateau, Ceará, Brazil

Lucas Farias Pinheiro<sup>1,7</sup>, Maria Isabela Cavalcante Vieira<sup>2,5</sup>, Valéria da Silva Sampaio<sup>3</sup>,  
Oriol Herrera Bonilla<sup>2,6</sup> & Eliseu Marlônio Pereira de Lucena<sup>4</sup>

### Abstract

The state of Ceará is located in the Northeast region of Brazil, which has a varied climatic condition, being predominantly formed by Caatinga vegetation, and there may also be remnants of Cerrado and other Semideciduous Seasonal Forest. The objective of this work was to carry out a floristic survey in vegetation fragments of Semideciduous Seasonal Forest and Cerrado found in the part of Serra das Flores located in the municipality of Viçosa do Ceará. Para tal, foram realizadas 12 coletas na área ao longo do ano de 2019. 220 species were recorded, belonging to 154 genera and 62 families. The most representative families in this area were Fabaceae (38 spp.), Rubiaceae (15 spp.) and Myrtaceae (nine spp.). The predominant habit were herbs and shrubs. The richest fragment was the Cerrado with 171 species, with the Typical Cerrado (104 spp.) phytophysognomy being the most representative. Of the total species, most are native, 16 are new records for Ceará, 12 are endemic to the Caatinga domain and seven are endemic to the Cerrado. Thus, the present site presents a high heterogeneity of species, in addition to varied habits, new records and endemic species of Cerrado and Caatinga.

**Key words:** endemisms, flora of Ceará, floristic survey, Viçosa do Ceará.

### Resumo

O estado do Ceará fica localizado na região Nordeste do Brasil, a qual possui uma variada condição climática, sendo formado predominantemente de vegetação de Caatinga, podendo também ocorrer remanescentes de Cerrado e de Floresta Estacional Semidecidual. O objetivo deste trabalho foi realizar o levantamento florístico em fragmentos vegetacionais de Floresta Estacional Semidecidual e Cerrado encontrados na parte da Serra das Flores localizada no município de Viçosa do Ceará. Para tal, foram realizadas 12 coletas na área ao longo do ano de 2019. Foram registradas 220 espécies, pertencentes a 154 gêneros e 62 famílias. As famílias mais representativas nessa área foram Fabaceae (38 spp.), Rubiaceae (15 spp.) e Myrtaceae (nove spp.). Os hábitos predominantes foram as ervas e os arbustos. O fragmento mais rico foi o de Cerrado com 171 espécies, sendo a fitofisionomia de Cerrado Típico (104 spp.) a mais representativa. Do total de espécies, a maioria são nativa, 16 são novos registros para o Ceará, 12 são endêmicas do domínio Caatinga e sete são endêmicas de Cerrado. Com isso o presente local apresenta uma alta heterogeneidade de espécies, além de variados hábitos, novos registros e espécies endêmicas de Cerrado e Caatinga.

**Palavras-chave:** endemismos, flora do Ceará, levantamento florístico, Viçosa do Ceará.

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<sup>1</sup> Universidade Estadual do Ceará, Centro de Ciências e Tecnologia, Prog. Pós-graduação em Ciências Naturais, Campus do Itaperi, Itaperi, Fortaleza, CE, Brazil. ORCID: <https://orcid.org/0000-0002-4722-7558>.

<sup>2</sup> Universidade Estadual do Ceará, Centro de Ciências da Saúde, Curso de Ciências Biológicas, Campus do Itaperi, Itaperi, Fortaleza, CE, Brazil.

<sup>3</sup> Universidade Estadual do Ceará, Faculdade de Filosofia Dom Aureliano Matos, Curso de Ciências Biológicas, Campus da FAFIDAM, Centro, Limoeiro do Norte, CE, Brazil. ORCID: <https://orcid.org/0000-0002-6551-8877>.

<sup>4</sup> Universidade Estadual do Ceará, Centro de Ciências da Saúde, Curso de Ciências Biológicas, Herbário do Museu de História Natural do Ceará Prof. Dias da Rocha, Campus do Itaperi, Itaperi, Fortaleza, CE, Brazil. ORCID: <https://orcid.org/0000-0002-8190-1702>.

<sup>5</sup> ORCID: <https://orcid.org/0000-0001-9753-6626>. <sup>6</sup> ORCID: <https://orcid.org/0000-0002-9140-6086>.

<sup>7</sup> Author for correspondence: [lucas.fpinheiro@gmail.com](mailto:lucas.fpinheiro@gmail.com)

## Introduction

The state of Ceará presents a great diversity of environmental and geomorphologic conditions. Five relief units are found: Coastal Region/Coastal features, River Plains, Inland Plains, Sertaneja Depression, and Residual massifs, among them there are different soil types, reliefs, and climatic factors, which allow the manifestation of various vegetational types, with several remnants of Brazilian domains (Castro *et al.* 2012; Moro *et al.* 2015), for example, the Atlantic forest and the Cerrado.

Caatinga is a phytogeographic domain that presents an area comprising about 912,000 km<sup>2</sup>, with an average annual rainfall that can reach 1,000 mm (Fernandes & Queiroz 2018) and has temperatures ranging from 25 to 30°C (Tabarelli *et al.* 2018), which is considered exclusively Brazilian, occurring only in the Northeast and Southeast regions of the country (Ramos *et al.* 2020). The vegetation presents adaptations so it can survive in this predominant climate, the semiarid, as small leaves and sometimes transformed into thorns, presence of thick cuticle and succulent stems. Many species in the dry season shed their leaves to reduce transpiration (Melo & Carneiro 2021). The Caatinga vegetation is quite varied and heterogeneous, thus having several classifications (Silva & Cruz 2018). According to Fernandes *et al.* (2019), the Caatinga has more than 3,347 plant species, of which 526 are endemic.

The Cerrado is considered the second largest phytogeographic domain in Brazil, occupying an area of approximately 2,036,448 km<sup>2</sup>, about 23% of the national territory, found mainly in the Midwest region of the country, thus forming the Brazilian Central Plateau, and there also may have patches of this domain elsewhere in the country (Brazil 2019; Casella & Silva Junior 2013; Finger & Finger 2015). It is characterized by a mosaic of 11 physiognomies, such as Cerrado formations (Cerrado *sensu stricto*), grassland (Campo Limpo), shrubby grasslands (Campo Sujo), Cerrado Woodlands (Cerradão), ranging from herbaceous to arboreal species, with water availability, edaphic and geomorphological characteristics, nutrient availability, and incidence of fire (Silva *et al.* 2015b; Buttler *et al.* 2012; Pizoletto *et al.* 2018), which are the main factors responsible for the characterization of the countryside, forest, and Cerrado phytophysognomies (Ribeiro & Walter 2008; Couto Júnior *et al.* 2011). In the Northeast region, Cerrado is considered marginal, being

found on the edges and in ecotonal areas with other ecosystems (Souza *et al.* 2010), and species from Caatinga and Amazonia may also occur. The states of the Northeast region in which Cerrado occurs are: Bahia, Maranhão and Piauí (IBGE 2021).

According to Moro *et al.* (2015) Cerrado areas are found in the state of Ceará in the coastal tablelands, thus characterizing the Coastal Cerrados, and in the Inland Chapadas (Serra da Ibiapaba and Chapada do Araripe) that surround the Sertaneja Depression, qualifying the Inland Cerrados. The National Forest Inventory has great importance in cataloging information on forest resources in Brazil and when the study in the territory of Ceará was carried out, about 0.4% of Cerrado vegetation phytophysognomy was found, with some endemic species of Cerrado, such as *Fraunhoferia multiflora* Mart. (Celastraceae), *Faramaea nigrescens* Mart. (Rubiaceae) and *Heteropterys pteropetala* A.Juss. (Malpighiaceae) (Brasil 2016).

The Caatinga phytogeographic domain can be found in the interior plateaus, characterizing the sedimentary Caatinga, and in the Depression Sertaneja, characterizing the Cristalino Caatinga (Moro *et al.* 2015). In Ceará we can also find fragments of Semideciduous Seasonal Forest, which can also be called Subcaducifolia Tropical Forest, being found mainly around the Humid Forests in the interior of the state (Figueiredo 1997; IBGE 2012).

Floristic studies in Cerrado areas are mainly concentrated in the Midwest region of Brazil (Giácomo *et al.* 2013; Lima *et al.* 2015; Oliveira *et al.* 2016; Ferreira *et al.* 2017; Abreu *et al.* 2015; Santos *et al.* 2016; Campos *et al.* 2018; Bordino *et al.* 2018; Miami *et al.* 2017; Schardong *et al.* 2020). In Ceará there are few studies involving the flora in Cerrado remnant areas, such as those carried out by Figueiredo (1989), Fernandes (1990), Costa *et al.* (2004), Moro *et al.* (2011), Silva *et al.* (2015a), Ribeiro-Silva *et al.* (2012), Guerra *et al.* (2020) and that of Nepomuceno *et al.* (2021), as well as in areas of Semideciduous Seasonal Forest (Lima *et al.* 2007; Lima *et al.* 2011; Lima *et al.* 2009).

The Cerrado areas in Ceará are found in areas with a sub-humid climate or on the Ibiapaba Plateau, and may also occur in a semi-arid climate, the most unique being those located in Lavras da Mangabeira, Várzea Alegre, Farias Brito, Granjeiro, Caririaçu and Aurora municipalities, and in the Serra das Flores locality (Figueiredo 1989). The Cerrado of this area are under pediplain surfaces with dense or open formations (Jordy Filho & Salgado 1981).

Thus, it is necessary to carry out more floristic studies in these remnants to better understand their floristic diversity, as well as the distribution of species and phytophysiognomies in the state. Therefore, the objective of this research was to carry out a floristic survey in vegetational fragments of Semideciduous Seasonal Forest and Cerrado found in the part of Serra das Flores located in the municipality of Viçosa do Ceará, a well-preserved area in the micro region of Ibiapaba.

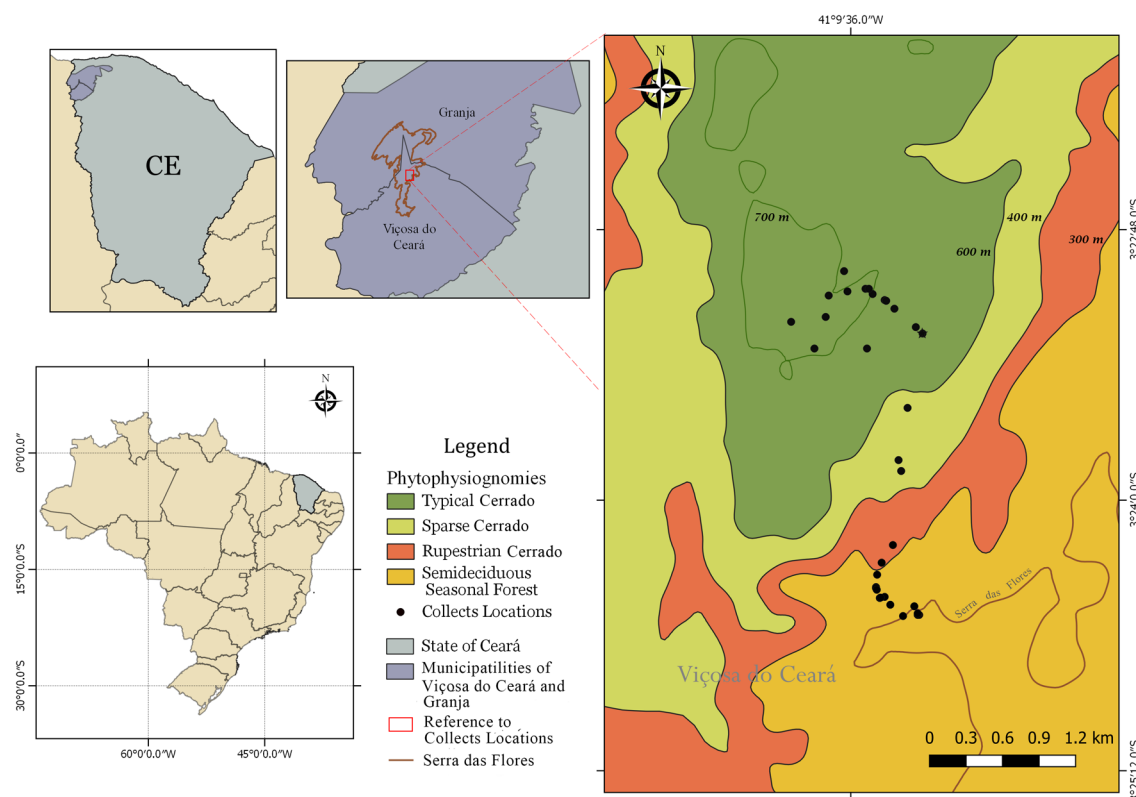
### Materials and Methods

#### Study area

The study area is located in Serra das Flores, which extends over Viçosa do Ceará and Granja municipalities; however, the research was conducted only in Viçosa do Ceará municipality, microregion of Ibiapaba, mesoregion of Northwest Ceará (Fig. 1). The Ibiapaba Plateau is part of the Sedimentary Sierras, located in the western part of Ceará (Fernandes 1990). These areas present ecotones among Cerrado, Caatinga and Semideciduous Seasonal Forest (Jordy Filho & Salgado 1981).

Viçosa do Ceará has a Warm Tropical Semiarid and Warm Tropical Subhumid climate, with an average temperature ranging from 22 to 24 °C, and rainfall of 1,349 mm. It has reliefs formed by the Ibiapaba Plateau and Sertanejo depressions, thus having vegetation such as Carrasco, Thorny Caducifolia Forest, Subcaducifolia Tropical Rain Forest, and Subperenifolia Tropical Pluvio-Nebular Forest, in addition to soils such as Quartzaceous Distrophic Sands, Litholics, Red-Yellow Latosol, Solodic Planosol and Red-Yellow Podzolic (IPECE 2018).

The Serra das Flores plateau (03°23'05.1''S, 41°09'33.4''W) is characterized by a Cerrado formation of Typical Cerrado (Cerrado Típico) phytophysiognomy, with a predominantly shrubby vegetation, with 20 to 50% tree cover, average height of 3–6 m, and presents a Quartz Sand soil, with altitudes higher than 600 m. The Sparse Cerrado (Cerrado Ralo) (03°23'43.6''S, 41°09'24.8''W) occurs at altitudes of 401 to 600 m, with a predominantly shrub-herbaceous vegetation, with 5 to 20% tree cover, average height 2–3 m, and presents litholic soils with the absence of rock



**Figure 1** – Location, vegetational types and altimetry of Serra das Flores, Viçosa do Ceará-CE.

outcroppings. At altitudes that vary between 301–400 m, occurs the Rupestrian Cerrado (Cerrado Rupestre) phytophysiology (03°24′04.3″S, 41°09′25.9″W), with a predominantly shrub-herbaceous vegetation, with 5 to 20% tree coverage, average height of 2–4 m, and presents litholic soils, where the vegetation settles between the cracks in the rocks, mainly due to the presence of rocky outcrops. Therefore, such phytophysiological characterizations characterize the Cerrado formations (Ribeiro & Walter 1998). Serra das Flores is also home to the Semideciduous Seasonal Forest (Mata Seca), which has a seasonal climate that promotes the fall of part of the leaves during the dry season, and is located at altitudes ranging from 100–300 m (Fig. 2).

Twelve sampling collections were carried out in the area throughout 2019. The walking collection method was used with random walks (Filgueiras *et al.* 1994), along the study area, from the base of the mountain range to the plateau, collecting all fertile species (flower and/or fruit) of angiosperms. Specimens were collected and stored in plastic bags during field collection and herborized according to Mori *et al.* (1985) and Gadelha-Neto *et al.* (2013). The exsiccata were deposited in the Prof. Dias da Rocha Herbarium of the Natural History Museum of Ceará (MHNCE-HER) of the State University of Ceará. Photographic records were also made to assist in the subsequent identification of specimens in the herbarium. The collected plants were classified into the types of phytophysiology where they occur. For the identification and characterization of the phytophysiological characterizations the key to identify the Cerrado phytophysiological characterizations from the study by Ribeiro & Walter (1998) was used, as well as the use of altimetric variation.

Identification keys, specialized bibliographies, and expert consultations were used to identify the specimens. The classification system adopted followed the Angiosperm Phylogeny Group IV (APG IV 2016), except for Turneraceae, considered independent from Passifloraceae.

To verify endemism and new records for the state of Ceará, the 2020 database of the Flora of Brazil List of Species (Flora of Brazil 2020, continuously updated) was used. Authors' names are according to IPNI (2021). To assess the conservation status of the species, the criteria of the International Union for Conservation of Nature (IUCN 2020) and CNCFlora (2018) were used. To complete the species listing, the Flora of Brazil 2020 (continuously updated) and CRIA (2021) sites were used.

## Results and Discussion

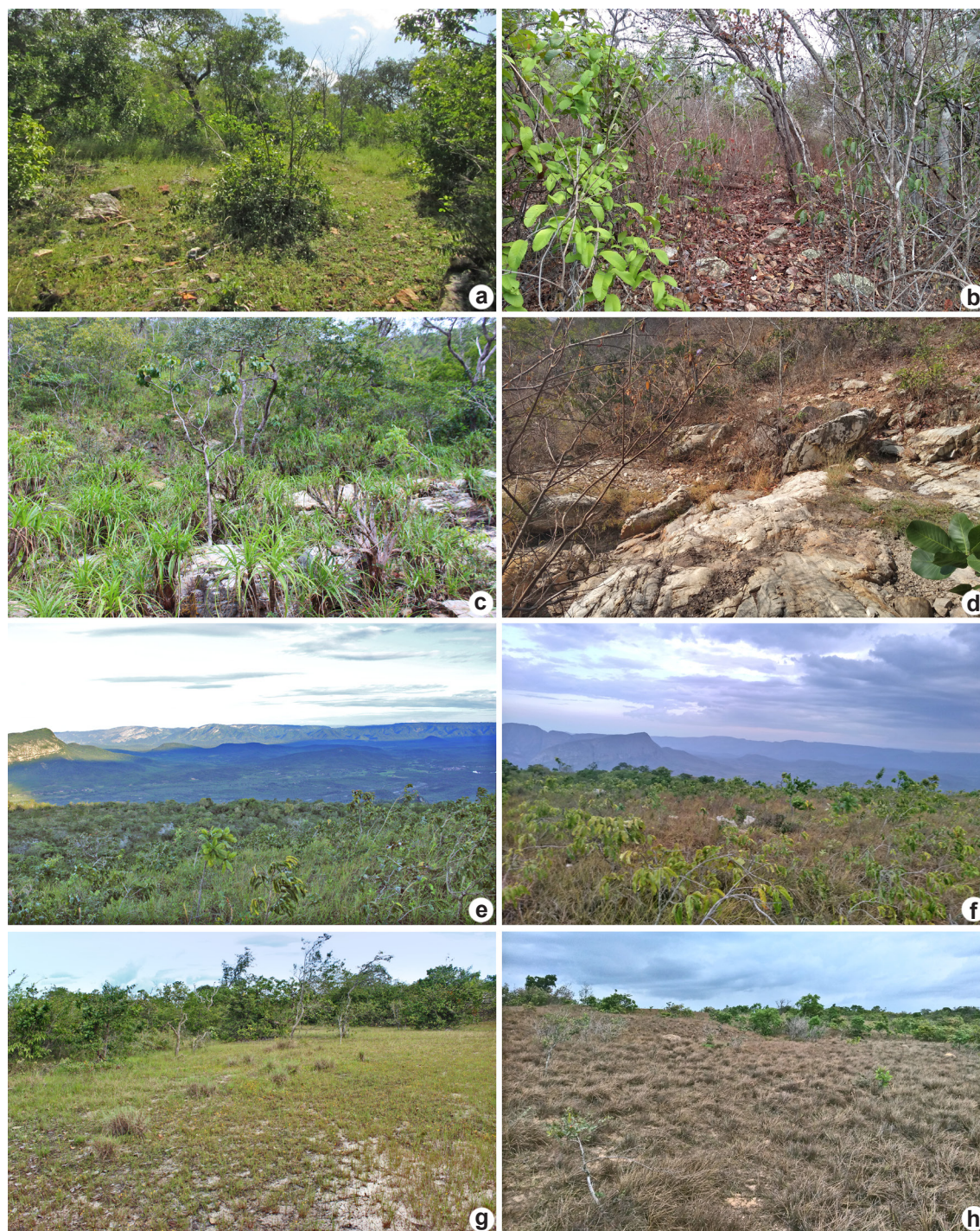
In the floristic survey 220 species were listed, distributed in 154 genera and 62 families, showing a high richness of species in Serra das Flores (Tab. S1, available on supplementary material <<https://doi.org/10.6084/m9.figshare.23907633.v1>>). The most representative families were Fabaceae (38 spp.), Rubiaceae (15 spp.), Myrtaceae (nine spp.), Convolvulaceae and Malvaceae (eight spp., each), Malpighiaceae, Asteraceae, Melastomataceae, Poaceae and Euphorbiaceae (seven spp., each), Lamiaceae (six spp.), Apocynaceae and Cyperaceae (five spp., each), which together total 58.6% of the flora cataloged (Fig. 3).

In the study carried out by Ribeiro-Silva *et al.* (2012) with the phytophysiological characterizations found in the Araripe-Apodi National Forest (Flona), they verified that Fabaceae, Rubiaceae, Asteraceae, Bignoniaceae, Myrtaceae, Euphorbiaceae, Apocynaceae, Malpighiaceae, Annonaceae and Solanaceae, were the most representative families in the Araripe-Apodi Flona. According to Moro *et al.* (2015), the Chapada do Araripe and Serra da Ibiapaba have wet sedimentary forest, dry sedimentary forest, Cerrado and Cerrado Woodlands Interior vegetation types.

Nepomuceno *et al.* (2021) when conducting floristic surveys in four Cerrado areas in Ceará, found that Fabaceae (49 spp.) and Rubiaceae (19 spp.) were also the families with the greatest richness. In a fragment located in southern Ceará, he also found the Fabaceae family to be the most diverse (Figueiredo & Fernandes 1987).

The species *Agonandra brasiliensis* Miers ex Benth. & Hook.f., *Anacardium occidentale* L., *Annona coriacea* Mart., *Byrsonima crassifolia* (L.) Kunth, *Curatella americana* L., *Hancornia speciosa* Gomes, *Jacaranda brasiliensis* (Lam.) Pers., *Krameria tomentosa* A.St.-Hil., *Ouratea fieldingiana* (Gardner) Engl., *Parkia platycephala* Benth., *Qualea parviflora* Mart., *Salvertia convallariodora* A.St.-Hil., *Simarouba versicolor* A.St.-Hil., *Tabebuia aurea* (Silva Manso) Benth. & Hook.f. ex S.Moore are also found in other Cerrado areas of Ceará (Figueiredo 1989), corroborating the findings of this study.

The remaining families had from one to four species, therefore, among the 62 families, 24 are represented by only one species (Acanthaceae, Anacardiaceae, Araceae, Dioscoreaceae, Erythroxylaceae, Heliconiaceae, Hypericaceae, Iridaceae, Krameriaceae, Lauraceae, Lentibulariaceae, Linderniaceae, Lorantheae,



**Figure 2** – a-h. Phytophysiognomies of Serra das Flores, Viçosa do Ceará-CE – a. Semideciduous Seasonal Forest in the rainy season; b. Semideciduous Seasonal Forest in the dry season; c. Rupestrian Cerrado in the rainy season; d. Rupestrian Cerrado in the dry season; e. Sparse Cerrado in the wet season; f. Sparse Cerrado in the dry season; g. Typical Cerrado in the rainy season; h. Typical Cerrado in the dry season.

Marcgraviaceae, Opiliaceae, Orobanchaceae, Oxalidaceae, Satanlaceae, Simaroubaceae, Smilacaceae, Triuridaceae, Velloziaceae, Verbenaceae e Xyridaceae), which correspond to 38.70% of the collected families and 10.90% of the catalogued species.

In the study by Ribeiro-Silva *et al.* (2012), the families Anacardiaceae (*Anacardium occidentale* L.), Hypericaceae [*Vismia guianensis* (Aubl.) Choisy], Krameriaceae (*Krameria* cf. *argentea* Mart. ex Spreng.), Loranthaceae (*Struthanthus* cf. *flexicaulis* Mart.) and Oxalidaceae (*Oxalis frutescens* L.), have only one specie, which corroborates the present research. Silva-Moraes *et al.* (2018) when analyzing the floristic similarity of 12 Cerrado areas in Maranhão with other Cerrado areas in Brazil, observed that the vegetation of the southern remnant of the state is floristically more similar to the Cerrado central Brazil, while those further north are considered isolated groups.

The most representative genera of this study were *Byrsonima* (Malpighiaceae), *Chamaecrista* (Fabaceae) with five species each, *Cyperus*, *Ipomoea* (Convolvulaceae), *Myrcia* (Myrtaceae), *Senna* (Fabaceae) with four each, *Bauhinia* (Fabaceae), *Centrosema* (Fabaceae), *Clusia* (Fabaceae), *Cordia* (Rubiaceae), *Mimosa* (Fabaceae), *Psidium* (Myrtaceae), *Sida* (Malvaceae), *Solanum* (Solanaceae) and *Zornia* (Fabaceae) with three species each.

For Ribeiro-Silva *et al.* (2012) in a fragment of the Araripe Forest in Ceará state, composed of Carrasco, Cerrado Woodlands, Cerrado formations and Semideciduous Seasonal Forest, the richest genera were *Borreria*, *Byrsonima*, *Casearia*, *Erythroxylum*, *Myrcia* and *Psychotria*, with three species each, *Senna* with four and *Solanum* with

five species. In the survey by Nepomuceno *et al.* (2021), *Ipomoea* and *Mimosa* were the genera with the highest richness in Cerrado-Caatinga areas in Ceará state. In the Araripe National Forest fragment, the genera *Psidium* (four spp.), *Byrsonima* and *Solanum* (three spp. each), were the richest (Costa *et al.* 2004).

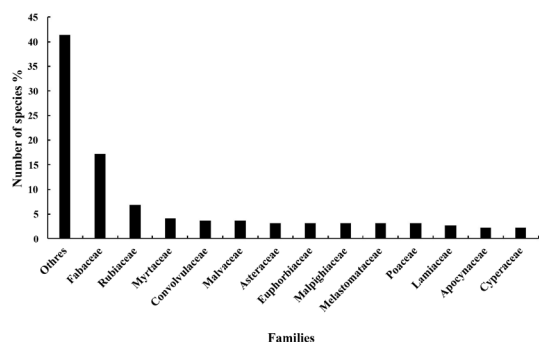
In a Cerrado Woodlands phytophysiology, the most representative genera were *Myrcia* (six spp.), *Banisteriopsis* C.B.Rob. ex Small and *Senna*, with three species each (Silva *et al.* 2015a). José Neto (2018), when carrying out the study in the Pombo Municipal Natural Park in the Três Lagoas municipality, Mato Grosso do Sul state, an area with Typical Cerrado vegetation, the most representative genera were, *Byrsonima*, *Eugenia* and *Miconia*, each with seven species, besides *Annona*, *Mimosa* and *Solanum*, with five species each.

Regarding habits, herbs (35%), shrubs (25%) and trees (15.9%) were the most representative (Tab. S1, available on supplementary material <<https://doi.org/10.6084/m9.figshare.23907633.v1>>). In an urban Cerrado fragment, located in Fortaleza municipality, herbs (38%) and shrubs (35%) were the most representative (Moro *et al.* 2011). Nepomuceno *et al.* (2021) when analyzing four areas of Cerrado fragments in the state of Ceará, in Granja and Martinópolis municipalities, observed that the herbaceous component (113 spp.) and the subshrub (27 spp.) were the most representative, totaling more than 50% of the species inventoried.

Araújo *et al.* (2020) when carrying out a survey in the Botanical Garden of São Gonçalo do Amarante in the state of Ceará, an area of Caatinga and Cerrado, the herbaceous layer was the most representative (53 spp.), followed by the tree (35 spp.) and shrub (34 spp.). In the Chapada das Mesas National Park, Maranhão, it was found that the trees (50.8%) and herbs (28.9%) presented the highest values. In a fragment of ecotonal Cerrado in Buriti dos Lopes-PI, it was found that the herbs and trees showed the highest richness (Silva *et al.* 2020).

Regarding the number of species and the diversity of habits found in each of the phytophysiological forms, the one that stood out the most was the Typical Cerrado, with 104 spp. (47.2%), followed by Semideciduous Seasonal Forest with 49 spp. (27.2%), and Rupestrian Cerrado with 37 spp. (16.8%) (Figs. 4-5).

In the study by Saraiva *et al.* (2020), in a Cerrado area in Maranhão state, of the 242 vascular



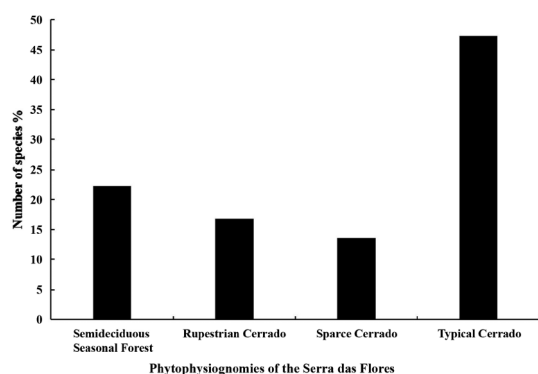
**Figure 3** – Number of species of the most representative botanical families of Serra das Flores, Viçosa do Ceará-CE.

plant species listed, Typical Cerrado (113 spp.), Cerrado Woodlands (65 spp.) and Rupestrian Cerrado (63 spp.) were the phytophysiognomies that presented the highest numbers of species, resembling the results in this study.

In the Rupestrian Cerrado phytophysiognomy of Serra das Flores, the most representative families were Fabaceae with 11 spp., Poaceae with four species, and Lamiaceae and Maranthaceae with three spp. each. The richest habits were herbs (14 spp.) shrubs and subshrubs (nine spp. each), as can be seen in Fig. 4.

Oliveira *et al.* (2019), when analyzing five areas of Rupestrian Cerrado in the Campo Maior Complex, northeastern Brazil, observed that of the 28 families collected, Fabaceae is the most abundant in number of species and Vochysiaceae the most representative in number of individuals. In this phytosociological study, the most abundant species were, *Plathymenia reticulata* Benth. (Fabaceae), *Psidium myrsinites* DC. (Myrtaceae), *Byrsonima correaifolia* A.Juss (Malpighiaceae), *Krameria tomentosa* A.St.-Hil. (Krameriaceae), *Qualea parviflora* Mart. (Ochnaceae). In the phytosociological study carried out by Leles & Diniz (2017) in the Piranhas municipality, Goiás, Apocynaceae, Fabaceae, Malpighiaceae, Vochysiaceae, Rubiaceae, and Melastomaceae, were the families that presented the highest values, and together they totaled 55.3% of the samples.

The Sparse Cerrado is one of the three forms of Cerrado formations, and is the lowest form of this phytogeographic domain, thus presenting the lowest number of species among the physiognomic

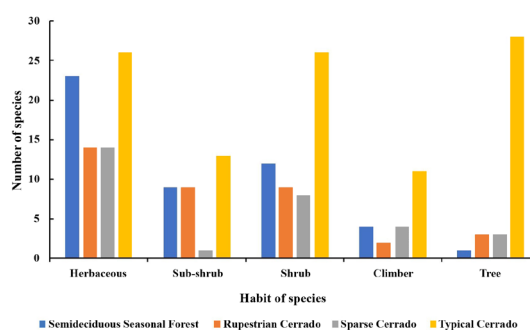


**Figure 4** – Distribution of species habits by physiognomy in Serra das Flores, Viçosa do Ceará-CE. Physiognomy (FTS) (SSF = Semideciduous Seasonal Forest; RC = Rupestrian Cerrado; SC = Sparse Cerrado; TC = Typical Cerrado).

forms (Ribeiro & Walter 2008; IBGE 2004). In this study, the Sparse Cerrado presented low species richness, with only 30 species, of which 14 are herbs, eight are shrubs, three trees, four climbers and one subshrub (Fig. 4). Fabaceae and Ochnaceae were the richest families in this phytophysiognomy with three species each and Orchidaceae with four (Tab. S1, available on supplementary material <<https://doi.org/10.6084/m9.figshare.23907633.v1>>). In the study carried out by Rodrigues & Conceição (2014) in Mirador State Park, Maranhão, in a Sparse Cerrado physiognomy, it also showed low richness, with only 13 species of the 140 listed, with the shrub form being the most predominant. The authors state that the arboreal habit presented low stature with sparse individuals. According to Ribeiro & Walter (2008) the most predominant habits in this physiognomy are herbs and shrubs.

The Typical Cerrado is an intermediate phytophysiognomy between the Dense Cerrado and the Sparse Cerrado, with low tree density, making the other strata richer in number of species (IBGE 2004). The Typical Cerrado in this study showed the highest species richness and strata richness, with 47.27% (104 spp.) of the species (Fig. 5). The herbaceous habit was similar to that which occurred in the Semideciduous Seasonal Forest phytophysiognomy, with a difference of three fewer species. The arboreal habit showed the highest value of all the phytophysiognomic forms, with 80% of the arboreal species. The other habits were also the most prominent. In this phytophysiognomy the climbers showed the greatest richness, with 11 species (Fig. 4).

The richest families in the Typical Cerrado phytophysiognomy were Fabaceae with 17 species, Rubiaceae, Myrtaceae with 7 species



**Figure 5** – Distribution of the number of species by physiognomy occurring in Serra das Flores, Viçosa do Ceará-CE.

each, and Malpighiaceae with 5. Most species of the Malpighiaceae family were collected in this phytophysiology, five from the genus *Byrsonima* and one from the genus *Stigmaphyllon* (Tab. S1, available on supplementary material <<https://doi.org/10.6084/m9.figshare.23907633.v1>>). This is similar to that observed by Rodrigues & Conceição (2014) in which all species of the Malpighiaceae family were collected in this phytophysiology, as well as the species of the genus *Byrsonima* that presented 12 species. It also presented Typical Cerrado species, such as *Hancornia speciosa* Gomes, *Himatanthus drasticus* (Mart.) Plumel, *Curatella americana* L and *Agonandra brasiliensis* Miers ex Benth. & Hook.f. The latter species has also been found in five Typical Cerrado areas in Ceará state (Figueiredo 1989). *Curatella americana*, *Krameria tomentosa* A. St. Hil and *Ouratea fieldingiana* Engl are considered Cerrado species (Jordy Filho & Salgado 1981). According to Ratter *et al.* (2003) and Ratter & Dargie (1992) the *Salvertia convallariodora*, *Byrsonima crassifolia*, *Curatella americana* species are widespread in Cerrado areas in Brazil.

In the floristic and phytosociological study conducted by Ribeiro *et al.* (2008) in a Cerrado formations phytophysiology, in the Nova Xavantina municipality, Mato Grosso, of 240 individuals, 42 species are from the Typical Cerrado, thus corroborating its richness. In the study carried out by José Neto *et al.* (2015) in a fragment of Typical Cerrado in the same state, 78% of the species surveyed were herbs and shrubs, with Annonaceae, Asteraceae, Bignoniaceae, Euphorbiaceae, Fabaceae and Malvaceae, Myrtaceae and Poaceae being the richest families in the study area. This low representation of tree species, since this physiognomy is of a forest nature, may be related to the location of this remnant, which is in an urban area.

The Semideciduous Seasonal Forest phytophysiology showed the second highest species richness (Fig. 5). The most representative habits were herbs, with 23 species, followed by shrubs with 12 species (Fig. 4). The families with the highest richness in this physiognomy were Fabaceae with seven species, Malvaceae with six spp., Rubiaceae and Convolvulaceae with five spp. each, and Euphorbiaceae with four species (Tab. S1, available on supplementary material <<https://doi.org/10.6084/m9.figshare.23907633.v1>>).

In Sítio Fundão State Park, Crato, Ceará, 61

species distributed in 28 families were collected, with Fabaceae (43.5%), Combretaceae (18.92%) and Anacardiaceae (8%) being the most representative families (Pereira 2016). Lima *et al.* (2011) when analyzing a fragment of Deciduous Seasonal Forest in the Serra das Almas Natural Reserve, Ceará, the authors found that in the woody component the richest families were Fabaceae, Euphorbiaceae, Myrtaceae, Erythroxylaceae and Bignoniaceae. For the herbaceous component, Poaceae and Bromeliaceae, especially *Streptostachys asperifolia* Desv., *Scaphispatha hastifolia* Hook. and *Bromelia auriculata* L.B.Sm.

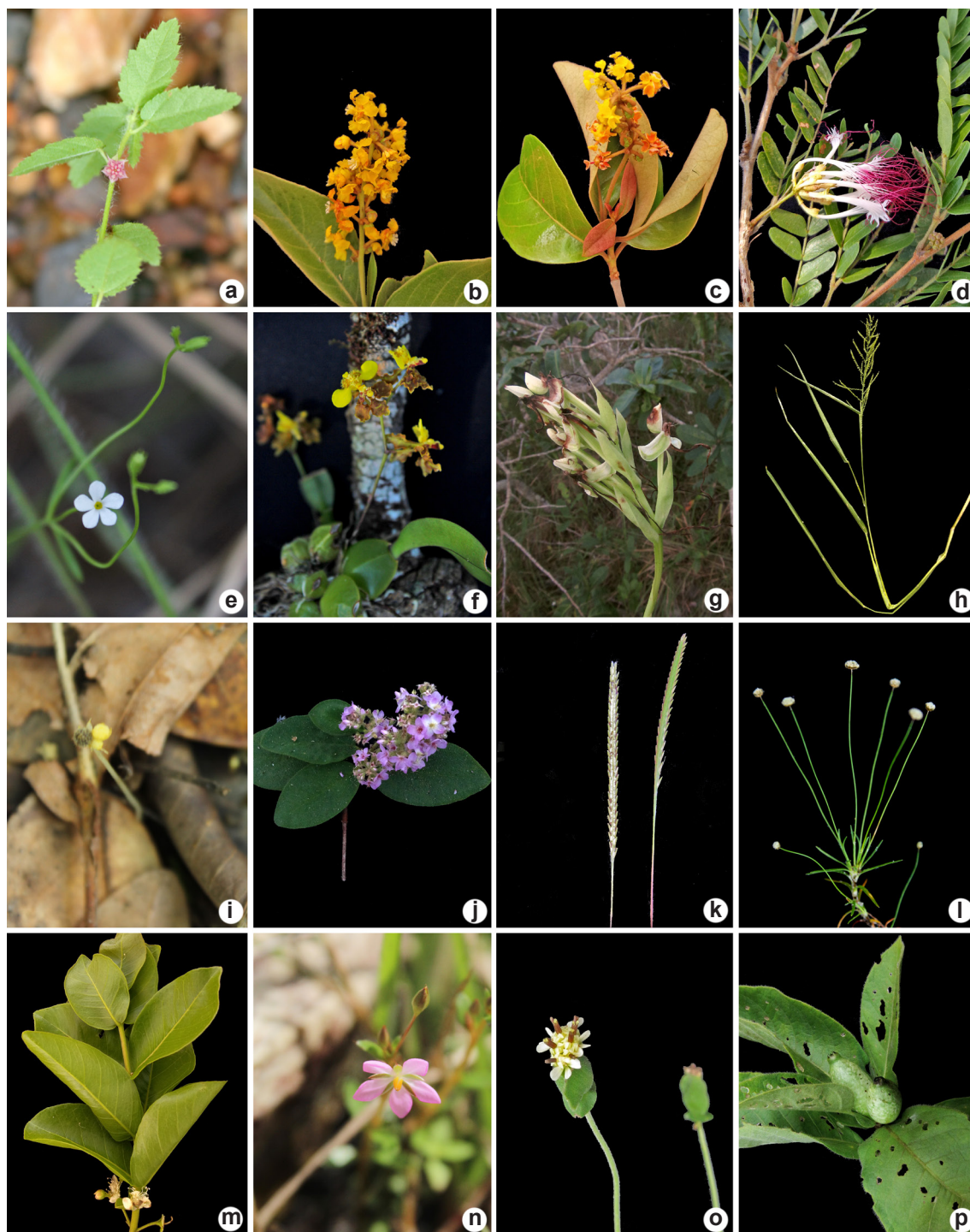
Of the listed species, 16 species are new records for Ceará state (Fig. 6; Tab. S1, available on supplementary material <<https://doi.org/10.6084/m9.figshare.23907633.v1>>). The species *Calliandra surinamensis* Benth. (Fig. 6d) only occurred in the Amazon region, thus being the first record for the Northeastern region, for a Cerrado area, in the Rupestrian Cerrado phytophysiology, where there are rocky outcrops. The other new occurrences already happened in other states of the Northeast region, thus being only new records for Ceará.

New occurrences are quite common in floristic surveys, mainly due to the scarcity of studies in little known areas, thus showing the importance of these studies, which can provide subsidies for future conservation research.

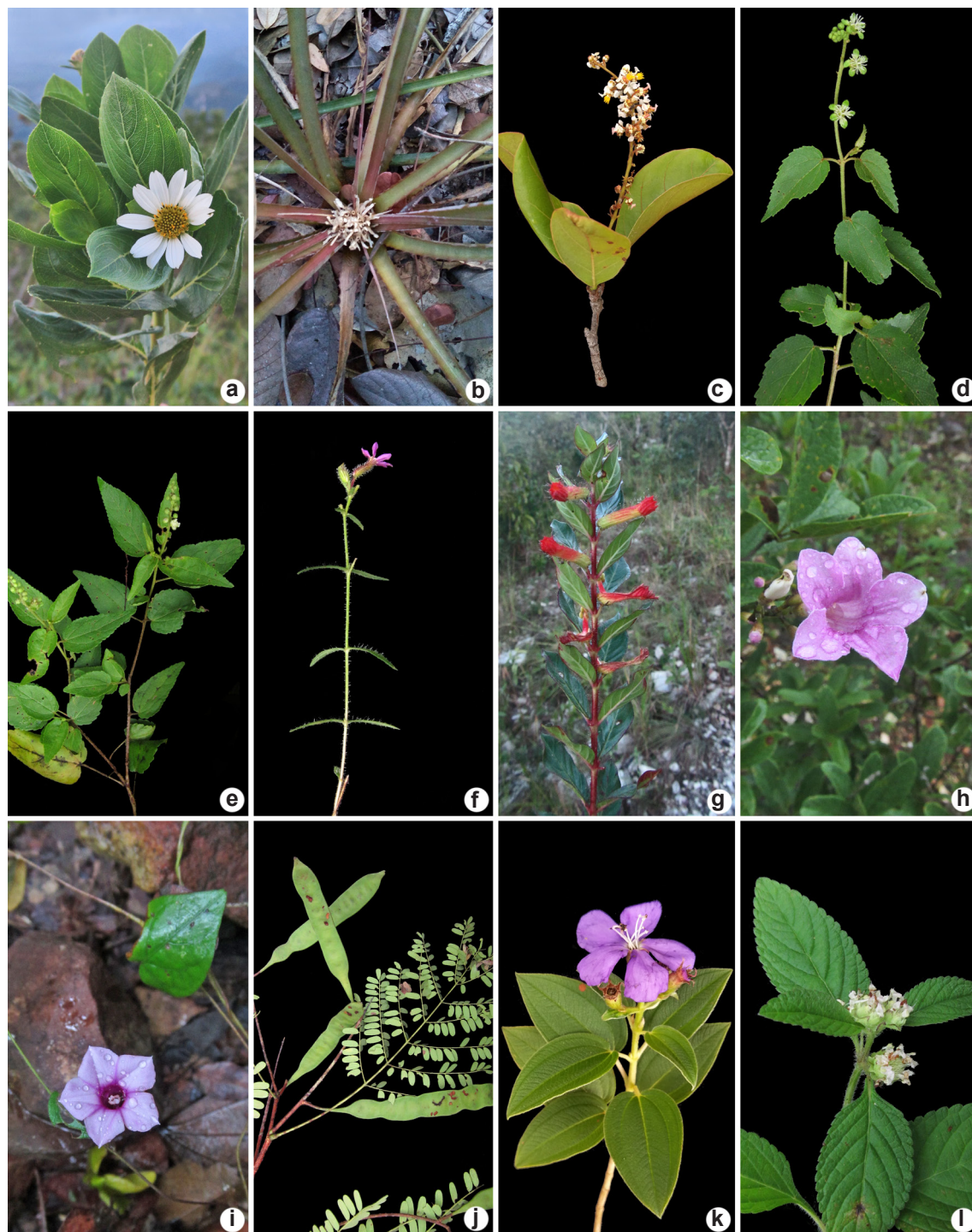
According to Meyer & Schwirkowski (2019), state species listings are constantly changing due to new findings, thus being considered an ongoing process. Saraiva *et al.* (2020) in their survey in Chapada das Mesas National Park, found 50 new occurrences for the state of Maranhão and four for the Cerrado, thus corroborating the relevance of this type of research.

Of the total number of cataloged species, 60 (27.2%) are endemic to Brazil. The endemism of *Sida ciliaris* L. is considered unknown. The species *Aspilia andrade-limae* J.U.Santos, *Fridericia pliciflora* (Mart. ex DC.) L.G.Lohmann, *Varronia leucocephala* (Moric.) J.S.Mill., *Bromelia auriculata* L.B.Sm., *Ipomoea chiquitensis* J.R.I. Wood & R.W. Scotland, *Cuphea loefgrenii* Bacig., *Croton grewoides* Baill., *Pleroma gardneri* (Naudin) P.J.F.Guim. & Michelang., *Byrsonima rotunda* Griseb., *Croton rudolphianus* Müll.Arg., *Parapiptadenia zehntneri* (Harms) M.P.Lima & H.C.Lima, *Cuphea campestris* Mart. ex Koehne, are endemic to the Caatinga domain (Fig. 7).





**Figure 6** – a–p. New records for the state of Ceará identified in Serra das Flores, Viçosa do Ceará-CE – a. *Ayenia erecta* (Malvaceae); b. *Byrsonima laxiflora* (Malpighiaceae); c. *Byrsonima stannardii* (Malpighiaceae); d. *Calliandra surinamensis* (Fabaceae); e. *Curtia tenella* (Gentianaceae); f. *Gomesa ciliata* (Orchidaceae); g. *Habenaria hamata* (Orchidaceae); h. *Hymenachne condensata* (Poaceae); i. *Lacandonia brasiliiana* (Triuridaceae); j. *Macairea pachyphylla* (Melastomataceae); k. *Mesosetum chaseae* (Poaceae); l. *Paepalanthus subtilis* (Eriocaulaceae); m. *Psidium firmum* (Myrtaceae); n. *Sauvagesia tenella* (Ochnaceae); o. *Staurochlamys burchellii* (Asteraceae); p. *Tocoyena hispidula* (Myrtaceae).



**Figure 7** – a-l. Endemic species of the Caatinga domain that occur in Serra das Flores, Viçosa do Ceará-CE – a. *Aspilia andrade-limae* (Asteraceae); b. *Bromelia auriculata* (Bromeliaceae); c. *Byrsonima rotunda* (Malpighiaceae); d. *Croton grewiooides* (Euphorbiaceae); e. *Croton rudolphianus* (Euphorbiaceae); f. *Cuphea campestris* (Lythraceae); g. *Cuphea loefgrenii* (Lythraceae); h. *Fridericia pliciflora* (Bignoniaceae); i. *Ipomoea chiquitensis* (Convolvulaceae); j. *Parapiptadenia zehntneri* (Fabaceae); k. *Pleroma gardneri* (Melastomataceae); l. *Varronia leucocephala* (Boraginaceae).

Because the state of Ceará is included within the Caatinga domain, many of the species end up invading the remnants, hence their occurrence. According to Nepomuceno *et al.* (2021), Some areas of Ceará's Cerrado are floristically more like Caatinga vegetation than the Cerrado one, due to the occurrence of a larger number of species of this domain, some of which are exclusive.

*Praxelis diffusa*, *Staurochlamys burchellii*, *Rourea induta* Planch., *Harpalyce brasiliiana* Benth., *Byrsonima stannardii*, *Ouratea hexasperma* (A.St.-Hil.) Baill., *Trichocentrum cepula* are endemic to Cerrado (Fig. 8). The other species may occur in more than one of these domains and in various vegetational types. Almost all of the species collected in Serra das Flores are native to Brazil (97.7%), with the exception of *Emilia sonchifolia* (L.) DC. which is considered naturalized (BFG 2018). This shows the importance of the conservation of this area, due to the presence of native and endemic species of the remnants of these Brazilian domains, including the presence of the new records.

The Cerrado has been greatly degraded in recent years, mainly by the strong expansion of the agricultural frontier and by anthropic actions, such as the replacement of native forest for pasture production, besides the fires. The knowledge of its biodiversity, especially its flora, brings several benefits for the understanding of its plant community as a whole, mainly concerning conservation and management (Andrella & José Neto 2017).

Regarding the conservation status of species, nine (4.5%) are classified in the category of Least Concern (LC), while the others have not been evaluated (NE) up to date (Tab. S1, available on supplementary material <<https://doi.org/10.6084/m9.figshare.23907633.v1>>). According to Pinheiro *et al.* (2020), the species conservation data show the importance of floristic surveys in forest remnants, since from them it is possible to classify the taxon, and thus identify vulnerable species. From the knowledge of a particular location flora, especially in little known areas or areas that have suffered from anthropic actions, these data help in the creation of conservation programs for certain species, especially endemic species or even the creation of conservation units.

Serra das Flores is an area of high species diversity, with the herbaceous and shrubby habit

being the most predominant, where almost all of them are native to Brazil. It presented species endemic to the Cerrado and Caatinga domains and 16 new occurrences for the state of Ceará, thus increasing the list of species in the state. This also proves the high diversity of environmental conditions that Ceará presents.

The Semideciduous Seasonal Forest phytophysiology showed similarity in the number of species when compared to the Typical Cerrado. It was possible to detect floristic differences between the studied phytophysiologicals, mainly marked by environmental and altimetric factors, as well as species richness, families and habits.

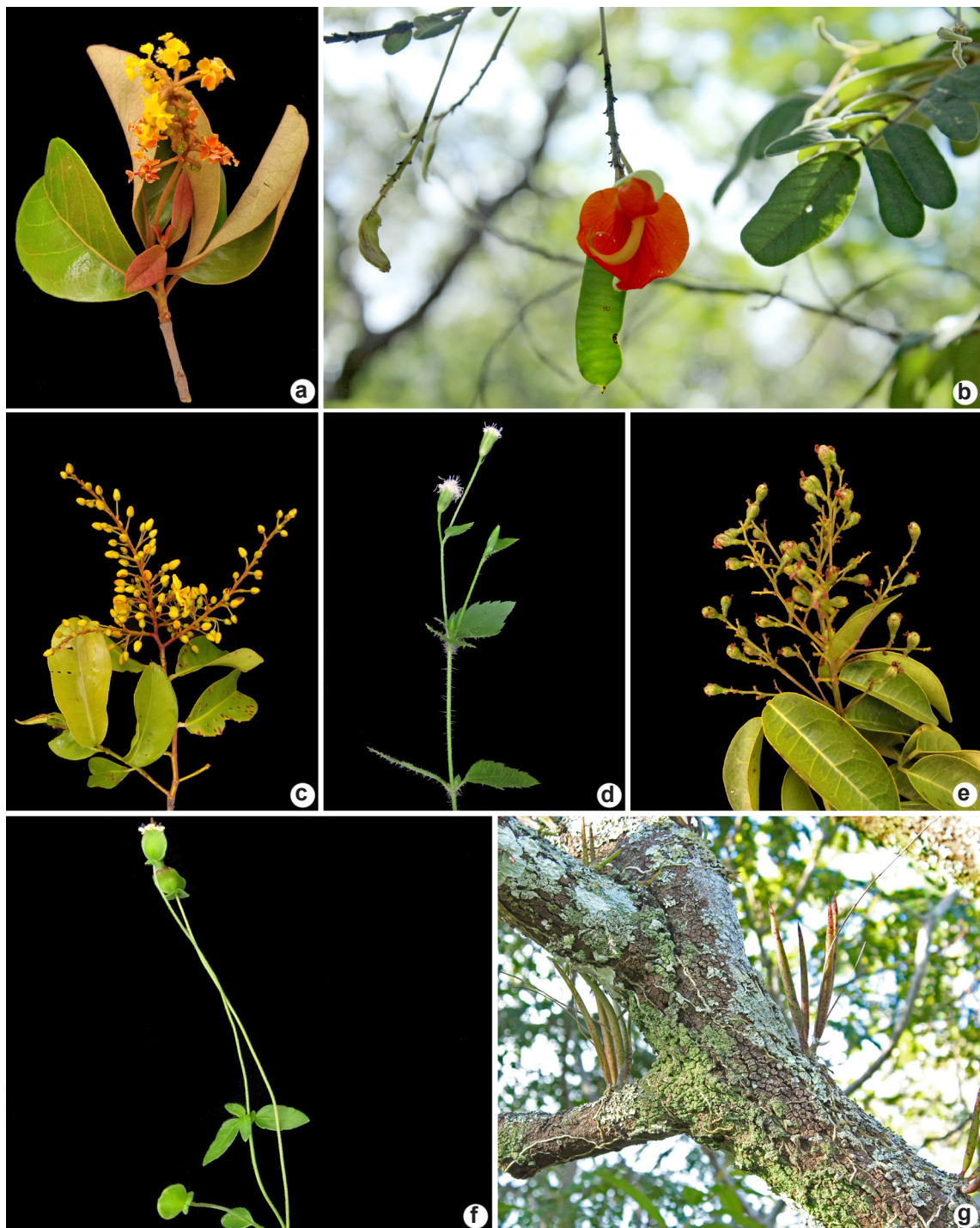
Therefore, more sample collections in little known areas such as the Serra das Flores are necessary to better understand the distribution of vegetational types and species of Cerrado and Semideciduous Seasonal Forest flora in the state of Ceará, helping to update the taxons and the distribution of vegetation for the state, helping to maintain the harmony of these ecosystems, avoiding future environmental damage.

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**Figure 8** – a-g. Endemic species of the Cerrado domain that occur in Serra das Flores, Viçosa do Ceará-CE – a. *Byrsonima stannardii* (Malpighiaceae); b. *Harpalyce brasiliana* (Fabaceae); c. *Ouratea hexasperma* (Ochnaceae); d. *Praxelis difusa* (Asteraceae); e. *Rourea induta* (Connaraceae); f. *Staurochlamys burchellii* (Asteraceae); g. *Trichocentrum cepula* (Orchidaceae).

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