



Phytosociology of the woody component of a vegetation area in Floriano, southern Piauí

Fitossociologia de componente lenhoso de uma área de vegetação em Floriano, sul do Piauí

M C. S. Dantas; J. R. Sousa Júnior; J. M. Monteiro*

Laboratório de Etnobiologia e Conservação, Campus Amílcar Ferreira Sobral, Universidade Federal do Piauí, 64808-605, Floriano - Piauí, Brasil

**juliommmonteiro@ufpi.edu.br*

(Recebido em 08 de junho de 2023; aceito em 10 de dezembro de 2023)

This study proposes to carry out a phytosociological inventory in a vegetation area with semi-arid characteristics, in the municipality of Floriano, southern region of the state of Piauí, aiming to minimize gaps in knowledge about the biome. In this state, phytophysionomies are influenced by different ecosystems and present transitional areas (caatinga-cerrado) that are still poorly studied. A sampling of vegetation was carried out at the Experimental Farm of the Technical College of Floriano (CTF), whose quadrant points were arranged. Phytosociological parameters (basal area, relative dominance, relative frequency, and relative density) were calculated using Fitopac 2.1 software and RStudio. In the inventoried area, 684 individuals were recorded (643 living individuals and 41 dead), totaling 28 ethnospecies (common names), identified among 13 species, nine genera, three at family level and five unknowns. Combretaceae stood out in the studied area. Probably because it is a pioneer, heliophile and adapts well to the local climate. The variation in the number of species found in the different studies for the caatinga and/or cerrado can be explained by some factors such as topography, soil type and permeability, local rainfall, anthropogenic disturbances and even the inclusion criteria for sample selection. This research is essential for developing conservation strategies due to the knowledge and record of the different floristic and phytophysionomic environments of the local flora.

Keywords: Caatinga, Cerrado, conservation.

Esse estudo se propõe realizar um inventário fitossociológico em uma área de vegetação com características de semiárido, no município de Floriano, região Sul do estado do Piauí, visando minimizar a lacunas no conhecimento sobre o bioma. Nesse estado, as fitosisionomias são influenciadas por distintos ecossistemas e apresenta áreas transicionais (caatinga/cerrado) ainda pobremente estudadas. Foi realizada uma amostragem da vegetação na Fazenda Experimental do Colégio Técnico de Floriano (CTF), cujos pontos quadrantes foram dispostos. Parâmetros fitossociológicos (área basal, dominância relativa, frequência relativa e densidade relativa) foram calculados usando o software Fitopac 2.1 e RStudio. Na área inventariada foram contabilizados 684 indivíduos (643 indivíduos vivos e 41 mortos), totalizando 28 etnoespécies, identificados entre 13 espécies, nove gêneros, três ao nível de família e cinco desconhecidos. Combretaceae se destacou na área estudada. Provavelmente por ser pioneira, heliófila e se adaptar bem ao clima local. Assim, a variação no número de espécies encontradas nos diversos estudos para a caatinga e/ou cerrado pode ser explicada por alguns fatores tais como, topografia, tipo e permeabilidade do solo, pluviosidade local, perturbações antrópicas e até os critérios de inclusão para a seleção da amostra. Essas pesquisas são essenciais para a elaboração de estratégias de conservação por conta do conhecimento e registro dos distintos ambientes florísticos e fitofisionômicos da flora local.

Palavras-Chave: Caatinga, Cerrado, conservação.

1. INTRODUCTION

The Caatinga biome, which corresponds to about 60% of the entire northeast region of the country, presents a very diversified environment with very heterogeneous abiotic conditions. It covers an area of 844,453 km² (about 10% of the national territory) and despite being mostly semi-arid, it is marked by vegetational differences, phytophysionomies that include forests with large arboreal size to hypoxerophilic environments with cacti and large areas with rocky outcrops [1-3]. Despite having large extensions, the caatinga is one of the least known and protected biomes, only 1.13% is protected in Conservation Units under Full Protection [4]. These dry areas have several species of useful flora that are threatened by anthropogenic disturbances. Currently,

around 390 species of arboreal or herbaceous individuals are collected for therapeutic purposes, whose collection pressure falls on exposed organs throughout the year, such as stem bark [5].

Research that facilitates the inventory and monitoring of plant formations or even populations of useful species can provide information that adds to the body of knowledge about the biome, and thus implement strategies aimed at the management and conservation of its genetic heritage, as well as its rational and sustained use [2]. Such actions can promote an interesting economic return to the occupants of dry forest areas, whose irregular distribution of rainfall, seasonally, has always marked people's lives as a constant challenge [5]. Considering the Cerrado, the second largest plant formation in the country, some authors have already highlighted the great local phytophysiognomic richness, however, such richness has been systematically replaced by pastures, monocultures, fires, and anthropized/urbanized areas [6].

There are interesting studies directed to the Piauí flora located in protected areas (National Parks of Serra da Capivara and Sete Cidades) and private farms, whose results point to a rich and diverse vegetation formation with a high degree of endemism [2, 7-10].

Even with floristic and phytosociological studies focused on the Caatinga and Cerrado, there are still gaps in knowledge about the biome, mainly in the state of Piauí, given its vast territorial extensions. In this state, the phytosociology is influenced by different ecosystems and presents transitional areas (Cerrado/Caatinga) still poorly studied. Therefore, this study proposes to carry out a phytosociological inventory in a vegetation area with semi-arid characteristics, in the municipality of Floriano, in the southern region of the state of Piauí.

2. METHODOLOGY

2.1. Study area

The vegetation cover of Piauí presents transition areas under the influence of other geographic domains, consisting of varieties in biocenosis, with a strong predominance of Cerrado/Caatinga (Figure 1), making more studies covering the different gradients necessary [11]. The climate in this region is semi-arid, temperature ranged from 24.4 - 31.05 °C and rainfall ranged from 0.0 to 226.12 mm³ during the study period (2019/2020), with a well-defined dry season during the summer [12]. The vegetation matrix is Cerrado, however there are patches of Caatinga and dry seasonal forests, characterizing an ecotonal zone between the Cerrado and Caatinga [13, 14]. In lower and periodically flooded areas, there is still a predominance of palm trees such as carnaúba (*Copernicia prunifera* [Miller] H. E. Moore), one of the main export products of the state [15]. All these vegetation types reinforce a mosaic panorama, whose floristic homogeneity does not exist [16]. Below, some important endemic species: *Stryphnodendron coriaceum* Benth. (barbatimão), *Parkia platycephala* Benth. (faveira de bolota), *Dimorphandra gardneriana* Tul. (fava danta), *Lafoensia replicata* Pohl. (mangabeira brava), *Caryocar coriaceum* Wittm. (pequi) and *Terminalia brasiliensis* Cambess. ex A. St.-Hil. (catinga de porco).

2.2 Data collection and analysis

To verify the floristic composition and species richness in the area, a vegetation sampling was carried out at the Experimental Farm of the Colégio Técnico de Floriano (CTF). 171 quadrant points were arranged in a phytophysiognomy in the vicinity of a local community [16]. The sample design consisted of transects/lines of 50m, lines installed perpendicular to the trails and the main roads that cross the forest, thus avoiding border zones and/or areas that may be affected by city development [16, 17]. The lines were spaced 10m apart and for every 10m, a point was defined for each sampling line [16, 18] (Figure 1). For each sample, measurements such as diameter at ground level (DNS), diameter at breast level (DBH) (having as inclusion criteria, individuals with DNS \geq 3cm, according to Rodal et al. (2013) [19], and an estimate of its height were performed.

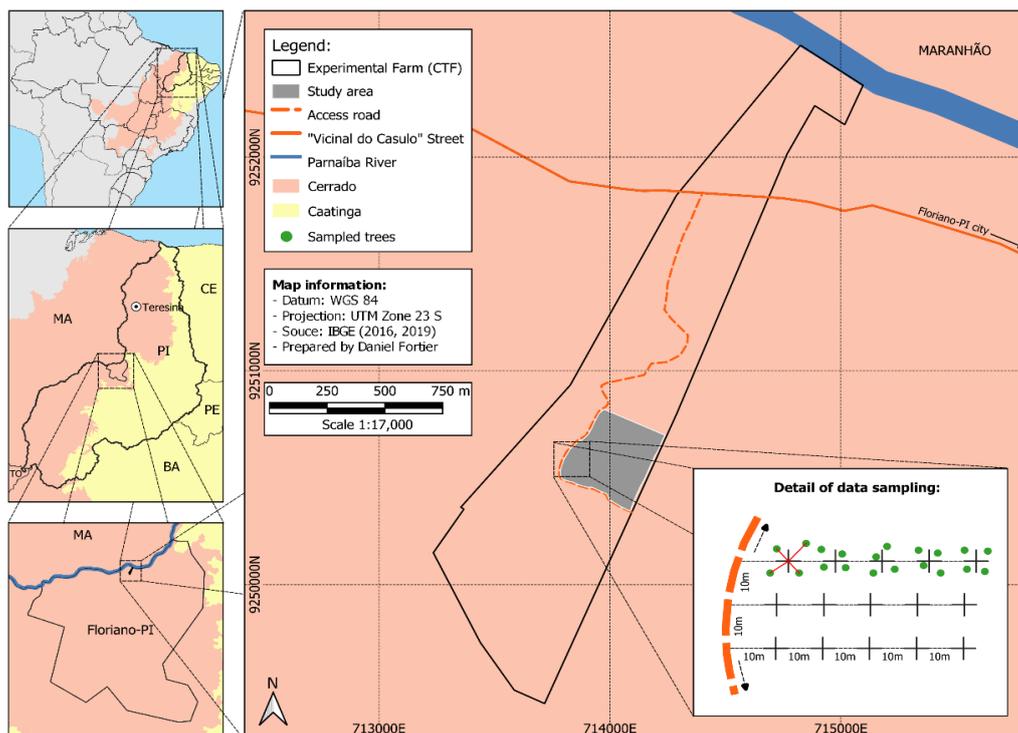


Figure 1. Representation of the study site and detail of the sampling procedure (quadrant point).

Phytosociological parameters (basal area, relative dominance, relative frequency, and relative density) were calculated using the Fitopac 2.1 software [20], and sample sufficiency was measured by RStudio software [21]. The botanical material of some individuals that were found to be fertile were collected, prepared and herborized for the assembly of specimens, addressed and deposited in the Graziela Barroso Herbarium of the Federal University of Piauí.

3. RESULTS AND DISCUSSION

Regarding the sufficiency of the sampling effort, it was found that as the line lengthens in the number of species there is greater stabilization, showing that the local floristics is well sampled (Figure 2). Some studies, both in the cerrado and in the caatinga, found stabilization of the curve (sample sufficiency) with a smaller number of individuals than those found here [22-24]. Alves et al. (2013) [2] highlighted that the species accumulation curves are essential in phytosociological research because they infer the adequate and necessary number of samples established in the place.

In the inventoried area, 684 individuals were recorded (643 living individuals and 41 dead), totaling 28 ethnospecies (common names), identified among 13 species, nine genera, three at family level and five unknown (Table 1). The botanical families were Combretaceae (62.48%), Myrtaceae (21.11%), Fabaceae (6.87%), Anacardiaceae (4.69%), Vochysiaceae (1.69%), Malpighiaceae (1.69%), Annonaceae (0.34%), Moraceae (0.16%), Apocynaceae (0.16%) and Euphorbiaceae (0.16%) (Figure 2). Some authors found similar numbers. In a cerrado area, Bom Jesus, in the south of Piauí, Alves et al. (2013) [2] inventoried 36 species. Felfili et al. (2007) [25] found 39 species in the cerrado area of Goiás. In general, the total number of species inventoried is considerable when compared to other studies in dry forests in the country, ranging from 24 to 61 species found, with sampled areas varying from 0.6 to 1.0 hectare (ha), between the surveys analyzed [2, 7, 26, 27]. The variation in the number of species found in studies can be explained by some factors such as temperature, topography, soil type and permeability, anthropogenic disturbances, or local rainfall [7, 27]. Another interesting aspect that explains these variations are

the criteria for including plants in the sample used. Many studies consider lianas and herbs, not considered here.

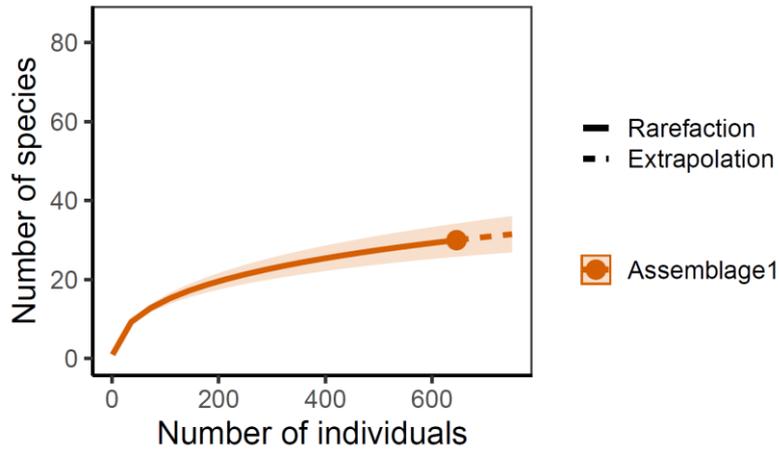


Figure 2. Graphical representation of sample sufficiency, in a fragment with *Caatinga* and *Cerrado* phytophysiology, Floriano, southern Piauí.

As for the number of individuals of each family, *Combretaceae*, *Myrtaceae* and *Fabaceae* were very representative, both in the number of individuals and in coverage values, totaling 90% of the analyzed vegetation. In different studies carried out in an area of *Cerrado*/*Caatinga* vegetation, these families were also very representative, providing qualitative and quantitative information about the area under study and decision-making for the best management of each type of vegetation [28-30]. Qualitative information can provide the main categories of use (medicinal, timber, fuel, or food, for example) belonging to the plants in the area. This can facilitate the identification of preferred or highly demanded plants - by human communities that reside close to vegetation - for a given category of use and thus facilitate local conservation proposals based on this demand.

Research on the phytosociological structure and floristic composition of forest developments are of paramount importance, as they make contributions to understanding the structure and dynamics of these formations, indispensable parameters for the management and regeneration of different plant populations [31].

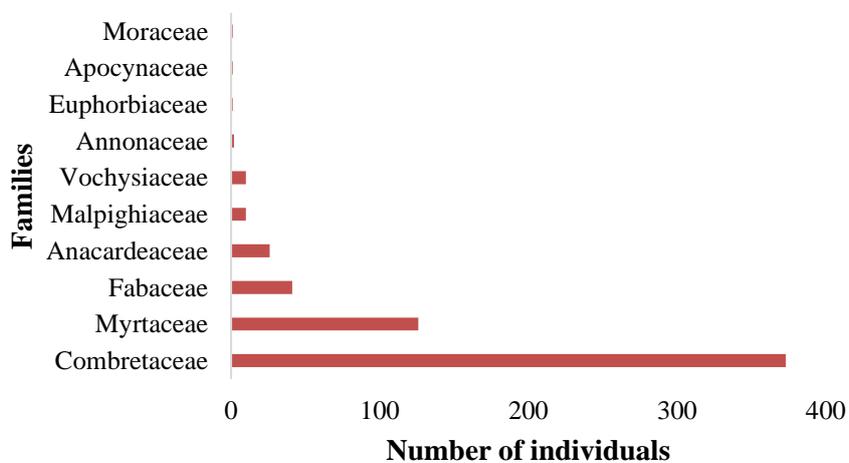


Figure 3. Botanical families and their respective numbers of individuals in the dry forest area studied in Floriano, southern Piauí.

Table 1 describes the species and their parameters, whose importance values (IV) are in descending order. These data indicate interesting information about the structure of a vegetation in each area, in addition to species relationships and/or groups of species, bringing a quantitative contribution on the main inferences such as density of individuals, distribution of heights and variations in circumference [32].

Table 1. Phytosociological analysis of adult shrub/tree individuals with higher IV in an ecotone region (Cerrado/Caatinga) in Floriano, Piauí, Brazil. Where: RD – relative density; RF – relative frequency; Rdo – relative dominance; CV – coverage value and IV – importance value.

Common name	Scientific name	RD	RF	RDo	CV	IV
Catinga de Porco	<i>Terminalia brasiliensis</i> (Cambess.) Eichler	20.55	21.00	39.83	60.38	81.38
Maria Preta	<i>Terminalia</i> sp.	33.24	26.62	17.35	50.58	77.21
Murta	<i>Blepharocalyx suaveolen</i> (Cambess.) Burret	18.51	17.75	6.13	24.65	42.69
Dead individuals	--	5.98	7.79	8.37	14.35	22.14
Paudóleo	<i>Copaifera langsdorffii</i> Desf.	3.79	4.76	8.90	12.68	17.45
Piquiá	<i>Aspidosperma multiflorum</i> A.DC.	2.19	2.38	3.31	5.50	7.88
Pau Terra	<i>Qualea grandiflora</i> Mart.	2.33	2.60	2.89	5.22	7.82
Fava d'anta	<i>Dimorphandra gardneriana</i> Tul.	1.02	1.52	2.88	3.90	5.42
Conduru	<i>Brosimum</i> sp.	1.75	1.95	0.59	2.34	4.28
Murici	<i>Byrsonima coccolobifolia</i> Kunth	1.46	1.73	0.63	2.08	3.82
Cajuí	<i>Anacardium occidentale</i> L.	0.87	1.30	1.43	2.30	3.60
Catinga Branca	<i>Combretum</i> sp. 1	1.46	1.52	0.34	1.80	3.32
Amargoso	<i>Schinopsis</i> sp.	0.44	0.65	2.04	2.98	3.13
Mufumbo	<i>Combretum leprosum</i> Mart.	1.31	1.73	0.08	1.40	3.13
Atraca	Not identified	0.73	0.87	0.52	1.25	2.11
Visgueiro	<i>Parkia platycephala</i> Benth.	0.44	0.43	1.16	1.59	2.03
Mororó	<i>Bauhinia</i> sp.	0.73	1.08	0.08	0.81	1.89
Araçá	<i>Psidium</i> sp.	0.29	0.43	1.12	1.42	1.85
Roseta	Fabaceae	0.58	0.65	0.03	0.61	1.26
Cagaita	<i>Eugenia dysenterica</i> (Mart.) DC.	0.44	0.65	0.16	0.60	1.25
--	Anacardiaceae	0.31	0.46	0.29	0.60	1.06
Violeta	<i>Machaerium acutifolium</i> Vogel	0.15	0.22	0.66	0.81	1.02
Unknown	Not identified	0.15	0.43	0.29	0.58	1.01
Folha larga	Not identified	0.29	0.22	0.44	0.58	0.80
Pirro	Not identified	0.31	0.23	0.01	0.32	0.55
Maniçoba	<i>Manihot</i> sp.	0.15	0.22	0.01	0.30	0.52
Angelim	<i>Andira</i> sp.	0.15	0.22	0.01	0.30	0.52
Maçaranduba do cerrado	Not identified	0.15	0.22	0.01	0.30	0.52
Farinha seca	<i>Combretum</i> sp. 2	0.15	0.22	0.01	0.30	0.52
Gonçalo Alves	<i>Astronium fraxinifolium</i> Schott.	0.15	0.22	0.01	0.30	0.52
Capitão do campo	Vochysiaceae	0.15	0.22	0.01	0.30	0.52

The species that had the highest number of individuals in the studied area were *Terminalia brasiliensis* (Cambess.) Eichler, *Terminalia* sp., *Blepharocalyx suaveolens* (Cambess.) Burret and *Copaifera langsdorffii* Desf., these had the highest relative frequencies. *T. brasiliensis* (Cambess.) Eichler, presented 141 individuals, that is, 21% of the species present in this area, standing out for presenting the highest importance value (81.38%) and coverage value (60.38%), in addition, the second highest relative frequency (21%) and relative density (20.55%). Its use is widespread locally, being used in folk medicine to treat disorders of the digestive system, it provides good quality and resistant wood for civil construction, joinery and carpentry, and the bark of the stem can be used in tanneries [33]. *T. brasiliensis* (Cambess.) Eichler, popularly known as ‘capitão’, ‘cerne’, ‘pau-sangue’ and ‘garrote’, is widely distributed in Brazilian territory. A deciduous and heliophyte plant, it is a very ornamental tree and can be used successfully in landscaping, especially for urban afforestation. A pioneering and fast-growing plant, it is excellent for reforestation and appears frequently in dry and sandy soils. It has a discontinuous distribution, occurring in dense primary forest and in secondary formations, preferably in sandy, well-drained terrain [34]. ‘Maria preta’ (*Terminalia* sp.) obtained the second highest importance value (77.21%) and coverage value (50.58%), standing out in first place in the relative density parameters (33.24%), that is, it is widely distributed in the study site, with 228 individuals present, representing 33% of the plant occupation of the species, belonging to the Combretaceae family, which is non-endemic. This family has a wide distribution in Brazilian territory and is found in the Caatinga, Amazon, Cerrado and Atlantic Forest [34, 35]. In total, there are 64 species, 13 of which are endemic, found among five genera [34]. *Terminalia* and *Combretum* are important genera, mainly in the cerrado biome. Some studies in the literature have pointed out some species of *Terminalia* with pharmacological, anti-inflammatory, sedative and antidiarrheal [36-38].

The species *B. suaveolens* (Cambess.) Burret, represented with 127 individuals, thus, 18.5% of the local vegetation acquired the third place in importance value (42.69%), relative density (18.51%) and coverage value (24.65%), we can highlight that the relative dominance of this plant was given by (6.13%), occupying the third place in the phytosociological parameters carried out. Few studies are available for this genus. Denardi and Marchiori (2005) [39] studied the anatomy of *Blepharocalyx salicifolius* (H. B. K.) Berg (Myrtaceae), in two regions of Rio Grande do Sul, and noticed the presence of xeromorphic characteristics in the wood of an individual in a region with less water availability. This may explain the good representation of *B. suaveolens* (Cambess.) Burret in the seasonally dry forest studied. *B. suaveolens* (Cambess.) Burret, was one of the representatives with more than half of the plant population in the sample area belonging to the Myrtaceae family. It is worth noting that both *T. glabrescens* Mart and *B. suaveolens* (Cambess.) Burret, have phytogeographic domains in the Cerrado/Caatinga. The Myrtaceae family is very important in beekeeping, one of the most important in Brazil, and the main floral resource offered is pollen, eventually associated with the presence of nectar [40]. It has great diversity in terms of fruit morphology, especially in terms of size, color and number of seeds [40].

The ‘pau-dóleo’ (*Copaifera langsdorffii* Desf.) was in fifth place with its importance value (17.45%), relative density (3.79%), absolute frequency (11.06%) and coverage value (12.68%). This plant is a tropical tree species widely distributed in Brazil, being found in the Amazon and Atlantic forests and in the riparian forests of the cerrado region, it produces oil-resin, which is found in secretory channels located in all parts of the tree, especially in the trunk [41]. In a phytosociological study in Bom Jesus, Piauí, Alves et al. (2013) [2] described that *C. langsdorffii* was the most prominent species and the highest IV. The authors also argued that this plant is heliophilous, has strong regrowth power and can be used in restoration plans for degraded forests. This plant contains an oil/resin that is widely used in traditional medicine to treat illnesses, mainly inflammation, and its wood is also appreciated in civil and naval construction, due to its strength and durability [41]. *Qualea grandiflora* Mart., presented 16 individuals with IV of (7.82%) and CV (5.22%), being a scleromorphic tree and *Combretum* sp. with 10 individuals, IV (3.32%) with a CV of (1.80%). Popularly known in the Northeast, *Anacardium occidentale* L. (Cajuí) had six individuals and a low IV and CV values that are (2.30%) and (3.60%) respectively, has food, timber, and high extractive value purposes. The cashew fruit is among the native fruit trees with the greatest potential in the Northeast region, a species still incipiently domesticated, thus, studies should be expanded mainly regarding its cultivation, conservation, and processing [42].

According to Rufino et al. (2008) [43], the chestnut is used to obtain almonds, its peduncle is used in the form of candy and its wood is very useful in the production of charcoal.

Schinopsis sp. and *Eugenia dysenterica* DC., both with 3 individuals, more, with a difference in importance value and coverage value. The first with IV of 3.13% and CV of 2.48% and the second species with IV of (1.25%) and CV (0.60%). 41 dead individuals were found in the area, with a IV of 22.14%, which may indicate recent disturbances in the analyzed area. Assunção and Felfili (2004) [44] found 64 dead individuals in a fragment of cerrado in a phytosociological study, relative density close to 7.3%, the authors considered this value high. The Shannon-Weaner (H') diversity index calculated for the studied area was 2.02 nats ind⁻¹. This value is very close to that of Alves et al. (2013) [2], 2.9 nats ind⁻¹, whose study area, in the south of Piauí, has characteristics of a dry forest. These results may contain quantitative variations, as they depend on sampling strategies and species inclusion criteria [2].

4. FINAL CONSIDERATIONS

In Piauí, studies related to fauna and flora are still incipient when considering its territorial extension [9]. Research with such purposes is essential for the elaboration of conservation strategies, through the knowledge and recording of the different floristic and phytophysognomic environments, indispensable for the understanding and local management. Thus, it is important to emphasize that more studies are needed focused on this ecotonal area (Caatinga/Cerrado), marked by great biological diversity and current lack of research.

The Combretaceae family had a large number of individuals and thus proved to be an important group in the studied location. This is probably due to the fact that this family presents pioneer, deciduous and heliophilous species, whose unique characteristics adapt well to the location. Euphorbiaceae, Vochysiaceae, Fabaceae, Anacardiaceae and Annonaceae are significant families with a good number of species reported for dry forests, however, few individuals were found in the present sample, compared to Combretaceae and Myrtaceae. A possible explanation is the existence of anthropic disturbances at the site (removal of useful plants by residents near the forest and cattle and goat pastures) that favor individuals of the genus *Terminalia*, to the detriment of others. Given this, greater sampling effort is necessary along with long-term monitoring of the structure of these plant populations with good records for dry forests. This would make it possible to better understand the entire local phytosionomic composition.

Many species described here and found in the area are useful, multifunctional and in great demand by the population. Therefore, sustainable management and collection strategies are urgent for these species with high demand locally.

5. ACKNOWLEDGEMENTS

The authors would like to thank the Experimental Farm of the Colégio Técnico de Floriano (CTF), Dr. Daniel C. Fortier for creating the map of the study area and Ronaldo A. Ibiapina, for help with the RStudio software. They also thank the anonymous reviewers who effectively contributed to improving the writing of this work.

6. REFERENCES

1. Ministério do Meio Ambiente. Uso sustentável e conservação dos recursos florestais da caatinga. Brasília (DF): Serviço Florestal Brasileiro; 2010.
2. Alves AR, Ribeiro IB, Sousa JRL, Barros S, Sousa PS. Análise da estrutura vegetacional em uma área de Caatinga no município de Bom Jesus, Piauí. *Rev Caatinga*. 2013;26(4):99-106.
3. Ferraz RC, Mello AA, Ferreira RA, Prata APN. Levantamento fitossociológico em área de caatinga no Monumento Natural Grota do Angico, Sergipe, Brasil. *Rev Caatinga*. 2013;26(3):89-98.
4. Fonseca CR, Antongiovanni M, Matsumoto M, Bernard E, Venticinque EM. Oportunidades de conservação na caatinga. *Cienc Cult*. 2018;70(4):44-51. doi: 10.21800/2317-66602018000400013

5. Albuquerque UP, Melo FP. *Sociologia da Caatinga*. *Cienc Cult*. 2018;70(4):40-4. doi: 10.21800/2317-66602018000400012
6. Borges HB, Nogueira E, Shepherd GJ. Flora e estrutura do estrato lenhoso numa comunidade de Cerrado em Santo Antônio do Leverger, MT, Brasil. *Rev Bras Bot*. 2005;28(1):61-74. doi: 10.1590/S0100-84042005000100006
7. Lemos JR, Rodal MJN. Fitossociologia do componente lenhoso de um trecho da vegetação de Caatinga no Parque Nacional Serra da Capivara, Piauí, Brasil. *Acta Bot Bras*. 2002;16(1):23-42. doi: 10.1590/S0102-33062002000100005
8. Lemos JR. Composição florística do parque nacional Serra da Capivara, Piauí, Brasil. *Rodriguésia*. 2004;55(85):55-66. doi: 10.1590/2175-78602004558503
9. Farias RRS, Castro AAJF. Florística e fitossociologia em trechos de vegetação do Complexo de Campo Maior, Piauí. *Acta Bot Bras*. 2004;18(4):949-63. doi: 10.1590/S0102-33062004000400025
10. Matos MQ, Felfili JM. Florística, fitossociologia e diversidade da vegetação arborea nas matas de galeria do Parque Nacional de Sete Cidades (PNSC), Piauí, Brasil. *Acta Bot Bras*. 2010;24(2):483-96. doi: 10.1590/S0102-33062010000200019
11. Amaral GC, Alves AR, Oliveira TM, Almeida KNS, Farias SGG, Botrel RT. Estudo florístico e fitossociológico em uma área de transição Cerrado-Caatinga no município de Batalha-PI. *Sci Plena*. 2012;8(4):1-5.
12. Agritempo [Internet]. Estatísticas; ©2002-2024 [cited 2023 Nov 15]. Available from: <https://www.agritempo.gov.br/agritempo/jsp/Estatisticas/index.jsp?siglaUF=PI>
13. Rizzini CT. *Tratado de Fitogeografia do Brasil. Aspectos sociológicos e florísticos*. São Paulo: Hucitec-Edusp; 1979.
14. Castro AAJF, Barros JS, Costa JM, Santos MPD, Pires MFO, Mendes MRA, et al. Cerrados marginais do Nordeste e ecótonos associados: Sítio 10 do PELD (período 2001/2011). Piauí: EDUFPI; 2010.
15. Brito JC, Costa AR. *Geografia do Piauí: Conhecer para valorizar*. Piauí: EDUFPI; 2012.
16. Souza AS, Albuquerque UP, Nascimento ALB, Santoro FR, Torres-Avilez WM, Lucena RFP, et al. Temporal evaluation of the Conservation Priority Index for medicinal plants. *Acta Bot Bras*. 2017;31:169-79. doi: 10.1590/0102-33062017abb0027
17. Felfili JM, Eisenlohr PV, Melo MMRF, Andrade LA, Meira Neto JAA. *Fitossociologia no Brasil: métodos e estudos de caso*. Viçosa (MG): UFV 2011.
18. Araújo EL, Ferraz EMN. Analysis of vegetation in ethnobotanical studies. In: Albuquerque UP, Lucena RF, Cunha LV, Alves RRN, editors. *Methods and techniques in Ethnobiology and Ethoecology*, New York: Springer; 2014. p. 141-60.
19. Rodal MJN, Sampaio EVSB, Figueiredo MA. *Manual sobre métodos de estudo florístico e fitossociológico - Ecossistema Caatinga*. Brasília: Sociedade Botânica do Brasil; 2013.
20. Shepherd GJ. *FITOPAC 2.0. Manual do usuário*. Campinas (SP): Departamento de Botânica, Universidade Estadual de Campinas; 2009.
21. RStudio Team. *RStudio: Integrated development environment for R*. Boston (US): RStudio, Inc.; 2016.
22. Teixeira MIJG, Araujo ARB, Valeri SV, Rodrigues RR. Florística e fitossociologia de área de Cerrado s.s. no município de Patrocínio Paulista, Nordeste do estado de São Paulo. *Bragantia*. 2004;63(1):1-11.
23. Medeiros MB, Walter BMT, Silva GT. Fitossociologia do cerrado *stricto sensu* no município de Carolina, MA, Brasil. *Cerne*. 2008;14(4):285-94.
24. Neto VLS, Oliveira AL, Ferreira RQS, Souza PB, Viola MR. Fitossociologia e distribuição diamétrica em uma área de cerrado *stricto sensu*, Dueré, TO. *Rev Ciênc Amb*. 2016;10(1):91-106.
25. Felfili JM, Nascimento AT, Fagg CW, Meirelles EM. Floristic composition and community structure of a seasonally deciduous forest on limestone outcrops in Central Brazil. *Rev Bras Bot*. 2007;30(4):611-21. doi: 10.1590/S0100-84042007000400007
26. Nascimento LM, Rodal MJN. Fisionomia e estrutura de uma floresta estacional montana do maciço da Borborema, Pernambuco – Brasil. *Rev Bras Bot*. 2008;31(1):27-39. doi: 10.1590/S0100-84042008000100004
27. Dantas DJ, Holanda AC, Silva SL, Japiassu A, Holanda EM. Structures of the arbustive/arboreal component of an area of caatinga located in Pombal, PB. *Rev Verde Agroecol Desenv Sust*. 2010;5(1):134-42.
28. Ferraz RC, Mello AA, Ferreira RA, Prata APN. Levantamento fitossociológico em área de Caatinga no monumento natural Grota do Angico, Sergipe, Brasil. *Rev Caatinga*. 2013;26(3):89-98.
29. Andrade LA, Pereira IM, Leite UT, Barbosa MRV. Análise da cobertura de duas fisionomias de caatinga, com diferentes históricos de uso, no município de São João do Cariri, Estado da Paraíba. *Cerne*. 2005;11(3):253-62.
30. Lemos JR, Meguro M. Estudo fitossociológico de uma área de Caatinga na Estação Ecológica (ESEC) de Aiuaba, Ceará, Brasil. *Rev Biotemas*. 2015;28(2):39-50. doi: 10.5007/2175-7925.2015v28n2p39

31. Chaves ADCG, Santos RMS, Santos JO, Fernandes AA, Maracajá PB. A importância dos levantamentos florístico e fitossociológico para a conservação e preservação das florestas. *Revista ACSA – Agropecuária Científica no Semiárido*. 2013;9(2):43-8.
32. Soares ZT, Costa APS, Soares EF, Cavalcanti VFS. Levantamento florístico e fitossociológico em uma área de cerrado no Sudoeste do Maranhão. *Iniciação Científica CESUMAR*. 2010;12(2):111-20.
33. Araújo DS, Chaves MH. Triterpenóides pentacíclicos das folhas de *Terminalia brasiliensis*. *Quim Nova*. 2005;28:996-9. doi: 10.1590/S0100-40422005000600012
34. Lorenzi, H. Árvores Brasileiras: Manual de identificação e cultivo de plantas arbóreas nativas do Brasil, vol. 1. 8ª ed. São Paulo: Instituto Plantarum de Estudos da Flora; 2020.
35. Sousa VF, Ribeiro RTM, Loiola MIB, Versieux LM. Combretaceae no estado do Rio Grande do Norte, Brasil. *Rodriguésia*. 2018;69(4):1771-87. doi: 10.1590/2175-7860201869417
36. Cock IE. The medicinal properties and phytochemistry of plant of the genus *Terminalia* (Combretaceae). *Prog Drug Res*. 2015;23:203-29. doi: 10.1007/s10787-015-0246-z.
37. Ribeiro SS, Jesus AM, Anjos CS. Evaluation of the cytotoxic activity of some Brazilian medicinal plants. *Planta Med*. 2012;78:1601-6. doi: 10.1055/s-0032-1315043.
38. Pádua PF, Dihl RR, Lehmann M, Abreu BR, Richter MF, Andrade HH. Genotoxic, antigenotoxic and phytochemical assessment of *Terminalia actinophylla* ethanolic extract. *Food Chem Toxicol*. 2013;62:521-7. doi: 10.1016/j.fct.2013.09.021.
39. Denardi L, Marchiori JNC. Anatomia ecológica da madeira de *Blepharocalyx salicifolius* (H.B.K) Berg. *Ci Flor*. 2005;15(2):119-27. doi: 10.5902/198050981829
40. Gressler E, Pizo MA, Morellato PC. Polinização e dispersão de sementes em Myrtaceae do Brasil. *Revis Bras Bot*. 2006;29(4):509-30. doi: 10.1590/S0100-84042006000400002
41. Veiga-Junior VF, Pinto AC. O gênero *Copaifera* L. *Quim nova*. 2002;25(2):273-86. doi: 10.1590/S0100-40422002000200016
42. Gomes SO, Sousa VAB, Costa MPD, Silva CCP, Vale EM, Sousa M, Brito JP. Avaliação da qualidade física e química de cajupú (*Anacardium* spp.) na região Meio-norte. *Rev Geintec*. 2013;3(3):139-45.
43. Rufino MSM, Corrêa MPF, Alves RE, Leite LAS. Utilização atual do cajupú nativo da vegetação litorânea do Piauí, Brasil. Parnaíba (PI): Embrapa; 2008.
44. Assunção SL, Felfili JM. Fitossociologia de um fragmento de cerrado *sensu stricto* na APA do Paranoá, DF, Brasil. *Acta Bot Bras*. 2004;18(4):903-9. doi: 10.1590/S0102-33062004000400021