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RELICTS OF CARRASCO IN THE TOCANTINS CERRADO: DIVERSITY AND FLORISTIC RELATIONSHIPS

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ABSTRACT

Objective: To describe the floristic and structural diversity of the Carrasco in the municipality of Porto Nacional.

Theoretical Framework: This study is based on analyzing the floristic diversity, vegetation structure, and floristic similarity to verify its classification as a phytophysiognomy associated with the Cerrado of Tocantins.

Method: Fifty plots measuring 10 x 10 meters were allocated. Sampling criteria included circumference ≥ 10 cm at ground level and height ≥ 1 m. The phytosociological data were analyzed using the FITOPAC software.

Results and Discussion: A total of 4,110 individuals were found, distributed among 59 species from 37 genera and 22 botanical families. The vegetation showed homogeneity and diversity comparable to other Cerrado areas but with distinct characteristics, such as the presence of lianas and low ecological dominance. The floristic similarity analysis revealed a low similarity between the "Carrasco" and other Cerrado phytophysiognomies, highlighting the uniqueness of this vegetation.

Research Implications: The 'Carrasco' possesses unique floristic, structural, and similarity characteristics, being a vegetational relict that justifies its designation as a new phytophysiognomy of Tocantins.

Originality/Value: This study contributes to the literature by providing a detailed analysis of the floristic composition of the “Carrasco” phytophysiognomy, a new xerophytic and deciduous phytophysiognomy on sandy soils in the state of Tocantins, highlighting its importance for biodiversity conservation within the Cerrado biome. The relevance of this research is to expand the understanding of the ecological characteristics of this relic, offering essential insights for future conservation and management actions.

Keywords: Cerrado Domain, Floristic Studies, Quartzarenic Neosols, Deciduous Vegetation.

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RELICTOS DE CARRASCO NO CERRADO TOCANTINENSE: DIVERSIDADE E RELAÇÕES FLORÍSTICAS

RESUMO

Objetivo: Descrever a diversidade florística e estrutural do Carrasco no munícipio de Porto Nacional, Tocantins.

Referencial Teórico: Fundamenta-se em analisar a diversidade florística, a estrutura da vegetação e a similaridade florística para comprovar sua classificação como uma fitofisionomia associada ao Cerrado Tocantinense.

Método: Foram alocadas 50 parcelas, com dimensões de 10 x 10 metros. Os critérios de amostragem incluíram circunferência ≥ 10 cm ao nível do solo e altura ≥ 1 m. Os dados fitossociológicos foram analisados utilizando o software FITOPAC.

Resultados e Discussão: Foram encontrados 4.110 indivíduos distribuídos em 59 espécies de 37 gêneros e 22 famílias botânicas. A vegetação apresentou homogeneidade e diversidade na média de outras áreas do Cerrado, mas com características distintas, como a presença de lianas e baixa dominância ecológica. A análise de similaridade florística revelou uma baixa similaridade entre o "carrasco" e outras fitofisionomias do Cerrado, destacando a singularidade dessa vegetação.

Implicações da Pesquisa: O "Carrasco" possui características florísticas, estruturais e de similaridade únicas, sendo um relicto vegetacional que justificam sua designação como uma nova fitofisionomia no Tocantins.

Originalidade/Valor: Este estudo contribui para a literatura ao fornecer uma análise detalhada da composição florística da fitofisionamia "Carrasco", uma nova fitofisionomia xerófila e caducifólia em solos arenosos do estado do Tocantins, destacando sua importância para a conservação da biodiversidade do domínio Cerrado. A relevância desta pesquisa é ampliar o entendimento sobre as características ecológicas desse relicto, fornecendo subsídios essenciais para futuras ações de conservação e manejo.

Palavras-chave: Domínio Cerrado, Estudos Florísticos, Neossolos Quartzarênicos, Vegetação Caducifólia.

RELICTOS DE CARRASCO EN EL CERRADO DE TOCANTINS: DIVERSIDAD Y RELACIONES FLORÍSTICAS

RESUMEN

Objetivo: Describir la diversidad florística y estructural del Carrasco en el municipio de Porto Nacional, Tocantins.

Marco Teórico: Este estudio se basa en analizar la diversidad florística, la estructura de la vegetación y la similitud florística para verificar su clasificación como una fitofisionomía asociada al Cerrado de Tocantins.

Método: Se asignaron 50 parcelas de 10 x 10 metros. Os critérios de museu incluem circunferência ≥ 10 cm ao nível do solo e altura ≥ 1 m. Los datos fitosociológicos fueron analizados utilizando el software FITOPAC.

Resultados y Discusión: Se encontraron un total de 4.110 individuos, distribuidos en 59 especies de 37 géneros y 22 familias botánicas. La vegetación mostró homogeneidad y una diversidad comparable a otras áreas del Cerrado, pero con características distintivas, como la presencia de lianas y baja dominancia ecológica. El análisis de similitud florística reveló una baja similitud entre el "carrasco" y otras fitofisionomías del Cerrado, destacando la singularidad de esta vegetación.

Implicaciones de la Investigación: El "Carrasco" posee características florísticas, estructurales y de similitud únicas, justificando su designación como una nueva fitofisionomía el Tocantins.

Originalidad/Valor: Este estudio contribuye a la literatura al proporcionar un análisis detallado de la composición florística de la fitofisionomía "Carrasco", una nueva fitofisionomía xerófila y caducifolia en suelos arenosos del estado de Tocantins, destacando su importancia para la conservación de la biodiversidad en el dominio del Cerrado. La relevancia de esta investigación radica en ampliar el conocimiento sobre las características ecológicas de este relicto, proporcionando información esencial para futuras acciones de conservación y manejo.

Palabras clave: Dominio del Cerrado, Estudios Florísticos, Neosuelos Cuarzoarenosos, Vegetación Caducifolia.

1 INTRODUCTION

The Cerrado is the predominant Domain in the state of Tocantins, representing 91% of the native vegetation (IBGE, 2004). Located in the central region of Brazil, it confluences with the surrounding Amazon Forest and Caatinga and presents a diversity of environments, from marshy areas, such as the island of Bananal to the southwest, extremely dry regions, such as Jalapão to the east and a small percentage of Amazon forest to the north of the state.

Among the phytophysiognomies found, it is found that in the central region of the state, on sandy soils, occurs the phytophysiognomy called "Carrasco", a type of shrub vegetation, dense and deciduous. The term "Carrasco" has been used to designate different types of vegetation of northeastern Brazil, covering scrubland Caatingas of stony soils, clearings and areas of open vegetation with small shrubs (Araújo *et al.* 1998). According to the authors, the "Carrasco" is given other names, such as catanduva, grameal, deciduous shrub vegetation, non-spiny, whose xerophile aspects are similar to Caatinga. Andrade-Lima (1978) distinguished physiognomically the Carrasco da Caatinga by the high density of woody individuals, which show fine and unistratified trunks and almost absence of Cactáceas and Bromeliaceae.

In the last few years, floristic and phytosociological studies carried out in Tocantins have contributed with the knowledge of the flora of Tocantins, among which it is worth highlighting the mappings and forest inventories carried out by Dambrós et al. (2005), Seplan (2012) and Haidar *et al.* (2013); floristic and phytosociological surveys carried out by Olmos *et al.* (2004), Quarry *et al.* (2011), Silva Neto *et al.* (2016b) and Viana *et al*. (2024) However, most of these studies were carried out in the narrow sense of the Cerrado, not including other types of vegetation such as the executioner.

In Tocantins, the "Marauder" occurs within the Cerrado Domain, mixed or interspersed with other phytophysiognomies. According to Olmos *et al.* (2004), in the state, there is occurrence of Carrasco in the municipalities of Ananas, Presidente Kennedy and in Porto Nacional, in the Environmental Protection Area Lake Palmas. However, so far no floristic, structural and comparison studies with other phytophysiognomies on this vegetation have been carried out.

In this context, considering that the Carrasco is a point phytophysiognomy and practically unknown in the state of Tocantins and in the North of Brazil, the present work that aims to describe the floristic and structural diversity of the Carrasco in the municipality of Porto Nacional, Tocantins, expanding the knowledge about the diversity and structure of this vegetation, aggregating information about the biodiversity that can later serve as subsidies for conservation and management of these areas.

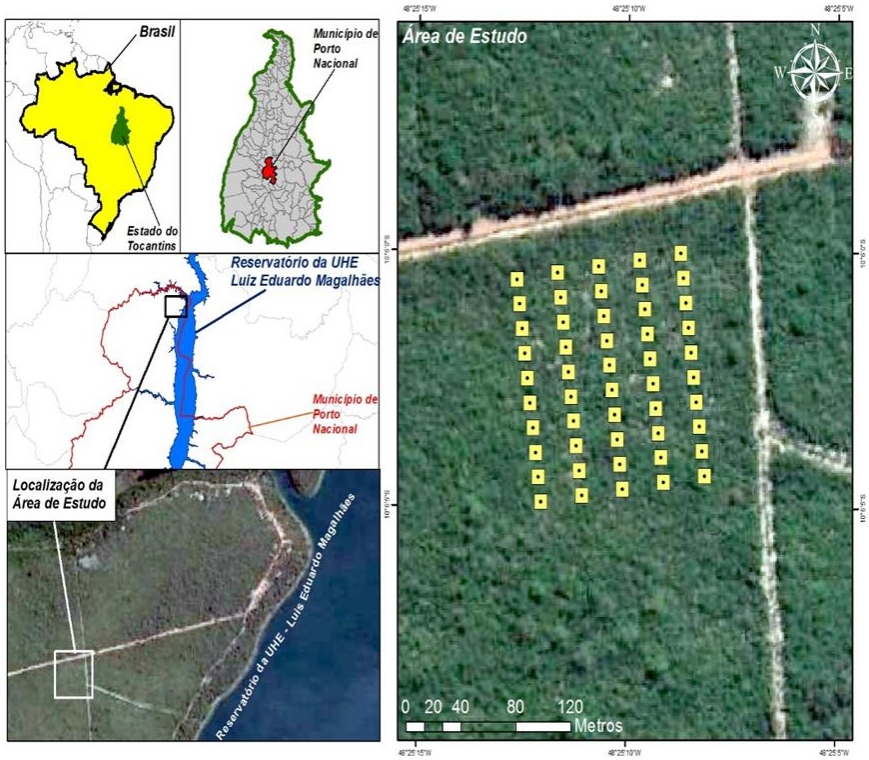
2 METHODOLOGY

2.1 DESCRIPTION OF THE FIELD OF STUDY

The study area is located in the municipality of Porto Nacional - TO, in the district of Luzimangues, in the Environmental Protection Area Lago de Palmas, a stretch between 10º05'57.2"S 048º25'07.1" W. The Conservation Unit Lago de Palmas has an area of 50,370 ha, inserted in the Basin of the River Tocantins, on the left bank (Figure 1).

Figure 1

Location of the study area in the Lake Palmas Environmental Protection Area, Porto Nacional, Tocantins with the respective plots allocated.



Source: Author, 2024.

The climate of the region is stational, average annual precipitation is 1,700 mm and the average temperature is 27ºC (SEPLAN, 2012). The soil is of the sandy type, classified as Typical Ortic Quartzenic Neosols and the relief of the region is flat and soft wavy (IBGE, 2004; SEPLAN, 2012).

The vegetation is predominantly shrub, has some trees reaching a maximum of six meters in height and there are no grasses. There is an abundance of lichens on the stems (Figure 2), lianas, pineapple (*Ananas ananassoide* (Baker) L. B. Sm.) and tucum-crawler (*Astrocaryum vulgareMart.) that form a tangle, making access to the area difficult.* During the dry season, deciduous vegetation occurs, which is a characteristic of this vegetation that acquires aspects of the Caatinga (scrubland) (Figure 3). In the Lake Palmas Environmental Protection Area, the Marauder occurs interspersed with the phytophysiognomies Cerrado restricted sense and Semideciduous Seasonal Forest.

Figure 2

Lichens found in executioner vegetation in the Lake Palmas Environmental Protection Area, Porto Nacional, Tocantins.

Source: Author, 2024.

Figure 3

Carcass vegetation in the Environmental Protection Area Lake Palmas, National Port, Tocantins. A) Carascus vegetation in the month of November, end of dry season. B) Carascus vegetation in the month of April, end of the rainy season.

Source: Author, 2024.

2.2 VEGETATION SAMPLING

For the floristic and structural characterization of the plant community and vegetation sampling was used the parcel method (Müeller-Dombois and Ellenberg, 1974). 50 plots were allocated, with dimensions of 10 x 10 meters, as proposed by Araújo *et al.* (1998), totaling 0,5 ha.

The inclusion criterion was taken into account the low size of the vegetation, in which all individuals (alive and dead) that were standing and had height ≥ 1 meter and circumference ≥ 10 cm at soil level (CAS) were sampled.

Collections were carried out in the period from February to May 2018, in which plants that presented reproductive structures were also collected outside the sampling plots, with the intention of enriching the floristic listing. The collected material was identified using the Angiosperm Phylogeny Group IV classification system (2016) and conferred the synonymy of the species in the List of Flora and Funga Species of Brazil (REFLORA, 2024). Subsequently it was herborized and deposited as testimony in the Herbarium of Tocantins (HTO), Federal University of Tocantins, Campus of Porto Nacional - TO.

2.3 STATISTICAL ANALYZES

With the data obtained in the field, the phytosociological parameters were calculated: relative density (DR.), relative dominance (DoR), relative frequency (FR), importance value index (IVI), Shannon-Wiener diversity index (H'), and the Pielou equability by means of the Fitopac program, version 2.1.2 (Shepperd, 2010).

The structure of the tree component was described from the calculation, for each species, of the index of value of importance (IVI), calculated by the sum of: density, frequency and dominance, relative (Mueller-Dombois and Ellenberg, 1974).

To verify the structural organization of the tree community, the parcels were ordered by means of a Destined Correspondence Analysis (DCA), using abundance data of species that presented ten or more individuals in the total sampled.

To identify the floristic similarity of the executioner with other phytophysiognomies, calculations of similarity were carried out, using the Jaccard index (MAGURRAN, 1988), one of the tests most used in studies of biological communities that indicates the proportion of species shared between two samples in relation to the total of species and qualitatively compares the similarity of species that exists between successive samples taken in spatial and temporal intervals or along an environmental gradient (ZANINI, 2005).

To carry out the analysis of Floristic Similarity, eleven areas studied in the state of Tocantins, Maranhão and Ceará were selected, five of them from Cerrado restricted sense, two from Cerradão, one from Stational Forest, three from Carrasco in Caatinga vegetation and the study area. Based on the data collected, a table was assembled based on the presence and absence of species and multivariate analysis was processed using the PAST software (HAMMER, 2017).

3 RESULTS AND DISCUSSIONS

3.1 EXECUTIONER OF THE STATE OF TOCANTINS

The Cerrado is the predominant domain in the state of Tocantins and makes its confluence with other domains, such as the Amazon Forest and the Caatinga, providing a diversity of environments. Among the phytophysiognomies found in the Cerrado Tocantinense, stands out the formation called "Carrasco", a dense and deciduous shrub vegetation that occurs on sandy soils (Olmos et al., 2004).

Although the term "Carrasco" is traditionally used to designate vegetation of Northeast Brazil, associated with areas of shrub Caatinga in stony soils, the results of this study indicate that the Carrasco found in Porto Nacional - TO has floristic and structural characteristics that distinguish it from other formations. This vegetation was then classified as a relictual vegetation (IBGE 2012), for presenting unique floristic and ecological aspects, different from the surrounding phytophysiognomies, such as the Cerrado sense restricted and the Semideciduous Stational Forest.

The peculiarities observed suggest that the Carrasco tocantinense, although it shares some characteristics with the Carrasco nordestina (Northeastern Carrasco), is an individualized phytophysiognomy within the Cerrado.

3.2 PHYTOSOCIOLOGY AND FLOWER DIVERSITY

We sampled 4,110 individuals distributed in 59 species, belonging to 37 genera and 22 botanical families and three indeterminate species (Table 1 and 2). The ten species with the highest index of value of importance (IVI), in descending order, were: *Manilkara triflora* (German) Monach., *Cordiera elliptica*(Cham.) Kuntze, Esenbeckia pumila Pohl., German Myracrodruon urundeuva, Byrsonima coccolobifolia Kunth., Toulicia crassifolia Radlk., Buchenavia tetraphylla(Aubl.) R.A. Howard., Peltogyne confertiflora(Mart. ex Hayne) Benth., Hymenaea eriogyne Benth. and

The species *M. triflora, C. elliptica, E. pumila, T. crassifolia and H. eriogyne* were not recorded in most studies conducted in the state of Tocantins (Santos and Lolis, 2007; Lavor, Silva e Chaves, 2013; Ferreira *et al.* 2015; Silva Neto *et al.* 2016a). However, *E. pumila, T. crassifolia and H. eriogyne* are abundant in the sandy soils of Jalapão (VIANA, 2023, 2024), usually in shrub form. This data corroborates the statement of Haidar *et al.* (2013) that these species have restricted distribution in Tocantins.

Peltogyne confertiflora is among one of the species that has been rarely sampled in the Cerrado and is considered uncommon in areas of Cerrado restricted sense (Ratter, Bridgewater and Ribeiro, 2003). However, it seems to be well adapted to the rupestral environment, as studies carried out by Lima *et al.* (2010), in the area of Cerrado Rupestre in Caldas Novas, Goiás, this species was the most representative in the area.

Two species were found which are configured as the first occurrence in the State of Tocantins; *Wunderlichia crulsiana and M. triflora,* both of them present restricted distribution in the Cerrado, without records on the official website (REFLORA) of the occurrence of this

species in the *state of Tocantins.* According to Ribeiro e Walter (2008) *W. crulsiana is a* rare species in the Cerrado, associated with rupestral environments. *This species of the family* Asteraceae occurs < 1% in the Cerrado Domain (Ratter, Bridgewater and Ribeiro, 2003), being considered endemic in Chapada dos Veadeiros (Lenza *et al.* 2011). The *M. triflora,* plant with higher index of value of importance (IVI) is quite common in the region of Northeast Brazil, and is also the most representative species in studies carried out by Castro, Moro and Menezes (2012), in an area of Restinga in the Northern Coast.

In the state of Maranhão, Almeida Jr. *et al*. (2018), recorded the occurrence of *M. triflora* in restingas areas, which suggests that the species is better adapted to sandy, nutrient-poor and humid soils, as observed by Rodal, Barbosa and Thomas (2008)[1]. In this sense, it is important to note that the Carrasco studied occurs on the left bank of the Tocantins River valley, in a continuous sandy strip that follows until the municipality of Miracema do Tocantins, probably being influenced by the humidity of the region.

In the Carrasco of Ubajara, Ceará, Araújo *et al.* (1999) have recorded the occurrence of *M. triflora* as a rare species. Besides this species of Sapotaceae, the northeastern flora shares other species that are restricted in distribution in Tocantins, such as *H. eriogyne, P. confertiflora* and *Buchenavia capitata*.

In studies carried out by Lombardi, Salino and Temoni (2005) in the area of Carrasco, in Januária, Minas Gerais, four species common to Carrasco studied in this work were found: *P. confertiflora, Copaifera martii, Callisthene mycrophylla* and *Tabebuia roseoalba*, corroborating the idea of a new phytophysonomy in Tocantins.

Table 1

Phytosociological parameters of the Carrasco vegetation of the Environmental Protection Area Lago de Palmas, Porto Nacional, Tocantins, in unbelievable order of Number of Individuals (NI) and their respective Relative Density (FR), Relative Frequency (FR), Relative Dominance (DOR), Value of Importance (IVI), Collector Number (NC) and Voucher of the Herbarium of Tocantins (HTO).

Espécie	Família	NI	DR	FR	DOR	IVI	NC	Voucher
Manilkara triflora (Allemão) Monach.	Sapotaceae	574	13,97	6,01	10,63	30,61	19	12076
Cordiera elliptica (Cham.) Kuntze	Rubiaceae	559	13,6	4,69	9,14	27,43	23	12031
Esenbeckia pumila Pohl.	Rutaceae	492	11,97	5,89	8,38	26,24	4	12092
Myracrodruon urundeuva Alemão	Anacardiaceae	254	6,18	5,17	10,66	22,01	6	12074
Byrsonima coccolobifolia Kunth.	Malpighiaceae	310	7,54	4,93	9,34	21,81	8	12079
Toulicia crassifolia Radlk.	Sapindaceae	197	4,79	4,93	2,94	12,66	10	12042
Buchenavia tetraphylla (Aubl.) R.A. Howard.	Combretaceae	143	3,48	1,68	7,16	12,32	61	12063
Peltogyne confertiflora (Mart. ex Hayne) Benth.	Fabaceae	158	3,84	3,97	3,88	11,69	7	12091
Hymenaea eriogyne Benth.	Fabaceae	154	3,75	3,37	4,3	11,42	21	12059
Myrcia sp.1	Myrtaceae	126	3,07	4,81	2,78	10,65	22	12028
Psidium sp.1	Myrtaceae	128	3,11	5,05	2,29	10,46	12	12043
Copaifera martii Hayne	Fabaceae	95	2,31	4,21	2,78	9,3	13	12033
Myrcia splendens (Sw.) DC.	Myrtaceae	117	2,84	4,09	2,53	9,46	40	12048
Myrcia sp.3	Myrtaceae	92	2,24	4,21	1,66	8,1	16	12036
Luehea divaricata Mart.e Zucc.	Malvaceae	105	2,55	3,73	1,72	8	3	12080
Indivíduos Mortos		62	1,51	3,61	2,18	7,29		
Callisthene microphylla Warm.	Vochysiaceae	64	1,56	2,52	3,08	7,16	1	12032
Copaifera langsdorffii Desf.	Fabaceae	47	1,14	1,68	1,99	4,82	33	12090
Aspidosperma sp.	Apocynaceae	53	1,29	1,92	1,58	4,8	34	12056
Doliocarpus dentatus (Aubl.) Standl.	Dilleniaceae	41	1	2,88	0,59	4,47	30	12085
Eugenia sp.	Myrtaceae	30	0,73	2,76	0,43	3,93	35	12049
Averrhoidium gardnerianum Baill.	Sapindaceae	41	1	2,16	0,68	3,84	25	12081
Andira sp.	Fabaceae	28	0,68	1,68	1,32	3,68	18	12054
Buchenavia capitata (Vahl)Eichler	Combretaceae	52	1,27	1,56	0,85	3,68	32	12062
Mouriri elliptica Marth.	Melastomataceae	23	0,56	1,56	0,39	2,52	5	12066
Buchenavia sp.	Combretaceae	17	0,41	0,36	1,48	2,26	37	12070
Casearia sp.	Salicaceae	20	0,49	1,2	0,52	2,21	14	12041
Erythroxylum sp 1.	Erythroxylaceae	23	0,56	0,96	0,45	1,98	11	12052
Myrcia sp.2	Myrtaceae	13	0,32	1,08	0,21	1,61	27	12027
Pouteria ramiflora (Mart.) Radlk.	Sapotaceae	10	0,24	0,6	0,45	1,29	39	12069
Parkia platycephala Benth.	Fabaceae	3	0,07	0,36	0,82	1,25	40	
Vatairea macrocarpa (Benth.) Ducke	Fabaceae	1	0,02	0,12	0,94	1,08	41	12089
Guapira sp.	Nyctagenaceae	9	0,22	0,48	0,37	1,07	20	12038
Swartzia sp.	Fabaceae	7	0,17	0,6	0,09	0,86	28	12030
Dimorphandra mollis Benth.	Fabaceae	3	0,07	0,36	0,29	0,72	42	12067
Combretum sp.	Combretaceae	4	0,1	0,48	0,08	0,66	43	12064
Heisteria ovata Benth.	Olacaceae	4	0,1	0,48	0,08	0,66	44	12077
Oxandra sessiliflora R.E.Fr.	Annonaceae	7	0,17	0,36	0,09	0,62	15	12086
Myrcia sp.4	Myrtaceae	4	0,1	0,36	0,07	0,53	45	12029
Bignoniaceae 1	Bignoniaceae	6	0,15	0,24	0,12	0,5	46	12035
Pouteria sp.	Sapotaceae	6	0,15	0,24	0,08	0,47	47	12068
Tocoyena formosa (Cham. & Schltdl.) K.Schum.	Rubiaceae	4	0,1	0,24	0,09	0,43	49	12055
Myrtaceae	Myrtaceae	4	0,1	0,24	0,05	0,38	48	12044

Espécie	Família	NI	DR	FR	DOR	IVI	NC	Voucher
Dioclea sp.	Fabaceae	2	0,05	0,24	0,06	0,35	50	12040
Byrsonina sp.	Malpighiaceae	2	0,05	0,24	0,04	0,33	9	12075
Cenostigma macrophyllum Tul.	Fabaceae	2	0,05	0,12	0,11	0,28	51	12060
Fabaceae sp.	Fabaceae	2	0,05	0,12	0,03	0,19	52	12083
Ourateia nana (A.St.-Hil.) Engl.	Ochnaceae	1	0,02	0,12	0,03	0,17	26	12047
Tabebuia roseoalba (Ridl.) Sandwith	Bignoniaceae	1	0,02	0,12	0,02	0,17	53	12039
Indeterminada 3	Indetrminada	1	0,02	0,12	0,02	0,16	54	12046
Bignoniaceae 2	Bignoniaceae	1	0,02	0,12	0,01	0,16	55	12034
Indeterminada 2	Indetrminada	1	0,02	0,12	0,01	0,16	56	12082
Erythroxylum sp 2.	Erythroxylaceae	1	0,02	0,12	0,01	0,16	29	12053
Cordiera cf. *obtusa* (Cham.) Kuntze	Rubiaceae	1	0,02	0,12	0,01	0,16	24	12045
Senna multijuga (Rich.) H.S.Irwin & Barneby	Fabaceae	1	0,02	0,12	0,01	0,16	17	12071
Ouratea hexasperma (A.St.-Hil.) Baill	Ochnaceae	1	0,02	0,12	0,01	0,16	57	12057
Indeterminada 1	Indeterminada	1	0,02	0,12	0,01	0,16	58	12037
Psidium sp.2	Myrtaceae	1	0,02	0,12	0,01	0,16	59	12084
Diospyros inconstans Jacq.	Ebenaceae	1	0,02	0,12	0,01	0,16	31	12065

Table 2

Species collected outside the parcels of the Carrasco vegetation of the Lake Palmas Environmental Protection Area, National Port, Tocantins, Collector's Number (NC) and Voucher of the Herbarium of Tocantins (HTO).

Florística - Espécies coletadas fora das Parcelas	Família	NC	Voucher
Blepharodon sp.	Apocynaceae	60	12073
Astrocaryum vulgare Mart.	Arecaceae		
Wunderlichia crulsiana Taub.	Asteraceae	62	12058
Ananas ananassoides (Baker) L.B.Sm.	Bromeliaceae	63	12088
Rourea induta Planch.	Connaraceae	65	12078
Fabaceae sp.	Fabaceae	67	12072
Sapotaceae sp.	Sapotaceae	66	12087
Smilax sp.	Smilacaceae	64	12061
Líquen 1	Indeterminada	68	12093
Líquen 2	Indeterminada	69	12094

Among the species found in the Carrasco, there are those characterized as fruitful, indispensable for the survival of the fauna and therefore protected according to Article 112 of the Constitution of Tocantins (1989), such as: B. capitata, B. coccolobifolia, C. elliptica and Mouriri elliptica; species of commercial importance such asT. roseoalba andM. urundeuva, both protected by Decree No. 838, of October 1 999 on the Forestry Policy of the State of Tocantins.

The species C. martii and C. langsdorffii, popularly known as copaiba, locally copaiba, andpau-de-oleum are also species of economic value, mainly by the extraction of oil, a substance used for medicinal purposes.

The families that contributed most to the species richness were: Fabaceae, with 13 species (21%); Myrtaceae with 10 (16%) and Combretaceae with four (6.67%), adding 45% of the total species sampled. The families Sapotaceae, Rubiaceae and Bignoniaceae each had three

species, Erythroxylaceae, Sapindaceae, Ochnaceae and Malpighiaceae two species each and the other families one species.

In relation to diversity, the Shannon-Wiener (H') index in the studied area was 3.0 nats/ind., a value similar to other areas of Cerrado in the state of Tocantins that varied between 2.10 and 3.70. In other regions of Areias Quartzozas, in areas of Cerrado sense restricted as in the Espigão Mestre do São Francisco, Bahia (Felfili e Silva Junior, 2005), the diversity index obtained were close to the values found in the study area (3.04 nats/ind.). In the northeastern Marauders (Araújo *et al*. 1998; Araújo *et al.* 1999), also in sandy soils, the values varied between 2.89 and 3.20, which indicates that the torturer is in the average of the other studies carried out in this phytophysiognomy, inferring a good state of conservation.

Regarding the distribution of the species, the equability value (0.73) suggests that individuals are distributed throughout the area, characterizing low ecological dominance, that is, the vegetation is homogeneous. Eight species were observed that presented only one individual and were therefore considered rare species in the study area: Ouratea nana, T. roseoalba, C. cf. obtusa, Senna multijuga, Diospyros inconstans, T. roseoalba, C. cf. obtusa, Senna and as indeterminate 1 and 3.

On the other hand, there is an abundance of pineapple (*Ananas ananassoides*), tucum (locallyAstrocaryum vulgare), mainly of the Fabaceae and Bignoniaceae families and to a lesser extent the Apocynaceae and Smilacaceae, which were not sampled because they did not meet the inclusion criteria. The marked presence of lianas was highlighted by Oliveira *et al.* (1997) in a transitional area Sand Caatinga - Carrasco, by Araújo *et al.* (1998) and Lombardi, Salino and Temoni (2005) who found 63 species of lianas in an area of Carrasco in the north of Minas Gerais, plants abundant in this phytophysiognomy.

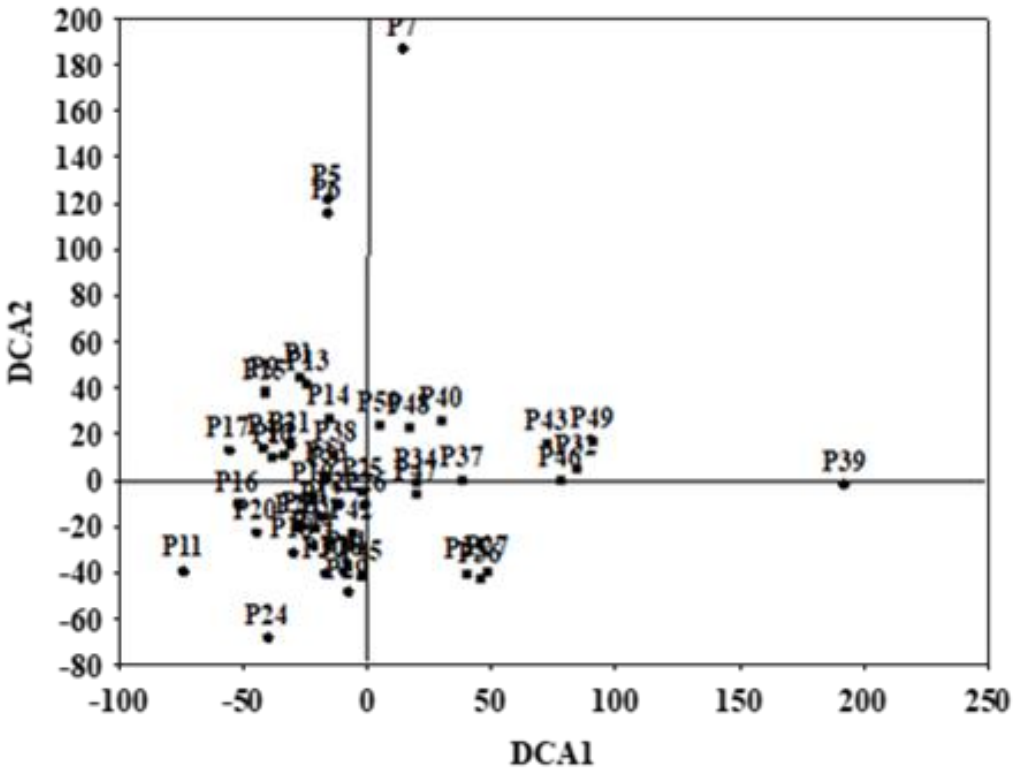
In relation to the height of the vegetation, the plants are small, reaching 6 m at the most. The average height in this study was 2.94 m, indicating that Carrasco is constituted by a nanofanerophytic shrub vegetation (IBGE, 2012). The average diameter was 4.2 cm, with more than 90% of the plants showing a diameter of less than 12 cm, similar to the northeastern Marauder, where more than 88% of the plants showed this characteristic, corroborating the statement by Andrade-Lima (1978) about the predominance of thin stems in the Marauder.

3.3 STRUCTURAL ORGANIZATION OF THE PLANT COMMUNITY

From the ordering of the parcels by means of the DCA, it was possible to observe that the structural organization of the tree community was, in a general manner, homogeneous in the area, presenting few variations, highlighting as extreme variations parcels 5, 6, 7 and 39 (Figure 4), which are distinguished from the others due to the higher density of the species *Buchenavia* sp. (5), *B. tetraphylla* (6), *Erythroxylun* sp. (14), *Myrcia splendens* (Sw.) DC. (23) and *P. ramiflora* (28).

Figure 4

Diagram of the Analysis of Destined Correspondence (DCA) of plots (P) of the Executioner of the Environmental Protection Area Lago de Palmas, Porto Nacional, Tocantins.



Source: Author, 2024.

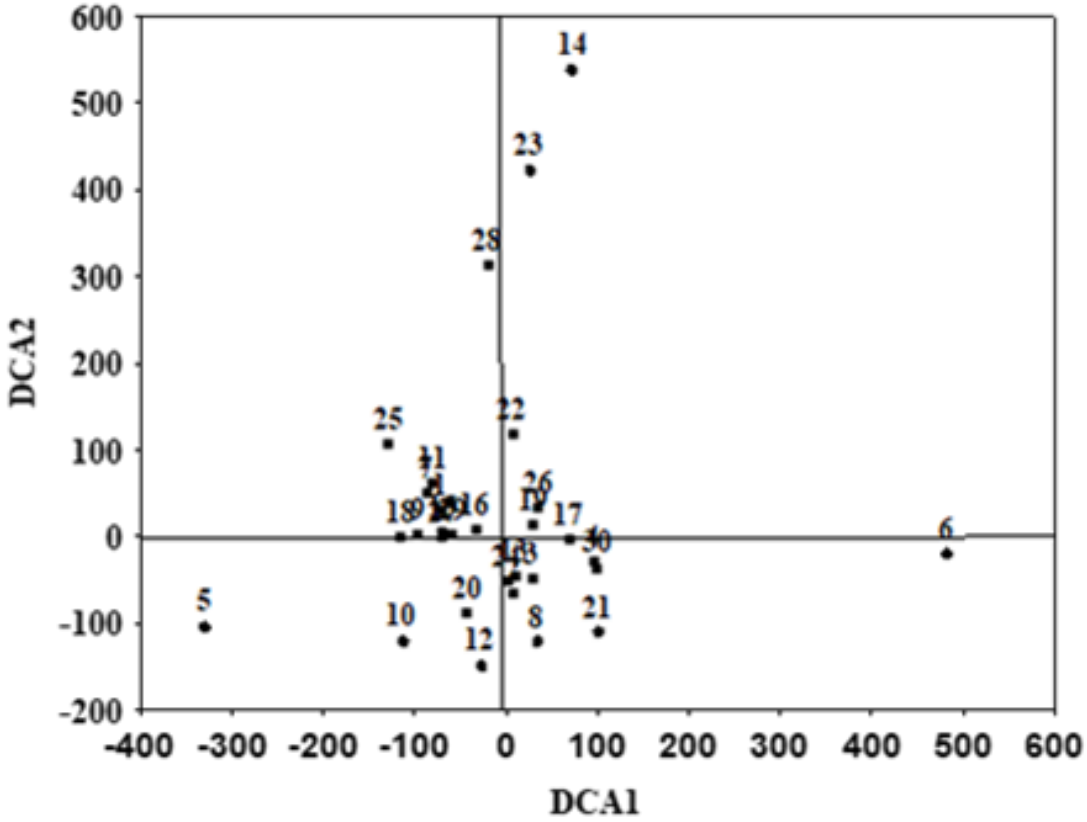
In the Destined Correspondence Analysis (DCA) for the most abundant species (above 10 individuals) (Figure 5), the first and second axes contributed 18 and 14% of the total variance, respectively. The ordering diagram of this analysis showed that axis 1 is strongly influenced by the species *B. tetraphylla* (6)and the species *B.* tetraphylla (6)and the species

Buchenavia (5), which occupy inverse spaces on the axis and do not coexist in the parcels, which may be related to ecological factors such as competition, dispersion or soil variations.

On axis 2, (Figure 5) the outstanding species were *Erythroxylun* sp1., *M. splendens* and*P. ramiflora* (14, 23 and 28 respectively). The greater density of the species *M. splendens* and *P. ramiflora* may be associated with the availability of light, as verified by Cardoso and Schiavini (2002), where there was a greater concentration of these species on the edges of the Cerradão and in the clearings, and is therefore favored by the greater luminosity.

Figure 5

Diagram of the Analysis of Distended Correspondence (DCA) of the 30 species that presented 10 or more individuals in the Executioner of the Environmental Protection Area Lago de Palmas, Porto Nacional, Tocantins.



Legend of species: 1) *Andira sp.; 2) Aspidosperma sp.; 3) A. gardnerianum.; 4) B. capitata; 5) Buchenavia sp.; 6)B. tetraphylla; 7) Aspidosperma sp.; 8) C. microphylla; 9) Casearia sp.; 10) C. langsdorffii; 11) C. martii; 12) C. elliptica; 13) D. dendendendi atus; 14) Erythroxylum sp.1; 15) E. pumila; 16) Eugenia sp.; 17) H. eriogyne; 18) L. divaricata; 19) M. triflora; 20) Dead; 21) M. elliptica; 22) M. urundeuva; 23) M. splendens; 24) Myrcia sp.; 25) Myrcia sp2.; 26) Myrcia sp3.; 27) P. confertiflora; 8) P. ramiflora; 29) Psidium sp.; 30) T. crassifolia.*
Source: Author, 2024.

These structural and ecological characteristics are fundamental for understanding the dynamics of the distribution of the vegetation of the Carrasco. Adaptation to the extreme conditions of seasonality, drainage and soil poverty is one of the most relevant factors for the plants of this phytophysiognomy.

3.4 FLORISTIC SIMILARITY

Analyzing the cladogram (Figure 6), one observes the dissimilarity of the study area with the other areas. The formation of the groups was influenced by the geographical location and distribution of species, as found by Balduino *et al.* (2005) and Neri *et al.* (2007). Areas A4 and A5 showed greater similarity, both of Cerrado sense restricted, located in Carolina, Maranhão, and Philadelphia, Tocantins, respectively. This similarity can be attributed to geographical proximity, with a distance of about 50 km between them. Areas A6 and A7, despite being different phytophysiognomies (Cerradão and Cerrado restricted sense), are also geographically close, located in the northern region of the state of Tocantins.

The three areas of Carrasco in Caatinga (A2, A11 and A12), all located in the northeastern region of the state of Ceará, under similar climatic and soil conditions, formed a group. The executioner from Jaburuna (A2) and the one from the Ibiapaba Plateau (A11), closest to each other geographically, showed greater similarity than the vegetation from Novo Oriente, Ceará (A12).

Figure 6

Cladogram of similarity of the Carrasco of the Environmental Protection Area Lago de Palmas, Porto Nacional, Tocantins and eleven areas of the state of Tocantins, Maranhão and Ceará.

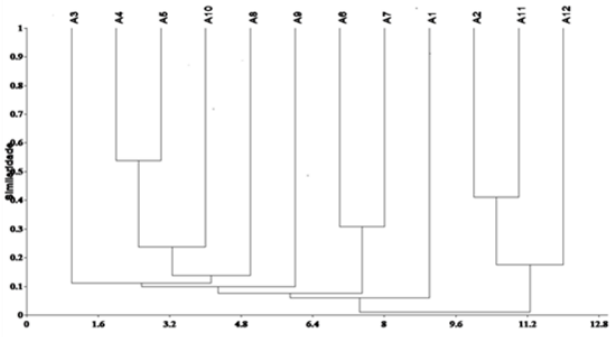


***Figure 6: A1 - Carrasco - Porto Nacional/TO (study area); A2- Carrasco - Jaburuna/CE (ARAÚJO** et al. 1999); A3- Seasonal Forest /TO (HAIDAR et al. 2013); A4 - Cerrado restricted sense- Carolina/MA (MEDEIROS and WALTER, 2012); A5 -Cerrado restricted sense - Philadelphia / TO (MEDEIROS and WALTER, 2012); A6 - Cerradão/Tocantins (HAIDAR et al.2013); A7 - Cerrado restricted sense / TO (HAIDAR et al. 2013); A8 - Cerrado restricted sense - National Port/ TO (PEDREIRA et al.2011); A9 - Cerradão - Palmas/ TO (MIGUEL et al.2016); A10 - Cerrado restricted sense -Dueré/ TO (SILVA NETO et al.2 016a); A11 - Carrasco - Planalto do Ibiapaba/ CE (ARAÚJO et al. 1999); A12 - Carrasco - Novo Oriente/ CE (ARAÚJO et al. 1998).*
Source: Author, 2024.

The vegetation of the study area (A1) did not form any group, indicating its uniqueness in relation to other areas of the state of Tocantins and of the other regions studied. The closest geographical areas, A8 (Cerrado restricted sense/National Port) and A9 (Cerradão/Palmas), showed no floristic similarity with the vegetation of the Lake Palmas Environmental Protection Area. Oliveira *et al.* (1997) also found low similarity between Carrasco, Cerrado restricted sense and Cerradão in a transition area Caatinga-Carrasco in Piauí.

Felfili and Silva Júnior (2005) found that, in the same system of lands, the distance is not determinant for floristic similarity, since distant locations about 500 km were more similar among themselves than distant locations only 50 km or less. According to the authors, physiographic gradients such as soil and relief may have a greater influence on diversity patterns than latitudinal and longitudinal variations within the Cerrado domain. This justifies the little similarity observed in the areas of this domain, which can be explained by the edaphic variations.

In other regions studied, Carrasco also showed low floristic similarity with other types of phytophysiognomy. Giulietti *et al.* (2003) point out that, although the Carrasco resembles the Caatinga by deciduous vegetation, it shows great floristic variation between the areas and a greater phytodiversity than the Caatinga and similar to the forest. These statements corroborate the phytosociological and floristic data obtained in the area of study, which clearly demonstrate the peculiarities of the Carrasco's vegetation. Figueiredo (1986) regarded the Carrasco as an

individualized plant formation, made up of species of its own and of others coming from geographically close formations, like the Forest, the Cerrado (wooded savanna) and the Caatinga (scrubland).

4 CONCLUSION

This research confirmed that the study area houses a unique vegetation, characterized by deciduous and predominant species such as *Manilkara triflora* and *Cordiera elliptica*, typical of xerophile formations. The floristic and structural diversity registered differentiates this vegetation from the descriptions found in other inventories carried out in the Cerrado.

The analysis of floristic similarity reinforced this singularity, by revealing low similarity with other phytophysiognomies, indicating that the floristic composition of Carrasco in Porto Nacional is influenced by ecological processes and specific environmental interactions that shape this formation.

Although there are still significant gaps in the knowledge about Carrasco's vegetation, and some controversies among the authors, this study offers valuable information about this peculiar plant formation, composed of exclusive and highly adapted species. The results broaden the understanding of the ecological characteristics of this report, providing essential subsidies for future conservation and management actions.

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