Tree community structure in a reserve area at the Federal Goiano Institute – Rio Verde Campus

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ABSTRACT. The Cerrado Biome is the second largest biome in Brazil, it has a rich diversity of fauna and flora, it no longer has its original coverage, even the protected reserves suffer from anthropic actions and invasive plants and animals. In addition, the cerrado has a diversity of habitats and numerous plant species that are at risk of extinction. Therefore, tools such as a floristic survey and a phytosociological study are used to study degraded areas that suffer from anthropic action and modified fragments. Thus, this work aimed to evaluate the floristic composition and structure of the shrub-tree community in a reserve area located at Instituto Federal Goiano. Fifteen systematized plots of 20x20m were established, spaced 10m apart and distributed in four transects, totaling 0.6 ha of sampling. All tree individuals with CAP ≥ 10 cm were numbered using aluminum plates. Circumference measurements were obtained using a tape measure and height was estimated. Classic phytosociological parameters were calculated. A total of 618 individuals distributed in 21 families and 41 species were sampled. Six individuals were not identified. The Shannon diversity index was 2.56 and the Pielou evenness was 0.69. It is concluded that the diversity of species found within the plots is much lower than it should be, with low species variability and the distribution of individuals is disproportionate.

Keywords: Lifting, Floristic, Phytosociology.

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INTRODUCTION

The Cerrado Biome is the second largest biome in Brazil, second only to the Atlantic Forest, and interfaces with other biomes forming a biodiversity corridor (Ribeiro & Walter, 2008, Franco et al., 2016). It has a rich diversity of fauna and flora, and can be found in the states of Tocantins, Bahia, Minas Gerais, Goiás, Mato Grosso, Mato Grosso do Sul (Ribeiro & Walter, 2008). The Cerrado no longer has its original coverage, which used to be around 2 million square kilometers, now it is estimated that 67% is "highly modified" vegetation and only 20% can be considered native flora (Costa et al., 2019). It is also on the list of biomes with a high rate of degradation, even protected reserves suffer from anthropic actions and invasive plants and animals (Pimm et al., 1998, Silva et al., 2002, Costa et al., 2019).

The Cerrado Biome is undergoing accelerated degradation, and has been fragmented by the advance of anthropic actions and the lack of specific measures for protection and conservation (Franco et al., 2016). Ribeiro & Walter (2008), described 11 phytophysiognomic types within the Cerrado Biome. Due to the diversity of habitats, there are numerous species of plants, and they are at risk of extinction (Franco et al., 2016). Brazilian environmental legislation has developed several strategies for the protection and conservation of areas that have been degraded, such as conservation units (UCs), permanent preservation areas (APP) and legal reserves (RL), each with its function (Ganem et al., 2013). For this reason, tools such as a floristic survey and a phytosociological study are important for studying the vegetation, climate, soil, plant characteristics, which provide quantitative data so that measures can be implemented to slow down the growing degradation of this biome (Chaves et al., 2013, Franco et al., 2016).

Among the states where the Cerrado Biome can be found, due to degradation and human action for the development of cities, many fragments of Cerrado stricto sensu may be present within the municipalities, in addition, they have been modified over time and growth of the municipalities and lost a large part of the original flora (Ribeiro & Walter, 2008, Franco et al., 2016, Pimm et al., 1998, Silva et al., 2002, Costa et al., 2019). Therefore, the importance of this work is to know the flora of a highly modified area in a fragment located in the municipality of Rio Verde within the reserve area of the IF Goiano, Rio Verde campus.

Therefore, this work aimed to evaluate the floristic composition and structure of the shrub-tree community in a reserve area located at the Instituto Federal Goiano.

MATERIAL AND METHODS

Characterization of the study area

The present study was carried out in a reserve area of the Instituto Federal Goiano (17°49'0.40" S; 50°53'58.57" W), in the municipality of Rio Verde - GO.

Sampling and Data Collection

Fifteen systematized plots of 20x20m were established, spaced 10 m apart and distributed in four transects, totaling 0.6 ha of sampling. All tree individuals with CAP (Circumference at Breast Height at 1.30 cm from the ground) ≥ 10 cm were numbered using aluminum plates. CAP measurements were obtained with the aid of a tape measure and the height was estimated.

All individuals were identified at the family, genus and species level through comparisons with specialized literature, comparison with specimens from the Herbarium of Rio Verde, located at the Instituto Federal Goiano - Campus Rio Verde and sent to specialists. The botanical nomenclature was checked on the “Flora do Brasil” website.

Data analysis

Phytosociological parameters

The phytosociological parameters were calculated (Mueller-Dombois and Elen-Berg, 1974): absolute and relative density, absolute and relative dominance, absolute and relative frequency, and obtained from these, the importance value index (IVI) of each species sampled. Pielou evenness and Shannon diversity index were also calculated. According to Oliveira and Amaral et al. (2004), among the phytosociological parameters, the following can be estimated:

Absolute density (AD): represents the average number of trees of a given species per unit area. The sampling unit commonly used for forest formations is one hectare (10,000m²). The formula is as follows:

$$ADi = ni/A;$$

Where:
ADi **=** absolute density of the species, in number of individuals per hectare;
ni = number of individuals of the species;
A = total sampled area, in hectare.

Relative density(%): is defined as the percentage of the number of individuals of a given species in relation to the total number of individuals sampled.

$$RDi = ni \cdot 100/N;$$

Where:
ni= number of individuals of species i;
N = total number of individuals

Absolute Dominance (AD): calculated from the sum of the basal area of individuals of each species.

$$ADi = BAi\ U./A;$$

Where:
ADi = absolute dominance of the species, in m²/ha;
BAi = basal area of the species, in m², in the sampled area;
A = sampled area, in hectare;
U = Sampling unit (ha)

Relative dominance (%): is the ratio between the total basal area of a species and the total basal area of all species

$$RD = (BAi / ABT) \times 100;$$

Where:
BAi = is the basal area of each individual of the species;
ABT = is the sum of the basal areas of all species

Absolute frequency (AF): is the percentage of sampling units with occurrence of the species, in relation to the total number of sampling units:

$$AFi = Pi \cdot 100/P;$$

Where:
Pi = number of plots or sampling points where the species occurred;
P = Total number of plots or sampling points

Relative frequency (%): obtained from the relationship between the absolute frequency of each species and the sum of the absolute frequencies of all sampled species.

$$RFi = AFi \cdot 100/ FAZ;$$

Where:
AFi = absolute frequency of the species in the plant community;
RFi = relative frequency of the species in the plant community;

$$\text{Basal area} = \pi \times (DBH)^2 / 2$$

Importance Value Index (IVI): This parameter allows species to be sorted according to their importance in the community. This index is calculated according to Curtis & McIntosh (1951), where:

IVI = Relative abundance + Relative dominance + Relative frequency

Diversity Index: used to obtain an estimate of the floristic heterogeneity of the studied area. Among the various existing indices, the ShannonWeaver (H') is commonly used.

$$H' = \Sigma\ Pi.\ Ln\ (Pi)$$

Where:
Pi = ni/N where n is the number of individuals of the species and N is the total number of individuals.

ln = neperian logarithm

Pielou evenness: derived from the Shannon diversity index and allows representing the uniformity of distribution of individuals among existing species (Pielou, 1966). Its value ranges from 0 (minimum uniformity) to 1 (maximum uniformity).

$$J = H' / Hmáx;$$

Where:
Hmax = ln (S)
S = number of sampled species

The calculations were made using the Excel for Windows program and the distribution in diameter and height classes was also made.

RESULTS AND CONCLUSIONS

618 individuals distributed in 21 families and 41 species were sampled. Six individuals were not identified. The families that are most present in the plots are Fabaceae with 59.223301%, Cannabaceae with 3.354070%, Malvaceae 0.189955%, Piperaceae 0.008914% and Anacardiaceae 0.000389% (Figure 1). Forzza (2010), draws attention to the Fabaceae family, which stood out with an endemicity rate of 54.1%. Souza (2011) reported that the Fabaceae family appears as an important representative in other regions, also being the family with the highest number of individuals among the others found.

Among the families with the highest number of individuals are Fabaceae with 366, followed by Malvaceae and Cannabaceae with 35, Piperaceae 29, Anacardiaceae with 27 and Meliaceae with 24 individuals. According to Borges & Azevedo (2017), they described that within their work it was observed that the families with the highest number of species were Fabaceae, Asteraceae, Piperaceae, Rubiaceae, Melastomataceae and Myrtaceae, in addition it was observed that among the families the the only one that is not part of the ten most representative families of the flora of Brazil is the Piperaceae family. Freitas et al. 2016), observed that the studied species Piper arboreum Aubl. (Family Piperaceae) was among the predominant species both in the plantation and in the plot in the restored forest area.

Among the species that stood out was Senegalia polyphylla (DC.) Britton & Rose, which had the highest number of individuals (221) and also appeared in all 15 plots, followed by Anadenanthera colubrina (Vell.) Brenan with 90 individuals and appeared in 14 of the 15 plots and Celtis iguanaea (Jacq.) Sarg., with 35 individuals, appeared in 12 plots (Table 1). Franco et al. (2016), report that the cerrado is a mosaic of plant physiognomies, with varied habitats and a high diversity of species.

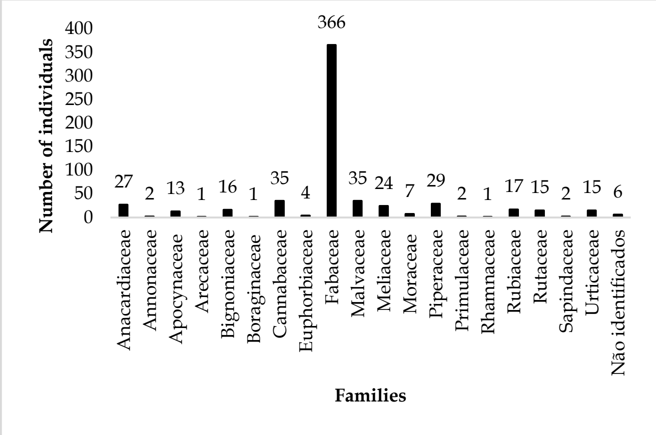

Figure 1: Number of individuals per family of individuals sampled at the Instituto Federal Goiano reserve – Campus Rio Verde.

As for the distribution in diameter classes, the inverted J pattern was not found (Figure 2). What according to Cain et al. (2018), would show that they are stable and that there is a balance between mortality and the appearance of new individuals. In this case, it did not happen since Classes 1 and 2 are close to each other and Classes 3 and 4 are also close and in Class 5 there is a significant drop in the number of individuals (Figure 2). What was expected, according to Ricken (2013), was that the trees that have the smallest diameter would join the classes of larger diameters in the future and be regenerated naturally, but this was not found. And according to Santos et al. (2020), structural knowledge can help in the management of natural forests.

Table 1: Number of individuals per species (NI) and number of plots where the species is found (NP) in the Instituto Federal Goiano reserve – Campus Rio Verde.

SPECIES	NI	NP
Senegalia polyphylla (DC.) Britton & Rose	221	15
Anadenanthera colubrina (Vell.) Brenan	90	14
Celtis iguanaea (Jacq.) Sarg.	35	12
Sterculia apetala (Jacq.) H.Karst.	30	11
Piper arboreum Aubl.	29	7
Astronium urundeuva (M.Allemão) Engl.	21	7
Libidibia ferrea (Mart. ex Tul.) L.P.Queiroz	20	10
Guarea guidonia (L.) Sleumer	18	9
Cecropia pachystachya Trécul	15	7
Zanthoxylum petiolare A.St.-Hil. & Tul.	15	10
Randia armata (Sw.) DC.	14	8
Aspidosperma subincanum Mart.	13	4
Handroanthus impetiginosus (Mart. ex DC.) Mattos	10	7
Fabaceae sp1	7	2
Inga laurina (Sw.) Willd.	7	3
Maclura tinctoria (L.) D.Don ex Steud.	7	4
Astronium fraxinifolium Schott	6	4
Cedrela fissilis Vell.	6	3
Hymenaea courbaril L.	6	4
Platypodium elegans Vogel	6	2
Sapium sp	4	1
Senna sp.	4	4
Copaifera langsdorffii Desf.	3	2
Genipa americana L.	3	2
Handroanthus ochraceus (Cham.) Mattos	3	2
Não identificada Sp2	3	3
Cardiopetalum calophyllum Schltdl.	2	2
Dilodendron bipinnatum Radlk.	2	2
Machaerium acutifolium Vogel	2	2
Myrsine guianensis (Aubl.) Kuntze	2	1
Não identificada Sp1	2	2
Pachira aquatica Aubl.	2	1
Tabebuia roseoalba (Ridl.) Sandwith	2	2
Acrocomia aculeata (Jacq.) Lodd. ex Mart.	1	1
Ceiba sp	1	1
Cordia sp	1	1
Dipteryx alata Vogel	1	1
Handroanthus serratifolius (Vahl) S.Grose	1	1
Luehea grandiflora Mart.	1	1
Rhamnidium elaeocarpum Reissek	1	1
Sem folha sp1	1	1

As for the distribution in height classes, among all the species found, only Senegalia polyphylla and Sterculia apetala appeared in all classes. Class 5 had only four species and the one that stood out was Anadenanthera colubrina (Vell.) Brenan with 20 individuals. In Class 1, despite having a greater number of species, there were only 28 individuals (Figure 3).

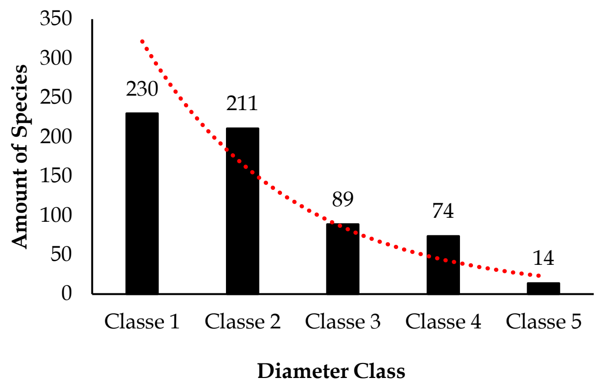

Figure 2: Distributionofindividuals in diameter classes. Where: Class 1 - (≥ 3 ≤ 6); Class 2 - (> 6 ≤ 12); Class 3 – (> 12 ≤ 24); Class 4 – (> 24 ≤ 48); Class 5 – (> 48).

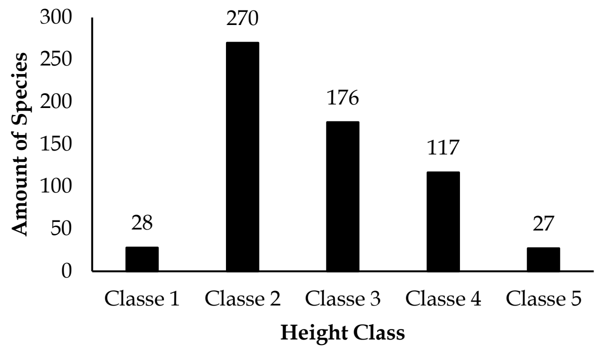

Figure 3: Numberofindividualsbyheightclass: Class 1 -(> 0 ≤ 4); Class 2 - (>4 ≤ 8); Class 3 – (> 8 ≤ 12); Class 4 – (> 12 ≤ 16); Class 5 – (> 16).

Ten species stood out, showing higher values of importance. Among those that stood out, the one in first place is Anadenanthera colubrina (Vell.) Brenan, with the highest DR (Relative Density) 14.56 and DoR (Relative Dominance) 64.45 (Table 2). According to Oliveira et al. (2017), Anadenanthera colubrina (Vell.) Brenan had a high mortality rate, a total of 85.45% of the total plots studied in the highland swamp in Bananeiras in its seedling stage. In addition, they also observed that this situation is mainly linked to anthropic action, since the growth of A. colubrina was greater in the center of the plots, where it had less anthropic influence. According to Anselmo et al. (2020), the values found may vary depending on the area studied, from a protected area to a modified one, in addition, another factor must also be taken into account, which is the relationship between people and the species, which may be affecting the occurrence of the same.

Senegalia polyphylla (DC.) Britton & Rose appeared in second position with importance value (VI) 57.459, DR 35.761, DoR 13.224 and FR 8.475 (Table 2). According to Souza et al. (2018), S. polyphylla produces a high amount of seeds that allows the species a natural regeneration and, as it is a rustic and fast-growing plant, it becomes a very suitable species for degraded areas.

Table 2: Name of the species found, Basalarea (BA), Absolute density (AD), Relative density (RD), Absolute dominance (ADo), Relative dominance (RDo), Absolute frequency (AF), Relative frequency (RF), Importance Value (IV) and Coverage Value (CV).

SPECIES	BA	AD	RD	ADo	RDo	AF	RF	IV	CV
Anadenanthera colubrina (Vell.) Brenan	9,14	150,00	14,56	15,24	64,46	93,33	7,91	86,93	79,02
Senegalia polyphylla (DC.) Britton & Rose	1,88	368,33	35,76	3,13	13,22	100,00	8,47	57,46	48,98
Celtis iguanaea (Jacq.) Sarg.	0,15	58,33	5,66	0,26	1,08	80,00	6,78	13,52	6,74
Sterculia apetala (Jacq.) H.Karst.	0,33	50,00	4,85	0,55	2,33	73,33	6,21	13,40	7,18
Piper arboreum Aubl.	0,11	48,33	4,69	0,19	0,81	46,67	3,95	9,46	5,50
Libidibia ferrea (Mart. ex Tul.) L.P.Queiroz	0,05	33,33	3,24	0,08	0,34	66,67	5,65	9,23	3,58
Astronium urundeuva (M.Allemão) Engl.	0,26	35,00	3,40	0,44	1,86	46,67	3,95	9,21	5,26
Guarea guidonia (L.) Sleumer	0,10	30,00	2,91	0,17	0,70	60,00	5,08	8,70	3,61
Zanthoxylum petiolare A.St.-Hil. & Tul.	0,03	25,00	2,43	0,06	0,24	66,67	5,65	8,32	2,67
Cecropia pachystachya Trécul	0,25	25,00	2,43	0,42	1,77	46,67	3,95	8,15	4,19
Randia armata (Sw.) DC.	0,03	23,33	2,27	0,05	0,21	53,33	4,52	7,00	2,48
Handroanthus impetiginosus (Mart. ex DC.) Mattos	0,09	16,67	1,62	0,14	0,61	46,67	3,95	6,18	2,23
Aspidosperma subcanum	0,10	21,67	2,10	0,17	0,72	26,67	2,26	5,09	2,83
Fabaceae sp1	0,37	11,67	1,13	0,61	2,58	13,33	1,13	4,84	3,71
Hymenaea courbaril L.	0,20	10,00	0,97	0,33	1,39	26,67	2,26	4,62	2,36
Maclura tinctoria (L.) D. Don ex Steud.	0,06	11,67	1,13	0,09	0,40	26,67	2,26	3,79	1,53
Astronium fraxinifolium Schott	0,05	10,00	0,97	0,08	0,36	26,67	2,26	3,59	1,33
Inga laurina (Sw.) Willd.	0,05	11,67	1,13	0,08	0,33	20,00	1,69	3,16	1,46
Senna sp.	0,02	6,67	0,65	0,03	0,12	26,67	2,26	3,03	0,77
Platypodium elegans Vogel	0,12	10,00	0,97	0,20	0,84	13,33	1,13	2,94	1,81
Pachira aquatica Aubl.	0,28	3,33	0,32	0,47	1,98	6,67	0,56	2,87	2,31
Cedrela fissilis Vell.	0,03	10,00	0,97	0,05	0,20	20,00	1,69	2,87	1,17
Machaerium acutifolium Vogel	0,14	3,33	0,32	0,24	1,02	13,33	1,13	2,47	1,34
Não identificada Sp2	0,01	5,00	0,49	0,02	0,08	20,00	1,69	2,27	0,57
Copaifera langsdorffii Desf.	0,03	5,00	0,49	0,06	0,24	13,33	1,13	1,85	0,72
Genipa americana L.	0,01	5,00	0,49	0,02	0,08	13,33	1,13	1,70	0,57
Handroanthus ochraceus (Cham.) Mattos	0,01	5,00	0,49	0,01	0,05	13,33	1,13	1,66	0,53
Não identificada Sp1	0,01	3,33	0,32	0,02	0,09	13,33	1,13	1,54	0,41
Tabebuia roseoalba (Ridl.) Sandwith	0,01	3,33	0,32	0,02	0,08	13,33	1,13	1,53	0,40
Cardiopetalum calophyllum Schltdl.	0,01	3,33	0,32	0,02	0,07	13,33	1,13	1,53	0,40
Dilodendron bipinnatum Radlk.	0,00	3,33	0,32	0,01	0,03	13,33	1,13	1,48	0,35
Ceiba sp	0,08	1,67	0,16	0,14	0,58	6,67	0,56	1,31	0,75
Sapium sp	0,01	6,67	0,65	0,02	0,10	6,67	0,56	1,31	0,74
Myrsine guianensis (Aubl.) Kuntze	0,04	3,33	0,32	0,07	0,29	6,67	0,56	1,18	0,61
Dipteryx alata Vogel	0,06	1,67	0,16	0,10	0,43	6,67	0,56	1,16	0,59
Acrocomia aculeata (Jacq.) Lodd. ex Mart.	0,02	1,67	0,16	0,04	0,18	6,67	0,56	0,90	0,34
Handroanthus serratifolius (Vahl) S.Grose	0,01	1,67	0,16	0,01	0,04	6,67	0,56	0,77	0,20
Sem folha sp1	0,00	1,67	0,16	0,01	0,04	6,67	0,56	0,76	0,20
Rhamnidium elaeocarpum Reissek	0,00	1,67	0,16	0,00	0,02	6,67	0,56	0,74	0,18
Cordia sp	0,00	1,67	0,16	0,00	0,01	6,67	0,56	0,74	0,18
Luehea grandiflora Mart.	0,00	1,67	0,16	0,00	0,01	6,67	0,56	0,74	0,17

Two species showed approximate values of IVI, what differentiated was the relative density (DR) and relative dominance (DoR), Celtis iguanaea (Jacq.) Sarg., with (VI) 13.523, DR 5.663, DoR 1.080 and FR 6.780 (Table two). According to Pilati et al. (2006), C. iguanaea is a typical pioneer species of riparian forest. Sterculia apetala presented the following values (VI) 13.398, DR 4.854, DoR 2.329 and FR 6.215 (Table 2). Medeiros et al. (2017), describes characteristics of economic value of the S. apetala species, such as easy workability and easy manual cutting, in addition to its applicability for construction and food purposes, and can also be used to recover degraded areas.

Piper arboreum, Libidibia ferrea and Astronium urundeuva demonstrate similar importance value being differentiated by the values of DR, DoR and FR (Table 2).

Souza et al. (2009), report the importance of the P. arboreum species for folk medicine, economics and commerce, as it is possible to extract essential oils that can be used by the condiment industry, pharmaceutical industry and for insecticides. Souza and Lorenzi (2019) point out that the Fabaceae family occurs in most ecosystems in Brazil, and species such as Libidibia ferrea have been used in the afforestation of environments across the country, in ornamentation and their wood, for being of good quality, has been valued, in addition to being also used in green manure. Mendes et al. (2021), report that Libidibia ferrea is present in the list of plants with medicinal properties that can be found in the bark extract of the species.

Moura et al. (2022), describe that Astronium urundeuva, a species widely distributed mainly in the cerrado, has medicinal properties and is economically important because of its wood. Verly et al. (2021), describe that species such as Cecropia pachystachya, Astronium urundeuva and Anadenanthera colubrina are species that have wide occurrence in the national territory, and also wide distribution in the different vegetative formations of the Cerrado. Souza et al. (2014), through studies using C. pachystachya, obtained results that indicate that the extract and fractions of C. pachystachya were effective in enhancing the antibacterial action of aminoglycosides against Staphylococcus aureus, as they have compounds with antibacterial activity.

Guarea guidonia, Zanthoxylum petiolare and Cecropia pachystachya appear in the eighth, ninth and tenth place in the table, with similar importance values, the difference being the values of DR, DoR and FR (Table 2). Oliveira et al. (2013), say that G. guidonia is a pioneer species, has a preference for humid environments, has fast growth, and can live for more than 150 years. Gandra et al. (2011), described that G. guidonia had an importance value of 36.87 and a cover value of 25.31, and it was also observed that G. guidonia was described as the species that most contributes to tree communities in secondary forests due to its high number of individuals. Saraiva Filho et al. (2020), studied the genus Zanthoxylum, among the genera is present Z. petiolare, popularly known as lemon, orange or pau-barrão, can be found as a tree or shrub, and can reach up to 14 meters in height. Narvaes et al. (2008), describe Zanthoxylum petiolare as a ciópһyte and selective xerophyte species, which can occur on dry or steep slopes of primary forests, has a stage of minor alteration, which allows the occurrence of species adapted to shaded environments.

Shannon's diversity index was 2.56, which is considered low compared to the values found by Furtado & Viera (2020) who found for the cerrado (3.24), cerrado sensu stricto (3.13) and cerradão (3.23). On the other hand, Pielou equability, which according to Barreira et al. (2015), the degree of evenness (J') can vary on a scale of $0 \leq J' \leq 1$, and the closer to 1, the more individuals are better distributed among species, was 0.69. When compared with the work by Ferreira et al. (2017), who found in the three fragments of cerrado sensu stricto that they studied in Gurupi – TO, values J'= 0.81 0.79 and 0.87 of Pielou equability, being therefore lower, demonstrating a poor distribution of individuals between species.

CONCLUSION

As it is a Cerrado fragment, the diversity of species found within the plots is much lower than it should be, with low variability of species and the distribution of families is disproportionate. The family that stood out was Fabaceae with 366 individuals and few species had a significant number of individuals per plot such as Senegalia polyphylla (DC.) Britton & Rose with 221 individuals, being present in all 15 plots, followed by Anadenanthera colubrina (Vell.) Brenan with 90 individuals present in 14 of the 15 plots and Celtis iguanaea (Jacq.) Sarg., with 35 individuals and appeared in 12 plots. With the low species richness and dominance of few species, it is necessary to intervene to recover the area through enrichment planting with more species and native families.

CONFLICT OF INTEREST DECLARATION

The authors declare no potential conflict of interest in connection with the research, authorship, and/or publication of this article.

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