Special Supplement: *Cerrado* **[Brazilian Savanna]**

Floristic and structural aspects of Brazilian Savanna phytophysiognomies in the northern Goiás state, Brazil[1]

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ABSTRACT

The Legado Verdes do Cerrado Sustainable Development Reserve is home to the largest private contiguous area of native vegetation in the Cerrado (Brazilian Savanna) biome, but its flora is still little studied. A floristic and phytosociological study was carried out in four phytophysiognomies of the Reserve (cerrado *sensu stricto*, cerradão, dry forest and ciliary forest). Eighty 10 x 10-m plots were systematically installed, with 20 in each phytophysiognomy. All live woody individuals with diameter at breast height ≥ 5 cm and height greater than 130 cm were measured. A total of 933 live individuals were sampled, with an estimated density of 1,166 ind ha^{-1}, belonging to 154 species and 46 families. Diversity and equability were assessed at 4.47 nats ind^{-1} and 0.88, respectively. The diametric distribution of the individuals showed a negative exponential (reverse J), while the one for height classes showed a tendency towards normal distribution. Species richness and structural parameters were within the values found for native vegetation, except for the cerrado *sensu stricto*.

KEYWORDS: Native vegetation, biodiversity, conservation units.

RESUMO

Aspectos florísticos e estruturais de fitofisionomias de Cerrado no norte do estado de Goiás

A Reserva de Desenvolvimento Sustentável Legado Verdes do Cerrado abriga a maior área contígua particular de vegetação nativa do bioma Cerrado, porém, com flora ainda pouco estudada. Objetivou-se realizar estudo florístico e fitossociológico em quatro fitofisionomias da Reserva (cerrado sentido restrito, cerradão, mata seca e mata ciliar). Foram instaladas de forma sistemática 80 parcelas de 10 x 10 m, 20 em cada fitofisionomia. Todos os indivíduos lenhosos vivos com diâmetro à altura do peito ≥ 5 cm e altura superior a 130 cm foram mensurados. No total, foram amostrados 933 indivíduos vivos, densidade estimada em 1.166 ind ha^{-1}, pertencentes a 154 espécies e 46 famílias. A diversidade e a equabilidade foram avaliadas em 4,47 nats ind^{-1} e 0,88, respectivamente. A distribuição diamétrica dos indivíduos apresentou exponencial negativo (J-reverso) e a de classes de altura mostrou tendência à distribuição normal. A riqueza de espécies e os parâmetros estruturais obtidos estão dentro dos valores encontrados para vegetações nativas, com exceção do cerrado sentido restrito.

PALAVRAS-CHAVE: Vegetação nativa, biodiversidade, unidades de conservação.

INTRODUCTION

The Cerrado (Brazilian Savanna) biome owns diverse landscapes and vegetation that form a true mosaic (Bueno et al. 2018, Felfili & Felfili 2001). At least 25 phytophysiognomies have already been mentioned in the literature, considering subtypes, inserted in forests, savannas and grasslands formations (Ribeiro & Walter 2008, Walter et al. 2015). Despite its biological relevance, much of the Cerrado vegetation is fragmented, with around 50-55 % of its original coverage remaining (Françoso et al. 2015, Sano et al. 2019, Alencar et al. 2020). Of this total, only 3 % is considered strictly protected in conservation units (Françoso et al. 2015). The creation and implementation of conservation units are important tools for protecting biodiversity. However, to be effective, they need to be concretely implemented, with adequate management levels (Coelho & Rezende 2016).

The Reserva de Desenvolvimento Sustentável Legado Verdes do Cerrado (Legado Verdes do Cerrado Sustainable Development Reserve - LVC), located in Niquelândia, in the northern region of the Goiás state, Brazil, is a type of conservation unit that falls under the sustainable development

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reserve category. The LVC is home to a flora that has been poorly studied. Botanical collections of arboreal plants in the region are restricted to a study by Mendonça et al. (2007), who sampled a nearby area in Chapada dos Veadeiros. However, there is no specific floristic list or structural data for the region's vegetation.

It is important to emphasize the importance of floristic and phytosociological studies that aim to acquire knowledge and conserve remaining native areas. These studies generate data on the species distribution, frequency and dominance, and provide a basis to propose management plans involving areas or species (Batista et al. 2019). In addition, the registration of the deposit (voucher) of samples (exsiccates) in herbariums is essential for future studies related to taxonomic and occurrence data of the sampled species. According to Castro et al. (1999), a good taxonomy is preceded by good collections, with systematic visits to study sites, in order to sample plants in their reproductive phases, although it is difficult to obtain these data in a short period of time.

In this context, this study aimed to contribute to the biodiversity knowledge and conservation in the LVC, as well as to generate data on the different Cerrado woody communities present in the conservation unit. This study was guided by the following questions: 1) How is the flora of the cerrado *sensu stricto*, cerradão, dry forest and ciliary forest phytophysiognomies in the LVC composed?; 2) How are the four plant communities in the LCV structured, considering the horizontal (diameter) and vertical (height) structure of the arboreal vegetation?

MATERIAL AND METHODS

The study was carried out in four Cerrado phytophysiognomies (cerrado *sensu stricto*, cerradão, dry forest and ciliary forest) (Ribeiro & Walter 2008) within the Reserva de Desenvolvimento Sustentável Legado Verdes do Cerrado (Legado Verdes do Cerrado Sustainable Development Reserve - LVC), in Niquelândia, Goiás state, Brazil (14º29'55"S; 48º28'5"W) (Figure 1), between October 2017 and December 2020.

The LVC belongs to the Companhia Brasileira de Alumínio and encompasses 32,000 ha (about 80 % being native vegetation). The area is of relevant ecological interest, as it houses a variety of phytophysiognomies of the Cerrado biome, from forest to savanna and grassland formations (Ribeiro & Walter 2008).

The floristic and phytosociological inventory was performed with the systematic allocation of twenty 10 x 10-m plots spaced equidistantly (50 m) in each phytophysiognomy, for a total of 80 plots/sample unit. All live woody individuals with a diameter at breast height (DBH) $\geq$ 5 cm and height greater than 130 cm were numbered with metal plates and subsequently measured for diameter and total height, the latter with the aid of a clinometer.

Fertile samples were collected and deposited in the herbariums of the Universidade Federal de Goiás (UFG) (Goiânia, Goiás state) and Cenargen-Embrapa (Brasília, Federal District), both in Brazil. The botanical families followed the classification system of the Angiosperm Phylogeny Group IV (Chase et al. 2016), while spelling, authorship and synonymy of scientific names were confirmed by consulting Flora do Brasil (Rio de Janeiro 2020). The choice of forest phytophysiognomies, plot size, inclusion criteria for arboreal individuals and botanical collection followed the National Forest Inventory standards (SFB 2015), in order to ultimately include the results in its database.

The structure of woody communities was explained by means of phytosociological parameters described by Mueller-Dombois & Ellenberg (2002). Floristic diversity was assessed using the Shannon's diversity index (H') and Pielou's equability (J') (Magurran 2019). The sampling sufficiency in each phytophysiognomy was assessed using species accumulation and rarefaction curves (Mao tau) (Colwell et al. 2004). The floristic similarity among the phytophysiognomies was calculated using the Dice-Sorensen index, with grouping via dendrogram, using the unweighted pair group method with arithmetic mean (UPGMA). The analyses were performed using the PAST software, version 4.03 (Hammer et al. 2001). Horizontal (diameters) and vertical (heights) structures were analyzed using frequency histograms in the R statistical environment (R Core Team 2020). The Spiegel formula (Spiegel 1976) was used to determine the ideal interval for the distribution of data among the classes.

RESULTS AND DISCUSSION

The Cerrado communities sampled in the LVC showed a high floristic diversity (H' between 3.04

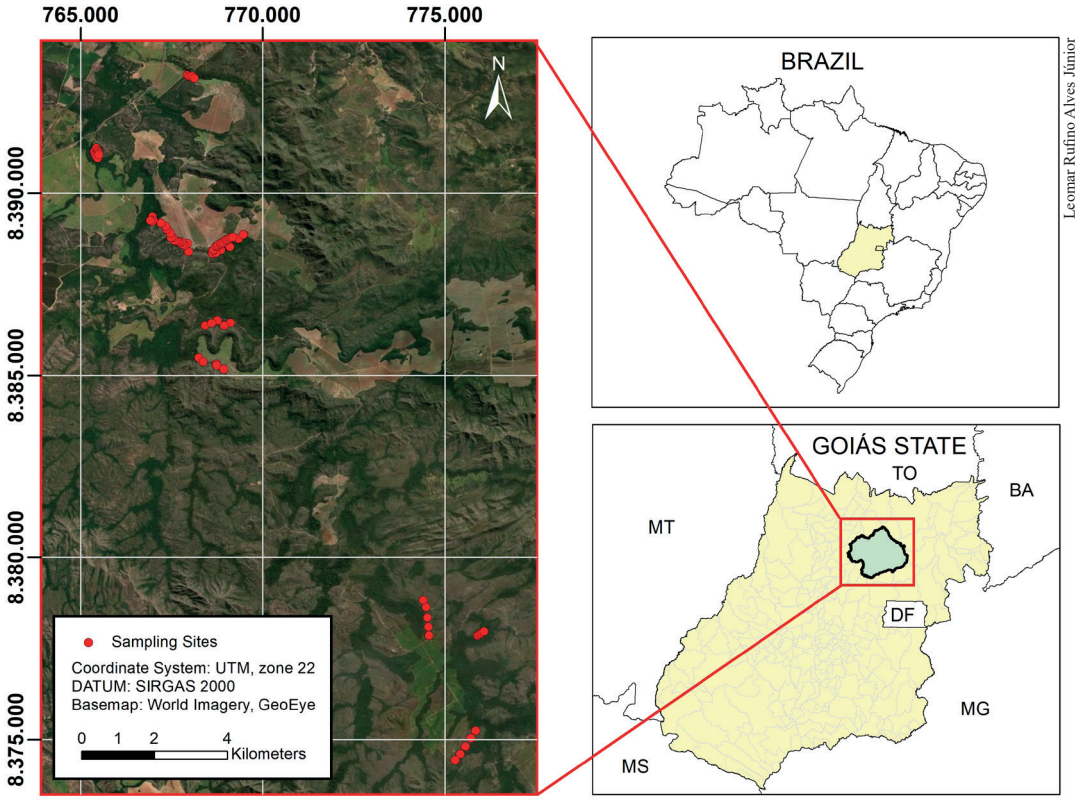

Figure 1. Location of the Legado Verdes do Cerrado Sustainable Development Reserve, in Niquelândia, Goiás state, Brazil.

and 3.94) and equitable distributions of individuals among the sampled species (J' between 0.84 and 0.92) (Table 1). Our results are similar to those of Silva et al. (2019) for three areas of cerrado *sensu stricto* (H' from 3.20 to 3.62), and within the range found by Miranda et al. (2017) for 12 areas of cerradão (2.13 to 4.00). The results obtained for dry and ciliary forests were superior to those found, respectively, by Walter et al. (2015) (2.98) and Ferreira et al. (2017) (3.25), as well as by Silva et al. (2015) (3.32) and Gomes et al. (2014) (3.62).

The total floristic survey sampled 933 live individuals, with estimated 1,166 ind ha^{-1}. These individuals represent 154 species, belonging to 103 genera and 46 botanical families (Tables 2a-d). Of the 154 species, three were identified only to the family level and five to genus. The five richest families (Fabaceae, Myrtaceae, Malpighiaceae, Malvaceae and Vochysiaceae) accounted for 63 % of the total number of individuals sampled. Of this total, eight families were common to all phytophysiognomies (Anacardiaceae, Annonaceae, Apocynaceae, Fabaceae, Myrtaceae, Nyctaginaceae, Sapindaceae and Vochysiaceae) and, thus, representative in the tree strata of the Cerrado biome. Fabaceae, with 39 species, stood out regarding richness, accounting for 25 % of the total. Fabaceae was also the richest family in each of the different communities studied. This family is considered one of the largest in the world, and has a great importance for nitrogen balance in savanna ecosystems (Goodland & Ferri 1979).

The genera with the greatest richness were *Byrsonima* (cerrado *sensu stricto* and cerradão) and *Machaerium* (dry and ciliary forests). *Byrsonima* is common in the Cerrado with about 130 species (Mamede & Francener 2015) that are distributed in various types of plant formations (Mendonça et al. 2008), while *Machaerium* has 22 species in the same biome and is more common in forest areas (Rio de Janeiro 2020). The flora sampled in this study included species in common with the floristic list of Mendonça et al. (2008) and added to the list generated by Mendonça et al. (2007) for the Parque Nacional da Chapada dos Veadeiros, a nearby area, namely: *Oxandra* sp.; *Syagrus oleracea* (Mart.) Becc.; *Erythroxylum citrifolium* A. St.-Hil.; *Inga ingoides* (Rich.) Willd.; *Myroxylon peruiferum* L. f.; *Stryphnodendron rotundifolium*

Table 1. Floristic and structural parameters of four Cerrado phytophysiognomies in the Legado Verdes do Cerrado Sustainable Development Reserve, in Niquelândia, Goiás state, Brazil.

Parameters	TV*	Phytophysiognomies			
		Css	Cd	Fd	Fc
Number of plots	80	20	20	20	20
Sampled individuals (N)	933	126	305	283	219
Species diversity					
Shannon's index (H')	4.47	3.04	3.83	3.66	3.94
Pielou's equability (J')	0.88	0.84	0.88	0.87	0.92
Floristics					
Families	46	20	32	25	31
Genera	103	28	62	57	63
Species (S)	154	36	76	65	73
Rare species (%)	30	36	36	41	39
Exclusive species (%)	-	39	29	16	47
Structure					
Basal area (m^2 ha^{-1})	12.70	4.40	14.50	17.00	15.20
Height (median) (m)	7.50	3.60	6.70	8.90	9.80
Height (mean) (m)	9.13	4.00	7.40	11.50	11.40
CV Height (%)	67.00	45.00	49.00	63.00	57.00
DBH (median) (cm)	8.60	7.00	8.90	8.91	9.54
DBH (mean) (cm)	10.37	8.59	10.02	10.76	11.42
CV DBH (%)	53.00	46.00	45.00	54.00	59.00
Density (ind ha^{-1})	1,166.00	630.00	1,525.00	1,415.00	1,095.00

TV: total value; Css: cerrado *sensu stricto*; Cd: cerradão; Fd: dry forest; Fc: ciliary forest; DBH: diameter at breast height; CV: coefficient of variation.

Mart.; *Swartzia multijuga* Vogel; *Byrsonima guilleminiana* A. Juss.; *Agonandra excelsa* Griseb.; and *Myrsine gardneriana* A. DC. It is noteworthy that *E. citrifolium*, *M. peruiferum* and *A. excelsa* are quite common in the studied phytophysiognomies of the LVC. The great Cerrado heterogeneity (Ratter et al. 2003, Costa-Coutinho et al. 2019) highlights the importance of establishing conservation units such as the LVC to protect species that occur regionally. Among the species sampled in the present research, *Apuleia leiocarpa* (Vogel) J. F. Macbr. and *Cedrela fissilis* Vell. are considered vulnerable (Lima et al. 2013), with recommendations for the monitoring of populations and the implementation of sustainable management strategies. In general, more than 30 % of the woody species found in the communities are considered locally rare, that is, they are represented by a single individual. Of the four sampled communities, the dry forest had the highest percentage of rare species (Table 1). These species are important in the floristic differentiation of Cerrado communities and contribute to the genetic diversity of these areas.

The sampling methodology proved to be sufficient for dry forest, ciliary forest and cerradão (Figures 2B, 2C and 2D). However, it represented only 50 % of the estimated richness for the cerrado *sensu stricto* (Figure 2A).

According to Felfili et al. (2005), the sampling sufficiency in this community can be obtained using the inclusion criterion of woody individuals with a base diameter ≥ 5 cm and a minimum sampling of one hectare. It is noteworthy that the methodology adopted in this study sought to standardize data for inclusion in the National Forest Inventory database, which diverges from the criteria proposed by Felfili et al. (2005).

The floristic similarities between cerradão and cerrado *sensu stricto* and between these and the dry forest were high (Figure 3).

In fact, most of the species occurring in the cerradão (71 %) were shared with other phytophysiognomies, corroborating that this phytophysiognomy is characterized by the presence of species from cerrado *sensu stricto* and those occurring in different forest formations (Ribeiro & Walter 2008, Ferreira et al. 2017). Geographical proximity and, consequently, similarities in local environmental conditions may have contributed to the overlap of species among these phytophysiognomies (Pinto et al. 2009, Ferreira et al. 2019). The ciliary forest was the most distinct phytophysiognomy of the four, sharing 40 % of its species with dry forest (Figure 3) and with 47 % exclusive species, probably due to the environmental conditions of association with a water source (Silva et al. 2015).

Table 2a. Floristic list of four Cerrado phytophysiognomies in the Legado Verdes do Cerrado Sustainable Development Reserve, in Niquelândia, Goiás state, Brazil.

Botanic Family/ Popular name	Species	— Phytophysiognomies —				Herbarium records	
		Cd	Css	Fc	Fd	UFG	Cenargen
Anacardiaceae							
Cajú	*Anacardium occidentale* L.	x	x		x	66415	109764
Gonçalo-Alves	*Astronium fraxinifolium* Schott	x		x	x	66420	
Aroeira	*Myracrodruon urundeuva* M. Allemão			x	x	66416	
Pombo	*Tapirira guianensis* Aubl.	x			x	66419	109760
Annonaceae							
Araticum-do-brejo	*Annona glabra* L.			x		69214	
Envira-do-cocho	*Oxandra* sp.			x	x		109790
Pimenta-de-macaco	*Xylopia aromatica* (Lam.) Mart.	x	x	x	x	66429	
Apocynaceae							
Casco-d'anta	*Aspidosperma nobile* Müll. Arg.		x			66401	109753
Peroba-rosa	*Aspidosperma pyrifolium* Mart. & Zucc.				x	68390	
Guatambú-da-mata	*Aspidosperma subincanum* Mart.	x		x	x	66432	109769
Guatambú-do-cerrado	*Aspidosperma tomentosum* Mart. & Zucc.	x	x		x	66417	109759
Pau-de-leite	*Himatanthus obovatus* (Müll. Arg.) Woodson	x	x			65447	
Pau-de-leite	*Himatanthus articulatus* (Vahl) Woodson			x			
Araliaceae							
Mandiocão	*Schefflera macrocarpa* (Cham. & Schltdl.) Frodin			x		65468	
Arecaceae							
Macaúba	*Acrocomia aculeata* (Jacq.) Lodd. ex Mart.	x		x		69222	
Catolé	*Syagrus comosa* (Mart.) Mart.	x	x			66441	
Gueiroba	*Syagrus oleracea* (Mart.) Becc.			x			
Asteraceae							
Coração-de-negro	*Piptocarpha rotundifolia* (Less.) Baker	x	x			65454	
Bignoniaceae							
Ipê-amarelo	*Handroanthus ochraceus* (Cham.) Mattos	x				68392	
Ipê-roxo	*Handroanthus impetiginosus* (Mart. ex DC.) Mattos				x		
Ipê-branco	*Tabebuia roseoalba* (Ridl.) Sandwith	x		x	x		
Boraginaceae							
Louro-branco	*Cordia glabrata* (Mart.) A.DC.	x			x		
Fruta-de-morcego	*Cordia sellowiana* Cham.			x		66430	109767
Burseraceae							
Breu	*Protium heptaphyllum* (Aubl.) Marchand			x	x	68380	
Calophyllaceae							
Pau-santo	*Kielmeyera coriacea* Mart. & Zucc.		x				
Cannabaceae							
Pulero-de-jacú	*Celtis iguanaea* (Jacq.) Sarg.			x	x	69210	
Caryocaraceae							
Pequi	*Caryocar brasiliense* Campess.	x			x	66402	109749
Celastraceae							
Bacuparí	*Salacia elliptica* (Mart.) G. Don			x		68381	
Chrysobalanaceae							
Coco-de-bode	*Hirtella glandulosa* Spreng.	x				66400	109752
Bosta-de-cabra	*Hirtella gracilipes* (Hook. f.) Prance			x		66408	109772
Combretaceae							
Maria-preta	*Buchenavia tomentosa* Eichler				x	68387	
Maria-preta	*Terminalia argentea* Mart. & Zucc.	x		x	x	67892	
Connaraceae							
Botica-inteira	*Rourea induta* Planch.	x				69229	109788
Dilleniaceae							
Lixeira	*Curatella americana* L.	x	x		x	65452	109765
Lixeirinha	*Davilla elliptica* A. St.-Hil.	x	x			66439	109795
Lixeira-folha-lisa	*Davilla grandiflora* A. St.-Hil.		x			67883	109773

Cd: cerradão; Css: cerrado *sensu stricto*; Fc: ciliary forest; Fd: dry forest; UFG: Universidade Federal de Goiás; Cenargen: Embrapa Recursos Genéticos e Biotecnologia.

Table 2b. Floristic list of four Cerrado phytophysiognomies in the Legado Verdes do Cerrado Sustainable Development Reserve, in Niquelândia, Goiás state, Brazil.

Botanic Family/ Popular name	Species	— Phytophysiognomies —				Herbarium records	
		Cd	Css	Fc	Fd	UFG	Cenargen
Ebenaceae							
Unha-de-boi	*Diospyros sericea* A. DC.	x				68393	
Erythroxylaceae							
Pimentinha	*Erythroxylum citrifolium* A. St.-Hil.		x			66407	109776
Fruto-de-pomba	*Erythroxylum daphnites* Mart.	x			x	66473	109781
Cabelo-de-negro	*Erythroxylum suberosum* A. St.-Hil.		x			65451	109762
Euphorbiaceae							
Vaquinha	*Maprounea guianensis* Aubl.	x					
Fabaceae							
Farinha-seca	*Albizia niopoides* (Spruce ex Benth.) Burkart			x	x		
Angico-preto	*Anadenanthera peregrina* (L.) Speg.	x		x	x	66930	
Angelim	*Andira fraxinifolia* Benth.			x			
Mata-barata	*Andira vermifuga* (Mart.) Benth	x	x		x	65460	
Garapa	*Apuleia leiocarpa* (Vogel) J. F. Macbr.	x		x	x	67874	
Pata-de-vaca	*Bauhinia rufa* (Bong.) Steud.			x		68375	
Sucupira-preta	*Bowdichia virgilioides* Kunth	x	x		x	66409	109766
Copaíba	*Copaifera langsdorffii* Desf.	x		x	x	66411	109757
Faveira	*Dimorphandra mollis* Benth.	x				65450	
Baru	*Dipteryx alata* Vogel	x			x	65448	
Tamboril	*Enterolobium contortisiliquum* (Vell.) Morong			x		67879	
Jatobá-da-mata	*Hymenaea courbaril* L.			x		69228	
Jatobá-da-mata	*Hymenaea martiana* Hayne	x		x	x	69226	
Jatobá-do-cerrado	*Hymenaea stigonocarpa* Mart. ex Hayne	x	x			65461	
-	Indeterminada 3	x					
Ingá	*Inga cylindrica* (Vell.) Mart.			x		69225	
Ingá	*Inga ingoides* (Rich.) Willd.			x		68372	
Amargosinho	*Leptolobium dasycarpum* Vogel	x					
Feijão-cru	*Lonchocarpus cultratus* (Vell.) A. M. G. Azevedo & H. C. Lima			x			
Pau-mocó	*Luetzelburgia auriculata* (Allemão) Ducke		x		x	68373	
Pau-de-angu	*Machaerium aculeatum* Raddi				x		
Jacarandá-bico-de-papagaio	*Machaerium acutifolium* Vogel	x		x	x	69220	
Jacarandá	*Machaerium brasiliense* Vogel			x			109791
Jacarandá-de-espinho	*Machaerium hirtum* (Vell.) Stellfeld			x			
Jacarandá-do-cerrado	*Machaerium opacum* Vogel				x	69223	
Balsamo	*Myroxylon peruiferum* L.f.			x	x	69224	
Roxinho	*Peltogyne confertiflora* (Mart. ex Hayne) Benth	x				68394	
Angico-jacarandá	*Piptadenia gonoacantha* (Mart.) J. F. Macbr.			x	x	69215	
Vinhático	*Plathymenia reticulata* Benth.				x	67871	
Jacarandá	*Platymiscium floribundum* Vogel			x		70075	
Jacarandá	*Platymiscium trinitatis* Benth.			x			
Canzileiro	*Platypodium elegans* Vogel	x		x		66406	109755
Sucupira-branca	*Pterodon emarginatus* Vogel	x	x			66436	109771
Barbatimão	*Stryphnodendron rotundifolium* Mart				x		109775
Barbatimão	*Stryphnodendron adstringens* (Mart.) Coville	x				65453	
Banha-de-galinha	*Swartzia multijuga* Vogel			x	x	68376	
Pau-bosta	*Tachigali aurea* Tul.	x				66475	109783
Carvoeiro	*Tachigali vulgaris* L. G. Silva & H. C. Lima	x	x			66399	10950
Amargoso	*Vatairea macrocarpa* (Benth.) Ducke	x			x	69212	
Lamiaceae							
Piúna	*Vitex polygama* Cham.			x			

Cd: cerradão; Css: cerrado *sensu stricto*; Fc: ciliary forest; Fd: dry forest; UFG: Universidade Federal de Goiás; Cenargen: Embrapa Recursos Genéticos e Biotecnologia.

Table 2c. Floristic list of four Cerrado phytophysiognomies in the Legado Verdes do Cerrado Sustainable Development Reserve, in Niquelândia, Goiás state, Brazil.

Botanic Family/ Popular name	Species	— Phytophysiognomies —				Herbarium records	
		Cd	Css	Fc	Fd	UFG	Cenargen
Lythraceae							
Pacari	*Lafoensia pacari* A. St.-Hil.		x			66422	
Cega-machado	*Physocalymma scaberrimum* Pohl	x		x		66405	
Malpighiaceae							
Murici-pequeno	*Byrsonima clausseniana* A. Juss.	x			x	66931	109792
Murici-rosa	*Byrsonima coccolobifolia* Kunth	x	x			67881	109774
Murici	*Byrsonima guilleminiana* A. Juss.		x				
Murici	*Byrsonima pachyphylla* A. Juss.	x			x	65456	
Murici-vermelho	*Byrsonima* sp. 2	x				67887	
Muricizão	*Byrsonima verbascifolia* (L.) DC.		x			65455	
Murici-macho	*Heteropterys byrsonimifolia* A. Juss.		x			66425	109793
Malvaceae							
Pau-jangada	*Apeiba tibourbou* Aubl.			x		66452	109778
Paineira	*Eriotheca gracilipes* (K. Schum.) A. Robyns	x			x	66410	
Mutamba	*Guazuma ulmifolia* Lam.			x	x	67889	
Açoita-cavalo	*Luehea candicans* Mart. & Zucc.	x		x	x	67888	
Açoita-cavalo	*Luehea divaricata* Mart. & Zucc.	x			x	67890	
Embiruçú	*Pseudobombax longiflorum* (Mart.) A. Robyns	x				68391	
Embiruçú	*Pseudobombax tomentosum* (Mart.) A. Robyns				x		
Melastomataceae							
Pixirica	*Miconia albicans* (Sw.) Triana	x				68384	
Pixirica	*Miconia burchelli* Triana		x			66474	109782
Pixirica	*Miconia* sp.		x			67885	
Meliaceae							
Cedro	*Cedrela fissilis* Vell.			x			
Marinheiro	*Guarea guidonia* (L.) Sleumer			x		66479	
Figo-do-mato	*Guarea kunthiana* A. Juss.			x			
Moraceae							
Amoreira-de-espinho	*Maclura tinctoria* (L.) D. Don ex Steud.			x	x	69207	
Myristicaceae							
Bicuíba	*Virola sebifera* Aubl.			x		65463	
Myrtaceae							
Gabiroba-arbórea	*Campomanesia velutina* (Cambess.) O. Berg	x		x	x	66927	109787
Cagaita	*Eugenia dysenterica* (Mart.) DC				x	66434	
Guamirim	*Eugenia florida* DC.			x		68385	
-	*Eugenia* sp.			x		69206	
Araçazinho	*Myrcia guianensis* (Aubl.) DC.	x		x		66478	109786
Araçá	*Myrcia splendens* (Sw.) DC.	x		x	x	66477	109785
Goiaba-do-mato	*Myrcia tomentosa* (Aubl.) DC.	x			x	66471	109779
Araçá	*Psidium myrsinites* DC.	x	x			65458	
Nyctaginaceae							
Maria-mole	*Guapira graciliflora* (Mart. ex Schmidt) Lundell	x	x	x	x	69208	
João-mole	*Guapira opposita* (Vell.) Reitz			x		69217	
Capa-rosa	*Guapira noxia* (Netto) Lundell	x				69213	
Ochnaceae							
Vassoura-de-bruxa	*Ouratea hexasperma* (A. St.-Hil.) Baill.		x			65449	109754
Opiliaceae							
Cerveja-de-pobre	*Agonandra brasiliensis* Miers ex Benth. & Hook. f.	x	x				
Cerveja-de-pobre	*Agonandra excelsa* Griseb.			x		68386	
Primulaceae							
Pororoca	*Myrsine gardneriana* A. DC.	x		x	x	69209	
Pororoca	*Myrsine umbellata* Mart	x				68383	

Cd: cerradão; Css: cerrado *sensu stricto*; Fc: ciliary forest; Fd: dry forest; UFG: Universidade Federal de Goiás; Cenargen: Embrapa Recursos Genéticos e Biotecnologia.

Table 2d. Floristic list of four Cerrado phytophysiognomies in the Legado Verdes do Cerrado Sustainable Development Reserve, in Niquelândia, Goiás state, Brazil.

Botanic Family/ Popular name	Species	— Phytophysiognomies —				Herbarium records	
		Cd	Css	Fc	Fd	UFG	Cenargen
Proteaceae							
Fruta-de-morcego	*Euplassa inaequalis* (Pohl) Engl.	x				68388	
Carne-de-vaca	*Roupala montana* Aubl.			x	x	68377	
Rhamnaceae							
Cafezinho	*Rhamnidium elaeocarpum* Reissek				x	66476	109784
Rubiaceae							
Marmelada	*Alibertia edulis* (Rich.) A. Rich.	x		x	x	66433	
Falsa-quina	*Coussarea hydrangeifolia* (Benth.) Müll. Arg.			x		69205	
Veludo-branco	*Guettarda viburnoides* Cham. & Schltdl.	x			x	67873	
Congonha-de-bugre	*Rudgea viburnoides* (Cham.) Benth.				x	69230	
Jenipapo-de-cavalo	*Tocoyena formosa* (Cham. & Schltdl.) K. Schum.	x		x	x	66449	109777
Rutaceae							
Mamica-de-porca	*Zanthoxylum rhoifolium* Lam.			x			
Mamica-de-porca	*Zanthoxylum riedelianum* Engl.	x				65467	
Salicaceae							
	Casearia rupestris Eichler				x		
Sapindaceae							
Camboatá	*Cupania vernalis* Cambess.			x			
Maria-pobre	*Dilodendron bipinnatum* Radlk.	x		x	x	67882	
-	Indeterminada 1			x			
-	Indeterminada 2			x			
Tinguí	*Magonia pubescens* A. St.-Hil.	x	x	x	x	66419	
Camboatá-branco	*Matayba guianensis* Aubl.			x	x	65466	
Pitomba	*Talisia esculenta* (Cambess.) Radlk.			x		69216	
Sapotaceae							
Pururuca	*Pouteria gardneri* (Mart. & Miq.) Baehni			x		69227	
Curriola	*Pouteria ramiflora* (Mart.) Radlk.	x				66442	
Simaroubaceae							
Mata-cachorro	*Simarouba amara* Aubl.			x		66398	
Mata-cachorro	*Simarouba versicolor* A. St.-Hil.		x			66403	109758
Siparunaceae							
Negramina	*Siparuna guianensis* Aubl.	x			x	65462	
Styracaceae							
Laranjinha-do-cerrado	*Styrax ferrugineus* Nees & Mart.		x			65465	
Laranjeira-do-brejo	*Styrax pohlii* A. DC.			x			
Urticaceae							
Embaúba	*Cecropia pachystachya* Trécul	x				69218	
Vochysiaceae							
Pau-jacaré	*Callisthene fasciculata* Mart.				x	66440	
Pau-terra-da-mata	*Qualea dichotoma* (Mart.) Warm.	x					
Pau-terra-grande	*Qualea grandiflora* Mart.	x	x		x	65446	
Pau-terrinha	*Qualea multiflora* Mart.			x	x	66929	109789
Pau-terra	*Qualea parviflora* Mart.	x	x			65445	
Gomeirinha	*Vochysia elliptica* Mart.	x	x			66438	
Pau-doce	*Vochysia rufa* Mart.	x				66414	

Cd: cerradão; Css: cerrado *sensu stricto*; Fc: ciliary forest; Fd: dry forest; UFG: Universidade Federal de Goiás; Cenargen: Embrapa Recursos Genéticos e Biotecnologia.

The analysis of the phytosociological parameters of the four communities revealed that *Anadenanthera peregrina* (L.) Speg, *Curatella americana* L. and *Dilodendron bipinnatum* Radlk. were the most important species, accounting for 12 % of the total importance value (IV). The *C. americana* species stood out as the most abundant in the joint analysis of the communities, with greater density and frequency, and occurring in three of the four formations, the exception being ciliary forest. This species was the most important in the cerrado *sensu stricto* (20 % of the total IV) and the sixth most

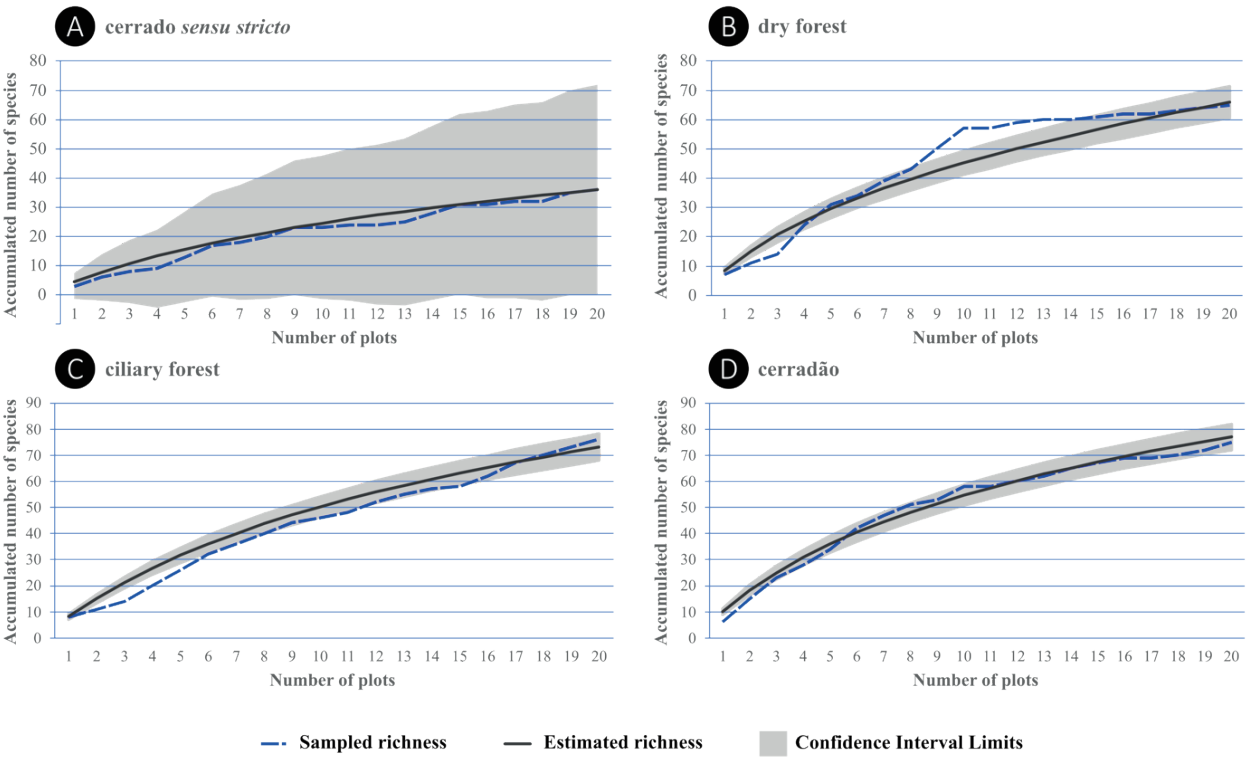

Figure 2. Species accumulation and rarefaction curves for the studied areas of cerrado *sensu stricto* (A), dry forest (B), ciliary forest (C) and cerradão (D), sampled in the Legado Verdes do Cerrado Sustainable Development Reserve, in Niquelândia, Goiás state, Brazil. Confidence interval: 95 %.

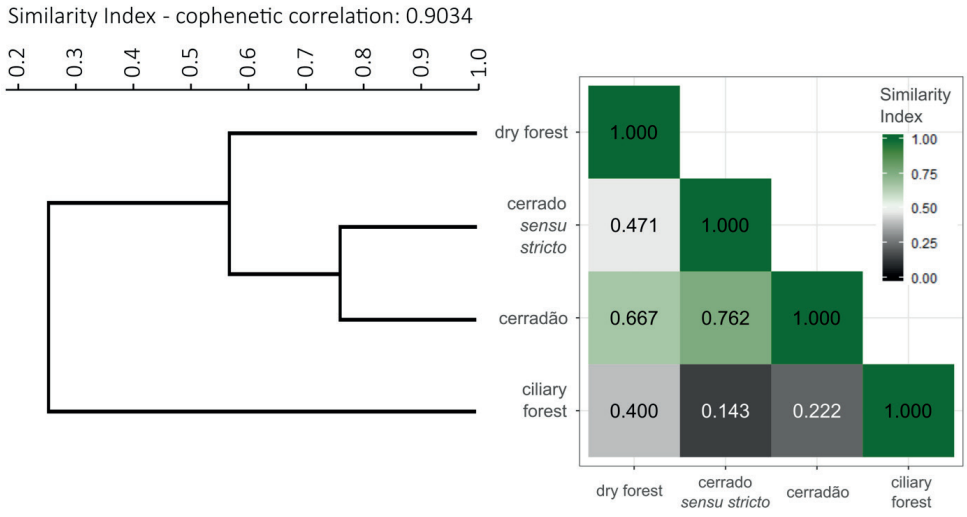

Figure 3. Floristic similarity (Sorensen Index - UPGMA) among the phytophysiognomies sampled in the Legado Verdes do Cerrado Sustainable Development Reserve, in Niquelândia, Goiás state, Brazil.

important in cerradão (4 % of the total IV). Matching results were found for the same species in different studies undertaken in the Cerrado (Ratter et al. 2003, Ferreira et al. 2017, Silva et al. 2019, Brasil 2020).

In the cerradão, *Tachigali vulgaris* L. G. Silva & H. C. Lima was the most important species (7 % of the total IV) and had the highest values for density and dominance. The species is considered an

indicator of dystrophic cerradão (Oliveira-Filho & Ratter 2002, Vasconcelos et al. 2020), although there are records of its occurrence in several areas of the Cerrado biome (Ratter et al. 2003).

The *A. peregrina* species was the most important in the analysis of the four communities (5 % of the total IV), as well as in the dry forest (11 % of the total IV). It is a typical species of seasonal forests (Haidar 2008, Ribeiro & Walter 2008). In the ciliary forest, *Aspidosperma subincanum* Mart. had high values for density and frequency (50 % of the plots), being considered the most important species (6 % of the total IV), as well as the fifth most important in the dry forest (5 % of the total IV). This species was considered to have a wide geographical distribution, according to a National Forest Inventory floristic survey conducted in the Federal District and in the states of Bahia, Goiás, Maranhão, Mato Grosso do Sul, Piauí, Paraná and Tocantins (Brasil 2020).

The studied communities differed with regard to mean values for diameter and height (Table 1). The forest phytophysiognomies had an average DBH above 10 cm, while the cerrado *sensu stricto* (savanna formation) had an average of 8.6 cm. The highest coefficient of variation was found for the ciliary forest, at around 60 % (Table 1). The cerrado *sensu stricto* was characterized by shorter trees, with an average of 4.0 m (CV = 45 %), while, in the cerradão, the average height was 7.4 m (CV = 49 %), a result of sharing species with the cerrado *sensu stricto* and forest formations. The average tree height for forests was 11.0 m, with a greater coefficient of variation for the dry forest (63 %) (Table 1).

The forest formations had an estimated density above 1,000 ind ha^{-1}, but the cerrado *sensu stricto*, due to the minimum criterion for inclusion in the sample, had an estimated density of 630 ind ha^{-1}, a value lower than the range of 906 to 1,859 ind ha^{-1} obtained in recent studies carried out in areas of cerrado *sensu stricto* (Silva et al. 2019, Ferreira et al. 2020). Abiotic factors (e.g., soil physical and chemical properties) may also influence the structural parameters of Cerrado communities on a local scale (Miranda et al. 2020).

The minimum criterion for inclusion in sampling also influenced the values obtained for estimated basal area for the cerrado *sensu stricto* and cerradão. The forest phytophysiognomies had expressive values for basal area (Table 1), which were related to the presence of large individuals.

The distribution of arboreal individuals by diameter class revealed a reverse J aspect, indicating that, in general, the communities are self-regenerating, with a greater concentration of individuals in the smallest diameter classes (Figure 4). As the LVC is a conservation unit, the absence of anthropic

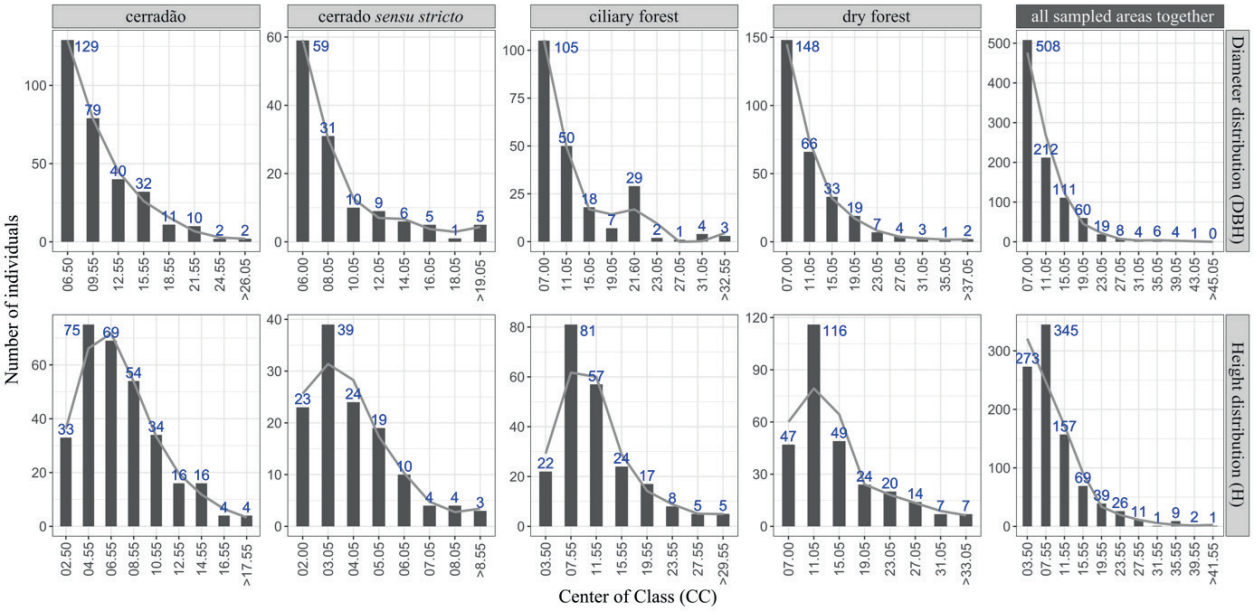

Figure 4. Distribution of arboreal individuals by center of diameter (diameter at breast height - DBH) and height (H) classes for four phytophysiognomies (cerradão, cerrado *sensu stricto*, ciliary forest and dry forest), as well as the four sampled together, in the Legado Verdes do Cerrado Sustainable Development Reserve, in Niquelândia, Goiás state, Brazil.

disorders may be contributing to the balance between mortality and recruitment of new individuals in these communities (Lisboa et al. 2019).

The mean values for DBH and height corroborated the expected gradient, with the smallest mean diameter for the cerrado *sensu stricto* (8.6 cm) and the largest (11.4 cm) for the ciliary forest (Table 1). The coefficient of variation for all phytophysiognomies being above 45 % (Table 1) reflects a variation in the data set related to the Cerrado heterogeneity. The distribution among height classes (Figure 4) revealed a unimodal pattern tending to a normal distribution, with individuals grouped mainly in the second and third classes, as seen in other studies (Maracahipes et al. 2011, Ferreira et al. 2015).

CONCLUSIONS

1. The studied tree communities are characterized by a high diversity, low species dominance and the presence of exclusive and rare species. The values for species richness are within those found for native vegetation, except for the cerrado *sensu stricto*;
2. Among the sampled species, *Apuleia leiocarpa* and *Cedrela fissilis* stand out for being considered with the vulnerable in nature status, which highlights the relevant importance of the Legado Verdes do Cerrado Sustainable Development Reserve to the conservation of the Cerrado native flora;
3. From a structural point of view, the values for the studied communities were within the ranges reported in the specialized literature, except for the cerrado *sensu stricto*;
4. Considering the values obtained for diversity, richness and structural characteristics of the four studied phytophysiognomies, it is possible to conclude that the Legado Verdes do Cerrado Sustainable Development Reserve plays an important role in conserving the remaining Cerrado biodiversity.

REFERENCES

ALENCAR, A.; SHIMBO, J. Z.; LENTI, F.; MARQUES, C. B.; ZIMBRES, B.; ROSA, M.; ARRUDA, V.; CASTRO, I.; RIBEIRO, J. P. F. M.; VARELA, V.; ALENCAR, I.; PIONTEKOWSKI, V.; RIBEIRO, V.; BUSTAMANTE, M. M. C.; SANO, E. E.; BARROSO, M. Mapping three decades of changes in the Brazilian Savanna native vegetation using landsat data processed in the Google Earth engine platform. *Remote Sensing*, v. 12, n. 6, e924, 2020.

BATISTA, F. G.; OLIVEIRA, B. T.; ALMEIDA, M. E. A.; BRITO, M. S.; MELO, R. R.; ALVES, A. R. Florística e fitossociologia de um remanescente florestal da Caatinga - Caicó RN, Brasil. *Revista Desafios*, v. 6, n. 3, p. 118-128, 2019.

BRASIL. *Inventário florestal nacional*. 2020. Available at: <https://www.florestal.gov.br/documentos/publicacoes/4358-levantamento-botanico-6/file>. Access on: 14 Mar. 2021.

BUENO, M. L.; DEXTER, K. G.; PENNINGTON, R. T.; PONTARA, V.; NEVES, D. M.; RATTER, J. A.; OLIVEIRA-FILHO, A. T. The environmental triangle of the Cerrado domain: ecological factors driving shifts in tree species composition between forests and savannas. *Journal of Ecology*, v. 106, n. 5, p. 2109-2120, 2018.

CASTRO, A. A. J. F.; MARTINS, F. R.; TAMASHIRO, J. Y.; SHEPHERD, G. J. How rich is the flora of Brazilian Cerrados? *Missouri Botanical Garden*, v. 86, n. 1, p. 192-224, 1999.

CHASE, M. W.; HRISTENHUSZ, M. F.; BYNG, J. W.; JUDD, W. S.; SOLTIS, D. E.; MABBERLEY, D. J.; SENNIKOV, A. N.; SOLTIS, P. S.; STEVENS, P. F. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society*, v. 181, n. 1, p. 1-20, 2016.

COELHO, H. A.; REZENDE, E. N. A efetiva implantação das unidades de conversação ambiental por meio da desapropriação. *Revista do Direito Público*, v. 11, n. 2, p. 165-195, 2016.

COLWELL, R. K.; MAO, C. X.; CHANG, J. Interpolating, extrapolating, and comparing incidence-based species accumulation curves. *Ecology*, v. 85, n. 10, p. 2717-2727, 2004.

COSTA-COUTINHO, J. M.; JARDIM, M. A. G.; CASTRO, A. A. J. F.; VIANA-JÚNIO, A. B. Conexões biogeográficas de savanas brasileiras: partição da diversidade marginal e disjunta e conservação do trópico ecotonal setentrional em um hotspot de biodiversidade. *Revista Brasileira de Geografia Física*, v. 12, n. 7, p. 2406-2427, 2019.

FELFILI, M. C.; FELFILI, J. M. Diversidade alfa e beta no Cerrado *sensu stricto* da Chapada Pratinha, Brasil. *Acta Botanica Brasilica*, v. 15, n. 2, p. 243-254, 2001.

FELFILI, M. F.; CARVALHO, F. A.; HAIDAR, R. F. *Manual para o monitoramento de parcelas permanentes nos biomas Cerrado e Pantanal.* Brasília, DF: Ed. UnB, 2005.

FERREIRA, F. G.; MACHADO, E. L. M.; SILVA-NETO, C. M.; SILVA JUNIOR, M. C.; MEDEIROS, M. M.; GONZAGA, A. P. D.; SOLÓRZANO, A.; VENTUROLI, F.; FAGG, J. M. F. Diversity and indicator species in the Cerrado biome, Brazil. *Australian Journal of Crop Science*, v. 11, n. 8, p. 1042-1050, 2017.

FERREIRA, I. N. M.; FERREIRA, F. G.; SANTANA, G. M.; GUIMARÃES, L. E.; VENTUROLI, F. Estrutura e diversidade da vegetação arbórea em cerradão no norte do estado de Goiás. *Tree Dimensional*, v. 4, n. 7, p. 31-45, 2019.

FERREIRA, R. Q. S.; CAMARGO, M. O.; SOUZA, P. B.; ANDRADE, V. C. L. Fitossociologia e estrutura diamétrica de um Cerrado *sensu stricto*, Gurupi - TO. *Revista Verde*, v. 10, n. 1, p. 229-235, 2015.

FERREIRA, R. Q. S.; SANTOS, L. A. C. S.; TEIXEIRA, P. R.; BORGES, L.; SOUZA, P. B. Estrutura fitossociológica de um cerrado *sensu stricto*, em Gurupi, Tocantins. *Fronteiras*, v. 9, n. 1, p. 316-329, 2020.

FRANÇOSO, R.; BRANDÃO, R.; NOGUEIRA, C. C.; SALMONA, Y.; MACHADO, R. B.; COLLI, G. R. Habitat loss and the effectiveness of protected areas in the Cerrado biodiversity hotspot. *Natureza & Conservação*, v. 13, n. 1, p. 35-40, 2015.

GOMES, F. S. G.; GUEDES, M. L. S.; VALADÃO, R. M.; PRATES, A. R. S.; COSTA, M. A. A. Florística e estrutura de um trecho de mata ciliar do rio Carinhanha, Feira da Mata, Bahia, Brasil. *Revista Biotemas*, v. 27, n. 3, p. 41-55, 2014.

GOODLAND, R.; FERRI, M. G. *Ecologia do Cerrado*. São Paulo: Edusp, 1979.

HAIDAR, R. F. *Fitossociologia, diversidade e sua relação com variáveis ambientais em florestas estacionais do bioma Cerrado no Planalto Central e Nordeste do Brasil*. Dissertação (Mestrado em Ciências Florestais) - Universidade de Brasília, Brasília, DF, 2008.

HAMMER, Ø.; HARPER, D. A. T.; RYAN, P. D. PAST: paleontological statistics software package for education and data analysis. *Palaeontologia Electronica*, v. 4, n. 1, p. 1-9, 2001.

LIMA, H. C.; SOUZA, E. R.; TOZZI, M. G. A.; PEREZ, A. P. F.; FLORES, A. S.; SARTORI, A. L. B.; VAZ, A. M. S. F.; FILARDI, F.; FERNANDES, F. M.; GARCIA, F. C. P.; VALLS, J. F. M.; LIMA, L. C. P.; COSTA, L. C.; QUEIROZ, L. P.; MORIM, M. P.; NUNES, N. L. A.; QUEIROZ, R. T.; MIOTTO, S. T. S.; DUTRA, V. F.; MANSANO, V. F.; SOUZA, V. C.; MESSINA, T.; KUTSCHENKO, D. C.; PENEDO, T. S. A.; VALENTE, A. M. Fabaceae/Leguminosae. *In*: MARTINELLI, G.; MORAES, M. A. (org.). *Livro vermelho da flora do Brasil*. Rio de Janeiro: Centro Nacional de Conservação da Flora, 2013. p. 516-548.

LISBOA, G. S.; VERES, K. J. I.; WATZLAWICK, L. F.; FRANÇA, L. C. J.; CERQUEIRA, C. L.; MIRANDA, D. L. C.; STEPKA, T. F.; LONGHI, R. V. Fitossociologia e dinâmica de crescimento em um fragmento de floresta estacional semidecidual. *Nativa*, v. 7, n. 4, p. 452-459, 2019.

MAGURRAN, A. E. *Medindo a diversidade biológica*. Curitiba: Ed. da UFPR, 2019.

MAMEDE, M. C. H.; FRANCENER, A. *Lista de espécies da flora do Brasil*: *Byrsonima* Rich. ex Kunth. 2015. Available at: <http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB8827>. Access on: 13 Mar. 2020.

MARACAHIPES, L.; LENZA, E.; MARIMON, B. S.; OLIVEIRA, E. A.; PINTO, J. R. R.; MARIMON JUNIOR, B. H. E. Estrutura e composição florística da vegetação lenhosa em Cerrado rupestre na transição Cerrado-Floresta Amazônica, Mato Grosso, Brasil. *Biota Neotropica*, v. 1, n. 1, p. 133-141, 2011.

MENDONÇA, R. C.; FILGUEIRAS, T. S.; FAGG, C. W. Análise florística da Chapada dos Veadeiros. *In*: FELFILI, J. M.; REZENDE, A. V.; SILVA JÚNIOR, M. C. (org.). *Biogeografia do bioma Cerrado*: vegetação e solos da Chapada dos Veadeiros. Brasília, DF: Ed. UnB, 2007. p. 121-237.

MENDONÇA, R. C.; FELFILI, J. M.; WALTER, B. M. T.; SILVA-JÚNIOR, M. C. S.; REZENDE, A. V.; FILGUEIRAS, T. S.; NOGUEIRA, P. E.; FAGG, C. W. Flora vascular do bioma Cerrado: um checklist com 12.356 espécies. *In*: SANO, S. M.; ALMEIDA, S. P.; RIBEIRO, J. F. (org.). *Cerrado*: ecologia e flora. Brasília, DF: Embrapa Informação Tecnológica, 2008. p. 422-442.

MIRANDA, S. C.; SILVA JÚNIOR, M. C.; VASCONCELOS, W. A.; CARVALHO, P. S. Relação solo-vegetação em duas áreas de Cerrado sentido restrito na Serra Dourada, Goiás. *Revista Ibero Americana de Ciências Ambientais*, v. 11, n. 4, p. 21-35, 2020.

MIRANDA, S. C.; VASCONCELOS, W. A.; CEZARE, C. H. G.; MATA, C. R.; FONSECA, K. S. O cerradão de Goiás e suas relações florísticas e estruturais com outras áreas no Brasil. *Enciclopédia Biosfera*, v. 14, n. 26, p. 1058-1069, 2017.

MUELLER-DOMBOIS, D.; ELLENBERG, H. *Aims and methods of vegetation ecology.* New York: Blackburn, 2002.

OLIVEIRA-FILHO, A. T.; RATTER, J. A. Vegetation physiognomies and wood flora of the Cerrado biome. *In*: OLIVEIRA, P. S.; MARQUIS, R. J. (ed.). *The Cerrados of Brazil*: ecology and natural history of a neotropical Savanna. New York: Columbia University, 2002. p. 91-120.

PINTO, J. R. R.; LENZA, E.; PINTO, A. S. Composição florística e estrutura da vegetação arbustivo-arbórea em

um Cerrado rupestre, Cocalzinho de Goiás, Goiás. *Revista Brasileira de Botânica*, v. 32, n. 1, p. 1-10, 2009.

R CORE TEAM. *R*: a language and environment for statistical computing. Vienna: R Foundation for Statistical Computing, 2020.

RATTER, J. A.; BRIDGEWATER, S.; RIBEIRO, J. F. Analysis of the floristic composition of the Brazilian Cerrado vegetation III: comparison of the woody vegetation of 376 areas. *Edinburgh Journal of Botany*, v. 60, n. 1, p. 57-109, 2003.

RIBEIRO, J. F.; WALTER, M. T. As principais fitofisionomias do bioma Cerrado. *In*: SANO, S. M.; ALMEIDA, S. P.; RIBEIRO, J. F. (ed.). *Cerrado*: ecologia e flora. Planaltina, DF: Embrapa Cerrados, 2008. p. 153-212.

RIO DE JANEIRO. Jardim Botânico. *Flora do Brasil*. 2020. Available at: <http://floradobrasil.jbrj.gov.br/>. Access on: 08 Mar. 2021.

SANO, E. E.; RODRIGUES, A. A.; MARTINS, E. S. BETTIOL, G. M.; BUSTAMANTE, M. C.; BEZERRA, A. S.; COUTO JUNIOR, A.; VASCONCELOS, V.; SCHULER, J.; BOLFE, E. L. Cerrado ecoregions: a spatial framework to assess and prioritize Brazilian Savana environmental diversity for conservation. *Journal of Environmental Management*, v. 232, n. 1, p. 818-828, 2019.

SERVIÇO FLORESTAL BRASILEIRO (SFB). *Manual de campo*: procedimentos para coleta de dados biofísicos e socioambientais. Brasília, DF: SBF, 2015.

SILVA, G. E.; GUILHERME, F. A. G.; CARNEIRO, S. E. S.; PINHEIRO, M. H. O.; FERREIRA, W. C. Heterogeneidade ambiental e estrutura da vegetação arbustivo-arbórea em três áreas de Cerrado sentido restrito no sudoeste goiano. *Ciência Florestal*, v. 29, n. 2, p. 924-940, 2019.

SILVA, L. S.; ALVES, A. R.; NUNES, A. K. A.; MACEDO, W. S.; MARTINS, A. R. Florística, estrutura e sucessão ecológica de um remanescente de mata ciliar na bacia do rio Gurguéia - PI. *Nativa Sinop*, v. 3, n. 3, p. 156-164, 2015.

SPIEGEL, M. P. *Estatística*. São Paulo: McGraw-Hill, 1976.

VASCONCELOS, W. A.; MIRANDA, S. C.; SILVA-NETO, C. M.; SOUZA, P. B. Caracterização florístico-estrutural e síndromes de dispersão de espécies lenhosas de remanescente de cerradão. *Nativa Sinop*, v. 8, n. 4, p. 514-522, 2020.

WALTER, B. M.; DURIGAN, G.; MUNHOZ, C. B. R.; RIBEIRO, J. F. Fitofisonomias do Cerrado: classificação, métodos e amostragens fitossociológicas. *In*: EISENLOHR, P. V.; FELFILI, J. M.; MELO, M. M. R. F.; MEIRA NETO, J. A. A. (ed.). *Fitossociologia no Brasil*: métodos e estudos de casos. Viçosa: Ed. UFV, 2015. p. 183-212.