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Floristic and dispersion syndromes of Cerrado species in the Chapada do Araripe, Northeast of Brazil

Florística e síndrome de dispersão de espécies de Cerrado na Chapada do Araripe, Nordeste do Brasil

Florística y síndrome de dispersión de especies de Cerrado en Chapada do Araripe, Noreste de Brasil

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Abstract

Through this study, the objective was to contribute to the knowledge regarding floristic composition, classification and conservation status of the studied plant species as well as the dispersion syndromes of flora found in a disjoint Cerrado area in the Chapada do Araripe, Crato-CE. For the research development Rapid Survey method, applied in three walking lines (Line 1, Line 2 and Line 3) was adopted. Floriferous branches, fruits and seeds from species in the study area were collected in order to identify them and to characterize their diaspores, in view of fitting them into the corresponding dispersion syndromes. A total of 103 species were identified, the richest species taxa were: Fabaceae, Apocynaceae, Euphorbiaceae,

Malpighiaceae and Myrtaceae. The most abundant species in the studied area were: *Cordiera myrciifolia* (“bola”) *Miconia albicans* (“Candeiro-de-pelo”), *Caryocar coriaceum* (pequi) and *Copaifera langsdorffii* (“pau d'oleo”). Three new occurrences were also recorded for the state of Ceará: *Eriope tumidicaulis*, *Myrciaria* cf. *tenella* and *Stachytapheta* cf. *crassifolia*. The most frequent dispersion syndrome was zoochoria, followed by anemocoria. Considering that most of the species occurring in the study area have their dispersion diaspores transported by a fauna element, the importance of these species for the maintenance of the observed floristic richness is evident.

Keywords: Cerrado; Conservation; Rapid survey; Species abundance; Fruit types.

Resumo

Através deste estudo, objetivou-se contribuir para o conhecimento sobre a composição florística, classificação e estado de conservação das espécies vegetais estudadas, bem como as síndromes de dispersão da flora encontradas em uma área disjunta de Cerrado na Chapada do Araripe, Crato-CE. Para o desenvolvimento da pesquisa foi adotado o método *Rapid Survey*, aplicado em três linhas de caminhada (Linha 1, Linha 2 e Linha 3). Foram coletados ramos floríferos, frutos e sementes de espécies da área de estudo, a fim de identificá-los e caracterizar seus diásporos, visando adequá-los às síndromes de dispersão correspondentes.Foram identificadas 103 espécies, distribuídas em 84 gêneros e 40 famílias botânicas. Os taxa que apresentaram maior riqueza de espécies foram: Fabaceae, Apocynaceae, Euphorbiaceae, Malpighiaceae, Myrtaceae. As espécies mais abundantes na área estudada foram: *Cordiera myrciifolia* (bola/café bravo), *Miconia albicans* (candeeiro-de-pelo), *Caryocar coriaceum* (pequi) e *Copaifera langsdorffii* (pau d´óleo). Foram registradas, também, três novas ocorrências para o estado do Ceará: *Eriope tumidicaulis*, *Myrciaria* cf. *tenella* e *Stachytapheta* cf. *crassifolia.* A síndrome de dispersão de maior ocorrência foi a zoocoria, seguida de anemocoria, autocoria e autocoria/zoocoria. Considerando que a maioria das espécies ocorrentes na área do estudo têm seus diásporos de dispersão transportados por algum elemento da fauna, comprova-se a importância destes para a manutenção da riqueza florística observada. Sendo assim, é evidente e necessário que ambos sejam conservados para manutenção dos processos ecológicos locais.

Palavras-chave: Cerrado; Conservação; Levantamento rápido; Abundância de espécies; Tipos de frutos.

Resumen

Con este estudio, nos propusimos contribuir al conocimiento sobre la composición florística, clasificación y estado de conservación de las especies vegetales estudiadas, así como los síndromes de dispersión de flora encontrados en un área disjunta del Cerrado en Chapada do Araripe, Crato-CE. Para el desarrollo de la investigación se adoptó el método Rapid Survey, aplicado en tres líneas de marcha (Línea 1, Línea 2 y Línea 3). Se recolectaron ramas florales, frutos y semillas de especies del área de estudio, con el fin de identificarlas y caracterizar sus diásporas, con el objetivo de adaptarlas a los correspondientes síndromes de dispersión. Se identificaron 103 especies, distribuidas en 84 géneros y 40 familias botánicas. Los taxones con mayor riqueza de especies fueron: Fabaceae, Apocynaceae, Euphorbiaceae, Malpighiaceae, Myrtaceae. Las especies más abundantes en el área de estudio fueron: Cordiera myrciifolia (bola / café silvestre), *Miconia albicans* (candeeiro-de-pelo), *Caryocar coriaceum* (pequi) y *Copaifera langsdorffii* (pau d´óleo). También se registraron tres nuevas ocurrencias para el estado de Ceará: *Eriope tumidicaulis*, *Myrciaria cf. tenella* y *Stachytapheta cf. crassifolia*. El síndrome de dispersión más común fue la zoocoria, seguido de la anemocoria, la autocoria y la autocoria / zoocoria. Considerando que la mayoría de las especies presentes en el área de estudio tienen sus diásporas de dispersión transportadas por algún elemento de la fauna, se comprueba su importancia para el mantenimiento de la riqueza florística observada. Por tanto, es evidente y necesario que ambos se conserven para mantener los procesos ecológicos locales.

Palabras clave: Cerrado; Conservación; Elevación rápida; Abundancia de especies; Tipos de frutas.

1. Introduction

The Cerrado (brazilian savannah) is considered the most diversified tropical savanna in the world regarding phytophysiognomies, possessing high biodiversity (Klink & Machado 2005; Lefebvre & Nascimento 2016) with vegetation that covers a true mosaic of environments sheltering diverse ecosystems, ranging from open formations, subdivided between rural and savanna formations, to forest physiognomies (Ribeiro & Walter 2008). It is, therefore, one of the global biodiversity hotspots due to its high degree of endemism (Myers *et al*. 2000; Ponciano 2015). According to Oliveira *et al.* (2014), this vegetation formation has phytophysiognomies delimited by the existence of an abundant partial or continuous herbaceous strip and a rich diversity of woody species.

In the Brazilian Northeast, the existence of Cerrado patches is attributed, mainly, to altitude, forming fragments resulting from the association with edaphic factors (Santos *et al.* 2014). In this region is the Chapada do Araripe which houses the Araripe National Forest - Apodi - FLONA Araripe, the first Brazilian National Forest, (Alves *et al.* 2011). The Cerrado present in this plateau occurs in the form of vegetative enclaves (Costa *et al.* 2004, Costa & Araújo 2007). Unfortunately, in recent years, due to the vast quantity of resources that it harbors, the Chapada do Araripe has been experiencing many forms of illegal exploitation, especially flora exploitation. Exploratory activities which have gathered attention for desolation, especially in Cerrado areas, are agricultural expansions, raising livestock and wood removal for industrial use (Andrade 2007), of which the latter, according to Barros *et al.* (2010), are usually extracted without management which according to Oliveira *et al.* 2014 can contribute to local extinction of fruit and seed dispersers affecting the interaction between species and successional dynamics, which may prevent or hinder the maintenance of certain species.

One of the main challenges for the conservation of the Cerrado is to demonstrate the importance that biodiversity plays in the functioning of ecosystems (Klink & Machado 2005). With this, the development of studies that lead to greater knowledge regarding flora and fauna and the interspecific relations that unites them is becoming more and more urgent and necessary, especially in Cerrado environments, since studies in this area are still scarce. It is hoped that research may lead to a better understanding of existing plant species' distribution in the Cerrado in the Chapada do Araripe.

In order to fill some of this knowledge gap, this study aimed to determine the floristic composition, conservation state of the studied plant species and the dispersion syndromes of species occurring in a disjoint Cerrado area of the Chapada do Araripe, Crato-CE, Northeast of Brazil, contributing to the understanding of the ecological processes that work in this vegetative formation.

2. Materials and methods

For generating new knowledge, useful for the advancement of Science, a research was characterized as basic in nature (SILVEIRA; CÓRDOVA, 2009). As for the approach, it was configured as quali-quantitative, since the numerical results of the survey were complemented by qualitative results (PEREIRA et al., 2018).

2.1 Study area

The Chapada do Araripe is a plateau located within the Caatinga (Seasonally Dry Tropical Forest) domain in the Brazilian Northeast, more precisely between the states of Ceará, Pernambuco and Piauí, and covers 38 municipalities, 15 in Ceará, 12 in Pernambuco and 11 in Piauí (Siebra *et al.* 2011; Novaes & Laurindo 2014). According to Loiola *et al.* 2015 the Cerrado occurs in the eastern area of the top of the plateau, being recognized as a semi-deciduous Savannah vegetation, with soils classified as aluminized leachate. It has a BSw'h' type climate, characteristic of a Hot and semi-arid climate (köeppen 1948) with annual average precipitation around 760 mm and average annual temperature of 24.1ºC (Costa *et al*., 2004).

The study was developed between October 2016 and December 2017 in a Cerrado area, occurring in the Chapada do Araripe, in the municipality of Crato-CE, Ceará, Northeast of Brazil, located at coordinates 7º20' S; 33º27' W at 900 m of altitude. For the floristic survey, two trails were selected, one in the Minguiriba locality (7°17'20,76" S and 39°32'19,59" W) where Line 1 (L1) was allocated, and the other in the Barreiro Novo locality, where this was fragmented into two areas, the first termed as Barreiro Novo 1 (7°17'20,48" S and 39º32'18,53" W) and the second termed as Barreiro Novo 2 (7°17'20,48" S and 39º30'1.79" W), where Line 2 (L2) and Line (3) were allocated, respectively.

2.2 Floristic composition

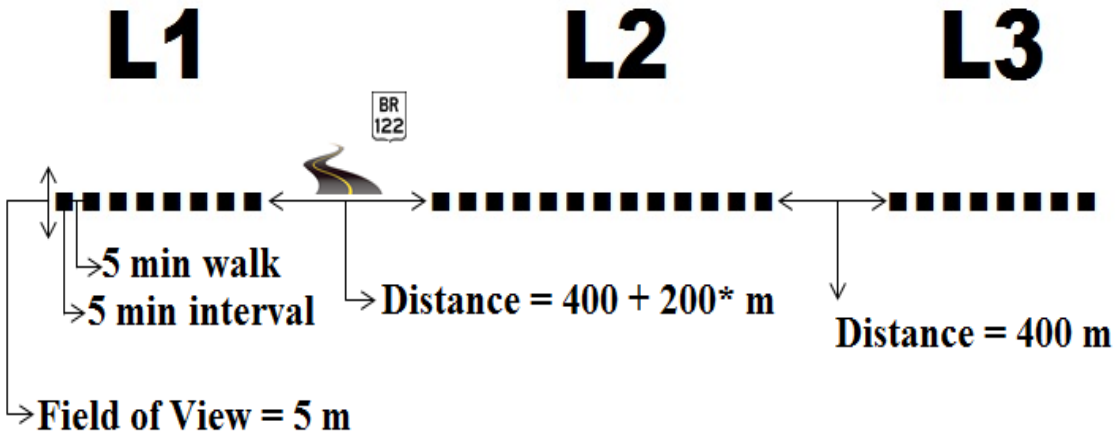
2.2.1 Transect allocation, collection and identification of botanical material

For the species listing, the Rapid Survey (RS) method developed by Ratter *et al.* 2001 and improved by Walter and Guarino 2006 with a quantitative-qualitative approach was used.

The RS was applied in three walking lines, called "Line 1" (L1), "Line 2" (L2) and "Line 3" (L3) where new species were recorded at each five minutes interval. This process continued until no new species were found, with the aim of detailing a construction data of the species × time curve. The three walking lines were distanced roughly 400 m from each other. The field of vision for each side of the walking line was arbitrated as up to 5 m, allowing better species visualization. Since L1 and L2 were separated by the BR-122 (a motorway), 100 m either side of the border were taken into account of the inside fragment in

order to minimize its possible impacts (Figure 1). Whilst RS is a method of immediate data collection, bi-monthly and/or monthly visits to the field were necessary since it was not possible to allocate all transects in a single day and not all plant species were in the reproductive period at the same time (Schierolz 1991, Alves-junior *et al.* 2006).

Figure 1. Allocation of walking lines in a Cerrado area in the municipality of Crato-CE.



Legend: Line 1 (L1), Line 2 (L2), Line 3 (L3), *metres taken into account to minimise possible border effects. Source: Authors

All species were initially identified by their popular name with the help of a guide. As floristic studies carried out in the Cerrado are restricted to arboreal and shrub strata, with the herbaceous and sub-shrub being commonly neglected (Assert *et al.* 2011), this study chose to collect all species that presented reproductive material in the studied period, regardless of their habit. The collected species were structurally classified according to the Brazilian Institute of Geography and Statistics (2012) as herbaceous, sub-shrub, shrub, tree, hemiparasite, climbing liana and climbing herbaceous.

The collected plant species were herborized following procedures described by (Mori *et al.* 1989) and later identified by comparison with previously identified specimens, specialized bibliography and submission to specialists. Families were identified according to Angiosperm Phylogeny Group IV (2016). For the correct spelling of the scientific names the List of Species from the Brazil Flora (2018) and The plant List (2013) were consulted.

Authorization for botanical material collection was provided by the System of Authorization and Information on Biodiversity (SISBIO) of the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), registered under number 57216-1.

All collected species were incorporated into the collection at the Caririense Dárdano de Andrade-Lima Herbarium (HCDAL) of the Regional University of Cariri (URCA).

2.2.2 Classification and conservation status of the studied plant species

Classification of species' conservation status followed recommendations of the Brazilian Institute of Geography and Statistics (2012) and the criteria adopted by Morellato & Leitão-Filho 1992, with adaptations, where species found along the walking lines were categorized into: Rare (species rarely found on walking lines, restricted to a single line) (<5 individuals); Occasional (species sporadically found on walking lines) (>5 up to 20 individuals); Frequent (species often found on two or all walking lines) (>20 up to 100 individuals); and Abundant (predominant species in all walking lines) (>100 individuals).

To verify the conservation status of the species, two databases were consulted: the IUCN Red List of Threatened Species (2017) and the List of Species from the Brazil Flora 2020 (2018).

2.3 Fruit collection and characterization of dispersion syndromes

Five to ten fruits from each species were collected (immature and mature). These were analyzed morphologically and structurally, according to the methodology proposed by Domingues *et al.* (2013). The fruits were previously classified according to their characteristics in the categories: Artrocarpic; Follicular; Nucoid; Samaroid; Bacoid; Drupoid; Schizocarpic and Capsular, followed by their subtypes, as recommended by Barroso *et al.* (1999).

Diaspora dispersal syndromes were classified, taking into account the morphological analysis of fruits and seeds, specialized literature and direct observation in the field, and were grouped according to Pilj (1972) in the following categories: I - Anemocoria: when the diaspores present morphological adaptations for wind dispersal, such as wings, feathers or winged appendages; II- Zoocoria: when the diaspores present attractive structure and/or food source, allowing their dispersion by animals; III - Autocoria, when the diaspores did not fit into the anemocoria or zoocoria categories, spreading through diaspores with explosive dehiscence (ballistic) or by the action of gravity (barocoria).

2.4 Statistical analysis

Statistical analysis of the data and graphical representation of the results were performed using the Paleontology Analysis Statistic 2.0 (PAST 2.0) and Microsoft Excel 2010 software.

Floristic similarity between the walking lines was performed using Sorensen's Similarity Index (Ss) (Muller-Dombois & Ellenberg 1994), Shannon-Wiener's Diversity Index (H') (Magurran 1988) and Pielou's equability index (J') to ascertain species distribution in the studied area.

3. Results and discussion

3.1 Structure and floristic sampling

5253 individuals belonging to 103 species, distributed across 84 genera and 40 botanical families were sampled. In relation to species richness, the families which stood out were Fabaceae (13 spp.), Apocynaceae (7 spp.), Euphorbiaceae (6 spp.), Malpighiaceae (6 spp.) and Myrtaceae (6 spp.), representing 38.83% of the total species sampled (Table 1). Among the families with the greatest representativiness, Fabaceae has been evidenced as one of the species with the highest number of species in the area, as shown by other studies carried out (Costa *et al.* 2004; Souza *et al.* 2007; Loiola *et al.* 2015; Silva *et al.* 2015). According to Cordeiro (2002), species from the Fabaceae family present greater acclimatization in Cerrado regions, which can confer a greater adaptive advantage over other species. This family is also identified as the most naturally occurring in Cerrado areas of Central Brazil (Medeiros 2007; Paula *et al.* 2015; Aguiar 2018).

Of the 103 species found in the studied Cerrado area, 35 were present in all walking lines: *Anacardium occidentale*, *Annona coriacea*, *Duguetia furfuracea*, *Secondatia floribunda*, *Himatanthus drasticus*, *Hancornia speciosa*, *Mandevilla scraba*, *Caryocar coriaceum*, *Hirtella racemosa*, *Erythroxylum barbatum*, *Erythroxylum rosuliferum*, *Erythroxylum loegrenii*, *Plathymenia reticulate*, *Stryphnodendron rotundifolium*, *Byrsonima sericea*, *Bowdichia virgilioides*, *Vismia guianensis*, *Mesosphaerum suaveolens*, *Ocotea cf. odorífera*, *Lafoensia pacari*, *Chamaecrista ramosa*, *Copaifera langsdorffii*, *Miconia albicans*, *Eugenia punicifolia*, *Guapira opposita*, *Ouratea castenifolia*, *Bredemeyera brevifolia*, *Roupala montana*, *Declieuxia fruticosa*, *Cordiera rígida*, *Cordiera myrciifolia*, *Zanthoxylum*

gardneri, *Casearia grandiflora*, *Serjania lethalis* and *Matayba guianensis.*

Many of these species also presented a wide distribution in Central Plateau Cerrado areas, such as *R. montana* (Reis *et al.* 2012; Ferreira *et al.* 2017); *A. occidentale* and *C. langsdorffii* (Ferreira *et al.* 2017); *C. brasiliense* and *M. albicans* (Torres *et al.* 2017); *A. coriacea* and *H. speciosa* (Bordino *et al.* 2018); *P. reticulata* (Reis *et al.* 2012); *B. virgilioides* (Medeiros *et al.* 2007); *L. pacari* and *M. guianensis* (Lima *et al.* 2015). According to Ferreira *et al.* (2017), species with a wide distribution can be used in recovery plans in regions with similar characteristics.

The floristic similarity evaluated by Sorensen's Index showed a greater similarity between Lines 2 - 3 (71.3) while Lines 1 - 2 and 1 - 3 obtained values of 66.2 and 67.6, respectively. According to Ritter & Moro (2007), both climatic elements and geographical proximity are determining elements for floristic similarity in Cerrado areas. The Shannon Diversity Index (H') obtained was 4.03 nats/individuals-^{1}, this value being higher than other studies performed in the disjoint Cerrado in the Brazilian Northeast (Table 2). Pielou's equability obtained a value of 0.87, showing that species are relatively well distributed in the studied area. According to Rocha, Netto & Lozi (2005) the great species diversity found in the Cerrado is associated with a vast heterogeneity, since it includes several types of plant formations.

Table 1. Floristic survey and dispersion syndromes of a disjoint Cerrado area in the Chapada do Araripe, Crato-CE.

(To be Continued)

Family/specie	Popular name	H	FT	D	RS			AF	A	CS	V
					L1	L2	L3				
Anacardiaceae											
Anacardium occidentale L.	cajuí	Arb	Aquenius	Zoo	X	X	X	48	F	NE	13123
Annonaceae											
Annona coriacea Mart.	araticum	Shr	Multiple strobiliform	Zoo	X	X	X	74	F	LC	12989
Duguetia furfuracea (A.St.-Hill.) Saff.	pinha-brava	Shr	Sincarpo	Zoo	X	X	X	41	F	NE	13035
Apocynaceae											
Blepharodon manicatum (Decne.) Fontella	orquídea do cerrado/ urtiga	Clim/Herb	Folicario	Ane	X			4	R	LC	13052
Blepharodon pictum (Vahl) W.D.Stevens	burra-leiteira	Clim/ Herb	Folicario	Ane		X		3	R	NE	12991
Hancornia speciosa Gomes.	mangaba	Arb	Berry	Zoo	X	X	X	31	F	NE	13013
Himatanthus drasticus (Mart.) Plumel	janaguba	Arb	Follicle	Ane	X	X	X	146	A	NE	13034
Secondatia floribunda A. DC.	catuaba-de-cipó	Clim/ Lia	Folicario	Ane	X	X	X	76	F	NE	13033
Mandevilla scabra (Hoffmans ex Roem. Et. schult.) K. Schum	salsa-parreira-amarela	Clim/Lia	Folicario	Ane	X	X	X	22	F	NE	13241
Temnadenia violacea (Vell.) Miers	salsa-parreira-roxa	Clim/Lia	Capsule septicide	Ane	X		X	10	O	LC	12998
Asteraceae											
Baccharis cinera DC.	mufumbim	Subshr	Cipsela	Ane			X	5	R	NE	13168
Dasyphyllum sprengelianum (Gardener) Cabreira	bico-de-garrincha	Shr	Cipsela	Ane	X		X	30	F	NE	13041
Eremanthus arboreus (Gardener) Maedeish	candeia	Shr	Cipsela	Ane			X	6	O	NE	13110
Lepidaploa remotiflora (Rich.) H.Rob.	balaio de velho	Herb	Cipsela	Ane		X	X	20	O	NE	13042
Moquiniastrum blanchetianum (DC.) G. Sancho	candeeiro-branco	Shr	Cipsela	Ane			X	92	F	NE	13109
Boraginaceae											
Cordia rufescens A. DC.	uva-brava	Shr	Drupe	Zoo	X	X		9	O	NE	13104
Myriopus salzmanii (DC.) Diane & Hilger	crista de galo do cerrado	Shr	Drupe	Zoo	X			4	R	NE	13379
Varronia leucomalloides (Taroda) J.S. Mill.	moleque duro	Subshr	Drupe	Zoo	X	X		15	O	NE	13046
Caryocaraceae											
Caryocar coriaceum Wittm.	pequi	Arb	Nuculanium	Aut/ Zoo	X	X	X	287	A	EN	13124

Table 1. (Continuation)

Family/specie	Popular name	H	FT	D	RS			AF	A	CS	V
					L1	L2	L3				
Chrysobalanaceae											
Hirtella ciliata Mart. & Zucc.	carrapateira	Arb	Drupe	Zoo		X	X	21	F	NE	12995
Hirtella glandulosa Spreng.	balaio-de velhodo cerrado	Herb	Drupe	Zoo	X		X	15	O	NE	13121
Hirtella racemosa Lam.	chorão	Arb	Drupe	Zoo	X	X	X	47	F	LC	13028
Convolvulaceae											
Ipomoea blanchetii Choisy	salsa-parreira-rosa	Clim/Lia	Capsule	Aut			X	3	R	NE	12992
Jacquemontia velutina Choisy	flor de anjo	Clim/Lia	Capsule	Aut		X		3	R	NE	13030
Cyperaceae											
Rhynchospora exaltata Kunth.	tiririca	Herb	Aquenius	Aut	X	X		61	F	NE	13014
Erytrhoxylaceae											
Erythroxylum barbatum O.E. Schulz	cururu	Shr	Drupe	Zoo	X	X	X	16	O	NE	13370
Erythroxylum cf. *stipulosum* Plowman	carrasquinho	Arb	Drupe	Zoo	X	X	X	11	O	NE	13377
Erythroxylum loefgrenii Diogo	carrasquinho	Subshr	Drupe	Zoo		X	X	169	A	NE	12997
Erythroxylum rosuliferum O.E.Schulz	bandeirinha	Arb	Drupe	Zoo	X	X	X	97	F	NE	13017
Euphorbiaceae											
Croton echioides Baill.	velame preto	Shr	Capsule	Zoo	X			7	O	NE	13022
Croton heliotropiifolius Kunth	velame branco	Shr	Capsule	Aut	X			42	F	NE	13024
Croton limae A.P. Gomes, M.F. Sales P.E. Berry	marmeleiro-de-vara	Shr	Globe capsule	Zoo	X			78	F	NE	13049
Croton sp.	marmelada	Subshr	Capsule	Aut		X	X	37	F	**	13376
Manihot caerulescens Pohl	maniçoba / mandioca brava	Shr	Loculicidal capsule	Aut/ Zoo	X	X		24	F	NE	13012
Maprounea guianensis Aubl.	cascudo	Arb	Drupe	Zoo	X		X	32	F	NE	13025
Fabaceae											
Bowdichia virgilioides Kunth	sucupira	Arb	Samarido legumen	Ane	X	X	X	31	F	NT	13374
Chamaecrista ramosa (Vogel) H.S.Irwin & Barneby.	orvalho de tatu	Shr	Legumen	Aut	X	X	X	12	O	NE	13115
Copaifera langsdorffii Desf.	pau-d'óleo/copaíba	Arb	Legumen	Zoo	X	X	X	266	A	LC	13047
Dalbergia miscolobium Benth.	violeta	Arb	Samarido legumen	Ane	X	X		9	O	NE	13228

Table 1. (Continuation)

Family/specie	Popular name	H	FT	D	RS			AF	A	CS	V
					L1	L2	L3				
Dimorphandra gardneriana Tul.	faveira	Arb	Nucoid legumen	Aut/ Zoo	X		X	50	F	NE	12990
Dioclea cf. *virgata* (Rich.) Amshoff	mucunã-de-estalo	Clim/Lia	Legumen	Aut		X	X	11	O	NE	12999
Mimosa sensitiva L.	maliça	Subshr	Craspedio	Aut		X		4	R	NE	13227
Parkia platycephala Benth.	visgueiro	Arb	Nucoid legumen	Aut/ Zoo		X	X	135	A	NE	13106
Plathymenia reticulata Benth. Lc/pp	amarelo	Arb	Legumen	Ane	X	X	X	18	O	NE	13004
Senna cearensis Afr. Fern.	quebra foice	Shr	Legumen	Aut	X	X		31	F	NE	13380
Senna rugosa (G.Don) H.S.Irwin & Barneby	lagarteiro	Shr			X		X	64	F	NE	13108
Stryphnodendron rotundifolium Mart.	barbatimão	Arb	Nucoid legumen	Zoo	X	X	X	154	A	NE	13002
Swartzia cf. *flaemingii* Raddi.	banha de galinha	Arb	Nucoid legumen	Aut/ Zoo	X			102	A	LC	13005
Hypericaceae											
Vismia guianensis (Aubl.) Choisy	lacre	Arb	Septífraga capsule	Zoo	X	X	X	46	F	NE	13171
Krameriaceae											
Krameria tomentosa A. St.-Hil.	carrapicho de boi	Subshr	Nucula	Zoo		X		5	R	LC	13000
Lamiaceae											
Amasonia campestris (Aubl.) Moldenke	anil	Subshr	Drupe	Zoo	X	X		9	O	NE	13024
Eriope tumidicaulis Harley	canela de ema	Herb	Schizocarpo	Aut		X		3	R	NE	13050
Hypenia salzmannii (Benth.) Harley	cidreira brava	Herb	Schizocarpo	Aut	X	X	X	21	F	NE	13172
Lauraceae											
Cassytha filiformis L.	bolinha	Hemipar	Nucula	Zoo		X		5	R	NE	13111
Ocotea fasciculata (Nees) Mez	louro cheiroso	Arb	Berry	Zoo	X	X	X	166	A	NE	13105
Ocotea nitida (Meisn.) Rohwer	louro preto	Arb	Berry	Zoo		X	X	110	A	NE	13001
Loganiaceae											
Strychnos parvifolia A.DC.	buril	Arb	Berry	Zoo			X	9	O	NE	13045
Loranthaceae											
Struthanthus flexicaulis (Mart.) Mart.	estreico de passarinho	Hemipar	Berry	Zoo	X		X	7	O	NE	13023
Lythraceae											
Lafoensia pacari A. St. Hill	romã	Arb	Capsule	Ane	X	X	X	40	F	LC	13225

Table 1. (Continuation)

Family/specie	Popular name	H	FT	D	RS			AF	A	CS	V
					L1	L2	L3				
Malpighiaceae											
Banisteriopsis malifolia (Ness & Mart.) B. Gates	orelha de rato	Clim/Lia	Samara	Ane	X			17	O	NE	13003
Banisteriopsis muricata (Cav.) Cuatrec.	orelha de rato do cerrado	Subshr	Samara	Ane	X	X		20	O	NE	13051
Banisteriopsis sp.	orelha de rato 2	Subshr	Samara	Ane	X	X		24	F	**	13051
Byrsonima gardneriana A. Juss.	murici de carrasco	Arb	Drupe	Zoo		X	X	31	F	NE	13009
Byrsonima sericea DC.	murici branco	Arb	Drupe	Zoo	X	X	X	19	O	NE	13027
Byrsonima verbascifolia (L.) DC.	murici branco	Arb	Drupe	Zoo		X		10	O	NE	13117
Malvaceae											
Melochia betonicifolia A.St.-Hil.	marmeleiro de carrasco	Subshr	Loculicidal capsule	Aut	X			10	O	NE	13007
Melastomataceae											
Miconia albicans (Sw.)Triana	candeeiro-de-pelo	Shr	Berry	Zoo	X	X	X	296	A	NE	13122
Myrtaceae											
Eugenia punicifolia (Kunth) DC.	murta	Arb	Berry	Zoo	X	X	X	73	F	NE	13016
Eugenia sonderiana O. Berg.	batinga	Arb	Berry	Zoo			X	14	O	NE	13120
Myrcia sp.	murta	Arb	Berry	Zoo	X	X		23	F	**	13103
Myrciaria cf. *tenella* (DC.) O. Berg	cambuí verdadeiro	Arb	Drupe	Zoo		X	X	121	A	DD	13166
Psidium myrsinites DC.	araçá de cerrado	Arb	Berry	Zoo		X	X	50	F	NE	12994
Psidium myrtoides O.Berg.	araçá	Arb	Berry	Zoo	X		X	41	F	NE	13043
Nyctaginaceae											
Guapira graciliflora (Mart. ex Schmidt) Lundell	pau-piranha	Arb	Nucula	Zoo	X	X	X	14	O	NE	13371
Ochnaceae											
Ouratea castaneifolia (DC.) Engl.	louro-amarelo	Shr	Multiply Free	Zoo	X	X	X	26	F	NE	13038
Olacaceae											
Ximenia americana L.	ameixa	Shr	Drupe	Zoo	X			64	F	NE	13375
Passifloraceae											
Piriqueta sidifolia (Cambess.) Urb. var. *multiflora* Urb.	marmeleiro	Subshr	Capsule	Zoo	X			2	R	NE	13048
Turnera melochioides Cambess.	vassourinha amarela	Herb	Capsule	Zoo	X	X		22	F	NE	13170
Poaceae											
Aristida longifolia Trin.	capim agreste	Herb	Cariopse	Zoo	X		X	172	A	NE	13029

Table 1. (Continuation)

Family/specie	Popular name	H	FT	D	RS			AF	A	CS	V
					L1	L2	L3				
Axonopus polydactylus (Steud.) Dedecca	capim touceira/mata fome	Herb	Cariopse	Zoo	X		X	90	F	NE	13031
Streptostachys asperifolia Desv.	capim quinsé	Herb	Cariopse	Zoo	X		X	41	F	NE	13020
Polygalaceae											
Bredemeyera brevifolia (Benth.) Klotzsch ex A.W.Benn.	manacá	Arb	Loculicidal capsule	Zoo	X	X	X	45	F	NE	13101
Polygala paniculata L.	vick	Herb	Capsule	Aut		X		7	O	NE	13053
Securidaca lanceolata A.St.-Hil. & Moq.	caninana	Clim/Lia	Samara	Ane		X	X	42	F	NE	13116
Proteaceae											
Roupala montana Aubl.	congonha	Arb	Follicle	Ane	X	X	X	51	F	NE	13373
Rhamnaceae											
Colubrina cordifolia Raissek.	guaxumbo	Arb	Schizocarpo	Aut	X	X		7	O	NE	13173
Rubiaceae											
Borreria verticillata (L.) G. Mey.	vassourinha de botão	Herb	Capsule septicide	Aut		X		10	O	NE	13039
Cordiera myrciifolia (K. Schum.) C.H. Perss. & Delprete	bola/ café bravo	Arb	Berry	Zoo	X	X	X	352	A	NE	13102
Cordiera rigida (K.Schum.) Kuntze	bola	Shr	Berry	Zoo	X	X	X	156	A	NE	12996
Declieuxia fruticosa (Willd. ex Roem. & Schult) Kuntze	alecrim campestre	Shr	Drupe	Zoo	X	X	X	11	O	NE	12993
Tocoyena formosa (Cham e Schltdl) K.S. Schum	jenipapinho	Arb	Berry	Zoo		X	X	19	O	NE	13011
Rutaceae											
Zanthoxylum gardneri Engl.	laranjinha	Arb	Follicle	Zoo	X	X	X	42	F	NE	13119
Salicaceae											
Casearia grandiflora Cambess.	touceira	Arb	Capsule	Zoo	X	X	X	141	A	NE	13015
Casearia javitensis Kunth	mutamba brava	Arb	Capsule	Zoo		X		21	F	NE	13224
Sapindaceae											
Matayba guianensis Aubl.	pitomba-brava	Arb	Loculicidal capsule	Zoo	X	X	X	112	A	NE	13008
Serjania lethalis A.St.-Hil.	cipó-uva	Clim/Lia	Samara	Ane	X	X	X	16	O	NE	13037
Sapotaceae											
Chrysophyllum arenarium Allemão	grão-de-galo	Arb	Berry	Zoo	X		X	48	F	LC	13010

Table 1. (Continuation)

Family/specie	Popular name	H	FT	D	RS			AF	A	CS	V
					L1	L2	L3				
Simaroubaceae											
Simarouba amara Aubl.	praíba	Arb	Drupe	Zoo	X		X	36	F	NE	13036
Similacaceae											
Smilax japicanga Griseb	japecanga	Clim/Lia	Berry	Zoo	X	X		8	O	NT	13229
Verbenaceae											
Lippia grata Schauer	alecrim de carrasco	Subshr	Schizocarpo	Aut		X	X	11	O	NE	13032
Lippia origanoides Kunth	alecrim de cheiro	Subshr	Schizocarpo	Aut	X		X	6	O	NE	13044
Stachytarpheta cf. *crassifolia* Schrad.	hortelã-bravo	Subshr	Schizocarpo	Aut		X	X	23	F	NE	13018
Vochysiaceae											
Qualea parviflora Mart.	pau-terra	Arb	Loculicidal capsule	Ane		X	X	15	O	NE	13100
TOTAL								5253			

Legend: Habitat (H), Arboreal (Arb), Shrub (Shr), Subshrub (Subshr), Climber (Clim), Liana (Lia), Herbaceous (Herb), Hemiparasite (Hemipar), Rapid Survey (LR), Line 1 (L1), Line 2 (L2), Line 3 (L3), Absolute Frequency (FA), Abundance (A), Rare (R), Occasional (O), Frequent (F), Abundant (A), conservation state (CS), Not Evaluated (NE), Least Concern (LC) Data deficiency (DD), Danger of extinction (EN), Near threatened (NT), ** (Taxon at the genera level), Voucher (V), Fruit type (TF), Dispersion (D), Anemocoria (Ane), Zoocoria (Zoo), autocoria (Aut). Source: Authors.

Table 2. Comparison of the Shannon-Wiener diversity index inthe disjoint Cerrado of the Chapada do Araripe with other disjoint Cerrado areas of the Brazilian Northeast.

Study/Location	Altitude	Annual or monthly* precipitation	Nº species	Shannon-Wiener
This study	900 m	760 mm	103	4.03
Mesquita and Castro (2007) /PE	200m	7-22 mm*	92	3.42
Silva, Figueiredo and Andrade (2008)/MA	-	-	69	3.31
Moro, Castro and Araújo (2011)	16m	1338 mm	151	2.64
Costa; Araújo (2007)/CE	900 m	760 mm	43	2.88

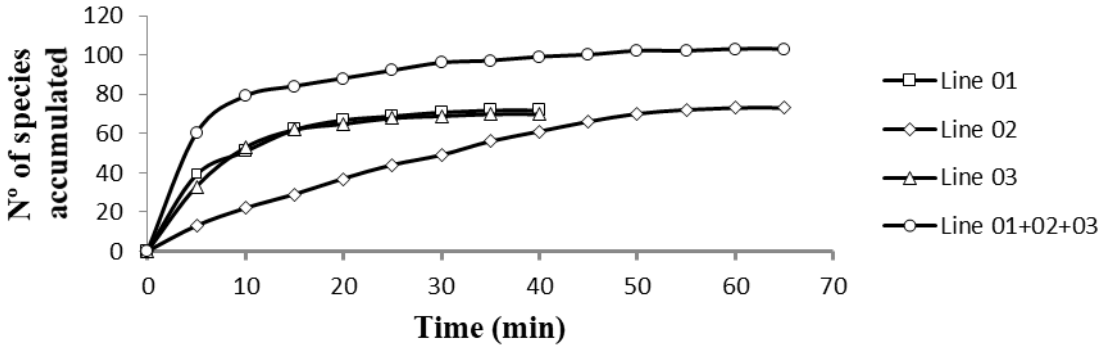
Legend: Note that altitude, annual precipitation and number of species data were used to compare the Shannon-Wiener index with studies carried out in other areas of the Cerrado of Brazil. Source: Authors.

As for the vegetation structure, the arboreal component stood out with 42.72% of the species, followed by shrub (19.42%), subbranch (13.59%), herbaceous (10.68%), climbing liana (9.71%), climbing herbaceous (1.94%) and hemiparasites (1.94%). These results corroborate with the study by Silva, *et al.* (2015) carried out in the Chapada do Araripe and Andrella & José Neto (2017) in the nuclear Cerrado area where the arboreal habit was the most abundant, results which differ from those recorded by Costa & Araújo (2007) in a study carried out in a disjoint Cerrado area and of studies carried out in core Cerrado areas with a higher proportion of individuals belonging to the shrub stratum (Oliveira, Resende & Schleder 2014; Lima, Rando & Barreto 2015).

In L1 a significant increase in the accumulated species/time curve from the 1 - 5 min interval up to the 3 - 5 min interval was observed (Figure 1), with no new species being observed in the 8-5 min interval. It took 40 min and 736 m to find 72 species. L2 obtained a significant increase in new species during the 1 - 5 min interval up to the 5 - 5 min interval, with 65 min and 761 ms being necessary to find 73 species in that line, which represented the largest number of species among the three studied lines. It was also observed that L2 obtained a greater species dispersion along the intervals, a consequence attributed to a possible border effect, since the distance taken into account to soften this effect in the area may not have been sufficient (Figure 2). According to Laurance & Vasconcelos (2009) and Calegare *et al.* (2010) the closer you are to the forest fragment edge the greater the rate of species loss and the greater the change in floristic composition occurs. In this same line a greater variation in the

number of meters traveled per time interval was observed, this difference being possibly due to a narrowing of the trail, making it difficult to see and differentiate the species in the area. In L3, a gradual increase in the number of species was observed between the 1 - 5 min interval up to the 3 - 5 min interval, where in total 70 species were found in 40 min and 1030 m (Table 3).

Figure 2. Species x time curve obtained in the Rapid survey conducted in a Cerrado area, Chapada do Araripe, Crato-CE.



Legend: The top three lines show the accumulated number of species for each walking interval, while the bottom line shows the combination of new species accumulated in the three studied intervals.
Source: Authors.

The sum of the three walking lines (L1+L2+L3) (Table 3) indicates the plant community is rather uniform in floristic composition. The species/time curve indicates sample adequacy since stability was achieved for all walking lines. The significance of the sampling is paramount for the real knowledge regarding plant richness of the studied area (Amaral *et al.* 2000). The species distribution by area was similar to Cerrado areas from the Federal District sampled by the same method (Walter & Guarino 2006).

Table 3. New species sampled using a Rapid Survey in a Cerrado area in the Chapada do Araripe, Crato-CE.

TI	L1		L2		L3		L1 + L2 + L3	
(min)	MT	NNS	MT	NNS	MT	NNS	AMT	NSA
5	68	39	28	13	66	33	54	60
10	61	12	30	9	78	20	56	19
15	64	11	31	7	97	9	64	5
20	89	5	25	8	149	3	88	4
25	100	2	24	7	143	3	89	4
30	102	2	31	5	164	1	99	4
35	118	1	27	7	153	1	99	1
40	134	0	35	5	180	0	116	2
45	-	-	38	5	-	-	13	1
50	-	-	89	4	-	-	30	2
55	-	-	91	2	-	-	30	0
60	-	-	159	1	-	-	53	1
65	-	-	153	0	-	-	51	0
Total	736	72	761	73	1030	70	842	103

Legend: Time Interval (TI), Metres Traveled (MT), Number of New Species (NNS), Average Metres Traveled (AMT) and New Species Accumulation (NSA). Source: Authors.

As registered in Flora do Brasil 2020 (2018) all sampled species are of native origin and 42 species are endemic to Brazil *Axonopus polydactylus, Baccharis cinera, Banisteriopsis malifolia, Blepharodon manicatum, Bredemeyera brevifolia, Byrsonima gardneriana, Caryocar coriaceum, Chrysophyllum arenarium, Colubrina cordifolia, Cordia rufescens, Cordiera rígida, Croton echioides, Croton limae, Dalbergia miscolobium, Dasyphyllum sprengelianum, Eremanthus arboreus, Eriope tumidicaulis, Erythroxylum barbatum, Erythroxylum cf. stipulosum, Erythroxylum loefgrenii, Erythroxylum rosuliferum, Eugenia punicifolia, Eugenia sonderiana, Guapira graciliflora, Himatanthus drasticus, Ipomoea blanchetii, Melochia betonicifolia, Moquiniastrum blanchetianum, Ocotea nítida, Parkia platycephala, Piriqueta sidifolia, Psidium myrsinites, Psidium myrtoides, Securidaca lanceolata, Senna cearenses, Smilax japicanga, Stachytarpheta cf. crassifólia, Strychnos parvifolia, Swartzia cf. flaemingii, Temnadenia violacea, Varronia leucomalloides, Zanthoxylum gardneri*, of these *Varronia leucomalloides*, *C. coriaceum, E. rosuliferum, C. limae, C. cordifolia* and *S. cearensis* occur only in the Northeast states where *E. arboreus* displays a restricted distribution only for the state of Ceará.

Based on data from Flora do Brasil 2020 (2018), three new plant species occurrences were observed for the state of Ceará (Table 4).

Table 4. Relationship of species occurring in the Cerrado area in the Chapada do Araripe, Crato-CE municipality, which constitute new records for the List of Brazilian Flora Species (2018).

Family/ Scientific name	Species scope in Brazil (Flora do Brasil 2020 (2018)	Scope of new record
Lamiaceae		
Eriope tumidicaulis Harley	BA, MG	Crato-CE
Myrtaceae		
Myrciaria cf. *tenella* (DC.) O. Berg	BA, MA, MG, PA, RJ, SP and Southern region	Crato-CE
Verbenaceae		
Stachytarpheta cf. *crassifolia* Schrad.	BA, MG	Crato-CE

Legend: Bahia (BA), Ceará (CE), Maranhão (MA), Mato Grosso (MG), Minas Gerais (MG), Rio de Janeiro (RJ), São Paulo (SP). Source: Authors.

3.2 Species conservation status

With regards to the species abundance classification in the conservation status for the studied areas, 41.75% of the species were classified as frequent, 32.04% as occasional, 15.53% as abundant and 10.68% as rare. For the Cerrado area, *stricto sensu*, Oliveira *et al.* (2015) also recorded vegetation characterized by the presence of few dominant and rare species, results differing from Carvalho & Marques-Alves (2008), which among 46 species studied in a Cerrado area *stricto sensu*, 11 were classified as rare.

Among the most abundant species in the area *Cordiera myrciifolia*, *Miconia albicans*, *Caryocar coriaceum* and *Copaifera langsdorffii* are found with 352, 296, 287 and 266 individuals, respectively, representing 22.8% of the total inventoried species, differing from Souza *et al.* (2007) in a Cerrado area of the Chapada do Araripe which indicate *Andira laurifolia* Benth. (265) and *Parkia platycephala* Benth. (159) as the most abundant species.

As for the rare species found in the study area, *Blepharodon pictum*, *Jacquemontia velutina*, *Ipomoea blanchetii* and *Eriope tumidicaulis*, with three individuals each, as well as *Pirita sidifolia* with only two individuals, were found. According to Aquino & Miranda (2008); Sano *et al.* (2014) and Macêdo (2015), while several factors exist to consider a species as rare, in conservation biology the most commonly used criteria are associated with a low frequency and distribution of these in their area of occurrence.

Determinants for the conservation of rare species are the same which justify those for other species, however, the extinction of these species may possibly represent an ecological imbalance in the ecosystem, which would be associated with both the factors related to its evolutionary process and the perspective of representing a potential source for the discovery

of medicinal drugs or even constitute a food source for future generations (Oliveira *et al.* 2018).

Among the abundant, frequent and occasional species a greater predominance of species with zoocoric dispersion syndrome was observed, these being 11.65%, 24.27% and 15.53%, respectively. For the other conservation statuses, 2.91% of abundant species were found to have an autocratic/zoocoric dispersion and 0.97% anemocoric; 8.84% of species classified as frequent were found to be anemocoric, 6.80% autocratic and 1.94% autocratic/zoocoric; meanwhile 8.74% of species classified as occasional were anemocoric and 7.77% were autocratic. For the rare species, 3.88% presented a zoocoric dispersion, with the same percentage being observed for autocratic species, moreover it is worth mentioning that only 2.91% were classified as anemocoric. The large number of rare and occasional species with zoocoric dispersion, demonstrates the increasingly urgent need for local fauna preservation, since the elimination of frugivorous animals from the environment tends to compromise the reproduction and dynamics of several species (Almeida *et al.* 2008; Stefanello *et al.* 2010).

In the studied area, *Bowdichia virgilioides* and *Smilax japicanga* are classified as endangered while *Caryocar coriaceum* has an endangered status, which corroborates with data from IUCN (2017) and Flora do Brasil 2020 (2018). These species were classified in the studied area as frequent, occasional and abundant, respectively. It is believed the progressive disappearance of these species in nature can be attributed not only to their own evolutionary processes, but to anthropic factors since they have food value, medicinal properties, ornamental and timber potential, which have been affected by predatory extractivism, without the competent bodies having a future concern for their preservation (Ribeiro & Rodrigues 2006). In addition, Machado *et al.* (2004); Klink & Machado (2005) point out that other factors such as loss of habitat and poor soil management are preponderant for the extinction of plant species in the Cerrado.

3.3 Dispersion syndromes and fruit characterization

Of the 103 described species, 56.31% were classified as zoocoric, 21.35% as anemocoric, 17.45% as autocoric and 4.85% as autocoric/zoocoric. In studies carried out in nuclear Cerrado areas by Silva & Rodal (2009); Reis *et al.* (2012); Oliveira *et al.* (2015); Rios & Souza-Silva (2017), zoocoria was the most representative dispersion mode, followed by anemocoria, which corroborates with the present research. However, a discordance with

Costa, Araújo & Lima-Verde (2004) and Silva *et al.* (2015) exists in studies carried out in Cerrado areas in the Chapada do Araripe in the municipalities of Barbalha and Nova Olinda, which, despite having a relative proximity to the site of this study, registered zoocoria followed by autocoria and anemocoria as the prevailing dispersion methods.

The dispersal of diaspores by animals is of great adaptive advantage for several plant species since this relation allows them to be carried away from the mother plant, and the animals can deposit them in favorable places for their germination (leal 2003). Dispersal by anemocoria is restricted to a few families, which confirms the advanced succession stage of the studied areas, since according to Liebsch &Acra (2007) this syndrome is associated with open areas with a predominance for pioneer species, as this structure favors the passage of the wind and consequent diaspore dispersion. Although the proportion of autocoric species has been shown to be low for the study, it has been characterized as one of the largest ever found in Cerrado areas, which may be related to a local pattern.

The zoocoria was predominant for the arboreal (32.35%), shrub (10.78%), subarbustive (6.96%) and hemiparasite (1.9%) components, however in the climbing and herbaceous components autocoria (10.78%) and anemocoria (7.84%) prevailed. Results which corroborate with studies carried out in central Cerrado areas by Asunción; Gugliere-Carporal; Sartori (2011); Oliveira; Resende; Schleder (2014); Oliveira *et al.* (2015); Ferreira *et al.* (2017); Rocha *et al.* (2017); Bonfim (2018) and in disjoint Cerrado areas in the Chapada do Araripe by Costa *et al.* (2004).

Harms *et al.* (2000) and Jordano & Godoy (2002) observed dispersal patterns by animals with seed accumulation at specific points, while much of the study area was not affected by dissemination, contrasting with generally more uniform anemocoric species patterns. Seed distribution is spatially heterogeneous due to animal behavior, which can cause deposits in preferred sites, such as burrows and nests, or in routine paths of passage (Schupp *et al.* 2002). For zoocoric species, the distance achieved should be more important than the possible advantages that could be provided by a spatially more uniform dispersion, since there would be less intraspecific competition.

For Silva, Assad & Evangelista (2008) the representative percentage of anemocoric species in Cerrado formations may be a consequence of the strong seasonality of this vegetation, which presents a well defined dry season, allowing the occurrence of abiotic dispersion.

As for fruit types, 23 were identified for the 103 sampled species. Those characterized as drupe obtained a greater number of occurrences (18.45%), followed by berry representing

14.56% and capsule (10.68%). The remaining fruit types obtained the following percentages: schizocarp and sambara (5.83%), legume, cipsela and loculative capsule (4.85%), follicle, leaflet and nucoid legume (3.88%), nucleus and cariopse (2.91%), septicidal capsule, samaroid and achene legume (1.94%), camponamesoid, globose capsule, craspedium, multiple strobiliform, free multiple, nuculanium and sincarpo (0.97%), together represented 53.41 % of the total.

The drupa and loculative capsule types were identified as the most recurrent in a central Cerrado area by Stefanello, Fernandes-Bulhão & Martins (2009) and in the Perennial Seasonal Forest located in the municipality of Querência-MT by Stefanello *et al.* (2010). The large proportion of these fruit types in the studied area may be related to dispersion patterns in the studied Cerrado area.

4. Final Considerations

The Fabaceae, Euphorbiaceae, Malpighiaceae, Apocynaceae, Myrtaceae and Rubiaceae families showed a greater number of species richness in the Cerrado area studied. With regards to species dominance *Cordiera myrciifolia* (“bola”/“café bravo”), *Miconia albicans* (“candeeiro-de-pelo”), *Caryocar coriaceum* (pequi) and *Copaifera langsdorffii* (“pau d´óleo”) stand out.

The studied vegetation has a higher occurrence of arboreal and shrub species, respectively.

Most of the species occurring in the transects are considered frequent when they are classified according to their conservation status. Moreover, rare species highlighted due to their low density were: *Blepharodon pictum, Jacquemontia velutina, Ipomoea blanchetii, Eriope tumidicaulis*, with three individuals each, and *Piriqueta sidifolia* with only two individuals. In this study the presence of three new species for the state of Ceará were verified: *Eriope tumidicaulis*, *Myrciaria* cf. *tenella* and *Stachytarpheta* cf. *crassifolia.*

The predominant dispersion syndrome among the studied species is zoocoria, followed by anemocoria and autocoria. Zoocoria was the most frequent among arboreal and shrub strata, which may be related to the drupa and berry fruits types, which were predominant among the identified species. In this way, the natural regeneration of forests is highly dependent on the fauna, evidencing that it must be protected for the maintenance of existing ecological processes, such as the propagation of propagules.

Considering the high number of endemic species that occur in the studied Cerrado

area and the species that are in danger of being extinct in nature, this study is hoped to serve as a subsidy for conservation programs in order to aid a greater local preservation.

Considering the high number of endemic species that occur in the studied Cerrado area and the species that are at risk of extinction in the wild, it is hoped that this study will serve as a subsidy for conservation programs in order to help greater local preservation.

Thus, it is necessary to carry out further studies that can identify as local fauna species responsible for the spread of propagules, a better end to the interspecific ecological processes occurring in the Araripe National Forest-Apodi.

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