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Biological spectrum and dispersal syndromes in an area of the semi-arid region of north-eastern Brazil

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ABSTRACT. The biological spectrum and diaspores dispersal syndromes of the species recorded in a stretch of vegetation in a semi-arid region within the Cariri Environment Protection Area, Boa Vista, Paraíba State (northeast) Brazil, are described. Collections were made from fertile specimens, preferentially bearing fruit, over a 15-month period. Life forms and syndromes were determined by field observations using specialized literature. One hundred and sixty-six species, distributed into 123 genera and 41 families, were reported. Abiotic syndromes (autochory and anemochory) represented 69.7% of all syndromes identified, whilst 30.3% of the species were classified as zoochory. In the life form spectrum therophytes represented 27.7% of species, followed by small- and medium-sized phanerophytes (23.5%) and chamaephytes (22.3%). The occurrence of hemicryptophytes (9%), cryptophytes (0.6%) and species that could not be classified according to their life forms was also recorded (16.9%). Results showed that the biological spectrum and the dispersal syndromes are highly relevant to understand the structure and function of this phytocenose, with subsidies for the development of other studies in the semi-arid areas of northeastern Brazil.

Keywords: *Caatinga*, disperser, diaspores, life forms.

Espectro biológico e síndromes de dispersão em uma área do semiárido do nordeste brasileiro

RESUMO. O presente trabalho objetivou descrever o espectro biológico e as síndromes de dispersão dos diásporos das espécies registradas em um trecho de vegetação do semiárido do nordeste brasileiro dentro da Área de Proteção Ambiental do Cariri, Boa Vista, estado da Paraíba, nordeste do Brasil. Durante 15 meses foram realizadas coletas de espécimes férteis, contendo frutos quando possível. As formas de vida e síndromes foram determinadas por meio de observações em campo e auxílio de literatura especializada. Foram encontradas 166 espécies distribuídas em 123 gêneros e 41 famílias. As síndromes abióticas (autocoria e anemocoria) representam 69,7% do total das síndromes identificadas, sendo a zoocoria a estratégia adotada por 30,3% das espécies. Quanto ao espectro de formas de vida, os terófitos representam 27,7% das espécies, seguidos pelos fanerófitos de pequeno e médio porte (23,5%) e caméfitos (22,3%). Também se registra a ocorrência de hemicriptófitos (9%) e um criptófito (0,6%), além das espécies que não puderam ser classificadas quanto à forma de vida (16,9%). Ambos os resultados inferem que tanto o espectro biológico como as síndromes de dispersão são de fundamental importância para a compreensão da estrutura e função desta fitocenose, também fornecendo subsídios para o desenvolvimento de outros estudos em áreas semiáridas do nordeste brasileiro.

Palavras-chave: Caatinga, dispersores, diásporos, formas de vida.

Introduction

The strong seasonality in semi-arid regions requires that species adopt strategies for their survival during the driest periods. For instance, certain plant species adapt temporary life forms which produce vegetative buds that are protected until environmental conditions allow the development of the aerial parts (MANTOVANI; MARTINS, 1988). This close relationship between environmental conditions, prevalent life-forms and a given area has generated a system of vegetation classification based on the degree of protection of vegetative buds and their position on the plant's principal axis with regard to the substrate.

Proposed by Raunkiaer (1934), the system classifies plants according to forms used to protect their perennating buds during unfavorable seasons, and groups them into five main classes: therophytes, cryptophytes, hemicryptophytes, chamaephytes and phanerophytes, according to their different resistance strategies to environmental conditions.

Studies carried out in the *caatinga* region have demonstrated the predominance of therophytes over other life forms, at a proportion close to 40%, as underscored by Costa et al. (2006) and Porto et al. (2008). A high proportion of phanerophytes and chamaephytes, close to 30 and 15%, respectively, were also registered.

Dispersal syndromes comprise a series of morphological characters of fruit or seeds that, associated with the biology of the disperser, determines a specific mode of dispersal, which in turn is an adaptation that promotes the establishment, development and endurance of the vegetative species in a given environment (VAN DER PIJL, 1982; RENNER, 1987; VASCONCELOS et al., 2010). Fruiting and dispersal are important stages of the reproductive cycle of angiosperms, with the dispersal process being the most sensitive and critical stage in a plant life history (BAWA et al., 1989).

From an ecological viewpoint, the dispersal of diaspores is a process of great importance for plant species because it enables them to expand their area of occurrence, decreases intraspecies competition and allows increase of their genetic variability into the population (HOWE; MIRITI, 2004). Efficiency of the dispersal mode also translates into increased recruitment of seedlings, by reducing competition and predation of seeds (HOWE, 1993).

According to Van der Pijl (1982), the richness and spatial distribution of plant populations are determined by dispersal modes and the frequency the diaspores reach favorable locations for the establishment of seedlings. In this context, Terborgh et al. (2002) found that the geographic distribution patterns of species and community structures depended on interactions between the community´s biotic and abiotic components. The natural dispersal of diaspores has also an important role in the natural regeneration of plant ecosystems, enabling the re-colonization of degraded areas (DEMINICIS et al., 2009). According to Gentry (1983), information on dispersal ecology represents an important step in the understanding of the structure and function of plant communities in Neotropical forests, as well as in the restoration of degraded areas.

The frequency of different dispersal strategies is influenced by several factors, among which water availability in the environment is prominent, as observed by Silva and Rodal (2009).

Data on the dispersal syndromes in semi-arid regions of northeast Brazil have been expanded over the last decade. Since the first studies it has been observed that anemochoric species predominate in dry forests, while in humid forests zoochory is more important (HOWE; SMALLWOOD, 1982; GENTRY, 1983). This pattern was also observed in studies conducted by Barbosa et al. (2002), Griz and Machado (2001) and Griz et al. (2002).

Current study describes the floristic biological spectrum and dispersal syndromes of the flora in a conservation area (the Cariri Environment Conservation Area) in the semi-arid region of the northeastern state of Paraíba, Brazil, to verify whether the syndromes of the studied area are similar to those registered in other areas of the Brazilian northeast Caatinga region.

Material and methods

Study area

Current study was developed on the Fazenda Salambaia, a rural area in the municipality of Boa Vista, in the central region of the Borborema plateau in the northeastern state of Paraíba, Brazil. According to Köeppen and Geiger (1928), the region's climate is Bshw or semi-arid hot climate, with a 8 – 11-month dry season, an average temperature of 26°C and average annual rainfall not exceeding 600 mm (MOREIRA, 1988). The soils of the region are of the brown soil without calcium type, with dystrophic regosol areas (EMBRAPA, 2006).

The farm lies within the Cariri conservation area, specifically established to protect the scenic beauty of the region. The area comprises many rock formations where archaeological sites containing cave paintings and other records of prehistoric civilizations have been discovered. The vegetation of the studied area is characterized by sparse trees, shrubs and sappy thorny plants, or rather, predominantly dry shrub forest with xerophytic characteristics. Although it was not clear-cut in the last 20 years (according to information from a local resident), the local vegetation has been and is still impacted by goats, sheep and cattle grazing and trampling.

Field and laboratory procedures

Samples, collected every two weeks, between July 2010 and October 2011, consisted of fertile branches from individual trees, shrubs and herbaceous plants during walks through the area under analysis. After taxonomic identification, all species were classified by life form, according to a modified version (MUELLER-DOMBOIS; ELLENBERG, 1974) of Raunkiaer's (1934) classification system. So that the floristic biological spectrum of the vegetation could be determined, species were also classified according to fruit type, based on the morphological characteristics described by Van der Pijl (1982) and by Barroso et al. (1999), as well as the dispersal strategy adopted by each species, using specialized literature. The floristic list was prepared according to APG III (2009) and the species names and respective authors were verified in Forzza et al. (2014).

Following Van der Pijl (1982), the syndromes were classified into three groups: (a) zoochorous, when diaspores are dispersed by animals; for example, those with sweet flesh, and seeds with arils; species dispersed by insects, vertebrates and man are included in this group; (b) anemochorous, when the diaspores are adapted to wind dispersal, featuring structures such as feathers and wings; (c) autochorous, when the plants have their own dispersion mechanisms: seeds are either launched on the surrounding areas by any particular mechanism or they are simply released by the plant directly on the ground, or barochoric (gravity) which comprise species with explosive dispersal or dispersal by gravity.

Based on this dispersal syndrome classification, the community profile of a given area may be described according to the relative proportion of each dispersal strategy. The profile corresponds to the dispersion spectrum. However, it must be underscored that the object in current study is only the primary dispersal of diaspores. In other words, secondary events after departure from the parent plant were not observed. Following Barroso et al. (1999), a morphological classification of the fruit of the species that fruited during the period of data collection period was performed to characterize the syndromes.

Results

One hundred and sixty-six species, belonging to 123 genera and 41 families of angiosperms, were identified. Further, eight taxa were identified only at genus level and four taxa only at family level (Table 1). The richest family was Fabaceae, with 27 species recorded in this study.

Table 1. Floristic list containing fruit types, respective dispersal syndromes and life forms. Key: Fruit types. Cap = capsule; Ach = achene; Fol = follicle; Utr = utricle; Dru = drupe; Sam = samara; Cyp = cypsela; Ber = berry; Cer = ceratium; Sch= schizocarp; Leg= legume; Lom= loment; Car= caryopsis; Coc = coccarium. Dispersal syndromes types. Aut = autochory; Ane= anemochory; Zoo = zoochory. Life forms. Cha = chamaephyte; The = therophyte; Hem = hemicryptophyte; Pha = phanerophyte; Cry = cryptophyte. Collector: *E.A. Lima*.

Family/ Species	Fruit type	Dispersal syndrome	Life form	*Voucher*
Acanthaceae				
Dicliptera ciliaris Juss.	Cap	Aut	Cha	-
Ruellia asperula (Mart. & Nees) Lindau	Cap	Aut	Cha	-
Ruellia bahiensis (Nees) Morong	Cap	Aut	Cha	-
Ruellia geminiflora Kunth	Cap	Aut	Cha	72
Ruellia paniculata L.	Cap	Aut	Cha	110
Alismataceae				
Echinodorus grandiflorus (Cham. & Schltdl.) Micheli	Ach	Ane	-	75
Hydrocleys modesta Pedersen	Fol	-	-	112
Amaranthaceae				
Alternanthera brasiliana (L.) Kuntze	Utr	Ane	The	223
Alternanthera pungens Kunth	Utr	Ane	-	39
Alternanthera tenella Colla	Utr	Ane	Hem	142
Amaranthus spinosus L.	Utri	Ane	-	148
Froelichia humboldtiana (Roem. & Schult.) Seub.	Utri	Ane	-	08
Gomphrena vaga Mart.	Cap	Ane	Hem	-
Anacardiaceae				
Myracrodruon urundeuva Allemão	Dru	Ane	Pha	-
Schinopsis brasiliensis Engl.	Sam	Ane	Pha	-
Spondias tuberosa Arruda	Dru	Zoo	Pha	-
Apocynaceae				
Allamanda blanchetii A.DC.	Fol	Ane	Hem	177
Aspidosperma pyrifolium Mart.	Fol	Ane	Pha	-
Mandevilla tenuifolia (J.C. Mikan) Woodson	-	Ane	Cry	129
Araceae				
Pistia stratiotes L.	Utr	Zoo	-	140
Asteraceae				
Acanthospermum hispidum DC.	Cyp	Zoo	The	147
Acmella uliginosa (Sw.) Cass.	Cyp	Ane	The	71
Ageratum conyzoides L.	Cyp	Ane	The	187
Bidens pilosa L.	Cyp	Zoo	The	67
Centratherum punctatum Cass.	Cyp	Ane	The	155
Chrysanthellum indicum DC.	-	-	-	185
Conocliniopsis prasiifolia (DC.) R.M. King & H. Rob.	Cyp	Ane	The	69
Eclipta prostrata (L.) L.	Cyp	Ane	-	144
Emilia sonchifolia (L.) DC.	Cyp	Ane	The	-
Tilesia baccata (L.) Pruski	Dru	Zoo	-	123

continue...

Table 1. (Continued)

Family/ Species	Fruit type	Dispersal syndrome	Life form	*Voucher*
Bignoniaceae				
Handroanthus impetiginosus (Mart. ex DC.) Mattos	Cap	Zoo	Pha	131
Tabebuia aurea (Silva Manso) Benth. & Hook. f. ex S. Moore	Cap	Ane	Pha	-
Bixaceae				
Cochlospermum vitifolium (Willd.) Spreng.	Cer	Ane	Pha	121
Boraginaceae				
Euploca procumbens (Mill.) Diane & Hilger	Sch	Zoo	The	-
Heliotropium angiospermum Murray	Sch	Zoo	The	132
Varronia dardani (Taroda) J.S. Mill.	Dru	Zoo	Pha	153
Bromeliaceae				
Bromelia laciniosa Mart. ex Schult. f.	Cap	Ane	Cha	-
Encholirium spectabile Mart. ex Schult. f.	Cap	Ane	Cha	-
Neoglaziovia variegata (Arruda) Mez.	Cap	Ane	Cha	-
Tillandsia recurvata (L.) L.	Cap	Ane	Pha	26
Tillandsia streptocarpa Baker	Cap	Ane	Pha	-
Burseraceae				
Commiphora leptophloeos (Mart.) Gillet.	Dru	Zoo	Pha	-
Cactaceae				
Cereus jamacaru DC.	Ber	Zoo	Pha	-
Melocactus ernestii Vaupel	Ber	Zoo	Hem	-
Melocactus zehntneri (Britton & Rose) Luetzelb.	Ber	Zoo	Hem	-
Pilosocereus gounellei (F.A.C.Weber) Byles & G.D.Rowley	Ber	Zoo	Pha	-
Pilosocereus pachycladus F. Ritter	Ber	Zoo	Pha	-
Tacinga inamoena (K. Schum.) N.P. Taylor &Stuppy	Ber	Zoo	Cha	-
Tacinga palmadora (Britton & Rose) N.P. Taylor & Stuppy	Ber	Zoo	Cha	-
Capparaceae				
Cynophala flexuosa (L.) J. Presl	Ber	Aut	Pha	-
Physostemon guianensis (Aubl.) Malme	Cer	Aut	The	-
Physostemon lanceolata (Mart. & Zucc.) D.R. Hunt.	Cer	Aut	The	-
Tarenaya spinosa (Jacq.) Raf.	Cer	Aut	Cha	-
Commelinaceae				
Callisia filiformis (M. Martens & Galleotti) D. R. Hunt.	-	Zoo	The	33
Callisia repens L.	Cap	Aut	The	214
Commelina erecta L.	Cap	Aut	The	-
Commelina obliqua Vahl	Cap	Aut	The	-
Convolvulaceae				
Evolvulus filipes Mart.	Cap	-	The	-
Evolvulus glomeratus Nees & C. Mart.	Cap	-	The	25
Ipomoea subincana (Choisy) Meisn.	Cap	-	Cha	118
Jacquemontia multiflora Haller f.	Cap	-	-	57
Operculina macrocarpa (L.) Urb.	Cap	-	-	216
Cyperaceae				
Cyperus ligularis L.	Ach	Aut	Hem	106
Cyperus odoratus L.	Ach	-	-	113
Cyperus surinamensis Rottb.	Ach	-	Hem	194
Cyperus uncinulatus Schrad. ex Nees	Ach	-	The	90
Eleocharis elegans (Kunth) Roem. & Schult.	Ach	-	-	136
Eleocharis geniculata (L.) Roem. & Schult.	Ach	Zoo	The	-
Eleocharis interstincta (Vahl) Roem. & Schult.	Ach	-	-	137
Eragrostis ciliaris (L.) R.Br.	Ach	-	The	-
Fimbristylis cymosa R. Br.	Ach	-	Hem	139
Pycreus macrostachyos (Lam.) J. Raynal	Ach	-	The	212
Cucurbitaceae				
Momordica charantia L.	Cap	Zoo	-	-
Euphorbiacae				
Cnidoscolus quercifolius Pohl	Coc	Aut	Pha	-
Cnidoscolus urens (L.) Arthur	Cap	Aut	Cha	-
Croton blanchetianus Baill.	Coc	Aut	Pha	182
Croton heliotropiifolius Kunth	Cap	Aut	Pha	221
Jatropha mollissima (Pohl) Baill.	Sch	Aut	Pha	-
Jatropha ribifolia (Pohl) Baill.	Sch	Aut	Cha	152
Manihot catingae Ule	Sch	Aut	Cha	-
Fabaceae				
Anadenanthera colubrina (Vell.) Brenan	Fol	Aut	Pha	-
Bauhinia cheilantha (Bong.) Steud.	Leg	Aut	Pha	225
Bauhinia subclavata Benth.	Leg	-	Pha	175
Poincianella pyramidalis (Tul.) L.P. Queiroz	Leg	Aut	Pha	-
Centrosema brasilianum (L.) Benth. var. *angustifolium* Amshoff	Leg	Aut	Hem	101
Centrosema brasilianum (L.) Benth. var. *brasilianum* Benth.	Leg	Aut	Hem	231
Centrosema virginianun (L.) Benth.	Leg	Aut	-	178
Chamaecrista rotundifolia (Pers.) Greene	Leg	Aut	Hem	189
Desmodium glabrum (Mill.) DC.	Lom	Zoo	Hem	79
Dioclea grandiflora Mart. ex Benth.	Leg	Zoo	Pha	135

continue...

Table 1. (Continued)

Family/ Species	Fruit type	Dispersal syndrome	Life form	*Voucher*
Dioclea violacea Mart. ex Benth.	Leg	Zoo	-	116
Erythrina velutina Willd.	Fol	Zoo	Pha	-
Indigofera blanchettiana Benth.	Leg	-	Cha	-
Indigofera suffruticosa Mill.	Fol	Aut	Cha	227
Libidibia ferrea (Mart. ex Tul.) L.P. Queiroz	Leg	Aut	Pha	97
Mimosa tenuiflora (Willd.) Poir.	Leg	Aut	Pha	-
Piptadenia stipulacea (Benth.) Ducke	Leg	Aut	Pha	-
Poincianella pyramidalis (Tul.) L.P. Queiroz	Leg	Aut	Pha	127
Senna macranthera (DC. ex Collad.) Irwin & Barneby	Leg	Aut	Pha	-
Senna martiana (Benth.) Irwin & Barneby	Leg	Ane	Pha	180
Senna obtusifolia (L.) Irwin & Barneby	-	-	Cha	103
Senna splendida (Vogel) Irwin & Barneby	Leg	Aut	Pha	226
Stylosanthes viscosa (L.) Sw.	Lom	Zoo	-	65
Vigna adenantha (G.Mey) Marechal, Mascherpa & Stainer	Leg	-	Hem	230
Zornia gemella (Willd.) Vogel	Lom	Zoo	The	192
Zornia leptophylla (Benth.) Pittier	Lom	Zoo	The	204
Zornia myriadena Benth.	Lom	Zoo	The	29
Gentianaceae				
Schultesia pohliana Progel	Cap	Aut	The	99
Hydrocharitaceae				
Apalanthe granatensis (Bonpl.) Planch.	Cap	-	-	-
Lamiaceae				
Hyptis fruticosa Salzm. ex Benth.	Sch	Ane	The	145
Leonotis nepetifolia (L.) R.Br.	-	-	-	146
Raphiodon echinus Schauer	-	-	-	188
Loranthaceae				
Struthanthus syringifolius (Mart.) Mart.	Ber	Zoo	Pha	-
Lythraceae				
Cuphea campestres (Mart.) Koehne	Ber	Ane	The	215
Malvaceae				
Ceiba glaziovii (Kuntze) K. Schum.	Cap	Ane	Pha	-
Herissantia tiubae (K. Schum.) Brizicky	Sch	Zoo	Cha	76
Melochia pyramidata L.	Cap	Zoo	Cha	143
Melochia tomentosa L.	Cap	Ane	Cha	31
Sida galheirensis Ulbr.	Sch	Aut	Cha	32
Sida linifolia Cav.	Sch	Aut	The	228
Sidastrum paniculatum (L.) Fryxell	Sch	Aut	Cha	-
Waltheria rotundifolia Schrank.	Cap	-	Cha	229
Waltheria tomentosa H.St.-John	-	-	-	141
Molluginaceae				
Mollugo verticillata L.	Cap	-	The	170
Nyctaginaceae				
Boehravia diffusa L.	Ach	Zoo	Cha	126
Nymphaeaceae				
Nymphaea ampla (Salisb.) DC.	Cap	-	-	62
Onagraceae				
Ludwigia leptocarpa (Nutt.) Hara	Cap	Aut	The	198
Ludwigia octovalvis (Jacq.) P.H. Raven	Cap	Aut	The	-
Oxalidaceae				
Oxalis divaricata Mart. ex Zucc.	Cap	-	Cha	130
Passifloraceae				
Passiflora foetida L.	Ber	Zoo	Cha	232
Piriqueta duarteana (Cambess.) Urb.	Cap	Aut	Cha	20
Turnera subulata Sm.	Cap	Aut	Cha	233
Plantaginaceae				
Angelonia biflora Benth.	Cap	-	Hem	22
Angelonia campestres Nees & Mart.	Cap	-	-	179
Angelonia cornigera Hook.	Cap	-	The	-
Stemodia maritima L.	Cap	-	The	43
Plumbaginaceae				
Plumbago scandens L.	Cap	Aut	Cha	56
Poaceae				
Anthephora hermaphrodita (L.) Kuntze	Car	Ane	The	206
Chloris inflata Link	Car	Ane	The	210
Chloris orthonothon Döll.	Car	Ane	The	199
Dactylactenium aegyptium (L.) Willd.	Car	Ane	The	200
Digitaria eriantha Steud.	Car	Ane	The	202
Eragrostis ciliaris L.	Car	Ane	The	195
Eragrostis tenella (L.) P.Beauv. ex Roem. & Schult.	Car	Ane	The	209
Leptochloa fascicularis (Lam.) A. Gray	Car	Ane	The	211
Paspalum scutatum Nees ex Trin.	Car	Ane	The	203
Polygalaceae				
Polygala violacea Aubl.	Cap	-	The	224

continue...

Table 1. (Continued)

Family/ Species	Fruit type	Dispersal syndrome	Life form	*Voucher*
Pontederiaceae				
Eichhornia paniculata (Spreng.) Solms.	Cap	-	-	-
Heteranthera limosa (Sw.) Willd.	Cap	-	Cha	-
Heteranthera oblongifolia C. Mart. ex Roem.	Cap	-	-	134
Portulacaceae				
Portulaca elatior Mart. ex Rohrb.	Cap	Ane	The	124
Portulaca halimoides L.	Cap	Ane	Hem	125
Rhamnaceae				
Ziziphus joazeiro Mart.	Dru	Zoo	Pha	-
Rubiaceae				
Borreria verticillata (L.) G. Mey	Cap	Zoo	Cha	-
Mitracarpus frigidus (Willd. ex Roem. & Schult.) K. Schum.	Cap	Ane	Cha	98
Richardia grandiflora (Cham. & Schlecht.) Steud.	Cap	Aut	Cha	234
Sapindaceae				
Cardiospermum corindum L.	Cap	Ane	Cha	161
Serjania glabrata Kunth	Sam	Ane	Pha	222
Sapotaceae				
Syderoxylon obtusifolium (Roem. & Schult.) T.D. Penn.	Dru	Zoo	Pha	235
Solanaceae				
Nicotiana glauca Graham	Cap	Ane	Pha	36
Physalis angulata L.	Ber	Ane	Cha	54
Solanum agrarium Sendtn.	Ber	Zoo	-	-
Verbenaceae				
Lantana camara L.	Dru	Zoo	Pha	128
Lippia gracilis Schauer	Dru	Zoo	Cha	55
Stachytarpheta elatior Schrad. ex Schult.	Dru	Zoo	The	63

In terms of the floristic biological spectrum among the 166 species, therophytes (46) were predominant over other life forms, representing 27.7% of the total, whereas phanerophytes (39) and chamaephytes (37) respectively represented 23.5 and 22.3% (Figure 1). Fifteen species of hemicryptophytes have also been registered. They represent 9% of the cryptophytes species, or 0.6% of all the species recorded in the study area. The life form could not be determined in the remaining 28 species (16.9% of all recorded species).

When the dispersal modes of diaspores are taken into account (Figure 2), anemochorous is the predominant syndrome in the area, with 47 species, or 28.3% of total; followed by autochorous (43), or 25.9% of total, in which dispersal is the result of the plants' own mechanisms, such as explosive dehiscence of dry fruits or gravity. Only 39 species are zoochorous, with 23.5% of total. This factor depends on the activity of animals so that dispersal may occur within an adequate distance from the parent plant. Dispersal syndromes were not identified in 37, or 22.3% of the 166 species. This was due to the absence of fruit on the vegetative material collected which identified the type of fruit and consequently, the dispersal form adopted.

Twenty-two out of the 39 zoochorous species had fleshy fruit, such as the Cactaceae, whereas 17 species produced dry fruit, such as *Boerhavia diffusa* (Nyctaginaceae). Among the autochorous species, most had dry fruit, such as the Fabaceae species that produced legume or loment fruit types. All anemochorous species had dry fruits, featuring dispersal units (whether fruit or seeds) with tissue expansions such as wings or other structures that facilitated transport by wind, such as *Serjania glabrata* (Sapindaceae), *Schinopsis brasiliensis* (Anacardiaceae) and *Cochlospermum vitifolium* (Bixaceae).

Discussion

Results on dispersal syndromes show a predominance of abiotic vectors in dry areas and biotic vectors in more humid areas (FRANCKIE et al., 1974; HOWE; SMALLWOOD, 1982; GENTRY, 1983). According to the last author, there is a defined pattern in the frequency of dispersal syndromes where zoochory is the most frequent form in the species of Neotropical rainforests. This fact may be related to several factors, such as conditions of greater humidity and water availability in the environment, or the presence of different species of frugivorous animals, such as birds, rodents, bats and an array of invertebrate species, especially insects, that eat the fruit and disperse the seeds in the adjacent areas. In arid and semi-arid regions, the abiotic syndromes (anemochory and autochory) grow in importance, as several studies carried out on the *caatinga* have demonstrated (MACHADO et al., 1997; GRIZ; MACHADO, 2001; BARBOSA et al., 2002, 2003). In current study, the abiotic syndromes, autochory and anemochory, together represent 69.7% of the identified syndromes and corroborated the results of the previously mentioned investigations.

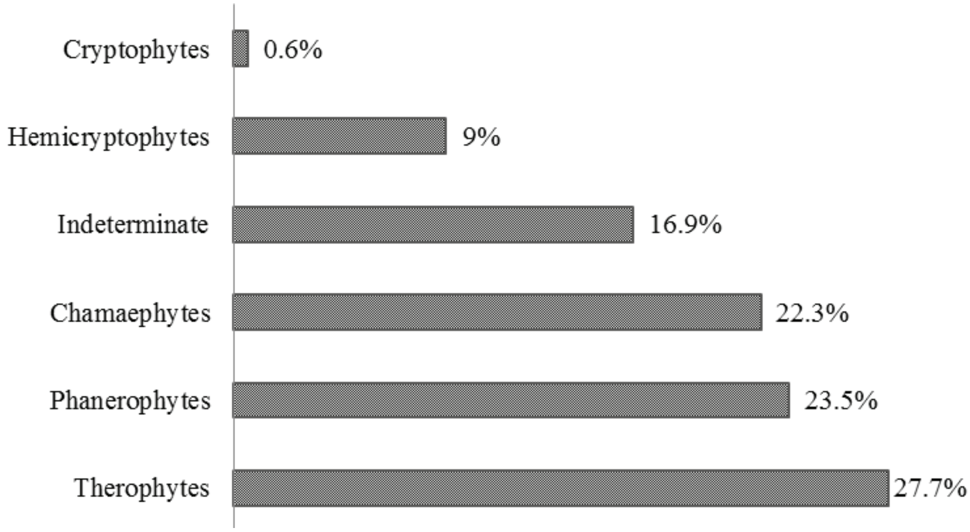

Figure 1. Percentage of life forms identified between species in the study area, *Fazenda Salambaia*, APA of Cariri, Paraíba State, Northeast, Brazil.
Source: The authors.

Figure 2. Percentage of dispersal syndromes recorded in the study area, *Fazenda Salambaia*, APA of Cariri, Paraíba State, northeast, Brazil.

The pattern of dispersal syndromes is related to a greater frequency of dry fruit (dispersed on the ground by autochory or anemochory) in drier areas with marked seasonality, already detected in the Brazilian savannah (Cerrado) and reported by Batalha and Mantovani (2000), Figueiredo (2008) and Oliveira (1998). However, another study for the Cerrado by Costa et al. (2004) underscored a predominance of zoochorous species over other dispersal modes.

There is evidence that a gradual change in the dispersal spectrum exists, from humid areas, where the predominant species have zoochorous syndromes, to drier ones, where syndromes of autochory or anemochory are more common. The above has been reported by Silva and Rodal (2009) who documented the dispersal syndromes in three areas with different rainfall levels in northeast Brazil. Vicente et al. (2005) also registered differences in the frequencies of dispersal syndromes between humid and semi-arid locations.

Barbosa et al. (2002) studied the phenology of woody species in the *caatinga* and reported the existence of a close relationship between the rainy season and the predominance of zoochorous species, whereas a higher percentage of autochorous and anemochorous species were reported in the dry season. According to Gentry (1983), differences in the amount and temporal distribution of rainfall are the most outstanding difference between wet and dry tropical forests, reflected in dispersal ecology.

In the case of the exclusive occurrence of small- and medium-sized phanerophytes in the studied area, similar data have been reported by Van Rooyen et al. (1990) for a semi-arid region in South Africa. According to these authors, the biological spectrum of species in an area indicates the survival strategy adopted by the local flora, while a high percentage of therophytes species represents an effective method for controlling water loss since the plant dies at the beginning of the dry season and avoids the water stress. Further, the seeds produced during its short life remain in the environment protected from desiccation by the seed coat and will grow when environmental conditions become favorable again, featuring an efficient escape strategy.

With regard to the life forms in the area under analysis, the therophytes form predominated and confirmed records in the literature showing the importance of this life form in the biological spectrum of other *caatinga* areas (ARAÚJO et al., 2005; RODAL et al., 2005; COSTA et al., 2006). It should be emphasized that the marked predominance of small- and medium-sized phanerophytes has been recorded in several studies on *caatinga* areas (ARAÚJO et al., 1995; ALCOFORADO-FILHO et al., 2003; FERRAZ et al., 2003).

Conclusion

Results of current investigation corroborate the few studies that address the biological spectrum and dispersal syndromes in *caatinga* areas and pointed the need for species to adopt strategies for their survival during the driest periods. It may also be inferred that both the biological spectrum and the dispersal syndromes are of fundamental importance for understanding the structure and function of this phytocenose and in particular the *caatinga* vegetation of northeast Brazil, perhaps one of the areas on the planet which is most threatened by anthropic action and yet one of the least known in terms of auto-ecology.

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