



ISSN: 2525-815X

Journal of Environmental Analysis and Progress

Journal homepage: www.jeap.ufrpe.br/

10.24221/jeap.3.4.2018.1673.396-405



Local scale variation in plant assemblage's attributes in the semi-arid region, Northeastern Brazil

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ARTICLE INFO

Received 18 Apr 2018

Accepted 08 Oct 2018

Published 17 Oct 2018

ABSTRACT

Variations in physiognomy and structure associated to abiotic factors in local scale rarely are reported for the typical vegetation of Northeastern Brazil semi-arid, Caatinga. It was tested if six adjacent biotopes with distinct altitudinal (450-690m) and pedological aspects present different woody plant attributes (structure and physiognomy). A total of 2,055 stems, 23 families, 64 species/morphospecies were recorded. Clear altitudinal or pedological local-scale gradient could not be defined along a priori defined biotopes, which hold in fact two phytocoenoses: Plateau Summit, at greatest altitude, with distinct physiognomy and exclusive taxa; and lower altitude assemblage, presenting physiognomic and structural similarity.

Keywords: Caatinga, spatial heterogeneity, structure, woody plants.

Introduction

A great portion of Tropical America, around 1.5 million of hectares, presents dry climates, including north of Venezuela and Colombia, Caribbean Islands, parts of Mexico and Guatemala and Brazilian Northeast (Diaz, 2001; DRY, 2016). Tropical dry and very dry forests and savanna occur in areas where mean annual precipitation ranges from 250 to 2000 mm and the ratio of potential evapotranspiration to precipitation is greater than one, to a maximum value of eight, using Holdridge criteria (Lugo et al., 1999; Khalyani et al., 2016).

In Northeastern Brazil, Souza et al. (1994) point out that the semi-arid area covers 788,064 km² and is characterized by scarce rainfall, irregularly distributed on time and space. Within this area, mean annual precipitation varies from 400 mm, on the driest parts (locally called "Sertão") to 800 mm on the dry and sub-humid areas ("Agreste") and mean annual temperature ranges from 23°C to 27°C, with a daily thermal amplitude of 5°C to 10°C. Mesoclimates over mountains and ridges are the only exception. Soils vary from deep, well drained and sandy, to shallow and clay, eroded and presenting intense runoff of surface water (Sampaio, 1995; Leal et al., 2003).

In extension, Caatinga vegetation is the predominant, following the limits of the semi-arid, predominantly on intermontane lowlands. This vegetation is classified as Stepic savanna according

IBGE (2012). There are 318 endemic plants (Giulietti et al., 2002) and being considered one important center of biodiversity in the Neotropics (Davis et al., 1997; Liberal et al., 2011). There are other physiognomies, from thorny deciduous scrubland to semi-deciduous forests, also including broad ecotones on the boundaries with savannah (cerrado) to the west and rain forest to the east/southeast (IBGE, 2012; Souza et al., 1994).

The Caatinga vegetation is characterized by the complete deciduousness of its components with water deficit during a considerable part of the year, varying from thorny scrubland to thorny woodland with terrestrial Cactaceae and Bromeliaceae prevailing on the landscape (Andrade-Lima, 1981). Although its floristic and physiognomic aspects have not been sufficiently studied (Rodal & Sampaio, 2002), core areas have been identified, where the most typical features of this vegetation are found, and marginal areas, where representative traits become lesser to a point that environment and plants define other vegetation type (Joly et al., 1999).

Over the last years, there has been an increase in knowledge of Caatinga biome in the core area (see Moro et al., 2016 for revision), especially covering phytogeographical aspects. Nevertheless, little is known about local variations and influence of abiotic factors on plant assemblages (Santos et al., 1992). Research at local-scale helps on the definition of the best

management techniques with minor impacts on the biodiversity.

At local scale, Rodal (1992) and Rodal et al. (2008) notes that variations in physiognomy and structure are associated to ecological systems (geomorphology, water availability and topography) within the Caatinga. Despite the influence of topography on vegetation features, Oliveira-Filho et al. (1997) observed that, along with other factors, terrain declivity produces various environmental gradients, such as in soil moist and chemical composition between summit and base of slopes.

Considering that abiotic factors control the distribution and structure of plant assemblages at local level in the Caatinga vegetation, it is expected that adjacent areas with distinct topographical features and pedological aspects present different attributes. In order to test this hypothesis, physiognomy (appearance) and structure (species abundance) of woody plants on six biotopes were studied in a protected area in the State of Pernambuco, Brazilian Northeast.

Material and Methods

Study area

The study area is the Private Reserve of the Natural Heritage (RPPN) Maurício Dantas, State of Pernambuco, Northeast Brazil, 450 km far from the State capital Recife. It occupies 1,485 ha, in the Sertaneja Depression, where the predominant lithology is composed by pre-Cambrian rocks on lowest altitudes, covered by Paleozoic sedimentary (Dantas, 1980; Brasil, 1983). Climate Köppen type is BSh'w, in which rainfall is concentrated between February and April, with a mean annual total of 604 mm, and a mean annual temperature of 27°C. Altitudes range from 490 to 545 m on the lowest levels up to 690 m on the summit of the sedimentary plateau. Based on topographical and pedological features, six different biotopes were identified: Plateau Summit (PS), 690 m; Upper Slope (US), 600 m; Lower Slope (LS), 550 m; Lowland 1 (LL1) and Lowland 2 (LL2), 500 m; and River Bank (RB), 450 m.

Sample procedures and data treatment

Seven field trips were carried out between January and July 2015. Firstly, the area was surveyed for recognition of different biotopes,

using topographic and geologic maps. In each one of the six biotopes identified, a 20 × 50 m Maximum distance between sample plots was 7 km. In each plot, all dead or live stems with diameter at soil level (DSL) equal or greater than 3 cm and height taller than 1 m were sampled, identified, and their heights and DSL were measured; lianas were not included. Multi-stemmed individuals of which a unique base could not be distinguished were considered as distinct individuals. Vouchers were deposited at the Herbarium Professor Vasconcelos Sobrinho (PEUFR) of the Universidade Federal Rural de Pernambuco (UFRPE), using APG III (2013).

Considering each biotope, relative density, and dominance (basal area) calculated for all families and species (Curtis & McIntosh, 1950), using Excel. Importance value (IV) was calculated as the sum of the two relative parameters, totaling 200%, which was then divided by two, following Gonzalez & Zak (1996). Additionally, physiognomy was assessed using density, basal area, heights and diameter for total sample in each of the six areas. It was used only descriptive statistics for not having plot repetitions in each biotope.

In order to characterize the relation between soil properties and plant assemblage structure, soil samples were taken from the center point of each plot, to a depth of 20 cm, totaling 1 kg of soil for each area for physical Soil Analyses by the Brazilian Agency for Agronomic and Cattle Raising Research (EMBRAPA, 1997).

To view differences between plant communities it was used cluster analysis (mean Euclidean distance and Ward linking method) and reciprocal average (Kent, 2012). All analyses were carried out using software PC-ORD 4.14 (McCune & Mefford, 1999).

Results

Physiognomy and structure

In 6,000 m² sampled, 2,055 stems were recorded. Approximately 78% of stems were shorter than 5 m and 74% presented less than 5 cm of diameter. Visually, greatest physiognomic differences are found between stem densities on PS and LS. These two biotopes, although presenting equivalent basal areas for plants taller than 5 m, possess very different stem densities (Table 1).

Table 1. Physiognomic parameters per biotope in Private Reserve of the Natural Heritage Maurício Dantas, Brazil. N.S. = Number of stems, B.A. = Basal area, H. = Height, D. = Diameter, MAX. = maximum, AVE, = Average. st = stem. * Plants higher than 5 m of height.

Biotope	N.S. (st. ha ⁻¹)	B.A. (m ² ha ⁻¹)	H.MAX. (m)	H.AVE. (m)	D.MAX. (cm)	D.AVE. (cm)	N.S.* (st. ha ⁻¹)	B.A.* (m ² ha ⁻¹)
Plateau Summit (690 m)	4230	23.44	8.0	4.0	27.37	7.23	102	11.2

Upper Slope (600 m)	4870	23.99	8.5	3.4	47.75	6.52	660	7.6
Lower Slope (550 m)	2690	25.41	8.5	3.3	48.70	8.63	310	12.2
Lowland 1 (500 m)	2530	18.72	6.0	3.5	39.47	8.02	30	2.1
Lowland 2 (500 m)	4340	21.79	12.0	3.1	42.34	6.62	280	7.9
River Bank (450 m)	1950	13.92	10.0	3.5	47.43	7.44	130	5.1

Twenty-three families, 61 species, plus three unknown taxa and dead plants were recorded. Greatest numbers for families (19) and species (33) were found on PS. There was no shared species

occurring in all six biotopes. Quantitative results for families and species on the six areas are listed on the Table 2.

Table 2. Families and species present in six biotopes organized according importance value. Private Reserve of the Natural Heritage Maurício Dantas, Brazil. PS = Plateau Summit, RB = River Bank, LL1 = Lowland 1, LS = Lower Slope, US= Upper Slope, and LL2 = Lowland 2.

Families/Species	PS	RB	LL1	LS	US	LL2
Fabaceae	47.61	39.52	57.22	31.75	39.41	28.85
Caesalpinioideae	23.93	19.13	50.05	23.06	30.22	23.24
<i>Caesalpinia pyramidalis</i> Tul. var. <i>diversifolia</i> Benth.	16.62	-	-	-	-	-
<i>Caesalpinia gardneriana</i> Benth.	-	10.66	47.93	15.25	14.35	21.56
<i>Bauhinia cheilantha</i> (Bong.) Steud	8.40	7.11	0.64	8.59	18.47	-
<i>Luetzelburgia auriculata</i> (Allemão) Ducke	0.90	-	-	-	-	-
<i>Bauhinia acuruana</i> Moric.	0.41	-	-	-	-	-
<i>Caesalpinia ferrea</i> Mart.	-	0.73	0.90	-	-	-
Faboideae	17.97	-	0.81	-	-	-
<i>Dalbergia cearensis</i> Ducke	16.25	-	-	-	-	-
<i>Peltogyne pauciflora</i> Benth.	0.84	-	-	-	-	-
<i>Platymiscium floribundum</i> Vogel	0.76	-	-	-	-	-
<i>Derris</i> sp.	0.51	-	-	-	-	-
<i>Amburana cearensis</i> Allemão	-	-	0.63	-	-	-
Mimosoideae	5.71	20.39	6.37	7.82	9.19	5.64
<i>Acacia</i> sp.	2.26	1.01	-	-	-	-
<i>Mimosa tenuifolia</i> L.	1.80	2.92	-	-	-	1.16
<i>Pithecellobium diversifolium</i> Benth.	0.72	-	1.54	-	-	-
<i>Acacia piauhiensis</i> Benth.	0.57	-	-	-	-	-
<i>Parapiptadenia zentheneri</i> (Harms) M. P. M. de Lima & H. C. de Lima	0.46	-	-	3.36	-	2.74
<i>Anadenanthera colubrina</i> (Vell.) Brenan	-	5.92	-	1.76	3.52	2.01
<i>Piptadenia obliqua</i> (Pers.) J.F. Macbr.	0.45	-	-	-	-	-
<i>Mimosa</i> sp.	0.38	-	-	-	-	-
<i>Piptadenia stipulacea</i> (Benth.) Ducke	-	6.63	0.75	-	-	-
<i>Mimosa ophthalmocentra</i> Mart. ex Benth.	-	5.20	4.14	1.47	5.62	1.16
Dead individuals	8.59	14.05	9.85	12.56	13.92	7.16
Dead individuals	7.83	12.43	8.60	10.09	12.00	5.82
Annonaceae	7.27	-	-	0.85	-	-
<i>Rollinia leptopetala</i> (Allemão) A.C. Smith	7.83	-	-	0.60	-	-
Bignoniaceae	6.85	-	-	-	-	-
<i>Tabebuia impetiginosa</i> (Mart. ex DC.) Standl.	6.34	-	-	-	-	-
Arecaceae	5.51	-	-	-	-	-
<i>Syagrus coronata</i> (Mart.) Becc.	5.17	-	-	-	-	-
Cactaceae	4.56	9.45	6.67	0.87	0.84	9.99
<i>Opuntia palmadora</i> Britton & Rose	-	8.06	4.77	0.62	0.65	5.93
<i>Cereus jamacaru</i> DC.	3.03	-	-	-	-	0.64
<i>Pilosocereus</i> sp.	0.67	-	2.24	-	-	-
<i>Pilosocereus gounellei</i> (F.A.C. Weber) Byles & G.D. Rowley	-	-	0.71	-	-	4.09
<i>Arrojadoa rodantha</i> (Gürke) Britton & Rose	-	-	-	-	-	0.61
Euphorbiaceae	4.26	21.62	10.73	38.68	38.92	36.18
<i>Manihot epruinosa</i> Pax & K. Hoffm.	1.34	-	-	-	-	0.57
<i>Croton micans</i> Müll. Arg.	2.90	-	-	-	-	-

<i>Croton rhamnifolioides</i> Pax & K. Hoffm.	-	7.63	0.99	29.28	35.96	26.70
<i>Croton sonderianus</i> Müll. Arg.	-	3.34	2.16	6.87	3.30	7.48
<i>Jatropha mollissima</i> (Pohl) Baill.	-	3.96	5.69	1.29	-	4.09
<i>Cnidocolus quercifolius</i> Pohl	-	4.33	1.73	2.63	-	0.52
<i>Cnidocolus bahianus</i> (Ule) Pax & K. Hoffm.	-	-	1.43	-	-	1.12
<i>Sapium glandulatum</i> (Vell.) Pax	-	0.69	-	0.68	-	-
<i>Sapium argutum</i> (Müll. Arg.) Huber	-	0.75	-	-	-	-
<i>Maprounea guianensis</i> Aubl.	-	3.59	-	0.67	-	-
<i>Manihot</i> sp.	-	1.34	1.30	3.13	-	-
Myrtaceae	4.01	-	-	-	-	-
Myrtaceae sp1	1.59	-	-	-	-	-
Myrtaceae sp2	0.78	-	-	-	-	-
Myrtaceae sp3	2.09	-	-	-	-	-
Nyctaginaceae	3.47	-	-	-	-	-
<i>Guapira noxia</i> (Netto) Lundell	3.04	-	-	-	-	-
Boraginaceae	1.92	-	-	-	-	-
<i>Cordia trichotoma</i> (Vell.) Arráb. ex Steud.	1.66	-	-	-	-	-
Capparaceae	1.75	-	-	0.84	1.80	0.99
<i>Capparis flexuosa</i> L.	1.50	-	-	0.60	1.42	0.82
Sapindaceae	0.93	-	-	-	0.84	-
<i>Allophylus quercifolius</i> Radlk.	0.76	-	-	-	0.64	-
Rubiaceae	0.71	-	-	-	-	-
<i>Tocoyena formosa</i> (Cham. & Schltld.) K.Schum.	0.63	-	-	-	-	-
Loganiaceae	0.56	-	-	-	-	-
<i>Strychnos rubiginosa</i> A. DC.	0.48	-	-	-	-	-
Meliaceae	0.48	-	-	-	-	-
<i>Trichilia emarginata</i> (Turcz.) C. DC.	0.39	-	-	-	-	-
Anacardiaceae	0.47	12.79	5.10	2.63	4.27	4.73
<i>Schinopsis brasiliensis</i> Engl.	-	-	4.79	-	0.77	4.39
<i>Myracrodruon ureundeuva</i> Allemão	0.38	7.21	-	2.14	3.48	-
<i>Spondias tuberosa</i> Arruda	-	4.61	-	-	-	-
Apocynaceae	-	0.88	4.82	0.84	-	12.07
<i>Aspidosperma pyriforme</i> Mart.	-	0.65	4.20	0.60	-	10.39
Sterculiaceae	-	0.85	-	-	-	-
<i>Helicteres mollis</i> C. Presl	-	0.62	-	-	-	-
Rhamnaceae	-	0.83	-	-	-	-
<i>Ziziphus joazeiro</i> Mart.	-	0.62	-	-	-	-
Bombacaceae	-	-	2.26	-	-	-
<i>Pseudobombax simplicifolium</i> A. Robyns	-	-	2.10	-	-	-
Combretaceae	-	-	1.60	-	-	-
<i>Combretum duarceanum</i> Cambess.	-	-	1.29	-	-	-
Burseraceae	-	-	-	9.47	-	-
<i>Commiphora leptophloeos</i> (Mart.) J.B. Gillett	-	-	-	8.49	-	-
Verbenaceae	-	-	-	2.39	-	-
<i>Lippia</i> sp	-	-	-	1.89	-	-
Unknown1	0.47	-	-	-	-	-
Unknown 1	0.38	-	-	-	-	-
Unknown 2	-	-	1.75	-	-	-
Unknown 2	-	-	1.44	-	-	-
Unknown 3	0.56	-	-	-	-	-
Unknown 3	0.50	-	-	-	-	-

Considering five biotopes (except PS), Euphorbiaceae, Fabaceae (Caesalpinoideae, and Mimosoideae) plus dead individuals represented 75% of the importance value. Plateau Summit holds many exclusive and important families such

as Arecaceae, Bignoniaceae, Myrtaceae, Annonaceae, and Fabaceae (Faboideae), the last two also found in LS, although with lower importance values.

Considering species, many important taxa recorded on PS are also exclusive, such as *Syagrus coronata* (Arecaceae), *Handroanthus impetiginosus* (Bignoniaceae), *Dalbergia cearensis* (Fabaceae, Faboideae), and *Guapira noxia* (Nyctaginaceae). Others, as *Schinopsis brasiliensis* (Anacardiaceae), *Aspidosperma*

pyrifolium (Apocynaceae), *Opuntia palmadora* (Cactaceae), and *Jatropha mollissima* (Euphorbiaceae) present high importance on lower areas, such as River Bank and lowlands biotopes, whereas *Croton rhamnifolioides* (Euphorbiaceae) is more important on LL1 and LL2 and US (Figure 1).

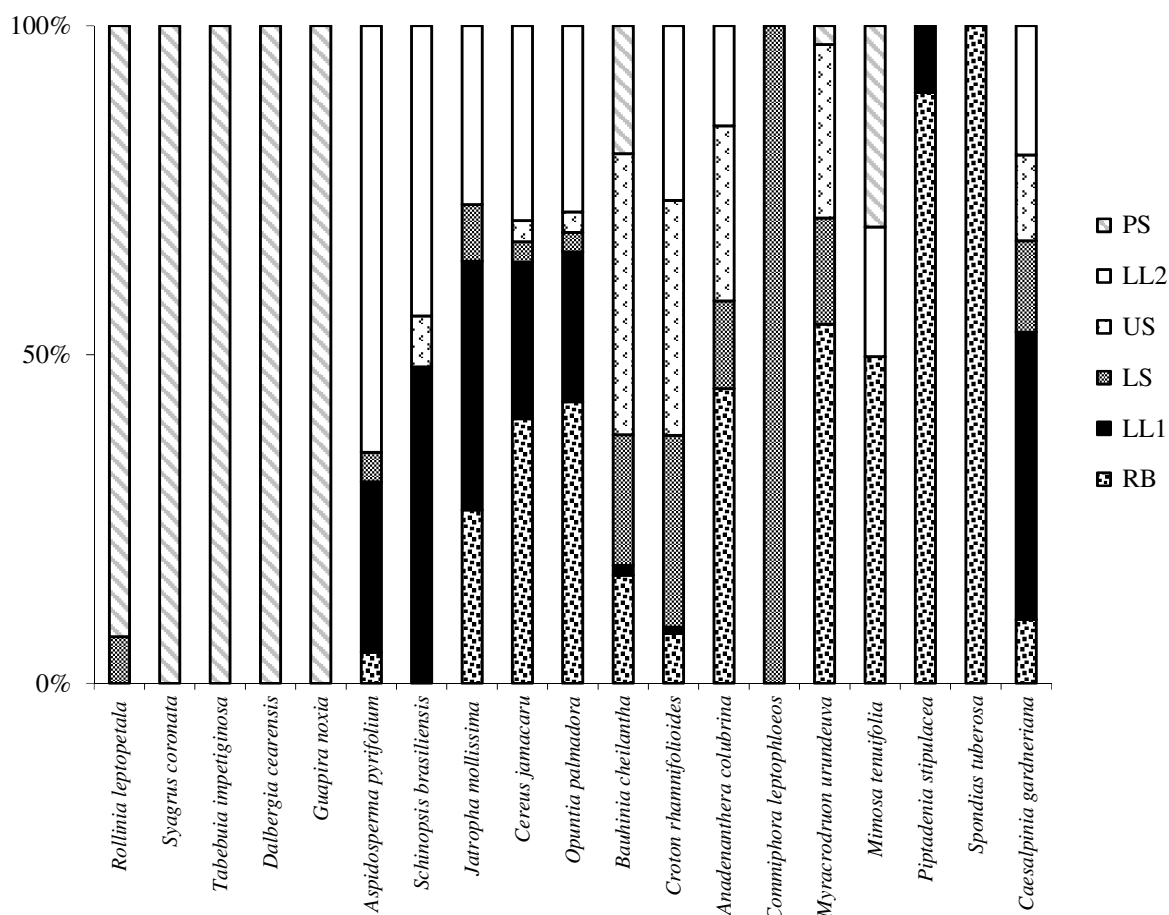


Figure 1. Distribution of Importance Value by specie in each biotope. Private Reserve of the Natural Heritage Maurício Dantas. Brazil.

Plant assemblage's vs altitude and soil

Reciprocal average analyses, using number of stems per species (Figure 2) indicated that most subplots of PS were individualized due to density of *Rollinia leptopetala* (Annonaceae), *Syagrus coronata* (Arecaceae), *Handroanthus impetiginosus* (Bignoniaceae), *Cordia trichotoma* (Boraginaceae), *Bauhinia acuruana*, *Luetzelburgia auriculata* (Fabaceae, Caesalpinioideae), *Dalbergia cearensis*, *Peltogyne pauciflora*, and *Platysmicum* cf. *floribundum* (Fabaceae, Faboideae), *Strichnus rubiginosa* (Loganiaceae), *Trichilia emarginata*

(Meliaceae), *Piptadenia obliqua* (Fabaceae, Mimosoideae), *Allophylus quercifolius* (Sapindaceae), and *Tocoyena formosa* (Rubiaceae).

Regarding soil texture on the study area, sandy soils are found on PS, changing to argilous on US, sandy loam on LS and RB, and sandy clay loam on LL1 and LL2 (Table 3). Soils with lowest pH, cation exchange capacity and base saturation, as well as lowest values for Ca^{2+} and Mg^{2+} are found on PS, whereas soils with highest pH, cation exchange capacity and base saturation, and highest values for Ca^{2+} and Mg^{2+} occur on US.

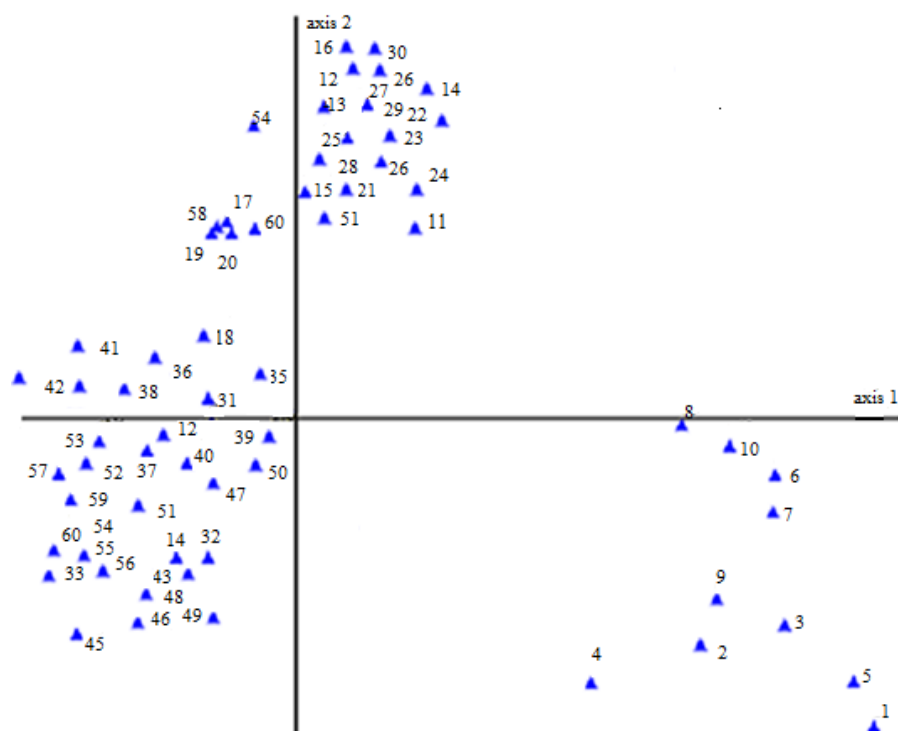


Figure 2. Ordination diagram (sub-plots) using axis I e II in reciprocal average in 60 sub-plots. Private Reserve of the Natural Heritage Maurício Dantas, Brazil. Plateau Summit (a1-a10); River Bank (a11-a20); Lowland 1 (a21-a30); Lower Slope (a31-a40); Upper Slope (a41-a50) and Lowland 2 (a51-a60). Matrix of number of stems by species.

Table 3. Values of physical and chemical properties in soil samples at deep 0- 20 cm in six biotopes of Private Reserve of the Natural Heritage Maurício Dantas, Brazil. T = texture, S = Sandy, SL = sandy loam, SCL = sandy clay loam, C = cation exchange capacity, B = base saturation.

Biotope	Sandy Silt Clay			T	Ca ²⁺ Mg ²⁺ H ⁺ Al Al C				pH	B	
	(%)	(%)	(%)		(cmol.kg ⁻¹)						(water)
Plateau Summit	90.8	3.8	5.4	S	1.56	0.12	0.90	0.10	1.84	5.34	65.15
River Bank	69.8	16.4	13.8	SL	3.23	0.25	1.05	0.25	3.84	5.52	78.53
Lowland 1	65.8	13.4	20.8	SC	7.53	0.70	1.20	0.05	8.76	6.36	87.95
Lower Slope	70.8	12.1	12.2	SL	5.25	2.01	0.45	0	7.64	6.23	94.44
Upper Slope	37.6	14.6	47.8	C	21.01	8.75	1.05	0	30.55	7.37	96.68
Lowland 2	53.6	22.6	23.8	SC	11.24	0.82	1.50	0	12.59	7.15	89.35

Discussion

Physiognomy and structure

The general physiognomy on the six biotopes is characterized by a great density of plants with short heights and relatively fine stems, similar to other areas in Caatinga (Sampaio, 1996).

It is important to note that, although PS present a relatively distinct physiognomy from the other biotopes, it does not represent a forest, once seasonal montane forests in the semi-arid are characterized by having 30% (Correia, 1996) to 22% (Ferraz et al., 2003) of plants taller than 8 m against a maximum value of 0.5% in PS. Also, floristic composition is very different from

seasonal forests in Pernambuco (Correia, 1996; Ferraz et al., 1998; Rodal & Nascimento, 2002).

Locally, from a floristic perspective, 11 from 33 species recorded in PS occur in other biotopes. Although distinct, plants in PS are deciduous and some are thorny such as *Cereus jamacaru* and *Pilosocereus* sp. (Cactaceae), *Senegalia piauhiensis*, *Mimosa tenuifolia* and *Pithecellobium diversifolium* (Fabaceae, Mimosoideae). Most species with greatest structural importance such as *Rollinia leptopetala* (Annonaceae), *Syagrus coronata* (Arecaceae), *Handroanthus impetiginosus* (Bignoniaceae), *Cordia trichotoma* (Boraginaceae), *Dalbergia*

cearensis, *Luetzelburgia auriculata*, *Peltogyne pauciflora* and *Platysmicium cf. floribundum* (Fabaceae, Faboideae), *Trichilia emarginata* (Meliaceae), and *Tocoyena formosa* (Rubiaceae) are cited for Caatinga vegetation on higher elevations (Sales et al., 1998; Rodal et al., 1999; Lemos & Rodal, 2002).

For the other biotopes, there is a structural similarity for families and species. Important taxa in these environments such as *Bauhinia cheilantha* (Fabaceae, Caesalpinioideae), *Opuntia palmadora* (Cactaceae), *Croton rhamnifolioides*, and *Jatropha mollissima* (Euphorbiaceae) are very common in many surveys of Caatinga vegetation (Rodal 1992; Araújo et al., 1995; Ferraz et al., 2003). Other species, less important in terms of structure but also present in Caatinga surveys were: *Aspidosperma pyrifolium* (Apocynaceae), *Myracrodruon urundeuva*, *Schinopsis brasiliensis*, *Spondias tuberosa* (Anacardiaceae), *Commiphora leptophloeos* (Burseraceae), *Pilosocereus gounellei* (Cactaceae) and *Cnidocolus quercifolius*, and *Jatropha mollissima* (Euphorbiaceae) (Rodal & Sampaio, 2002).

Results for cluster analysis, indicative species and reciprocal means confirm the data found on physiognomy and assemblage structure, separating a distinct group on the PS, with physiognomy and structure related with other surveys placed in sedimentary rocks (Rodal et al., 1999; Lemos & Rodal, 2002; Moro et al., 2016) from than surveys located in intermontane lowlands (Rodal, 1992).

Plant assemblage's vs altitude and soil

At regional scale, Lyra et al. (1984) observed that within the Caatinga vegetation, an increase in altitude leads to an increment on plant height as a function of a greater water availability, due to increasing in precipitation rates and decrease in temperature. In local scale, authors point out that physiognomic variations in Caatinga are correlated to the degree of water deficit in soil and topography (Sampaio et al., 1996). Our results show that interdependence between physiognomy and altitude is not clear, considering that altitudinal differences did not show and influence on diameter and height variations, but influenced variations on stem densities and basal area.

Richards (1996) points out that, in general, an increase in soil fertility and altitude leads to an increase on species richness in Neotropical plant assemblages. Although true for the entire Caatinga vegetation at regional scale, our data did not reveal a clear altitudinal or pedological local-scale gradient along the a priori defined six biotopes, once the greatest species diversity was found on

poorest soils at greatest altitudes (PS), adjacent to US, with lower species richness and more fertile soils. It is possible that other environmental factors such as solar radiation, wind speed, air humidity, soil depth and soil storage could explain such differences in species occurrence, which will only be assessed through the study of multidimensional gradients, as suggested by Pausas & Austin (2001).

Results for plant structure and soil also showed that the six a priori defined biotopes hold in fact two assemblages: PS assemblage, most species rich, related to sandy soils, lower values of base saturation and cation exchange capacity as well as higher altitudes; and lower-altitude assemblage (River Bank, Lowland 1, Lower Slope, Upper Slope, and Lowland 2), with a great number of similar species, although with variable abundance, including the five areas between slopes and lowlands, at lower altitudes, on less sandy, less acid and greater base saturation rates and cation exchange capacity.

Therefore, the apparent homogeneity in the Caatinga vegetation hides complex gradients of abiotic factors, with reflections on the superjacent plant cover. Although difficult to define limits between assemblages, attributes such as stem height and density, taxonomic richness, abundance of shared species and species exclusiveness must be considered when a model of vegetation variation is to be designed for conservation planning and vegetation management. Neglecting the existence of such local scale variations can lead to the complete exclusion of distinct assemblages, when only regional variety is considered.

Conclusion

Considering that some of the correlations found diverged from previously published results (such as the negative relationship between maximum height and mortality) may reflect regional climatic seasonality or indicate that this strategy benefits plant species that reach the upper canopy and thus become well-established.

Acknowledgements

Maria Jesus Nogueira Rodal was supported by grant from the Conselho Nacional de Desenvolvimento Científico e Tecnológico.

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