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Original Article

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Dynamics of dry tropical forest after three decades of vegetation suppression

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ABSTRACT

The aim of this study was to analyze the dynamics of the community and shrub-woody individuals in a dry forest in the Brazilian semiarid region after 29 years of vegetation suppression. Individuals with a circumference at 1.30 m above the ground (CBH) ≥ 6 cm were counted and their heights and CBH were measured in 40 permanent plots on three monitoring occasions (2011, 2013 and 2015). In the period between 2011 and 2015 the area presented a below average precipitation for the last 30 years. Phytosociological parameters and diversity were estimated. The density of individuals decreased from 2011 to 2015 ($p < 0.01$) and the basal area was similar. During the monitoring period, *Poincianella bracteosa* stood out in density, frequency and dominance. Phytosociological changes were more evident for an interval of four years. After 29 years of vegetation suppression, the community diversity is within the values for preserved semiarid (caatinga) vegetation. A long period of drought was the main disturbance factor affecting vegetation dynamics.

Keywords: caatinga, density, diversity, dominance, frequency, monitoring.

1. INTRODUCTION

The dynamics of a forest is the result of the cause and effect of natural and/or anthropic disturbances on a temporal scale. In monitoring this process, answers are looked for on forest behavior after disturbances in terms of changes in composition, diversity, structure, stock and growth (Murphy & Lugo, 1986; Lasky et al., 2016).

Vegetation called the Caatinga, a dry forest of the Brazilian semiarid region, has historically been suppressed by agricultural crops and/or pasture formation for cattle raising. Thus studies on existing remnants are important, especially in areas where vegetation has been suppressed, since information is scarce on the dynamics of their shrub-tree species after disturbance (Ferreira et al., 2016; Silveira et al., 2016). In addition to these historical disturbance factors, changes in the land structure of the properties, the urban expansion and infrastructure construction works are also associated.

Studying the dynamics of communities and populations of shrub-tree species consists of monitoring the changes due to natural and/or anthropic disturbances, mainly using permanent plots. These plots are periodically measured for both biological and ecological characterization purposes, and for planning timber and non-timber harvesting, which is essential to design future scenarios of floristic composition, phytosociological structure, biomass and ecosystem functioning (Rees et al., 2001).

Regarding the Brazilian semiarid region structural development and dynamics, studies are necessary to understand the behavior of the different Caatinga physiognomies when subjected to anthropic and natural actions (especially drought periods). These studies are essential to subsidize forest management plans, especially for estimating the time necessary for the vegetation stock to recover to a similar level as before the disturbance.

Therefore, the objective of this study was to analyze the dynamics of shrub-tree vegetation (caatinga vegetation) after anthropic disturbance by chain clearing, investigating the causes of phytosociological changes and diversity over time in the caatinga area in the city of Floresta, Pernambuco state.

2. MATERIAL AND METHODS

The research was conducted in the municipality of Floresta, Pernambuco state, in the mesoregion of São Francisco and microregion of Itaparica, at the coordinates 8°30’49” South Latitude and 37°57’44” West Longitude. The study area of approximately 50 ha was suppressed by chain clearing in 1987 for planting eucalyptus. But it was abandoned and has been in natural regeneration process for 29 years.

The area’s vegetation is classified as Shrub Savanna-steppe (Caatinga) (IBGE, 2012). The predominant climate in Floresta, Pernambuco state, is BSs’h, characterized by being very hot, semiarid steppe marked by a dry season and a rainy season. The average annual temperature is 26.5 °C, with average rainfall of 610.1 mm between 1961 and 1990 and of 406.1 mm between 1993 and 2015, with a period of concentrated rain from January to May (APAC, 2016). The soil of the region is characterized as shallow Chromic Luvisols, with an average sandy surface texture (EMBRAPA, 2007).

The annual precipitation and number of rainy days in the survey years are shown in Figure 1.

The sample structure was installed in 2008 and consists of 40 permanent plots of 400 m^2 (20 × 20 m), in which the circumferences and heights of all shrub-arboreal individuals with circumference at 1.30 m of the soil (CBH) ≥ 6.0 cm. In the monitoring periods of 2011, 2013 and 2015, the individuals tagged in 2008 were measured. Those that reached CBH ≥ 6.0 cm were also marked and measured, in addition to recording those which had died and fallen in the year under consideration. Identification regarding species and family was carried out based on Ferraz et al. (2014).

The individuals with shrub-tree size, as well as their number of stems, were considered in the data analysis, meaning that we sought to characterize multifaceted individuals. The following parameters were estimated at each measurement point: absolute and relative density, absolute and relative frequencies, absolute and relative dominance, importance value, the Shannon diversity

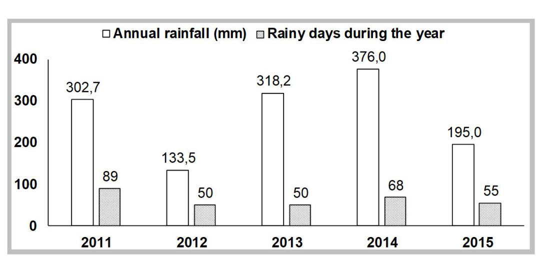

Figure 1. Annual rainfall and rainy days according to year, Floresta, PE. Source: APAC (2016).

index and Pielou evenness. For stem analysis, the calculations were performed using the function that considers each stem as an individual. Both analyses were carried out using the Mata Nativa 4 program (CIENTEC, 2016).

Based on the basal area found during the monitoring moments, annual periodic increments were estimated considering 25, 27 and 29 years of vegetation recovery.

A comparison between the means of the years for the variables was performed based on an intersection between the respective confidence intervals at the 5% probability level, according to Sokal & Rohlf (2012).

3. RESULTS AND DISCUSSION

In the monitoring period there were larger changes in terms of the total density of individuals and stems (Figure 2A), reducing 9%, 15% and 23%, respectively, in the periods 2011-2013, 2013-2015 and 2011-2015.

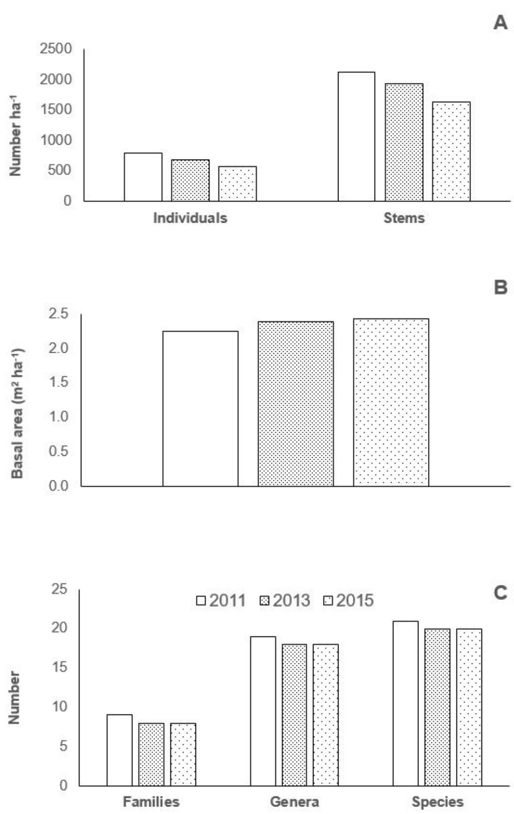

Figure 2. Total density (A), basal area (B), number of families, genera and species (C) in 2011, 2013 and 2015 in an anthropogenic caatinga area, Floresta, Pernambuco state.

On the other hand, the basal area in these periods was increased by 5.67%, 1.85% and 7.63%, respectively (Figure 2B). It is also observed that the floristic composition had little change in terms of families, genera and species (Figure 2C), thus showing stability. In a study of dry forests of Mexico in several successional stages, Dupuy et al. (2012) affirm that the basal area is determined by the age of the stands, while floristic composition and density are mainly influenced by soil variables associated with fertility and spatial autocorrelation. In addition, considerations regarding drought and its duration are necessary, as is the case in the present study.

The Fabaceae family presented higher number of species (Table 1), corroborating with Apgaua et al. (2014) and Banda-R et al. (2016), who point to this family as having great wealth in studies of seasonally dry tropical forests, indicating that their morphological characteristics allow them to be well adapted to severe periods of drought.

Regarding the number of shrub-tree species, the values in the three surveys are in the average for caatinga areas. But they were lower than those found by Barbosa et al. (2007), Ramalho et al. (2009), Souza & Rodal (2010) and Ferreira et al. (2016), and higher than in studies by Andrade et al. (2005), Bessa & Medeiros (2011), Calixto & Drumond (2014), Holanda et al. (2015), and Pereira et al. (2016). It is worth mentioning that the differences between the present study and those cited are due to several factors such as the inclusion level of individuals, disturbance level in the study area, studied physiognomy, among others.

In the present study, there were species characteristic of preserved areas, such as *B. cheilanta*, *M. tenuiflora*, *M. urundeuva*, and *C. leptophloeos* (Pereira et al., 2003; Andrade et al., 2005; Souza et al., 2015), indicating that vegetation is recovering 29 years after the disturbance caused by chain suppression. On the other hand, there is a great concentration of individuals belonging to few species in relation to the others. This demonstrates the dominance of one group over another, which is typical of forests in the regeneration stage (Pereira et al., 2016).

P. bracteosa, *P. moniliformis, M. ophthalmocentra* and *C. blanchetianus* stood out on the three monitoring occasions in this study. Of these, according to Sampaio et al. (1996), *C. blanchetianus* and *P. bracteosa* are highlighted

Table 1. Floristic characteristics, absolute density in shrub-tree individuals (N) and stems (S) in 2011, 2013 and 2015 in an anthropogenic caatinga area, Floresta, Pernambuco state.

Family/Species	Common name	N (S) ha^{-1}		
		2011	2013	2015
Anacardiaceae				
Myracrodruon urundeuva Allemão	Aroeira	17.5 (31.3)	18.8 (32.5)	18.1 (30.6)
Schinopsis brasiliensis Engl.	Baraúna	6.3 (10)	4.4 (8.1)	4.4 (7.5)
Apocynaceae				
Aspidosperma pyrifolium Mart.	Pereiro	10 (30)	9.4 (28.8)	9.4 (28.8)
Boraginaceae				
Varronia leucocephala (Moric.) J.S. Mill.	Moleque Duro	1.9 (3.8)	0.6 (0.6)	0.6 (0.6)
Burseraceae				
Commiphora leptophloeos (Mart.) J.B. Gillett	Imburana de Cambão	2.5 (4.4)	2.5 (4.4)	1.9 (2.5)
Combretaceae				
Combretum glaucocarpum Mart.	Sipauba	50.0 (61.9)	33.8 (38.8)	18.8 (19.4)
Euphorbiaceae				
Cnidoscolus quercifolius Pohl	Faveleira	35.0 (61.9)	28.8 (74.4)	26.9 (68.8)
Croton blanchetianus Baill.	Marmeleiro	56.3 (101.3)	48.8 (85.0)	36.9 (58.8)
Croton heliotropiifolius Kunth	Velame	6.3 (9.4)	5.0 (8.8)	3.8 (7.5)
Jatropha mollissima (Pohl) Baill.	Pinhão Bravo	59.4 (93.8)	29.4 (46.3)	20.6 (29.4)
Manihot carthaginensis subsp. *glaziovii* (Müll.Arg.) Allem	Maniçoba	3.8 (4.4)	1.9 (2.5)	0.6 (0.6)
Fabaceae				
Anadenanthera colubrina var. cebil (Griseb.) Altschul	Angico	3.8 (5.0)	3.1 (8.8)	1.3 (3.1)
Bauhinia cheilanta (Bong.) Steud.	Mororó	3.1 (3.8)	2.5 (2.5)	1.9 (1.9)
Mimosa ophthalmocentra Mart. ex Benth.	Jurema de Embira	72.5 (348.8)	53.8 (303.8)	33.8 (180.0)
Mimosa tenuiflora (Willd.) Poir.	Jurema Preta	4.4 (21.9)	3.1 (3.8)	2.5 (3.1)
Piptadenia stipulacea (Benth.) Ducke	Jurema Branca	3.8 (8.1)	3.1 (7.5)	1.9 (5.0)
Pityrocarpa moniliformis (Benth.) Luckow & R.W. Jobson	Quipembe	85.6 (166.3)	76.3 (143.1)	67.5 (130.0)
Poincianella bracteosa (Tul.) L.P. Queiroz	Catingueira	360.0 (1101.9)	354.4 (1122.5)	326.9 (1045.6)
Senna spectabilis (DC.) H.S. Irwin & Barneby	Pau de Besouro	4.4 (10.0)	4.4 (6.9)	2.5 (4.4)
Sapotaceae				
Sideroxylon obtusifolium (Roem. & Schult.) T.D.Penn.	Quixabeira Brava	0.6 (4.4)	0.6 (3.1)	0.6 (3.1)
Verbenaceae				
Lippia microphylla Cham.	Alecrim de Vaqueiro	1.9 (5.0)	0 (0)	0 (0)
	Total	**788.8 (2122.5)**	**684.4 (1931.9)**	**579.4 (1630.6)**

in relation to the number of individuals for most of the studies in caatinga areas, as they are considered colonizers. According to Sann et al. (2016), structural recovery in tropical dry secondary forest in areas after disturbances is mainly led by the dominant species.

The presence of multifocal individuals is characteristic in 100% of the species (Table 1) and ~85% of the sampled individuals. In dry forests of Mexico Dupuy et al. (2012) found 80% of the species and 35% of the sampled individuals with several stems. According to Murphy & Lugo (1986), this multifaceted behavior is a response to the *modus operandi* of anthropic disturbances (agriculture, cattle ranching, among others) to which dry tropical forests have been subjected in various parts of the planet, along with drought.

A decrease was also observed regarding the number of stems during the monitoring. The species with the highest number of stems (*P. bracteosa*, *M. ophthalmocentra*, *P. moniliformis*, *C. blanchetianus* and *C. quercifolius*) have this characteristic due to their adaptive physiology to avoid water loss during periods of drought. They seem to have advantages in coping with longer droughts, such as the one occurred in the period of the present study.

The horizontal structure was represented by a decrease in absolute density during monitoring, with

788.75 individuals (ind) ha^{-1} in 2011, 684.38 ind ha^{-1} in 2013, and 579.44 ind ha^{-1} in 2015.

Low rainfall occurred in the study area region (Figure 1), especially in 2015, when compared to the average of the last 30 years (406.1 mm), which accentuated the decrease of sampled individuals. In dry environments such as those in the caatinga, water availability is a factor that can influence population densities, so it could be expected to decrease in more severe periods (Worbes, 1999). Therefore, it is believed that the low rainfall associated with the number of rainy days (Figure 1) may have influenced the total density, since there are no records of disturbances in the study area such as fire or wood cuttings. The direct and indirect impacts of rainfall distribution seem to be the main causes of population mortality (Albuquerque et al., 2012). Consequently this can imply in reduced density of individuals and of stems in Caatinga. Furthermore, in the present work it can be considered as the main factor for density reduction. Marengo et al. (2016) affirm that a long period of drought began in Northeast Brazil in 2010, and from 2011 to 2015 there were lower than average rainfalls. This is precisely the period in which the present study was conducted.

Lower results were found for the total densities (Table 2) in studies in caatinga areas, ranging from 1,437 to 3,805 ind ha^{-1} (Alcoforado et al., 2003; Andrade et al., 2005; Rodal et al., 2008; Pereira et al., 2012, 2016). This can be explained by differences in anthropogenic pressures exerted by different types of use (Calixto & Drumond, 2014), since these authors found a density of 925 ind ha^{-1} in a degraded environment; a value close to that of this study.

Although the density of live individuals decreased, there was an increase in basal area. This can be explained by the addition of stems, meaning that stems were not included in a given monitoring occasion because they did not have CBH ≥ 6cm. Therefore, the increase in basal area cannot be attributed solely to an individual's own growth. On the other hand, in the seasonal period of water deficit, shrub species of tropical dry forests present a diversity of growth rates, functional traits and drought responses, suggesting that each species may have different strategies to grow under different conditions of water availability (Mendivelso et al., 2013).

The variation in basal area values among the studies of caatinga vegetation areas is quite common, since such values depend on several factors such as precipitation, degree of anthropization, type of soil, among others. Thus, even with the study area being in a regeneration process for 29 years, it has a basal area among the values found for areas that were not cut and more preserved, which vary from 4 to 52 m^2 ha^{-1} (Sampaio et al., 1996).

Due to the adaptation to water stress, it is quite common for caatinga individuals to present several stems with small diameters in the juvenile phase as a survival strategy, as is the case of *Poincianella bracteosa*, which excelled in structure in all the monitoring years. This species also concentrated much of the importance value in a study on structure and spatial pattern in caatinga vegetation in Floresta, Pernambuco state (Marangon et al., 2013), and it is common to observe a higher density of *P. bracteosa* individuals when the degradation level is high (Galindo et al., 2008).

P. bracteosa presented higher density, frequency and dominance (Table 2). It frequently appears at the top of the lists of caatinga studies (Sampaio et al., 1996) because it is one of the dominant species also in natural regeneration (Alves et al., 2013). Despite a relatively small initial growth, its drought resistance and good competition capacity make it one of the dominant species in the later stages of the succession process (Sampaio et al., 1998).

On the other hand, large species such as *Commiphora leptophloeos*, *Myracrodruon urundeuva* and *Schinopsis brasiliensis*, have small numbers of individuals per unit area (Sampaio et al., 1998), but may have greater dominance expression, as observed in the present work. In this sense, when analyzing two areas of caatinga in the municipality of Floresta, Pernambuco state, Meunier et al. (2015) found that a significant part of the estimated volume for exploration was associated with large species, as was the case of *M. urundeuva* in the present study.

Although not many *M. urundeuva* individuals were found when compared to the species with the highest importance values, it obtained one of the greatest dominances due to having large diameters, standing out in IV when compared to some species with a greater amount of individuals, but with lower basal area. The presence of *Commiphora leptophloeos*, a species commonly found in more protected areas or in well-conserved forests and rarely in heavily anthropogenic

Table 2. Absolute (AD) and relative (RD) densities; absolute (AF) and relative (RF) frequencies; absolute (ADo) and relative (RDo) dominance; absolute (IV) and relative importance value (IV%) in 2011, 2013 and 2015 in the anthropized caatinga area, Floresta, Pernambuco state.

Species	AD	RD	AF (%)	RF (%)	ADo	RDo	IV	IV%
	(ind ha^{-1})		(%)		(m^2 ha^{-1})		(%)	
2011								
Poincianella bracteosa	360.00	45.64	97.5	22.03	1.150	50.98	118.66	39.55
Mimosa ophthalmocentra	72.50	9.19	42.5	9.60	0.277	12.30	31.10	10.37
Cnidoscolus quercifolius	35.00	4.44	35.0	7.91	0.252	11.17	23.51	7.84
Jatropha mollissima	59.38	7.53	52.5	11.86	0.067	2.98	22.37	7.46
Pityrocarpa moniliformis	85.63	10.86	15.0	3.39	0.163	7.22	21.46	7.15
Combretum glaucocarpum	50.00	6.34	40.0	9.04	0.025	1.13	16.51	5.50
Myracrodruon urundeuva	17.50	2.22	32.5	7.34	0.081	3.59	13.15	4.38
Croton blanchetianus	56.25	7.13	12.5	2.82	0.043	1.90	11.85	3.95
Schinopsis brasiliensis	6.25	0.79	17.5	3.95	0.038	1.69	6.44	2.15
Aspidosperma pyrifolium	10.00	1.27	20.0	4.52	0.013	0.59	6.38	2.13
Mimosa tenuiflora	4.38	0.55	7.5	1.69	0.090	4.01	6.26	2.09
Senna spectabilis	4.38	0.55	15.0	3.39	0.005	0.23	4.18	1.39
Croton heliotropiifolius	6.25	0.79	10.0	2.26	0.003	0.12	3.18	1.06
Commiphora leptophloeos	2.50	0.32	10.0	2.26	0.007	0.29	2.87	0.96
Other species (7)*	18.77	2.40	35.0	7.89	0.041	1.81	12.09	4.03
Total	788.8	100	442.5	100	2.2550	1000	300	100
2013								
Poincianella bracteosa	354.38	51.78	97.5	24.38	1.391	58.39	134.55	44.85
Mimosa ophthalmocentra	53.75	7.85	37.5	9.38	0.307	12.87	30.10	10.03
Pityrocarpa moniliformis	76.25	11.14	15.0	3.75	0.167	7.03	21.92	7.31
Cnidoscolus quercifolius	28.75	4.20	27.5	6.88	0.208	8.75	19.82	6.61
Jatropha mollissima	29.38	4.29	42.5	10.63	0.031	1.30	16.22	5.41
Combretum glaucocarpum	33.75	4.93	37.5	9.38	0.020	0.83	15.14	5.05
Myracrodruon urundeuva	18.75	2.74	32.5	8.13	0.093	3.92	14.79	4.93
Croton blanchetianus	48.75	7.12	12.5	3.13	0.040	1.67	11.91	3.97
Aspidosperma pyrifolium.	9.38	1.37	20.0	5.00	0.015	0.64	7.01	2.34
Schinopsis brasiliensis	4.38	0.64	12.5	3.13	0.041	1.70	5.47	1.82
Senna spectabilis	4.38	0.64	15.0	3.75	0.004	0.16	4.55	1.52
Commiphora leptophloeos	2.50	0.37	10.0	2.50	0.008	0.32	3.19	1.06
Mimosa tenuiflora	3.12	0.46	5.0	1.25	0.030	1.27	2.97	0.99
Croton heliotropiifolius	5.00	0.73	7.5	1.88	0.004	0.15	2.76	0.92
Other species (7)*	11.9	1.74	27.5	6.89	0.024	1.01	9.61	3.21
Total	684.4	100	400	100	2.3830	100	300	100
2015								
Poincianella bracteosa	326.88	56.30	97.5	26.53	1.548	63.52	146.35	48.78
Mimosa ophthalmocentra	33.75	5.81	32.5	8.84	0.222	9.12	23.77	7.92
Pityrocarpa moniliformis	67.50	11.63	15.0	4.08	0.171	7.03	22.73	7.58
Cnidoscolus quercifolius	26.88	4.63	27.5	7.48	0.227	9.33	21.44	7.15
Myracrodruon urundeuva	18.13	3.12	32.5	8.84	0.102	4.17	16.13	5.38
Jatropha mollissima	20.63	3.55	37.5	10.20	0.025	1.00	14.76	4.92
Combretum glaucocarpum	18.75	3.23	30.0	8.16	0.013	0.51	11.91	3.97
Croton blanchetianus	36.88	6.35	12.5	3.40	0.031	1.26	11.01	3.67
Aspidosperma pyrifolium	9.38	1.62	20.0	5.44	0.019	0.79	7.85	2.62
Schinopsis brasiliensis	4.38	0.75	12.5	3.40	0.043	1.74	5.90	1.97
Senna spectabilis	2.50	0.43	10.0	2.72	0.003	0.14	3.29	1.10
Croton heliotropiifolius	3.75	0.65	7.5	2.04	0.004	0.16	2.85	0.95
Commiphora leptophloeos	1.88	0.32	7.5	2.04	0.003	0.11	2.48	0.83
Other species (7)*	8.15	1.40	22.5	6.12	0.016	0.69	8.23	2.74
Total	579.4	100	365	100	2.4270	100	300	100

**Anadenanthera colubrina*, *Bauhinia cheilanta*, *Lippia microphylla*, *Manihot carthaginensis*, *Piptadenia stipulacea*, *Sideroxylon obtusifolium* and *Varronia leucocephala*.

areas (Andrade et al., 2005), may indicate that this area is undergoing recovery (Araújo et al., 2012) or that there are remnant individuals from disturbances.

In the caatinga vegetation, total density and basal area vary from 459 to 701.5 ind ha^{-1} and 2.3 to 50.32 m^2 ha^{-1}, respectively (Andrade et al., 2011). The values in the present study are compatible with these results. However, it should be emphasized that comparisons should be made with care and caution, since there are methodological differences between the works. For example, inclusion level based on height (Santana & Souto, 2006; Rodal et al., 2008), in circumference at 0.30 m from the soil (Bessa & Medeiros, 2011; Pereira et al., 2012; Calixto & Drumond, 2014) and at 1.3 m from the soil (Ferraz et al., 2013; Ferraz et al., 2014; Brand et al., 2015; Menino et al., 2015; Souza et al., 2015; Pimentel et al., 2016; present work).

A reduced average number of individuals was observed for *P. bracteosa* from 2011 to 2015 (Table 3), however, there was an increase in mean basal area. This result can be explained due to the inflow of stems in the remaining individuals, which compensated the mortality loss. However, *M. ophthalmocentra* and *J. molíssima* had a reduction in number and baseline area from 2011 to 2015, meaning that mortality for them may not have been offset by the inflows.

The caatinga stood out with greater density in a study by Ferraz et al. (2014) in an area of preserved caatinga located in the same area of the present study, and the second one of greater density in an anthropic area, demonstrating that this species is well adapted to the place and surrounding areas.

The mean values of trunk/tree, number of trees, number of stems and basal area did not show significant differences between the studied years (Table 4). The average height of individuals in 2015 (4.63 m) was higher than that of those measured in 2011 and 2013, which can enable concluding that in addition to the individuals advancing to the highest height classes between 2013 and 2015, there was a significant loss of individuals in the lower classes, thus influencing their estimation.

Table 3. Confidence interval for mean number of individuals (N) and basal area (BA) for the highest density species in anthropic caatinga area, Floresta, Pernambuco state.

Species	N (ind ha^{-1})			BA (m^2 ha^{-1})		
	2011	2013	2015	2011	2013	2015
Poincianella bracteosa	360.00 ± 48.25 a	354.28 ± 49.50 b	326.88 ± 47.00 b	1.1500 ± 0.1175 a	1.3925 ± 0.1400 b	1.5428 ± 0.1625 c
Mimosa ophthalmocentra	72.50 ± 20.25 a	53.75 ± 16.25 ab	33.75 ± 8.75 b	0.2775 ± 0.0875 a	0.3075 ± 0.1000 b	0.2220 ± 0.0725 c
Croton blanchetianus	56.25 ± 29.75 a	48.75 ± 25.00 a	36.88 ± 18.00 a	0.0425 ± 0.0225 a	0.0400 ± 0.0200 a	0.0310 ± 0.0150 a
Jatropha mollissima	59.38 ± 19.00 a	29.38 ± 8.25 b	20.63 ± 5.75 c	0.0675 ± 0.0200 a	0.0300 ± 0.0100 b	0.0250 ± 0.0075 c
Pityrocarpa moniliformis	85.63 ± 41.00 a	76.25 ± 34.75 a	67.50 ± 30.75 a	0.1625 ± 0.0800 a	0.1675 ± 0.0800 a	0.1710 ± 0.0800 a

Means followed by the same letter in the line and same variable do not differ because there is no intersection between confidence intervals of the difference between means at the 5% probability level.

Table 4. Confidence interval for mean density of individuals and stems, mean density ratio of stems/individuals, mean basal area and mean height in an anthropic caatinga area, Floresta, Pernambuco state.

Year	Density of individuals	Density of stems	Stem/individual	Basal area	Average height
	(N ha–1)	(F ha–1)		(m2 ha)	(m)
2011	775 ± 238.0 a	2125.0 ± 526.75 a	86.75 ± 15.25 a	2.2550 ± 0.3950 a	3.57 ± 0.28 b
2013	675 ± 207.0 a	1925.0 ± 471.25 a	92.00 ± 14.75 a	2.3825 ± 0.3950 a	3.93 ± 0.27 b
2015	575 ± 175.5 a	1625.0 ± 392.00 a	96.00 ± 16.50 a	2.4375 ± 0.3950 a	4.63 ± 0.27 a

Means followed by the same letter in the column do not differ because there is no intersection between confidence intervals of the difference between means at the 5% probability level.

The mean heights found in this study were higher than that obtained by Amorim et al. (2005) in an area of Caatinga do Seridó (Rio Grande do Norte state), finding an average height of 3.40 m; by Rodal et al. (2008) in studying the structure of the thorny deciduous vegetation of an area in the central interior of Pernambuco, where it was obtained an average height of 2.37 m; and the work conducted by Santana & Souto (2006) in studying the structure and phytosociological diversity of the Caatinga in the *Estação Ecológica do Seridó* (Rio Grande do Norte), obtaining an average height of 2.65 m.

The results in mean height were smaller than the studies of Sanquetta et al. (2014) in a caatinga area in Brumado, southeastern Bahia state, with an average height of 4.93 m and standard deviation of 2.30 m, and Brand et al. (2015) with an average height of 5.6 m in caatinga vegetation in the south of Piauí state. The differences between the present work and the others are associated to the great heterogeneity of caatinga environments, so the structures of each vegetation are very unusual and influenced by several factors such as soil type, altitude and climate, which are reflected in different height strata.

The species with higher average heights were *A. columbrina*, *M. tenuiflora*, *Q. quercifolius* and *M. urundeuva*. Also, even with higher number of individuals and basal area, *P. bracteosa* presented a mean height of only 3.45 m in 2011, 3.81 m in 2013 and 4.45 m in 2015. This is a common characteristic in this species because it has medium size.

In 2009 in the same study area, Ferraz et al. (2014) found the average number of individuals similar to that found in 2011 in the present study, but a smaller number of harvested trees (82) when compared to 2011, consequently lower stem/individual ratio (3.2), but higher basal area (0.0979 m^2 plot^{-1}).

In the analysis of two caatinga areas with and without desertification in Paraíba, Souza et al. (2015) found an average number of 76 individuals for the non-desert environment, and 49 for the desert environment. When compared with the present study, these values indicate that the dry forests existing in northeastern Brazil have very unusual characteristics that vary from site to site/region to region, and depend on the biotic and abiotic conditions where the vegetation is inserted. Thus the floristic composition, wealth and structure vary between semi-arid areas.

The average number of individuals per hectare decreased in the evaluated periods, which also occurred for the average number of stems per hectare (Table 5).

We observed lower values than those reported by Ferraz et al. (2014), who found an average annual increment of 0.11113 ± 0.0031 m^2 ha^{-1} year^{-1} referring to the estimated basal area in anthropic area of 2.4486 m^2 ha^{-1} in 2008, and based on the estimated basal area of 4.5549 m^2 ha^{-1} in a conserved area, inferring a cycle of 40.9 years to reestablish the wood/tree stock.

It is also observed that there was a deceleration in the basal area growth rate. However, once again the extrapolations regarding the growth rate should be viewed with caution, since in the monitoring in the present study there was a drought influence which has occurred in the area since 2011 (APAC, 2016), in addition to no animal grazing control. However, considering that the present research was carried out in the same anthropized area as Ferraz et al. (2014), it is inferred that it would take more years for the vegetation to recover in the basal area.

Table 5. Confidence interval for number of individuals, stems and basal area per hectare, and estimated periodic annual increment (PAI) for the years 2011, 2013 and 2015 in an anthropized caatinga area, Floresta, Pernambuco state.

	Mean Confidence Interval		
	2011	**2013**	**2015**
Number of individuals ha^{-1}	789 ± 75.79 a	684 ± 65.87 b	581 ± 55.84 b
Number of stems ha^{-1}	2122 ± 167.67 a	1932 ± 149.24 b	1629 ± 124.74 b
Basal area (m^2 ha^{-1})	2.2550 ± 0.1328 a	2.3825 ± 0.1331 a	2.4375 ± 0.1397 a
Estimated PAI (m^2 ha^{-1} year^{-1})	**0.0902 ± 0.0053 a**	**0.0882 ± 0.0049 a**	**0.0841 ± 0.0048 a**
Years without disturbance	**25**	**27**	**29**

Means followed by the same letter in the line do not differ because there is no intersection between confidence intervals of the difference between means at the 5% probability level.

In addition, the mean basal area was considered small and strongly affected by the presence of many bifurcated species, which usually have small diameter stems. The percentage distribution of individuals predominated in the first diametric classes, thus reflecting the low volume of lumber in the area after 29 years of cutting.

In the analysis of floristic diversity, we found a Shannon index of 1.94, 1.79 and 1.67 nats ind^{-1} in 2011, 2013 and 2015, respectively. Although the observed diversity values were below average for studies in preserved areas (Pereira et al., 2002; Alcoforado et al., 2003; Santana & Souto, 2006; Guedes et al., 2012; Calixto & Drumond, 2014; Sanquetta et al., 2014), they are within the range of 1.5 to 3 nats ind^{-1} for most of the caatinga cited by Sampaio (2010), but the effect of chain clearing suppression is still present. However, a comparison of the diversity values should also be made with caution, since the indices are influenced according to sampling methodology such as inclusion level, area size and number of sample plots.

In the study area, precipitation data for the Floresta municipality in the periods of 1961-1990 (610.1 mm) and 1993-2015 (406.1 mm) show a decrease over time, which may have affected the community and their species, and thereby also the diversity index.

Regarding Pielou's evenness index, values of 0.64 for 2011, 0.60 for 2013 and 0.56 for 2015 were observed for the adult component. These values are slightly lower than those found by Ferraz et al. (2014), with 0.73, also at the Fazenda Itapemirim, Floresta, Pernambuco, but the area had no preceding major disturbances. In contrast, these are larger than in the studies of Calixto & Drumond (2011) with 0.50, and Barbosa et al. (2012) with 0.57, where one or few species predominated over the others, a fact that also occurred in the present study.

The decrease in the evenness value indicates that vegetation is being dominated by only a few species over the years, since species would tend to balance the number of individuals.

4. CONCLUSIONS

The floristic composition and vegetation diversity suppressed 29 years ago are found to be among existing values for other areas of preserved caatinga.

The communities, as well as their species, presented more evidenced structural and phytosociological changes when considering the interval of 4 years (2011-2015), since it covers a period of greater water deficit.

Poincianela bracteosa was the most important phytosociological species in the adult community.

The prolonged drought period was the main disturbance factor affecting vegetation dynamics.

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