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Original Research Article

Diversity and structure of adult and regenerating forest component in inselberg 'Alto-Montana', Paraíba-Brazil

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The objective of this work was to study the diversity and similarity profiles of vegetal species from adult and regenerating arboreal component in "Alto-Montana" *inselberg* forest area, evaluating and modulating the effective numbers of vegetal species on the different strata. An area of 4400 m2 (Open Ombrophylous Forest) was sampled in which woody species of adult stratum and regenerating were measured. The effective Hill diversity numbers (qD) and the respective sampled intensity curves, calculated by rarefaction (α = 0.05), were estimated. Vegetal species richness remained unchanged among strata, however, the pattern of proportionality in species abundance changed as the community moved to the adult stratum. The hypothesis on similarity in floristic similarity was confirmed, indicating reasonable perspectives on the regeneration power of these forests on a scenario of moderate disturbances observed in the studied area.

Keywords: Altitude swamps, plant diversity profiles, floristic composition.

1. INTRODUCTION

Plants diversity is a complex concept, multifaceted, that includes not only the richness of species, but also the abundance and factors that have some effect on the community structure, which are considered crucial for its understanding [11 and 34]. For decades, studies on diversity in tree species community had as base only the absolute numbers of species and the index values with so insufficient mathematical properties [10, 12 and 20]. Under this approach, the true profiles that make up the plants diversity are lowered and underused, since the traditional methodologies are inadequate and tendentious [15].

Part of the Atlantic Forest in Brazilian Northeast is comprised of *inselberg* Alto-Montana areas, known in Brazil as 'brejo de altitude, which are inserted in phytogeographic domain of "Caatinga" [8 and 21]. These areas are located predominantly in 'Agreste' region between Paraíba and Pernambuco states, Brazil, and have intermediate heather, hot and dry climate that are specifically from semi-arid and subhumid areas from in Atlantic Forest [28]. These particularities compose part of abiotic factors that lead to diversity of these vegetation refuges, considered important for the distribution of many endemic species [36].

Despite this complexity, according to data from first records [8 and 25], there are only 2,626.68 km² from swamp forest areas of original vegetation, of which 18,500 km² of semideciduous and open ombrophilous forests have already been represented. The remaining vegetation from this

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sector is one of the most threatened in Brazilian Atlantic Forest; first, because it is not possible to establish how much this value represents in terms of occupied area; second, the latest official estimates do not consider these refuges in the last surveys [41]. In addition, many existing floristic and diversity information in Northeast, Brazil are directed mainly to the coastal Atlantic Forest, and may not apply to interior forest zones'reality. Therefore, one of the worrying issues is that the lack of ecological information may put in risk the maintenance and conservation of these forest mosaics that remain in the Brazilian Northeast. Nevertheless, empirical studies describing diversity processes are very scarce, and when they exist, they are directed only at floristic-descriptive aspects, requiring a better exploitation of this information.

Parallel, it is known that the natural regeneration processes can provide a greater level of understanding about the survival and future consequences of the community, since the forest dynamics maintenance depends strictly on this process for its functioning [17]. Thus, this diagnosis becomes a fundamental component to direct the current conservation and food status prognoses about its possible responses to natural or anthropic disturbances [24 and 33]. On the other hand, the absence of on-site information, capable of monitoring possible modulations and effects on composition and species richness, is increasingly necessary and difficult to get due to the high costs for implementation of long-term researches. Therefore, a first approximation of the responses to the associations of the components of species diversity, as well as their regenerant contribution, is shown as a valuable source of information for local conservation.

The conjecture of diversity processes in particular environments assumes a fundamental role in other generalist botanical works, which can be integrated in studies with biogeography (eg, [27]). Upon these questions, the objective of this work was to describe modulations of woody species diversity from adult and regenerating stratum in forest area of *inselberg* 'Alto-Montana', evaluating floristic similarity and possible alterations of the diversity profiles between strata. In order to do so, we tried to test the following hypotheses: i) diversity plants pattern change among strata, because the relative abundance stabilization among species in adult forest stratum is greater, which indicates greater ecological stability in diversity; ii) at moderate disturbance levels (i.e., trampling of animals and occasional tree cuttings), similarity is little changed in the community and the conjecture of natural regeneration in the current scenario allows reasonably good prognoses.

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2. MATERIAL AND METHODS / EXPERIMENTAL DETAILS / METHODOLOGY (ARIAL, BOLD, 11 FONT, LEFT ALIGNED, CAPS)

The research was carried out at a forest fragment belonging to the Paraíba Federal University (UFPB) in Bananeiras, Paraíba state, Brazil (Figure 1). The area has approximately 49.5 ha, it is part of an important vegetation refuge complex (located under the coordinates: 6°45' S and 35°39' O) has altitude variations around 510 and 617 m, classified as Open Ombrophylous Forest [21]. The climate of the region is As' (tropical rainy), warm and humid (Köppen Classification), presenting maximum temperature of 38° C and minimum of 18° C, with rainfall from autumn to winter (concentrated in the months of May to August). The soil is dystrophic yellow latosol with texture varying from light sand consistency to clayish soil, under-evergreen tropical forest, geomorphologically, is characterized by mild and slightly undular relief [16]. Although the area belongs to the institution, the reserve passes through small levels of natural and man-made disturbances, e.g., falling trees in sloping areas, cattle treading, and sporadic tree cuttings.

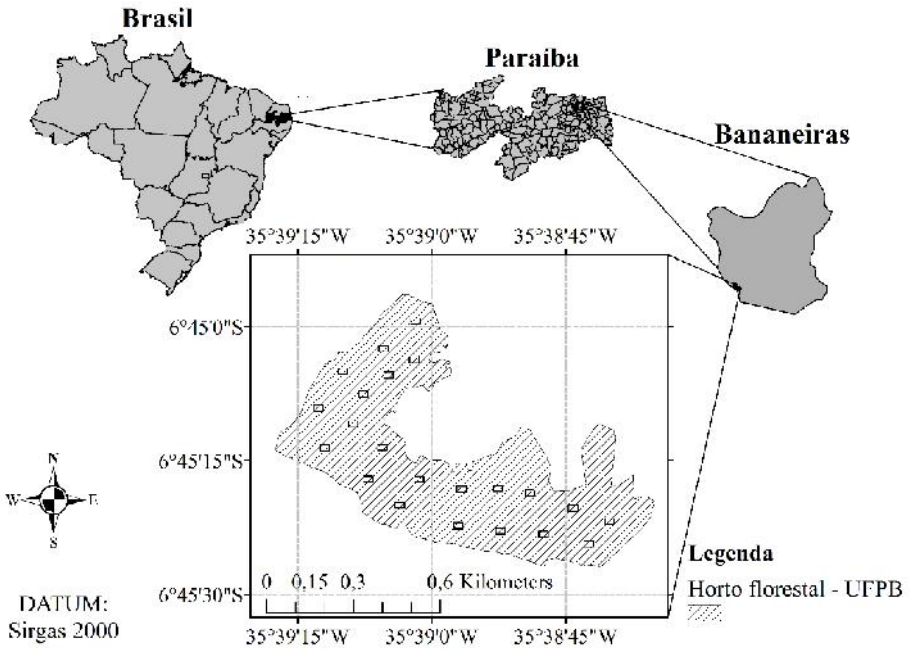

Figure 1. Geographic location of forest garden in UFPB area, municipality of Bananeiras - PB, Brazil. Details with rectangles (□) denote the distribution of experimental units.

Data collection

Twenty-two plots of 10 x 20 m were distributed randomly which totaled an area of 4400 m² (8.88% of the total area) (Figure 1). In this survey was considered all woody individuals of the adult extract, CFG ≥ 10 cm in circumference (circumference at 30 cm from the ground). Regenerating were measured in the same plot (CFG < 10 cm), to justify richness and diversity comparisons in the same scale of area [22]. The individuals were divided into three height classes (H), where class 1: H ≥ 1.0 m H ≤ 2.0 m, class 2 H> 2.0 m and H ≤ 3.0 m and class 3 with H> 3.0 m [26]. All individuals represented from both strata were identified and measured the CFG (at 30 cm from the ground), using a dendrometric caliper, and estimated the total height at the apex of the treetop.

The community structure parameters were calculated using main phytosociological parameters [29]. For natural regeneration, Total Natural Regeneration (TNR) was considered, obtained it from the relative frequencies of individuals per species in each size class (i.e., class 1, 2 and 3). All the structural parameters were estimated with Mata Nativa® software version 4.0 [13]. The botanical

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material of the taxa was collected and sent to "Herbarium Jaime Coelho de Morais" at Agricultural Sciences Center (CCA) in UFPB, Areia - PB. Species were identified by comparisons and expert assistance according to Angiosperm Phylogeny Group - APG III [7]. The species current nomenclature was conferred by means of consulting to Missouri Botanical Garden database.

Diversity profiles analysis

It was used a sample coverage estimator [equation 1 -12] with the aim of quantifying the sampling intensity from strata, which can be calculated by the iNEXT package (iNterpolation / EXTrapolation) developed by . This package provides functions for calculating and plotting sampling curves by interpolation and extrapolation, based on the intensity of sampling coverage along confidence intervals at 95% probability. *Bootstrap* randomization method was applied to obtain approximate variances for each diversity component (q = 1, 2 and 3), and later to construct the associated confidence limits (α = 0.05).

$$\hat{C}_n = 1 - \frac{f_1}{n}\left[\frac{(n-1)f_1}{(n-1)f_1+2f_2}\right] \quad (1)$$

where: $\hat{C}_n$= sampling coverage intensity; f_1 = species represented by exactly one individual in the reference sample and f_2 = number of duplicated species in the reference sample. The entropy based on Hill's (1973) effective diversity numbers for both strata was calculated. This estimator includes the three most widely used species diversity profiles: species richness (*q*=0), Shannon diversity (q = 1, Shannon entropy exponential) and Simpson diversity (*q*=2; inverse of Simpson's dominance) [cf, 10], and can be calculated by equation 2:

$$\left(\sum_{i=1}^{S} p_i^q\right)^{1/(1-q)} \quad (2)$$

where: *S* = number of species; p_i = relative abundance and *q* = is the parameter that determines the sensitivity to relative abundance on the diversity profiles.

Shannon-Weaver (H '), Simpson's dominance (-ln (D') and Pielou's Equation's (J) traditional indices were calculated from the 'vegan' (ecological diversity) software package R [30]. The similarity between the strata of the community: "adult" and "regenerating" was calculated by the Chao-Sørensen index (ChaoS ') with the aid of the "fossil" package [40], according to a methodology proposed by [5]. All data statistical manipulation and chart construction were performed using ambient R version 3.4.0 [35].

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Results

Floristics and structures

It were sampled 2308 individuals, distributed into 36 families, 54 genera and 80 species, with predominance of tree species (56.25%), followed by shrubs and subshrubs, including two species of lianas (43.75%). The families with greatest richness were Fabaceae (14 species), Anacardiaceae and Myrtaceae (four species each), Erythroxylaceae, Malvaceae, Sapotaceae and Sapindaceae (three species each). Seventeen were identified at genus level, four at family level, and 12 were not identified due to the absence of fertile botanical samples and were described as indeterminate.

Adult tree stratum presented 800 individuals, distributed into 32 families and 71 species. The most abundant botanical families were Anacardiaceae (four species), Fabaceae (13 species), Erythroxylaceae, Malvaceae, Myrtaceae, Sapindaceae and Sapotaceae (three species each one). Regenerating stratum presented 1508 individuals, distributed into 69 species and 32 families. Plant families with highest richness were the same ones recorded to adult stratum, except: Malvaceae (anyone specie), Anacardiaceae, Fabaceae (three species each one), Myrtaceae (four species). The number registered for regenerating individuals was higher than adult stratum, due to the plot size, since in this study the same plot was considered for both strata (200 m²). Floristic composition did not show significant differences among the strata, which shared 60 species (~ 84% species). This result was confirmed by ChaoS' similarity test, which revealed high similarity between the strata (0.9854).

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It should be pointed out that *E. pauferrense, H. courbaril, M. caesalpiniifolia, P. nitens* species are included in threatened flora official list (*The* IUCN *Red List of Threatened Species* TM 2017), confirming the importance of preserving biodiversity in the area. In addition, the presence of an exotic species (*Artocarpus heterophyllus* Lam.) and many regenerating individuals outside the experimental units were recorded, especially in places more anthropized. Other species of plants were also recorded outside the experimental units, in fragment edge, areas close to trail and roads, for example: *Cassia ferruginea* (Schrad.) Schrad. ex DC. (Fabaceae), *Eriotheca macrophylla* (K.Schum.) *A. robyns* (Malvaceae) and *Maclura tinctoria* (L.) D.Don ex Steud. (Moraceae).

Table 1. Woody component, adult and regenerating strata floristic sampled in *inselberg* Alto-Montana - "swamp altitude", municipality of Bananeiras – Paraíba state, Brazil. Species in alphabetical order of family, genus and species.

Family/species	Common name	In	
		A	R
Anacardiaceae			
Anacardium occidentale L.	“Cajueiro”	5	1
Anacardium sp.	“Cajueiro-do-mato”	2	–
Tapirira guianensis Aubl.	“Cupiúba”	21	20
Thyrsodium spruceanum Benth.	“Caboatã-de-leite”	39	28
Annonaceae			
Xylopia frutescens Aubl.	“Embira”	–	2
Apocynaceae			
Tabernaemontana sp.	“Leiteira”	3	1
Araliaceae			
Schefflera morototoni (Aubl.) Maguire et al.	“Sambaquim”	1	–
Bignoniaceae			
Handroanthus sp. 1	“Ipê”	5	7
Handroanthus sp. 2	“Ipê-amarelo”	1	7
Boraginaceae			
Cordia taguahyensis Vell.	“Frei-jorge”	10	101
Burseraceae			
Protium heptaphyllum (Aubl.) Marchand	“Amescla-de-cheiro”	36	171
Cannabaceae			
Celtis iguanaea (Jacq.) Sarg.	“Cabrinha”	–	3
Capparaceae			
Cynophalla flexuosa (L.) J.Presl	“Feijão-bravo”	2	1
Clusiaceae			
Clusia sp.	“Clusia”	2	20
Connaraceae			
Connarus sp.		20	20
Erythroxylaceae			
Erythroxylum sp.		8	1
Erythroxylum pauferrense Plowman	“Guarda-orvalho”	85	274
Erythroxylum simonis Plowman	“Quebra-foice”	28	37
Euphorbiaceae			
Croton sp.	“Marmeleiro”	–	3
Fabaceae			
Albizia polycephala (Benth.) Killip ex Record	“Vassourinha”	8	5
Anadenanthera colubrina (Vell.) Brenan	“Angico-de-caroço”	21	–
Bowdichia virgilioides Kunth	“Sucupira-preta”	9	5
Enterolobium contortisiliquum (Vell.) Morong	“Timbaúva”	5	–
Fabaceae 1		7	32
Fabaceae 2		–	7
Hymenaeae courbaril L.	“Jatobá”	10	2
Inga sp. 1		2	6
Inga sp. 2		4	8
Inga sp. 3	“Inga-feijão”	11	24
Mimosa caesalpiniifolia Benth.	“Sabiá”	56	15
Piptadenia stipulacea (Benth.) Ducke	“Jurema-branca”	2	2
Pterogyne nitens Tul.	“Madeira-nova”	9	3

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Senegalia tenuifolia (L.) Britton & Rose	"Jequirí"	1	6
Hypericaceae			
Vismia guianensis (Aubl.) Choisy	"Lacre"	5	6
Indeterminadas			
Indeterminada 1		2	–
Indeterminada 2		1	2
Indeterminada 3		2	2
Indeterminada 4		2	23
Indeterminada 5		1	135
Indeterminada 6		1	7
Indeterminada 7		1	7
Indeterminada 8		1	8
Indeterminada 9		1	2
Indeterminada 10		–	1
Indeterminada 11		–	1
Indeterminada 12		–	1
Lamiaceae			
Vitex rufescens A.Juss.	"Mama-cachorro"	1	–
Lauraceae			
Ocotea glomerata (Nees) Mez	"Louro-preto"	13	20
Lecythidaceae			
Eschweilera ovata (Cambess.) Mart. ex Miers	"Imbiriba"	45	23
Lecythis pisonis Cambess.	"Sapucaia"	22	9
Malpighiaceae			
Byrsonima sericea DC.	"Murici"	11	3
Malvaceae			
Ceiba glaziovii (Kuntze) K.Schum.	"Barriguda"	1	–
Guazuma ulmifolia Lam.	"Mutamba"	1	–
Luehea paniculata Mart. & Zucc.	"Açoita-cavalo"	6	–
Melastomataceae			
Miconia albicans (Sw.) Triana	"Quaresmeira"	1	3
Miconia minutiflora (Bonpl.) DC.	"Tinteiro"	4	7
Moraceae			
Brosimum guianense (Aubl.) Huber	"Quiri"	15	18
Sorocea sp.	"Folha-de-serra"	3	23
Myrtaceae			
Myrcia sp.	"Araçá-bravo"	2	11
Myrcia splendens (Sw.) DC.	"Araçazinho"	7	108
Myrtaceae 1		6	5
Psidium sp.	"Araçá"	1	5
Nyctaginaceae			
Guapira laxa (Netto) Furlan	"Guapira"	16	–
Guapira opposita (Vell.) Reitz	"João-mole"	34	12
Peraceae			
Pera distichophylla (Mart.) Baill.	"Rabo-de-galo"	–	5
Piperaceae			
Piper mollicomum Kunth.	"Pimenteira-do-mato"	30	51
Polygonaceae			
Coccoloba sp.	"Cravaçú"	9	6
Rubiaceae			
Guettarda viburnoides Cham. & Schltdl.	"Veludo-branco"	–	4
Randia sp.	"Baga-preta"	5	10
Rutaceae			
Zanthoxylum rhoifolium Lam.	"Limãozinho"	1	2
Salicaceae			
Casearia sylvestris Sw.	"Café-bravo"	15	16
Sapindaceae			
Allophylus edulis (A.St.-Hil. et al.) Hieron. ex Niederl.	"Baga-se-morcego"	10	30
Cupania impressinervia Acev.-Rodr.	"Caboatã"	51	80

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Talisia esculenta (Cambess.) Radlk.	"Pitomba"	19	22
Sapotaceae			
Pouteria sp. 1		8	5
Pouteria sp. 2		8	6
Sapotaceae 1		12	11
Simaroubaceae			
Simarouba amara Aubl.	"Pau-paraíba"	3	2
Solanaceae			
Brunfelsia uniflora (Pohl) D.Don	"Manacá-de-cheiro"	5	4
Urticaceae			
Cecropia pachystachya Trécul	"Embaúba"	5	–
Total		**800**	**1508**

A = adult; **R** = regenerant and **In** = individuals number, details with dash (−)represent absence of species.

It were sampled 800 individuals (4132 ind/ha) and 1508 individuals (7789 ind./ha) in adult stratum and in regenerating stratum, respectively. Basal areas were estimated at 33.4429 and 0.7322 m²/ha, concerned to adult and regenerating strata. Genera *Erythroxylum* (three species - 121 individuals), *Mimosa* (one species - 56 individuals), *Cupania* (one species - 51 individuals) and *Eschweilera* (one species - 45 species) represent that with more individulas (In). In the regenerating extract genera with more representants were: *Erythroxylum* (three species - 312 individuals), *Protium* (one species - 171 individuals), indeterminate genera 5 (one species - 135 individuals) and *Myrcia* (three species - 124 individuals). Although there were no differences in floristic composition, species relative abundance pattern showed clear divergences on its distribution. In other words the regenerating stratum concentrated most of the relative values of density individuals in 11 morphospecies (RD = 69.43%); a contrast with the adult stratum, since the relative contribution of individuals density was more distributed among the species, about 18 morphospecies (RD = 70.75%).

Species with the highest importance value (IV) in the adult stratum were: *G. opposita* (26.46), *M. caesalpiniifolia* (19.31), *A. colubrina* (18.18), E. pauferrense (16), *T. guianensis* (15.64), *C. impresinervia* (14.89). Among these species, morphospecies with the highest structural representativity (Relative Dominance - RDo) of this component were: *G. opposita* (17.39%), *A.colubrina* (13.15%), *T. guianensis* (10.61%) and *M. caesalpiniifolia* (9.50%). In relation to regenerating stratum, the species with the highest Total Natural Regeneration were: *E. pauferrense* (10.96%), with higher expressiveness in the first class (1 ≤ H ≤ 2 m), *P. heptaphyllum* (10.76%), *M. splendens* (10.20%) and Indeterminate 5 (8.07%), with expressiveness in all classes, and *P. mollicomum* (7.18%) with higher distribution in the last class (H> 3 m) (data not shown).

Vegetal species profile diversity

Shannon's index value (S ') ranged from 3.62 to 3.23 nats. ind^{-1}, while Simpson's dominance index (D ') ranged from 3.21 to 2.63, arboreal and regenerating strata, respectively. According to these values, the vegetal species profile diversity from adult woody component was higher in both facets, that is, considering the rare species or most common species. The dominance equability (J) was also higher for adult stratum (0.85) than for the regenerant (0.76), which confirms the presumption of a major relative abundance distribution for the most adult component of the forest.

The effective plant species numbers (qD) were estimated at 71.00; 37.48 and 25.31 species in relation to adult stratum, and 69.0, 25.36 and 16.87 species for the regenerant, q = 0, 1 and 2, respectively. Regardless of the sample size (by interpolation or extrapolation), in both strata, confidence limits at 95% of probability overlap, suggesting similarity for species richness (q = 0) among adult and regenerant strata (Figure 2a). On the other hand, when plant species abundances are intensified as more important in the diversity measures (order q> 0), it was proved that the tree component began to maintain greater diversity, respectively, by Shannon and Simpson's entropy (Figure 2b and c).

The differences in the diversity profiles for q> 0 are more visible because the parameter 'q' increasing determines greater sensitivity to the abundance of individuals (Figure 2b and c). This pattern specially occurs because the abundance is more distributed in a larger number of species in the tree stratum. In contrast, the regenerating stratum of plants community, which concentrated high values for abundance in a smaller effective number of species (qD = 16.87).

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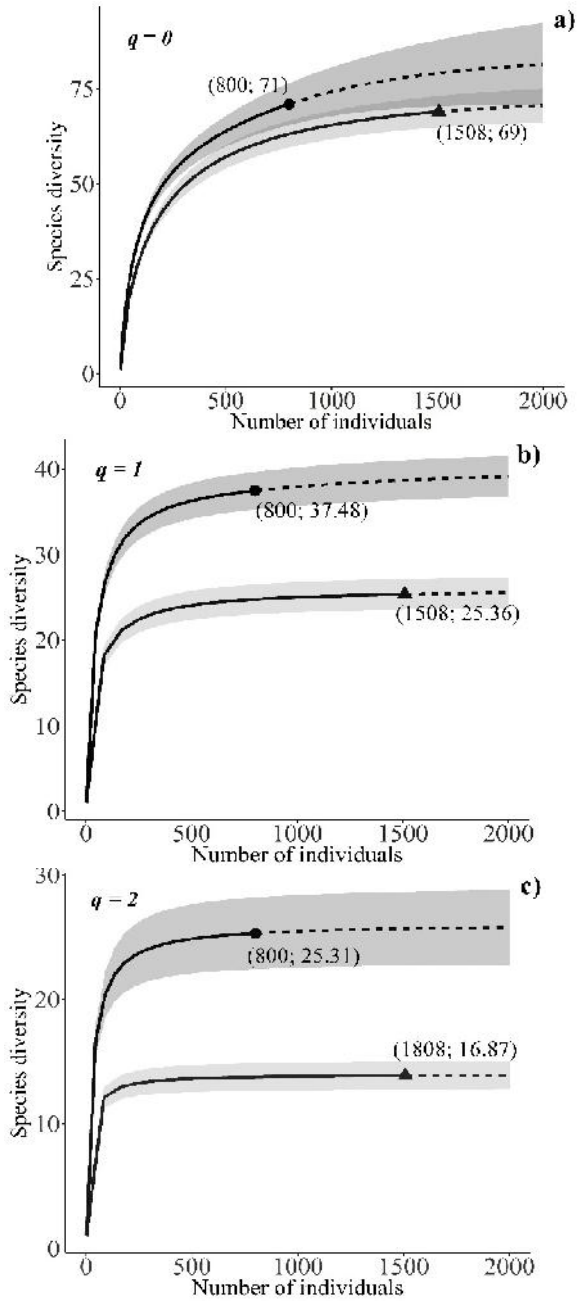

Figure 2. Sampling curves by interpolation (-) and extrapolation (--), both with 95% confidence intervals (shaded areas). Data from adult and regenerant strata are shown separately by diversity profiles. Points and solid triangles represent the limits from reference samples; numbers in parentheses represent the number of individuals and the effective number of species (qD = Hill numbers in q order).

In all diversity components (ie, Hill's numbers in the order of q = 0; 1 and 2), the sample size was extrapolated to 2000 individuals to avoid possible effects of sample size on the diversity components, due the fact that the arboreal stratum sample was almost twice smaller. The theoretical expectations of Shannon and Simpson's entropy for before reference sample confirming the sampling efficiency for both strata (Figure 3a, b and c).

Yield curve of rarefaction is the expected increasing if an individual is added to the sample. In other words it is the probability of the next individual sampled be a new species not previously sampled [12]. In this sense, considering the sample standardized in 98 and 99% for the sample intensity curve ($\hat{C}_m$), arboreal and regenerating stratum, respectively, it is observed that sample

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coverage estimates slightly increase qD values (q=1 and 2), confirming satisfactory sample levels (Figure 3b and c). This property becomes more visible in the diversity components, whose Hill number q> 0 (Figure 3c). It occurs because the effect on the sample intensity curve ($\hat{C}_n$) is more dominated by common species, presenting less pronounced curves for effective species numbers [10]

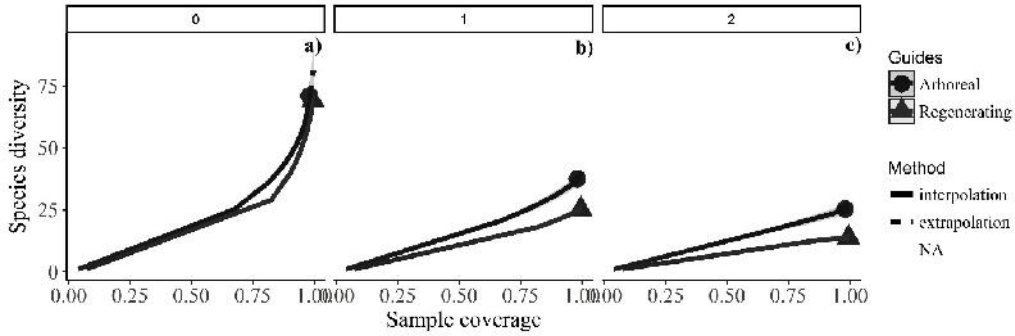

Figure 3. Sample intensity curve by interpolation (-) and extrapolation (--), both with 95% confidence intervals (shaded areas). Arboreal community data: arboreal and regenerating are shown separately by diversity profiles (order: q = 0, 1 and 2). Points and solid triangles represent the sample limits of the reference sample, the numbers in parenthesis represent sample sufficiency (%) and the effective number of species (qD = Hill numbers in q order).

Discussion

The floristic and physiognomic profile of the area contains conspicuous elements, which characterize a closer approximation to Atlantic Forest of the coast (eg, *Tapirira guianenses, Protium heptaphyllum, Eschweilera ovata*) than the Northeast Caatinga (eg, *Piptadenia stipulacea, Croton* sp., *Senegalia tenuifolia*). In the broad sense, it is known that other floristic and physiognomic changes can also be evidenced as it is far from the coast and close to “sertão” areas, and those changes are also found in western part of Northeast [8 and 28]. According to [1] there is a greater floristic overlap of these areas with thorny deciduous vegetation from the region, probably due to proximity.

In terms of diversity, for adult stratum, there is a considerable similarity to the regional surveys of the Atlantic Forest in the Zona da Mata in Pernambuco state, Brazil, for example, [2] and [18] who found: 3.09; 3.20; 3.83 and 3.43 nats. ind. -1 for H ', based on inclusion criteria similar to that adopted by this study (CAB ≥ 15cm). For regenerating stratum, were found 3,20 and 3.32 and 3.45 nats. ind.$^{-1}$ in papers of [6, 23, and 32], respectively, considering the same inclusion criterion in regenerant classes. These generalizations, while showing little implication in conservation, confirm a slight idea of the similarity of the diversity of the woody component between the coastal Atlantic Forest and the innermost areas (i.e., when they move away from the coast towards the West).

Locally it is possible to highlight the similarity of surveys carried out on the eastern escarpment of Planalto da Borborema; "Mata do Brejão", municipality of Bonito-PE, eg, where important plant species were listed, predominant from forest canopy [36], similar to that recorded in the present study. According to these authors, taxonomically the differences are associated to the differences of habitat, because of the water availability. In "Mata do Pau-Ferro" State Ecological Reserve, where the inclusion limit was adopted over 5 cm of DAP (15 ≥ CAB) [4], 35 plant families were sampled in 67 species. In this area H' ranged from 3.04 to 2.99 nats. ind.-1, for different ciliary forest environments. Structurally, there was higher individuals’ density in the area where the present study was conducted, as was the basal area. This fact is largely due to methodological sampling discrepancies and inclusion limits adopted.

As demonstrated in other studies, the first regenerating plant class was responsible for most of the TNR (92.75%), followed by classes 2 (5.03%) and 3 (2.22%). This result generalizes as an expected consensus in tropical forests, due to high proportion of regenerating individuals in early ontogenetic classes. As plants recruit to larger classes, mortality rates increase because of the risks associated with herbivory, competition and other biotic and abiotic stresses, so that only the most adapted individuals continue developing [3, 24 and 33],. In the present study, *G. opposita* species, predominant in the phytogeographic domain of the Atlantic Forest, presented high values for adult component, however, low values for TNR (0.80%). These results seem to point to difficulties, which

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species face in recruiting new individuals into length classes and consequently reaching higher forest stratum.

From 71 morphospecies sampled in the adult woody component, only 11 were not recorded in the regenerating stratum (see Table 1). Among these, most are considered rare species of spatial distribution. If we portray the biological risks these species presents, knowledge can often not be scaled and compared, since the sample area is much smaller than the scope of distribution of these biological entities. On the other hand, some species such as *G. opposita, B. sericea* and *E. contortisiliquum* seem to have problems in regeneration, suggesting that the reduction of propagule availability may be limiting, making these species more susceptible to future changes in the forest.

Among threatened species, *E. pauferrense* has recently been discovered in the botanical field [42], it has endemism restricted to the forest areas of swamp in Paraíba state and is threatened with extinction. One of concerns is due to habitat deforestation and the isolation of subpopulations, as well as the decline of individuals [14]. However, the species does not go through problems, due to its high abundance listed also in other works in this typology [4, 5]. The fact that the species shows high values for TNF is associated with the habit of shrub growth and the ecological preference for the lower forest stratum (sub-forest), a fact observed *in-situ* in the fragment studied.

In this work, it was proved that there are no significant differences for richness and floristic composition, considering adult and regenerating stratum in the same area. However, this pattern has changed when diversity components that prioritize species abundance were incorporated. In this sense, the community of the adult stratum modulated the diversity, so that the adult arboreal stratum obtained a greater diversity ($\alpha = 0.05$) (Figure 2). In other words, it is defended the hypothesis that, when properly protected, these areas have the capacity to regenerate themselves easily, and this process assumes a fundamental role in the natural reconstruction and conservation of this forest typology.

It is important to note that the similarity in species richness between adult and regenerating arboreal strata does not mean that the identities of the species are the same [22]. It was observed that there is a floristic similarity between two strata cited above independent of the patterns of richness described. As diversity does not depend exclusively on total density, it would be easy to point out greater diversity for the regenerating stratum, which has similar species richness, as long as that the individuals' abundance is almost twice greater than the density of individuals in the adult stratum. In this conception, the tree community had greater distribution on individuals/species' abundance becoming a more tolerant environment, presenting natural ecological levels of ecological stability.

The perspective of natural regeneration in these environments, after moderate disturbance levels, tends to increase significantly the complexity levels of wealth and structure's components (ie, density, biomass, richness and equitability) after few years of disturbance [5]. These authors, who studied the natural regeneration of shrub-arboreal component, in disturbed areas with different years old, proved that clear advances in the forest with 20 years old much approached to what was expected concerned to older forests.

Conclusions

The present study confirmed the hypotheses of natural changes in diversity between adult and regenerating strata in the *inselberg* Alto-Montana forest area. Species richness remains unchanged among strata. However, the pattern of proportionality in species abundance changes systematically as the community directs its development to the adult stratum. The hypothesis on floristic similarity was confirmed, indicating reasonable perspectives on the regeneration power of these forests, front of the great scenario of moderate disturbances.

These findings provide informations for studies in diversity of phytophysiognomic sectors that are still little known and, also, value the importance of small forest fragments for woody flora conservation and their role in maintaining the Atlantic Forest biodiversity.

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