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Original Paper

Functional diversity of plant communities at edge and interior of a submontane Atlantic Forest: greater functional than compositional stability

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Abstract

We compared the functional diversity of community at edge and interior areas of an Atlantic forest fragment to test the hypothesis that higher functional diversity exists along edges - in consonance with their higher abundance and floristic diversity as compared to the interior of the forest. By considering a set of vegetative, reproductive and phenological traits and ecosystem service aspects of edge and interior environments, we defined plant functional groups using Cluster Analysis, followed by a silhouette width analysis, together with functional diversity indices of richness, divergence, evenness and dispersion. The main functional groups formed were similar between the edges and interior. Functional richness was the only index that demonstrated differences between edge and the interior. Alterations were perceived in relation to species richness and the Shannon index. Edge effects were not significant in the formation of functional groups. In contrast to our original hypothesis, similar groups were formed both along the edge in the interior - indicating that species played similar ecological roles in both environments, with similar responses to different environmental factors - so that forest edges were colonized by a series of different species that maintained diversity patterns similar to those found in the forest interior.

Key words: artificial borders, Atlantic Forest, Chapada Diamantina, forest fragmentation, functional diversity.

Resumo

Comparamos a diversidade funcional de comunidades em áreas de borda e interior de um fragmento de Floresta Atlântica para testar a hipótese de que existe maior diversidade funcional ao longo da borda em consonância com sua maior abundância e diversidade florística quando comparada com o interior da floresta. Considerando um conjunto de características vegetais, reprodutivas fenológicos, e serviços ecossistêmicos dos ambientes de borda e interior, foram definimos grupos funcionais de plantas usando Análise de Cluster, e por uma análise de silhueta, juntamente com índices de diversidade funcional de riqueza, divergência, uniformidade e dispersão. Os principais grupos funcionais formados são semelhantes ao longo da borda e do interior. Riqueza funcional foi o único índice de diversidade que apresentou diferença entre borda e interior. Alterações foram percebidas em relação à riqueza de espécie e ao índice de Shannon. Efeitos de borda não foram significativos na formação de grupos funcionais. Em contraste com nossa hipótese original, grupos semelhantes foram formados tanto na borda quanto no interior, indicando que espécies desempenharam papeis ecológicos semelhantes em ambos ambientes, com respostas similares a diferentes fatores ambientais, de modo que as bordas da floresta foram colonizadas por uma série de espécies diferentes que mantinham padrões de diversidade como os encontrados no interior.

Palavras-chave: borda artificial, Floresta Atlântica, Chapada Diamantina, fragmentação florestal, diversidade funcional.

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Introduction

Forest ecosystems have been historically and continually devastated, leading to the reduction of biodiversity. Many studies indicate (Murcia 1995; Mendes *et al.* 2016; Melo *et al.* 2019) that ecosystem fragmentation and the edge effect contribute to this loss. Forest fragmentation creates abrupt edges that can severely alter microclimatic conditions (Laurance *et al.* 2002; Santos *et al*. 2008). Among the resulting changes, perhaps the most striking are related to variations in solar irradiation that increase the temperature and affect soil and air humidity and wind velocity (Tabarelli *et al.* 2008; Laurance *et al.* 2011; Carvalho *et al.* 2016). Increasing fragmentation reduces intact areas and leads to interruptions of dispersal, migration, and can even prevent plant establishment (Cordeiro & Howe 2001). Additionally, the forest edges become altered, with previously protected forest nuclei becoming increasingly exposed to external conditions that provoke progressive biodiversity erosion and the degradation of ecosystem functioning (Murcia 1995; Tabarelli *et al.* 1999; Laurance *et al.* 2006).

Changes in floristic composition can also be linked to functional aspects, since environmental changes would result in greater recruitment (or reduced mortality) of light tolerant species near new forest edges (Laurance *et al.* 2006; Tabarelli *et al.* 2008; Santos *et al.* 2012; Girão *et al.* 2007). The various modifications of the flora and fauna resulting from fragmentation can influence biotic interactions and affect ecological functions such as predation, parasitism, herbivory, pollination, seed dispersal and ecosystem services (Galetti *et al.* 2003; Lopes *et al*. 2009; McCauley *et al.* 2013) as well as promote changes in the reproductive traits of plants (Girão *et al.* 2007). Phenology, pollination and dispersal modes, especially abiotic syndromes, have been associated with plant strategies that coexist in seasonal contexts and affect ecosystem services (Jara-Gerrero *et al*. 2011; Perez-Harguindeguy *et al*. 2013; Sfair *et al*. 2016). Researchers have reported significant differences in the reproductive phenologies of species as result of the formation of both natural and anthropogenic edges (Cunnigham 2000; Athayde & Morellato 2014; Pires *et al.* 2014; Menezes *et al.* 2018). Edge creation can strongly affect species composition and phenodynamics, strongly influence community functioning and ecosystem processes, as well as decrease the functional diversity of forest patches (Girão *et al.* 2007).

Numerous studies have shown that edge influences represent one of the most important drivers of species losses in fragmented forests throughout the world through, for example, invasion of alien species and higher nest predation (*e.g.*, Haddad *et al.* 2015; Esseen *et al.* 2016). Few studies, however, have evaluated the impacts of edge effects on plant functional groups composition and community functional diversity, as most studies have only assessed changes in arboreal forest components (Girão *et al.* 2007; Carreño-Rocabado *et al.* 2012; Maeshiro *et al.* 2013). The Brazilian Atlantic Forest domain comprises ombrophilous and semi-deciduous forests, including small disjunct forests in the Espinhaço Range (Oliveira-Filho & Fontes 2000; Silveira *et al.* 2019) that are surrounded by vegetation matrices dominated by savanna and rupestrian grasslands (Funch *et al.* 2009; Silveira *et al.* 2016). Those forest patches represent critically endangered biodiversity hotspots harboring numerous endangered species (Coelho *et al.* 2018). Such threat mainly is due to anthropogenic factors and forest fragmentation that have led to the destruction and loss of biodiversity.

Linear infrastructure installations, such as the construction of roads, pipelines, and high-voltage transmission lines, alter natural landscapes, and often require the deforestation of corridors inside forests, thus creating linear edges (Murcia 1995). As linear edges were found to impact the floristic composition, diversity, and abundance of arboreal species of submontane seasonal forest in the Chapada Diamantina (Couto-Santos *et al.* 2015), we sought to detect linear edge effects on the functional aspects of a tropical seasonal forest community, considering all of its growth forms.

In this study, we evaluated whether the transmission lines (a corridor of approximately 10 m wide) established in the 1960s causes edge effects that alter the functional diversity patterns and functional groups compositions of forest edge and interior areas of inland Atlantic Forest in Chapada Diamantina, in northeastern Brazil. As such, we addressed the following questions: (i) What are the main functional groups in the submontane forest, and how do they vary between the forest edge and interior? (ii) Are there significant variations in functional diversity between the edge and interior in relation to species richness and diversity? (iii) Are the co-occurring species in the two areas assembled into distinct functional groups?

Material and Methods

Study area

The Chapada Diamantina Mountains (part of the larger Espinhaço Range in northeastern Brazil) shows high floristic diversity associated with various vegetation types (Couto *et al.* 2011), including submontane seasonal forest growing on deep, yellow-red latosols. This tall forest on the eastern flank of the Chapada Diamantina is set within a matrix of open vegetation (*cerrado* and *caatinga*). Significant percentages of that forest have been cleared in the last 30 years for timber and charcoal extraction, the construction of highways and electric transmissions networks, and especially for pasture formation - leading to fragmentation and biodiversity losses (Funch *et al.* 2005, 2008; Couto *et al.* 2011; Couto-Santos *et al.* 2015).

The study was conducted between April and September/2015 in a forest fragment resulting from anthropic action about 1,000 ha growing on deep yellowish-red latosols, within the boundaries of the Chapada Diamantina National Park, on the eastern flank of the Chapada Diamantina Mountains, Bahia state, Brazil. The study area (12º28’20”–12º28’29”S, 41º23’13”–41º23’00” W) is divided by two parallel corridors of high-voltage transmission lines (each a clear-cut corridor approximately 10 m wide, with regular management due to the transmission lines) established in the 1960s. The vegetation there is original submontane seasonal forest, with the presence of emergent trees up to 26 m tall, including *Protium heptaphyllum* Aubl. Marchand (Burseraceae), *Maprounea guianensis* Aubl. (Euphorbiaceae), *Hirtella glandulosa* Spreng. (Chrysobalanaceae), and *Aspidosperma discolor* A. DC. (Apocynaceae), with poorly defined stratification, and a well-illuminated understory predominantly composed of young individuals of upper canopy species and species of Rubiaceae, Melastomataceae and Poaceae. Vines are abundant, but epiphytes and hemi-parasites are rare (Couto *et al.* 2011).

The regional landscape is undulating, with altitudes varying between 400 and 600 m, with clayey latosols containing only low amounts of organic material (Funch *et al.* 2005).The regional climate is classified as Aw (Alvares *et al.* 2014), with heavy rains during the Austral summer (November through January) and a secondary rainfall peak from March to April; the summers are rainy, and the winters are dry. Monthly rainfall varies from 35 mm (July through August) to 184 mm (December), with mean monthly rainfall rates exceeding 100 mm during the rainy season. Mean monthly temperatures vary from approximately 18 ºC during the coldest months (April through September) to approximately 22 ºC during the warmest months (October through February). Those environmental conditions typify the vegetation at the study site as Submontane Seasonal Forest (IBGE 2012).

Species surveys

An earlier floristic and phytosociological survey undertaken in the same area (Couto-Santos *et al.* 2015) established thirty randomly placed 10 × 10 m plots (0.3 ha total), with 15 plots near the linear edge formed by the power line (0–100 m from the power line) and 15 plots in the forest interior (> 150 m from the power line), with different distances from the linear edger and with unequal distances between them.

Trees, shrubs, vines, herbs, and epiphytes (71 species) were selected for the functional study according to their abundance, importance value and frequency in the area, corresponding to 75% of the total number of species found in the study plots (Couto-Santos *et al.* 2015). Only individuals (n = 491) located within the plots were selected for this study. All of the taxa studied were collected and herborized when in their reproductive phases, following Mori *et al.* (1989), and subsequently deposited in the HUEFS herbarium. The identifications of the plant materials were made by comparisons with specimens housed at the HUEFS and by consulting specialists.

Functional aspects

As we were interested in changes of forest community functionality and associated ecosystem services caused by linear edges, we measured traits related to pollination, seed dispersal, and carbon storage (McCauley *et al.* 2013) (Tab. 1) among species that were collected during a phenological and phytosociological study undertaken by Couto-Santos (2014); complementary data concerning pollination and dispersal syndrome were obtained from the literature and used to identify functional groups (FG). A matrix was established describing the binary and continuous functional characteristics of the species in the edge and interior areas (Violle *et al.* 2017) (Tab. 1). After converting the trait matrix into a numerical matrix, the data was

Table 1 – Functional traits used for describing the plant species at the edge and in the interior of a submontane seasonal forest, Chapada Diamantina, Northeastern Brazil.

	Functional traits	**Traits description**	**Associated ecosystem services**
Structural features	Life forms	Tree (1), shrub (2), vine (3), terrestrial herb (4), epiphyte (5)	Carbon storage
	Stratum	Canopy (1), sub canopy (2)	Carbon storage
Phenological patterns	Leaf phenology	Perennial (1), semi-deciduous (2) deciduous (3), leafless (4)	Carbon storage
	Reproductive phenology		Pollination and seed dispersal
	Synchrony	Asynchronic (1), low synchronic (2) high synchronic (3)	
	Frequency	Continual (1), subannual (2), annual (3) supra-annual (4)	
	Regularity	Irregular (0) regular (1)	
	Duration	Brief (1), intermediate (2), extended (3)	
Reproductive aspects	Dispersal syndrome	Zoochory (1), anemochory (2), autochory (3)	Seed dispersal
	Pollination syndrome	Anemophily (1), cantharophyly (2), phalenophily (3), melittophily (4), ornithophily (5), psicophily (6), zoophily not specialized (7)	Pollination
	Pericarp texture	Dried fruit (0), fleshy fruit (1)	Seed dispersal

scaled, and the functional groups were defined by Hierarchical Cluster Analysis. We used the Gower distance (Pla *et al.* 2012) and the average linkage in the *NbClust* package (Charrad *et al*. 2015) to form the FG. The number of ideal groups per local (border or interior) was analyzed using the silhouette width based on the silhouette function (Borcard *et al*. 2018). All cluster analysis was performed using free R version 3.6.1 software (R Core Team 2019). The cophenetic correlation was calculated according to the methodology proposed by Bussab & Morettin (2017), with an agreement measure between the groupings obtained and the original matrix of distances being obtained using PAST software (Hammer *et al.* 2001).

There are several methods and indexes for calculating functional diversity (Song *et al.* 2014). Those indices differ in their mathematical properties, in that they emphasize the location or dispersion of measures, consider single or multiple characteristics, and include abundances in the trace values and functional components (richness, divergence and evenness) (Mason *et al.* 2005; Mouch *et al.* 2010; Casanoves *et al.* 2011). The indexes of Functional richness (FRic - represent the trait space filled by the community), Functional divergence (FDiv - quantify how the trait values are spread along the range of a trait space), Functional evenness (FEve - measures the regularity of spacing between species in the trait space as did the univariate), and Functional dispersion (FDis - is a multidimensional index based on multitrait dispersion) (Casanoves *et al.* 2011), were used to quantify the total functional diversity of the system (FD) (Petchey & Gaston 2002), considering that differences in those functional indexes would be related to changes in ecosystem services caused by linear edges (Cadotte *et al.* 2011).

Those calculations were performe using FDiversity software <http://www.fdiversity.nucleodiversus.org> (Casanoves *et al.* 2011), including the abundance of each species per plot.

Statistical analyses

Permutational multivariate analysis (PERMANOVA) was performed to verify the existence of significant floristic difference between edges and interior (Anderson 2001). One-Way ANOVA was used to test for differences in functional diversity between edge and interior areas and was used to test the relationships between the functional diversity indices and species richness (numbers of species - S), as well as the diversity (Shannon - Wiener (*H*') in each plot. Those analyses were performed using BioEstat5.3 software (Ayres *et al.* 2007), considering, in all cases, $\alpha = 0.05$. The normality of data was evaluated using the Shapiro-Wilk test ($P > 0.05$).

Results

A total of 61 species were found in the forest edge sites and 50 species in the forest interior (Appendix S1, available on supplementary material <https://doi.org/10.6084/m9.figshare.13683961.v1>); 40 of those species were common to both environments. The edge demonstrated a cophenetic correlation of 0.79 and the interior 0.82. The main functional groups formed at the edge and in the forest interior (as determined by Cluster analysis) were defined based on life forms, stratum, leaf phenology, and fruit pericarp consistency (Tab. 2). The floristic difference between edge and interior was confirmed by PERMANOVA ($P < 0.001$).

Cluster analysis revealed the existence of two principal functional groups (Fig. 1a) along the edge; the first (BG1) comprised 47 species, and the second (BG2) 13 species (Fig. 2). In terms of their functional traits, group BG2 was found to be formed by understory vines, shrubs, herbs, and perennial epiphytes producing dry fruits. BG1

Table 2 – Characterization of plant functional groups at the edge and in the interior of a submontane seasonal forest, Chapada Diamantina, Northeastern Brazil.

	Group (G)	Subgroup (SG)	Species (n)	Predominant characters
Edges	BG1	BSG1	3sp	Shrubs, sub canopy, flowering and fruiting annual, zoochory and fleshy fruit
		BSG2	26sp	Trees, canopy, perennial, annual reproductive phenology, zoochory and fleshy fruit
		BSG3	10sp	Vines, canopy, perennial, high synchronic reproductive phenophases, melittophily
		BSG4	8sp	Trees, canopy, perennial, annual reproductive phenology zoochory and anemochory, dried fruit
	BG2	BSG5	2sp	Vines and shrubs, sub canopy, perennial, intermediate phenophases, anemochory, dried fruit
		BSG6	11sp	Herbs and epiphytes, sub canopy, perennials, melittophily in anemophily,dried fruit
Interior	IG1	ISG1	8sp	Trees, canopy,annual reproductive phenology of intermediate duration melittophily, dried fruit
		ISG2	9sp	Vines, canopy, perennial,high synchronic reproductive phenophases, melittophilous, dried fruit
		ISG3	15 sp	Trees, canopy, perennial, low synchronic reproductive phenophases, zoochory, fleshy fruit
		ISG4	7sp	Trees,canopy, semi-deciduous, annualreproductive phenophasesof intermediate duration,melittophily, zoochoric, fleshy fruit
	IG2	ISG5	6sp	Shrubs, sub canopy, annualreproductive phenophasesof intermediate duration, zoochory, fleshy fruit
		ISG6	4sp	Herb, sub canopy, perennial, anemophily, anemochory, dried fruit

included shrubs, trees, and vines, most of them being perennial and occupying the canopy layer and producing fleshy fruits.

Cluster analysis of the interior region demonstrated the formation of two large functional groups, the first with 39 species distributed into four subgroups, and the second with 10 species divided into two subgroups (Fig. 3). Silhouette analysis, however, indicated that the ideal number of functional groups is five (Fig. 1b). The first functional group, IG1, includes the trees and vines composing the upper canopy, groups ISG1 and ISG2 produce dry fruits but differ in terms of their life forms, while ISG3 and ISG4 produced fleshy fruits but differ in terms of their leaf phenologies. The second functional group, IG2, is formed by herbs and shrubs of the subcanopy, differing principally by their pollination and dispersal syndromes and the types of fruits produced (Tab. 2). Considering the species co-occurring in both the edge and interior areas, 77.5% of them belong to the same functional group, with some species of BSG2 [*Myrcia obovata* (Berg.) Niedz., *Pouteria torta* (Mart.) Radlk., *Pouteria ramiflora* (Mart.) Radlk.] forming a distinct group in the forest interior (ISG4).

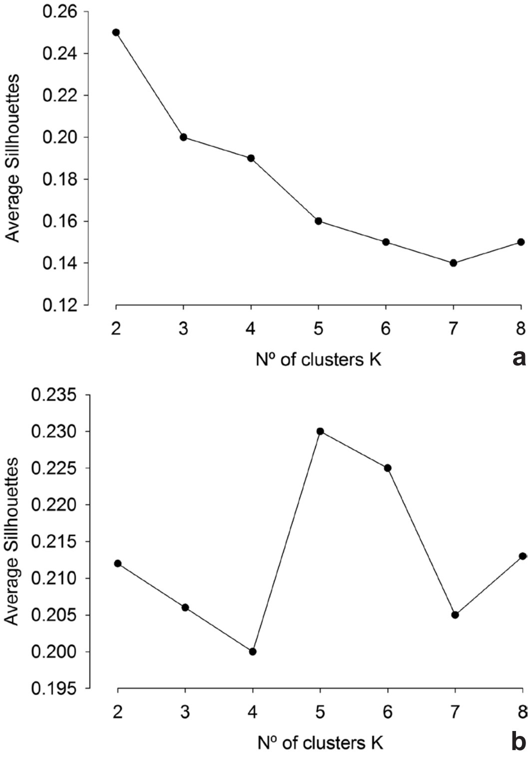

Figure 1 – a-b. Number of ideal cluster formed at the studied submontane seasonal forest, Chapada Diamantina, Northeastern Brazil, based on the Silhouette index – a. border; b. interior.

The functional diversity indexes (Tab. 3) showed slightly higher average values in the edge environment although they were not statistically different, except FRic, which showed higher values in the forest interior and was statistically different from the edge and interior areas. The diversity indices were affected in terms of species richness and the Shannon diversity index (Tab. 3), except for the Shannon index in edge and interior areas for FDis (edge: F = 0.5898; *P* = 0,45 and interior: F = 3.103; *P* = 0,0921).

Discussion

We found that the forest edge and interior had similar functional groups - indicating that despite the presence of different species in the edge and interior sites, they exercised similar ecological functions in both environments and demonstrated similar responses to environmental factors. Except in terms of richness, the other aspects of functional diversity (evenness, divergence, dispersion) were similar in both the forest edge and interior, suggesting no alterations in ecosystem services - which contrasts with the literature (McCauley *et al.* 2013; Lopes *et al.* 2009). Our data indicated that although the forest edge had been colonized by a series of different species, it nonetheless maintained functional diversity patterns similar to those found in the forest interior; similar results were found for understory communities in an Atlantic forest (Prieto *et al.* 2014).

Grouping analysis showed that a single species could be placed in different groups (considering attributes of phenological synchrony, regularity, and duration) depending on whether its individuals grew in the forest interior or forest edge (Santos 2007; Vale *et al.* 2011). Numerous studies have shown that fragmentation exposes forest species to new environmental conditions and promotes changes in their reproductive traits (Reznik *et al.* 2012), and significant changes having been noted in the phenologies of plant species within border and interior contexts (Girão *et al.* 2007; Cara 2006; Reznik *et al.* 2012).

Due to the impacts of linear edges on floristic composition, diversity, and species abundance in the studied sites (Couto-Santos *et al.* 2015), and considering that sites closer to the edge will experience greater exposure to its effects (Pohlman

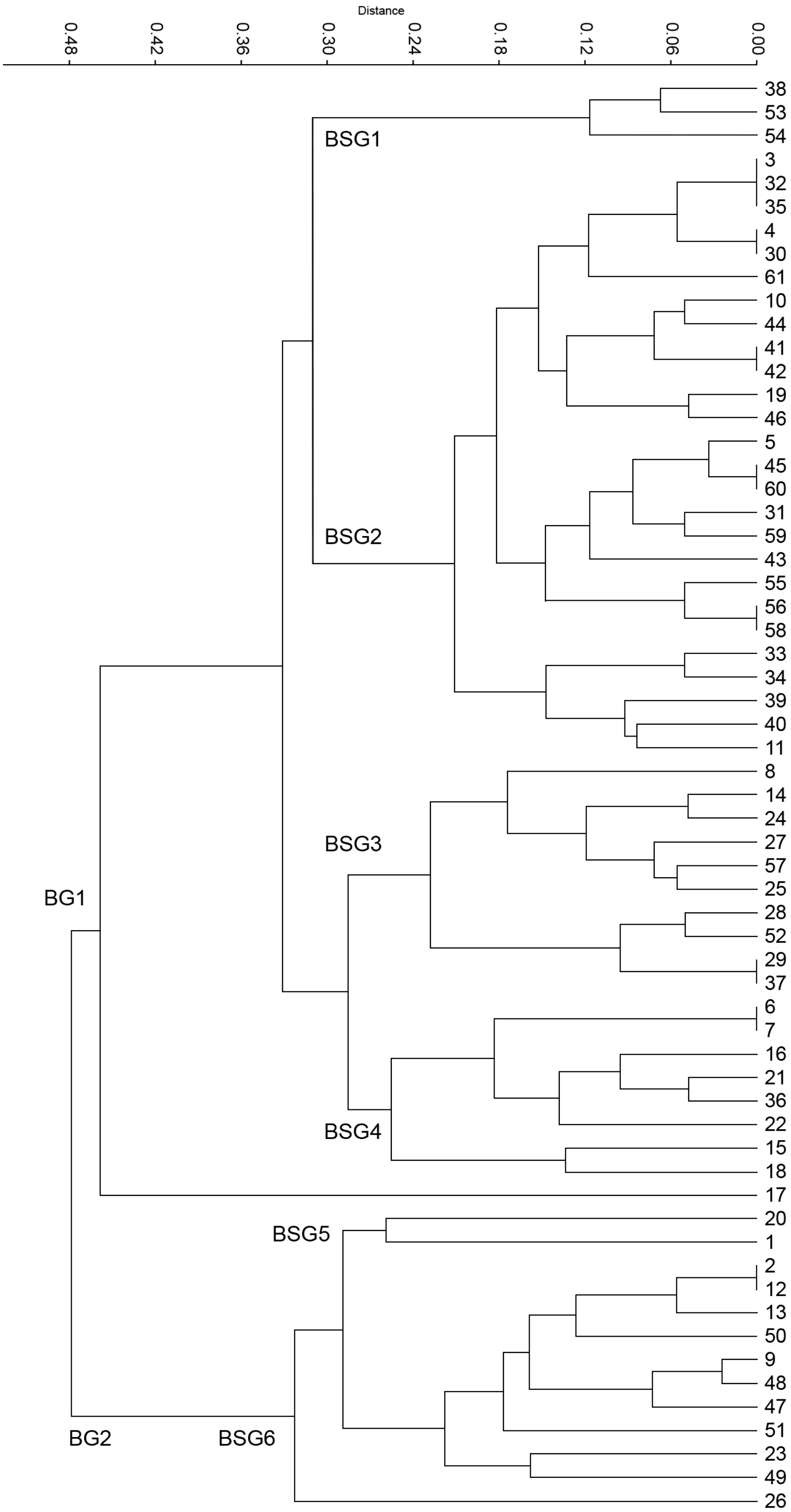

Figure 2 – Functional groups of plant species at the edge of a submontane seasonal forest, Chapada Diamantina, Northeastern Brazil. Groups defined by the Gower distance with numbered individuals as species listed in Appendix S1 (available on supplementary material <https://doi.org/10.6084/m9.figshare.13683961.v1>). BG = group; BSG = subgroups.

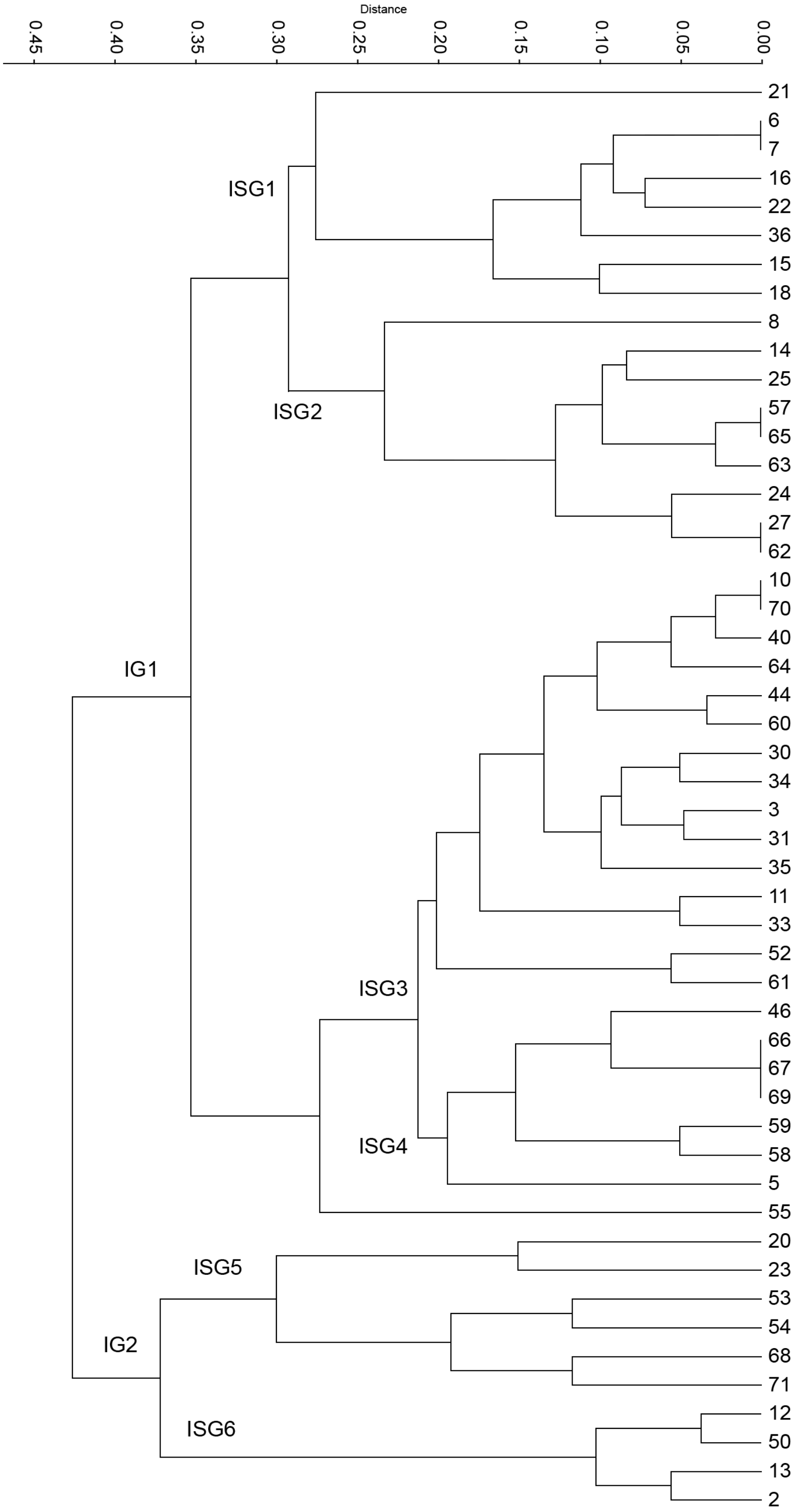

Figure 3 – Functional groups of plant species in the interior of a submontane seasonal forest, Chapada Diamantina, Northeastern Brazil. Groups defined by the Gower distance with numbered individuals as species listed in Appendix S1 (available on supplementary material <https://doi.org/10.6084/m9.figshare.13683961.v1>). IG = group; ISG = subgroup.

Table 3 – Mean and standard deviation of functional diversity indices at the edges and in the interior of a submontane seasonal forest, Chapada Diamantina, Northeastern Brazil, analysis of variance of classification criterion (One-way ANOVA) between areas and between the diversity indices and species richness (S) and Shannon index (H’). Values significant $P < 0.05$. FRic, FDiv, FEve and FDis refer to Functional richness, Functional divergence, Functional evenness and Functional dispersion.

		FRic	**FDiv**	**FEve**	**FDis**
Edge		0.003 ± 0.004	0.80 ± 0.04	0.75 ± 0.07	2.46 ± 0.3
Interior		0.14 ± 0.3	0.77 ± 0.06	0.74 ± 0.06	2.36 ± 0.3
			ANOVA		
Edge X Interior		F = 2.554 P = 0.001736	F = 1.556 P = 0.222	F = 0.233 P = 0.638	F = 0.738 P = 0.596
Edge	S	F = 143.2 P = 4.986E-08	F = 126.3 P = 1.00E-07	F = 127.2 P = 9.57E-08	F = 93.72 P = 4.70E-07
	H’	F = 838.3 P = 1.78E-12	F = 364.5 P = 1.28E-10	F = 375.3 P = 4.59E-11	F = 0.5898 P = 0.45
Interior	S	F = 114.5 P = 3.28E-07	F = 101.6 P = 6.79E-07	F = 102.2 P = 6.58E-07	F = 70.23 P = 3.74E-06
	H’	F = 289.2 P = 3.84E-14	F = 259 P = 1.57E-09	F = 271 P = 1.24E-09	F = 3.103 P = 0.09207

et al. 2007), it would be expected that the indexes of functional diversity would vary in relation to the forest edge and interior. Variations were only observed, however, in terms of Functional richness: ANOVA demonstrated that the linear edge did not affect other aspects of functional diversity - indicating that the effects of that power line edge were less severe than edges formed between forests and open fields (Paciência & Prado 2005; Ribeiro *et al.* 2009; Reznik *et al.* 2012). Similar patterns of edge effects have been described in tropical forest fragments (Laurance *et al.* 2006; Michalski *et al.* 2007; Oliveira *et al.* 2008).

From a biological point of view, as tropical forests are characterized by having stable microclimates and complex architectures (Laurance *et al.* 2009), linear edges surrounded by forest fragments will experience minimal microclimatic changes, having readily available seed sources for colonization - which will result in the similar functional structures observed here in the study area. Another relevant point to be considered is the time elapsed after the establishment of a linear edge. Recently created edges would tend to be structurally homogeneous (or at least very similar) to the forest interior (Holanda *et al.* 2010), but the power line that established the linear corridor in the seasonal forest investigated here was implanted approximately 50 years ago - sufficient time for alterations in the plant community to have occurred or for the forest to have established a new equilibrium. A study by Chazdon (2012), on the other hand, demonstrated that forest fragments can still show signs of change even 15–50 years after a disruption event.

The similar functional diversities of the edge area and forest interior were visible in terms of their equivalent functional diversity indices, the co-occurrence of species, and the formation of functional groups based on similar attributes. The linear edge altered the functional richness and affected the diversity indices (S and *H*’) without affecting other aspects of functional diversity, thus corroborating the study by Couto-Santos *et al.* (2015) that reported altered species composition, abundance, and distributions.

The greater functional richness index observed in the forest interior reflected biological losses caused by edge creation, as observed, for example, in the greater abundance of *Casearia arborea* (Rich) Urban, *Copaifera langsdorffii* Desf., *Ocotea nitida* (Meisn.) Rohwere, and *Eschweilera tetrapetala* Mori in the forest interior

(Couto-Santos *et al.* 2015), the latter species is endemic to this unique forest fragment in Bahia State, and threatened with extinction (CNCFlora 2016). Menezes *et al.* (2018) demonstrated that climatic changes (due to *ElNiño*) and anthropogenic alterations (in this case related to edge creation) influenced the reproductive phenology and floral visitors of *E. tetrapetala*, whose flowering and fruiting were more intense in the forest interior (and it was visited by potential pollinators only in that context).

Considering the small sizes of the disjunct Atlantic Forest areas in the Espinhaço Range and threats of species extinctions, their conservation will require special attention (Coelho *et al.* 2018). The consequences of edge effects from linear canopy openings must be considered in conservation planning, especially in forest fragments (such as the present study, inserted in various matrix that largely determine the magnitude of edge effects) (Prieto *et al.* 2014). Although the forest fragment studied here is included within the boundaries of the Chapada Diamantina National Park and it is protected by the Atlantic Forest Act (Federal Law nº 11.428/2006), its proximity to the main tourist attractions of the Chapada Diamantina generates immense anthropogenic pressure.

We concluded here that the seasonal tropical forest examined was more stable in terms of its functionality than its floristic composition (richness and diversity) after the establishment of the linear edge - indicating that edge effects from linear canopy openings provide excellent opportunities for field experiments to understand fragmented forest landscapes and help preserve diversity and function (Prieto *et al.* 2014). This research should therefore contribute to our understanding the impacts of linear edge creation and forest fragmentation on tropical forest communities.

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