NATURAL REGENERATION OF TREE SPECIES IN A CLOUD FOREST IN SANTA CATARINA, BRAZIL[1]

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[1] Received on 14.09.2014 accepted for publication on 27.10.2016.
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ABSTRACT – This paper aims at characterizing the tree species natural regeneration and evaluating the relation of this stratum to both the adult component and the environmental variables in a fragment of a cloud forest in Santa Catarina, Brazil. In each of 25 20 × 20 m plots, where the adult component and environmental variables have previously been evaluated, subplots of different sizes varying according to plants' height were then allocated as follows: Class 1 - plants with a height varying from 0.15 cm up to 1 m, being evaluated within 5 m^2; Class 2 - plants with a height varying from 1 up to 3 m, being evaluated within 10 m^2; Class 3 - plants with a height greater than 3 m and DBH smaller than 5 cm, being evaluated within 20 m^2. Data have been analyzed with regard to the determination of diversity (Shannon index), evenness (Pielou), Natural Regeneration Index (NRI), similarity with the adult component (Jaccard and Bray-Curtis), floristic-structural organization (Nonmetric Multidimensional Scaling - NMDS) and their relation to environmental variables. A total of 518 individuals distributed in 28 species were sampled. The low values of Shannon index (2.51 nat/ind) and evenness (0.75) suggest low diversity and elevated ecological dominance. The highest NRI has been found in the species *Symphyopappus itatiayensis* (Hieron.) R.M.King & H.Rob (19.36%). The similarity with the adult component were of 0.45 (Jaccard) and 0.24 (Bray-Curtis), demonstrating a low overall similarity (<0.50). The soil compaction was the only variable that has shown a relation with regeneration, which can be related to cattle's presence in the fragment.

Keywords: Phytosociology; Araucaria Forest; Forest management.

REGENERAÇÃO NATURAL DE ESPÉCIES ARBÓREAS EM UMA FLORESTA NEBULAR EM SANTA CATARINA, BRASIL

RESUMO – Os objetivos do presente estudo foram caracterizar a regeneração natural arbórea e relacionar esse estrato com o componente adulto e com variáveis ambientais em um fragmento de floresta nebular em Santa Catarina. Em cada uma das 25 parcelas de 20 × 20 m, onde previamente foi realizado um estudo com caracterização do componente adulto e de variáveis ambientais, foram estabelecidas subparcelas, com tamanhos diferenciados de acordo com o tamanho das plantas, para a avaliação dos regenerantes: Classe 1, plantas com altura de 0,15 cm até 1 m, avaliadas em 5 m², Classe 2, plantas com altura entre 1 e 3 m, avaliadas em 10 m², e; Classe 3, plantas com altura maior que 3 m e DAP menor que 5 cm, avaliadas em 20 m². Foram determinadas: diversidade (índice de Shannon), equabilidade (Pielou), Índice de Regeneração Natural (IRN),

http://dx.doi.org/10.1590/0100-67622016000600013

similaridade com o componente arbóreo adulto (Jaccard e Bray-curtis), organização florística-estrutural (escalonamento multidimensional não-métrico - NMDS) e relação com as variáveis ambientais. Foram amostrados 518 indivíduos distribuídos em 28 espécies. O valor do índice Shannon (2,51 nat/ind) e da equabilidade de Pielou (0,75) sugerem baixa diversidade e elevada dominância ecológica. A espécie de maior IRN foi ***Symphyopappus itatiayensis*** *(Hieron.) R.M.King & H.Rob (19,36%). As similaridades com os adultos foram de 0,45 (Jaccard) e 0,24 (Bray-Curtis), demonstrando baixa similaridade (<0,50). A compactação do solo foi a única variável que apresentou relação com a regeneração, o que pode estar relacionado com a presença de gado no fragmento.*

Palavras-chave: *Fitossociologia; Floresta Ombrófila Mista; Manejo florestal.*

1. INTRODUCTION

In the southern Brazil, the upper montane Araucaria Forest reaches altitudes above 1,000 (IBGE, 2012). It is often covered by haze or clouds, being therefore also called cloud forest (FALKENBERG, 2003). Such ecosystem gets additional rainfall moisture, which influences the hydrological regime, radiation balance and other climatic, pedological and ecological variables (STADTMÜLLER, 1987). A lower incidence of solar radiation, for instance, results in a low evapotranspirative capacity, which makes the environment more selective (HIGUCHI et al., 2013).

Cloud forests have high importance for fresh water supply due to their ability to intercept cloud moisture (HAMILTON et al., 1995) and because they work as a rivers' sources protector and as a slope's stabilizer (BIGARELLA et al., 1978). However, due to global climatic changes and human pressures, their conservation has been compromised (BUBB, 2004) and their areas reduced to just a few remnant forests. Wood exploitation and the expansion of agricultural areas are some of the factors responsible for the significant reduction of their areas (BACKES, 1983), as well as the reforestation with exotic species and the expansion of cities. The impact of cattle is also important, since the entry of animals into fragments may be frequent and therefore impact the natural regeneration of species.

Natural regeneration has been conceptualized in different ways; by considering either a dynamic or a static approach in time. In the dynamic concept, it represents an important process in the forest cycle as it refers to the initial stages of plant growth and is responsible for the establishment of a forest ecosystem (GAMA et al., 2002). The static concept understands the natural regeneration of tree species as the individuals below a certain level of inclusion (VOLPATO, 1994). Studies with both approaches are relevant, since they allow us to understand the regenerative capacity of a certain forest, as well as to infer about its future behavior and development (GAMA et al., 2002).

Despite the environmental importance of cloud forests, little is known about the natural regeneration in such environments. Studies of this nature are thus relevant since they may support the conservation and recovery plans of these areas as they enable the identification of limiting environmental factors and infer over the forest's future dynamics. Therefore, the goal of our work was to characterize the tree species natural regeneration in a cloud forest located in Santa Catarina, Brazil, and to observe its relationship to both the adult component and the environmental variables. We have worked with the following hypotheses: i) the floristic and structure of the regenerating component is similar to the tree species adult component; and ii) the regenerating component floristic-structural variation is associated with the existing environmental heterogeneity.

2. MATERIALS E METHODS

The forest fragment under study has 346 ha and is located in the municipality of Urubici, a mountain region in Santa Catarina, Brazil, at latitude 28°04'27"S and longitude 49°37'30"W reaching an altitude of approximately 1,600 m. Such altitude is considered to be close to the altitudinal tree line of the region, which is an imaginary line above which environmental conditions do not enable the emergence of the tree species component; therefore, only the herbaceous vegetation occurs (PAYETTE et al., 1985; GRACE et al., 2002). According to Köppen classification, the region is classified as a Cfb climate with an average annual temperature from 15 to 16°C so that there are frost and snow in colder periods. The average annual precipitation varies from 1,200 to 1,900 mm well-distributed along the year. Soils are shallow, mainly occurring as Litholic Neosol as well as Cambisols. In accordance with IBGE

(2012), the fragment's phyto-physiognomy can be classified as an Upper Montane Mixed Ombrophilous forest, which frequent cloudiness makes it a cloud forest. It is in an advanced stage of regeneration, having a history of selective wood removal in the past, however, nowadays only the impact of cattle is observed.

The fragment under study was systematically sampled through 25 sample units (plots) of 400 m^2 (20 m × 20 m) each, allocated by Marcon et al. (2014) for studying the tree species adult component (DBH $\geq$ 5 cm). Within these plots, always along the same side of the square that has defined the sample unit, subplots have been installed in order to evaluate their natural regeneration. Subplots differ in size due to the regenerating height class, in accordance with the methodology applied by Volpato (1994) and Higuchi et al. (2006): i) Class 1 – plants with a height from 15 cm to 1 m, being evaluated in 5 m² (5 × 1 m); ii) Class 2 – plants with a height from 1 to 3 m, being evaluated in 10 m² (10 × 1 m); iii) Class 3 – plants with a height greater than 3 m and DBH (diameter at breast height) smaller than 5 cm, being evaluated in 20 m² (20 × 1 m). Species sampled in the subplots have been identified and classified in families according to the APG III system (ANGIOSPERM PHYLOGENY GROUP, 2009).

For each of the 25 sample units, Marcon et al. (2014) have identified the edaphic and topographic environmental variables, as well as luminosity and environmental impact. By assuming that such variables represent all the area of the 20 × 20 m sample unit and therefore of its subplots, we have considered them as possible explanatory variables for the regenerative component floristic-structural patterns. The soils' physicochemical properties were obtained through nine composite samples in each plot, carried out in a 0 to 20 cm profile. Analyzes were carried out at both the Physics Laboratory and the Soils Chemistry Laboratory of the Santa Catarina University (UDESC) in accordance with the Official Network of Soil and Plant Tissue Analysis Laboratories of Rio Grande do Sul and Santa Catarina (ROLAS) protocol. Ph, Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Aluminum (Al), organic matter (OM), effective cation exchange capacity (CEC), base saturation on effective CEC (V) and levels of sand, silt and clay have then been quantified. The soil's compaction degree was measured through soil vertical penetration resistance tests by making use of a PLG1020 Falker penetrolog of digital impact through a type 2 cone with readings in soil moisture conditions corresponding to field capacity. For each plot, ten systematic replications have been carried out at a depth of 0 to 20 cm and the plot mean has then been collected. Data were obtained from a penetration resistance at 20 cm, consisting in the resistance mean for the entire profile and the profile's maximum value resistance. Regarding the topographic survey, three variables have been collected in each allocated plot: altimetric height, maximum unevenness and mean slope. The altimetric height was obtained from the average of the values observed for each plot vertices; the maximum unevenness has been considered as the largest vertical distance among plot vertices (OLIVEIRA FILHO et al., 1994); the mean slope has been calculated through the slope mean of the four sides of the plots (CARVALHO et al., 2005). The luminosity was evaluated through the forest canopy cover (%) though a concave spherical densitometer (LEMMON, 1956) which readings have been carried out in June. Four reading were performed at the center of each plot, towards the North, South, East and West directions, and the readings mean were therefore determined. For evaluating the environmental impacts, the presence of trails as well as the impacts caused by cattle and by the selective cutting of trees were observed within the plots according to a scale from 0 to 5, being 0 the absence of observable impact.

Sampling sufficiency has been determined by the species accumulation curve, recorded by randomization (1,000 permutations). The diversity of the regenerative component has then been calculated by the Shannon's index (H') and the ecological dominance has been calculated by the Pielou's equitability index (J'). Both density and frequency phytosociological estimates have been calculated according to the species and their size class (Classes 1, 2 and 3) (MUELLER-DOMBOIS; ELLEMBERG, 1974). The Natural Regeneration Index (NRI) was therefore calculated according to relative frequency values and relative density values (VOLPATO, 1994).

In order to determine the similarity between the regenerative component and the adult component, the species presence-absence matrices as well as the individuals' abundance matrices of each species in both strata (adult and regenerative) have been considered; from them, we have been able to calculate the Jaccard (presence-absence) and Bray-Curtis (abundance) indexes.

Multivariate non-metric multidimensional scaling (NMDS) was used to order the floristic-structural composition data from the regenerative component. The stress value has been calculated for determining the analysis adequacy. Environmental variables were adjusted after the produced ordination by the *envfit* function based on 999 permutations. Significant variables ($p \leq 0.05$) were plotted in the form of level curves along with the ordination diagram through the *ordisurf* function.

All analyzes were held through an electronic spreadsheet (NRI) and the R program (R DEVELOPMENT CORE TEAM, 2014) by using the Vegan library (OKSANEN et al., 2014) (Shannon's, Pielous', Jaccard's, Bray-Curtis' indexes, NMDS, and *envfit* and *ordisurf* functions).

3. RESULTS

A total of 518 regenerating individuals (35,000 ind.ha^{-1}) belonging to 28 species, 19 genera and 15 families were sampled; one taxon of the Solanaceae family has not been identified at both generic and specific levels (Table 1). The richest family was the Myrtaceae, showing nine species. The species accumulation curve has tended to be stable (Figure 1) and, by adding the last plot, an increase of only 1.09% in the species number has been observed. Shannon's diversity value was 2.51 nat/ind and Pielou's equitability value was 0.75.

Despite Myrtaceae's richness, the *Symphyopappus itatiayensis* (Hieron.) R.M.King & H.Rob has shown the highest participation in the community ($_{total}$NRI = 19.36%) (Table 2). Its high participation was due to its high NRI in class 1 (15.7%) as a result of the species

Table 1 – Tree species and their respective numbers of individuals (N) sampled in the regenerative component in a cloud forest in the municipality of Urubici, SC, Brazil.
Tabela 1 *– Espécies com respectivos números de indivíduos (N) amostrados no componente regenerativo arbóreo de um fragmento de floresta nebular em Urubici, SC.*

Families	Species	N
Anacardiaceae	*Schinus polygamus* (Cav.) Cabrera	2
Aquifoliaceae	*Ilex microdonta* Reissek	21
	Ilex paraguariensis A.St.-Hil.	10
	Ilex theezans Mart. ex Reissek	1
Araucariaceae	*Araucaria angustifolia* (Bertol.) Kuntze	4
Asteraceae	*Dasyphyllum brasiliense* (Spreng.) Cabrera	2
	Moquiniastrum polymorphum (Less.) G. Sancho	1
	Symphyopappus itatiayensis (Hieron.) R.M.King & H.Rob.	129
Berberidaceae	*Berberis laurina* Billb.	3
Cardiopteridaceae	*Citronella paniculata* (Mart.) R.A.Howard	13
Celastraceae	*Maytenus boaria* Molina	3
Dicksoniaceae	*Dicksonia sellowiana* Hook.	1
Lauraceae	*Ocotea pulchella* Mart.	27
Myrsinaceae	*Myrsine coriacea* (Sw.) Roem. & Schult.	11
	Myrsine umbellata Mart.	2
Myrtaceae	*Eugenia pluriflora* DC.	1
	Myrceugenia euosma (O.Berg) D.Legrand	21
	Myrceugenia glaucescens (Cambess.) D.Legrand & Kausel	19
	Myrceugenia miersiana (Gardner) D.Legrand & Kausel	47
	Myrceugenia myrcioides (Cambess.) O.Berg	2
	Myrceugenia oxysepala (Burret) D.Legrand & Kausel	19
	Myrceugenia regnelliana (O.Berg) D.Legrand & Kausel	67
	Myrcia hatschbachii D.Legrand	1
	Myrrhinium atropurpureum Schott	3
Rosaceae	*Prunus myrtifolia* (L.) Urb.	13
Solanaceae	Solanaceae sp. 1	7
Symplocaceae	*Symplocos uniflora* (Pohl) Benth.	7
Winteraceae	*Drimys angustifolia* Miers	81
Total		518

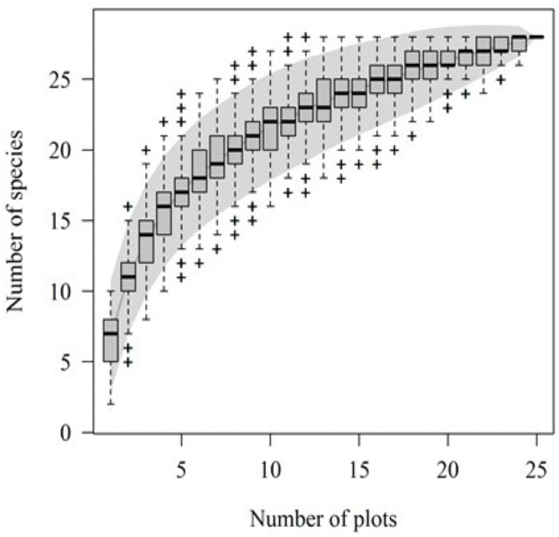

Figure 1 – Accumulation curve for the tree species sampled in the regenerative component in a fragment of a cloud forest in the municipality of Urubici, SC, Brazil.
Figura 1 – *Curva de acumulação das espécies amostradas no componente regenerativo arbóreo de um fragmento de floresta nebular em Urubici, SC.*

high values of density (RD = 26.29%) and frequency (RF = 12.44%). However, *S. itatiayensis* NRI has shown a reduction in class 2 (3.7%) and absence in class 3. *Myrceugenia regnelliana* (O.Berg) D.Legrand & Kausel has shown the highest IRN in class 2 (3,8%) and *Myrceugenia euosma* (O.Berg) D.Legrand in class 3 (1,6%).

Besides *Symphyopappus itatiayensis,* a high total NRI has been observed in the following species: *Drimys angustifolia* Miers (12.0%)*, Myrceugenia regnelliana* (11.8%)*, Myrceugenia miersiana* (Gardner) D.Legrand & Kausel (9.2%)*, Ocotea pulchella* Mart. (5.8%)*, Myrceugenia euosma* (5.6%)*, Ilex microdonta* Reissek (5.2%)*, Myrceugenia oxysepala* (Burret) D.Legrand & Kausel (4.2%)*, Prunus myrtifolia* (L.) Urb. (3.2%) e *Myrsine coriacea* (Sw.) Roem. & Schult. (3.2%). All together these 10 species account for 79.6% of the community's NRI. *Araucaria angustifolia* (Bertol.) Kuntze, the species that most characterizes the phyto-physiognomy, has obtained low abundance values (RD = 0.40%) and reached only up to the 16th place in the NRI classification.

The similarities between the sampled regenerative component and the adult component were 0.45 for the Jaccard index (floristic differences) and 0.24 for the Bray-Curtis index (floristic-structural differences).

The NMDS has shown a stress value of 10.0%, indicating that the ordination diagram is suitable for interpretation (Figure 2). The average penetration resistance was the only variable that has shown significant relation ($p \leq 0.05$) to the floristic-structural organization of the natural regeneration indicated by the NMDS. One can notice a gradient of average soil compaction, with *Maytenus boaria* Molina associated to sites of greater soil compaction (>780 kPa) and the species *Myrceugenia oxysepala*, *Moquiniastrum polymorphum* (Less.) G. Sancho and *Prunus myrtifolia* associated to lower average soil compaction plots (± 620 kPa).

4. DISCUSSION

Myrtaceae, sampled with the highest number of species, has previously been observed as a family of high representativeness in Araucaria forests (MAUHS; BAKES, 2002; SILVA et al., 2012; SOUZA et al., 2012; GASPER et al., 2013; HIGUCHI et al., 2013; GUIDINI et al., 2014), occurring both in the adult and the regenerative components of areas at different altitudes, which emphasizes its ecological importance. *Araucaria angustifolia*, which best characterizes the phyto-physiognomy, has occurred in low density levels both in the adult and regenerative components (MARCON et al., 2014). Such pattern represents a contrast in relation to what has been observed in lower altitude areas, where the species stands out in the forest canopy but with a low representativeness in regeneration (NARVAES et al., 2005). Thus, considering both our results and those described in the literature it is inferred that the *A. angustifolia* has a limited natural regeneration in Araucaria forest's understory areas; such a limitation is even more extreme at high altitudes areas (> 1,500 m).

As Kersten and Galvão (2011) state that sufficiency is reached when there is a tendency to stabilize the accumulation curve and the increase in sampling effort does not significantly alter the number of observed species, suggesting that a 10% increase in the sampling

Table 2 – Natural regeneration index (NRI, %) by classes (c1, c2 and c3) for total community, total relative density (RD, %) and total relative frequency (RF, %) for the regenerative component in a fragment of a cloud forest in the municipality of Urubici, SC, Brazil.

Tabela 2 – *Índice de regeneração natural (IRN, em %) por classe (c1, c2 e c3) e total, densidade relativa total (DR, em %) e frequência relativa total (FR, em %) para o componente regenerativo arbóreo de um fragmento de floresta nebular em Urubici, SC.*

Species	NRI-c1	NRI-c2	NRI-c3	NRI-total	RD-total	RF-total
Symphyopappus itatiayensis	15.69	3.67	0.00	19.36	26.29	12,44
Drimys angustifolia	7.91	2.93	1.18	12.01	13.89	10,14
Myrceugenia regnelliana	6.99	3.79	1.04	11.82	12.11	11,52
Myrceugenia miersiana	5.96	2.70	0.52	9.18	9.14	9.22
Ocotea pulchella	5.51	0.29	0.00	5.79	6.06	5.53
Myrceugenia euosma	2.30	1.78	1.55	5.63	2.97	8.29
Ilex microdonta	5.16	0.00	0.00	5.16	4.80	5.53
Myrceugenia oxysepala	3.33	0.63	0.26	4.22	3.83	4.61
Prunus myrtifolia	3.21	0.00	0.03	3.24	2.80	3.69
Myrsine coriacea	2.30	0.86	0.00	3.16	2.17	4.15
Myrceugenia glaucescens	1.95	0.86	0.26	3.07	3.37	2.76
Citronella paniculata	2.75	0.29	0.00	3.04	2.86	3.23
Ilex paraguariensis	2.64	0.29	0.00	2.93	2.17	3.69
Symplocos uniflora	2.18	0.00	0.00	2.18	1.60	2.76
Solanaceae sp. 1	1.72	0.00	0.00	1.72	1.60	1.84
Araucaria angustifolia	0.00	0.86	0.26	1.12	0.40	1.84
Myrrhinium atropurpureum	1.03	0.00	0.00	1.03	0.69	1.38
Maytenus boaria	0.69	0.29	0.00	0.98	0.57	1.38
Berberis laurina	0.34	0.34	0.00	0.69	0.46	0.92
Myrceugenia myrcioides	0.34	0.00	0.26	0.60	0.29	0.92
Schinus polygamus	0.00	0.29	0.26	0.55	0.17	0.92
Dasyphyllum brasiliense	0.46	0.00	0.00	0.46	0.46	0.46
Myrsine umbellata	0.46	0.00	0.00	0.46	0.46	0.46
Moquiniastrum polymorphum	0.34	0.00	0.00	0.34	0.23	0.46
Ilex theezans	0.34	0.00	0.00	0.34	0.23	0.46
Myrcia hatschbachii	0.34	0.00	0.00	0.34	0.23	0.46
Dicksonia sellowiana	0.00	0.29	0.00	0.29	0.11	0.46
Eugenia pluriflora	0.00	0.00	0.26	0.26	0.06	0.46
Total	73.94	20.16	5.88	100.00	100.00	100.00

area results in an increase of less than 5% in the number of species, the sampling sufficiency to quantify the species richness has therefore been reached. Thus, by including the twenty-fifth plot, which corresponds to 4% of the sampling area, there could be an increase of up to 2% in species. Once there was a 1.09% of increase, it is concluded that most of the tree species richness have been sampled.

The diversity index we have found may be considered low (2.51) since higher values are found for the regenerative component of tree species in forests of the same region at lower altitudinal floors (around 1,000 m). For instance, Mauhs and Backes (2002) and Dalla Rosa et al. (2015) have found values of 2.90 and 3.16, respectively. The lowest value we have found has probably occurred due to the limiting environmental conditions of the high mountain formation (FRANÇA; STEHMANN, 2004), such as low temperatures and lower incidence of solar radiation, due to which such physiognomy has a low evapotranspirative capacity as well as shallow soils, therefore constituting an ecologically selective environment which has enabled the development of a small number of species and high ecological dominance. Higher dominance has also been confirmed by the low Pielou's equitability value (0.75) and the high NRI value of only 10 species (79.6%).

The greater participation of Asteraceae (*Symphyopappus itatiayensis*), with abundance in the smaller size classes but absent from class 3, may indicate

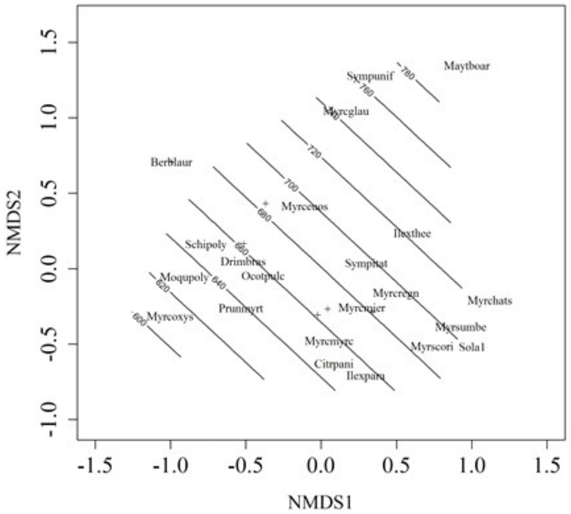

Figure 2 – Non-metric Multidimensional Scaling (NMDS) indicating the floristic-structural organization of the tree species regenerative component. Lines represent the soil compaction gradient in a fragment of a cloud forest, in the municipality of Urubici, SC, Brazil.

Figura 2 *– Escalonamento Multidimensional Não-Métrico (NMDS) indicando a organização florístico-estrutural do componente regenerativo arbóreo. Linhas representam o gradiente de compactação dos solos, em um fragmento de floresta nebular em Urubici, SC.*

a high propagule production and appropriate environmental conditions for its initial establishment – with ecological factors that limit the change for larger size classes, though. It is a pioneer species that invests in the production of large numbers of propagules being an excellent colonizer, but it has a low competitive capacity due to its high light-requirement (MALUF; WIZENTIER, 1998), which makes its development in the understory difficult, especially regarding this fragment where the mean value of canopy closure is 99.35% (MARCON et al., 2014). It is also worth noting the high richness of the *Myrceugenia* genus among the species of higher community participation and its presence in all height classes, being considered an important genus in the composition of high mountain forests (FRANÇA; STEHMANN, 2004; MEIRELES et al., 2008). According to Landrum (1981), this genus stands out along the Brazilian plateaus eastern coast at elevations above 900-1,000 m and under a cold and humid climate, which is in accordance with the features we have found.

As for the similarity of both regenerative and adult tree species components, the low values (<0.50) we have found indicate low floristic-structural sharing. Results can be explained due to the ecological differences among species in competitive terms throughout the forest establishment process. Ecological requirements for the initial establishment may differ from those required for the species to reach the upper stratum, resulting in a turnover gradient of species along the forest's vertical profile (LEYSER et al., 2012). In addition, it cannot be ruled out the possibility that part of the differences we have found represent a bias related to the methodological differences for studying both the adult and the regenerative components as far as the size of the plots is concerned, and to the inherent structuring of each component, such as the species aggregation level (e.g. HIGUCHI et al., 2010), which might have the potential of implicating the sub-sampling of some populations since the population grouping is not adequately conceived by the plots. As for the studying area, the cattle's entry in the fragment could also be considered since it may act as an ecological filter therefore making it easy or difficult to develop certain species of the regenerative stratum, which might cause divergences between strata as well as future floristic-structural changes. Accordingly, safer inferences about future changes in the floristic-structural profile can only be made from dynamics studies that enable to monitor the regenerating's growth.

The low relation of the regenerative component to environmental variables, as we have observed, is a pattern that may occur in natural forests (e.g. PAINE; HARMS, 2009; HIGUCHI et al., 2015). According to Higuchi et al. (2015), the natural regeneration process in a forest's understory starts with the arrival and subsequent germination of seeds on the forest floor, which, according to Guarigata and Pinard (1998), occurs in an irregular way. Thus, the vegetation × environment relation is expected to be more evident regarding the adult component since the environmental filter had a longer action on it, as it has been observed by Marcon et al. (2014).

Soil compaction, the only variable that has shown some relation with the regenerative components, might be associated with the presence of cattle in the fragment.

In addition to causing greater soil compaction, cattle influence the process of natural regeneration due to herbivory and trampling of plants. According to Mauhs and Backes (2002), the presence of cattle can be considered as the most influent factor for changing the regenerative component. More susceptible species regarding to cattle have high mortality of individuals, low establishment of seedlings and, consequently, smaller populations (SAMPAIO; GUARINO, 2007). That might be the case of *Myrceugenia oxysepala*, *Moquiniastrum polymorphum* and *Prunus myrtifolia* species, which have greatly appeared in lower compaction places. However, there are also species in which seedlings establishment and survival are not influenced by the presence of cattle once they have non-palatable leaves or another defense mechanism, such as sharp leaves (SAMPAIO; GUARINO, 2007). Such resistant species may also have undergone through morphological and physiological changes in their roots, enabling them to adapt to higher soil compaction conditions (MÜLLER et al., 2001). That may be the case of *Maytenus boaria* species since it has appeared in places of greater soil compaction. In addition, once cattle may negatively act on the abundance of some species, less susceptible species could be favored due to competition relief.

5. CONCLUSION

The cloud forest regenerative component has been characterized by the richness of the Myrtaceae family and the abundance of the species *Symphyopappus itatiayensis*, *Drimys angustifolia* and *Myrceugenia regnelliana*. Low floristic-structural similarity to the adult component has been observed and soil compaction has been the only significant environmental variable on the organization of the regenerative component, which may be related to the presence of cattle. Long-term temporal approach studies are necessary for more conclusive inferences on the process of natural regeneration in the studying area.

6. ACKNOWLEDGEMENTS

We thank to CNPq for granting a college scholarship to the first author of this paper, and for providing a research productivity grant to the second and third authors; and to PhD Marcos Eduardo Guerra Sobral, for identifying the *Myrceugenia* species.

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