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VERTICAL STRUCTURE OF THE ARBOREAL COMPONENT UNDER REGENERATION PHASE OF A DECIDUOUS FOREST FRAGMENT, SANTA CATARINA STATE, BRAZIL¹

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ABSTRACT – The objective of this study was to evaluate the structure (horizontal and vertical) of a Deciduous Forest, located between the municipalities of Piratuba and Ipira (SC). 14.000 m² of tree communities were analyzed, sub- divided into 14 plots of 10 x 100 m, where all individuals with DBH equal to or greater than 4.0 cm were sampled and identified. For natural regeneration were sampled 560 m², divided into 14 plots of 10 x 4 m. In the tree strata were sampled 2.125 individuals belonging to 34 families, 80 genera and 113 species with a total density of 1.517 ind.ha⁻¹. Natural regeneration were sampled 196 individuals belonging to 24 families and 49 species with a total density of 3.500 ind . ha⁻¹. *Luehea divaricata* Mart., *Actinostemon concolor* (Spreng) Müll. Arg. and *Parapiptadenia rigida* (Benth.) Brenan had of value of increased importance (7,1%, 7,0 % and 5,3%, respectively) . *Actinostemon concolor* got high value Relative Natural Regeneration (18,1%). The low percentage of natural regeneration of species as *Luehea divaricata* and *Parapiptadenia rigida*, respectively 3,7% and 1,5%, typical of EDF , may represent a maintenance commitment in the community. The study revealed the presence of exotic species with invasive potential, as *Hovenia dulcis* Thumb. These facts point to the importance of the adoption of management measures, since the forest fragment studied is advancing successional terms, however, anthropogenic interference with signals in the floristic composition. These facts point to the importance of the adoption of management measures, since the forest fragment studied is suffering anthropogenic impact, influencing the ecological succession mechanisms.

Keywords: Phytosociology; Forest ecology; Secondary succession.

ESTRUTURA VERTICAL DO COMPONENTE ARBÓREO EM FASE DE REGENERAÇÃO DE UM TRECHO DE FLORESTA DECIDUAL, SC

RESUMO – O objetivo deste trabalho foi avaliar a estrutura (horizontal e vertical) de um trecho de Floresta Estacional Decidua, localizado entre os municípios de Piratuba e Ipira (SC). Foram analisados 14.000 m² do estrato arbóreo, sub-divididos em 14 parcelas de 10 x 100 m, onde todos os indivíduos com DAP igual ou maior que 4,0 cm foram amostrados e identificados. Para regeneração natural foram amostrados 560 m², subdivididos em 14 parcelas de 10 x 4 m. No estrato arbóreo foram amostrados 2.125 indivíduos, pertencentes a 34 famílias, 80 gêneros e 113 espécies, com densidade total de 1.517 ind.ha⁻¹. Na regeneração natural foram amostrados 196 indivíduos, distribuídos em 24 famílias e 49 espécies, com densidade total de 3.500 plântulas.ha⁻¹. *Luehea divaricata* Mart., *Actinostemon concolor* (Spreng.) Müll. Arg. e *Parapiptadenia rigida* (Benth.) Brenan apresentaram os maiores Valores de Importância Ampliados (7,1%, 7,0% e 5,3%, respectivamente). *Actinostemon concolor* obteve elevado valor de Regeneração Natural Relativa (18,1%). O baixo percentual na regeneração natural de espécies como *Luehea divaricata* e *Parapiptadenia rigida*, respectivamente 3,7% e 1,5%, típicas das FED, pode representar um comprometimento de manutenção na comunidade. O estudo revelou a presença de espécies

*exóticas com potencial invasor, como a **Hovenia dulcis** Thumb. Esses fatos apontam para importância da adoção de medidas de manejo, uma vez que o fragmento florestal estudado encontra-se sofrendo interferência antrópica, influenciando nos mecanismos de sucessão ecológica.*

Palavras-chave: Fitossociologia; Ecologia florestal; Sucessão secundária.

1. INTRODUCTION

Seasonal Deciduous Forests (SDF) occur in regions with annual precipitation of less than 1,600 mm or in regions with intense cold, which results in more than 50% of leaf losses in trees of a forest (OLIVEIRA-FILHO et al., 2006).

Santa Catarina State, Brazil has undergone strong anthropic pressures, first with logging and subsequently due to the extensive agriculture. Currently, the urbanization process has provided significant changes in the relationships of the resources on the edge and inside forest (MOTTER; FIGUEIRÓ, 2010; GASPER et al., 2012; VIBRANS et al., 2013a; SEVEGNANI; SCHROEDER, 2013). However, the territory of Santa Catarina has the largest area of remaining Atlantic forest, which represents 16% of SDF (IBGE, 2013; VIBRANS et al., 2013b).

By the end of the last century, the researches on plant composition in the west of the state were still insufficient, even with some important initiatives, such as the “Flora Ilustrada Catarinense” (NEGRELLE; SILVA, 1992). From the Forest Floristic Inventory of Santa Catarina (FFISC), new efforts have contributed to broaden the knowledge about remaining forests (GASPER et al., 2012).

According to Freitas and Magalhães (2012), the study of the horizontal structure is concerned about the sociological analysis of the species in the distribution of a sinusia. Nevertheless, only this type of approach could not be enough for allowing a true characterization of the order of ecological importance of the species (FINOL, 1971). Thus, in order to get a more appropriate picture for the community knowledge, it is necessary to incorporate the arrangement of species along the vertical gradient (FARIAS et al., 1994).

The vertical structure defines the arrangement of different strata of a plant community (FREITAS; MAGALHÃES, 2012). The uneven-aged heterogeneous forests generally present a decrease in the availability of light along the vertical profile toward the ground, with greater differentiation of niches (SOUZA; SOUZA,

2004; MORAIS et al., 2013). Therefore, through the forest vertical stratification study, it is possible to obtain more detail about the richness, diversity, growth and biomass production (POLISEL, 2013).

Natural regeneration allows the effective analysis to diagnose the conservation state of the fragment and the response to the management as it represents the set of individuals that can be recruited for the later successional stages (SILVA et al., 2010).

According to Silva et al. (2010), the knowledge of the forest structure, combined with the analysis of natural regeneration, has a great importance for the elaboration of restoration plans, conservation and management of forest fragments, ensuring the maintenance of the community and composition species characteristics. However, when applied to a temporal scale, it contributes to a better understanding about the level of ecological stability and forest restoration velocity (SILVA et al., 2010).

This study aimed to evaluate the structure (horizontal and vertical) and the regeneration state of a Seasonal Deciduous Forest fragment located in the Santa Catarina Midwest region.

2. MATERIALS AND METHODS

2.1. Description of the study site

The study was conducted in a SDF fragment located between the cities Piratuba and Ipira, Midwest of the Santa Catarina State (27° 25' 34" S and 51° 47' 18" W). The municipalities of Piratuba and Ipira have a population density of 33 and 30 inhabitants per km², respectively (IBGE, 2013). In Piratuba, the industrial activities related to the agribusiness contribute to 50.6% of the GNP; in Ipira, the service sector and agriculture account for more than 80% of this indicator (SEBRAE, 2010a; SEBRAE, 2010b).

The regional climate is classified as Cfa, i.e., a temperate humid hot-summer climate (KÖPPEN, 1948). The monthly precipitation varies between 100 and 181 mm and the monthly average temperature ranges from

11 °C to 20 °C, with the minimum monthly average amplitude from 6 °C to 16 °C (May to July) and the maximum average from 18 °C to 26 °C (December to February) (SPINELLI, 2012).

The study site is a secondary fragment of vegetation with about 120 ha, which is bounded for both urban perimeter of the municipalities and small farms, mostly with activities related to poultry and/or pig production.

2.2. Collection and data analysis

To assess the parameters of the plant community structure, 14 plots of 10 × 100 m (14,000 m²) were used. In those plots, all trees with diameter at breast height (DBH) greater than or equal to 4.0 cm were identified and their DBH and height values recorded. For the Natural Regeneration analysis, it was considered the individuals with DBH less than 4.0 cm and equal to or greater than 2.0 cm in each of the 14 subplots of 40 m² (10 × 4 m), allocated in all transects, totaling 560 m².

The botanical material was collected and identified in the field and subsequently had its identification confirmed using specialized literature and comparison with the Herbarium Collection of the Federal University of Santa Catarina (FLOR). The families were organized according to the Angiosperm Phylogeny Group III (2009).

The phytosociological parameters used in the horizontal structure analysis were the Relative Frequency (RF), Relative Density (RD), Relative Dominance (RDo) Coverage Value (CV) and Importance Value (IV) (MULLER DUMBOIS; ELLEMBERG, 1974).

To assess the sociological position of each species in the community, the population was divided into three strata of total height (h_j) (SOUZA; LEITE, 1993) as follows: lower stratum: $h_j < (h_x - 1S)$; middle stratum: $(h_x - 1S) \leq h_j < (h_x + 1S)$; and upper stratum: $h_j \leq (h_x + 1S)$. Where h_x is the average height of the sampled individuals, S is the standard deviation of the total height of the stratum h_j and h_j is the total height of the j -th individual tree of the respective stratum.

The vertical stratification was obtained by using the estimates of Absolute Sociological Position (ASP_i) and Relative Sociological Position (RSP_i) per species (FINOL, 1971).

The Relative Natural Regeneration (RNR) was assessed by using the arithmetic average of Frequency,

Density and size relative class of regeneration for each species present in this compartment (FINOL, 1971).

The Expanded Importance Value (EIV) was calculated from the arithmetic average of $IV \times (RF + RD + RDo) + RSP + RNR$ for each species (FINOL, 1971).

The parameter analyses of the forest structure were calculated by using the software Mata Nativa 2 (CIENTEC, 2006).

The similarity of species among the strata was analyzed using the Venn diagram, as proposed by Pinheiro and Durigan (2012).

3. RESULTS

It was sampled 2,125 individuals of the arboreal stratum in 14,000 m², belonging to 34 families, 80 genera and 113 species (Table 1). The total density of arboreal individuals with DBH ≥ 4.0 cm in the sampled fragment was 1,517 individuals ha⁻¹.

The lower strata represented the trees with total height (h_j) < 3.67 m, totaling 190 individuals (8.4% of the total number of sampled species). The total density of this stratum was 136 individuals ha⁻¹, especially for *Actinostemon concolor* (Spreng.) Müll. Arg. (15.3%) (Figure 1).

The middle stratum included the range of heights between $3.67 \text{ m} \leq h_j < 9.24$ m, totaling 1,630 individuals (76.7% of the total number of sampled plants), with a total density of 1,165 individuals ha⁻¹. *Luehea divaricata* Mart., *Actinostemon concolor* and *Casearia sylvestris* Sw. were represented by the greatest number of individuals, with 7% each (Figure 1).

In its turn, the upper stratum included the trees with total height greater than or equal to 9.24 m, totaling 305 individuals (14.3%). The total density of this stratum was 218 individuals ha⁻¹. The dominant species were *Parapiptadenia rigida* (Benth.) Brenan (9.5%) and *Ocotea puberula* (Rich.) Nees (8.9%) (Figure 1).

The analysis of Sociological Position (SP) showed that among the 113 species found, six were exclusive to the lower stratum, 35 to the middle stratum, three to the upper stratum and 72 common to all strata (Figure 1). In the lower stratum, the exclusive species were *Celtis brasiliensis* (Gardner) Planch., *Myrciaria floribunda* (H. West ex Willd.) O. Berg, *Aloysia virgata* (Ruiz & Pav.) Pers. and others. *Calyptanthus triconus* D. Legrand,

Table 1 – Species sampled in stretch deciduous forest in western Santa Catarina, Brazil sorted in decreasing order of importance performed. BA: Basal area ($m^2 \cdot ha^{-1}$); Ls, Ms and Us: number of individuals of lower, medium and upper stratum, respectively; Nt: number of individuals in all strata; RD: relative density; RDo: relative dominance; RF: relative frequency; IV%: relative value of importance; CV%: relative coverage value; PSR: relative sociologic position; Nr: Number of individuals in natural regeneration; RNR: relative total natural regeneration; and EIV%: relative Expanded Importance Value.

Tabela 1 – Espécies amostradas em trecho de Floresta Estacional Decidual, meio oeste catarinense, Brasil, em ordem decrescente de importância. AB: Área basal ($m^2 \cdot ha^{-1}$); Ni, Nm e Ns: número de indivíduos dos estratos inferior, médio e superior, respectivamente; Nr: número de indivíduos em todos os estratos; DR: densidade relativa; DoR: dominância relativa; FR: frequência relativa; VI%: valor de importância relativo; VC: valor de cobertura relativo; PSR: posição sociológica relativa; Nr: Número de indivíduos na regeneração natural; RNR: regeneração natural total relativa; e EIV%: valor de importância ampliado relativo.

Scientific name	AB	Ls	Ms	Us	Nt	RD	Fr	RDo	IV (%)	CV (%)	RSP	Nr	RNR	EIV (%)
<i>Luehea divaricata</i> Mart.	5,1292	4	117	21	142	6,7	2,6	13,1	7,9	10,6	8,0	7	3,7	7,1
<i>Actinostemon concolor</i> (Spreng.) Müll. Arg.	0,5532	29	116	1	146	6,9	1,5	1,4	3,2	4,1	7,2	48	18,1	7,0
<i>Parapiptadenia rigida</i> (Benth.) Brenan	5,7390	3	61	29	93	4,4	2,2	14,7	7,1	9,5	3,9	2	1,5	5,3
<i>Casearia sylvestris</i> Sw.	1,2897	4	113	14	131	6,2	2,9	3,3	4,0	4,6	6,5	1	1,5	4,0
<i>Cupania vernalis</i> Cambess.	1,1032	9	80	17	106	5,0	2,0	2,8	3,3	4,0	5,2	0	4,8	4,0
<i>Guarea macrophylla</i> Vahl	0,2771	11	65	1	77	3,6	1,8	0,7	1,9	1,9	3,4	12	5,8	3,0
<i>Nectandra megapotamica</i> (Spreng.) Mez	1,0305	4	54	11	69	3,3	2,4	2,6	2,6	2,7	2,7	7	4,5	2,9
<i>Cabralea canjerana</i> (Vell.) Mart.	1,9576	1	48	20	69	3,3	1,8	5,0	3,3	4,0	2,6	1	0,8	2,6
<i>Ocotea puberula</i> (Rich.) Nees	2,1442	1	28	27	56	2,6	2,0	5,5	3,3	3,9	1,7	2	1,1	2,5
<i>Apuleia leiocarpa</i> (Vogel) J. F. Macbr.	1,9952	0	26	10	36	1,7	2,0	5,1	2,9	3,4	1,6	3	1,5	2,4
<i>Matayba elaeagnoides</i> Radlk.	0,3925	0	37	3	40	1,9	1,5	1,0	1,4	1,4	2,1	14	5,6	2,4
<i>Trichilia clausenii</i> C. DC	0,7544	2	40	5	47	2,2	1,5	1,9	1,9	2,1	2,7	7	3,7	2,4
<i>Morus nigra</i> L.	0,5523	8	35	0	43	2,0	1,5	1,4	2,1	2,4	3,4	2	1,1	2,2
<i>Sebastiania commersoniana</i> (Baill.) L.B. Sm. & Downs	0,6654	10	50	2	62	2,9	1,1	1,7	2,1	2,5	3,6	1	0,8	2,1
<i>Tabernaemontana catharinensis</i> A. DC.	0,6876	4	43	2	49	2,3	2,4	1,8	2,2	2,2	2,8	0	0,0	2,0
<i>Campomanesia xanthocarpa</i> O. Berg	0,7213	4	37	4	45	2,1	1,8	1,8	2,0	2,2	2,8	0	0,0	1,8
<i>Annona</i> sp	0,4813	0	36	2	38	1,8	2,0	1,2	1,7	1,5	2,1	2	1,1	1,6
<i>Sapium glandulosum</i> (L.) Morong	0,9342	0	23	10	33	1,6	2,4	2,4	2,0	1,9	1,2	1	0,8	1,6
<i>Hovenia dulcis</i> Thunb.	0,8689	2	25	21	48	2,3	1,8	2,2	2,0	2,1	1,5	0	0,0	1,5
<i>Inga marginata</i> Willd.	0,4978	2	37	4	43	2,0	2,4	1,3	1,8	1,5	2,0	0	0,0	1,5
<i>Machaerium paraguayense</i> Hassl.	0,2378	2	28	2	32	1,5	1,8	0,6	1,2	1,0	1,5	2	1,5	1,4
<i>Nectandra lanceolata</i> Nees	0,9816	1	18	18	37	1,7	1,3	2,5	1,8	2,0	1,0	1	0,8	1,4
<i>Ocotea odorifera</i> Rohrer	0,9478	0	24	9	33	1,6	1,5	2,4	1,8	1,9	1,4	0	0,0	1,4
<i>Brugmansia suaveolens</i> (Bonpl. ex Willd.) Bercht. & C. Presl	0,0472	8	1	0	9	0,4	0,9	0,1	0,5	0,3	0,1	11	4,7	1,3
Indeterminadas estrato arbóreo	0,5861	1	14	8	23	1,1	2,9	1,5	1,8	1,3	0,9	0	0,0	1,3
<i>Lonchocarpus</i> sp.	0,1979	1	25	0	26	1,2	1,8	0,5	1,2	0,9	1,4	2	1,5	1,3
<i>Myrcarpus frondosus</i> Allemão	0,4280	0	23	7	30	1,4	2,2	1,1	1,5	1,1	1,1	2	1,1	1,3
<i>Sebastiania brasiliensis</i> Spreng.	0,1795	5	34	0	39	1,8	0,7	0,5	1,0	1,2	2,1	2	1,1	1,3
<i>Calyptanthus triconda</i> D. Legrand	0,1839	0	19	0	19	0,9	1,3	0,5	0,9	0,7	1,1	5	2,2	1,2
<i>Chrysophyllum gonocarpum</i> (Mart.	0,2351	5	18	1	24	1,1	2,0	0,6	1,3	0,9	1,3	1	1,1	1,2

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Table 1...
Tabela 1...

& Eichler ex Miq.) Engl.	0,1691	2	19	0	21	1,0	2,4	0,4	1,2	0,6	0,9	1	0,8	1,1
<i>Allophylus edulis</i> (A.StHil., A. Juss. . & Cambess.) Hieron. ex Nied	0,2733	3	24	1	28	1,3	1,8	0,7	1,3	1,0	1,5	0	0,0	1,1
<i>Lonchocarpus nitidus</i> (Vogel) Benth.	0,2617	1	17	2	20	0,9	1,5	0,7	1,1	0,8	1,1	0	0,0	0,9
<i>Chrysophyllum marginatum</i> (Hook. & Arn.) Radlk.	0,542	1	8	2	11	0,5	1,5	1,4	1,2	1,1	0,8	0	0,0	0,9
<i>Ruprechtia laxiflora</i> Meisn.	0,8459	1	6	4	11	0,5	1,1	2,2	1,3	1,4	0,4	0	0,0	0,8
<i>Cordia americana</i> (L.) Gottschling & J.S. Mill.	0,2524	4	17	1	22	1,0	0,9	0,7	0,9	0,9	1,2	0	0,0	0,8
<i>Eugenia subterminalis</i> DC.	0,0740	4	15	0	19	0,9	0,4	0,2	0,5	0,5	0,8	1	1,5	0,8
Myrtaceae 4	0,0000	0	0	0	0	0,0	0,0	0,0	0,0	0,0	0,0	8	4,1	0,8
<i>Piper gaudichaudianum</i> Kunth -	0,0537	3	5	1	9	0,4	0,7	0,1	0,4	0,3	0,3	0	1,8	0,7
<i>Duranta vestita</i> Cham.	0,0875	6	10	0	16	0,8	1,1	0,2	0,7	0,5	0,7	0	0,0	0,6
<i>Citrus</i> sp	0,1872	1	8	1	10	0,5	1,1	0,5	0,7	0,4	0,4	1	0,8	0,6
<i>Ocotea</i> sp.	0,3394	0	3	6	9	0,4	0,9	0,9	0,7	0,7	0,2	1	0,8	0,6
<i>Prunus myrtifolia</i> (L.) Urb.	0,2245	0	14	5	19	0,9	0,7	0,6	0,7	0,7	0,8	0	0,0	0,6
<i>Albizia edwallii</i> (Hoehe) Barneby & J.W. Grimes	0,1007	1	7	2	10	0,5	1,3	0,3	0,7	0,3	0,4	0	0,0	0,5
<i>Casearia decandra</i> Jacq.	0,0612	1	18	0	19	0,9	0,9	0,2	0,6	0,4	0,8	0	0,0	0,5
<i>Casearia obliqua</i> Spreng.	0,2529	0	11	1	12	0,6	0,7	0,7	0,6	0,5	0,5	0	0,0	0,5
<i>Dalbergia frutescens</i> (Vell.) Britton	0,1248	1	13	0	14	0,7	0,9	0,3	0,6	0,5	0,7	0	0,0	0,5
<i>Endlicheria paniculata</i> (Spreng.) J.F. Macbr.	0,4692	0	6	3	9	0,4	0,7	1,2	0,8	0,8	0,4	0	0,0	0,5
<i>Ficus citrifolia</i> Mill.	0,2170	0	7	2	9	0,4	1,1	0,6	0,7	0,5	0,5	0	0,0	0,5
<i>Schinus terebinthifolia</i> Raddi	0,0158	2	3	0	5	0,2	0,4	0,0	0,2	0,1	0,2	3	1,5	0,5
<i>Strychnos brasiliensis</i> (Spreng.) Mart.	0,0771	0	6	0	6	0,3	0,4	0,2	0,3	0,3	0,5	1	0,8	0,5
<i>Cedrela fissilis</i> Vell.	0,2267	0	4	3	7	0,3	0,9	0,6	0,6	0,4	0,2	0	0,0	0,4
<i>Ocotea diospyrifolia</i> (Meisn.) Mez	0,0685	0	7	1	8	0,4	0,9	0,2	0,5	0,3	0,4	0	0,0	0,4
<i>Poecilanthus parviflora</i> Benth.	0,1629	1	6	2	9	0,4	0,7	0,4	0,5	0,4	0,4	0	0,0	0,4
Rubiaceae 1	0,0000	0	0	0	0	0,0	0,0	0,0	0,0	0,0	0,0	4	1,8	0,4
<i>Syagrus romanzoffiana</i> (Cham.) Glassman	0,3002	0	5	2	7	0,3	0,7	0,8	0,6	0,5	0,2	0	0,0	0,4
<i>Trichilia elegans</i> A. Juss.	0,0081	0	4	0	4	0,2	0,7	0,0	0,3	0,1	0,2	1	0,8	0,4
<i>Vassobia breviflora</i> (Sendtn.) Hunz.	0,0230	3	3	0	6	0,3	0,4	0,1	0,3	0,2	0,2	2	1,1	0,4
<i>Cinnamomum triplinerve</i> (Ruiz & Pav.) Kosterm.	0,0286	0	2	0	2	0,1	0,2	0,1	0,1	0,1	0,1	1	0,8	0,3
<i>Alchornea triplinervia</i> (Spreng.) Müll. Arg.	0,3050	0	1	2	3	0,1	0,4	0,8	0,5	0,5	0,1	0	0,0	0,3
<i>Annona sylvatica</i> (A. St.-Hil.) Martius	0,0000	0	0	0	0	0,0	0,0	0,0	0,0	0,0	0,0	2	1,6	0,3
<i>Bauhinia forficata</i> Link	0,0583	0	8	0	8	0,4	0,4	0,2	0,3	0,2	0,4	0	0,0	0,3
<i>Campomanesia guazumifolia</i> (Camb.) O. Berg	0,0332	0	7	0	7	0,3	0,7	0,1	0,4	0,2	0,4	0	0,0	0,3
<i>Eugenia pluriflora</i> DC.	0,0000	0	0	0	0	0,0	0,0	0,0	0,0	0,0	0,0	3	1,4	0,3
Indeterminadas estrato regeneração	0,0000	0	0	0	0	0,0	0,0	0,0	0,0	0,0	0,0	3	1,6	0,3
<i>Machaerium</i> sp.	0,0792	0	3	1	4	0,2	0,7	0,2	0,4	0,2	0,2	0	0,0	0,3

Continue...
Continua...

Table 1...
Tabela 1...

<i>Machaerium stipitatum</i> (DC.) Vogel	0,0353	0	7	1	8	0,4	0,9	0,1	0,4	0,2	0,3	0	0,0	0,3
<i>Ricinus communis</i> L.	0,0656	3	7	0	10	0,5	0,2	0,2	0,3	0,3	0,4	0	0,0	0,3
<i>Urea baccifera</i> (L.) Gaudich. ex Wedd.	0,0196	5	2	0	7	0,3	0,4	0,1	0,3	0,2	0,1	1	0,8	0,3
<i>Albizia niopoides</i> (Spruce ex Benth.) Burkart	0,0494	1	3	0	4	0,2	0,7	0,1	0,3	0,2	0,2	0	0,0	0,2
<i>Aloysia virgata</i> (Ruiz & Pav.) Pers.	0,0038	1	0	0	1	0,1	0,2	0,0	0,1	0,0	0,0	1	0,8	0,2
<i>Aspidosperma australe</i> Müll. Arg.	0,0165	3	3	0	6	0,3	0,2	0,0	0,2	0,2	0,2	0	0,0	0,2
<i>Balfouridendron riedelianum</i> (Engl.) Engl.	0,0375	0	1	2	3	0,1	0,4	0,1	0,2	0,1	0,1	0	0,0	0,2
<i>Boehmeria caudata</i> Sw.	0,0234	3	2	0	5	0,2	0,7	0,1	0,3	0,1	0,2	0	0,0	0,2
<i>Celtis iguanaea</i> (Jacq.) Sarg.	0,0876	0	4	0	4	0,2	0,7	0,2	0,3	0,2	0,2	0	0,0	0,2
<i>Coussarea contracta</i> (Walp.) Müll. Arg.	0,0018	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	1	0,8	0,2
<i>Erythrina falcata</i> Benth.	0,0964	0	1	1	2	0,1	0,4	0,3	0,3	0,2	0,1	0	0,0	0,2
<i>Escallonia</i> sp.	0,0000	0	0	0	0	0,0	0,0	0,0	0,0	0,0	0,0	1	0,8	0,2
<i>Esenbeckia grandiflora</i> Mart.	0,0012	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	1	0,8	0,2
<i>Eugenia burkartiana</i> (D. Legrand) D. Legrand	0,0320	2	3	0	5	0,2	0,2	0,1	0,2	0,2	0,2	0	0,0	0,2
<i>Eugenia uniflora</i> L.	0,0163	0	4	0	4	0,2	0,4	0,0	0,2	0,1	0,2	0	0,0	0,2
<i>Fabaceae</i> 1	0,0522	0	2	1	3	0,1	0,7	0,1	0,3	0,2	0,2	0	0,0	0,2
<i>Maclura tinctoria</i> (L.) D. Don ex Steud.	0,056	0	1	1	2	0,1	0,4	0,1	0,2	0,1	0,1	0	0,0	0,2
<i>Myrciaria floribunda</i> (H. West ex Willd.) O. Berg	0,0041	1	0	0	1	0,1	0,2	0,0	0,1	0,0	0,0	1	0,8	0,2
Myrtaceae 3	0,1063	0	2	2	4	0,2	0,7	0,3	0,4	0,2	0,1	0	0,0	0,2
<i>Peltophorum dubium</i> (Spreng.) Taub.	0,0000	0	0	0	0	0,0	0,0	0,0	0,0	0,0	0,0	1	0,8	0,2
<i>Picrasma crenata</i> Engl. in Engl. & Prantl	0,0445	0	3	0	3	0,1	0,4	0,1	0,2	0,2	0,2	0	0,0	0,2
<i>Piper</i> sp.	0,0000	0	0	0	0	0,0	0,0	0,0	0,0	0,0	0,0	2	1,1	0,2
<i>Sesseea regnellii</i> Taub.	0,0337	0	3	0	3	0,1	0,7	0,1	0,3	0,1	0,1	0	0,0	0,2
Solanaceae 1	0,0000	0	0	0	0	0,0	0,0	0,0	0,0	0,0	0,0	2	1,1	0,2
<i>Solanum</i> sp.	0,0000	0	0	0	0	0,0	0,0	0,0	0,0	0,0	0,0	2	1,2	0,2
<i>Terminalia australis</i> Cambess.	0,0500	4	1	0	5	0,2	0,2	0,1	0,3	0,3	0,3	0	0,0	0,2
<i>Trema micrantha</i> (L.) Blume	0,0427	0	2	0	2	0,1	0,4	0,1	0,2	0,1	0,2	0	0,0	0,2
<i>Vitex megapotamica</i> (Spreng.) Moldenke	0,0186	3	1	0	4	0,2	0,4	0,1	0,2	0,1	0,1	0	0,0	0,2
<i>Zanthoxylum</i> sp.	0,0754	0	0	2	2	0,1	0,4	0,2	0,2	0,1	0,0	0	0,0	0,2
<i>Aegiphila brachiata</i> Velloso	0,0040	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0	0,0	0,1
<i>Allophylus guaraniticus</i> Radlk.	0,0033	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0	0,0	0,1
<i>Ateleia glazioviana</i> Baill.	0,0315	0	1	1	2	0,1	0,4	0,1	0,2	0,1	0,1	0	0,0	0,1
<i>Campomanesia</i> sp.	0,0248	1	2	0	3	0,1	0,2	0,1	0,1	0,1	0,1	0	0,0	0,1
<i>Celtis brasiliensis</i> (Gardner) Planch.	0,0152	2	0	0	2	0,1	0,2	0,0	0,2	0,1	0,1	0	0,0	0,1
<i>Cestrum intermediatum</i> Sendtn.	0,0176	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0	0,0	0,1
<i>Citronella paniculata</i> (Mart.) R.A. Howard	0,0241	0	0	1	1	0,1	0,2	0,1	0,1	0,1	0,0	0	0,0	0,1
<i>Cordia ecalyculata</i> Vell.	0,0092	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0	0,0	0,1
<i>Coutarea hexandra</i> (Jacq.) K. Schum.	0,0020	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0	0,0	0,1
<i>Dahstedtia pinnata</i> (Benth.) Malme	0,0024	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	8	0,0	0,1
<i>Eugenia rostrifolia</i> D. Legrand	0,0012	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0	0,0	0,1

Continue...
Continua...

Table 1...	0,0179	0	4	0	4	0,2	0,2	0,1	0,1	0,1	0,1	0,2	0	0,0	0,1
<i>Eugenia</i> sp.	0,0022	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0,1	0	0,0	0,1
<i>Euphorbiaceae</i> 1.	0,0548	0	0	1	1	0,1	0,2	0,1	0,1	0,1	0,0	0	0	0,0	0,1
<i>Holocalyx balansae</i> Micheli	0,0013	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0	0	0,0	0,1
<i>Inga</i> sp. -	0,0067	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0	0	0,0	0,1
<i>Jacaranda micrantha</i> Cham.	0,0015	1	0	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0	0	0,0	0,1
<i>Julocroton</i> sp.	0,0038	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,0	0	0	0,0	0,1
<i>Manihot grahamii</i> Hook.	0,0194	1	3	0	4	0,2	0,2	0,1	0,2	0,1	0,1	0	0	0,0	0,1
<i>Mimosa bimucronata</i> (DC.) Kuntze	0,0020	1	0	0	1	0,1	0,2	0,0	0,1	0,0	0,0	0	0	0,0	0,1
<i>Myrcia oblongata</i> DC.	0,0012	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0	0	0,0	0,1
<i>Myrsine</i> sp.	0,0065	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0	0	0,0	0,1
<i>Myrsine umbellata</i> Mart.	0,0113	0	2	0	2	0,1	0,2	0,0	0,1	0,1	0,1	0	0	0,0	0,1
<i>Myrtaceae</i> 1	0,0035	0	1	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0	0	0,0	0,1
<i>Myrtaceae</i> 2	0,0494	0	1	0	1	0,1	0,2	0,1	0,2	0,1	0,2	0	0	0,0	0,1
<i>Pouteria salicifolia</i> (Spreng.) Radlk.	0,0050	1	0	0	1	0,1	0,2	0,0	0,1	0,0	0,1	0	0	0,0	0,1
<i>Sebastiania klotzschiana</i> (Müll. Arg.) Müll. Arg.	0,0514	0	2	0	2	0,1	0,2	0,1	0,2	0,1	0,1	0	0	0,0	0,1
<i>Solanum mauritianum</i> Scop.	0,0199	0	1	0	1	0,1	0,2	0,1	0,1	0,0	0,1	0	0	0,0	0,1
<i>Vasconcellea quercifolia</i> A. St.-Hil.	0,0173	1	1	1	3	0,1	0,2	0,0	0,1	0,1	0,1	0	0	0,0	0,1
<i>Zanthoxylum petiolare</i> A. St.-Hil. & Tul.	0,0068	0	3	0	3	0,1	0,2	0,0	0,1	0,1	0,1	0	0	0,0	0,1
<i>Zanthoxylum rhoifolium</i> Lam.	39,1096	190	1630	305	2125	100	100	100	100	100	100	189	100	100	100
TOTAL															

Bauhinia forficata Link and *Campomanesia guazumifolia* (Camb.) O. Berg occurred only in the middle stratum. On the other hand, *Zanthoxylum* sp., *Holocalyx balansae* Micheli and *Citronella paniculata* (Mart.) R.A. Howard were found only in the upper stratum.

The natural regeneration counted on 189 individuals distributed into 24 families and 49 species, in addition to the dead individuals (Table 1), with total density of 3,500 seedlings ha⁻¹. Among the recruiters, the species that presented the highest value for natural regeneration was *Actinostemon concolor* (18.1%), followed by *Guarea macrophylla* Vahl (5.8%) and *Matayba elaeagnoides* Radlk (5.6%). About 20% of the species occurred only in this compartment, especially *Piper gaudichaudianum* Kunth, *Eugenia pluriflora* DC., *Annona sylvatica* (A. St.-Hil.) Martius, *Peltophorum dubium* (Spreng.) Taub and others.

The EIV analysis pointed out that the species *Luehea divaricata*, *Actinostemon concolor*, *Parapiptadenia rigida*, *Casearia sylvestris* and *Cupania vernalis* Cambess. (Table 1) represent more than 25% of the total value of this parameter.

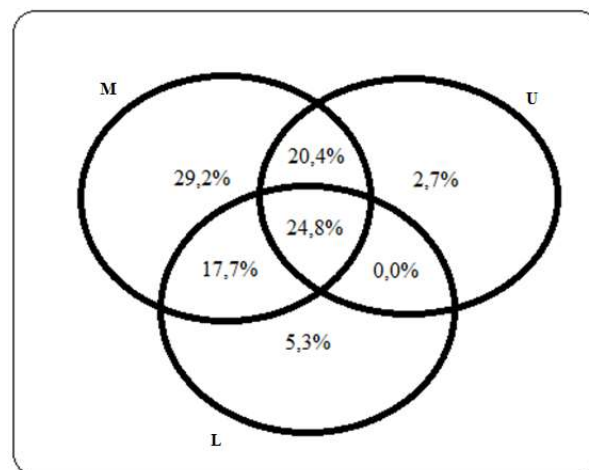


Figure 1 – Venn Diagram produced from exclusive and shared species among the three vegetation strata sampled in stretch deciduous forest in western Santa Catarina, Brazil. I = lower stratum ; M = medium and Stratum; S = upper stratum.

Figura 1 – Diagrama de Venn produzido a partir das espécies compartilhadas e exclusivas entre os três estratos da vegetação amostrados em um trecho de Floresta Estacional Decidua, meio oeste catarinense, Brasil. I = Estrato inferior; M = Estrato médio e; S = Estrato superior.

The species *Ocotea odorifera* Rohwer is listed in the list of endangered species of the Brazilian Institute of Environment and Renewable Natural Resources in the State of Santa Catarina (BRASIL, 2008). The study showed the presence of just over 4% of exotic species, such as *Cinnamomum triplinerve* (Ruiz & Pav.) Kosterm., *Citrus* sp., *Hovenia dulcis* Thunb. and *Morus nigra* L. and *Brugmansia suaveolens* (Bonpl. ex Willd.) Bercht. & C. Presl (1.05%) (FLORA BRASIL, 2014).

4. DISCUSSION

In the Atlantic forest, particularly in Seasonal Deciduous Forest formations, studies of floristic composition and arboreal stratum structure have been widely disseminated, especially during the last decades, in the Brazilian states of Rio Grande do Sul (SEMA/UFMS-RS, 2001; JURINITZ; JARENKOW, 2003; LINDENMAIER; BUDKE, 2006) and Santa Catarina (GASPER et al., 2012; GASPER et al., 2013). However, researches involving the assessment of the vertical distribution of arboreal species in this region are still poorly developed, especially due to the difficulty of identifying the species in juvenile stages (POLISEL, 2013).

Since the last century, some studies have been contributing to a better understanding of phytogeographical and floristic attributes of SDFs. Prado and Gibbs (1993) reported a tenuous connection between the vegetation of the Caatinga and the Argentine Chaco through species that cross Brazil occurring in areas of seasonal forests of the Atlantic forest (Seasonal Forests of Central Brazil and the channel of the Uruguay River) and the Cerrado region. Most likely, this vegetation corridor has reached its maximum extent during the Pleistocene (dry and cold climate), which can be observed from the species widely distributed (RATTER et al. 1978; PRADO; GIBBS, 1993; OLIVEIRA FILHO; FONTES, 2000; PENNINGTON et al., 2000).

According to Moraes and Silva (2006), the more regular the distribution of individuals of a species in the vertical structure of a forest is, the higher its value in the Relative Sociological Position. This descriptor shows the importance of *Luehea divaricata* (RSP = 7.10%), *Actinostemon concolor* (7.00%), *Casearia sylvestris* (6.79%), *Cupania vernalis* (4.93%) and *Parapiptadenia rigida* (3.91 %) in the studied community

structure. These species were also well represented in other studies conducted in deciduous forests in southern Brazil (FARIAS et al., 1994; LONGHI et al., 2000).

The great abundance of *Actinostemon concolor* in the natural regeneration corroborates the study of Jurinitz and Jarenkow (2003) when observe that it is a shrubby species and inhabit the lower stratum and understory of SDF. *Peltophorum dubium*, *Eugenia pluriflora* and *Annona sylvatica* were recorded only in the natural regeneration probably due to the randomness used in allocating the sample units. The species *Piper gaudichaudianum* has a shrubby habit and is common in clearings and forest edges (BARDELLI et al., 2008). The increase in sampling effort could better clarify the meaning of these numbers.

Considering the species with the highest EIV, *Luehea divaricata*, *Casearia sylvestris*, *Cupania vernalis*, *Guarea macrophylla* Vahl and *Cabralea canjerana* (Vell.) Mart. are considered as “supertramps”, i.e., species that are widely distributed in various phytophysionomies of forest in the Atlantic area in Brazil (OLIVEIRA FILHO; FONTES, 2000). The other five (*Actinostemon concolor*, *Parapiptadenia rigida*, *Nectandra megapotamica* (Spreng.) Mez, *Ocotea puberula* and *Apuleia leiocarpa* (Vogel) J. F. Macbr.) are pointed out by Fontana and Sevegnani (2012) as widely spread in the SDF of the state. Among the above species, only *Actinostemon concolor* has no entry problems in the community, since it is well represented in the lower stratum and natural regeneration (Table 1), which suggests the expansion of the sampling effort of the natural regeneration.

In Santa Catarina, *Hovenia dulcis* has been identified as an important exotic species with invasive potential, as observed in the Fritz Plaumann State Park, Concórdia, SC, Brazil (DECHOUM; ZILLER, 2013). In this study, this species presented a density in the middle and upper strata of respectively 18 individuals ha⁻¹ and 15 individuals ha⁻¹. However, in the lower stratum this species presented only 2 individuals ha⁻¹, which, at first sight, seems to corroborate the hypothesis of a problem associated with the invasion of species in the community. However, by observing the fragment as a whole, we observed a widespread occurrence of this species, both in the arboreal stratum and in regeneration. The presence of this species can be

associated with plantation and/or restoration activities for multiple uses that occurred in the recent past or due to the process of randomness of sampling, since the species has a preference for habitats with higher solar radiation (heliophytic species), occupying forest edges and recent clearings (CARVALHO, 1994). The same applies to the exotic species *Morus nigra* L., abundant in the middle stratum, and *Brugmansia suaveolens*, abundant in the natural regeneration (Table 1), which may cause problems of biological invasion in the future. The species *Guarea macrophylla* reached a moderate highlight in the regeneration (third place), in the lower stratum (second place) and in the middle stratum (fifth place). It is noteworthy that even native species, when considered dominants, may behave as invasive by some environmental disturbance, also requiring attention in the control and management of their populations (RICHARDSON et al., 2000). Thus, it is recommended to continue the study in order to assess the community dynamics compared to the possible effects of population dynamics of these species.

According to the CONAMA RESOLUTION from April, 1994 (BRASIL, 1994), which establish the succession stage of the Atlantic forest for the State of Santa Catarina. The forest structure of the fragment is in the successional stage from initial to medium, mostly due to the high value of basal area (27.94 m² ha⁻¹), but with anthropogenic interference signals in the floristic composition and in the recruitment of species in the community.

The results of this study can support important management measures for the fragment in question and others in the same physiographic condition. For example, the species *Luehea divaricata* (higher VI) could be used as anchor species for restoration models of forest fragments, resulting in a simpler and less costly strategy due to its greater adaptability to the current environmental conditions.

5. CONCLUSIONS

The main highlights in the horizontal structure were the species *Luehea divaricata* (142 individuals and 7.9% of IV) and *Parapiptadenia rigida* (93 individuals and 5.3% of IV). When the vertical structure were analyzed, it is possible to observe a low recruitment of these species, indicating problems in the regeneration possibly caused by anthropogenic changes. On the

other hand, *Actinostemon concolor* takes the second place in terms of EIV (7.0%) as a function of values obtained in its typical strata of occupation: natural regeneration (146 individuals), lower (29 individuals) and middle (116 individuals). In the community was also possible to identify the presence of exotic species with invasive potential (for example *Hovenia dulcis*). The presence of an endangered species (*Ocotea odorifera*) has been identified, in addition to others with economic potential (*Apuleia leiocarpa* and *Cabralea canjerana*), among species of high EIV. Given these facts, it is essential the implementation of management measures of forest fragments and the adoption of public policies aiming forest conservation in the region.

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