FLORISTIC, DIVERSITY AND SPATIAL DISTRIBUTION OF TREE SPECIES IN A DRY FOREST IN SOUTHERN BRAZIL

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Abstract. This study was conducted in a fragment of deciduous seasonal forest (DSF), located between the municipalities of Piratuba and Ipira, Santa Catarina. The objective was to evaluate the floristic composition and the successional stage through the ecological groups, the Shannon diversity index (H') and the dispersal syndromes of species, also using the H' and the McGinnies index (IGA) to determine the pattern of spatial distribution of species. 14 transects were installed, each with 1,000 m^2, considering all trees with Diameter at Breast Hight (DBH) ≤ 4.0 cm. In total, 2,125 individuals were sampled, belonging to 113 species and 34 families. Myrtaceae and Fabaceae were the families with the highest species richness, with 14.2% and 11.5%, respectively. Euphorbiaceae and Lauraceae added approximately 25% of the individuals. The most abundant species were *Actiniostemon concolor* (Spreng.) Müll. Arg (6.9%) and *Luehea divaricata* Mart. (6.7%). The ecological group of the pioneers totaled 40% of the individuals and 36.3% of the species. The zoochoric syndrome accounted for just over 60% of individuals and species. The H' was 3.92 nats. ind^{-1} and the Pielou evenness (J) was 0.82. The IGA revealed that only over 40% of the species and 60% of the individuals showed a clumped dispersion pattern. The community is on successional transition phase, from the initial to the intermediate stage. In this scenario, management measures adopted for the microscale could be implemented in order to preserve this important repository for diversity. The application of McGinnies index can be of great use in conservation and forest management, as its interpretation may contribute to the development of restoration methods of degraded areas, enrichment of forest remnants, germplasm conservation and other activities.
Keywords: *Atlantic Forest; biodiversity; forest ecology; McGinnies index; phytosociology*

Introduction

The Atlantic Forest originally extended from Rio Grande do Norte to Rio Grande do Sul, also covering inland portions of Brazil, Argentina and Paraguay, totaling approximately 12% of the Brazilian territory (Ribeiro et al., 2009; Fundação SOS Mata Atlântica and INPE - Instituto Nacional de Pesquisas Espaciais, 2011).

However, the industrial and agricultural development, associated with urban expansions, has generated a reduction of more than 80% of its original forest cover (Ribeiro et al., 2009). Today, the forest remnants are scattered in different sizes and exposed to many different disorders (Colombo and Joly, 2010). Therefore, the Atlantic Forest was framed among 25 global hotspots, that is, areas with high

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biodiversity, high rate of endemism and at the same time, under strong anthropogenic impacts (Santos et al., 2012).

In the state of Santa Catarina, the Atlantic Forest originally covered about 80% of its surface area, but today the native forest cover is about 30% of it (Vibrans et al., 2008). Particularly, the original seasonal dry forests areas have suffered intense deforestation process, in order that, currently, the sum of the fragments coverage of the same size or smaller than 50 ha represent only 14% of this original forest typology (Gasper et al., 2013).

According to Freitas and Magalhães (2012), the floristic analysis provides important information about the classification and taxonomic distribution of a plant community and also about ecological attributes of species, such as: diversity, dispersal syndromes, and ecological groups, among others.

The species are organized in different patterns of distribution, as follows: clumped, uniform or random, affected by the influence of abiotic, biotic or even random factors (Matteucci and Colma, 1982; Townsend et al., 2010; Freitas and Magalhães, 2014). The distribution pattern of tree species is a useful tool for the management strategy and / or conservation of a forest population or community (Freitas and Magalhães, 2014).

The aim of this study was to evaluate the floristic composition and the successional stage through the ecological groups and dispersal syndromes of the species present in a fragment of DSF in western Santa Catarina, and also to use the Shannon diversity (H'), the Pielou evenness (J) and the McGinnies (IGA) indices to determine the species distribution pattern.

Materials and Methods

Study Area

The study was conducted in the Peixe river basin, between the cities of Ipira and Piratuba, both located in western Santa Catarina, between the coordinates 27°25'34" South and 51°47'18" West.

The predominant climate in the region is Mesothermal Humid Subtropical, Cfa (Köppen), with no distinct dry season. The monthly rainfall exceeds 60 mm, with average temperatures of the warmest month above 22^{o}C and the coldest month below 18^{o}C and above 3^{o}C (Seiffert and Perdomo, 1998).

The characteristic vegetation formation of this Upper Uruguay river region is the DSF (IBGE – Instituto Brasileiro de Geografia e Estatística, 1992), which extends throughout the valley of the Uruguay river, including the portion of the tributaries that is up to 500 - 600 m high.

Field Procedure

This study adopted the systematic sampling in tracks (IBGE 1992), using transects of 10 x 100 m, in a sampling of 1,000 m^2, per transect. 14 transects were allocated throughout the area, totaling 14,000 m^2 (1.4 ha).

In the tree layer, the height and the Circumference at Breast Height (CBH), or 1.30 m above the ground, were measured for all trees with CBH $\geq$ 12.57cm (or DBH $\geq$ 4.0 cm), including the standing dead plants.

The taxonomic identification was carried out with the aid of specialized botanical literature and comparisons with the Herbarium Collection of the Federal University of

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Santa Catarina (UFSC). The validation of the names of species and the exclusion of synonyms were obtained through the website of Flora Brazil (2015). The adopted classification system for families was the APG III (2009)**,** except for Fabaceae, which is divided in three subfamilies: Faboideae, Mimosoideae and Caesalpinoideae (Cronquist, 1981).

Analysis Methods

The species found in the examined fragment were also classified according to their successional stages. According to Budowski (1965), the pioneer species grow in clearings or open spaces, and they are clearly dependent on high light conditions. The early secondary species prefer environments such as small gaps or areas of old clearings, next to pioneer species, while the late secondary species have shown to be shade tolerant in the juvenile stage, forming understory seedlings banks, with great mortality of individuals in the early years, presenting small to medium sized seeds with low viability. The climax species grow slowly, they are light intolerant when adults, with a high number of individuals in natural regeneration, with seed of large and short viability.

The determination of the dispersal syndromes of each species was carried out. Following the categories proposed by Van Der Pijl (1957), species can be classified as: anemochoric (dispersed by the wind), zoochoric (dispersed by animals), autochoric (self-dispersion) and those without classification.

This study also applied the H' and J indices (Brower and Zar, 1984), and the IGA index, which indicates that the distribution pattern is random when it is equal to one, uniform when it is below one, with tendency to cluster when it is above one and equal to or above two, and clumped when it is above two (McGinnies, 1934). The indices were calculated using Mata Nativa 3 (Cientec, 2012).

Results

This study recorded the presence of 2,125 individuals (2,754 stems), belonging to 34 botanical families, 83 genera and 113 species, disregarding the undetermined and dead individuals (*Tab. 1*).

The families presenting the highest species richness were Myrtaceae (16 or 14.2%), Fabaceae - Faboideae (13 or 11.5%), Euphorbiaceae (10 or 8.8%), Lauraceae (8 or 7.1%), Fabaceae - Mimosoideae and Rutaceae (6 or 5.3% each).

Of the sampled individuals, 1,711 (80.5%) are concentrated in only 10 botanical families, which are: Euphorbiaceae (297 or 14% of individuals), Lauraceae (223 or 10.5%), Meliaceae (204 or 9.6%), Sapindaceae (168 or 7.9%) Fabaceae - Faboideae (167 or 7.9%), Salicaceae (162 or 7.6%), Fabaceae - Mimosoideae (155 or 7.3%), Malvaceae (142 or 6.7%), Myrtaceae (138 or 6.5%) and Apocynaceae (55 or 2.6%). The other 550 individuals were distributed among the other 25 families.

In this study, the species with the greatest abundance were: *A. concolor* (146 individuals or 6.9%), *Luehea divaricata* Mart. (142 individuals or 6.7%), *Casearia sylvestris* Sw. (131), *Cupania vernalis* Cambess. (106), *Parapiptadenia rigida* (Benth.) Brenan (93), *Guarea macrophylla* Vahl (77), *Cabralea canjerana* (Vell.) Mart. (69), *Nectandra megapotamica* (Spreng.) Mez (69), *Sebastiana commersoniana* (Baill.) L.B. Sm. & Downs (62), *Ocotea puberula* (Rich.) Nees (56) and *Tabernaemontana catharinensis* A. DC. (49), representing about 50% of all individuals.

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Table 1. *Species sampled in a fragment of Deciduous Seasonal Forest in western Santa Catarina, Brazil, in alphabetical order.*

Scientific Name	BA	N_i	GA_I	Rating IGA	DS	EG
Actiniostemon concolor (Spreng.) Müll. Arg. - EUPHORBIACEAE	0.5532	146	15.05	Clumped	AUT	LS
Annona sp – ANNONACEAE	0.4813	38	5.63	Clumped	ZOO	ES
Apuleia leiocarpa (Vogel) J. F. Macbr. - FABACEAE – CAES.	19.952	36	2.64	Clumped	ANE	CL
Ateleia glazioveana Baill. - FABACEAE – FAB	0.0315	2	2.5	Clumped	ANE	PI
Balfourodendron riedelianum (Engl.) Engl. – RUTACEAE	0.0375	3	5.78	Clumped	ANE	LS
Brugmansia suaveolens (Bonpl. ex Willd.) Bercht. & C. Presl - SOLANACEAE	0.0472	9	3.71	Clumped	AUT	CL
Campomanesia guazumifolia (Camb.) O. Berg - MYRTACEAE	0.0332	7	5.82	Clumped	ZOO	LS
Campomanesia sp. – MYRTACEAE	0.0248	3	2.43	Clumped	ZOO	LS
Campomanesia xanthocarpa O. Berg – MYRTACEAE	0.7213	45	2.07	Clumped	ZOO	LS
Casearia decandra Jacq. – SALICACEAE	0.0612	19	2.89	Clumped	ZOO	ES
Casearia obliqua Spreng. – SALICACEAE	0.2529	12	3.79	Clumped	ZOO	LS
Casearia sylvestris Sw. – SALICACEAE	12.897	131	4.03	Clumped	ZOO	PI
Cedrela fissilis Vell. – MELIACEAE	0.2267	7	3.55	Clumped	ANE	ES
Celtis brasiliensis (Gardner) Planch. – CANNABACEAE	0.0152	2	3.55	Clumped	AUT	PI
Citronella paniculata (Mart.) R.A. Howard - CARDIOPTERIDACEAE	0.0241	1	2.06	Clumped	ZOO	LS
Cordia ecalyculata Vell. – BORAGINACEAE	0.0092	1	2.59	Clumped	ZOO	LS
Dalbergia frutescens (Vell.) Britton - FABACEAE – FAB	0.1248	14	7.35	Clumped	ANE	PI
Endlicheria paniculata (Spreng.) J.F. Macbr. - LAURACEAE	0.4692	9	2.97	Clumped	ZOO	LS
Erythrina falcata Benth. - FABACEAE – FAB	0.0964	2	2.67	Clumped	ANE	ES
Eugenia uniflora L. – MYRTACEAE	0.0163	4	3.86	Clumped	ZOO	ES
Euphorbiaceae 1. – EUPHORBIACEAE	0.0022	1	4.67	Clumped	AUT	NC
Hovenia dulcis Thunb. – RHAMNACEAE	0.8689	48	6.49	Clumped	AUT	CL
Luehea divaricata Mart. – MALVACEAE	51.292	142	2.36	Clumped	ANE	ES
Machaerium paraguariense Hassl. - FABACEAE – FAB	0.2378	32	2.19	Clumped	ANE	LS
Machaerium sp. - FABACEAE – FAB	0.0792	4	5.21	Clumped	ANE	PI
Machaerium stipitatum (DC.) Vogel - FABACEAE – FAB	0.0353	8	2.7	Clumped	ANE	ES
Dead	**0.1872**	**10**	**4.12**	**Clumped**	**-**	
Morus nigra L. – MORACEAE	0.5523	43	3.86	Clumped	ZOO	ES
Myrciaria floribunda (H. West ex Willd.)O.Berg - MYRTACEAE	0.0041	1	4.43	Clumped	ZOO	LS
Nectandra megapotamica (Spreng.) Mez – LAURACEAE	10.305	69	8.8	Clumped	ZOO	PI
Ocotea diospyrifolia (Meisn.) Mez – LAURACEAE	0.0685	8	4.72	Clumped	ZOO	ES

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Ocotea odorifera Rohwer – LAURACEAE	0.9478	33	3.2	Clumped	ZOO	LS
Ocotea sp. – LAURACEAE	0.3394	9	3.4	Clumped	ZOO	NC
Parapiptadenia rigida (Benth.) Brenan - FABACEAE – MIM.	57.39	93	3.88	Clumped	AUT	PI
Picrasma crenata Engl. in Engl. & Prantl - SIMAROUBACEAE	0.0445	3	5.3	Clumped	ZOO	LS
Prunus myrtifolia (L.) Urb. – ROSACEAE	0.2245	19	2.67	Clumped	ZOO	PI
Schinus terebinthifolia Raddi - ANACARDICEAE	0.0158	5	2.32	Clumped	ZOO	PI
Sebastiania brasiliensis Spreng. – EUPHORBIACEAE	0.1795	39	11.55	Clumped	AUT	PI
Sebastiania commersoniana (Baill.) L.B. Sm. & Downs - EUPHORBIACEAE	0.6654	62	10.02	Clumped	ZOO	ES
Strychnos brasiliensis (Spreng.) Mart. – LOGANIACEAE	0.0771	6	2.78	Clumped	ZOO	LS
Syagrus romanzoffiana (Cham.) Glassman – ARECACEAE	0.3002	7	2.07	Clumped	ZOO	ES
Tabernaemontana catharinensis A. DC. – APOCYNACEAE	0.6876	49	2.27	Clumped	ZOO	LS
Terminalia australis Cambess. – COMBRETACEAE	0.05	5	4.82	Clumped	ANE	PI
Trichilia claussenii C. DC. – MELIACEAE	0.7544	47	4.84	Clumped	ZOO	CL
Urera baccifera (L.) Gaudich. ex Wedd. – URTICACEAE	0.0196	7	3.24	Clumped	ZOO	PI
Vassobia breviflora (Sendtn.) Hunz. – SOLANACEAE	0.023	6	2.78	Clumped	ZOO	PI
Zanthoxylum petiolare A. St.-Hil. & Tul. – RUTACEAE	0.0173	3	2.89	Clumped	ZOO	ES
Zanthoxylum rhoifolium Lam. – RUTACEAE	0.0068	3	2.89	Clumped	ZOO	PI
Albizia edwallii (Hoehne) Barneby & J.W. Grimes - FABACEAE – MIM	0.1007	10	1.28	Tend. Cluster	ANE	PI
Albizia niopoides (Spruce ex Benth.) Burkart - FABACEAE – MIM	0.0494	4	1.18	Tend. Cluster	ANE	PI
Alchornea triplinervia (Spreng.) Müll. Arg. - EUPHORBIACEAE	0.305	3	1.39	Tend. Cluster	ZOO	ES
Boehmeria caudata Sw. – URTICACEAE	0.0234	5	1.39	Tend. Cluster	ANE	PI
Cabralea canjerana (Vell.) Mart. – MELIACEAE	19.576	69	1.48	Tend. Cluster	ZOO	PI
Calyptranthes tricona D. Legrand – MYRTACEAE	0.1839	19	1.91	Tend. Cluster	ZOO	LS
Celtis iguanaea (Jacq.) Sarg. – CANNABACEAE	0.0876	4	1.49	Tend. Cluster	ZOO	PI
Cestrum intermedium Sendtn. – SOLANACEAE	0.0176	1	1.93	Tend. Cluster	ZOO	ES
Chrysophyllum gonocarpum (Mart. & Eichler ex Miq.) Engl. - SAPOTACEAE	0.2351	24	1.18	Tend. Cluster	ZOO	CL
Cinnamomum verum J. Presl – LAURACEAE	0.0286	2	1.66	Tend. Cluster	AUT	PI
Citrus sp – RUTACEAE	0.0875	16	1.93	Tend. Cluster	ZOO	NC
Coussarea contracta (Walp.) Müll. Arg. – RUBIACEAE	0.0018	1	1.78	Tend. Cluster	ZOO	LS
Fabaceae 1 - FABACEAE – FAB	0.0522	3	1.85	Tend. Cluster	ZOO	NC
Holocalyx balansae Micheli - FABACEAE – CAES	0.0548	1	1.45	Tend. Cluster	ZOO	PI

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Jacaranda micrantha Cham. – BIGNONIACEAE	0.0067	1	1.99	Tend. Cluster	ANE	ES
Maclura tinctoria (L.) D. Don ex Steud. – MORACEAE	0.056	2	1.18	Tend. Cluster	ZOO	ES
Manihot grahamii Hook. – EUPHORBIACEAE	0.0038	1	1.7	Tend. Cluster	AUT	PI
Myrcia oblongata DC. – MYRTACEAE	0.002	1	1.62	Tend. Cluster	ZOO	ES
Myrsine umbellata Mart. – PRIMULACEAE	0.0065	1	1.71	Tend. Cluster	ZOO	PI
Myrtaceae 3 – MYRTACEAE	0.1063	4	1.93	Tend. Cluster	ZOO	NC
Nectandra lanceolata Nees – LAURACEAE	0.9816	37	1.18	Tend. Cluster	ZOO	LS
Ocotea puberula (Rich.) Nees – LAURACEAE	21.442	56	1.7	Tend. Cluster	ZOO	ES
Ruprechtia laxiflora Meisn. – POLYGONACEAE	0.542	11	1.13	Tend. Cluster	ANE	LS
Sapium glandulosum (L.) Morong – EUPHORBIACEAE	0.9342	33	1.53	Tend. Cluster	ZOO	PI
Solanum mauritianum Scop. – SOLANACEAE	0.0514	2	1.93	Tend. Cluster	ZOO	PI
Trichilia elegans A. Juss. – MELIACEAE	0.0081	4	1.18	Tend. Cluster	ZOO	PI
Vitex megapotamica (Spreng.) Moldenke – LAMIACEAE	0.0186	4	1.85	Tend. Cluster	ZOO	CL
Aegiphila brachiata Velloso – LAMIACEAE	0.004	1	0.96	Uniform	ZOO	ES
Allophylus edulis (A. St.-Hil., A. Juss. & Cambess.) Hieron. ex Niederl. SAPINDACEAE	0.1691	21	0.97	Uniform	ZOO	PI
Allophylus guaraniticus Radlk.- SAPINDACEAE	0.0033	1	0.96	Uniform	ZOO	ES
Aloysia virgata (Ruiz & Pav.) Pers. – VERBENACEAE	0.0038	1	0.96	Uniform	ANE	PI
Aspidosperma australe Müll. Arg. – APOCYNACEAE	0.0165	6	0	Uniform	ANE	CL
Bauhinia forficata Link - FABACEAE – FAB	0.0583	8	0.93	Uniform	AUT	PI
Chrysophyllum marginatum (Hook. & Arn.) Radlk. - SAPOTACEAE	0.2617	20	0.96	Uniform	ZOO	PI
Cordia americana (L.) Gottschling & J.S. Mill. - BORAGINACEAE	0.8459	11	0.96	Uniform	ANE	CL
Coutarea hexandra (Jacq.) K. Schum. – RUBIACEAE	0.002	1	0.96	Uniform	ZOO	LS
Cupania vernalis Cambess. – SAPINDACEAE	11.032	106	0.96	Uniform	ZOO	PI
Dahlstedtia pinnata (Benth.) Malme - FABACEAE – FAB	0.0024	1	0.96	Uniform	AUT	ES
Duranta vestita Cham. – VERBENACEAE	0.0537	9	0.96	Uniform	ZOO	CL
Esenbeckia grandiflora Mart. – RUTACEAE	0.0012	1	0.93	Uniform	AUT	LS
Eugenia burkartiana (D. Legrand) D. Legrand - MYRTACEAE	0.032	5	0	Uniform	ZOO	LS
Eugenia rostrifolia D. Legrand – MYRTACEAE	0.0012	1	0.96	Uniform	ZOO	LS
Eugenia sp – MYRTACEAE	0.0179	4	0	Uniform	ZOO	LS
Eugenia subterminalis DC. – MYRTACEAE	0.2524	22	0.96	Uniform	ZOO	LS
Ficus citrifolia Mill. – MORACEAE	0.217	9	0.96	Uniform	AUT	ES

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Scientific Name	**BA**	**N_i**	**GA_I**	**Rating IGA**	**DS**	**EG**
Guarea macrophylla Vahl – MELIACEAE	0.2771	77	0.89	Uniform	ZOO	PI
Inga marginata Willd. - FABACEAE – MIM	0.4978	43	0	Uniform	ZOO	PI
Inga sp. - FABACEAE – MIMOSOIDEAE	0.0013	1	0	Uniform	ZOO	ES
Julocroton sp. – EUPHORBIACEAE	0.0015	1	0.96	Uniform	AUT	NC
Lonchocarpus nitidus (Vogel) Benth. - FABACEAE – FAB	0.2733	28	0.96	Uniform	ANE	ES
Lonchocarpus sp. - FABACEAE – FAB	0.1979	26	0.96	Uniform	ANE	NC
Matayba elaeagnoides Radlk. – SAPINDACEAE	0.3925	40	0.93	Uniform	ZOO	ES
Mimosa bimucronata (DC.) Kuntze - FABACEAE – MIM	0.0194	4	0.96	Uniform	AUT	PI
Myrocarpus frondosus Allemão - FABACEAE – FAB	0.428	30	0.96	Uniform	ANE	ES
Myrsine sp. – PRIMULACEAE	0.0012	1	0.96	Uniform	ZOO	NC
Myrtaceae 1 – MYRTACEAE	0.0113	2	0.96	Uniform	ZOO	NC
Myrtaceae 2 – MYRTACEAE	0.0035	1	0.96	Uniform	ZOO	NC
Myrtaceae 4 – MYRTACEAE	0.074	19	0.96	Uniform	ZOO	NC
Poecilanthe parviflora Benth. - FABACEAE – FAB	0.1629	9	0	Uniform	AUT	LS
Pouteria salicifolia (Spreng.) Radlk. SAPOTACEAE	0.0494	1	0	Uniform	ZOO	PI
Ricinus communis L. – EUPHORBIACEAE	0.0656	10	0.96	Uniform	AUT	PI
Sebastiania klotzschiana (Müll. Arg.) Müll. Arg. - EUPHORBIACEAE	0.005	1	0.96	Uniform	AUT	PI
Sessea regnellii Taub. – SOLANACEAE	0.0337	3	0.89	Uniform	AUT	PI
Trema micrantha (L.) Blume – CANNABACEAE	0.0427	2	0.93	Uniform	ZOO	PI
Vasconcellea quercifolia A. St.-Hil. – CARICACEAE	0.0199	1	0.96	Uniform	ZOO	PI
Zanthoxylum sp. RUTACEAE	0.0754	2	0.93	Uniform	ZOO	PI
INDETERMINATE	**0.5861**	**23**	**-**	**-**	**-**	**-**
TOTAL	**391.096**	**2.125**	-	-	-	-

BA: Basal Area (m^2 x ha^{-1}); N_i: number of individuals; GA_I: Mc Ginnies index; Rating IGA; SD: dispersal syndrome; EG: ecological group

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With regard to the ecological groups, 40% of the individuals and 36.3% of the species were categorized as early individuals and late successional species, amounted to 22.1% and 23%, respectively (*Fig. 1*). The zoochoric syndrome accounted for a little over 60% of individuals and species (*Fig. 2*).

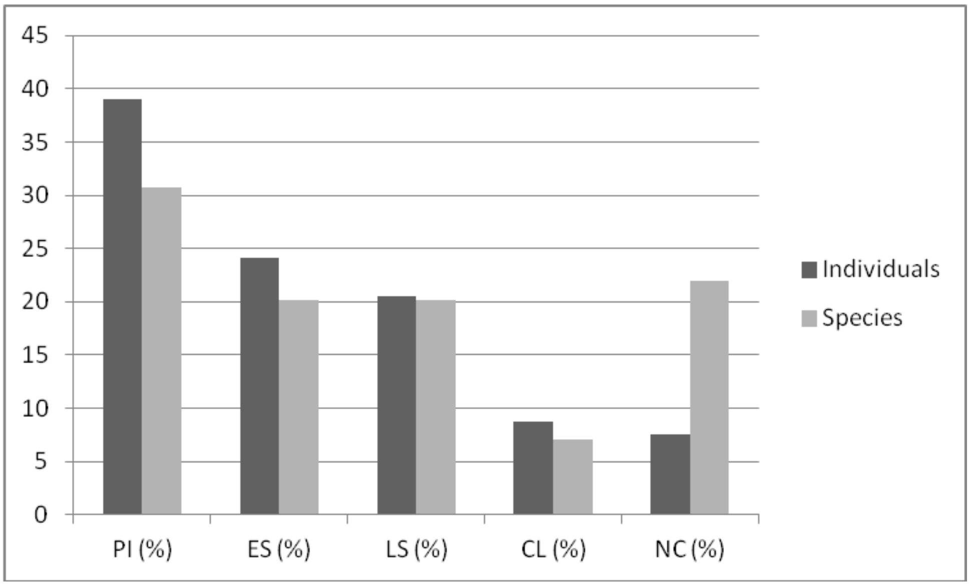

Figure 1. *Frequency distribution of the number of individuals and species, according to ecological groups, in a deciduous seasonal forest fragment in western Santa Catarina, Brazil. CL - Climax; LS - Late Secondary; ES - Early Secondary; PI -Pioneer; NC - Not Classified.*

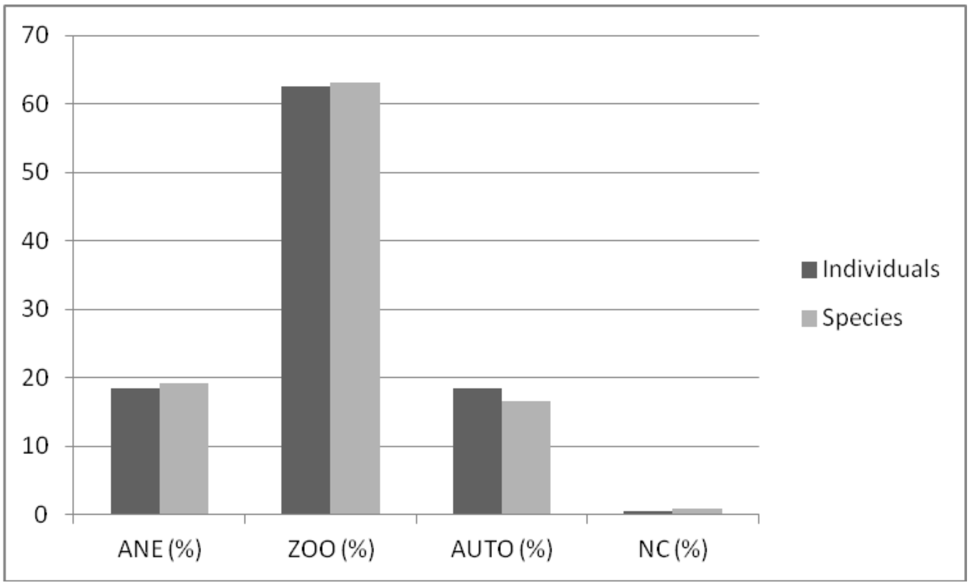

Figure 2. *Frequency distribution of the number of individuals and species, according to the dispersal syndrome, in a deciduous seasonal forest fragment in western Santa Catarina, Brazil. ANE - Anemochoric; AUTO - Autochoric; ZOO - Zoochoric; NC - Not Classified.*

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The H' and the J were, respectively, 3.92 nats. ind^{-1} and 0.82.

This community showed the predominance of a cluster spatial distribution pattern for a little over 40% of the species and for about 60% of the individuals (*Fig. 3*).

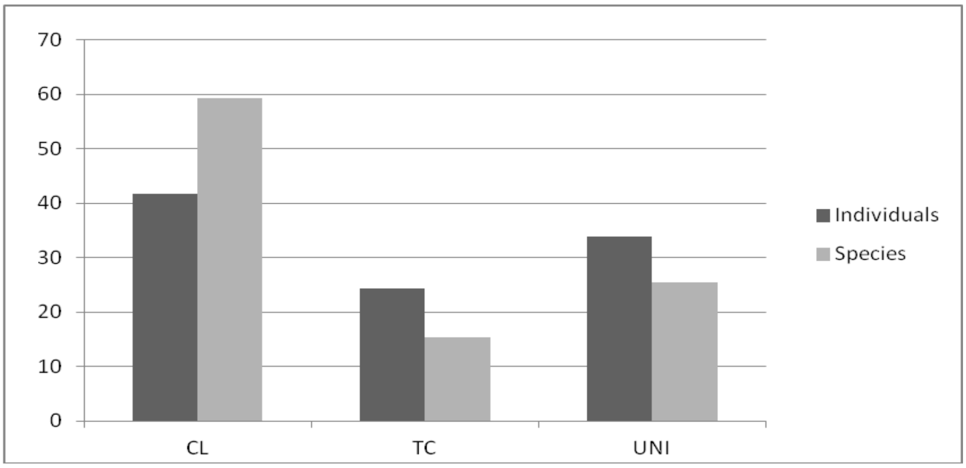

Figure 3. *Frequency distribution of the number of individuals and species, according to McGinnies spatial distribution pattern, in a deciduous seasonal forest fragment in western Santa Catarina, Brazil. CL - Clumped; TC - Tendency to Cluster; UNI -Uniform.*

This study recorded the presence of 11.6% of the species and 5.6% of the individuals considered exotic, such as: *Cinnamomum verum* J. Presl, *Citrus* sp, *Hovenia dulcis* Thunb. and *Morus nigra* L. (Flora Brasil, 2015). The species *Brugmansia suaveolens* (Bonpl. ex Willd.) Bercht. & C. Presl (1.05%) is considered a sub-spontaneous plant, also exotic, but that has adapted to the environment without causing adverse reactions in the community (Flora Brazil, 2015).

Discussion

The floristic comparisons between DSF remnants have shown that these areas are extremely diverse, with low similarity values, even between areas of high spatial proximity, and replacing the longitudinal distribution of deciduous formations (Prado and Gibbs, 1993; Oliveira-Filho and Fontes, 2000; Pennington et al., 2000; Oliveira-Filho et al., 2006). Bolzon and Marchiori (2002) affirm that the deciduous and semideciduous forests are closely associated with the climate history of South America, started in the tertiary period, during the Pliocene.

According to Jasper et al. (2013)**,** Santa Catarina’s DSF structure has high species richness when compared to other seasonal forests, which may be associated with higher levels of rainfall in the regions where they occur, and a remarkable presence of widely distributed families and genera in neotropical dry forests.

The results corroborate that Myrtaceae and Fabaceae have a representative presence in many areas of DSF (Oliveira-Filho and Fontes, 2000). The Myrtaceae family has its participation justified by its broad longitudinal distribution spectrum (Negrelle, 2013). However, Gasper et al. (2013) claim that this family is best represented in the rain forests than in the seasonal forests, tending to decline in richness in the Cerrado and Amazon biomes.

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According to Ribeiro and Lima (2009) the Fabaceae (Leguminosae) family is more diversified in seasonal environments, which can be explained from the Tertiary, when the dry forests dominated the major regions of the world, from where the association of legumes with nitrogen-fixing bacteria created efficient evolutionary mechanisms, providing greater plasticity for the occupation in poor environments in nutrients and regeneration.

Five of the 10 species with the highest number of individuals recorded in this study were also cited by the Floristic and Forest Inventory of Santa Catarina (IFFSC) for the DSF, as follows: *O. puberula*, *N. megapotamica*, *L. divaricata*, *C. vernalis* and *C. sylvestris* (Vibrans et al., 2013). The species *C. canjerana* and *P. rigida*, common in DSF, are also present with relative abundance in the Dense Ombrophilous Forest (DOF) in Santa Catarina (Gasper et al., 2012; Gasper et al., 2013). For these authors, *A. concolor* is one of the main species in regenerating layers of DSF, but it rarely appears in DOF.

Some species found in this study are considered as having high timber value, as follows: *Apuleia leiocarpa* (Vogel) J. F. Macbr., *C. canjerana, Nectandra lanceolata* Nees, *P. rigida* and others (Fontana and Sevegnani, 2012).

According to Meyer et al. (2012), among the exotic species recorded in this study, only *H. dulcis* demands further attention. According to these authors, this species occurs with relative abundance in Santa Catarina DSF, deserving greater monitoring in the recruitment process and occupation in forest fragments in the initial and intermediate stages, their typical colonization in environments, and to adopt measures for its management, due to its high potential for competition.

Approximately 25% of the abundance of the examined fragment was represented by pioneer species, as *N. megapotamica*, *C. canjerana*, *G. macrophylla*, *P. rigida*, *C. vernalis* and *C. sylvestris*. Nevertheless, the species *L. divaricata* (early secondary) and *A. concolor* (late secondary) amounted to almost 15% of the sampled tree individuals (*Tab. 1*).

The analysis of dispersal syndromes (*Tab. 1*) indicated that most species and individuals (a little over 60%) use animals as dispersing agents, pattern already evidenced in several studies in the Atlantic Forest, as described by Almeida-Neto et al. (2008). As reported by Gentry (1982), the zoochory is the most important dispersal mode of woody species in the tropical region. In this sense, the community in question is very important for maintaining both its plant populations and the associated fauna.

Considering the participation of ecological groups and dispersal syndromes, it can be seen in the *Table 1* that there is a significant participation of species and pioneer individuals in the study area. There is also a relatively large proportion of more demanding species concerning the quality of their habitats (late secondary and climax) and, at the same time, the associated fauna plays an important role in spreading seedlings. According to Carvalho (2010), forests in the initial stages have lower species richness with biotic dispersion in relation to the preserved forests, and little participation of zoochoric species. Given this hypothesis, it can be suggested that the community in question adds favorable conditions to evolve in successional stages, considering the biotic mechanisms involved in the maintenance of ecosystems.

According to the IFFSC, the examined fragment is highly relevant in terms of diversity and evenness, as their maximum values recorded for samples in Piratuba (H '= 3.13 nats. ind^{-1} and J = 0.63) and Ipira (H'= 2.63 nats. ind^{-1} and J = 0.78) were lower than those found in this study (H' = 3.92 nats. ind^{-1} and J = 0.82) (Vibrans et al., 2013).

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For this community, the level measured by the value of evenness (J = 0.82) confirms the high value of H'. As stated by Werneck et al. (2000), high evenness values indicate more homogeneous abundance distribution among species and may be related to the high uniformity in the proportions of individuals in relation to the species within the community.

Oliveira-Filho and Fontes (2000) stated that Santa Catarina DSF establishes or provides a transition between the typical species from ombrophilous and seasonal environments, a fact that may be one of the arguments to explain the relative richness and diversity of species of Santa Catarina DSF.

Hay et al. (2000) consider three main scales: macro (biogeographical), meso (community) and micro (individuals within a community). The micro scale was considered in this study, restricted to the understanding of the distribution of species in a forest fragment of a small area (about 120 ha).

With respect to both individuals and species, a more uniform pattern was observed in the examined fragment, according to McGinnies index. Rondon Neto et al. (2000) report that the aggregation of tree species in tropical ecosystems may be associated to the kind of seeds dispersion, seeds sources distance, to variations in environmental conditions, particularly as regards their quality and intensity, in addition to the chemical and physical soil characteristics. For Silva et al. (2008), Cain et al. (2011), clusters indicate a mechanism of attraction, demonstrating that the chance of survival of an individual is increased by the presence of others of the same species or the availability of a common resource.

According to Fundação SOS Mata Atlântica and INPE (2015), deforestation rates in Ipira reduced 6% in the period from 2013 to 2014, while in Piratuba numbers remained the same during the same period, suggesting that anthropogenic changes in the region have been at least controlled.

From these results, it can be assumed that the fragment in question is in successional transition phase, from the initial to the intermediate stage, considering the species richness and evenness, and biotic mechanisms as facilitators: the predominance of zoochory, the participation of more demanding species concerning the habitat quality (late secondary and climax) and the clumped distribution of species.

Thus, management measures adopted for a microscale, for example, the choice of species to enrich fragments or the identification of forest species matrices for seed collection may be taken towards the handling and storage repository for this important diversity. Such actions can have a positive impact in the short term, on alpha diversity, i.e., on the number of species in a fragment, and they may, in the medium term, contribute to beta diversity (diversity of habitats). Whittaker (1972) postulated that maintaining the alpha and beta diversity is fundamental to the success of the gamma diversity (regional diversity).

This study corroborates the assumption that the Santa Catarina DSF still presents forest remnants with high richness and diversity of species, such as the case of the analyzed fragment (113 species and H '= 3.92 nats. ind.$^{-1}$). The studied fragment is in transition, from the initial to the intermediate stage, and it can be favored by biotic regulatory mechanisms, especially the zoochory and the clustered pattern distribution.

The application of McGinnies index can be of great use in the conservation and forest management, as their interpretation may contribute to the development of restoration methods of degraded areas, enrichment of forest remnants, germplasm conservation and other activities.

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