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Mimosa scabrella Benth. as Facilitator of Forest Successional Advance in the South of Brazil

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ABSTRACT

Pioneer species have the potential to colonize disturbed environments, contributing to the establishment of other species and driving the dynamics and advancement of the structure of forest communities. The aim of this study was to assess the evolution of floristic-structural composition in the regenerating stratum of communities formed in the *Mimosa scabrella* Benth. understory with different ages. The study was carried out in four municipalities located in the Santa Catarina State South Plateau, on communities with different successional ages. The plot method was applied to the survey of all arboreal individuals with height ≥ 10 cm. The floristic-structural patterns found were compatible with the expected trend of Araucaria Forest successional dynamic, showing higher richness and abundance of regenerating individuals in the older understories.

Keywords: bracatinga, forest succession, natural regeneration, facilitation, Araucaria Forest.

1. INTRODUCTION

Tree species contribute directly and indirectly to improvements in the ecosystem and accelerate biodiversity restoration (Elliott et al., 2000). The natural regeneration of native populations of pioneer species is an important way to restore the functionality of altered environments, especially where propagules provided by the landscape matrix are available. Some authors have emphasized conducting natural regeneration as one of the most promising alternatives due to ecological and economic aspects (Alvarenga et al., 2006).

Studying natural regeneration represents an important factor for analysing successive evolutionary communities (Melo & Durigan, 2007), and may indicate the effectiveness of tree cover in forming habitat which is favourable for colonising new species (Kabakoff & Chazdon, 1996). Haggar et al. (1997) observed that trees with high growth rates generally stimulate higher levels of regeneration in their understory. Chada et al. (2004) verified that reforestation with tree legumes proved to be effective in activating natural succession mechanisms, and after seven years, 50 species of 25 botanical families have already colonized the understory of the study area.

Mimosa scabrella Benth., popularly known as *bracatinga*, is a tree species belonging to the Fabaceae family. It is native and endemic to Brazil (Dutra & Amorim, 2012), and represents an important function in the secondary succession of natural or anthropic clearings of Araucaria Forest, where it can form dense, almost pure nuclei (Reitz et al., 1978). Due to its high adaptability to the edaphic soil conditions of river banks and patches (Reitz et al., 1978), tolerance to physical soil conditions (Inoue et al., 1984), and also its high levels of interactions with micro-organisms of the soil, entomofauna and vertebrates Araucaria Forest, it is considered one of the main indicated species for environmental restoration programs (Reis & Kageyama, 2003).

Considering the adaptive potential of *M. scabrella* to colonise altered areas, it is expected that the regeneration existing in forest understories of populations of this species with different ages presents floristic-structural variations, following the patterns of forest succession dynamics. Thus, the objective was to evaluate the successional evolution of the regenerating arboreal stratum in understories of *M. scabrella* populations with different ages using analysis of floristic-structural patterns. Specifically, we sought to answer the following questions: (1) Are there variations in the diversity and richness of the regenerating stratum occurring in *M. scabrella* populations with different ages? (2) Does the floristic-structural pattern of the different *M. scabrella* understories reflect successional dynamics according to ecological groups?

2. MATERIALS AND METHODS

The study was conducted in an understory with natural *Mimosa scabrella* populations present in Montana Araucaria Forest remnants (IBGE, 2012) located in the Santa Catarina State South Plateau. Three populations were selected to cover different ages, which were defined by the succession time (natural regeneration) of the areas (Table 1). The average precipitation of the studied areas is 1,200 mm/year and the climate is Cfb by the Köppen classification (Alvares et al., 2014). The plots were located in gently undulating relief areas in the study sites.

Table 1. Description of the regenerating community areas in understory *Mimosa scabrella* Benth. populations, Santa Catarina State South Plateau.

Characteristics	*Mimosa scabrella* Benth. populations		
	Four years	Seven years	Nine years
Municipality	Bocaina do Sul	Ponte Alta	Lages
Altitude (m)	850	880	916
Mean temperature (°C)	16.5	16.9	16.5
Soil type	Aluminic Cambisol	Humic Cambisol	Lithic Neosol
Total area of population (ha)	389.7	88.0	13.4

The populations of four and seven years characterized areas destined to enlarging the riparian strips in silvicultural farms (*Pinus* and *Eucalyptus* genera). In the landscape context, the population of four years was located in a matrix with few conserved fragments, differing from the population of seven years (Figure 1).

The population of nine years colonised a natural environment after the last *Merostachys multiramea* Hack. reproductive event, occurring between 2006 and 2008 in the Santa Catarina mountain range (Santos et al., 2012). This area is located amid secondary forest fragments in medium-advanced successional stage and silvicultural plantations (*Pinus* spp.).

The regenerating shrub-arboreal vegetation in the understory of the *M. scabrella* populations was evaluated using the fixed plot method, two sample units per population, with dimensions of 40 × 20 m, totalling 800 m^2/population. All individuals with height ≥ 10 cm were sampled, with diameter-at-breast-height (DBH) measurements taken for individuals with DBH ≥ 5 cm, and collar diameter (CD) for those with DBH < 5 cm.

For the floristic composition, all the species present in the sample units were identified in the field when possible, and botanical material was collected for those not identified for later identification in the LUSC Herbarium of the Santa Catarina State University.

The binomial nomenclature was verified using the List of Flora species of Brazil (Flora do Brasil 2020). Estimation and comparison of the richness among the study sites was performed by species/individual analysis using the rarefaction method with 1000 randomizations, generated based on the abundance data matrix in each sample unit. The Shannon diversity index (H') and the Pielou evenness index (J') were calculated for estimating floristic diversity, which enable representing the distribution uniformity of individuals among the existing species. The H' value was compared between the areas using the Hutcheson t-test. A number of authors were consulted for characterising the species in relation to the ecological groups, using the data in works covering forests of the Atlantic Forest domain, especially consultations with *Flora Ilustrada Catarinense* (Reitz, 1971), where the nomenclature proposed by Budowski (1965) of pioneers (PI), early secondary (ES) and late secondary (LS) species were incorporated. The relative participation of the ecological groups (proportion of the individuals belonging to each ecological group in relation to the total sampled) for the three evaluated understories was analysed by a test of proportion ($p \leq 0.01$). Phytosociological descriptors were calculated for analysing the structure of the communities (Martins, 1993). The data ordination concerning the floristic-structural pattern among the communities was evaluated by the Non-metric multidimensional scaling (NMDS) method from the abundance matrix of the species in each sampled site. All analyses were performed using RStudio statistical software (R Development Core Team, 2015).

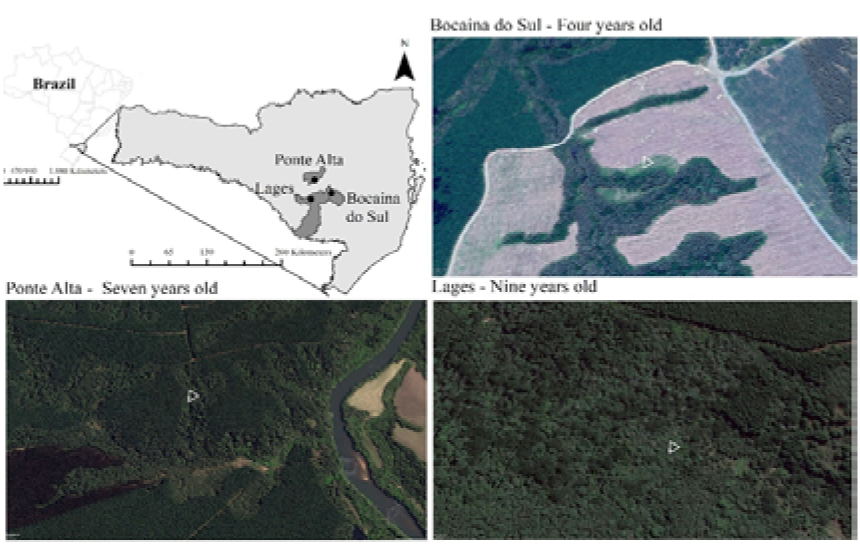

Figure 1. Location and landscape matrix of the study areas of the regenerating community in *Mimosa scabrella* Benth. understories located in Santa Catarina State South Plateau.
Source: Google Earth (2018).

3. RESULTS

In the *Mimosa scabrella* understories, 2692 individuals belonging to 27 botanical families and 74 species were sampled. Of these, two were identified at the family level and three at the gender level. The ecological indexes evaluated in the three studied areas are presented in Table 2. The lowest Shannon diversity index (H') was recorded in the lesser understory (four years), presenting a significant difference from other sampled areas at a probability < 0.001 (Hutcheson t-test). No significant differences were observed in the H' value for the areas of seven and nine years.

Considering the three areas studied, the total number of individuals, families and species was proportional to the regeneration time of each *M. scabrella* understory, being higher in the nine-year understory (Table 2).

In the younger area (four years), Asteraceae was noted for its richness and abundance, representing approximately 27% of the species and 34% of the sampled individuals. In the seven-year understory, Lauraceae and Solanaceae represented approximately 30% of the species and individuals. In the older understory (nine years), Myrtaceae stood out as the richest (18%) and most abundant (26%) family.

In relation to the structural analysis, three species represented more than 50% of the importance value index (IVI) in the four years area, namely: *Vernonanthura discolor* (Spreng.) H.Rob., *Croton reitzii* L.B.Sm. & Downs cf. and *Baccharis uncinella* DC. (Table 3).

Table 2. Regeneration characteristics in communities of *Mimosa scabrella* understories Benth. located in Santa Catarina State South Plateau.

Ecological indicators	*Mimosa scabrella* Benth. populations		
	Four years	Seven years	Nine years
Total number of individuals	433	452	1807
Number of species	27	40	61
Rarefied richness (433 individuals*)	27	39	39
Number of families	14	20	27
Shannon diversity index (*H'*)	2.31	2.96	3.12
Pielou evenness index (*J'*)	0.71	0.80	0.76

* abundance limit for constructing the rarefaction curve using 1000 randomizations.

Table 3. List of tree species sampled in the *Mimosa scabrella* Benth. understory regenerating four, seven and nine years ago with their respective phytosociological descriptors and ecological groups.

Mimosa scabrella Benth. understory in regeneration for four years							
Family	Species	N	RD	RF	RDo	IVI	EG
Euphorbiaceae	*Croton reitzii* L.B.Sm. & Downs	187	43.19	14.81	36.33	31.44	PI
Asteraceae	*Baccharis uncinella* DC.	65	15.01	12.04	21.52	16.19	PI
Asteraceae	*Vernonanthura discolor* (Spreng.) H.Rob.	64	14.78	11.11	9.56	11.82	PI
Asteraceae	*Baccharis semiserrata* DC.	13	3	8.33	6.46	5.93	PI
Solanaceae	*Solanum lacerdae* Dusén	19	4.39	6.48	5.57	5.48	PI
Lauraceae	*Cinnamomum amoenum* (Nees & Mart.) Kosterm.	22	5.08	4.63	1.83	3.85	LS
Sapindaceae	*Matayba elaeagnoides* Radlk.	12	2.77	4.63	3.5	3.63	LS
Asteraceae	*Piptocarpha angustifolia* Dusén ex Malme	6	1.39	3.7	3.36	2.82	PI
Solanaceae	*Solanum variabile* Mart.	6	1.39	4.63	0.87	2.29	PI
Primulaceae	*Myrsine coriacea* (Sw.) R.Br. ex Roem. & Schult.	5	1.15	4.63	0.45	2.08	ES
Solanaceae	*Solanum mauritianum* Scop.	3	0.69	2.78	1.6	1.69	PI
Fabaceae	*Dalbergia frutescens* (Vell.) Britton	3	0.69	2.78	1.32	1.6	ES
Lauraceae	*Nectandra lanceolata* Nees	6	1.39	1.85	0.61	1.28	ST

Table 3. Continued...

Mimosa scabrella Benth. understory in regeneration for four years							
Family	Species	N	RD	RF	RDo	IVI	EG
Aquifoliaceae	*Ilex paraguariensis* A.St.-Hil.	1	0.23	0.93	2.3	1.15	LS
Lauraceae	*Ocotea puberula* (Rich.) Nees	3	0.69	1.85	0.63	1.06	ES
Fabaceae	*Inga lentiscifolia* Benth.	3	0.69	1.85	0.59	1.04	PI
Myrtaceae	*Eugenia pluriflora* DC.	2	0.46	1.85	0.68	0.69	ES
Aquifoliaceae	*Ilex* sp.	2	0.46	1.85	0.52	0.5	UN
Bignoniaceae	*Jacaranda puberula* Cham.	2	0.46	1.85	0.47	0.5	ES
Clethraceae	*Clethra scabra* Pers.	2	0.23	0.93	0.68	0.42	PI
Salicaceae	*Casearia obliqua* Spreng.	1	0.23	0.93	0.35	0.42	LS
Aquifoliaceae	*Ilex microdonta* Reissek	1	0.23	0.93	0.35	0.42	LS
Sapindaceae	*Cupania vernalis* Cambess.	1	0.23	0.93	0.12	0.42	ES
Styracaceae	*Styrax leprosus* Hook. & Arn.	1	0.23	0.93	0.12	0.42	ES
Lauraceae	*Cryptocarya aschersoniana* Mez	1	0.23	0.93	0.09	0.42	LS
Rosaceae	*Prunus myrtifolia* (L.) Urb.	1	0.23	0.93	0.09	0.42	ES
Annonaceae	*Annona rugulosa* (Schltdl.) H.Rainer	1	0.23	0.93	0.05	0.4	LS
Total		433	100	100	100	100	

Mimosa scabrella Benth. understory in regeneration for seven years							
Family	Species	N	RD	RF	RDo	IVI	EG
Clethraceae	*Clethra scabra* Pers.	70	15.49	0.63	14.92	10.34	PI
Solanaceae	*Solanum variabile* Mart.	49	10.84	0.63	17.18	9.55	PI
Lauraceae	*Ocotea puberula* (Rich.) Nees	29	6.42	0.63	13.46	6.83	ES
Myrtaceae	*Myrcia splendens* (Sw.) DC.	25	5.53	1.24	10.34	5.71	ES
Sapindaceae	*Matayba elaeagnoides* Radlk.	40	8.85	0.63	6.94	5.47	LS
Dicksoniaceae	*Dicksonia sellowiana* Hook.	46	10.18	1.25	0.82	4.08	LS
Primulaceae	*Myrsine coriacea* (Sw.) R.Br. ex Roem. & Schult.	26	5.75	3.13	2.9	3.92	PI
Aquifoliaceae	*Ilex paraguariensis* A.St.-Hil.	27	5.97	0.63	4.88	3.83	PI
Lauraceae	*Ocotea pulchella* (Nees & Mart.) Mez	11	2.43	6.88	1.43	3.58	ES
Styracaceae	*Styrax leprosus* Hook. & Arn.	6	1.33	8.75	0.35	3.48	ES
Rosaceae	*Prunus myrtifolia* (L.) Urb	21	4.65	3.13	1.84	3.2	ES
Melastomataceae	*Miconia hyemalis* A.St.-Hil. & Naudin	2	0.44	8.75	0.35	3.28	PI
Erythroxylaceae	*Erythroxylum deciduum* A.St.-Hil.	1	0.22	8.13	0.05	2.8	ES
Asteraceae	*Baccharis semiserrata* DC.	10	2.21	1.25	4.66	2.71	PI
Asteraceae	*Vernonanthura discolor* (Spreng.) H.Rob.	11	2.43	1.25	4.12	2.6	PI
Fabaceae	*Dalbergia frutescens* (Vell.) Britton	2	0.44	6.88	0.33	2.55	ES
Asteraceae	*Baccharis uncinella* DC.	4	0.88	3.75	2.09	2.24	PI
Fabaceae	*Inga lentiscifolia* Benth.	3	0.66	5.63	0.43	2.24	LS
Lauraceae	*Cinnamomum amoenum* (Nees & Mart.) Kosterm.	18	3.98	1.25	1.46	2.23	LS
Lauraceae	*Nectandra grandiflora* Nees	3	0.66	4.38	0.65	1.9	LS
Lauraceae	*Persea major (Meisn.)* L.E.Kopp	2	0.44	3.75	0.25	1.48	LS
Euphorbiaceae	*Sapium glandulosum* (L.) Morong	2	0.44	3.13	0.58	1.38	PI
Canellaceae	*Cinnamodendron dinisii* Schwanke	1	0.22	3.75	0.03	1.33	ES
Asteraceae	*Piptocarpha angustifolia* Dusén ex Malme	6	1.33	0.63	2.01	1.32	PI

Table 3. Continued...

Mimosa scabrella Benth. understory in regeneration for seven years							
Family	**Species**	**N**	**RD**	**RF**	**RDo**	**IVI**	**EG**
Solanaceae	*Solanum mauritianum* Scop.	3	0.66	0.63	2.39	1.23	PI
Euphorbiaceae	*Sebastiania commersoniana* (Baill.) L.B.Sm. & Downs	7	1.55	0.63	1.43	1.2	ES
Salicaceae	*Casearia decandra* Jacq.	2	0.44	2.5	0.35	1.1	LS
Annonaceae	*Annona rugulosa* (Schltdl.) H.Rainer	6	1.33	1.25	0.44	1.01	LS
Lauraceae	*Nectandra lanceolata* Nees	5	1.11	1.25	0.48	0.94	LS
ceae	*Araucaria angustifolia* (Bertol.) Kuntze	2	0.44	1.25	0.9	0.86	PI
Araucariaceae	*Solanum lacerdae* Dusén	1	0.22	1.88	0.38	0.83	PI
Solanaceae	*Solanum sanctaecatharinae* Dunal.	1	0.22	1.88	0.29	0.79	ES
Lauraceae	*Nectandra megapotamica* (Spreng.) Mez	1	0.22	1.88	0.03	0.71	LS
Sapindaceae	*Allophylus edulis* (A.St.-Hil. et al.) Hieron. ex Niederl.	2	0.44	1.25	0.37	0.69	ES
Lauraceae	*Persea willdenovii* Kosterm.	1	0.22	1.25	0.35	0.61	UN
Anacardiaceae	*Schinus terebinthifolius* Raddi	1	0.22	1.25	0.13	0.53	PI
Bignoniaceae	*Jacaranda puberula* Cham.	1	0.22	1.25	0.02	0.5	ES
Aquifoliaceae	*Ilex microdonta* Reissek	2	0.44	0.63	0.08	0.38	LS
Aquifoliaceae	*Ilex dumosa* Reissek	1	0.22	0.63	0.17	0.34	ES
Myrtaceae	*Eugenia pluriflora* DC.	1	0.22	0.63	0.16	0.33	ES
Total		452	100	100	100	100	
Mimosa scabrella Benth. understory in regeneration for nine years							
Family	**Species**	**N**	**RD**	**RF**	**RDo**	**IVI**	**EG**
Myrtaceae	*Myrcia splendens* (Sw.) DC.	418	23.13	4.56	14.51	14.07	ES
Solanaceae	*Solanum variabile* Mart.	155	8.58	4.56	14.73	9.29	PI
Asteraceae	*Vernonanthura discolor* (Spreng.) H.Rob.	109	6.03	3.70	14.76	8.17	PI
Bignoniaceae	*Jacaranda puberula* Cham.	111	6.14	4.56	11.36	7.35	ES
Primulaceae	*Myrsine coriacea* (Sw.) R.Br. ex Roem. & Schult.	202	11.18	4.27	3.88	6.44	ES
Asteraceae	*Piptocarpha* angustifolia Dusén ex Malme	52	2.88	4.56	11.66	6.36	PI
Salicaceae	*Casearia decandra* Jacq.	67	3.71	3.70	3.50	3.64	LS
Sapindaceae	*Matayba elaeagnoides* Radlk.	61	3.38	4.56	2.36	3.43	LS
Sapindaceae	*Cupania vernalis* Cambess.	55	3.04	3.99	1.91	2.98	ES
Primulaceae	*Myrsine parvula* (Mez) Otegui	69	3.82	3.70	1.26	2.93	ES
Lauraceae	*Nectandra lanceolata* Nees	59	3.27	3.42	1.61	2.77	LS
Proteaceae	*Roupala montana* Aubl.	35	1.94	3.99	1.97	2.63	LS
Aquifoliaceae	*Ilex paraguariensis* A.St.-Hil.	36	1.99	3.70	2.10	2.60	PI
Annonaceae	*Annona rugulosa* (Schltdl.) H.Rainer	39	2.16	3.99	0.91	2.35	LS
Primulaceae	*Myrsine umbellata* Mart.	53	2.93	3.13	0.80	2.29	PI
ceae	Araucaria angustifolia (Bertol.) Kuntze	37	2.05	2.85	0.61	1.84	PI
Araucariaceae	*Ilex brevicuspis* Reissek.	29	1.60	2.28	0.61	1.50	LS
Myrtaceae	Myrtaceae sp	29	1.60	2.28	0.50	1.46	UN
Rutaceae	*Zanthoxylum rhoifolium* Lam.	19	1.05	2.85	0.46	1.45	PI
Lauraceae	*Ocotea pulchella* (Nees & Mart.) Mez	19	1.05	1.99	1.29	1.45	ES

Table 3. Continued...

Mimosa scabrella Benth. understory in regeneration for nine years							
Family	**Species**	**N**	**RD**	**RF**	**RDo**	**IVI**	**EG**
Solanaceae	Solanaceae 1	14	0.77	2.28	0.98	1.35	UN
Lauraceae	*Ocotea puberula* (Rich.) Nees	24	1.33	1.99	0.36	1.23	ES
Meliaceae	*Cabralea canjerana* (Vell.) Mart.	11	0.61	1.99	0.61	1.07	ES
Fabaceae	*Dalbergia frutescens* (Vell.) Britton	15	0.83	1.14	0.78	0.92	ES
Myrtaceae	*Myrcia hatschbachii* D. Legrand.	9	0.50	1.42	0.51	0.81	ES
Myrtaceae	*Myrcia hartwegiana* (O.Berg) Kiaersk.	3	0.17	0.85	0.81	0.61	ES
Salicaceae	*Casearia obliqua* Spreng.	4	0.22	1.14	0.31	0.56	LS
Lauraceae	*Nectandra megapotamica* (Spreng.) Mez	5	0.28	1.14	0.22	0.55	LS
Euphorbiaceae	*Sapium glandulosum* (L.) Morong	3	0.17	0.85	0.52	0.51	PI
Aquifoliaceae	*Ilex theezans* Mart. ex Reissek	3	0.17	0.85	0.39	0.47	ES
Styracaceae	*Styrax leprosus* Hook. & Arn.	6	0.33	0.57	0.35	0.42	ES
Cannabaceae	*Celtis iguanaea* (Jacq.) Sarg.	4	0.22	0.85	0.13	0.40	PI
Myrtaceae	*Campomanesia xanthocarpa* Berg	4	0.22	0.85	0.06	0.38	ES
Erythroxylacea	*Erythroxylum deciduum* A.St.-Hil.	3	0.17	0.85	0.10	0.37	ES
Salicaceae	*Casearia sylvestris* Sw.	4	0.22	0.85	0.04	0.37	PI
Cardiopteridaceae	*Citronella paniculata* (Mart.) Howard.	1	0.06	0.28	0.72	0.35	ES
Euphorbiaceae	*Sebastiania commersoniana* (Baill.) L.B.Sm. & Downs	4	0.22	0.57	0.14	0.31	ES
Canellaceae	*Cinnamodendron dinisii* Schwacke	1	0.06	0.28	0.59	0.31	PI
Myrtaceae	*Myrcia laruotteana* Cambesse	4	0.22	0.57	0.09	0.29	ES
Solanaceae	*Solanum mauritianum* Scop.	2	0.11	0.28	0.40	0.26	PI
Clethraceae	*Clethra scabra* Pers.	3	0.17	0.57	0.04	0.26	PI
Meliaceae	*Cedrela fissilis* Vell.	3	0.17	0.57	0.02	0.25	PI
Sapindaceae	*Allophylus* edulis (A.St.-Hil. et al.) Hieron. ex Niederl.	2	0.11	0.57	0.06	0.25	ES
Salicaceae	*Xylosma ciliatifolia* (Clos) Eichler	1	0.06	0.28	0.39	0.24	ES
Sapindaceae	*Allophylus guaraniticus* (A. St.-Hil.) Radlk.	2	0.11	0.57	0.04	0.24	LS
Rosaceae	*Prunus myrtifolia* (L.) Urb.	2	0.11	0.57	0.03	0.24	ES
Solanaceae	*Solanum sanctaecatharinae* Dunal.	2	0.11	0.57	0.02	0.23	ES
Aquifoliaceae	*Ilex dumosa* Reissek	1	0.06	0.28	0.10	0.15	LS
Solanaceae	*Solanum lacerdae* Dusén	1	0.06	0.28	0.09	0.14	PI
Fabaceae	*Inga vera* Willd.	1	0.06	0.28	0.08	0.14	LS
Elaeocarpaceae	*Sloanea hirsuta* (Schott) Planch. ex Benth.	1	0.06	0.28	0.05	0.13	LS
Myrtaceae	*Calyptranthes concinna* DC.	1	0.06	0.28	0.05	0.13	LS
Myrtaceae	*Myrciaria delicatula* (DC.) O.Berg	1	0.06	0.28	0.03	0.12	LS
Cardiopteridaceae	*Citronella gongonha* (Mart.) R.A.Howard	1	0.06	0.28	0.02	0.12	LS
Myrtaceae	*Eugenia pluriflora* DC.	1	0.06	0.28	0.02	0.12	ES
Aquifoliaceae	*Ilex microdonta* Reissek	1	0.06	0.28	0.02	0.12	LS
Melastomataceae	*Miconia sellowiana* Naudim	1	0.06	0.28	0.01	0.12	UN
Solanaceae	*Solanum* sp1	1	0.06	0.28	0.01	0.12	UN
Myrtaceae	*Myrciaria* sp.	1	0.06	0.28	0.01	0.12	UN

Mimosa scabrella Benth. understory in regeneration for nine years							
Family	**Species**	**N**	**RD**	**RF**	**RDo**	**IVI**	**EG**
Myrtaceae	*Myrcia palustris* DC.	1	0.06	0.28	0.01	0.12	ES
Rhamnaceae	*Rhamnus sphaerosperma* Sw.	1	0.06	0.28	0.00	0.11	ES
Total		1807	100	100	100	100	

Legend: N: total number of individuals; RD: relative density (%); RF: relative frequency (%); RDo: relative dominance IVI: importance value index (%); EG: ecological group; PI: pioneer; ES: early secondary; LS: late secondary (%); UN: undetermined.

Among the species of higher IVI in the understory of seven years (*Clethra scabra* Pers., *Solanum variabile* Mart., *Ocotea puberula* (Rich.) Nees, *Myrcia splendens* (Sw.) DC. and *Matayba elaeagnoides* Radlk), three already belong to the secondary group (Table 3).

In the more advanced understory (nine years), the structure was represented by more than 50% of IVI by the following species: *Myrcia splendens* (Sw.) DC., *S. variabile*, *V. discolor*, *Jacaranda puberula* Cham., *M. coriacea* and *Piptocarpha angustifolia* (Table 3).

Regarding ecological group participation in the different succession times, it is observed that there is a significant difference by the test of proportions (< 0.001). The most representative group in the understory with four years of natural regeneration was the pioneer group (85.2%). For the environments in seven and nine years of regeneration, the early secondary group contributed with 24.1% and 53.7%, respectively. The seven-year understory had the highest abundance of late secondary species (28.4 %).

The data ordination produced by the NMDS presented a stress value of 14.34, indicating that the ordination is representative and adequate for the interpretation. From the ordination represented in the diagram (Figure 2), it was verified that the different understory ages of *M. scabrella* showed species substitution.

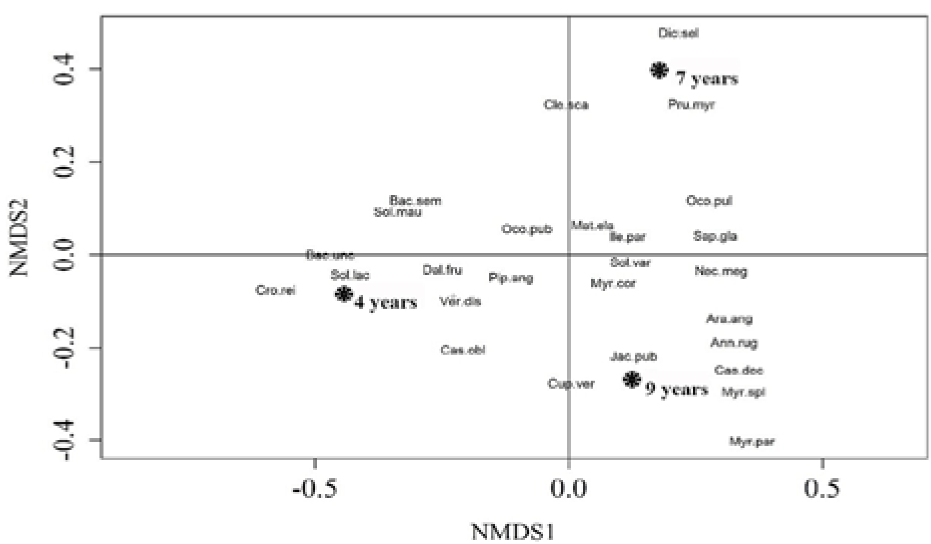

Figure 2. Ordination diagram produced by Non-metric Multidimensional Scaling analysis. (NMDS) of a regenerating tree community in *Mimosa scabrella* Benth. understories located in the Santa Catarina State South Plateau. Where: Ann.rug: *Annona rugulosa*; Ara.ang: *angustifolia*; Bac.sem: *Baccharis semiserrata*; Bac.unc: *Baccharis uncinella*; Cas.dec: *Casearia decandra*; Cas.obl: *Casearia obliqua*; Cle.sca: *Clethra scabra*; Cro.rei: *Croton reitzii*; Cup.ver: *Cupania vernalis*; Dal.fru: *Dalbergia frutescens*;Ile.par: *Ilex paraguariensis*; Jac.pub: *Jacaranda puberula*; Mat.ela: *Matayba elaeagnoides*; Myr.cor: *Myrsine coriacea*; Myr.par: *Myrsine parvula*; Myr.spl: *Myrcia splendens*; Nec.meg: *Nectandra megapotamica*; Oco.pub: *Ocotea puberula*; Oco.pul: *Ocotea pulchella*; Pip.ang: *Piptocarpha angustifolia*; Pru.myr: *Prunus myrtifolia*; Sap.gla: *Sapium glandulosum*; Sol.lac: *Solanum lacerdae*; Sol.mau: *Solanum mauritianum*; Sol.var: *Solanum variabile*; Ver.dis: *Vernonanthura discolor*.

4. DISCUSSION

The lowest Shannon (H') diversity index value was recorded in the younger understory (four years), with this value being higher than that found by Barbosa et al. (2009) who studied an *Araucaria angustifolia* (Bertol.) Kuntze understory for about 12 years. The community registered in the areas of seven and nine years showed low dominance according to the Pielou index values (J'). These results corroborate with those found in regeneration studies carried out in Araucaria Forest (Narvaes et al., 2005; Kanieski et al., 2012).

The short temporal scale between the studied sites (understories of seven and nine years) can be evidenced when the rarefied richness is analyzed. Still, the environments structure is characterized by an increase in abundance and wealth, evidencing the successional advance.

Species belonging to Asteraceae and Solanaceae were prominent in the lower understory (four years), as they preferentially occur in open environments and fragment edges (Tabarelli & Mantovani, 1999; Barroso & Bueno, 2002). This result suggests that the successional process is still in its initial phase, unlike the other studied environments (seven and nine years), where there was greater Lauraceae and Myrtaceae representation. These families are commonly registered in Araucaria Forest studies at more advanced stages in Southern Brazil (Jarenkow & Baptista, 1987; Narvaes et al., 2005; Herrera et al., 2009; Silva et al., 2012).

Based on the observation of the most representative species in the structural analysis in the area of four years, it was verified that they are pioneer species with characteristics of initial succession stages in Araucaria Forest, becoming abundant in altered environments (Barroso & Bueno, 2002; Machado et al., 2006; Herrera et al., 2009; Ferreira et al., 2012). In the seven years understory, the species with higher IVI (*Ocotea puberula* (Rich.) Nees, *Myrcia splendens* (Sw.) DC. and *Matayba elaeagnoides* Radlk) belong to the secondary group. This aspect shows that although the area is in the initial stage due to the short regeneration time, it is possible to verify the species substitution dynamics in relation to the ecological succession.

Some pioneers are still present in the more advanced understory (nine years), where early and late secondary species participation represent more than half of the registered individuals. The species with higher IVI in these areas were: *M. splendens* (ES), *S. variabile* (PI) and *M. coriacea* (ES), and are zoochorically dispersed, demonstrating the presence of interactions with the fauna and of this ecosystem's functionality having returned.

The data ordination (NMDS) showed that the different ages of *M. scabrella* underwent species substitution, and this floristic-structural gradient is associated to the successional dynamics process. The predominance of species belonging to the pioneer ecological group is associated with the younger community (four years), as well as the higher occurrence of late secondary species in the seven and nine-year-old understories. Considering this aspect, it is possible to verify that *M. scabrella* presents as a potential facilitator species for altered areas, since the increase in diversity from the initial (four years) to medium (seven and nine years) can act in improving the soil and climatic conditions. In this way, it is possible to verify that, as the development of these populations occurs, the conditions for successional processes to occur can be expanded, enabling more species to be established. However, it is important to emphasize that this process will be conditioned by the presence of remnant fragments in the landscape, which directly act as propagule sources for the revegetation of these areas.

It is also worth noting the importance of preserving areas in the secondary succession process, since they are vegetation cover with potentially endangered species, such as *Araucaria angustifolia* and *Cedrela fissilis*, recorded in this study and included on the threatened species list of the International Union for Conservation of Nature and Natural Resources (IUCN, 2016).

5. CONCLUSIONS

The highest regenerant richness was recorded in the *Mimosa scabrella* understory at a more advanced age.

The areas under natural regeneration in *Mimosa scabrella* understories with different ages presented different floristic-structural patterns, which are compatible with the characteristic trends of successional dynamics of Araucaria Forest, mainly due to the effect of the landscape matrix.

The increase in diversity in the understories of the *Mimosa scabrella* populations in the early to middle stages suggests the potential of this species as a facilitator for restoring altered areas.

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