Revista Brasileira de Biociências
Brazilian Journal of Biosciences
http://www.ufrgs.br/seerbio/ojs
ISSN 1980-4849 (on-line) / 1679-2343 (print)

ARTICLE

Floristics and structure of the tree component in a Seasonal Forest remnant, Chiapetta, Rio Grande do Sul State, Brazil

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Received: November 20 2008 Received after revision: August 06 2009 Accepted: October 14 2009
Available online at http://www.ufrgs.br/seerbio/ojs/index.php/rbb/article/view/1135

ABSTRACT: (Floristics and structure of the tree component in a Seasonal Forest remnant, Chiapetta, Rio Grande do Sul State, Brazil). In a patchy landscape, the forest remnants are important to the conservation of wild species. A phytossociological study of tree component in a remnant of Seasonal Semideciduous Forest site namely Mato do Silva (27º55'26'' S, 53º53'15'' W, 290 ha) was accomplished aiming to obtain data of plant community structure and its conservation status, comparing with other Seasonal Forest sites. A sample of 508 trees (DBH ≥ 5.0 cm), belonging to 31 families and 63 species, was attained through the point-quarter procedure. The outstanding families in terms of richness were Fabaceae (eleven species), Myrtaceae, Rutaceae, Sapindaceae, Lauraceae and Euphorbiaceae (four species each one). The species with the highest importance value were *Cordia americana* (L.) Gottschling & J.E.Mill. (35.5), *Diatenopteryx sorbifolia* Radlk. (32.3) and *Prunus myrtifolia* (L.) Urban (19.1). The dead trees presented a relative density of 4.9%. The majority of the species (65%) and individuals (55%) were zoochoric. Otherwise, the anemochory presented higher relative coverage (55%). The species with the higher IV values were mainly early secondary and anemochoric. The Shannon index of diversity (H') was 3.68 and the Pielou's evenness index (J') was 0.89. These values are among the highest values observed in Seasonal Forests of South Brazil. The floristic inventory counted 117 tree species.
Key words: forest fragmentation, ecological succession, biodiversity conservation, dispersal modes.

RESUMO: (Florística e estrutura do componente arbóreo de um remanescente de Floresta Estacional, Chiapetta, Rio Grande do Sul, Brasil). Em uma paisagem fragmentada, os remanescentes florestais são importantes para a conservação das espécies silvestres. Um estudo fitossociológico do componente arbóreo em um remanescente de Floresta Estacional Semidecidual denominado Mato do Silva (27º55'26''S, 53º53'15''O) foi realizado com objetivo de obter dados sobre a estrutura da comunidade vegetal e seu status de conservação, estabelecendo uma comparação com outras florestas estacionais. Uma amostra de 508 indivíduos do componente arbóreo (DAP ≥ 5,0 cm), distribuídos em 31 famílias e 63 espécies, foi obtida através do método de quadrantes. As famílias que se sobressaíram em riqueza foram Fabaceae (onze espécies), Myrtaceae, Rutaceae, Sapindaceae, Lauraceae e Euphorbiaceae (quatro espécies cada). As espécies com os maiores valores de importância (VI) foram *Cordia americana* (L.) Gottschling & J.E.Mill. (35,5), *Diatenopteryx sorbifolia* Radlk. (32,3) e *Prunus myrtifolia* (L.) Urban (19,1). As árvores mortas representaram uma densidade relativa de 4,9%. A maioria das espécies (65%) e indivíduos (55%) apresentou zoocoria. Entretanto, a anemocoria teve maior cobertura relativa (55%). As espécies com os valores mais elevados de VI são predominantemente secundárias iniciais e anemocóricas. O índice de diversidade de Shannon (H') foi de 3,68 e o índice de equitabilidade de Pielou (J') foi de 0,89. Estes valores estão entre os mais altos encontrados em Florestas Estacionais do sul do Brasil. O inventário florístico resultou em 117 espécies arbóreas.
Palavras-chave: fragmentação de florestas, sucessão ecológica, conservação da biodiversidade, modos de dispersão.

INTRODUCTION

In South and Southeast Brazil, the expansion of the monocultures in the last decades brought an increasing reduction and fragmentation of native forests. The Atlantic Forest was reduced to only 7.5% of its original cover (Myers *et al.* 2000). The Subtropical Atlantic Forest, also named Seasonal Forest, with an original cover of 1,000,000 km^2 among Brazil, Argentine and Paraguay, nowadays exhibits only 6% of that area (Burkart & Fernández 2002).

The Northwest of the Rio Grande do Sul, between the Turvo and Ijuí River basins, corresponds to a region originally dominated by the Seasonal Forest (Teixeira & Coura-Neto 1986, Marchiori 2002). In the present time, its cover is highly reduced and fragmented (Granell-Pérez *et al.* 1999, Schenkel *et al.* 2003, FUNDAÇÃO SOS MATA ATLÂNTICA/ INPE 2002).

The fragmentation modifies the evolutional processes of the natural populations of plants and animals. These modifications affect in distinct manners the demographic parameters of different species, and therefore the composition and dynamics of the ecosystems. In the case of the tree species, the alteration in the abundance of pollinators, dispersers, predators and pathogens alters the recruitment levels. In addition, the fires and microclimatic changes, which affect more intensely the edges, modify the adult tree mortality rates (Laurance *et al.* 1997, 1998, Viana & Pinheiro 1998, Cunningham 2000).

Many plants rely on a range of dispersers of pollen and seed, all of which are affected by their environment in terms of connectivity (Murphy & Lovett-Doust 2004). Small fragments can constitute a network, favoring the transit among greater remnants or conservation units and supporting regional populations of sufficient size

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for longer-term persistence (Gascon & Lovejoy 1998, Honnay *et al.* 2005).

Even relatively small remnants could have a chief importance in the biodiversity conservation and in supplying genetic material to forest restoration (Turner & Corlett 1996), particularly the more ancient remnants with moderate disturbances as they conserve the pristine flora better than others with secondary or new forest vegetation (Honnay *et al.* 2005). Floristic and phytosociological data contribute to research species permanence, local extinctions, events of re-occupation or biological invasions (Turner et al. 1995, Bossuyt et al. 1999).

A floristic inventory and phytossociological study were carried out in Mato do Silva Seasonal Forest Remnant, one of the few remnants with more than two hundred hectares in the Northwest Region of the Rio Grande do Sul. The aims were to evaluate the diversity and conservation of the tree species, quantify the proportion of dispersion mechanisms and successional guilds, comparing with other sites in conservation units or forest fragments of Seasonal Forests.

MATERIALS AND METHODS

The study site (27° 55' 11" S e 53° 52' 40" W) is located in Chiapetta, Rio Grande do Sul State. The climate is L PU perhumid subtropical (Maluf 2000). The altitude ranges between 400 and 472 m above mean sea level. The Forest formation corresponds to the Seasonal Forest. The forest remnant comprehends 230 ha of primary-like forest and near 70 ha of areas in secondary succession and marshes (Fig. 1). It is considered here primary-like forest as a forest without known perturbations in the last thirty years, according to local informants. Previously, the area was disturbed due to timber harvest, whose intensity could not be determined.

The area of secondary succession was dominated by *Ateleia glazioveana* Baill., which is virtually the exclusive species of the dossel.

The geology of the region pertain to the Serra Geral domain, characterized by basaltic rocks derived from volcanisms of Jurassic and Cretaceous, which produced several lava overflows (Rambo 1956). The prevalent soil is oxisols (according to the international classification, USDA 1999) characterized by low nutrients levels and acid pH (Tab. 1). The physico-chemical profile of the soil in the primary-like forest of the Mato do Silva was provided by UNIJUÍ Soil Laboratory and obtained under the methodological recommendations of Tedesco *et al.* (1995).

The phytosociological investigation was carried out through the point quarter method (Cottam & Curtis 1956). The 127 sample units were marked 20 m apart in two parallel lines, recording tree individuals with DBH ≥ 5.0 cm (measured 1.3 m above the ground). The samples were obtained in the interfluvial area between the two first-order streams that pass through the forested area (Fig. 1), therefore avoiding the riparian forest. The sample sufficiency was analyzed by the species-point curve and also by the rarefaction curve (Gotelli & Colwell 2001), which were performed with EstimateS 8.00 (Colwell 2006).

The phytosociological data were complemented by a floristic inventory of the woody species in the complete Seasonal Forest area of the remnant. The criterion for the inclusion in the tree synusia was to present at least one individual with DBH ≥ 5.0 cm (Sobral *et al.* 2006). The data were obtained between September 2006 and October 2007, examining thoroughly the remnant, including riparian forest of the Inhacorá River and riparian areas along their first-order tributaries, and also the secondary forest. The floristic search was performed during 12 days, with a sum of 60 hours.

The phytosociological parameters frequency, density and coverage, the Importance Value (IV), the Shannon index of diversity H' and the Pielou's evenness index J' were determined according to Brower *et al.* (1998).

The species taxonomy was determined with the assistance of experts, herbaria and literature (Sobral *et al.* 2006). The classification followed the APG II system (Souza & Lorenzi 2005) and the nomenclature was according the International Plant Names Index (IPNI 2006). Voucher materials were deposited in the Rogério Bueno Herbarium of the UNIJUÍ University (HUI).

To designate the dispersion mode, the classification proposed by Van Der Pijl (1982) was adopted, dividing the diaspore types according to the features of the dispersion unit. Zoochory was characterized by presence of potential rewards or attractives, such as arile, pigmentation and flesh pulp. Anemochory was identified by structures that favor the wind dispersion such as wings. The autochory was characterized by the absence of clear adaptations to the others dispersion modes. The classification of the species was obtained by the direct observation and with the assistance of the literature (Oliveira & Moreira 1992, Barroso *et al.* 1999, Ruchel *et al.* 2007).

Table 1. Physico-chemical profile of the soil, Mato do Silva forest remnant, Chiapetta, Rio Grande do Sul State, Brazil, November 2008.

	Clay %	51.0
	pH	4.8
mg/dm³	P	< 3.0
	K	53.0
	S	10.5
	Cu	2.8
	Zn	2.0
	Mn	58.1
cmolc/dm³	Al	1.0
	Ca	3.4
	Mg	1.8
	CEC (pH = 7.0)	10.9
	H + Al	16.3
	V %	32.8
	M* %	15.8
	O.M. (%)	3.3

*Al saturation

The species were circumscribed to the successional guilds according Carvalho (1994) who based his classification in agreement to Budowski (1965), and from the observations of the authors. The applied categories were pioneer, early secondary, late secondary and shade tolerant, the last being considered equivalent to climax.

The proportions of the dispersion modes and successional guilds were calculated from the phytosociological data, excluding the dead individuals. The trees of different dispersion modes were compared in relation to the mean DBH. The data were analyzed through a one-way ANOVA and multiple comparisons were made with the Tukey test ($P < 0.05$).

RESULTS

The total floristic richness included 117 woody species pertaining to 82 genera and 42 families (Tab. 2). The family with the great richness was Fabaceae with 18 species followed by Myrtaceae (11), Rutaceae (9) and Lauraceae (6). There are three exotic species, *Hovenia dulcis* (Rhamnaceae) and two species of *Citrus* (Rutaceae).

The 508 trees recorded in the phytosociological survey included 63 species pertaining to 52 genera and 31 families (Table 2). Again, the Fabaceae was outstanding with eleven species. One specimen of *Hovenia dulcis*, a transcontinental exotic species, was registered in the phytosociological inventory. The species-point accumulation curve and the rarefaction curve did not indicate a clear asymptotic richness level (Fig. 2).

Cordia americana showed the greater IV (35.5) and remarkable values of frequency and density. Besides, high values of IV were observed to *Diatenopteryx sorbifolia* (32.3) and *Prunus myrtifolia* (19.1). The species with coverage higher than 5% were *C. americana* (17.1%),

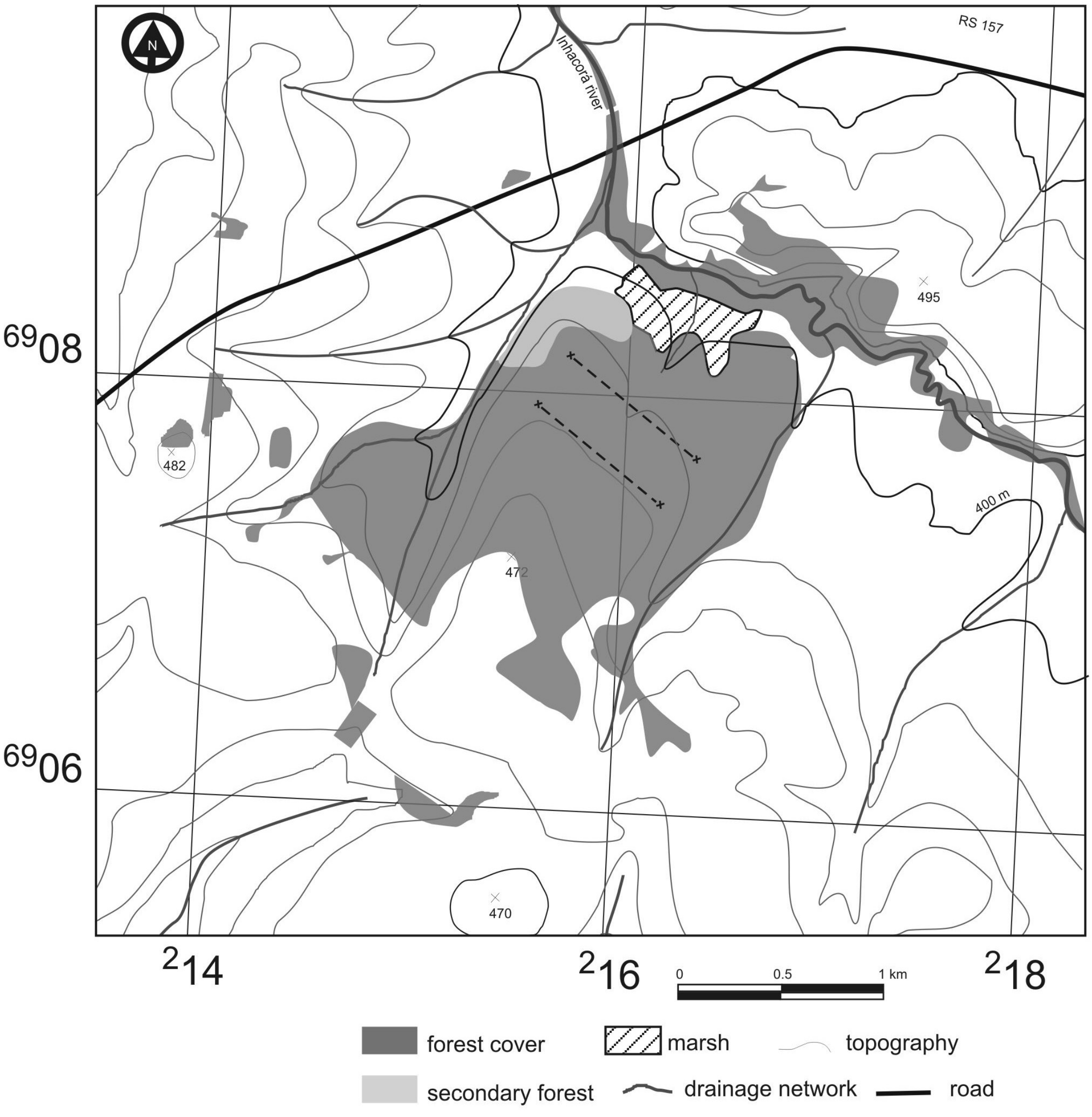

Figure 1. Map of the Mato do Silva forest remnant. The two parallel traced lines indicate the sample transects.

Table 2. Tree species checklist from the Mato do Silva ordered in families according to the APG II system.

Anacardiaceae
Schinus terebinthifolius Raddi
Anonnaceae
Rollinia rugulosa Schltdl.
Rollinia salicifolia Schltdl.
Apocynaceae
Aspidosperma australe Müll. Arg.
Aquifoliaceae
Ilex brevicuspis Reissek
Ilex paraguariensis A. St.-Hilaire
Araliaceae
Aralia warmingiana (March.) Wen
Schefflera morototoni (Aubl.) Mag., Steyerm & Frod.
Arecaceae (=Palmae)
Butia capitata (Mart.) Beccari
Syagrus romanzoffiana (Cham.) Glassman
Asteraceae
Piptocarpha angustifolia Dusén ex Malme
Bignoniaceae
Jacaranda micrantha Cham.
Boraginaceae
Cordia ecalyculata (Vell.) Arrab. & Steud.
Cordia trichotoma Vell.
Cordia americana (L.) Gottschling & J. E. Mill.
Cannabaceae
Celtis iguanae (Jacq.) Sarg.
Trema micrantha (L.) Blüme
Cardiopteridaceae
Citronella paniculata (Mart.) Howard
Caricaceae
Jacaratia spinosa (Aubl.) DC.
Celastraceae
Maytenus muelleri Schwacke
Schaefferia argentinensis Speg.
Erythroxylaceae
Erythroxylum deciduum A. St.-Hilaire
Euphorbiaceae
Gymnanthes concolor Spreng.
Sebastiania brasiliensis Spreng.
Sebastiania commersoniana (Baill.) Smith & Downs
Tetrorchidium rubrivenium Poppig & Endlicher
Fabaceae (=Leguminosae)
Albizia edwallii (Hoehne) Barneby & J.W.Grimes
Apuleia leiocarpa (Vogel) Macbride
Ateleia glazioveana Baill.
Bauhinia forficata Link
Enterolobium contortisiliquum (Vell.) Mor.
Erythrina crista-galli L.
Erythrina falcata Bentham
Gledtisia amorphoides (Griseb.) Taubert
Holocalyx balansae Micheli
Inga marginata Willd.
Inga virescens Benth.
Lonchocarpus campestris Mart. ex Bentham
Lonchocarpus nitidus (Vogel) Benth.
Machaerium nictitans (Vell.) Benth.
Machaerium paraguariense Hassler
Machaerium stipitatum Vogel
Myrocarpus frondosus Freire Allemão
Parapiptadenia rigida (Benth.) Brenan
Lamiaceae
Vitex megapotamica (Spreng.) Mold.
Lauraceae
Endlicheria paniculata (Spreng.) Macbride
Nectandra lanceolata Nees
Nectandra megapotamica (Spreng.) Mez
Ocotea diospyrifolia (Meissner) Mez
Ocotea puberula Nees
Ocotea pulchella (Nees) Nees
Laxmanniaceae
Cordyline spectabilis Kunth & Bouché
Loganiaceae
Strychnos brasiliensis (Spreng.) Mart.
Malpighiaceae
Bunchosia maritima (Vell.) J. F. Macbr.
Malvaceae
Luehea divaricata Mart.
Melastomataceae
Miconia cinerascens Miq.
Meliaceae
Cabralea canjerana (Vellozo) Mart.
Cedrela fissilis Vellozo
Trichilia catigua A. Jussieu
Trichilia claussenii C. De Candolle
Trichilia elegans A. Jussieu
Monimiaceae
Hennecartia omphalandra J. Poiss.
Moraceae
Ficus citrifolia Mill.
Sorocea bonplandii (Baill.) Burger, Lanj. & Boer
Myrsinaceae
Myrsine coriacea (Sw.) R. Br.
Myrsine laetevirens (Mez.) Arechav.
Myrsine guianensis (Aubl.) Kuntze
Myrtaceae
Calyptranthes concinna DC.
Campomanesia guazumifolia (Camb.) Berg
Campomanesia xanthocarpa Berg
Eugenia pyriformis Camb.
Eugenia involucrata DC.
Eugenia rostrifolia Legr.
Eugenia uniflora L.
Myrceugenia glaucescens(Camb.) Legr. & Kausel
Myrcia bombicina (O. Berg) Nied.
Myrcianthes gigantea (Legr.) Legr
*Myrcia palustris*DC.
Nyctaginaceae
Pisonia aculeata L.
Pisonia zapallo Griseb.
Phytolaccaceae
Phytolacca dioica L.
Rhamnaceae
Hovenia dulcis L.
Rosaceae
Prunus myrtifolia L.
Rubiaceae
Randia ferox (Cham. & Schltdl.) DC.
Machaonia brasiliensis (Hoffmanns. ex Humb.) Cham. & Schltdl.
Rutaceae
Balfourodendron riedelianum (Engler) Engler
Citrus limon (L.) Burm. F.
Citrus cf. sinensis Osbeck
Helietta apiculata Benth.
Pilocarpus pennatifolius Lemaire
Zanthoxylum caribaeum Lam.
Zanthoxylum fagara (L.) Sarg.
Zanthoxylum petiolare A. St. Hil. & Tul.
Zanthoxylum rhoifolium Lamarck
Salicaceae
Banara tomentosa Clos
Casearia decandra Jacquin
Casearia sylvestris Swartz
Xylosma pseudosalzmannii Sleumer
Xylosma tweediana (Clos.) Heichl.
Sapindaceae
Allophylus edulis (A. St.-Hilaire) Niederl.
Allophylus guaraniticus Camb.
Cupania vernalis Camb.

Table 2. Cont.

Diatenopteryx sorbifolia Radlk.	*Solanum pseudo-quina* (Vell.) A. St. Hil.
Matayba elaeagnoides Radlk.	*Solanum sanctae-catharinae* Dunal
Sapotaceae	*Vassobia breviflora* (Sendtn.) Hunz.
Chrysophyllum gonocarpum (Mart. & Eichler) Engler	**Styracaceae**
Chrysophyllum marginatum Hook. & Arn.) Radlkofer	*Styrax leprosus* Hook. & Arn.
Pouteria salicifolia (Spreng.) Radlk.	**Symplocaceae**
Simaroubaceae	*Symplocos* cf. *tetrandra (*Mart.) Miq.
Picrasma crenata (Vell.) Engl.	*Symplocos uniflora* (Pohl) Bentham
Solanaceae	**Urticaceae**
Solanum compressum L. B. Sm. & Downs	*Urera baccifera* (L.) Gaudich. ex Wedd.
Solanum mauritianum Scop.	

D. sorbifolia (16.0%), *P. myrtifolia* (8.7%), *Matayba elaeagnoides* (6.9%) and *Machaerium stipitatum* (5.1 %) (Tab. 3).

The eleven more abundant species *C. americana*, *D. sorbifolia*, *P. myrtifolia*, *M. elaeagnoides*, *M. stipitatum*, *Cabralea canjerana*, *Helietta apiculata*, *Luehea divaricata*, *Nectandra megapotamica*, *Chrysophyllum marginatum*, and *Sorocea bonplandii*, comprised more than 50% of the individuals (Tab. 3). Meanwhile, 46 % of the species presented a relative density less than 1%. The Shannon index (H') was 3.68 (nats) and the evenness (J') was 0.89.

The density of trees with DBH ≥ 5.0 cm was 524.7 ha^{-1} and with DBH ≥ 10.0 cm was 384.2 ha^{-1}. The coverage (basal area) of trees with DBH ≥ 5.0 cm was 26.72 m^{2} · ha^{-1}.

Among the 63 species recorded in the phytosociological survey, there is a predominance of zoochory in terms of number of species and individuals, while the anemochory predominated in relative basal area (Tab. 4). The early secondary tree species were the major guild, followed by the late secondary species (Tab. 5). The proportion of zoochory increases in the successional categories sequence, while the proportion of anemochory decreases (Fig. 3).

Among the species with greater IV (Tab. 2), there was a predominance of early secondary and anemochoric ones. The trees pertaining to the anemochoric species presented a greater average diameter than the zoochoric and autochoric trees (Fig. 4).

DISCUSSION

The relatively high number of tree species in Mato do Silva points out to the importance of these forest remnants to the biodiversity conservation at regional scale. On the other hand, some empirical evidence pointed out the higher resistance of tree populations towards local extinction than the populations of herbaceous species (Turner *et al.* 1996). Additional investigations are being carried out on the diversity status of the other synusia in the Mato do Silva.

There is a similarity between the floristic composition of Mato do Silva and Turvo State Park, which has 17,500 ha and is located 70 km towards North. Of the 117 tree taxa of Mato do Silva, 98 occur also in Turvo Park, which has near 150 tree species, where an exhaustive inventory was carried out (Brack *et al.* 1985). In addition, further surveys did not modify significantly the floristic checklist of Turvo State Park, with only one new tree species pointed by Ruchel *et al*. (2007) and one subtraction assigned by Neubert & Miotto (1996; see also Sobral *et al*. 2006). It highlights the higher diversity of relatively small remnants such as Mato do Silva.

There are two additional species that occurs in Turvo State Park but they were not included in the tree species

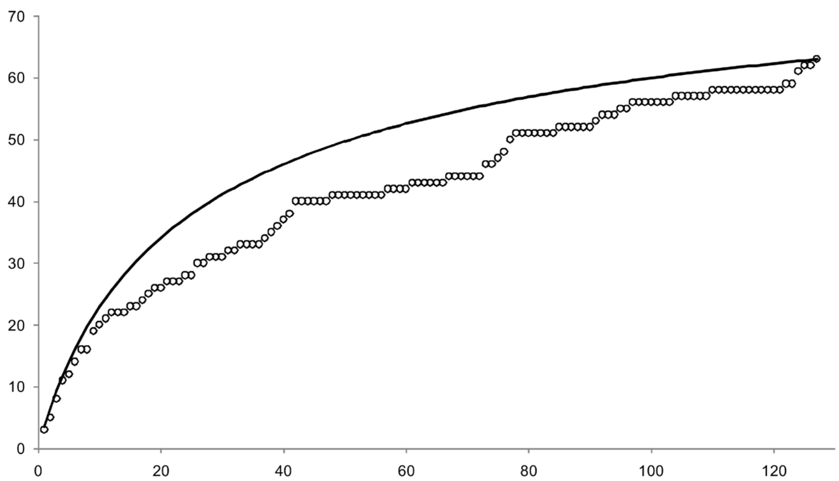

Figure 2. Species richness accumulation curve (circles) and rarefaction curve (solid line) of the tree synusia species in the Mato do Silva.

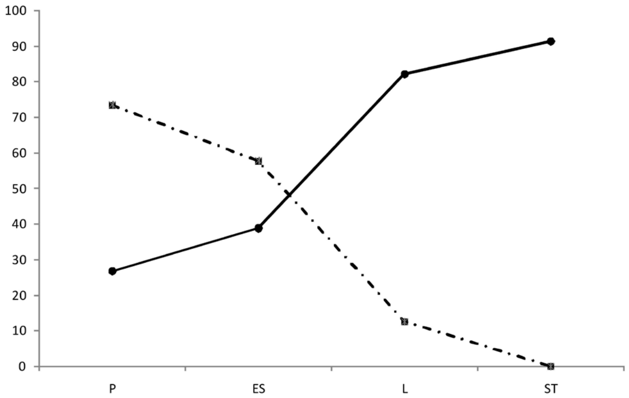

Figure 3. Proportion (%) of zoochory (solid line) and anemochory (dashed line) among the successional guilds of tree species: pioneer (P), early secondary (ES), late secondary (L) and shade tolerant (ST).

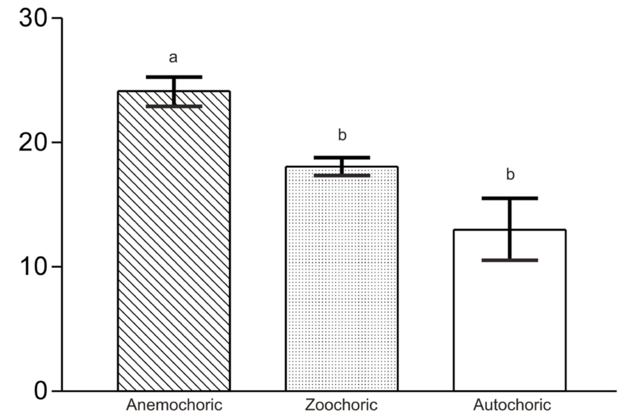

Figure 4. Average diameter at breast height (cm) of trees and the dispersion mechanism. The errors bars indicate the standard error of the mean, different letters indicate differences in the Tukey test (P < 0.05).

checklist of Mato do Silva because it was not possible to observe any individual with tree life form, in spite of their presence as shrubs. These species were *Manihot grahamii* Hooker (Euphorbiaceae) and *Miconia pusilliflora* (DC.) Naud. (Melastomataceae).

The 19 tree species from Mato do Silva, which do not occur in the Turvo Park (Brack *et al.* 1985, Ruchel *et al.* 2007), could be divided in different floristic groups. One of these represent the contribution from the Araucaria Forest of the Rio Grande do Sul State highlands and is comprised by *Ilex paraguariensis*, *Piptocarpha angustifolia, Schaefferia argentinensis, Ocotea pulchella*, *Inga virescens*, *Myrcia palustris*, *Solanum compressum*, *Myrcianthes gigantea* and *Xylosma tweediana*. The last two species occur also in the Southeast plateau region of Rio Grande do Sul State (Sobral *et al.* 2006). There is another group whose species present ample distribution including Seasonal Forests and were not recorded to the Turvo Park (Brack *et al.* 1985, Ruchel *et al*. 2007). It comprises *Zanthoxylum fagara*, *Myrsine guianensis*, *Symplocos* cf. *tetrandra* and *Erythrina crista-galli*. *E. crista-galli* is typical of marshes and very humid soils. Another species, *Zanthoxylum caribaeum*, can more be a species related with the Atlantic Forest *strictu sensu* (Sobral *et al.* 2006), but additional surveys could be necessary to clarify its occurrence in the Seasonal Forest.

Other two species, *Butia capitata* and *Machaonia brasiliensis*, possibly represent a contribution from the open woodlands such as the "palmares" plant communities. The anthropogenic disturbances along the edges of the remnant possibly favored these species of open habitats in the edges of the Mato do Silva forest remnant. The disturbances could also be favorable to the presence of the three intercontinental exotic tree species (*Citrus* and *Hovenia*).

The predominance of Fabaceae is typical in the Seasonal Forest from South Brazil (Vasconcellos *et al.* 1992, Bencke & Soares 1998, Jarenkow & Waechter 2001, Giehl *et al.* 2007). The elevate richness of Fabaceae is originated from the immigration corridor of tropical tree species delineated by the Seasonal Forest of the upper Uruguay River Basin (Rambo 1951, Jurinitz & Jarenkow 2003). Oppositely, Fabaceae presents reduced richness in Araucaria Forests or even in more Southern Seasonal Forests (Jurinitz & Jarenkow 2003), indicating that the contribution of the Fabaceae decreases according to the distance from that corridor (Jarenkow & Baptista 1987, Nascimento *et al.* 2001).

The species-point accumulation curve and the rarefaction curve did not reached an asymptotic richness level. A similar result was obtained in the Seasonal Forest of Turvo State Park, and was attributed to the heterogeneity of the environment (Ruchel *et al*. 2007). Atlantic Forest areas submitted to human influence also have a similar pattern, where an asymptotic richness level was not observed (Oliveira 2007). However, the present data do not permit to affirm that the pattern observed in the richness curves of Mato do Silva is an anthropic product.

The dead individuals represented 4.9% of the trees. This value could be considered in the normal range of the Neotropical Forests, where the dead tree biomass is generally estimated between 2.7 and 10.0 % (Martins 1991). The range of relative density of dead trees in the Seasonal Forest sites of Rio Grande do Sul State, Brazil, is between 1.6 and 8.9% (Tab. 6).

Mato do Silva, in contrast with the majority of Seasonal Forest sites (Tab. 6), has a predominance of secondary species. Seasonal Forests in South Brazil commonly present high phytosociological values of shade tolerant species such as *Sorocea bonplandii*, *Euterpe edulis* and *Gymnanthes concolor* (Vasconcellos *et al.* 1992, Jarenkow & Waechter 2001, Jurinitz & Jarenkow 2003). This difference could be a result of the anthropogenic disturbances (previous than the last 30 years) reported by local people, such as timber extraction and fires, which create gaps and less closed habitats. Other features of Mato do Silva could be related to these disturbances, e.g. low total density of trees (Tab. 6) and low abundance of

Table 3. Phytosociological data of the tree strata in Mato do Silva, Chiapetta, RS, in decreasing sequence of Importance Values (IV); number of individuals (n), relative density (DR), relative frequency (FR), relative coverage (CR), dispersion mode (D) and successional guild (G). An = anemochoric; Zo = zoochoric; Aut = autochoric; P = pioneers; SE = early secondary; L = late secondary; E = shade tolerant.

	n	DR	FR	CR	IV	D	G
Cordia americana	45	0.093	0.090	0.171	0.355	An	ES
Diatenopteryx sorbifolia	39	0.081	0.081	0.160	0.323	An	ES
Prunus myrtifolia	27	0.056	0.048	0.087	0.191	Zo	ES
Matayba elaeagnoides	26	0.054	0.054	0.069	0.177	Zo	L
Machaerium stipitatum	22	0.046	0.038	0.051	0.135	An	ES
Luehea divaricata	14	0.029	0.029	0.040	0.099	An	ES
Cabralea canjerana	18	0.037	0.041	0.016	0.094	Zo	L
Ocotea puberula	5	0.010	0.009	0.063	0.082	Zo	ES
Nectandra megapotamica	14	0.029	0.029	0.021	0.079	Zo	L
Helietta apiculata	15	0.031	0.027	0.016	0.074	An	P
Machaerium paraguariense	13	0.027	0.027	0.015	0.069	An	ES
Ilex paraguariensis	11	0.023	0.023	0.021	0.066	Zo	ST
Chrysophyllum marginatum	14	0.029	0.029	0.008	0.066	Zo	ST
Celtis iguanae	13	0.027	0.027	0.008	0.062	Zo	ES
Sorocea bonplandii	14	0.029	0.027	0.003	0.060	Zo	ST
Casearia decandra	11	0.023	0.023	0.008	0.054	Zo	L
Cordia trichotoma	8	0.017	0.018	0.019	0.054	An	ES
Gleditsia amorphoides	7	0.014	0.016	0.020	0.050	Aut	L
Ateleia glazioveana	7	0.014	0.016	0.017	0.047	An	P
Cupania vernalis	9	0.019	0.020	0.007	0.046	Zo	ES
Campomanesia xanthocarpa	9	0.019	0.020	0.007	0.046	Zo	ES
Eugenia rostrifolia	9	0.019	0.020	0.005	0.044	Zo	L
Myrocarpus frondosus	7	0.014	0.016	0.013	0.043	An	L
Nectandra lanceolata	6	0.012	0.014	0.016	0.042	Zo	ES
Jacaranda micrantha	7	0.014	0.016	0.011	0.042	An	ES
Sapium glandulatum	7	0.014	0.014	0.010	0.039	Zo	ES
Sebastiania commersoniana	6	0.012	0.014	0.008	0.034	Aut	ES
Banara tomentosa	7	0.014	0.016	0.003	0.034	Zo	L
Cedrela fissilis	4	0.008	0.009	0.015	0.032	An	ES
Eugenia uniflora	6	0.012	0.011	0.006	0.029	Zo	ES
Parapiptadenia rigida	4	0.008	0.009	0.012	0.029	An	ES
Allophylus edulis	6	0.012	0.014	0.003	0.029	Zo	L
Symplocos cf. tetrandra	5	0.010	0.011	0.006	0.028	Zo	ES
Apuleia leiocarpa	5	0.010	0.011	0.005	0.027	An	L
Strychnos brasiliensis	4	0.008	0.009	0.005	0.022	Zo	P
Balfourodendron riedelianum	4	0.008	0.009	0.003	0.021	An	L
Schefflera morototoni	4	0.008	0.007	0.005	0.020	Zo	ES
Albizia edwallii	3	0.006	0.007	0.003	0.016	Aut	ES
Gymnanthes concolor	4	0.008	0.007	0.0004	0.016	Aut	ST
Dalbergia frutescens	3	0.006	0.007	0.002	0.015	An	ES
Myrsine laetevirens	2	0.004	0.005	0.006	0.015	Zo	ES
Syagrus romanzoffianum	3	0.006	0.005	0.004	0.014	Zo	ES
Ocotea diospyrifolia	3	0.006	0.007	0.001	0.014	Zo	L
Chrysophyllum gonocarpum	3	0.006	0.007	0.001	0.014	Zo	ST
Rollinia rugulosa	3	0.006	0.007	0.001	0.014	Zo	L
Casearia sylvestris	3	0.006	0.005	0.003	0.014	Zo	ES
Solanum mauritianum	2	0.004	0.005	0.003	0.012	Zo	P
Eugenia involucrata	2	0.004	0.005	0.002	0.011	Zo	L
Zanthoxylum petiolare	2	0.004	0.005	0.001	0.010	Zo	ES
Vitex megapotamica	2	0.004	0.005	0.001	0.010	Zo	ES
Picrasma crenata	2	0.004	0.005	0.001	0.009	Zo	L
Holocalyx balansae	2	0.004	0.005	0.0005	0.009	Zo	L
Erythroxylum deciduum	1	0.002	0.002	0.003	0.007	Zo	ES
Trichilia claussenii	2	0.004	0.002	0.0003	0.007	Zo	L
Achatocarpus praecox	1	0.002	0.002	0.002	0.007	Zo	ES
Rupretchia laxiflora	1	0.002	0.002	0.002	0.007	An	ES
Hovenia dulcis	1	0.002	0.002	0.002	0.006	Zo	P
Zanthoxylum rhoifolium	1	0.002	0.002	0.001	0.006	Zo	ES
Solanum compressum	1	0.002	0.002	0.001	0.006	Zo	ES
Pisonia ambigua	1	0.002	0.002	0.001	0.006	Zo	ES
Sebastiania brasiliensis	1	0.002	0.002	0.001	0.005	Aut	ES
Trema micrantha	1	0.002	0.002	0.0003	0.005	Zo	P
Lonchocarpus campestris	1	0.002	0.002	0.0002	0.005	An	ES

Table 4. Proportion of richness (S), relative density (DR) and relative coverage (CR) among the dispersion modes, Mato do Silva, Chiapetta-RS, Brazil.

	S	DR	CR
Anemochoric	27.0	41.2	55.4
Autochoric	7.9	4.3	3.3
Zoochoric	65.1	54.5	41.3

Table 5. Proportion of richness (S), relative density (DR) and relative coverage (CR) among the successional guilds, Mato do Silva, Chiapetta-RS, Brazil.

	S	DR	CR
Pioneer	9.5	6.2	4.3
Early Secondary	55.6	57.8	75.2
Late Secondary	27.0	26.5	17.1
Shade Tolerant	7.9	9.5	3.3

shade tolerant species, which presented 9.5% of relative density. In other forest types, abundance of shade tolerant species is inversely correlated with disturbance regime intensity (Bhuju & Ohsawa 2001).

Dense patches of typical shade-tolerant tree species from Seasonal Forest such as *G. concolor* and *S. bonplandii* can reduce local diversity (Budke *et al*. 2008). In one Seasonal Forest site of Rio Grande do Sul State, Brazil, expanding the sampling inclusion criteria (from DBH ≥ 10 cm to DBH ≥ 5 cm) increases the phytosociological values of the understory shade tolerant tree species while decreased the Shannon Index of diversity in the tree synusia (Jurinitz & Jarenkow 2003). The succession dynamics, in the measure where it increases the density of the shade tolerant species, could coincide with the reduction of other species typical of the early successional stages. In such way, the reduced density of shade tolerant tree species in Mato do Silva could be related to the dominance of the secondary tree species.

The relatively high Shannon index (H') and evenness index values (J) observed in Mato do Silva could also be related to a more distributed dominance among the tree species. In fact, only with eleven species is possible to reach more than 50% of the total individuals, while in Turvo Park eight species were sufficient to do this (Vasconcellos *et al.* 1992). Moreover, in a Southern Seasonal Forest in Camaquã, Rio Grande do Sul State, Brazil, six species reach more than 50% of the total individuals (Jurinitz & Jarenkow 2003). A non-excluding alternative source of explanation to the high diversity indexes values in Mato do Silva is the association of areas with different successional stages, which can also lead to a high diversity (Bencke & Soares 1998).

Ecological stability during long periods can favor the dominance of few species, reducing the diversity. Moderate and infrequent disturbances can promote the rise of diversity (Lovelock 1992, Molino & Sabatier 2001, Bhuju & Ohsawa 2001, Keddy 2005), thought it could determine the loss of species especially in small fragments (Ross *et al.* 2002). The raise on the diversity caused by moderate disturbances is particularly true when these disturbances are adverse to the dominant species, or when it causes the creation of new habitats, for instance the creation of gaps.

The proportion of zoochoric species (65%) and zoochoric individuals (54%) in Mato do Silva is typical of the tropical and subtropical forests (Howe & Smallwood 1982, Morellato 1995, Budke *et al.* 2005), including the Seasonal Forests from South Brazil (Nascimento *et al.* 2000, Giehl *et al.* 2007, Ruchel *et al.* 2007). On the other hand, the zoochoric species comprised only 41% of total basal area. The high basal area of the wind-dispersed species (55%) is caused by elevate coverage of some dominant anemochoric species such as *C. americana, D. sorbifolia, L. divaricata* and *M. stipitatum*. In addition, the anemochoric species exhibited the greater value of

Table 6. Phytosociological data of Seasonal Forest sites in South Brazil; H'=Shannon index, J' = evenness index, BA = basal area per hectare (m^2), n_5 = trees with DBH ≥ 5.0 cm per hectare, n_{10} = trees with DBH ≥ 10 cm per hectare, Dd (%) = proportion of dead trees, salient Families in richness and dominant species (according IV or other parameter adopted by the authors).

Site	H'	J'	BA	n_5	n_{10}	Dd (%)	Richness	Dominants
Turvo[1]	3.52	0.86			428	4.4	Fabaceae	*Sorocea bonplandii*
Turvo[2]	3.73	0.86	25.1	879			Fabaceae	*Syagrus romanzoffiana* *Cedrela fissilis* *Nectandra megapotamica*
Mato do Silva	3.70	0.89	27.5	524	384	4.9	Fabaceae	*Cordia americana* *Diatenopterix sorbifolia*
Vale do Sol[3]	2.24	0,56	41.6	1,855		1.9	Fabaceae, Myrtaceae	*Gymnanthes concolor* *Euterpe edulis* *Sorocea bonplandii*
Candelária[5]	2.9	0.74				2.2	Fabaceae, Myrtaceae	*Euterpe edulis* *Alchornea triplinervea* *Nectandra megapotamica*
Sta. Cruz do Sul[4]	3.22	0.85	22.3		713	8.9	Fabaceae	*Nectandra megapotamica* *Cupania vernalis*
Camaquã[6]	3.20	0.76	37.6	2,236		1.6	Myrtaceae, Lauraceae, Euphorbiaceae	*Gymnanthes concolor* *Esenbeckia grandiflora*

1.Vasconcellos et al. 1992 ; 2. Ruchel et al. 2007; 3. Jarenkow & Waechter 2001; 4. Bencke & Soares 1998; 5. Nascimento et al. 2000; 6. Jurinitz & Jarenkow 2003.

average diameter. These species tends to be the trees with the greater dimensions in the forest, because the anemochory requires high wind availability (Giehl *et al.* 2007). Taller trees allow fewer barriers and longer periods in the air to the diaspores, promoting farther dispersion (Horn *et al.* 2001). The relative higher coverage of anemochoric tree species was also observed in the Turvo Seasonal Forest (Ruchel *et al.* 2007). The zoochory tends to increase among the late successionary species, while the anemochory decreases. It suggest that the successional dynamics, in the measure that generate more closed environments, favors the zoochory in relation to the anemochory. The last requires open areas with wind abundance and fewer barriers to the diaspores.

The predominance of the secondary tree species and scarcity of pioneer tree species in Mato do Silva was also observed by Ruchel *et al.* (2007) in the forest of Turvo Park, and it could be typical of the Seasonal Forest. However, the relatively low proportion of the shade tolerant tree species in Mato do Silva is a rare condition to Seasonal Forests and, as already mentioned, it could be related to past disturbances. Complementary research on the understory strata and recruitment are being conducted to interpret the ecological succession and plant community structure in this remnant.

ACKNOWLEDGEMENTS

To Chiapetta municipal government and to Mato do Silva landowners for the license to perform the work. To UNIJUÍ for the research support. To Lenice Medeiros and colleagues who proposed the Biological Research Practices course in the Biological Sciences graduation of UNIJUÍ, from which the main ideas that inspired this research emerged. To the botanic specialists Renato Goldenberg (UFPR) and Marcelo A. Pinho Ferreira (ESALQ/USP) who helped us with the plant taxonomy. To Andressa Felipin for the English review.

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