ISSN 0798 1015

REVISTA ESPACIOS

HOME Revista ESPACIOS ÍNDICES A LOS AUTORES

Vol. 38 (Nº 28) Año 2017. Pág. 18

Floristic richness in a transitional area between Mixed and Semideciduous Forests in the middle Tibagi River region, southern Brazil

Riqueza florística em uma área de transição entre Florestas Mistas e Semidecíduas na região média do rio Tibagi, sul do Brasil

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Recibido: 31/12/16 • Aprobado: 25/01/2017

Content

ABSTRACT:

The vast forest that covered the state of Parana has been reduced to small forest fragments. The Tibagi River watershed has some of best fragments, but with little detailed information about this region is available. This study documented the tree and shrub vegetation found within the limits of the town of Telêmaco Borba, state of Parana. It recorded 221 species in 51 families and 138 genera, among which are one tree species previously unreported from that state and eight endangered species. The information obtained shows the relevance of forest fragments for the Tibagi River as well as that of floristic studies to preserve forest ecosystems.
Key words: Atlantic Forest, Ecotone, Ecological Group.

RESUMO:

A vasta floresta que cobria o estado do Paraná foi reduzida a pequenos fragmentos florestais. A bacia do rio Tibagi tem alguns dos melhores fragmentos, mas com pouca informação detalhada sobre esta região está disponível. Este estudo documentou a vegetação arbórea e arbórea encontrada dentro dos limites do município de Telêmaco Borba, estado do Paraná. Registou 221 espécies em 51 famílias e 138 gêneros, entre os quais uma espécie de árvore anteriormente não declarada desse estado e oito espécies ameaçadas de extinção. As informações obtidas mostram a relevância de fragmentos florestais para o rio Tibagi, assim como os estudos florísticos para preservar os ecossistemas florestais.
Palavras-chaves: Floresta Atlântica, Ecótono, Grupo Ecológico.

1. Introduction

Over the past thousands years, great transformations have shaped the Brazilian vegetation into its current physiognomic configuration. Palynological records on southern Brazil during the last glacial period indicate the predominance of grassland vegetation (grasslands and *cerrado*) in regions now covered with forests (Behling, 1995). During the late Quaternary, due to changes in climatic conditions and abundant rainfall, forests began to prevail over grasslands and cerrados on hillside slopes and in river valleys (Behling 2002). Until a few decades ago, the state of Parana had one of the richest forest covers in Brazil (Maack, 2012).

Nowadays, forest advance is no longer detained by climatic conditions, but by such anthropogenic pressures as agriculture, livestock, and wood exploitation. Forest which used to cover 83% of the state of Parana (Maack, 2012) only occupy 10.52% of its territory, most of it as fragments (SOS Mata Atlântica,2009).

Remnants of the Atlantic Forest domain, to which all the forests found in that state belong, are insufficiently sampled (Giulietti et al., 2005). This is particularly the case of the middle Tibagi River basin, which, nevertheless, is an area of high conservation priority according tothe Brazilian Ministry of Environment (MMA, 2007). Little detailed information about this region is available (Medri et al., 2002), although it has some of the largest and best remnants in that state (Torezan, 2002). Therefore, studies are urgently needed to understand the regional flora, redirect planning efforts, and preserve ecosystems.

The Tibagi River has its source in the Campos Gerais, to the west of the Devonian escarpment, and runs approximately 550 km before it empties into the Paranapanema River (Maack, 2012). Due to its extension, it flows through most of the lithologies found in the state of Parana (Pinese, 2002), which, in addition to the transition between Cfa and Cfb climates (Mendonça & Oliveira, 2002), promotes a great variety of soils and associations (Stipp, 2002). Together, such features imply the presence of different environments and distinct phytogeographic regions (IBGE, 2012) in this basin, whose main forest types are Mixed and Semideciduous Forests, (Dias et al., 2002; Cardoso & Sajo, 2004; Carmo & Assis, 2012).

Given the ecological importance of forest remnants in the middle Tibagi River watershed, Paraná, we intend, based on a floristic survey, to provide information on the tree and shrub species richness, the occurrence of endangered species, and the representation of its ecological groups.

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2. Materials and Methods

2.1. Study Area

Study area is a 2.675 ha forested area located within the limits of the county of Telêmaco Borba, in the central-eastern part of the Second Parana Plateau, at coordinates 24º07’02” S and 50º41’20” W, in the middle Tibagi River watershed. Geologically, it corresponds to the sediment sequence of the Sedimentary Basin of the state of Parana, and outcropping rocks belong to the Itararé, Guatá, and Passa Dois groups (Milaniet al., 1994). Prevailing soils are Argisols, Latosols, Neosols, Nitosols, and Cambisols (EMBRAPA, 2006). According to Köppen’s classification, Cfb (humid with temperate summer) climate prevails in the region. Average annual temperature is 18°C (IAPAR, 1978) and average annual rainfall, 1.577 mm (SUDERHSA, 1998).

It is located on the Atlantic Forest Domain inserted at the Campos Gerais, according to Maack’s definition (2012). The geological, pedological, and climatic variations occurring in the Tibagi River watershed (Medri et al., 2002) allow the development of different plant types. Yet our study area is covered with both Semideciduous and Mixed Forests (Medri et al., 2009).

2.2. Data Collection

Our floristic survey follows the walk-through methodology proposed by Filgueiras et al., (1994). It consists in establishing parallel transects 100 m apart. Since our area is quite wide (2,675 ha), our collection efforts focused on approximately 2 ha sample blocks and, to encompass the most diverse environments, we walked along pre-established trails adjacent to the Tibagi River and its tributary, as well as on by- and main roads.

During our walks, we collected fertile samples of tree and shrub species with a diameter at breast height (DBH ~ 1.3 m above ground level) equal or superior to 15 cm. Data collection took place between December/2010 and February/2012. Botanical material was herborized and identified, with specialized bibliography and consultation to the Museu Botânico Municipal (MBM - City Botanical Gardens) of Curitiba, Paraná. Classification is based on APG III (2009), and botanical nomenclature was confirmed both by the Flora do Brasil (2016) and the Tropicos.org (2016). Collected samples and voucher specimens were deposited at the following herbaria: MBM, UPCB, HCF and RB, acronyms according to Thiers (2016).

To simplify the interpretation of the floristic composition, species were separated in ecological groups, defined according to Swaine & Whitmore (1988), and divided into three groups: pioneers (P), non-pioneer light-demanders (CL), and non-pioneer shade-tolerant (CS). Ecological information on species was found in the following bibliography: Gandolfi et al., (1995); Reis (1995); Ivanauskas et al.,(1999); Fonseca & Rodrigues (2000); Iserhagen et al., (2002); Silva et al.,(2003); Mantovani et al.,(2005); Carvalho et al.,(2006); Guarantini et al., (2008); Rodrigues et al., (2009); Lorenzi (2000; 2002; 2009); Carvalho (2003; 2006; 2008; 2010) and complemented with the authors' knowledge.

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3. Results

The survey documented 221 native and four exotic species: seven tree ferns (Cyatheaceae and Dicksoniaceae), one Gymnosperms (Araucariaceae), and 213 Angiosperms (Table 1) distributed in 51 families and 138 genera.

The richest families were Fabaceae (33 species), Myrtaceae (29), Euphorbiaceae (13), Meliaceae and Lauraceae (10 each), Rutaceae (9), Salicaceae (8) Rubiaceae, and Moraceae (7), totalizing 57% of all the species recorded. In the remaining families, approximately 8.1% (18) presented only one species. The richest genera were *Eugenia* L. (9 species), *Machaerium* (6), *Casearia*, *Cyathea*, *Ficus, Solanum*, and *Trichilia* (5 each).

Among tree species, *Aspidosperma riedelii* Müll. Arg. (Apocynaceae) had only been reported in the states of São Paulo and Santa Catarina in the Flora do Brasil (2016). It is thus a new record of occurrence to Paraná State. It was solely found on superficial fractures of diabase dikes in an area with Litholic Neosol.

The species *Araucaria angustifolia* (Bertol.) Kuntze (Araucariaceae), *Cedrela fissilis* Vell. (Meliaceae), and *Dicksonia sellowiana* Hook. (Dicksoniaceae), are listed as endangered in Brazil (Martinelli et al., 2013), and *Balfourodendron riedelianum* (Engl.) Engl. (Rutaceae), *Aspidosperma australe* Müll. Arg., *Aspidosperma polyneuron* Müll. Arg. (Apocynaceae), *Machaerium paraguariense* Hassl., and *Myrocarpus frondosus* Allemão (Fabaceae) have been described as rare in this state (MMA, 2008).

Classification into ecological groups revealed that 59.3% (131 species) are non-pioneer light-demanders, 24.9% (55) are non-pioneer shade-bearers and 15.8% (35) are pioneers.

Table 1 – Species checklist organized by ecological group and voucher numbers, documented in the forest fragment located within the limits of the county of Telêmaco Borba, PR. GE – Ecological Group (P = pioneer; CL = non-pioneer light-demander; CS = non-pioneer shade-tolerant; NC = not classified; I = Invasive-exotic; * identified in the field, but no fertile specimens were found.

FAMILY/SPECIES	GE	VOUCHER
ANACARDIACEAE		
Astronium graveolens Jacq.	CL	*
Lithraea molleoides (Vell.) Engl.	P	UPCB 75667
Schinus terebinthifolius Raddi	P	MBM 375749
Rhus succedanea L.	I	*
ANNONACEAE		
Annona cacans Warm.	CL	HCF 12239
Guatteria australis A.St.-Hil.	CL	*
Annona sylvatica A.St.-Hil.	CL	*
Xylopia brasiliensis Spreng.	CL	MBM 385373
APOCYNACEAE		
Aspidosperma australe Müll. Arg.	CS	MBM 387196
Aspidosperma polyneuron Müll. Arg.	CS	MBM 388165
Aspidosperma riedelii Müll. Arg.	CL	*
Rauvolfia sellowii Müll. Arg.	CL	HFC12316
Tabernaemontana catharinensis (A.DC.) Miers	P	*
AQUIFOLIACEAE		
Ilex brevicuspis Reissek	CL	MBM 387456
ARALIACEAE		
Dendropanax cuneatus (DC.) Decne. & Planch.	CL	*
Schefflera morototoni (Aubl.) Maguire et al.	CL	HCF 12250
ARAUCARIACEAE		

Araucaria angustifolia (Bertol.) Kuntze	CL	*
ARECACEAE		
Euterpe edulis Mart.	CS	*
Geonoma schottiana Mart.	CS	*
Syagrus romanzoffiana (Cham.) Glassm.	CL	*
Syagrus oleracea (Mart.) Becc.	CL	*
ASTERACEAE		
Piptocarpha axillaris (Less.) Baker	P	*
BIGNONIACEAE		
Cybistax antisyphilitica (Mart.) Mart.	CL	*
Jacaranda puberula Cham.	CL	MBM 385539
Jacaranda micrantha Cham.	P	MBM 388161
BORAGINACEAE		
Cordia americana (L.) Gottschling & J.S.Mill.	P	*
Cordia ecalyculata Vell.	CS	MBM 388166
Cordia superba Müll. Arg.	CS	MBM 385598
Cordia trichotoma (Vell.) Arráb. ex Steud.	P	*
CANNABACEAE		
Celtis iguanaea (Jacq.) Sarg.	P	MBM 389764
Trema micrantha (L.) Blume	P	UPCB 75684
CARDIOPTERIDACEAE		
Citronella paniculata (Mart.) Howard	Cl	*
CARICACEAE		
Jacaratia spinosa (Aubl.) DC.	CS	*

Vasconcellea quercifolia A. St.-Hil.	P	*
CELASTRACEAE		
Maytenus aquifolia Mart.	CS	MBM 388163
Maytenus gonoclada Mart.	CL	*
COMBRETACEAE		
Terminalia triflora (Griseb.) Lillo	P	*
CYATHEACEAE		
Alsophila setosa Kaulf.	CS	*
Cyathea atrovirens (Langsd. & Fisch.) Domin	CS	HCF 12192
Cyathea corcovadensis (Raddi) Domin	CS	*
Cyathea delgadii Sternb.	CS	*
Cyathea hirsuta C.Presl	CS	*
Cyathea phalerata Mart.	CS	*
DICKSONIACEAE		
Dicksonia sellowiana Hook.	CS	HCF 12417
EBENACEAE		
Diospyros inconstans Jacq.	CL	HCF 12435
ELAEOCARPACEAE		
Sloanea monosperma Vell.	CL	*
ERYTHROXYLACEAE		
Erythroxylum cuneifolium (Mart.) O.E. Schulz	P	*
Erythroxylum deciduum A. St.-Hil.	P	MBM 385542
EUPHORBIACEAE		

Actinostemum concolor (Spreng.) Müll. Arg.	CS	MBM 385625
Alchornea glandulosa Poepp.	CL	MBM 385551
Alchornea sidifolia Müll. Arg.	CL	MBM 389778
Alchornea triplinervia (Spreng.) Müll. Arg.	CL	HCF 12284
Croton floribundus Spreng.	P	RB 606583
Croton urucurana Baill.	P	UPCB 75766
Manihot grahamii Hook.	P	MBM 389762
Phyllanthus sellowianus (Klotzsch) Müll.Arg.	P	*
Sapium glandulosum (Vell.) Pax	CL	*
Sebastiania brasiliensis (L.) Spreng.	CL	MBM 385615
Gymnanthes klotzschiana Müll.Arg.	P	HCF 12229
Sebastiania schottiana (Müll.Arg.) Müll.Arg.	P	*
Tetrorchidium rubrivenium Poepp. & Endl.	CL	*
FABACEAE		
Albizia niopoides (Spruce ex Benth.) Burkart	P	MBM 385587
Albizia polycephala (Benth.) Killip ex Record	CL	*
Anadenanthera colubrina (Vell.) Brenan	P	*
Bauhinia forficata Link	CL	*
Bauhinia longifolia (Bong.) Steud.	P	*
Cassia leptophylla Vog.	CL	MBM 389766
Centrolobium tomentosum Guill. ex Benth.	P	HCF 12337
Copaifera langsdorffii Desf.	CL	MBM 385540

Dalbergia frutescens (Vell.) Britton	CL	MBM 385533
Enterolobium contortisiliquum (Vell.) Morong	CL	*
Erythrina crista-galli L.	P	*
Erythrina falcata Benth.	CL	*
Holocalyx balansae Mich.	CL	HCF 12382
Inga marginata Willd	CL	HCF 12291
Inga sessilis (Vell.) Mart.	CL	*
Inga striata Benth	CL	MBM 388152
Inga vera Willd	CL	*
Lonchocarpus campestris Mart.ex Benth.	CL	HCF 12386
Lonchocarpus cultratus (Vell.) A. M. G. Azevedo	CL	RB 607125
Lonchocarpus muehlbergianus Hassl.	CL	HCF 12375
Lonchocarpus subglaucescens Mart ex Benth.	CS	HCF 12432
Machaerium aculeatum Raddi	CL	UPCB 75685
Machaerium brasiliense Vog.	CL	MBM 385536
Machaerium nyctitans (Vell.) Benth.	P	*
Machaerium paraguariense Hassl.	CL	MBM 388151
Machaerium scleroxylon Tul.	CL	*
Machaerium stipitatum Vog.	CL	HCF 12228
Myrocarpus frondosus Allemão	CL	MBM 389740
Ormosia arborea (Vell.) Harms	CL	MBM 385604
Parapiptadenia rigida (Benth.) Brenan	CL	*
Peltophorum dubium (Spreng.) Taub.	CL	*

Piptadenia gonoacantha (Mart.) J.F.Macbr.	CL	*
Schizolobium parahyba (Vell.) Blake	P	*
LAMIACEAE		
Aegiphila sellowiana Cham.	CL	*
Vitex megapotamica (Spreng.) Moldenke	CL	RB 607303
LAURACEAE		
Cryptocarya aschersoniana Mez	CL	HCF 14249
Endlicheria paniculata (Spreng.) J. F. Macbr.	CL	*
Nectandra lanceolata Nees	CL	MBM 387459
Nectandra megapotamica (Spreng.) Mez	CL	MBM 385580
Nectandra oppositifolia Nees	CS	HCF 12388
Ocotea dyospirifolia (Meisn.) Mez	CL	RB 606199
Ocotea elegans Mez	CL	*
Ocotea corymbosa (Meisn*.)* Mez	CL	*
Ocotea puberula (Rich.) Nees	CL	MBM 385581
Persea willdenovii Kosterm.	CL	MBM 389756
LAXMANNIACEAE		
Cordyline spectabilis Kunth & C.DC. Bouché	CL	*
LECYTHIDACEAE		
Cariniana legalis (Mart.) Kuntze	CL	*
LOGANIACEAE		
Strychnos brasiliensis (Spreng.) Mart	CL	*

LYTHRACEAE		
Lafoensia pacari A. St.-Hil.	CL	*
MAGNOLIACEAE		
Magnolia ovata A.St.-Hil. (Spreng.)	CL	*
MALVACEAE		
Bastardiopsis densiflora (Hook & Arn) Hassl.	P	HCF 12317
Ceiba speciosa (A. St-Hil.) Ravenna	CL	RB 608779
Helicteres brevispira A.St.-Hil.	CL	UPCB 75769
Heliocarpus papayensis Kunth	P	*
Luehea divaricata Mart	CL	HCF 12319
Pseudobombax longiflorum (Mart. & Zucc.) A.Robyns	CL	*
MELASTOMATACEAE		
Miconia cineracens Miq.	CS	MBM 385535
MELIACEAE		
Cabralea canjerana (Vell.) Mart.	CL	HCF 12235
Cedrella fissilis Vell.	CL	*
Guarea guidonia (L.) Sleumer	CS	*
Guarea kunthiana A. Juss.	CL	*
Guarea macrophylla Vahl.	CL	HCF 12216
Trichilia casaretti C. DC.	CS	MBM 385562
Trichilia catigua A. Juss.	CS	*
Trichilia claussenii C. DC.	CS	*
Trichilia elegans A. Juss.	CS	*
Trichilia pallida Sw.	CS	MBM 387461

MORACEAE		
Ficus enormis (Miq.) Miq.	CL	*
Ficus glabra Vell.	CL	*
Ficus guaranitica Chodat	CL	MBM 389774
Ficus insipida Willd.	CL	*
Ficus luschnathiana (Miq.) Miq.	CL	*
Maclura tinctoria L.	CL	MBM 387367
Sorocea bonplandii (Baill.) W.C.Burger et al.	CS	MBM 385557
MYRTACEAE		
Calyptranthes concinna DC.	CS	MBM 385545
Campomanesia eugenioides (Cambess.) O. Berg	CL	MBM 387454
Campomanesia guaviroba (DC.) Kiaersk.	CL	RB 608037
Campomanesia guazumifolia (Cambess.) O.Berg	CS	*
Campomanesia xanthocarpa O. Berg	CS	MBM 385553
Eugenia blastantha (O.Berg) D. Legrand	CS	*
Eugenia brasiliensis Lam.	CS	*
Eugenia florida DC.	CL	*
Eugenia involucrata DC.	CL	*
Eugenia neoverrucosa Sobral	CS	*
Eugenia pluriflora DC.	CL	*
Eugenia pyriformis Cambess.	CL	*
Eugenia uniflora L	CL	*
Eugenia uruguayensis Cambess.	CL	*

Gomidesia palustris DC.	CL	*
Myrceugenia euosma (O. Berg) D. Legrand	CL	*
Myrcia anacardiifolia Gardner	CL	*
Myrcia laruotteana Cambess.	CS	*
Myrcia splendens (Sw.) DC.	CS	*
Myrcianthes pungens (O.Berg) D. Legrand	CL	*
Myrciaria cuspidata O.Berg	CS	*
Myrciaria deliculata (DC.) O. Berg	CL	*
Myrciaria floribunda (H.West ex Willd.) O. Berg	CL	*
Neomitranthes glomerata (D.Legrand) D.Legrand	CS	*
Plinia rivularis (Cambess.) Rotman	CL	RB 606744
Plinia trunciflora (O. Berg) Kausel	CS	*
Psidium cattleyanum Sabine	CL	*
Psidium guajava L.	CL	*
Siphoneugena crassifolia (DC.) Proença & Sobral	CS	*
NYCTAGINACEAE		
Bougainvillea glabra Choisy	CL	UPCB 75689
Guapira hirsuta (Choisy) Lundell	CS	*
Guapira opposita (Vell.) Reitz	CS	HCF 12464
Pisonia ambigua Heimerl	CL	*
PHYTOLACCACEAE		
Gallesia integrifolia (Spreng.) Harms	CL	*
Phytolacca dioica L.	CL	HCF 12234

PICRAMNIACEAE		
Picramnia parvifolia Engl.	CS	*
Picramnia ramiflora Planch.	CS	MBM 389785
PRIMULACEAE		
Myrsine coriacea (Sw.) R. Br.	P	HCF 12194
Myrsine gardneriana A.DC.	CL	*
Myrsine umbellata Mart.	CL	HCF 12430
PROTEACEAE		
Roupala montana var. brasiliensis (Klotzsch) K.S.Edwards	CL	HCF 12380
RHAMNACEAE		
Hovenia dulcis Thunb.	I	*
ROSACEAE		
Eriobotrya japonica Lindl.	I	*
Prunus myrtifolia (L.) Urb.	CL	MBM 385830
RUBIACEAE		
Bathysa australis (A.St.-Hil.) K.Schum.	CL	HCF 12336
Psychotria carthagenensis Jacq.	CS	MBM 389642
Psychotria suturella Müll. Arg.	CS	HCF 12242
Psychotria vellosiana Benth.	CS	*
Randia cf. *armata* (Sw.) DC.	CS	*
Rudgea jasminoides (Cham.) Müll. Arg.	CS	RB 575620
Rudgea parquioides (Cham.) Müll. Arg.	CS	MBM 389759
RUTACEAE		
Balfourodendron riedelianum (Engl.)		

Engl.	CL	HCF 12391
Citrus limon (L.) Osbeck	I	*
Esenbeckia febrifuga (A. St.-Hil.) A. Juss. ex Mart.	CL	HCF 12233
Esenbeckia grandiflora Mart.	CL	*
Pilocarpus pennatifolius Lem.	CL	*
Zanthoxylum caribaeum Lam.	P	*
Zanthoxylum fagara (L.) Sarg.	P	MBM 385623
Zanthoxylum petiolare A. St.-Hil.	P	*
Zanthoxylum rhoifolium Lam.	P	HFC12414
SALICACEAE		
Banara tomentosa Clos	CS	*
Casearia decandra Jacq.	CS	*
Casearia gossypiosperma Briq.	CS	*
Casearia lasiophylla Eichler	CL	*
Casearia obliqua Spreng.	CS	HCF 12387
Casearia sylvestris Sw.	CL	*
Prockia crucis P. Browne ex. L.	CL	*
Xylosma ciliatifolia (Clos) Eichler	CL	*
SAPINDACEAE		
Allophylus edulis (A. St.-Hil. et al.) Hieron. ex Niederl.	CL	*
Cupania vernalis Cambess.	CL	HCF 12279
Dianopteryx sorbifolia Radlk.	CL	MBM 385541
Matayba elaeagnoides Radlk.	CL	MBM 388179

SAPOTACEAE		
Chrysophyllum marginatum (Hook. & Arn.) Radlk.	CL	HCF 12196
Chrysophyllum gonocarpum (Mart. & Eichl.) Engl.	CS	UPCB 75775
Pouteria beaurepairei (Glaz. & Raunk.) Baehni	CL	*
SOLANACEAE		
Solanum swartzianum Roem. & Schult.	CL	*
Solanum granulosoleprosum Dunal	CL	*
Solanum mauritianum Scop	CL	*
Solanum pseudoquina A. St.-Hil.	CL	*
Solanum sanctaecatharinae Dunal	CL	*
STYRACEAE		
Styrax acuminatus Pohl	CL	*
Styrax leprosus Hook. & Arn.	CL	*
SYMPLOCACEAE		
Symplocos tenuifolia Brand	CS	MBM 389761
THEACEAE		
Laplacea fruticosa (Schrad.) Kobuski	CS	*
URTICACEAE		
Boehmeria caudata Sw.	P	MBM 385538
Cecropia glaziovii Snethl.	CL	HCF 12221
Cecropia pachystachya Trécul	P	HCF 12205
Urera baccifera (L.) Gaudich. ex Wedd.	CL	*
VERBENACEAE		

Aloysia virgata (Ruiz & Pav.) Juss.	CL	HCF 12385
Citharexylum myrianthum Cham.	CL	MBM 385544

4. Discussion

The high species richness of Fabaceae and Myrtaceae, as found in this study, is recurrent in forest formations from southern and southeastern Brazil (Ivanauskas & Rodrigues 2000; Colonetti et al., 2009; Higuchi et al., 2012; Kurtz et al., 2009; Ribeiro et al., 2013), as well as in fragments located in the Tibagi River watershed (Dias et al.,1998; Bianchini et al., 2003; Costa et al., 2011; Carmo & Assis, 2012), especially in its middle course (Silva et al.,1995; Dias et al., 2002).

According to Torezan (2002), the Tibagi River watershed is composed of grassland and forest phytophysiognomies whose proximity favors the growth of a higher number of species typical of each. Thus, the high species richness of Myrtaceae and Fabaceae found in this study area is linked to its closeness to the lower Tibagi River, covered by semideciduous seasonal forests, in which these families, especially Fabaceae, are very species-rich (Jarenkow & Waechter, 2001; Leite et al., 2013; França & Stehmann, 2013).

Eugenia and *Machaerium*, which are frequent in this survey, are also part of the main species growing in this watershed (Bianchini et al., 2003; Carmo & Assis, 2012) and, exceptionally, in the middle Tibagi River area (Dias et al., 2002; Yamamoto et al., 2005). Studies carried out in forests of southern Brazil report that both genera present the highest number of species (Leite et al., 2013) and are distributed on the different forest layers (Dias et al., 2002).

Based on floristic and phytosociological surveys and on the consultation herbaria, 547 tree and shrub species have so far been mentioned as occurring in the (25.000 km2) Tibagi River watershed (Dias et al., 2002). Since our study area shelters 221 species, i.e. 40% of the total species of the whole watershed, it is a taxon rich habitat.

The high species richness probably is related to both the geo-pedological (Pinese, 2002; Stipp, 2002) and climatic (Mendonça & Oliveira, 2002) conditions and their local associations watershed, which allow environment diversification and, consequently, the presence of more species (Torezan, 2002). Another relevant factor is the species mix of typical of distinct phytogeographic regions: mixed ombrophilous forests, characterized by the presence of *Araucaria angustifolia*, and semideciduous seasonal forest, identified by the occurrence of *Aspidosperma polyneuron*. Such results indicate that the middle Tibagi River area is an ecotone region (Carmo & Assis, 2012; Dias et al., 2002). According to Durigan et al., (2008), transition areas tend to present high species richness and diversity because taxa from distinct phytogeographic regions co-occurs.

The presence of species in the different ecological groups allows us to infer that this fragment constitutes a mosaic of different successional stages, where areas sheltering non-pioneer shade-bearers or light-demanders are adjacent to disturbed ones occupied by early successional species. The alternation of ecological groups, forming a dynamic component of overcoming among species, was also observed by Silva et al., (2003) and Mantovani et al., (2005), who pointed out changes in plant communities over time as possible causes.

Non-pioneer light-demanders were the prevailing ecological group, followed by non-pioneer shade-bearers. According to Mantovani et al., (2005), this denotes conditions are better suited to a successful recruitment of late successional species. However, the predominance of light-demanders suggests that the area has not yet reached its full development or that another factor may have modified its successional status.

According to Peixoto (2004), among the factors that can delay succession are fires and

selective logging. Guarantini et al., (2008) also noted species richness in early ecological groups, after fires in semideciduous seasonal forests. They stated that natural or anthropic disturbance originates small gaps that can be colonized by light-demanding species, which can thus be quite numerous within the forest.

Furthermore, with regard to climax species, it is worth stressing that emrgent tree species *Annona cacans*, *Araucaria angustifolia*, *Aspidosperma polyneuron*, *Machaerium scleroxylon*, and *Myrocarpus frondosus*, were distributed within the whole survey area. Similar results were obtained by Ivanauskas & Rodrigues (2000) and Costa et al., (2011) who studied the successional character of tree species in forest fragments of Southern Brazil and acknowledged species typical of climax and/or better preserved forests.

Information on the richness of the regional flora including endangered species and a new tree species in this state proves the relevance of forest fragments in the Tibagi River watershed as well as the importance of floristic studies to preserve forest ecosystems and maintain their ecological functions.

Acknowledgements

The authors thank the Companhia Paranaense de Energia (COPEL), and more particularly Murilo Lacerda Barddal, who allowed data collection and provided the necessary infrastructure; Osmar dos Santos Ribas, curator at the Museu Botânico de Curitiba (MBM), for his help in the identification of species; and the Cooperativa Interdisciplinar de Serviços Técnicos (INTERCOOP), for their help in collecting and identifying species.

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http://dx.doi.org/10.1590/S0100-84042005000100016

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Revista ESPACIOS. ISSN 0798 1015
Vol. 38 (Nº 28) Año 2017

[Índice]