TREE SPECIES DIVERSITY OF COASTAL LOWLAND SEMIDECIDUOUS FOREST FRAGMENTS IN NORTHERN RIO DE JANEIRO STATE, BRAZIL

DIVERSIDADE DE ESPÉCIES ARBÓREAS EM FRAGMENTOS DE FLORESTA SEMIDECIDUAL DE TERRAS BAIXAS COSTEIRAS NO NORTE DO ESTADO DO RIO DE JANEIRO, BRASIL

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ABSTRACT: Habitat destruction has caused Brazilian coastal lowland semideciduous forests to suffer severe fragmentation. In the state of Rio de Janeiro, especially in the northern region, these fragments are under severe threat of destruction, while data on their floristic diversity and community structure are still lacking. In this study, six secondary forest fragments (henceforth called sites) of coastal lowland semideciduous forests with areas ranging from 13 to 1200 ha were studied. The objective was to evaluate the structure and diversity of trees of these sites and relate them to the conservation status of this region. Five plots of 20 x 20 m were established in each site, totalling a sample area of 1.4 ha and all trees with DBH ≥ 5cm were sampled. The families with the highest species richness were Fabaceae, Sapotaceae, Myrtaceae and Meliaceae. The most abundant species were: *Metrodorea nigra*, *Pseudopiptadenia contorta* and *Senefeldera verticillata*. The richness, evenness and Shannon diversity values ranged from 59 to 89 species, 0.75 to 0.87 and from 2.59 to 3.79 nats.ind^{-1}, respectively. Sites showed high floristic similarity. The tree density values varied from 1410 to 1840 ind.ha^{-1} and were within the levels expected for semideciduous forest; however, the basal area values (19.8 to 28.0 m^2.ha^{-1}) are those usually observed in disturbed forests. Despite being secondary forests, the sites had high species diversity with occurrence of tree species of recognized conservation value. Urgent action must be taken to manage and conserve these forests, such as: (i) forest corridors establish connecting fragments especially using zoochorous tree species, and (ii) use forest enrichment techniques using species that are absent or presently at low density as a result of intensive exploitation in the past.

KEYWORDS: Brazilian Atlantic Forest. Fragmentation. Floristics, Phytosociology. *Tabuleiros*.

INTRODUCTION

Extensive landscapes once covered by continuous dense forest vegetation have been fragmented by human activity to form mosaics of native vegetation occurring as islands of different sizes and shapes (PAULA; RODRIGUES, 2002). The Atlantic Forest *sensu lato* (IBGE, 2008) is a clear example of this process since it originally occupied approximately 150 million hectares of Brazil (RIBEIRO et al., 2009) and today only 13% of the original forest cover remains (Fundação SOS Mata Atlântica/INPE, 2011). Despite this unfavorable scenario, the Atlantic Forest *sensu lato* still has a high biodiversity and a large number of endemic species, being considered as a priority area for world biodiversity conservation (GALINDO-LEAL; CÂMARA, 2005).

Although forest destruction causes a loss of diversity, much of this can be prevented by the maintenance of fragments (TABARELLI et al., 1999). Studies have also demonstrated the value of small fragments for floristic conservation (ARROYO-RODRÍGUEZ et al.. 2009; CARVALHO et al., 2009) and environmental services such as the protection of soil and water sources (SCARANO et al., 2009; NASCIMENTO et al., 2010a). It is well known that forest fragmentation causes dramatic shifts in forest structure and floristic composition and thus contributes to landscape change and decrease in biodiversity (TURNER, 1996; MELO et al., 2006).

Intense forest fragmentation has occurred in the state of Rio de Janeiro, especially in the northern region, where approximately only 13% of the original Atlantic Forest remains (Fundação SOS Mata Atlântica/INPE, 2011). Knowledge of diversity and community structure of trees is still lacking in this region, where forest fragments are under severe threat of destruction (SCARANO et al., 2009). The municipal district of *São Francisco de Itabapoana* represents the southern limit of distribution of the coastal lowland semideciduous forest. This forest type, also called *tabuleiro* forest,

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differs from the other formations of the Atlantic Forest as it occupies a large coastal plain on Tertiary deposits (NASCIMENTO; LIMA, 2008), featuring a low occurrence of epiphytes (RUSCHI, 1950) and the presence of sclerophylly (RIZZINI, 1979). The *tabuleiro* forest has suffered severe fragmentation from agriculture and industrialization (GIULIETTI; FORERO, 1990). However, to date there have been relatively few phytosociological studies in the *tabuleiro* forests of Rio de Janeiro state (SILVA; NASCIMENTO, 2001; NASCIMENTO; LIMA, 2008). The latter authors emphasized the need for a broader floristic survey in this region, since it may shows significant tree species richness for the northern part of Rio de Janeiro state.

The purpose of our study was to evaluate the diversity of tree species and the structure of fragments of *tabuleiro* forest in northern Rio de Janeiro State and to relate them to the conservation status of this region. Our main hypothesis was that the fragments, as disturbed forests, have characteristic tree species dominating the forest canopy (i.e. low evenness), a high floristic similarity among them and a lower proportion of late secondary tree species than expected in a mature semideciduous forest.

MATERIAL AND METHODS

Study Site: The forest fragments studied are located in the municipality of São Francisco de Itabapoana, Rio de Janeiro State, Brazil. They consist mainly of coastal semideciduous forest called *tabuleiro*. According to Fidalgo et al. (2005) the *tabuleiro* forest grows on extensive tabular surfaces of Tertiary sediments from the *Barreiras* formation, slightly dissected by a drainage system which runs directly into the Atlantic ocean and produces U-shaped valleys. The relief is of low altitude, with elevations between 15 and 40 m, rising inland from the coastline and the channel of the Paraíba do Sul river (Projeto RioRural/GEF, 2007). According to the Brazilian soil classification (EMBRAPA, 2006) the soils are *Latossolos amarelos coesos* (cohesive yellow latosols). Due to the favorable conditions of soil and topography, human settlement in the region is dense, and the economy of the São Francisco de Itabapoana county and surrounding areas is predominantly agricultural. The deforested areas of the region are mostly pastures and sugar cane monocultures, in addition to extensive plantations of pineapple, passion fruit and cassava (Projeto RioRural/GEF, 2007).

The regional climate is classified by Köppen (1948) as Cwa, as it has low precipitation and marked seasonality with a dry season from May to August. Data from the Meteorological Station at PESAGRO-Rio, Campos dos Goytacazes-RJ from 1997 to 2006 showed average annual precipitation as 912 mm and annual average temperature 24ºC, varying from 21 to 29ºC.

For this study we selected six forest sites (Figure 1), including the *Mata do Carvão* (21°24'54.8" S - 41°04'38.9" W), the largest forest remnant in this region. This site is located in the Guaxindiba Ecological Station (*Estação Ecológica Estadual de Guaxindiba*), and was included in the Biosphere Reserve of the Atlantic Forest, recognized by UNESCO in 1992, comprising an area of about 3000 hectares of forests and swamps.

The *Mata do Carvão* has since been reduced to the current 1189.81 ha of forest by deforestation that occurred mainly during the 1960s and 1970s as a consequence of the production of sugar cane, livestock, charcoal and timber (SILVA; NASCIMENTO, 2001). Two areas of this site were studied: the sector with selective logging (CV1 - where there is evidence that this occurred in the 1990s) and the sector without logging (CV2 - where there is no record or evidence of selective extraction of timber in the past 50 years) (VILLELA et al., 2006).

Among the six sites, four are on private property located 4 to 7 km from the *Mata do Carvão*, namely: *Fazenda Imburi* - FI (21°19'31.7 " S - 41°06'00.0" W / 13 ha), *Fazenda Santana* - FS (21°20'08.7" S - 41°08'18.3" W / 35 ha), *Fazenda Palmeiras* - FP (21°19'17.7" S - 41°07'11.3" W / 49 ha), *Fazenda Santo Antônio* - FSA (21°17'48.7" S - 41°05'25.2" W / 55 ha) and one, the *Mata do Funil* - MF (21º33'17.1" S - 41°12'15.3" W / 128 ha) located on the settlement of *Zumbi dos Palmares*, approximately 18 km from the *Mata do Carvão*.

In the past, for over 40 years, there was a time of intense deforestation in the region, when hardwoods were removed for timber and common woods were used as firewood in local flour mills and pottery factories. Consequently, all the sites studied with exception of CV2 suffered intense selective illegal logging for several consecutive decades. This still occurs, especially of *Paratecoma peroba* (Record) Kuhlm (white peroba), a timber species in high demand in the region's illegal trade. Information from residents revealed that the *Fazenda Palmeiras* and *Mata do Carvão* sites were intensively exploited by their owners, especially in the period from 1960 to 1980.

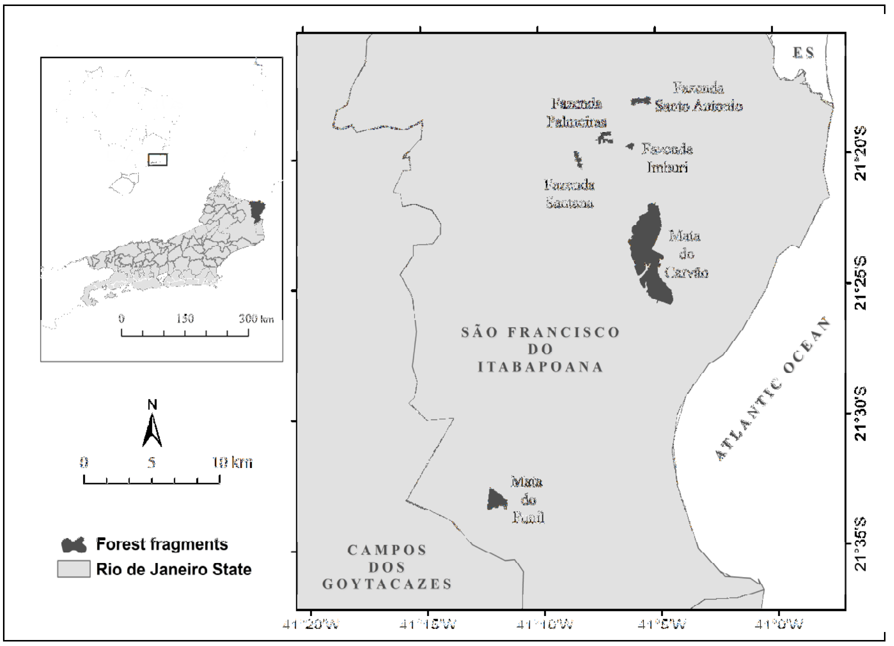

Figure 1. Map showing the forest fragments selected for study in the county of *São Francisco de Itabapoana*, North of Rio de Janeiro State.

Field survey: In August 2009, five replicate plots of 20 x 20 m (0.2 ha) were randomly located in each of the fragments, except for the *Mata do Carvão*. In the latter, two sampling areas were studied (CV1 - logged and CV2 - unlogged, each of 0.2 ha). Thus, the total sampling area was 1.4 ha. From March to December 2010, all trees ≥ 5 cm DBH were recorded, measured for diameter, and marked with permanent aluminum tags. Each stem was measured separately in trees with multiple stems, , and the sum of the basal areas was used. Lianas, dead and sprouting trees, rooted within the plots (DBH ≥ 5 cm) were recorded to assess the degree of disturbance of the fragments.

Data Analysis: The families were classified according to the APG III (BREMER et al., 2009) system. Voucher specimens are incorporated in the herbaria of the *Universidade Estadual do Norte Fluminense* (UENF) and the *Jardim Botânico do Rio de Janeiro* (RB). Species were identified using the collections of UENF and RB as reference, in addition to consultations with experts and specialized bibliographies. The endangered species based on the Official List of Endangered Species of Brazilian Flora (Normative Instruction nº 6, September 23, 2008) were listed. The species were classified into ecological groups based on field observations and information from literature. The successional classification follows Gandolfi et al. (1995), with the species categorized as Pioneers (Pi), Early Secondary (ES), Late Secondary (LS) and unclassified because of insufficient information (NC). The Van der Pijl (1982) terminology was adopted for dispersal syndromes, namely: anemochoric (ane), autochoric (aut) and zoochoric (zoo).

The Shannon-Wiener diversity index (H') and the Pielou evenness index (J') (MAGURRAN, 2004) were calculated for each of the sites and for the whole survey. Individual-based rarefaction curves with 95% confidence intervals were constructed using EcoSim 7 (GOTELLI; ENTSMINGER, 2011) to compare the species richness and diversity in the sites studied. Floristic similarity of fragments was calculated using the Sørensen qualitative and the Morisita-mod.Horn quantitative similarity indexes (MAGURRAN, 2004). A dendogram was produced by applying Unweighted Pair Groups Method using Arithmetic Averages (UPGMA) (BELBIN; MCDONALD, 1993) to the floristc similarity data between sites. The analyses were performed by the program MVSP (KOVACH, 2004).

The phytosociological analysis was based on the absolute and relative parameters of density, dominance, frequency, importance value, coverage and basal area values (MUELLER-DOMBOIS; ELLENBERG, 2002) obtained with the program Mata Nativa 3 (Cientec, 2010). An ANOVA test (ZAR, 2010) was used to compare the mean values of basal area and percentage of lianas. A Kruskal-Wallis test followed by the post-hoc Dunn's test ($p < 0.05$) (Zar, 2010) was used for the mean values of density, percentage of dead trees and sprouting trees because these data did not meet the requirements for a parametric test. The analyses were performed using the program GraphPad Prism 5.0 (MOTULSKY, 2007).

RESULTS

Structure, Floristic Composition and Diversity: The mean basal area values per hectare for the forest fragments ranged from 19.83 to 28.03 $m^2.ha^{-1}$ (Table 1) and these values did not differ statistically between sites. Density values ranged from 1410 to 1840 $ind.ha^{-1}$, with the highest values observed for CV1 and CV2 but they only differed statistically from the FSA site (Table 1). Values varied from 4.1% to 11.6% for dead standing trees, with the lowest value found for CV2. The site MF had the highest percentage of trees with multiple stems, although statiscally different only from FI (Table 1).

Table 1. Mean values (± standard deviation) of basal area (BA), tree density (D), percentage of standing dead trees (DT), lianas (L) and trees with multiple stems (MS) for individuals with DBH ≥ 5 cm occurring in five 20 m x 20m replicate plots in the forest sites *Fazenda Imburi* (FI), *Fazenda Santana* (FS), *Fazenda Palmeiras* (FP), *Fazenda Santo Antônio* (FSA), *Mata do Funil* (MF), *Mata do Carvão* logged area (CV1) and *Mata do Carvão* unlogged area (CV2). Means within a column followed by different letters are significantly different at P≤0.05.

Sites	BA (m^2/ha)	D (ind/ha)	DT (%)	L (%)	MS (%)
FI	28.03 (± 4.18)	1515 (± 37.08) ab	6.2 (±2.38)	3.2 (±2.44)	3.3 (±2.60) a
FS	23.29 (± 6.07)	1535 (± 64.71) ab	7.2 (±3.82)	4.3 (±2.02)	7.9 (±2.86) ab
FP	21.88 (± 6.51)	1570 (± 146.84) ab	5.2 (±2.60)	2.3 (±2.42)	6.9 (±3.30) ab
FSA	22.36 (± 2.81)	1410 (± 89.44) b	9.3 (±3.75)	2.4 (±1.96)	4.6 (±2.66) ab
MF	21.36 (± 3.22)	1585 (± 263.75) ab	8.7 (±4.11)	5.2 (±2.25)	16.1 (±8.55) b
CV1	19.83 (± 4.27)	1805 (± 205.70) a	11.6 (±6.17)	4.8 (±2.45)	4.8 (±3.84) ab
CV2	22.19 (± 3.26)	1840 (± 260.17) a	4.1 (±1.95)	1.5 (±1.55)	4.6 (±2.34) ab

A total of 2252 trees were recorded, belonging to 194 species and 42 families (Table 2). About 92.5% of the individuals (n = 2087) have been identified to species, with 121 trees identified to genus and 44 trees only to family or not at all (2% of individuals). The richest families were Fabaceae (31), Sapotaceae (18), Myrtaceae (14) and Meliaceae (10), representing nearly 37.5% of species and 30% of individuals.

Table 2. List of tree species recorded in *São Francisco do Itabapoana*, RJ. FI= Fazenda Imburi, FS= Fazenda Santana, FP= Fazenda Palmeiras, FSA= Fazenda Santo Antônio, MF= Mata do Funil, CV= Mata do Carvão, SC= successional classification (LS= Late Secondary, ES - Early Secondary, Pi= Pioneer), DS= dispersion syndrome (ane= anemochoric, zoo= zoochoric, aut= autochoric), NC= not classified.

Family / Species	FI	FS	FP	FSA	MF	CV	SC	DS
Achariaceae								
Carpotroche brasiliensis (Raddi) Endl.	X	X	X	X		X	LS	zoo
Anacardiaceae								
Astronium concinnum Schott	X	X	X	X	X	X	LS	ane
Astronium graveolens Jacq.	X	X	X		X	X	ES	ane
Astronium sp.	X	X	X	X	X	X	ES	ane
Spondias venulosa Mart. ex. Engl.	X						ES	zoo
Annonaceae								
Duguetia microphylla (R.E. Fr.) R.E. Fr.					X		NC	zoo
Duguetia pohliana Mart.	X	X				X	NC	zoo
Duguetia riedeliana R.E.Fr.			X			X	LS	zoo
Ephedranthus sp. nov.	X		X	X			LS	zoo
Oxandra nitida R.E.Fr.	X	X	X	X	X	X	NC	zoo

Porcelia macrocarpa (Warm.) R.E.Fr.		X					ES	zoo
Xylopia laevigata (Mart.) R.E.Fr.		X	X			X	LS	zoo
Apocynaceae								
Aspidosperma illustre (Vell.) Kuhlm. & Pirajá						X	LS	ane
Aspidosperma parvifolium A.DC.				X	X		LS	ane
Bignoniaceae								
Handroanthus serratifolius (Vahl) S. O.Grose	X	X	X		X	X	ES	ane
Handroanthus cf. *umbellatus* (Sond.) Mattos	X	X	X		X	X	ES	ane
Jacaranda sp.	X	X					ES	ane
Paratecoma peroba (Record) Kuhlm.	X	X	X		X	X	LS	ane
Sparattosperma leucanthum (Vell.) K.Schum.				X			Pi	ane
Tabebuia roseoalba (Ridl.) Sandwith						X	ES	ane
Handroanthus sp.		X					NC	ane
Boraginaceae								
Cordia taguahyensis Vell.	X	X	X			X	LS	ane
Burseraceae								
Protium heptaphyllum (Aubl.) Marchand		X				X	ES	zoo
Protium warmingianum Marchand	X						LS	zoo
Cactaceae								
Brasiliopuntia brasiliensis (Willd.) A.Berger		X	X		X	X	ES	zoo
Cannabaceae								
Celtis iguanaea (Jacq.) Sarg.	X		X	X		X	Pi	zoo
Capparaceae								
Monilicarpa brasiliana (Banks ex DC.) Cornejo & Iltis	X		X		X		ES	zoo
Caricaceae								
Jacaratia heptaphylla (Vell.) A.DC.	X		X	X		X	ES	zoo
Celastraceae								
Maytenus ardisiaefolia Reissek	X						LS	zoo
Maytenus cestrifolia Reissek		X		X		X	NC	zoo
Maytenus obtusifolia Mart.	X		X			X	LS	zoo
Maytenus sp.		X	X		X	X	LS	zoo
Chrysobalanaceae								
Hirtella angustifolia Schott ex Spreng.						X	NC	zoo
Hirtella sp.	X	X					NC	zoo
Licania kunthiana Hook.f.		X			X		LS	zoo
Clusiaceae								
Garcinia gardneriana (Planch. & Triana) Zappi						X	LS	zoo
Combretaceae								
Terminalia glabrescens Mart.			X				ES	ane
Terminalia kuhlmannii Alwan & Stace	X	X			X		ES	ane
Terminalia riedelii Eichler	X						NC	ane
Terminalia sp.						X	ES	ane
Erythroxylaceae								
Erythroxylum cuspidifolium Mart.						X	LS	zoo
Erythroxylum sp.						X	NC	zoo
Euphorbiaceae								
Actinostemon verticillatus (Klotzsch) Baill.	X	X	X			X	LS	aut
Algernonia leandrii (Baill.) G.L.Webster			X			X	LS	aut
Algernonia obovata (Müll.Arg.) Müll.Arg.	X						ES	aut
Joannesia princeps Vell.		X		X	X		Pi	aut
Pachystroma longifolium (Nees) I.M.Johnst.	X		X	X		X	ES	aut
Sebastiania brasiliensis Spreng.			X		X	X	ES	aut
Senefeldera verticillata (Vell.) Croizat	X	X	X	X	X	X	LS	aut

Fabaceae Caesalpinioideae								
Apuleia leiocarpa (Vogel) J.F.Macbr.	X		X		X		ES	ane
Chamaecrista ensiformis (Vell.) H.S.Irwin & Barneby		X	X	X			ES	aut
Copaifera lucens Dwyers	X	X	X	X	X	X	LS	zoo
Hymenaea aurea Y.T.Lee & Langenh.	X						LS	zoo
Hymenaea courbaril L.		X			X		LS	zoo
Libidibia ferrea (Mart. ex Tul.) L.P.Queiroz					X		LS	aut
Melanoxylon brauna Schott		X	X	X			LS	ane
Peltogyne discolor Vogel		X		X	X		LS	ane
Fabaceae Faboideae								
Acosmium lentiscifolium Schott		X	X	X	X	X	LS	ane
Centrolobium sclerophyllum H.C.Lima	X	X		X			LS	ane
Exostyles venusta Schott	X				X	X	LS	zoo
Grazielodendron rio-docensis H.C.Lima		X					ES	aut
Machaerium brasiliense Vogel		X	X			X	ES	ane
Machaerium incorruptibile (Vell.) Benth.	X	X		X	X	X	ES	ane
Machaerium nyctitans (Vell.) Benth.					X		ES	ane
Myrocarpus frondosus Allemão	X	X		X		X	LS	ane
Myroxylon peruiferum L.f.						X	ES	ane
Platymiscium floribundum Vogel	X						LS	ane
Platypodium elegans Vogel					X	X	LS	ane
Poecilanthe falcata (Vell.) Heringer			X				LS	ane
Swartzia simplex (Sw.) Spreng.				X	X		LS	zoo
Vatairea heteroptera (Allemão) Ducke			X		X		ES	ane
Fabaceae Mimosoideae								
Albizia polycephala (Benth.) Killip ex Record	X					X	ES	ane
Anadenanthera colubrina (Vell.) Brenan	X				X	X	ES	ane
Inga lenticellata Benth.	X				X	X	Pi	zoo
Inga sp.					X		NC	zoo
Parapiptadenia pterosperma (Benth.) Brenan	X	X	X		X	X	ES	ane
Pseudopiptadenia contorta (DC.) G.P.Lewis & M.P.Lima	X	X	X	X	X	X	ES	ane
Senegalia polyphylla (DC.) Britton & Rose	X	X	X	X	X	X	ES	ane
Senegalia sp.					X		ES	ane
Fabaceae Mimosoideae sp.					X		ES	NC
Lauraceae								
Ocotea argentea Mez		X					LS	zoo
Ocotea silvestris Vattimo-Gil				X			LS	zoo
Ocotea sp.1		X					NC	zoo
Ocotea sp.2			X			X	NC	zoo
Lecythidaceae								
Cariniana legalis (Mart.) Kuntze					X	X	LS	ane
Couratari asterotricha Prance		X	X				ES	ane
Couratari macrosperma A.C.Sm.		X	X			X	ES	ane
Eschweilera ovata (Cambess.) Mart. ex Miers				X			LS	zoo
Lecythis lurida (Miers) S.A.Mori		X		X		X	LS	aut
Lecythis pisonis Cambess.						X	LS	aut
Malpighiaceae								
Byrsonima ligustrifolia A.Juss.					X	X	NC	zoo
Malvaceae								
Basiloxylon brasilensis (All.) K.Schum.	X		X			X	LS	ane
Eriotheca candolleana (K.Schum.) A.Robyns	X	X	X	X	X	X	ES	ane
Eriotheca pentaphylla (Vell.) A.Robyns		X		X		X	ES	ane

Guazuma crinita Mart.		X	X				Pi	ane
Luehea conwentzii K.Schum.						X	ES	ane
Luehea divaricata Mart. & Zucc.		X	X	X	X		ES	ane
Pseudobombax grandiflorum (Cav.) A.Robyns						X	ES	ane
Sterculia curiosa (Vell.) Taroda	X	X				X	ES	aut
Meliaceae								
Guarea sp.					X		NC	zoo
Trichilia casaretti C.DC.		X	X		X	X	LS	zoo
Trichilia catigua A. Juss.		X	X				LS	zoo
Trichilia elegans A. Juss.	X	X	X	X	X	X	LS	zoo
Trichilia lepidota Mart.	X	X	X	X	X	X	LS	zoo
Trichilia martiana C.DC.						X	ES	zoo
Trichilia pseudostipularis (A.Juss.) C.DC.	X	X	X		X		LS	zoo
Trichilia ramalhoi Rizzini	X	X	X	X	X	X	LS	zoo
Trichilia silvatica C.DC.			X		X	X	LS	zoo
Trichilia sp.	X	X			X	X	LS	zoo
Moraceae								
Brosimum guianense (Aubl.)Huber	X		X	X	X	X	ES	zoo
Ficus sp.				X			ES	zoo
Myrtaceae								
Campomanesia guazumifolia (Cambess.) O.Berg	X	X	X				ES	zoo
Eugenia rostrata O.Berg.	X						ES	zoo
Eugenia umbelliflora O.Berg					X		LS	zoo
Eugenia sp.1	X						NC	zoo
Eugenia sp.2		X					NC	zoo
Eugenia sp.3	X						NC	zoo
Marlierea sucrei G.M.Barroso & Peixoto						X	ES	zoo
Myrcia splendens (Sw.) DC.				X		X	ES	zoo
Myrciaria floribunda (H.West ex Willd.) O.Berg		X		X		X	LS	zoo
Myrciaria guaquiea (Kiaersk.) Mattos & D.Legrand	X						LS	zoo
Neomitranthes langsdorffii (O.Berg) Mattos	X				X	X	LS	zoo
Psidium cattleianum Sabine	X	X		X		X	ES	zoo
Psidium oligospermum DC.						X	NC	zoo
Psidium rufum Mart. ex. DC.	X	X	X	X		X	ES	zoo
Nyctaginaceae								
Andradaea floribunda Allemão	X	X					ES	ane
Guapira opposita (Vell.) Reitz	X	X				X	ES	zoo
Nyctaginaceae sp.1	X	X					NC	zoo
Nyctaginaceae sp.2		X					NC	NC
Olacaceae								
Heisteria perianthomega (Vell.) Sleumer						X	NC	zoo
Picramniaceae								
Picramnia sp.				X			NC	zoo
Polygalaceae								
Acanthocladus pulcherrimus (Kuhlm.) J.F.B.Pastore & D.B.O.S.Cardoso	X		X	X		X	NC	zoo
Polygonaceae								
Coccoloba alnifolia Casar.	X				X		ES	zoo
Coccoloba declinata (Vell.) Mart.						X	NC	zoo
Coccoloba warmingii Meisn.	X	X	X		X	X	ES	zoo
Ruprechtia laurifolia (Cham. & Schltdl.) A.C.Meyer						X	NC	ane
Rhamnaceae								
Rhamnidium glabrum Reissek				X	X		ES	zoo
Ziziphus platyphylla Reissek		X	X		X		LS	zoo

Rubiaceae								
Alseis pickelli Pilger & Schmale	X	X	X	X	X	X	LS	ane
Bathysa cuspidata (A.St.-Hil.) Hook.f. *ex* K.Schum.	X	X					ES	aut
Melanopsidium nigrum Colla	X						LS	zoo
Randia armata (Sw.) DC.					X		ES	zoo
Rutaceae								
Almeidea rubra A.St.-Hil.	X	X	X		X	X	LS	aut
Angostura bracteata (Nees & Mart.) Kallunki					X	X	LS	aut
Balfourodendron riedelianum (Engl.) Engl.					X		ES	ane
Esenbeckia grandiflora Mart.	X		X				LS	aut
Metrodorea nigra A.St.-Hil.	X	X	X	X	X	X	LS	aut
Neoraputia alba (Nees & Mart.) Emmerich ex Kallunki		X	X	X	X	X	LS	aut
Zanthoxylum rhoifolium Lam.						X	Pi	zoo
Zanthoxylum riedelianum Engl.		X					ES	zoo
Salicaceae								
Casearia arborea (Rich.) Urb.						X	ES	zoo
Casearia obliqua Spreng.					X		LS	zoo
Casearia souzae R. Marquete & Mansano,		X				X	ES	zoo
Macrothumia kuhlmannii (Sleumer) M.H.Alford		X		X	X	X	LS	zoo
Sapindaceae								
Allophylus edulis (A.St.-Hil., Cambess. & A.Juss.) Hieron. ex Niederl.	X	X	X			X	Pi	zoo
Cupania emarginata Cambess.		X					ES	zoo
Cupania oblongifolia Mart.					X		NC	zoo
Matayba sp.	X				X		NC	zoo
Talisia coriacea Radlk.	X	X	X	X	X	X	LS	zoo
Sapotaceae								
Chrysophyllum flexuosum Mart.		X		X		X	LS	zoo
Chrysophyllum gonocarpum (Mart. & Eichler ex Miq.) Engl.	X	X	X				LS	zoo
Chrysophyllum lucentifolium Cronquist	X	X	X	X	X	X	LS	zoo
Manilkara salzmannii (A.DC.) H.J.Lam.		X					LS	zoo
Pouteria bangii (Rusby) T.D.Penn.			X				LS	zoo
Pouteria bullata (S.Moore) Baehni				X			LS	zoo
Pouteria caimito (Ruiz & Pav.) Radlk.						X	LS	zoo
Pouteria filipes Eyma	X	X	X	X			LS	zoo
Pouteria guianensis Aubl.		X					LS	zoo
Pouteria macahensis T.D.Penn.					X		NC	zoo
Pouteria ramiflora (Mart.) Radlk.			X				NC	zoo
Pouteria reticulata (Engl.) Eyma		X				X	NC	zoo
Pouteria sp.1	X						NC	zoo
Pouteria sp.2						X	NC	zoo
Pradosia lactescens (Vell.) Radlk.	X	X	X				LS	zoo
Sideroxylon obtusifolium (Roem. & Schult.) T.D.Penn.			X	X		X	ES	zoo
Sapotaceae sp.1		X					NC	zoo
Sapotaceae sp.2				X			NC	zoo
Simaroubaceae								
Simaroubaceae sp.			X				NC	zoo
Solanaceae								
Metternichia princeps J.C.Mikan	X					X	ES	zoo
Solanum lycocarpum Mart. & Sendtn.					X	X	ES	zoo
Trigoniaceae								

Trigoniodendron spiritusanctense E.F.Guim. & Miguel	X	X	X	X	X	X	LS	zoo
Ulmaceae								
Ampelocera glabra Kuhlm.	X						LS	zoo
Violaceae								
Rinorea bahiensis (Moric.) Kuntze		X		X			LS	zoo
Vochysiaceae								
Qualea sp.					X		NC	ane
Indeterminadas								
Indeterminada sp.1	X						NC	NC
Indeterminada sp.2	X						NC	NC
Indeterminada sp.3	X						NC	NC
Indeterminada sp.4	X						NC	NC
Indeterminada sp.5			X				NC	NC
Indeterminada sp.6				X			NC	NC
Indeterminada sp.7					X		NC	NC
Indeterminada sp.8						X	NC	NC
Indeterminada sp.9					X	X	NC	NC
Indeterminada sp.1						X	NC	NC

A total of 79 species (41%) occurred in only one site (Table 2), with 82 species occurring only as a single individual, and so being considered rare (Table 3). Such singletons represented 31% of the species richness but only 2.7% of trees. The 20 most important species in the sites were in general the same (Table 3), with *Metrodorea nigra* showing the highest cover values, except for MF, where it was fourth.

Table 3. Phytosociological position of the 20 most important tree species sampled in the forest sites *Fazenda Imburi* (FI), *Fazenda Santana* (FS), *Fazenda Palmeiras* (FP), *Fazenda Santo Antônio* (FSA), *Mata do Funil* (MF), *Mata do Carvão* logged area (CV1) and *Mata do Carvão* unlogged area (CV2). Species ranked by Cover Values.

Species	FI	FS	FP	FSA	MF	CV1	CV2
Metrodorea nigra	1	1	1	1	4	1	1
Pseudopiptadenia contorta	3	7	2	3	2	2	3
Astronium concinnum	25	2	3	5	22	26	-
Trigoniodendron spiritusanctense	4	8	6	4	39	8	16
Senefeldera verticillata	7	54	5	6	29	6	24
Parapiptadenia pterosperma	15	30	27	-	1	11	14
Astronium sp.	37	10	4	7	8	29	10
Alseis pickelli	17	13	8	16	11	7	6
Copaifera lucens	8	3	9	12	6	-	29
Talisia coriacea	20	11	18	8	12	13	4
Senegalia polyphylla	6	4	38	27	65	21	11
Chrysophyllum lucentifolium	9	15	22	2	19	22	50
Paratecoma peroba	5	24	47	-	13	5	48
Trichilia lepidota	63	37	10	43	14	10	7
Acosmium lentiscifolium	-	6	13	17	5	39	22
Neoraputia alba	-	19	52	39	16	3	15
Astronium graveolens	10	22	11	-	18	33	9
Pachystroma longifolium	62	-	15	21	-	4	12
Metternichia princeps	41	-	-	-	-	9	2
Actinostemon verticillatus	2	85	7	-	-	31	-

Other abundant species in the sites were *Pseudopiptadenia contorta* (DC.) G.P.Lewis & M.P.Lima, *Senefeldera verticillata* (Vell.) Croizat, *Astronium* sp., *Talisia coriacea* Radlk., *Actinostemon verticillatus* (Klotzsch) Baill. and *Metternichia princeps* J.C.Mikan, which together with *M. nigra* represented a total of 42% of the number of individuals (Table 4).

Table 4. Phytosociological parameters in order of importance value analyzed for tree communities in *São Francisco do Itabapoana*, RJ. N - Number of individuals, BA - Basal Area, RD - Relative Density, RF - Relative Frequency, RDo - Relative Dominance, CoV - Cover Value, IV - Importance Value.

Species	N	BA	RD	RF	RDo	CoV	IV
Metrodorea nigra	539	6.88	23.93	3.17	21.65	45.59	48.76
Pseudopiptadenia contorta	109	2.80	4.84	3.17	8.80	13.64	16.81
Astronium concinnum	51	1.55	2.26	2.11	4.89	7.16	9.27
Trigoniodendron spiritusanctense	44	1.27	1.95	2.43	3.99	5.94	8.37
Senefeldera verticillata	86	0.53	3.82	2.11	1.68	5.50	7.61
Parapiptadenia pterosperma	49	1.11	2.18	1.80	3.50	5.68	7.48
Astronium sp.	64	0.73	2.84	2.22	2.29	5.13	7.35
Alseis pickelli	44	0.76	1.95	2.64	2.40	4.35	6.99
Copaifera lucens	49	0.69	2.18	2.33	2.17	4.35	6.67
Talisia coriacea	56	0.47	2.49	2.54	1.49	3.97	6.51
Senegalia polyphylla	29	0.72	1.29	2.11	2.26	3.55	5.66
Chrysophyllum lucentifolium	45	0.39	2.00	2.33	1.23	3.23	5.55
Paratecoma peroba	15	1.06	0.67	1.37	3.33	3.99	5.37
Trichilia lepidota	44	0.37	1.95	2.22	1.17	3.12	5.34
Acosmium lentiscifolium	30	0.76	1.33	1.59	2.39	3.72	5.30
Neoraputia alba	50	0.23	2.22	1.69	0.71	2.93	4.62
Astronium graveolens	28	0.48	1.29	1.80	1.50	2.79	4.58
Pachystroma longifolium	47	0.31	2.09	1.27	0.98	3.07	4.34
Metternichia princeps	52	0.36	2.31	0.74	1.14	3.45	4.19
Actinostemon verticillatus	52	0.17	2.31	1.16	0.55	2.86	4.02
Total (20 spp.)	1483	21.65	65.90	40.80	68.12	133.99	174.80
Others (174 spp.)	769	10.14	34.10	59.20	31.88	66.01	125.20
Total (1.4 ha)	**2252**	**31.79**	**100**	**100**	**100**	**200**	**300**

Several species of recognized conservation importance, such as *Protium heptaphyllum* (Aubl.) Marchand, *Terminalia kuhlmannii* Alwan & Stace and *Marlierea sucrei* G. M. Barroso & Peixoto, were sampled in the sites. Another five species are classified as critically endangered: *Melanoxylon brauna* Schott, *Grazielodendron rio-docensis* H.C.Lima, *Couratari asterotricha* Prance, *Melanopsidium nigrum* Colla and *Trigoniodendron spiritusanctense* E. F. Guim. & Miguel.

It is also worth noting the presence of new species of *Casearia souzae* R. Marquete & Mansano and *Ephedranthus*, that is in process of description by specialist, and *Psidium oligospermum* D.C., a new occurrence for Rio de Janeiro State. Among the timber species, there are *Aspidosperma illustre* (Vell.) Kuhlm. & Pirajá, *Aspidosperma parvifolium* A.DC, *Handroanthus serratifolius* (Vahl) S. O.Grose, *Paratecoma peroba* (Record) Kuhlm, *Tabebuia roseoalba* (Ridl.) Sandwith, *Melanoxylon brauna* Schott, *Myrocarpus frondosus* Allemão, *Cariniana legalis* (Mart.) Kuntze, *Peltogyne discolor* Vogel and *Libidibia ferrea* (Mart. ex Tul.) L. P. Queiroz.

The sites varied in relation to species richness and diversity, with values ranging from 59 to 89 species and 2.59 to 3.79 for Shannon's diversity index (Table 5). The values of species evenness indicated an occurrence of species dominance, especially in FSA (J' = 0.64) due to the high abundance of *Metrodorea nigra* A.St.-Hil. The relative density of this species ranged from 17 (MF) to 47.5% (FSA).

The comparison of the rarefaction curves of species richness of the six sites revealed the existence of three distinct groups of sites, the first showing the highest values (sites FS and FI), the second with intermediate values (MF, FP, CV1, CV2) and the last with the lowest values (FSA) (Figure 2A). The rarefaction curves of Shannon's diversity index showed four groups with the sites FS and MF representing the highest diversity group followed by two intermediate groups (FI and FP;

CV1 and CV2) and FSA representing the group with the lowest diversity (Figure 2B).

Table 5. Values of number of tree species, (Nsp), number of unique species (Nun), number of families (Nfm), Shannon species diversity index (H') and Pielou species evenness index (J') in 0.2 ha plots in the forest sites *Fazenda Imburi* (FI), *Fazenda Santana* (FS), *Fazenda Palmeiras* (FP), *Fazenda Santo Antônio* (FSA), *Mata do Funil* (MF), *Mata do Carvão* logged area (CV1) and *Mata do Carvão* unlogged area (CV2).

Sample Area	Nsp	Nun	Nfm	H'	J
FI (0.2ha)	84	18	28	3,52	0,79
FS (0.2ha)	88	12	26	3,79	0,85
FP (0.2ha)	72	06	28	3,43	0,80
FSA (0.2ha)	56	08	26	2,59	0,64
MF (0.2ha)	75	15	27	3,74	0,87
CV1 (0.2ha)	72	12	32	3,26	0,76
CV2 (0.2ha)	71	08	26	3,21	0,75
Total (1.4ha – DBH ≥ 5cm)	**194**	**79**	**42**	**3,90**	**0,74**
Total (1.4ha – DBH ≥ 10cm)	**143**	**-**	**36**	**3,62**	**0,73**

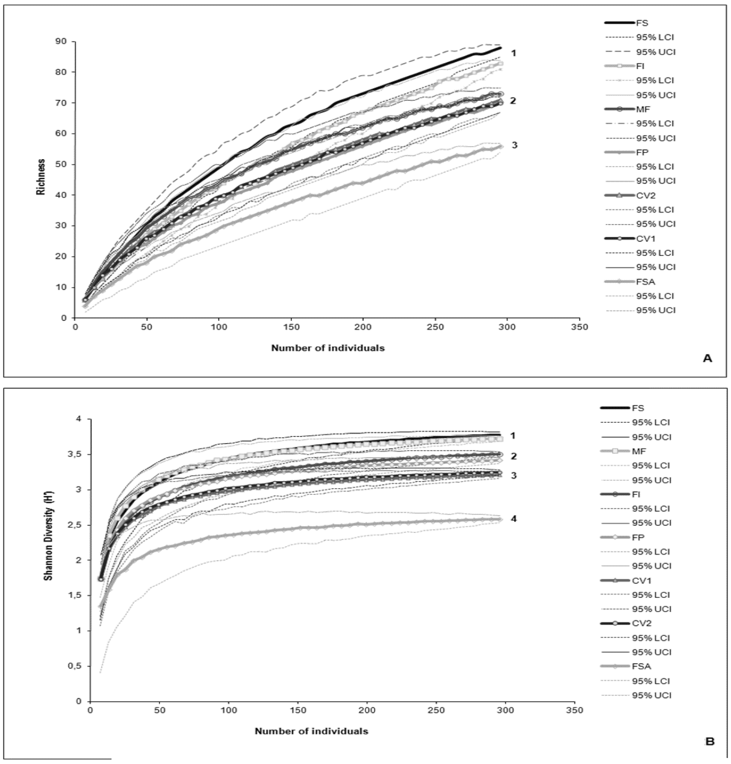

Figure 2. (A) Individual-based rarefaction curves (95% confidence intervals) for species richness showing three distinct groups of sites, 1- FS and FI, 2- MF, FP, CV1, CV2 and 3- FSA; (B) Shannon's species diversity index showed four groups, 1- FS and MF, 2- FI and FP; 3- CV1 and CV2; and 4- FSA. The study sites are *Fazenda Imburi* (FI), *Fazenda Santana* (FS), *Fazenda Palmeiras* (FP), *Fazenda Santo Antônio* (FSA), *Mata do Funil* (MF), *Mata do Carvão* logged area (CV1) and *Mata do Carvão* unlogged area (CV2). Dotted lines are the lower (LCI) and upper (UCI) confidence intervals.

The sites showed a high similarity in species composition, with values of Sørensen indexes varying from 0.41 to 0.60 (Figure 3A). The greatest similarity was observed between FS and FP, and these sites with FI, while FSA had the lowest similarity to the other sites (Figure 3A). The values of species density obtained by the Morisita-Horn similarity index were even higher, ranging from 0.41 to 0.90, showing that not only the presence, but also the abundance of species is similar among the sites studied (Figure 3B). The dendrogram (Figure 3B) showed that the forest fragments were split into three main floristic blocks. The first group consisted only of MF, and the second was sites FI, FP, and FS, and the third CV1, CV2 and FSA.

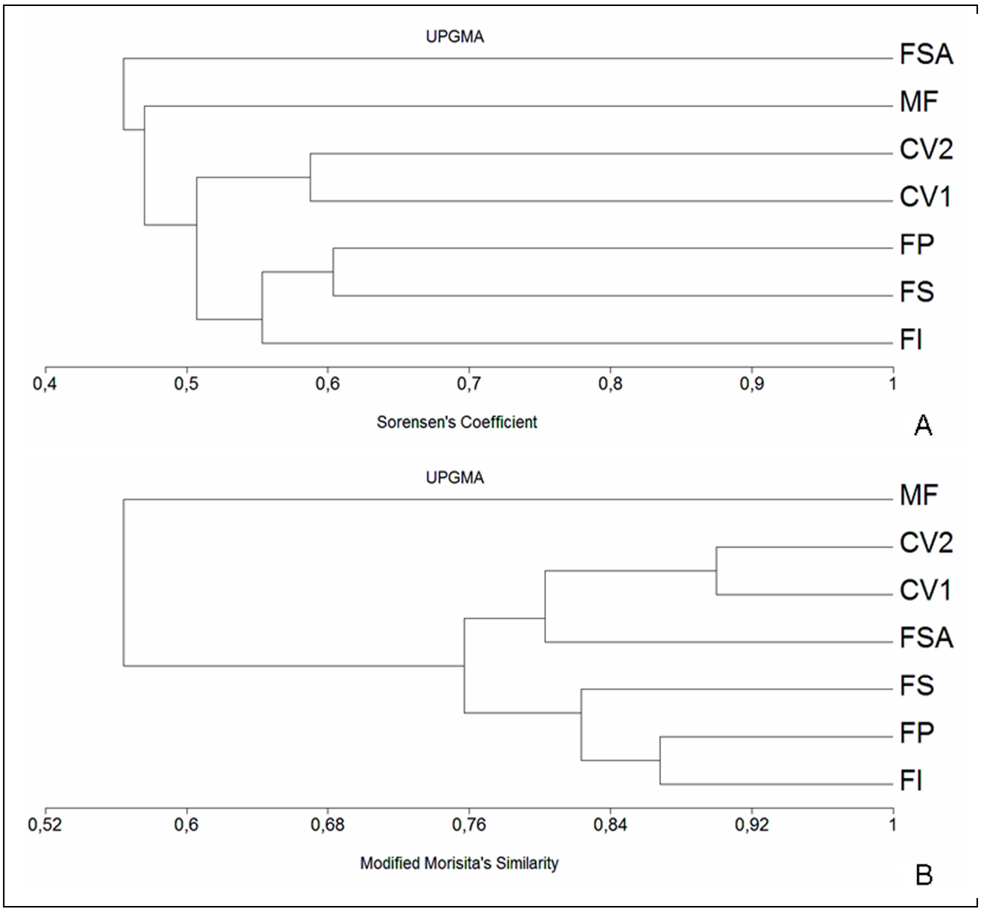

Figure 3. Dendrograms of tree species similarity among sample areas of *São Francisco do Itabapoana*, RJ, through the unweighted pair group method with arithmetic mean (UPGMA), from indexes of (A) Sørensen and (B) Morisita (mod. Horn). The study sites are *Fazenda Imburi* (FI), *Fazenda Santana* (FS), *Fazenda Palmeiras* (FP), *Fazenda Santo Antônio* (FSA), *Mata do Funil* (MF), *Mata do Carvão* logged area (CV1) and *Mata do Carvão* unlogged area (CV2).

Ecological groups: Pioneer species were poorly represented in the sites, both by number of species and individuals (Table 2 and Figure 4A). In general, the sites had 41.7 - 53.6% of species classified as late secondary, 30.4 - 41.7% as early secondary tree species and 2.7 - 5.4% as pioneers (Figure 4A). However the sites showed a dominance of late secondary species when the abundance of individuals was considered (Figure 4B).The sites showed a predominance of species belonging to the zoochoric dispersion syndrome (Table 2, Figure 4C). However, when population size is taken into account the importance of autochorics is seem to increase (Figure 4D).

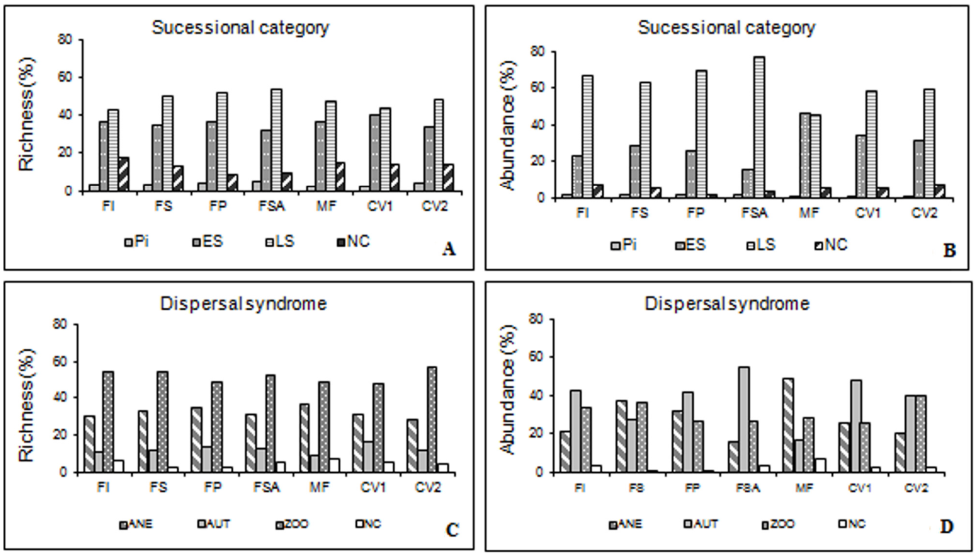

Figure 4. Ecological groups (represented in percentage) of tree species in *Fazenda Imburi* (FI), *Fazenda Santana* (FS), *Fazenda Palmeiras* (FP), *Fazenda Santo Antônio* (FSA), *Mata do Funil* (MF), *Mata do Carvão* logged area (CV1) and *Mata do Carvão* unlogged area (CV2) in *São Francisco do Itabapoana*-RJ. (A) Species per successional classification; (B) Individuals per successional classification; (C) Species per dispersion syndrome; (D) Individuals per dispersion syndrome. LS - Late Secondary, ES - Early Secondary, Pi - Pioneer; ANE - anemochoric, ZOO - zoochoric, AUT - autochoric; NC - not classified due to lack of sufficient information.

DISCUSSION

The occurrence of Fabaceae, Sapotaceae, and Myrtaceae as the families with the highest species richness in our study agrees with those of Oliveira-Filho; Fontes (2000) for the Southeast region of Brazil and Mori et al. (1983), Peixoto; Gentry (1990), Jesus; Rolim (2005), and Nascimento; Lima (2008) for the coastal lowland semideciduous Atlantic forests.

The seasonality of climate and the occurrence of the genera *Anadenanthera, Aspidosperma, Astronium, Copaifera, Parapiptadenia, Lecythis* and *Tabebuia*, and the greater number of deciduous species (*Paratecoma peroba, Myrocarpus frondosus* Allemão*, Tabebuia roseoalba* (Ridl.) Sandwith*, Machaerium incorruptibile* (Vell.) Benth., amongst others), is typical of Semideciduous Tropical Forest formations (VELOSO et al., 1991; Oliveira-Filho; Fontes, 2000). The sites studied showed a floristic composition similar to semideciduous forests in the northern region of the state of Rio de Janeiro (CARVALHO et al., 2006; DAN et al., 2010), where the occurrence of some typical species (RIZZINI, 1979; RADAMBRASIL, 1983) were common, and are now rare due to successive selective logging (SILVA; NASCIMENTO, 2001; VILLELA et al., 2006).

Numerous tree species registered in São Francisco do Itabapoana are common to other *tabuleiro* forests located in southern limits of occurrence of this forest type, in Buzios and Cabo Frio (BOHRER et al., 2009; DANTAS et al., 2009). According to Silva; Nascimento (2001), numerous tree species are common to northeastern Espírito Santo and in the Mata do Carvão. These results are corroborated by Giaretta et al. (2013), who listed the preferential species of the tabuleiro forests of north Espírito Santo, with 28 species common to these registered in our work. Araújo et al. (1998) and Lima (2000) also found other species (e.g., *Grazielodendron rio-docensis, Astronium concinnum, Parapiptadenia pterosperma*) whose southern distribution limits extend to the coastal lowland forests of Rio de Janeiro, mainly in the Cabo Frio region and in the São João river basin. According to Nascimento; Lima (2008), the concentration of tree species with southern limits of occurrence in northeastern Rio de Janeiro shows a disjunction between Rio de Janeiro and Bahia/Espírito Santo, suggesting a former connection between these two areas of *tabuleiro* forest, separated today because of forest fragmentation. Bohrer et al. (2009) corroborated this observation relating that several studies have found a high similarity between coastal lowland forests of

Rio de Janeiro, Espírito Santo and Bahia, suggesting a single cover linking these areas in recent past.

The Shannon diversity index and the species richness found in FSA are very close to those found in severely altered areas (CARVALHO et al., 2009; DAN et al., 2010). This site also showed a lower evenness index and a higher relative density of a single species (*Metrodorea nigra*) amongst sites. According to the concept of Gusson et al. (2009), the values found for Shannon diversity and Pielou evenness indexes in FSA can be considered low for Semideciduous Tropical Forests. For the other sites, the diversity values found were close to the values of other studies carried out in secondary forests of the northern region of the state of Rio de Janeiro (SILVA; NASCIMENTO, 2001; CARVALHO et al., 2006; DAN et al., 2010) and lower than values found for mature forests (Table 6).

Table 6. Analyzed parameters in some Semideciduous Seasonal Forest. Pres.= preserved forest; Pert.= perturbed forest; AB.ha^{-1}= values of basal area per hectare; Ni.ha^{-1}= tree density per hectare (D), H'= Shannon species diversity index

Sites	AB.ha^{-1}	Ni.ha^{-1}	H'	Reference
Rio Capivari (1,12 ha) – pres.	31,03	1487	4,26	Souza et al. (2003)
PE Rio Bonito (2,4 ha) – pert.	20,50	1724	4,56	Dalanesi et al. (2004)
Sítio Bom Sucesso (0,5 ha) – pres.	38,45	1704	3,52	Campos et al. (2006)
Bom Jesus (84 pontos) – pert.	17,30	_	4,02	Carvalho et al. (2006)
Fazenda Raio de Sol (0,4 ha) – pert.	20,08	1855	3,8	Imaña-Encinas et al., 2008
Fazenda Tucumã (1,0 ha) – pert.	15,50	837	2,94	Gusson et al. (2009)
Fazenda Sucupira-Caçu (1,0 ha) – pres.	45,80	805	3,33	Dias-Neto et al. (2009)
APA do Pau Brasil (0,5 ha) – pert.	23,60	2386	3,6	Kurtz et al. (2009)
Cambiocó (0,2 ha) – pert.	15,32	1105	2,81	Dan et al. (2010)
Emboque (0,2 ha) – pert.	18,17	905	3,83	Dan et al. (2010)
Camancho (0,2 ha) – pert.	25,89	950	3,84	Dan et al. (2010)
Prosperidade II (0,2 ha) – pert.	28,35	1315	3,63	Dan et al. (2010)
Prosperidade I (0,2 ha) – pert.	48,81	1445	3,87	Dan et al. (2010)
RPPN Cafundó (2,5 ha) – pres.	33,02	1823	4,13	Archanjo et al. (2012)
FLONA Pacotuba (2,4 ha) – pert.	25,72	1488	3,31	Abreu et al. (2013)

The similarity analysis using quantitative data showed that species abundance provided a greater floristic similarity between specific sites, indicating that they share a group of species which are the most abundant trees among sites. A similar result was found by Carvalho et al. (2009), who correlated the reduced number of species with high dominance as a determining factor for this result.

Pioneer and early secondary species have been considered indicators of anthropogenic disturbance (FONSECA; RODRIGUES, 2000; GANDOLFI et al., 1995) and their occurrence is generally related to a history of disturbance of the area (GANDOLFI et al., 1995; IVANAUKAS et al., 1999; MARANGON et al., 2007; CARVALHO et al., 2009). This was not evident in our analysis, since the number of individuals from the late secondary species group surpassed that of early secondary species by about 30%, mainly due to the great abundance of *Metrodorea nigra* (38% of late secondary individuals). However, the late group did not show a high species richness, with the average species number being only 8% greater than the value found for the early group. The low occurrence of late secondary species in the sites can be explained by the history of anthropogenic action, since every site had its timber used intensely in the past (until the end of the nineties). However, some of them still suffer from selective logging and in this case, the most exploited species are of the late secondary group (VILLELA et al., 2006). Another important factor is that the emergence of gaps made by selective logging favors colonization by early secondary groups, according to the findings of many authors (VILLELA et al., 2006; GUSSON et al., 2009). These gaps, with different shapes and sizes, are quite evident in the landscape of studied sites. Thus, the formation of gaps, mainly due to the extraction of *Paratecoma peroba*, seems to have led to the increase of early secondary species, such as *Pseudopiptadenia contorta* and *Parapiptadenia pterosperma* (Benth.) Brenan.

The prevalence of zoochory in forest fragments has been observed by many authors (MORELLATO; LEITÃO-FILHO, 1992; SANTOS; KINOSHITA, 2003; YAMAMOTO et al., 2007; GUSSON et al., 2009; BARCELOS et al., 2012). Howe; Smallwood (1982) noted that a percentage of zoochoric species over 70% is expected for tropical forest but in our sites this did not exceed 51%. However, the values found for anemochory rates fall within the expected number for semideciduous forests. According to Piña-Rodrigues; Piratelli (1993), these more open forest formations showed anemochory rates between 20 and 30%, where conditions are more conducive to the dissemination of seeds by the wind.

Tree density data fitted those for Semideciduous Tropical Forests (Table 6). All sites had basal area values varying from 19 to 28 $m^2.ha^{-1}$, which can be considered similar or even higher than those of other secondary forests in the region (CARVALHO et al., 2006; DAN et al., 2010), but lower than values found for mature forests (Table 6). These values are similar to those normally observed in areas in intermediate stages of succession (CONAMA nº 6, on the 4th of May of 1994). The *Mata do Carvão* (CV), despite being the largest fragment studied, has an elongated shape and is crossed by trails used for illegal logging (VILLELA et al., 2006), showing in the logged sector (CV1) the lowest basal area value, probably due to the intense exploitation and the trail effect (EISENLOHR et al., 2009; 2011).

Dead trees had percentages consistent with those of other studies in secondary forests, showing values between 7% and 12% as normal in Brazil (TABANEZ et al., 1997; IVANAUSKAS et al., 2002; SILVA; SOARES, 2002). Peixoto et al. (2005) considered 6% a high value for dead trees. In fact, the percentage of standing dead trees is expected to be about 2% in natural forests (ROLIM et al., 2006; WERNECK et al., 2000; RUSCHEL et al., 2009). The high levels of dead trees in the deforested area of *Mata do Carvão* is possibly related not just to logging, but also to the level of disturbance (fragmentation, fire and edge effects) suffered by the area (VILLELA et al., 2006).

The phytosociological pattern of forest sites in the *São Francisco de Itabapoana* region followed the tendency observed in other disturbed forests in the northern Rio de Janeiro state, i.e., the occurrence of few tree species dominating forest fragments (CARVALHO et al., 2006). The occurrence of *Metrodorea nigra* as a dominant species has been observed in several sites on the northern coast of Rio de Janeiro and in the state of São Paulo. This species showed high importance values in studies made by Martins (1993), Salis et al. (1994), Nascimento et al. (1999), Durigan et al. (2000) and Silva; Soares (2002). According to Martins (1993) and Villela et al. (2006), the selective logging of hardwood trees may be one of the main factors that contributed to the increase of *Metrodorea nigra* in semideciduous forests in southeastern Brazil. However, other factors related to deforestation can alter the abundance of tree species, with common species become commoner while rare species become rarer (TABARELLI et al., 1999).

The occurrence of *Pseudopiptadenia contorta* among the species with higher cover values in our sites was also found in other studies of Semideciduous Tropical Forests where this species had high abundance (PEIXOTO et al., 2005; DAN et al., 2010). Other species among those with higher importance values in this paper (*Trigoniodendron spiritusanctense, Pachystroma longifolium, Astronium graveolens* and *Talisia coriacea*) were also very abundant in other semideciduous forest fragments (DAN et al., 2010; SILVA; SOARES, 2002).

The floristic richness and the occurrence of rare and endangered timber species such as *Aspidosperma ilustre, Grazielodendron rio-docensis, Melanopsidium nigrum, Paratecoma peroba* and *Talisia coriacea* reaffirm the importance and immediate need for conservation of these forest fragments. Comparative studies have documented a large floristic and structural variability (MEIRA-NETO et al., 1997; METZGER et al., 1998; Torres et al., 1997; Salis et al., 1995; Pinto et al., 2008) in Semideciduous Tropical Forests. However, the structure and floristic variations found for these sites can mostly be explained by land use history, especially selective logging.

Urgent actions must be taken to manage and conserve the remnants of the *tabuleiro* forests. Forest corridors should be established connecting fragments especially by use of zoochoric tree species important for the local fauna (MESQUITA; PASSAMANI, 2012) such as *Inga lenticellata* Benth., *Hymenaea aurea* Y.T.Lee & Langenh., *H. courbaril* L., *Trichilia martiana* C.DC., *Eugenia rostrata* O.Berg., *E.umbelliflora* O. Berg, *Marlierea sucrei* G. M. Barroso & Peixoto, *Myrciaria guaquiea* (Kiaersk.) Mattos & D.Legrand, *Psidium rufum* Mart. ex. DC., *P. cattleianum* Sabine, *Ocotea argentea* Mez, *O. silvestris* Vattimo-Gil, *Coccoloba alnifolia* Casar., *C. confusa* R.A.Howard, *Zanthoxylum riedelianum* Engl., *Chrysophyllum gonocarpum* (Mart. & Eichler ex Miq.) Engl., *Pouteria bangii* (Rusby) T.D.Penn., *P. bullata* (S.Moore) Baehni, *P. caimito* (Ruiz & Pav.) Radlk. Forest enrichment techniques should be applied in the studied sites, using species that are missing or presently at a low density as a result of the intensive exploitation in the past (e.g. *Aspidosperma illustre, Grazielodendron rio-docensis, Melanopsidium nigrum, Paratecoma peroba* and *Talisia coriacea*). Nascimento et al. (2010b) indicated 50 important tree species to be used in restorations in this region.

It is worth noting that fragments of Semideciduous Tropical Forests should be considered individually in the adoption of management and conservation plans, considering their particular structural and floristic characteristics (CIELO FILHO; SANTIN, 2002).

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RESUMO: A destruição de habitat levou as florestas estacionais semideciduais de tabuleiro brasileiras a sofrerem intensa fragmentação. No estado do Rio de Janeiro, especialmente na região norte, esses fragmentos estão sob grave ameaça de destruição e os dados sobre a florística, diversidade e estrutura da comunidade ainda são insuficientes. Neste estudo, seis fragmentos secundários de florestas semidecíduas costeiras de baixa altitude, com áreas variando de 13 a 1200 ha foram estudados. O objetivo do presente trabalho foi avaliar a estrutura e a diversidade arbórea nesses locais e relacionar esses dados com o estado de conservação da região. Cinco parcelas de 20 x 20 m, foram alocadas em cada local, totalizando uma área amostral de 1,4ha e todas as árvores com DAP ≥ 5cm foram amostradas. As famílias com maior riqueza de espécies nas áreas foram Fabaceae, Sapotaceae, Myrtaceae e Meliaceae. As espécies mais abundantes nas áreas foram: *Metrodorea nigra*, *Pseudopiptadenia contorta* e *Senefeldera verticillata*. Os valores de riqueza, diversidade de Shannon e eqüitabilidade, variaram de 59 a 89 espécies, 0,75 a 0,87 e 2,59 a 3,79 nats.ind^{-1}, respectivamente. Foi encontrada alta similaridade florística entre as áreas. Os valores de densidade de árvores variou de 1410 a 1840 ind.ha^{-1}, estando dentro do esperado para uma floresta estacional semidecidual, no entanto, os valores de área basal (19,8-28,0 m^2.ha^{-1}) são normalmente observados em florestas perturbadas. Apesar dos fragmentos estudados serem florestas secundárias, os mesmos apresentaram alta diversidade, com ocorrência de espécies de valor conservacionista reconhecido. Medidas urgentes devem ser tomadas para o manejo e conservação dos remanescentes de florestas de tabuleiro, tais como: (1) corredores florestais devem ser definidos conectando fragmentos, especialmente utilizando espécies de árvores zoocóricas e (2) técnicas de enriquecimento florestal, utilizando espécies que estão ausentes ou ocorrem com baixa densidade como resultado da exploração intensiva no passado.

PALAVRAS-CHAVE: Mata Atlântica. Fragmentação. Florística. Fitossociologia. Tabuleiros.

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