Species composition and floristic relationships in southern Goiás forest enclaves

Composição e relações florísticas de encraves florestais no sul de Goiás

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Abstract
Hinterland fragments of Atlantic forests situated in transitional areas are poorly known with respect to the effects of human impacts on their species composition and regeneration. The purpose of this study was to describe and characterize the structure and composition of the tree community of forest remnants located in Itumbiara, Goiás State, Central Brazil, and to analyze their floristic relationship with other areas of seasonal and transitional vegetation ecotones. Five forest fragments were chosen for tree community sampling. The survey was carried out using PCQ (point-centered quarter) method and 25 points were distributed along linear transects totalling 125 sampling units. Four live trees with circumference at breast height (1.30 m) \( > 15 \) cm were recorded at each point. The floristic and phytosociological surveys recorded 149 tree species belonging to 110 genera and 47 families. The analysis of similarity confirmed the ecotonal character with many generalist species and other with occasional occurrence in ‘Cerrado’ (woody savanna) and seasonal forests. The forest remnants in Itumbiara showed a high tree species diversity. In spite of this, the tree community species suggests higher similarity with savanna vegetation.

Key words: Atlantic rainforest, Cerrado, secondary forest, ecotone.

Introduction
The Atlantic Domain comprises various threatened ecosystems with high structural and floristic complexity and acknowledged value (SOS Mata Atlântica & INPE 2008). It covers the mountain ranges of the eastern Brazilian coast and extends far inland (Morellato & Haddad 2000; Oliveira-Filho & Fontes 2000), where it intersects with Caatinga to the North, Cerrado in its central part and Araucaria forests to the South (Oliveira-Filho & Fontes 2000). Remnants are estimated to represent only 7% of its original extension (SOS Mata Atlântica & INPE 2008).

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Deforestation main causes have been lumbering and farming activities, not to mention urban expansion. According to Oliveira-Filho & Fontes (2000), Atlantic forest formations include the ombrophilous and seasonal types, which are associated to high rainfall and temperatures, and to their seasonality, respectively.

Since agricultural borders, energy production, population and road networks are ever expanding, forest fragmentation provoked by human influence is a continuous process that often has irreparable consequences on the environment (Sabbag 2003). Fragments of Atlantic Forest are scattered throughout what used to be its original territory. In Central Brazil, relict formations are found in southern Goiás and in Mato Grosso do Sul (MMA 2000). Penetration occurs through riparian forests, which act as ecological corridors (Ledru et al. 1998; Oliveira-Filho & Ratter 2000). According to Ab’sáber (2003), these relics, surrounded and enclosed in morphoclimatic and phytogeographic Cerrado domain, reflect the impact of the Quaternary climatic and paleoecological changes on the formation and fragmentation of corridors or, on a wider scale, on the expansion and retraction of biomes.

In Goiás, the Atlantic Forest, which covers 4% of the state, includes seasonal deciduous and semi-deciduous forests (SOS Mata Atlântica & INPE 2008), associated with recently exposed valleys and slopes with mineral-rich rocks or soils of medium to high fertility (Oliveira-Filho & Ratter 2000; Imaña-Encinas et al. 2007). The township of Itumbiara, southern Goiás, is characterized as an ecotone between Atlantic Forest and Cerrado physiognomies. Since local plant cover is no exception to the national disturbance history, fragments result from the interaction between urban growth and the use of environmental resources. Atlantic Forest, which used to cover approximately 54% of the township, has now been reduced to 3% of its surface (SOS Atlantic Forest & INPE 2008), mainly owing to the excellent farming potential of its soils of basaltic origin (Oliveira-Filho & Ratter 2000). The region is classified as “insufficiently known, likely to be biologically valuable”, so that surveys are needed in order to establish in situ conservation units to protect biological diversity (MMA 2000).

The present study describes the structure and composition of the community in forest remnants located in Itumbiara, Goiás, and analyzes their floristic relationships with Atlantic and Cerrado formations to characterize the influence of these domains on species composition. It also analyzes forest regeneration in different-aged communities, in this transitional area, to obtain data that help us understand better the dynamics of the vegetation confronted to the current model of land use and occupation, and make decisions to preserve these ecosystems.

Material and Methods

This work was conducted at the Fazenda São Fernando (18°21’S and 49°06’W), in Itumbiara, southern Goiás. Located on the banks of river Paranaíba, its circa 1,470 ha are mostly used to grow sugar cane. The landscape presents forest and Cerrado physiognomies, in addition to areas with huge gullies, where research is developed to recover plant communities. Mean altitude is 448 m and climate is “Aw”, according to Köppen’s classification, with two distinct seasons: dry winters (4 to 5 months) and humid summers (SEPLAN-GO 2005; EPE 2006). Ninety percent of annual rainfall (between 1,200 and 1,800 mm) occur in the wet season, with monthly rates superior to 100 mm (SEPLAN-GO 2005; EPE 2006). Temperatures have monthly means superior to 18°C, and annual amplitude is inferior to 4°C (EPE 2006). According to Oliveira-Filho & Fontes (2000), within the Atlantic domain, forest communities located to the North of 23°20’S, characterized by a dry season superior to 30 days, and at altitudes between 300 and 700 m, are classified as seasonal semi-deciduous submontane forests. The occurrence of various Cerrado physiognomies (Ribeiro & Walter 1998) was also observed in the region, which includes Cerradão, the forest physiognomy of that Domain. The forest fragments located at the Fazenda São Fernando are usually smaller than 5 ha and at different successional stages.

Based on aerial pictures shot in 1968 (Fig. 1a) and 2005 (Fig. 1b), we selected five fragments to sample the tree community (Fig. 1). In fact, in 1968, two fragments (A1 and A2) were already observed and considered in a more advanced stage of natural regeneration since they presented an established tree community. The three other remnants (R1, R2 and R3) comprehended degraded areas covered mainly with herbaceous and shrub sinuiae, which have been regenerating over the last 40 years and currently present a forest physiognomy. Since the establishment of their tree community is more recent, they were categorized as at an earlier stage of regeneration. The point-centered quarter method (Mueller-Dombois & Ellenberg 1974; Brower & Zar 1984; Martins 1991) was used to describe the tree phytocoenosis. In each fragment, a 10 m transect...
with 25 equidistant points was established, totaling 5 transects, 125 points and 500 individuals. At each point, four live tree specimens with a circumference at breast level (CBH) equal or superior to 15 cm were inventoried in 2008. Specimens with multiple stems were only sampled when their quadratic mean CBH met the minimum criteria for inclusion. The total height, estimated with the help of (10 m long) pruning shears, and circumference of each individual were recorded. When possible, species were identified in the field. Voucher material of all individuals was collected either to confirm or determine identifications through bibliographic research or comparisons with specimens kept at the ESAL herbarium of the Federal University of Lavras. The family classification of the Angiosperm Phylogeny Group (APG III 2009) was used. Nomenclature was checked based on the Tropicos database (2010), but synonymies and new combinations follow Oliveira-Filho (2009).

For the phytosociological analyses, we separated the samples into two groups: collected in fragments in more advanced stage of regeneration (A1+A2) and gathered in communities at earlier stages (R1+R2+R3). Both Shannon’s diversity and Pielou’s evenness indexes were obtained. The former were compared both through pairwise t-test (Zar 1999) and diversity curves generated from 500 randomizations of Shannon’s index per fragment. The diversity curves were constructed with the help of EstimateS 8.0 (Colwell 2006). To compare the structural patterns between groups, heights and diameters (at CBH) were distributed into frequency classes and then compared through a partition chi-square test (Ayres et al. 2007) to quantify the influence of the different disturbance histories on tree species stratification. A Kruskal-Wallis test was run (Zar 1999) to observe possible differences among basal area values in the groups.

The occurrence of the species sampled in this study in different phytophysiognomies of the Atlantic and Cerrado domains was determined according to data found in Treeatlan 1.0 (Oliveira-Filho 2009) and Mendonça et al. (1998) and used to construct a Venn diagram to characterize phytogeographical relationships. We also constructed a UPGMA dendrogram based on Sørensen similarity index, involving tree communities from the Cerrado and seasonal forests of center-western (Distrito Federal, Goiás and Mato Grosso do Sul) and eastern (Minas Gerais) Brazil (Tab. 1). Data from a preparatory floristic survey carried out in the Fazenda in 2007 were added to the inventory and PC-ORD 4.0 (McCune & Mefford 1999) was used to construct the dendrogram. An abundance matrix was generated to perform a Detrended Correspondence Analysis (DCA) and verify vegetation gradients between the two groups, due to their distinct preservation history. EstimateS 8.0 also constructed accumulation curves for the specific richness observed (Mao Tau) in the different fragments, after 500 randomizations (Colwell 2006).

**Results**

We recorded 149 tree species pertaining to 110 genera and 47 families (Tab. 2), with a predominance of Fabaceae (31 species), which corresponds to

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**Figure 1**– Images taken from the air in 1968 (a) and 2005 (b) of the forest fragments in São Fernando farm, Itumbiara, Goiás State. A1 and A2 are forest fragments in later successional phases; R1, R2 and R3 are forest fragments in earlier successional phases.
The difference in tree species composition between the fragments in different stages of regeneration became evident in the Detrended Correspondence Analysis (DCA), with high eigenvalues on the first two axes (Braak 1995). Axis 1 (0.879) distinguishes fragments in a more advanced stage of regeneration from those in earlier stage of regeneration (Fig. 3), while axis 2 (0.762) differentiates the composition within the very communities both in advanced and earlier stages (Fig. 3). The biggest differences in structure and composition were observed between fragments A1 and R3, represented at the extremities of axis 1.

With regard to the distribution of the identified species (Fig. 4), 64.2% are common both to the
Table 1 – Tree community surveys used for similarity analysis. CAP or DAP, circumference or diameter at breast height (1.30 m); CA30 or DA30, circumference and diameter at 0.30 m above ground; M, methods; Q, point-centered quarter; P, plots; H’, Shannon diversity index; J’, Pielou evenness index; NI, number of individuals per hectare; FED or FES, semideciduous and deciduous forest, respectively; Ce, Cerrado; GO and MG, Goiás and Minas Gerais States, respectively; DF, Distrito Federal.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Locality</th>
<th>Geographical coordinates</th>
<th>Climate</th>
<th>Admission criteria (cm)</th>
<th>M</th>
<th>H’</th>
<th>J’</th>
<th>NI</th>
<th>Nº of species (% rare)</th>
<th>Typology</th>
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<tbody>
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<td>Presente trabalho</td>
<td>Itumbiara, GO</td>
<td>18°21’S 49°06’W</td>
<td>Aw</td>
<td>CAP&gt;15</td>
<td>Q</td>
<td>3.3 to 3.7</td>
<td>0.8 to 0.9</td>
<td>972</td>
<td>148 (32.7)</td>
<td>FLO-GO 1</td>
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<tr>
<td>Balduino et al. 2005</td>
<td>Paraopeba, MG</td>
<td>19°20’S 44°20’W</td>
<td>Cwb</td>
<td>CA30&gt;15.7</td>
<td>P</td>
<td>3.6</td>
<td>0.8</td>
<td>1990</td>
<td>75 (14.7)</td>
<td>CE-MG 1</td>
</tr>
<tr>
<td>Costa &amp; Araújo 2001</td>
<td>Uberlândia, MG</td>
<td>19°10’S 48°23’W</td>
<td>Aw</td>
<td>CAP&gt;15</td>
<td>P</td>
<td>3.8</td>
<td>0.8</td>
<td>1867</td>
<td>107 (11.2)</td>
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</tr>
<tr>
<td>Espírito-Santo et al. 2002</td>
<td>Lavras, MG</td>
<td>21°13’S 44°57’W</td>
<td>Cwb</td>
<td>DAP&gt;5</td>
<td>P</td>
<td>4.2</td>
<td>0.8</td>
<td>1411 to 1700</td>
<td>238 (23.0)</td>
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<td>15°52’S 47°50’W</td>
<td>Aw a Cwa</td>
<td>DA30&gt;5</td>
<td>P</td>
<td>3.2 to 3.4</td>
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<td>1219</td>
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<td>P</td>
<td>-</td>
<td>-</td>
<td>1097</td>
<td>124 (17.5)</td>
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<td>P</td>
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<td>0.9</td>
<td>1855</td>
<td>83 (18.1)</td>
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<td>DAP&gt;5</td>
<td>P</td>
<td>-</td>
<td>-</td>
<td>663</td>
<td>52 (28.8)</td>
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<td>CAP&gt;9</td>
<td>Q</td>
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<td>0.8 to 0.9</td>
<td>1020 to 3240</td>
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<td>São Domingos, GO</td>
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<td>DAP&gt;5</td>
<td>P</td>
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<td>924</td>
<td>48 (22.9)</td>
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<td>CAP&gt;15</td>
<td>P</td>
<td>3.3 to 3.7</td>
<td>0.7 to 0.8</td>
<td>1472.5</td>
<td>110 (8.18)</td>
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</tr>
<tr>
<td>Souza et al. 2007</td>
<td>Uberlândia, MG</td>
<td>18°48’S 48°10’W</td>
<td>Aw</td>
<td>CAP&gt;15</td>
<td>P</td>
<td>2.6 to 2.8</td>
<td>0.7</td>
<td>1279</td>
<td>59 (20.33)</td>
<td>FED-MG</td>
</tr>
<tr>
<td>Sposito &amp; Stehmann 2006</td>
<td>Belo Horizonte, MG</td>
<td>20°05’S 43°46’W</td>
<td>Cwb</td>
<td>CAP&gt;15</td>
<td>Q</td>
<td>3.0 to 4.0</td>
<td>0.8 to 1.0</td>
<td>1724 to 4058</td>
<td>221 (36.19)</td>
<td>FES-MG 2</td>
</tr>
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</table>
(ombrophilous and/or seasonal) forest and savanna physiognomies. The species that only occur in the Atlantic Domain accounted for 33.5% of the total. Nonetheless, the floristic relationships between the tree community of the Fazenda São Fernando and other formations point out a greater similarity to Cerrado vegetation (Fig. 5).

Analyzing the frequency distribution of individuals in height ($X^2_{0.05, 5} = 30.63; p < 0.0001$) and diameter ($X^2_{0.05, 5} = 24.72; p = 0.01$) classes showed significant differences between fragments. A reduction of higher specimens was observed in the fragments at earlier stages of regeneration, especially of individuals higher than 12 m (Fig. 6a) and over 25 cm in diameter (Fig. 6b). On the whole, individuals are between 4.1 m and 8 m high and correspond to 48% in the earlier fragments and 54.6% in the more advanced ones. The distribution of individuals in diameter classes (Fig. 6b) showed a higher abundance of sampled trees in the smaller size classes and a gradual decrease as we move toward bigger classes. A difference ($H_{0.05, 1} = 7.02; p = 0.008$) between basal area values was also observed: they were higher in the more mature fragments, 23.71 m²·ha⁻¹, than in the ones at an earlier stage of regeneration, 11.11 m²·ha⁻¹.

Discussion

This survey recorded generalist species with a wide geographical distribution that colonize from Atlantic rainforest to hinterland savanna communities, as is the case of *Amaioua guianensis* Aubl., *Apuleia leiocarpa* (Vogel) J.F. Macbr., *Casearia sylvestris* Sw. and *Cecropia pachystachya* Trécul (Oliveira-Filho & Fontes 2000; Oliveira-Filho 2009). On the other hand, *Byrsonima crassa* Nied., *Ferdinandusa ovalis* Pohl, *Mouriri elliptica* Mart., *Sorocea sprucei* (Baill.) J.F. Macbr., *Tachigali vulgaris* L.G. Silva & H.C. Lima – predominantly distributed in Central Brazil – and *Erythroxylum tortuosum* Mart., *Salacia crassifolia* (Mart.) G.Don and *Zeyheria montana* Mart., characteristic of Cerrado (Mendonça et al. 1998; Oliveira-Filho 2009), were also reported. According to Mendonça et al. (1998), the distribution of *F. ovalis* and *S. sprucei* in the Cerrado Domain is limited to riparian forests, while *B. crassa*, *M. elliptica* and *T. vulgaris* are more directly associated with lower savanna formations. On the other hand, among the species predominantly distributed in the Atlantic Domain “sensu latissimo” (Oliveira-Filho 2006), we reported *Machaerium stipitatum* (DC.) Vogel, *Nectandra lanceolata* Nees, *Bauhinia ungulata* L., *Manihot*

![Figure 3](image3.png)

**Figure 3** – Detrended correspondence analysis (DCA) of 125 sample points used to survey the forest fragments at São Fernando farm, Itumbiara, GO. A1 and A2 are forest fragments in later successional phases; R1, R2 and R3 are forest fragments in earlier successional phases.

![Figure 4](image4.png)

**Figure 4** – Venn diagram produced for the tree species surveyed in forest fragments of the São Fernando farm, Itumbiara, Goiás State, floristic and phytosociological stands showing number of species shared by rain, semideciduous and deciduous forests and Cerrado (woody savanna) vegetation. N, total number of species.
Table 2 – Families and species recorded in floristic and phytossociological surveys carried out in forest fragments with different disturbance histories in Itumbiara, Goiás State. N, number of individuals; AB, basal area in m²; NP, number of point-quarter species occurrence; VI, Importance Value; ***Species surveyed only in floristic surveys.

<table>
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<tr>
<th>FAMILIES/SPECIES</th>
<th>Floristic communities</th>
<th>Initial stage</th>
<th>Advanced stage</th>
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<td></td>
<td>N</td>
<td>AB</td>
<td>NP</td>
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<td>Anacardiaceae</td>
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<td></td>
</tr>
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<td>Astronium fraxinifolium Schott. ex Spreng.***</td>
<td>26</td>
<td>0.421</td>
<td>26</td>
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<td>Myracrodruon urundeuva Allemão</td>
<td>17</td>
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<td>17</td>
</tr>
<tr>
<td>Tapirira guianensis Aubl.</td>
<td>18</td>
<td>2.95</td>
<td>18</td>
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<tr>
<td>Cardiopetalum calophyllum Schltld.***</td>
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<td>Guatteria aff. pogonopet Mart.***</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>Xylopia aromaticia (Lam.) Mart.</td>
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<td>3.67</td>
<td>43</td>
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<td>Xylopia sericeta A.St.-Hil.***</td>
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<td>-</td>
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<td>Apocynaceae</td>
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<td>Aspidosperma cf. cuspa (Kunth) S.F.Blake ex Pittier***</td>
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<td>Schefflera morototoni (Aubl.) Maguire et al.***</td>
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<td>-</td>
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<td>Arecales</td>
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<td>Mauritia flexuosa L.f.***</td>
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<td>Zeyheria montana Mart.***</td>
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anomala Pohl and Trichilia hirta L., and B. unguulata, M. anomala and T. hirta, which are related to seasonal forests (Oliveira-Filho 2009). Other species found in ecotonal areas as Dipterix alata Vogel, Emmotum nitens (Benth.) Miers, Hirtella glandulosa Spreng., Magonia pubescens A. St.-Hil. and Myracrodruon urundeuva Allemão reaffirm the transition between Atlantic Forest and Cerrado Domain (Oliveira-Filho & Ratter 2002). Few recorded species are exclusive to semi-deciduous formations, as Ixora brevifolia Benth. and Styx pohlii A. DC. (Oliveira-Filho 2009). Among the species associated with the semi-deciduous forests of western Brazil (Oliveira-Filho & Fontes 2000) are Acosmium dasycarpum (Vogel) Yakovlev, Albizia niopoides (Spruce ex Benth.) Burkart, Apeiba tibourbou Aubl., Astronium fraxinifolium Schott. ex Spreng., Callisthene major Mart., Cordiera concolor (Cham.) kuntze, Diospyros hispida A.DC., Eugenia panicifolia (Kunth) DC., Machaerium acutifolium Vogel, Myrcia tomentosa (Aubl.) DC., Platypodium elegans Vogel, Siparuna guianensis Aubl., Siphoneugena cf. densiflora O.Berg, Terminalia argentea (Cambess.) Mart., Virola sebifera Aubl., Xylopia aromatica (Lam.) Mart. and Zanthoxylum rhoifolium Lam.

The high values of specific richness and diversity reported for the tree phytocoenosis of the Fazenda São Fernando were compatible with those obtained in semi-deciduous forests in the Atlantic Domain (Meira-Neto & Martins 2002) and are also characteristic of southern Goiás woodlands, which are considered as ecotonal areas (Oliveira-Filho & Ratter 2002). Central Brazil forests constitute an important link between northeastern, southeastern and Pantanal seasonal formations and pre-Amazonian vegetation (Oliveira-Filho & Ratter 2000; Felfili 2003; Haidar et al. 2005) and, naturally, their composition is influenced by these zones (Leitão Filho 1987). According to surveys carried out by Haidar et al.
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(2005) and Imaña-Encinas et al. (2007) in Goiás semi-deciduous forests, the most representative species in the community structures were *Acacia polyphylla* DC., *Amatoua guianensis* Aubl., *Anadenanthera colubrina* (Vell.) Brenan, *Callisthene major* Mart., *Dilodendron bipinnatum* Radlk., *Guazuma ulmifolia* Lam., *Myracrodruon urundeuva* Allemão, *Protium heptaphyllum* (Aubl.) Marchand, *Qualea multiflora* Mart., and *Tapirira guianensis* Aubl., which were also recorded in the present study. Nonetheless, the similarity of the tree community inventoried in Itumbiara to savanna formations reveals the remarkable influence of the *Cerrado* Domain, highlighted by the increased importance of genera associated with it, as *Byrronima* and *Qualea* (Ledru 1993; Mendonça et al. 1998; Oliveira-Filho & Ratter 2002; Ratter et al. 2003; Carvalho & Marques-Alves 2008). Thus, the records of species characteristic of Goiás semi-deciduous forests and of species distributed in the Atlantic Domain as well as the floristic relationships to *Cerrado* manifest that this area is an ecotone between seasonal and *Cerradão* types. Delimiting the extension of *Cerradão* communities (*Cerrado* Domain) and of seasonal forests (Atlantic Forest) in transition areas is complex (Ribeiro et al. 1983). *Cerradão* can act as a distribution limit for tree species of the Atlantic Domain (Costa & Araújo 2001) and share a high number of species with the latter (Rizzini 1979).

Differences among the compositions of plant communities can derive from habitat heterogeneity, climatic and edaphic conditions and modifications, inter-specific interactions, and disturbance histories (Whittaker 1972; Ledru 1993; Oliveira-Filho et al. 2001; Tabarelli et al. 2004; Sposito & Stehmann 2006). Since they modify the demographic rates, the geographical distribution of plant populations and impact the extension of the biome zones (Ledru 1993; Ledru et al. 1996; Ledru et al. 1998; Hill & Curran 2003; Tabarelli et al. 2004; Durigan & Ratter 2006; Malhi et al. 2008; Lenoir et al. 2008; Ledru et al. 2009; Mantgem et al. 2009), such factors interfere in the vegetation resilience and generate floristic dissimilarities. According to Oliveira-Filho & Ratter (2002), the forest physiognomies of Central Brazil can be distinguished according to the availability of water in the soil and fertility of the latter. Then, except for the variable climate (the proximity between fragments leads us to presuppose they are submitted to similar climatic conditions), the other factors potentially affect the floristic composition of the fragments at the Fazenda São Fernando. There was a clear distinction between species whose high importance values stood out, as *Xylopia aromatica* and *Nectandra lanceolata*, which demonstrated a lower recruitment capacity in forests in more advanced and earlier successional stages, respectively. Floristic separations also occurred between fragments of similar ages, albeit on a minor scale. Again, the composition peculiarities between fragments can reflect soil modifications (Oliveira-Filho & Ratter 2002) or correspond to distinct successional stages (Durigan & Ratter 2006). Also, the differences between fragments of the Fazenda São Fernando can be explained by past disturbances, since those in earlier stages of regeneration were exposed to human activity for a longer period of time. Such disturbances affect both water sources and the availability of propagules to restore vegetation (Castellani & Stubblebine 1993; Roberts & Gillian 1995; Frelich et al. 1998).

The tree density obtained for the community inventoried in Itumbiara is inferior to that found in savanna formations and other semi-deciduous forests, and is closer to that of Goiás deciduous forests (Tab. 1). Lower densities can be attributed to the presence of clearings (caused by the fall of trees or parts of them) and/or to the penetration of *Cerrado* physiognomies, characterized by fewer and lower tree specimens, into the forest. In such circumstances, the lesser presence of trees entails an increase in the mean value of the point-plant distance and, consequently, in the mean area, which, in turn, implies a lower estimate of absolute density. In the fragments in more advanced stages of regeneration, we mainly observed clearings, while in those at earlier stages of regeneration we found intersections with lower savanna types. In the communities regenerated

![Figure 5](image-url)
Figure 6 – Frequency distribution into height (A) and diameter (B) classes of the tree specimens surveyed in São Fernando farm forest fragments, Itumbiara, Goiás State. A1+A2, forest fragments in later successional phases; R1+R2+R3, forest fragments in earlier successional phases.

over the last 40 years, basal area and structural complexity were lower. According to Rosa & Schiavini (2006), the tree stratum of Central Brazil mesophytic forests comprises individuals between 15 and 25 m high. Yet, mainly in the fragments in earlier stages of regeneration, we checked the absence of specimens higher than 12 m, which made these communities similar to Cerradão or Campo Cerrado phytophysognomies, depending on the fragments (according to Silva & Bates 2002; Durigan & Ratter 2006). In this survey, biomass loss and stratum reductions in the canopy are probably due to the fact that sampling included Cerrado patches composed of lower specimens. It is worth highlighting that in the more mature fragments, where intersections with lower savanna communities were less frequent, the basal area value (23.71 m².ha⁻¹) was superior to that obtained by Haidar et al. (2005) (19.9 m².ha⁻¹) and Imaña-Encinas et al. (2007) (20.08 m².ha⁻¹) in Goiás semi-deciduous forests.

Thus, the greater representativeness of savanna phytophysognomies in the fragments at an earlier stage of regeneration also gave rise to the differences and to species diversity, increasing the values of the latter to numbers closer to those proposed by Sposito & Stehmann (2006). Another source of biological variability can be the conjugation of the permanence of species related to the beginning of succession and of the recruitment of species from more advanced stages, in a facilitation model (Connell & Slatyer 1977), thus weakening possible dominance relationships among species. The occasional occurrence of disturbances can generate and/or maintain plant community diversity (Connell 1978) and prevent competitive exclusion. However, the increase in frequency and intensity of these disturbances impoverishes the community composition and structure.

During the Quaternary climatic fluctuations, oscillations in the territorial extension of biomes (Ledru 1993; Ledru et al. 1996; Ledru et al. 1998; Oliveira-Filho & Ratter 2000; Ab’sáber 2003; Joly 2007; Ledru et al. 2009;) provoked speciations and promoted geographical dissimilarities (Joly 2007; Ledru et al. 2009). Cerrado expanded over mesophytic forests, which were unable to re-expand their zone, a failure that can be attributed to human actions (Oliveira-Filho & Ratter 2000). The succession process encompasses a recovery of species richness and diversity, guild recomposition, flora restoration and, finally, a vegetation restructuring (Brown & Lugo 1990; Tabarelli & Mantovani 1999; Oliveira-Filho et al. 2004). The Fazenda São Fernando in southern Goiás represents an ecotonal area between the Atlantic and Cerrado domains. Its vegetation was degraded and is currently undergoing a natural regeneration process. Characterizing the local vegetation and following its transformations can provide information allowing to understand the phytogeographical relationships. Although we found species richness and diversity values compatible with other semi-deciduous formations, the composition of the inventoried remnants showed floristic relationships closer to savanna tree communities. In Itumbiara, it was estimated that the Atlantic forest covered more than 50% of the township (SOS Mata Atlântica & INPE 2008) and it may have been predominant in the study area. Thus, two hypotheses can be formulated: the past vegetation was mainly constituted by species...
of the Atlantic Forest, but environmental degradation drastically reduced their populations, and natural regeneration encompassed the recruitment of species from adjacent savanna physiognomies, in which case the balance between forest physiognomies and types would result from the interaction between disturbance frequency and intensity (Durigan & Ratter 2006); or, the floristic relationships with Cerrado used to be and still are narrower, so that phytosociological distinction depends mainly on edaphic attributes (Oliveira-Filho & Ratter 2002) and the disturbance history affects the similarity between local communities because it impacts the succession process. Further clarification with regard to these hypotheses can come out of edaphic, paleoecological and palynological surveys or even of a monitoring of the forest community development over time (Durigan & Ratter 2006). This scenario demonstrates how difficult it is to delimit zones or vegetation types. Nevertheless, the forest community inventoried in Itumbiara, Goiás, presented high species richness and it is located in a transitional area between two hotspots characterized by the urgency of surveys and palynological surveys or even of a monitoring of the forest community development over time (Durigan & Ratter 2006). This scenario demonstrates how difficult it is to delimit zones or vegetation types. Nevertheless, the forest community inventoried in Itumbiara, Goiás, presented high species richness and it is located in a transitional area between two hotspots characterized by the urgency of surveys describing their biological diversity and allowing to implement conservationist activities.

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