



# Floristic and structural comparisons between woody communities of two seasonal forest fragments in the Tocantins river basin and other remnants of this forest physiognomy in Brazil

*Comparações florísticas e estruturais entre comunidades arbóreas de dois fragmentos de florestas estacionais na bacia do rio Tocantins e outros remanescentes desta fisionomia florestal no Brasil*

Marcelo Brilhante de Medeiros<sup>1,3</sup>, Bruno Machado Teles Walter<sup>1</sup> & Washington Luis Oliveira<sup>2</sup>

## Abstract

This work describes the woody layer composition and structure in two seasonal forest fragments in the Tocantins river basin and compares them to other remnants of this forest physiognomy in Brazil. The survey was carried out by using 17 plot samples (20 × 50 m) located in Palmeirópolis, state of Tocantins, and in Minaçu, state of Goiás. All woody individuals showing diameters ≥ 5 cm, at 1.30 cm above ground level, were recorded. The higher floristic similarity of these forest remnants compared with other closer seasonal forests did not show a distinct pattern. The floristic composition was more similar to that of a deciduous seasonal forest in the Paranã valley, and more dissimilar to other forests in this same valley. This result and a higher dissimilarity related to the southern forests in Goiás suggest that the forest fragments showed a floristic composition and structure typical of lowland seasonal forests in the Tocantins river basin. The results also indicated that the forest fragments have distinct floristic compositions with a relatively similar structure and diversity.

**Key words:** dry seasonal forests, diversity, composition.

## Resumo

A composição e a estrutura do componente arbóreo foram caracterizadas em dois fragmentos de floresta estacional na bacia do médio rio Tocantins e comparadas com outros remanescentes dessa fitofisionomia em outras regiões do Brasil. Os indivíduos foram amostrados em 17 parcelas de 20 × 50 m, nos municípios de Palmeirópolis (TO) e Minaçu (GO). Em cada parcela foram mensurados todos os indivíduos lenhosos que apresentaram diâmetro igual ou superior a 5 cm, medido a 1,30 m do solo (DAP ≥ 5 cm). A maior similaridade florística desses dois remanescentes com outras florestas estacionais mais próximas não apresentou um padrão claro. A composição florística nos fragmentos estudados foi mais similar a uma floresta estacional decidual no vale do Paranã, embora muito dissimilar em relação à outra floresta decidual nesse mesmo vale. Esse resultado e a maior dissimilaridade em relação às florestas do sul de Goiás sugerem que as atuais florestas apresentaram composição e estrutura características de florestas estacionais de baixa altitude da bacia do médio/alto rio Tocantins. Os resultados também indicam que cada fragmento investigado apresenta uma flora própria, com estrutura e diversidade relativamente similares.

**Palavras-chave:** mata seca, diversidade, composição.

## Introduction

From 2000 to 2010 tropical deforestation due to agricultural development showed signs of falling in a number of tropical countries, although the scale of this activity continues to cause concern (CDB 2010). During this time about 130,000 km<sup>2</sup> of forests

were converted into other land uses each year and the data from the past decade showed deforestation rates of 160,000 km<sup>2</sup>.year<sup>-1</sup> (CDB 2010).

Seasonal forests, also known as dry forests, deciduous or semi-deciduous forests, are often considered the most endangered types of tropical

<sup>1</sup> Embrapa Recursos Genéticos e Biotecnologia, Parque Estação Biológica, Av. W5 Norte (Final) s/n°, Brasília, DF, 70770-917, Brazil.

<sup>2</sup> Universidade de Brasília, Depto. Ecologia, Curso de Pós-graduação em Ecologia, Campus Universitário Darcy Ribeiro, Brasília, DF, 70910-900, Brazil.

<sup>3</sup> Author for correspondence: [marcelo.brilhante@embrapa.br](mailto:marcelo.brilhante@embrapa.br)

forests because of the widespread fragmentation and area reduction caused by agriculture, logging of selected woods and mining (Janzen 1997; Scariot & Sevilha 2005; Espirito-Santo *et al.* 2009). It is common for seasonal forest to undergo disturbances such as fire and invasive species (Janzen 1997). In addition to these impacts, conservation efforts in recent decades have been directed toward tropical rain forests, and less attention has been paid to dry forests (Vieira & Scariot 2006a). This type of vegetation had estimated annual deforestation rates between 1981 and 1990 of 0.94%.year<sup>-1</sup>, or 61 million hectares.year<sup>-1</sup>. On the other hand, tropical rain forests showed lower deforestation rates of 0.64%.year<sup>-1</sup> or 46 million hectares.year<sup>-1</sup> (Whitmore 1997).

Knowledge about the floristic distribution patterns of seasonal forests could provide valuable information for conservation actions (Scariot & Sevilha 2000). The highest values of similarity of seasonal forests have been associated with the influence of nearby vegetation formations in northeastern and central Brazil (Garcia *et al.* 2011; Santos *et al.* 2012). However, there is a lack of studies comprising the seasonal forests in some regions of central Brazil such as the “mato grosso goiano” in northeastern Goiás and southern Tocantins.

The valley of the middle Tocantins river, located between the municipalities of Palmeirópolis, in the state of Tocantins (TO), and Minaçú, in Goiás (GO), has few and small seasonal forest remnants in an extensive agricultural landscape planted with exotic grasses for grazing. This region in central Brazil comprises the northeastern edge of the former forest swathe called the “mato grosso goiano”, which originally covered large areas of the state of Goiás, from the south, through the valley of the Paranaíba river and stretching north to the valley of the Paranã river and some areas of the middle Tocantins (Faissol 1953; Veloso 1963). This forest was converted into an intensive agriculture landscape throughout the 20<sup>th</sup> century in a south-north direction, and nowadays these forest remnants are just disconnected fragments.

The aim of this study was to characterize the floristic composition and horizontal structure of the woody layer of two forest fragments in the region of the former “mato grosso goiano”, in the middle Tocantins river basin, and to compare them to other remnants of this forest physiognomy in Brazil. The study also aims to evaluate the influence of

nearby seasonal forests on the floristic distribution and structural patterns of these fragments in this region in order to provide information about the community ecology of these highly endangered seasonal forests.

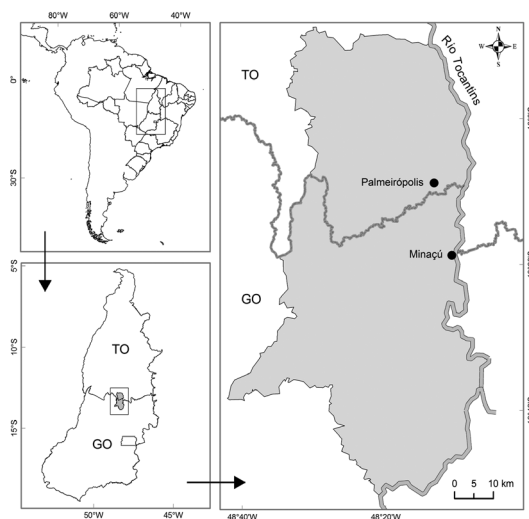
## Material and Methods

### Study area

The two semi-deciduous seasonal forest fragments were sampled in the municipalities of Palmeirópolis-TO (13°08'47''S and 48°13'13''W) and Minaçú-GO (13°18'44''S and 48°10'45''W) (Figure 1). These forest fragments are inside a large belt of intensive agriculture with exotic grasses and some native remnants with savanna vegetation.

The climate in this region is classified as Aw in accordance with Köppen, which means wet tropical with two well marked climatic seasons (dry winters and wet summers). The mean annual rainfall is from 1,400 to 1,800 mm and the mean annual temperature is from 23 to 25°C (Silva *et al.* 2008). The altitude of the fragments is between 300 and 370 m and the relief is from flat to smooth slopes located in the Tocantins valley, Tocantins middle river basin (BRASIL 1981). In Palmeirópolis, the plots were located on a flat site and in Minaçú the plots lay on a smooth slope.

The forest fragments are classified as sub-mountainous semi-deciduous seasonal forest in accordance with IBGE vegetation classification (IBGE 2012). In accordance with Ribeiro &



**Figure 1** – Study area in the municipalities of the states of Goiás (GO) and Tocantins (TO), Brazil.

Walter (2008) these forests would be classified as semi-deciduous dry forests. The forests are not associated with bodies of water, and in the Cerrado biome three subtypes can be found (evergreen, semi-deciduous and deciduous), which are different because of the amount of foliage that persists in the dry season, the floristic composition and the soil type (Ribeiro & Walter 2008).

The most common soil type in both fragments is argisols, in addition to some sites with lithosols and red latosols (SEPLAN 2008; SIEG 2010). Soils such as the argisols of the Tocantins river basin are related to high levels of Ca and Mg in areas of seasonal forests (Scariot & Sevilha 2005).

The study areas were fragmented, with common evidence of human disturbances typical of this region. These human disturbances comprise agriculture, grazing, fire and logging, and the sites showed an abundance of lianas, bamboo invasion (*Guadua paniculata* Munro frequent) and exotic trees such as *Citrus*.

### Vegetation survey

The vegetation was surveyed during the wet season in November 2009. Seventeen permanent plots (20 × 50 m) were randomly allocated, 10 plots were set up in Palmeirópolis and seven plots in Minaçu because of the smaller area in the latter site.

In each plot all the woody and palm individuals were sampled if their diameter was at least 5 cm at 1.30 cm from soil height ( $dbh \geq 5\text{cm}$ ), measured using a caliper, and their height was estimated by visual perception. Woody lianas were not included in this sampling and were considered only for analysis as a disturbance indicator, as explained below. The species identification was performed in the field surveys and in herbarium. The floristic survey follows the Angiosperm Phylogeny Group III (2009). Vouchers were incorporated into the Embrapa Recursos Genéticos e Biotecnologia herbarium (CEN herbarium).

A dissimilarity qualitative analysis was carried out by using the UPGMA (unweighted pair grouping method using arithmetic averages) linkage method and by Sørensen index (Legendre & Legendre 2012) regarding the selected fragments and literature data of seasonal forests in Goiás (Silva & Scariot 2003; Haidar *et al.* 2005; Nascimento *et al.* 2004; Imaña-Encinas *et al.* 2007; Garcia *et al.* 2011). The phytosociological parameters of horizontal structure (density, frequency, dominance and value of importance) were calculated for the

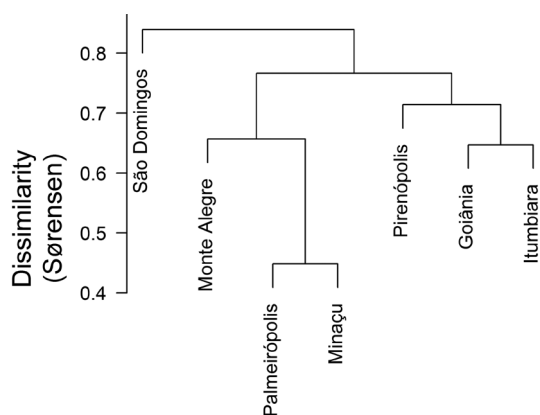
woody communities in each fragment by using the Mata Nativa 2 software (CIENEC 2004). The floristic diversity was calculated by using the Shannon index ( $H'$ ) with  $\log n$  and the evenness was calculated by the Pielou ( $J'$ ) index (Magurran & McGill 2011). Rarefaction (sample based) was used to compare the richness between the fragments in accordance with Gotelli & Colwell (2001). Three richness estimators (Chao 1, Jackknife 1 and 2 and Bootstrap) were used to evaluate the number of non-sampled species in addition to the sampled richness in each fragment (Palmer 1990). The analyses were performed by using the statistical environment R (R Development Core Team 2011), with functions available from Vegan package (Oksanen *et al.* 2011).

In order to characterize the liana tangles, a variable used as human disturbance indicator (Oliveira-Filho *et al.* 1997), eight sub-samples of 25 m<sup>2</sup> were taken from an area of 20 × 10 m allocated randomly to each plot. Each liana tangle represented a set of at least four lianas in each sub-sample, even if the roots were inside or outside the sub-sample. A diameter at breast height (DBH)  $\geq 3$  cm was established to record the trunks, excluding ferns, Araceae and small vines (Oliveira-Filho *et al.* 1997).

## Results

### Similarity

The UPGMA dendrogram (Fig. 2) showed that the fragments in Palmeirópolis and Minaçu have a floristic composition that is more similar



**Figure 2** – Dissimilarity dendrogram by using Sørensen index for the woody communities in Palmeirópolis (TO), Minaçu (GO), Goiânia (GO), São Domingos (GO), Monte Alegre (GO), Itaituba (GO) and Pirenópolis (GO).

to the deciduous seasonal forest of Monte Alegre de Goiás, located in the valley of the Paranã River, in comparison to the other areas. The data from the deciduous forest in the municipality of São Domingos, located in the same valley, showed higher dissimilarity values than those in the current study. In comparison to some seasonal semi-deciduous forests in central-southern Goiás, the dissimilarity also showed high values, above 70% in comparison to this study. In fact, Palmeirópolis and Minaçu made a strong cluster in spite of the higher dissimilarity in relation to other studies with seasonal forests in Goiás, including areas of the same semi-deciduous sub-type.

### Species richness and diversity

The data on species richness, Shannon diversity index, Pielou evenness, density, volume, basal area, dead individuals and liana density are described in Table 1. Some parameters commonly used in the phytosociology of other seasonal forests are described in Table 2.

In Palmeirópolis, 31 families, 63 genus and 68 species were sampled (Tab. 3). The ten species with the highest values of importance (*Anadenanthera colubrina*, *Eugenia dysenterica*, *Aspidosperma subincanum*, *Dilodendron bipinnatum*, *Aspidosperma pyrifolium*, *Myracrodruon urundeuva*, *Hymenaea courbaril*, *Bauhinia rufa*, *Handroanthus impetiginosus* and *Swartzia acutifolia*) comprised 57.8% of the total importance and 70.9% of the dominance. In the total of the 837 sampled individuals, 88 (10.5%) were dead but upright.

In the Minaçu fragment, 23 families, 45 genus and 49 species were sampled (Tab. 4). The ten species with the highest values of importance (*Pseudobombax tomentosum*, *Dilodendron bipinnatum*, *Tabebuia roseoalba*, *Anadenanthera colubrina*, *Luehea paniculata*, *Magonia pubescens*, *Callisthene fasciculata*, *Guettarda viburnoides*, *Myracrodruon urundeuva* and *Aspidosperma subincanum*) comprised 55% of the total value of importance and 70.1% of the value of dominance. Out of the total of 539 sampled individuals in 0.7 ha, 57 (10.57%) were dead individuals, but standing. In considering the density per hectare this percentage persists unaltered (10.58%).

### Discussion

The low similarity between areas has been a common pattern in seasonal forests (Pennington

*et al.* 2006), and the results of the dissimilarity analyses indicated distinct composition in relation to the deciduous and semi-deciduous seasonal forests from Goiás. The closer similarity between the semi-deciduous forests of Palmeirópolis and Minaçu in relation to the deciduous seasonal forest of Monte Alegre de Goiás sampled by Nascimento *et al.* (2004) could suggest the influence of nearby vegetation formations. This was a suggestion made by Garcia *et al.* (2011) and Santos *et al.* (2012), without considering the remnants of seasonal forests of the “mato grosso goiano”, as performed in this study. However, in the same valley of the Paranã river, the deciduous forest of São Domingos municipality (Silva & Scariot 2003) showed the most dissimilar fragment in comparison to the current study, which left this analysis inconclusive. Also in a similar position, the semi-deciduous forests from Central and South Goiás (Haidar *et al.* 2005; Imaña-Encinas *et al.* 2007; Garcia *et al.* 2011) were dissimilar to this study. These forests belong to the same sub-type of vegetation as the fragments in this study, increasing the lack of precision regarding any patterns that might emerge. Hence, neither the geographic distances nor the same sub-type of vegetation were enough to explain the patterns of floristic similarity.

The biogeographic patterns of the seasonal forests have suggested a woody flora highly limited by dispersion in remnants of northeastern and central Brazil (Santos *et al.* 2012). The species observed in the current study, like the floristic studies carried

**Table 1** – Patterns of woody communities of seasonal forest fragments in Palmeirópolis (TO) and Minaçu (GO), located in the middle Tocantins river basin. (\*) Richness rarefaction values; (\*\*) Richness estimators: Chao 1; Jackknife (1<sup>a</sup> order); Jackknife (2<sup>a</sup> order); Bootstrap.

| Parameter                                      | Palmeirópolis | Minaçu    |
|--|---------------|-----------|
|  | TO            | GO        |
| Richness of the woody layer                    | 68 (60)*      | 49 (49)*  |
| Richness estimators**                          | 111; 97;      | 61; 63;   |
|  | 113; 81       | 68; 55    |
| Diversity (H')                                 | 3.15          | 3.28      |
| Evenness (J')                                  | 0.75          | 0.84      |
| Density (n.ha <sup>-1</sup> )                  | 749           | 688       |
| Basal area (m <sup>2</sup> .ha <sup>-1</sup> ) | 16.5          | 11.9      |
| Volume (m <sup>3</sup> .ha <sup>-1</sup> )     | 179.37        | 95.6      |
| Dead standing individuals /                    |               |           |
| VI (%)   | 88 / 9.11     | 57 / 7.23 |
| Liana tangle frequency                         | 80%           | 28.5%     |

**Table 2** – Phytosociology of seasonal forests of Brazil. H' = Shannon index; J' = Pielou evenness; BA = basal area (m<sup>2</sup>/ha); D = density (trees/ha); UF = federation unit; D = minimum diameter for sampling (in cm); DAP = diameter at breast height level; DAS = diameter at soil height level; Area = sample area (ha); p.q. = number of points. \* more than one area of study \*\* study with two temporal scales.

| Reference                       | Richness        | H'        | J'        | BA          | D                       | UF | Physiognomy (Forest)       | D          | Area | Method     |
|---------------------------------|-----------------|-----------|-----------|-------------|-------------------------|----|----------------------------|------------|------|------------|
| Carvalho <i>et al.</i> (2007)   | 174             | 4.41      | 0.85      | 42.27       | 1481                    | MG | Seasonal semi-deciduous    | DAP ≥ 5.0  | 1.2  | plots      |
| Lopes <i>et al.</i> (2002)      | 143             | 3.98      | 0.80      | 26.94       | 1569                    | MG | Pristine Forest            | DAP ≥ 4.8  | 0.5  | p.q. (200) |
| Botrel <i>et al.</i> (2002)     | 140             | 3.73      | 0.76      | 29.31       | 2683                    | MG | Seasonal semi-deciduous    | DAP ≥ 5.0  | 1.0  | plots      |
| Silva <i>et al.</i> (2004)      | 124             | 3.56      | -         | 28.70       | 2786                    | MG | Seasonal semi-deciduous    | DAP ≥ 4.8  | 0.5  | plots      |
| Araújo & Haridasan (1997)*      | 93/96           | 3.70/4.10 | -         | 23.80/28.00 | 2202/1632               | MG | Seasonal semi-deciduous    | DAP ≥ 3.2  | 1.0  | plots      |
| Silva & Araújo (2009)**         | 95/95           | 4.05/3.72 | 0.62/0.57 | 28.86/26.84 | 1636/1732               | MG | Seasonal semi-deciduous    | DAP ≥ 3.2  | 0.5  | plots      |
| Silva & Soares (2002)           | 84              | -         | -         | -           | 1239                    | SP | Seasonal semi-deciduous    | DAP ≥ 5.0  | 1.0  | plots      |
| Siqueira <i>et al.</i> (2009)*  | 64/46           | 2.76/2.59 | 0.66      | 16.25/14.02 | 1695/937                | MG | Seasonal deciduous         | DAP ≥ 4.8  | 1.2  | plots      |
| Nascimento & Rodal (2008)       | 62              | 2.99      | -         | 39.00       | 1553                    | PE | Seasonal mountainous       | DAP ≥ 5.0  | 1.0  | plots      |
| Fonseca & Rodrigues (2000)      | 61              | 2.72      | 0.66      | 41.78       | 1280                    | SP | Seasonal semi-deciduous    | DAP ≥ 4.8  | 1.0  | plots      |
| Cestaro & Soares (2004)*        | 56/45           | 3.19/3.26 | 0.79/0.86 | 15.88/15.86 | 1587/1924               | RN | Seasonal deciduous         | DAP ≥ 3.2  | -    | p.q. (200) |
| Jerenkow & Waechter (2001)      | 55              | 2.24      | 0.56      | -           | 1855                    | RS | Seasonal                   | DAP ≥ 5.0  | 1.0  | plots      |
| Ivanauskas & Rodrigues (2000)   | 54              | 3.00      | 0.70      | 29.70       | 2176                    | SP | Seasonal deciduous         | DAP ≥ 4.8  | 0.4  | plots      |
| Pereira <i>et al.</i> (2002)    | 54              | 2.99      | -         | 34.77       | 3253                    | PB | Mountainous Woody Caatinga | DAS ≥ 3.0  | 0.6  | plots      |
| Kunz <i>et al.</i> (2010)       | 53              | 3.38      | 0.85      | 25.8        | 745                     | MT | Seasonal                   | DAP ≥ 10.0 | -    | p.q. (200) |
| Nascimento <i>et al.</i> (2004) | 52              | -         | -         | 19.36       | 663                     | GO | Seasonal deciduous         | DAP ≥ 5.0  | 1.0  | plots      |
| Silva & Scariot (2004a)         | 51              | 3.18      | 0.81      | 18.63       | 860                     | GO | Seasonal deciduous         | DAP ≥ 5.0  | 1.0  | plots      |
| Silva & Scariot (2004)          | 48              | 2.99      | 0.77      | 9.90        | 924                     | GO | Seasonal deciduous         | DAP ≥ 5.0  | 1.0  | plots      |
| Salis <i>et al.</i> (2004)*     | 47/25/<br>32/24 | -         | -         | -           | 3240/2960/<br>1020/1350 | MS | Seasonal deciduous         | DAP ≥ 2.9  | -    | p.q. (110) |
| Silva & Scariot (2003)          | 36              | 2.99      | 0.83      | 8.45        | 536                     | GO | Seasonal deciduous         | DAP ≥ 5.0  | 1.0  | plots      |
| Lima <i>et al.</i> (2010)       | 34/33           | 2.9/2.93  | 0.82/0.84 | 32.14/38.31 | 916/963                 | MS | Seasonal deciduous         | DAP ≥ 4.8  | -    | p.q. (156) |

**Table 3** – Woody community in one hectare of semi-deciduous seasonal forest in the municipality of Palmeirópolis (TO). Decreasing Values of Importance (VI): D= Density (ind./ha), Do = Dominance (m<sup>2</sup>/ha), F = Frequency (%), A = absolute, R = relative.

| Scientific name   | Family         | DA    | DR   | FA    | FR  | DoA | DoR  | VI   | VI (%) |
|---|----------------|-------|------|-------|-----|-----|------|------|--------|
| <i>Anadenanthera colubrina</i> (Vell.) Brenan             | Fabaceae       | 46.0  | 6.1  | 100.0 | 4.5 | 4.2 | 25.3 | 36.0 | 12.0   |
| <i>Eugenia dysenterica</i> DC.                            | Myrtaceae      | 168.0 | 22.4 | 90.0  | 4.1 | 1.3 | 7.6  | 34.1 | 11.4   |
| <i>Aspidosperma subincanum</i> Mart.                      | Apocynaceae    | 88.0  | 11.8 | 100.0 | 4.5 | 1.1 | 6.6  | 22.9 | 7.6    |
| <i>Dilodendron bipinnatum</i> Radlk.                      | Sapindaceae    | 50.0  | 6.7  | 80.0  | 3.6 | 0.9 | 5.4  | 15.7 | 5.2    |
| <i>Aspidosperma pyrifolium</i> Mart.                      | Apocynaceae    | 39.0  | 5.2  | 90.0  | 4.1 | 0.5 | 3.2  | 12.5 | 4.2    |
| <i>Myracrodruon urundeuva</i> Allemão                     | Anacardiaceae  | 22.0  | 2.9  | 70.0  | 3.2 | 1.0 | 5.9  | 12.0 | 4.0    |
| <i>Hymenaea courbaril</i> L.                              | Fabaceae       | 29.0  | 3.9  | 70.0  | 3.2 | 0.7 | 4.0  | 11.1 | 3.7    |
| <i>Bauhinia rufa</i> (Bong.) Steud.                       | Fabaceae       | 36.0  | 4.8  | 80.0  | 3.6 | 0.3 | 1.8  | 10.2 | 3.4    |
| <i>Handroanthus impetiginosus</i> (Mart. ex DC.) Mattos   | Bignoniaceae   | 9.0   | 1.2  | 50.0  | 2.3 | 1.1 | 6.7  | 10.2 | 3.4    |
| <i>Swartzia acutifolia</i> Vogel                          | Fabaceae       | 12.0  | 1.6  | 70.0  | 3.2 | 0.7 | 4.3  | 9.1  | 3.0    |
| <i>Agonandra brasiliensis</i> Miers ex Benth. & Hook.f.   | Opiliaceae     | 26.0  | 3.5  | 70.0  | 3.2 | 0.3 | 2.1  | 8.7  | 2.9    |
| <i>Tabebuia roseoalba</i> (Ridl.) Sandwith                | Bignoniaceae   | 18.0  | 2.4  | 80.0  | 3.6 | 0.3 | 1.9  | 7.9  | 2.6    |
| <i>Casearia rupestris</i> Eichler                         | Salicaceae     | 14.0  | 1.9  | 60.0  | 2.7 | 0.2 | 1.0  | 5.6  | 1.9    |
| <i>Terminalia argentea</i> Mart.                          | Combretaceae   | 6.0   | 0.8  | 40.0  | 1.8 | 0.5 | 2.8  | 5.4  | 1.8    |
| <i>Machaerium</i> cf. <i>aculeatum</i> Raddi              | Fabaceae       | 11.0  | 1.5  | 50.0  | 2.3 | 0.3 | 1.6  | 5.3  | 1.8    |
| <i>Guapira</i> sp.1                                       | Nyctaginaceae  | 9.0   | 1.2  | 70.0  | 3.2 | 0.1 | 0.5  | 4.8  | 1.6    |
| <i>Apeiba tibourbou</i> Aubl.                             | Malvaceae      | 4.0   | 0.5  | 30.0  | 1.4 | 0.5 | 2.9  | 4.8  | 1.6    |
| <i>Callisthene fasciculata</i> Mart.                      | Vochysiaceae   | 5.0   | 0.7  | 50.0  | 2.3 | 0.3 | 1.7  | 4.7  | 1.6    |
| <i>Psidium myrtoides</i> O.Berg                           | Myrtaceae      | 11.0  | 1.5  | 60.0  | 2.7 | 0.1 | 0.3  | 4.5  | 1.5    |
| <i>Rhamnidium elaeocarpum</i> Reissek                     | Rhamnaceae     | 10.0  | 1.3  | 50.0  | 2.3 | 0.1 | 0.8  | 4.3  | 1.5    |
| <i>Sapium glandulosum</i> (L.) Morong                     | Euphorbiaceae  | 9.0   | 1.2  | 40.0  | 1.8 | 0.2 | 1.3  | 4.3  | 1.4    |
| <i>Senegalia polyphylla</i> (DC.) Britton & Rose          | Fabaceae       | 11.0  | 1.5  | 50.0  | 2.3 | 0.1 | 0.5  | 4.2  | 1.4    |
| <i>Campomanesia velutina</i> (Cambess.) O.Berg            | Myrtaceae      | 13.0  | 1.7  | 40.0  | 1.8 | 0.1 | 0.5  | 4.0  | 1.3    |
| <i>Sterculia striata</i> A.St.-Hil. & Naudin              | Malvaceae      | 4.0   | 0.5  | 40.0  | 1.8 | 0.2 | 1.2  | 3.5  | 1.2    |
| <i>Magonia pubescens</i> A. St.-Hil.                      | Sapindaceae    | 5.0   | 0.7  | 30.0  | 1.4 | 0.2 | 1.3  | 3.3  | 1.1    |
| <i>Cheilochlinium cognatum</i> (Miers) A.C. Sm.           | Celastraceae   | 6.0   | 0.8  | 50.0  | 2.3 | 0.0 | 0.2  | 3.2  | 1.1    |
| <i>Guazuma ulmifolia</i> Lam.                             | Malvaceae      | 9.0   | 1.2  | 30.0  | 1.4 | 0.0 | 0.2  | 2.8  | 0.9    |
| <i>Margaritaria nobilis</i> L.f.                          | Phyllanthaceae | 4.0   | 0.5  | 40.0  | 1.8 | 0.0 | 0.3  | 2.6  | 0.9    |
| <i>Pseudobombax longiflorum</i> (Mart. & Zucc.) A. Robyns | Malvaceae      | 3.0   | 0.4  | 20.0  | 0.9 | 0.3 | 1.8  | 3.1  | 0.9    |
| <i>Syagrus oleracea</i> (Mart.) Becc.                     | Arecaceae      | 5.0   | 0.6  | 30.0  | 1.4 | 0.1 | 0.6  | 2.6  | 0.9    |
| <i>Dipteryx alata</i> Vogel                               | Fabaceae       | 4.0   | 0.5  | 20.0  | 0.9 | 0.1 | 0.7  | 2.1  | 0.7    |
| <i>Tetragastris altissima</i> (Aubl.) Swart               | Anacardiaceae  | 5.0   | 0.7  | 20.0  | 0.9 | 0.0 | 0.3  | 1.8  | 0.6    |

| Scientific name   | Family          | DA           | DR           | FA            | FR           | DoA         | DoR          | VI           | VI (%)       |
|---|-----------------|--------------|--------------|---------------|--------------|-------------|--------------|--------------|--------------|
| <i>Astronium fraxinifolium</i> Schott ex Spreng.            | Anacardiaceae   | 3.0          | 0.4          | 20.0          | 0.9          | 0.1         | 0.5          | 1.8          | 0.6          |
| <i>Maclura tinctoria</i> (L.) D. Don ex Steud.              | Moraceae        | 3.0          | 0.4          | 10.0          | 0.5          | 0.2         | 0.9          | 1.8          | 0.6          |
| <i>Vatairea macrocarpa</i> (Benth.) Ducke                   | Fabaceae        | 3.0          | 0.4          | 20.0          | 0.9          | 0.1         | 0.5          | 1.7          | 0.6          |
| <i>Albizia</i> sp.  | Fabaceae        | 2.0          | 0.3          | 10.0          | 0.5          | 0.1         | 0.9          | 1.6          | 0.5          |
| <i>Varronia sessilifolia</i> (Cham.) Borhidi                | Boraginaceae    | 4.0          | 0.5          | 20.0          | 0.9          | 0.0         | 0.1          | 1.5          | 0.5          |
| <i>Erythroxylum daphnites</i> Mart.                         | Erythroxylaceae | 3.0          | 0.4          | 20.0          | 0.9          | 0.0         | 0.1          | 1.4          | 0.5          |
| <i>Myrcia splendens</i> (Sw.) DC.                           | Myrtaceae       | 3.0          | 0.4          | 20.0          | 0.9          | 0.0         | 0.1          | 1.4          | 0.5          |
| <i>Acrocomia aculeata</i> (Jacq.) Lodd. ex Mart.            | Arecaceae       | 2.0          | 0.3          | 20.0          | 0.9          | 0.0         | 0.2          | 1.3          | 0.5          |
| <i>Buchenavia tomentosa</i> Eichler                         | Combretaceae    | 2.0          | 0.3          | 20.0          | 0.9          | 0.0         | 0.1          | 1.2          | 0.4          |
| <i>Tocoyena formosa</i> (Cham. & Schldl.) K. Schum.         | Rubiaceae       | 2.0          | 0.3          | 20.0          | 0.9          | 0.0         | 0.1          | 1.2          | 0.4          |
| <i>Platypodium elegans</i> Vogel                            | Fabaceae        | 2.0          | 0.3          | 20.0          | 0.9          | 0.0         | 0.1          | 1.2          | 0.4          |
| <i>Apuleia leiocarpa</i> (Vogel) J.F. Macbr.                | Fabaceae        | 2.0          | 0.3          | 10.0          | 0.5          | 0.0         | 0.2          | 0.9          | 0.3          |
| <i>Eugenia bimarginata</i> DC.                              | Myrtaceae       | 2.0          | 0.3          | 10.0          | 0.5          | 0.0         | 0.2          | 0.9          | 0.3          |
| <i>Simira</i> cf. <i>corumbensis</i> (Standl.) Steyerm.     | Rubiaceae       | 2.0          | 0.3          | 10.0          | 0.5          | 0.0         | 0.1          | 0.8          | 0.3          |
| <i>Matayba guianensis</i> Aubl.                             | Sapindaceae     | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.2          | 0.8          | 0.3          |
| <i>Piper arboreum</i> Aubl.                                 | Piperaceae      | 2.0          | 0.3          | 10.0          | 0.5          | 0.0         | 0.0          | 0.7          | 0.3          |
| <i>Trichilia elegans</i> A. Juss.                           | Meliaceae       | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.2          | 0.7          | 0.2          |
| <i>Ximena americana</i> L.                                  | Olaceae         | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.1          | 0.7          | 0.2          |
| <i>Guapira</i> sp.2   | Nyctaginaceae   | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.1          | 0.7          | 0.2          |
| <i>Qualea multiflora</i> Mart.                              | Vochysiaceae    | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.1          | 0.7          | 0.2          |
| <i>Copaifera langsdorffii</i> Desf.                         | Fabaceae        | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.1          | 0.7          | 0.2          |
| <i>Diospyros hispida</i> A.DC.                              | Ebenaceae       | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.1          | 0.6          | 0.2          |
| <i>Siphoneugena densiflora</i> O.Berg                       | Myrtaceae       | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.0          | 0.6          | 0.2          |
| <i>Celtis iguanaea</i> (Jacq.) Sarg.                        | Cannabaceae     | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.0          | 0.6          | 0.2          |
| <i>Endlicheria</i> sp.                                      | Lauraceae       | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.1          | 0.6          | 0.2          |
| <i>Genipa americana</i> L.                                  | Rubiaceae       | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.0          | 0.6          | 0.2          |
| <i>Cybistax antisyphilitica</i> (Mart.) Mart.               | Bignoniaceae    | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.0          | 0.6          | 0.2          |
| <i>Byrsonima pachyphylla</i> A.Juss.                        | Malpighiaceae   | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.0          | 0.6          | 0.2          |
| <i>Rudgea viburnoides</i> (Cham.) Benth.                    | Rubiaceae       | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.0          | 0.6          | 0.2          |
| <i>Myrcia tomentosa</i> (Aubl.) DC.                         | Myrtaceae       | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.0          | 0.6          | 0.2          |
| <i>Sebastiania brasiliensis</i> Spreng.                     | Euphorbiaceae   | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.0          | 0.6          | 0.2          |
| <i>Qualea grandiflora</i> Mart.                             | Vochysiaceae    | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.0          | 0.6          | 0.2          |
| <i>Pouteria ramiflora</i> (Mart.) Radlk.                    | Sapotaceae      | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.0          | 0.6          | 0.2          |
| <i>Cordia trichotoma</i> (Vell.) Arráb. ex Steud.           | Boraginaceae    | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.0          | 0.6          | 0.2          |
| <i>Schefflera</i> cf. <i>calva</i> (Cham.) Frodin & Fiaschi | Araliaceae      | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.0          | 0.6          | 0.2          |
| <i>Citrus</i> sp.   | Rutaceae        | 1.0          | 0.1          | 10.0          | 0.5          | 0.0         | 0.0          | 0.6          | 0.2          |
| <b>Total</b>  |                 | <b>749.0</b> | <b>100.0</b> | <b>2220.0</b> | <b>100.0</b> | <b>16.5</b> | <b>100.0</b> | <b>300.0</b> | <b>100.0</b> |

**Table 4** – Woody community in one hectare of semi-deciduous seasonal forest in the municipality of Minaçu (GO). Decreasing Values of Importance (VI): D= Density (ind./ha), Do = Dominance (m<sup>2</sup>/ha), F = Frequency (%), A = absolute, R = relative.

| Scientific name   | Family          | DA   | DR   | FA    | FR  | DoA | DoR  | VI   | VI (%) |
|---|-----------------|------|------|-------|-----|-----|------|------|--------|
| <i>Pseudobombax tomentosum</i> (Mart. & Zucc.) A.Robyns           | Malvaceae       | 28.6 | 4.2  | 85.7  | 3.9 | 2.0 | 17.0 | 25.0 | 8.3    |
| <i>Dilodendron bipinnatum</i> Radlk.                              | Sapindaceae     | 65.7 | 9.5  | 100.0 | 4.5 | 1.0 | 8.6  | 22.6 | 7.6    |
| <i>Tabebuia roseoalba</i> (Ridl.) Sandwith                        | Bignoniaceae    | 77.1 | 11.2 | 100.0 | 4.5 | 0.7 | 6.2  | 21.9 | 7.3    |
| <i>Anadenanthera colubrina</i> (Vell.) Brenan                     | Fabaceae        | 34.3 | 5.0  | 100.0 | 4.5 | 0.9 | 7.2  | 16.7 | 5.6    |
| <i>Luehea paniculata</i> Mart. & Zucc.                            | Malvaceae       | 21.4 | 3.1  | 85.7  | 3.9 | 0.9 | 7.6  | 14.6 | 4.9    |
| <i>Magonia pubescens</i> A. St.-Hil.                              | Sapindaceae     | 27.1 | 3.9  | 71.4  | 3.2 | 0.8 | 6.9  | 14.0 | 4.7    |
| <i>Callisthene fasciculata</i> Mart.                              | Vochysiaceae    | 25.7 | 3.7  | 71.4  | 3.2 | 0.8 | 6.3  | 13.3 | 4.4    |
| <i>Guettarda viburnoides</i> Cham. & Schltdl.                     | Rubiaceae       | 42.9 | 6.2  | 85.7  | 3.9 | 0.4 | 3.2  | 13.2 | 4.4    |
| <i>Myracrodruon urundeuva</i> Allemão                             | Anacardiaceae   | 25.7 | 3.7  | 100.0 | 4.5 | 0.5 | 4.2  | 12.4 | 4.1    |
| <i>Aspidosperma subincanum</i> Mart.                              | Apocynaceae     | 31.4 | 4.6  | 85.7  | 3.9 | 0.4 | 2.9  | 11.4 | 3.8    |
| <i>Erythroxylum daphnites</i> Mart.                               | Erythroxylaceae | 41.4 | 6.0  | 71.4  | 3.2 | 0.2 | 1.9  | 11.1 | 3.7    |
| <i>Campomanesia velutina</i> (Cambess.) O.Berg                    | Myrtaceae       | 38.6 | 5.6  | 85.7  | 3.9 | 0.2 | 1.6  | 11.0 | 3.7    |
| <i>Acrocomia aculeata</i> (Jacq.) Lodd. ex Mart.                  | Arecaceae       | 25.7 | 3.7  | 85.7  | 3.9 | 0.4 | 3.1  | 10.7 | 3.6    |
| <i>Eugenia dysenterica</i> DC.                                    | Myrtaceae       | 28.6 | 4.2  | 71.4  | 3.2 | 0.3 | 2.4  | 9.8  | 3.3    |
| <i>Astronium fraxinifolium</i> Schott ex Spreng.                  | Anacardiaceae   | 18.6 | 2.7  | 100.0 | 4.5 | 0.3 | 2.3  | 9.5  | 3.2    |
| <i>Byrsonima pachyphylla</i> A.Juss.                              | Malpighiaceae   | 22.9 | 3.3  | 57.1  | 2.6 | 0.2 | 1.5  | 7.4  | 2.5    |
| <i>Cordia trichotoma</i> (Vell.) Arráb. ex Steud.                 | Boraginaceae    | 15.7 | 2.3  | 57.1  | 2.6 | 0.2 | 1.4  | 6.2  | 2.1    |
| <i>Dipteryx alata</i> Vogel                                       | Fabaceae        | 7.1  | 1.0  | 57.1  | 2.6 | 0.3 | 2.6  | 6.2  | 2.1    |
| <i>Andira</i> sp.   | Fabaceae        | 8.6  | 1.2  | 57.1  | 2.6 | 0.1 | 1.1  | 5.0  | 1.65   |
| <i>Terminalia argentea</i> Mart.                                  | Combretaceae    | 8.6  | 1.2  | 42.9  | 1.9 | 0.2 | 1.7  | 4.9  | 1.6    |
| <i>Syagrus flexuosa</i> (Mart.) Becc.                             | Arecaceae       | 10.0 | 1.5  | 57.1  | 2.6 | 0.1 | 0.5  | 4.5  | 1.5    |
| <i>Swartzia acutifolia</i> Vogel                                  | Fabaceae        | 5.7  | 0.8  | 57.1  | 2.6 | 0.1 | 0.7  | 4.1  | 1.4    |
| <i>Pseudobombax longiflorum</i> (Mart. & Zucc.) A. Robyns         | Malvaceae       | 4.3  | 0.6  | 28.6  | 1.3 | 0.1 | 0.9  | 2.8  | 0.9    |
| <i>Tabebuia aurea</i> (Silva Manso) Benth. & Hook. f. ex S. Moore | Bignoniaceae    | 2.9  | 0.4  | 28.6  | 1.3 | 0.1 | 1.1  | 2.8  | 0.9    |
| <i>Jacaranda brasiliana</i> (Lam.) Pers.                          | Bignoniaceae    | 8.6  | 1.2  | 14.3  | 0.6 | 0.1 | 0.8  | 2.7  | 0.9    |
| <i>Agonandra brasiliensis</i> Miers ex Benth. & Hook.f.           | Opiliaceae      | 4.3  | 0.6  | 28.6  | 1.3 | 0.1 | 0.7  | 2.6  | 0.9    |
| <i>Copaifera langsdorffii</i> Desf.                               | Fabaceae        | 1.4  | 0.2  | 14.3  | 0.6 | 0.2 | 1.7  | 2.5  | 0.9    |
| <i>Myrcia</i> sp.   | Myrtaceae       | 5.7  | 0.8  | 28.6  | 1.3 | 0.0 | 0.2  | 2.3  | 0.8    |
| <i>Pouteria macrophylla</i> (Lam.) Eyma                           | Sapotaceae      | 5.7  | 0.8  | 28.6  | 1.3 | 0.0 | 0.2  | 2.3  | 0.8    |
| <i>Cordia</i> sp.   | Boraginaceae    | 5.7  | 0.8  | 28.6  | 1.3 | 0.0 | 0.2  | 2.3  | 0.76   |
| <i>Symplocos</i> sp.  | Symplocaceae    | 4.3  | 0.6  | 28.6  | 1.3 | 0.0 | 0.3  | 2.2  | 0.7    |
| <i>Handroanthus impetiginosus</i> (Mart. ex DC.) Mattos           | Bignoniaceae    | 1.4  | 0.2  | 14.3  | 0.6 | 0.2 | 1.3  | 2.2  | 0.7    |
| <i>Rhamnidium elaeocarpum</i> Reissek                             | Rhamnaceae      | 4.3  | 0.6  | 28.6  | 1.3 | 0.0 | 0.2  | 2.1  | 0.7    |
| <i>Byrsonima</i> sp.  | Malpighiaceae   | 2.9  | 0.4  | 28.6  | 1.3 | 0.0 | 0.2  | 1.9  | 0.6    |
| <i>Psidium myrtoides</i> O.Berg                                   | Myrtaceae       | 2.9  | 0.4  | 28.6  | 1.3 | 0.0 | 0.1  | 1.8  | 0.6    |
| <i>Cordia sessilis</i> (Vell.) Kuntze                             | Rubiaceae       | 2.9  | 0.4  | 28.6  | 1.3 | 0.0 | 0.1  | 1.8  | 0.6    |



| Scientific name   | Family                | DA           | DR           | FA            | FR           | DoA         | DoR          | VI           | VI (%)       |
|---|-----------------------|--------------|--------------|---------------|--------------|-------------|--------------|--------------|--------------|
| <i>Simira</i> cf. <i>corumbensis</i> (Standl.) Steyerm. | Rubiaceae             | 2.9          | 0.4          | 14.3          | 0.6          | 0.0         | 0.1          | 1.1          | 0.4          |
| <i>Alibertia edulis</i> (Rich.) A. Rich.                | Rubiaceae             | 1.4          | 0.2          | 14.3          | 0.6          | 0.0         | 0.3          | 1.1          | 0.4          |
| <i>Diospyros hispida</i> A.DC.                          | Ebenaceae             | 1.4          | 0.2          | 14.3          | 0.6          | 0.0         | 0.1          | 1.0          | 0.3          |
| <i>Roupala montana</i> Aubl.                            | Proteaceae            | 1.4          | 0.2          | 14.3          | 0.6          | 0.0         | 0.1          | 1.0          | 0.3          |
| <i>Eriotheca gracilipes</i> (K. Schum.) A. Robyns       | Malvaceae             | 1.4          | 0.2          | 14.3          | 0.6          | 0.0         | 0.1          | 0.9          | 0.3          |
| <i>Kielmeyera coriacea</i> Mart. & Zucc.                | Clusiaceae            | 1.4          | 0.2          | 14.3          | 0.6          | 0.0         | 0.1          | 0.9          | 0.3          |
| <i>Leptolobium elegans</i> Vogel                        | Fabaceae              | 1.4          | 0.2          | 14.3          | 0.6          | 0.0         | 0.1          | 0.9          | 0.31         |
| <i>Tocoyena formosa</i> (Cham. & Schltdl.) K. Schum.    | Rubiaceae             | 1.4          | 0.2          | 14.3          | 0.6          | 0.0         | 0.0          | 0.9          | 0.3          |
| <i>Qualea grandiflora</i> Mart.                         | Vochysiaceae          | 1.4          | 0.2          | 14.3          | 0.6          | 0.0         | 0.0          | 0.9          | 0.3          |
| <i>Machaerium acutifolium</i> Vogel                     | Fabaceae<br>Faboideae | 1.4          | 0.2          | 14.3          | 0.6          | 0.0         | 0.1          | 0.9          | 0.3          |
| <i>Lafoensia pacari</i> A. St.-Hil.                     | Lythraceae            | 1.4          | 0.2          | 14.3          | 0.6          | 0.0         | 0.1          | 0.9          | 0.3          |
| <i>Aspidosperma pyrifolium</i> Mart.                    | Apocynaceae           | 1.4          | 0.2          | 14.3          | 0.6          | 0.0         | 0.1          | 0.9          | 0.3          |
| <i>Cheilochlinium cognatum</i> (Miers) A.C. Sm.         | Celastraceae          | 1.4          | 0.2          | 14.3          | 0.6          | 0.0         | 0.0          | 0.9          | 0.3          |
| <b>Total</b>  |                       | <b>688.6</b> | <b>100.0</b> | <b>2228.6</b> | <b>100.0</b> | <b>12.0</b> | <b>100.0</b> | <b>300.0</b> | <b>100.0</b> |

out in the fragments in the valley of Paranã (Silva & Scariot 2003, 2004, 2004a; Scariot & Sevilha 2005) suggest links with the seasonal forests of the Caatinga biome in the vegetation defined as “Caatinga Arbórea” (Santos *et al.* 2012), which has a high frequency of species such as *Anadenanthera colubrina*, *Aspidosperma pyrifolium*, *Myracrodruon urundeuva* and *Handroanthus impetiginosus*, besides other examples.

The species richness of the forest fragments was similar to a wide range of variation for this type of tropical ecosystem (Murphy & Lugo 1986; Gillespie *et al.* 2000), which occupies different Brazilian biomes such as the Cerrado, Caatinga and the Atlantic Forest. As regards the sampling in Palmeirópolis, the Chao and Jackknife richness estimators reported values higher than the observed richness. Krebs (1989) and Hellmann & Fowler (1999) suggested that, for samples smaller than 20 plots, the variations of the Jackknife method showed a better performance than estimates from the Bootstrap method, which provides more trustworthy data in larger samples. However, the results of the Bootstrap method were more similar to the observed richness of the current study.

The values the Shannon diversity index and evenness were lower than the diversity recorded in many preserved semi-deciduous forests in other regions in Brazil (Silva *et al.* 2003; Silva & Araújo 2009) and also presented lower values

than those in semi-deciduous forests with some degree of human disturbance in the past (Araújo & Haridasan 1997; Garcia *et al.* 2011). However, the observed values of the Shannon diversity index and evenness are included in the wide range of variation found in surveys in intact and human-disturbed semi-deciduous and deciduous forests, being higher than the records from human-disturbed semi-deciduous forests (Fonseca & Rodrigues 2000). The evenness in both fragments did not indicate a powerful dominance of a few species over others, suggesting a relatively stability in the species distribution.

The occurrence of cattle, the abundance of *Guadua paniculata*, the evidence of fire inside the fragments and the logging observed in the field seem to have provided conditions for lianas to become abundant, as one could see in other South American seasonal forests (Fredericksen & Mostacedo 2000). The liana tangles can reduce the natural regeneration process in forest formations for years (Schnitzer *et al.* 2000; Tabanez & Viana 2000). In the deciduous forests of the Paranã valley, Vieira & Scariot (2006b) reported a liana occupation of 22% in a disturbed area, whereas preserved areas showed 6% of occupation. Both studied fragments showed especially high values for liana tangle frequency, which is typical of disturbed environments (Oliveira-Filho *et al.* 1997; Vieira & Scariot 2006b).

The values of density, volume and dominance/basal area were included in the typical range of seasonal forests and were even higher than in some less disturbed deciduous forests (Scariot & Sevilha 2005). The comparison with these forests indicates the variability of density and basal area and that the studied fragments were a little denser and with more dominance than the deciduous forests in Table 2. However, the values were lower than other semi-deciduous forests from Goiás, Minas Gerais and São Paulo. Haidar *et al.* (2005) reported density values of 1097.8 ind.ha<sup>-1</sup> in central-southern Goiás. Also in southern Goiás, Garcia *et al.* (2011) reported slightly lower density values, at between 882 and 1039 ind.ha<sup>-1</sup>. These authors also calculated the value of 11.1 m<sup>2</sup>.ha<sup>-1</sup> for the basal area in semi-deciduous forest fragments in early regeneration stage, which is near the value recorded in Minaçu. Araújo & Haridasan (1997) indicated density values higher than 1800 ind.ha<sup>-1</sup> and 2500 ind.ha<sup>-1</sup> for two forest fragments in Uberlândia. In São Paulo, Ivanauskas *et al.* (2002) reported density of 2125 ind.ha<sup>-1</sup> and a high value of 45.22m<sup>2</sup>.ha<sup>-1</sup> for basal area. The results of the current study suggest the fragments of seasonal forests in northeastern Goiás were structurally closer to the deciduous forests in Goiás recorded in the Paranã river valley than to the semi-deciduous forests sampled in areas located in the southern.

In spite of the high number of dead standing individuals in both studied forest fragments, these values were similar to those recorded in other surveys in a number of regions (Ivanauskas & Rodrigues 2000; Ivanauskas *et al.* 2002; Silva & Soares 2002; Lopes *et al.* 2002; Silva & Scariot 2003; Haidar *et al.* 2005). So this variable did not add information about possible patterns of the community structure.

Several species, such as *Anadenanthera colubrina*, *Aspidosperma pyrifolium*, *Aspidosperma subincanum*, *Dilodendron bipinnatum*, *Hymenaea courbaril*, *Myracrodruon urundeuva*, *Pseudobombax tomentosum*, *Handroanthus impetiginosus* and *Tabebuia roseoalba* also showed high values of importance in deciduous forest located in the Paranã river valley (Silva & Scariot 2003; 2004; 2004a; Nascimento *et al.* 2004; Scariot & Sevilha 2005). Are these results related to the geographic distance? Is it a remnant of the fragmentation in the former “mato grosso goiano”? With the current available data it is not possible to reach a final conclusion. Furthermore, the species

*A. colubrina*, *D. bipinnatum*, *H. courbaril* and *M. urundeuva* also stood out in the semi-deciduous forest from central Goiás (Haidar *et al.* 2005) in spite of the lower similarity and higher geographic distance. These species were also highlighted by Oliveira-Filho *et al.* (2006), showing a high frequency on checklists from low-altitude tropical seasonal forests in the central-western region of Brazil. In particular, the value for *A. colubrina*, the first IV in Palmeirópolis and the fourth in Minaçu, is interesting given the high frequency of this species in Central Brazil, and which was not considered in past studies (Prado & Gibbs 1993; Pennington *et al.* 2000; Prado 2000) because of the lack of published data.

The small and human-disturbed forest fragments studied showed composition and structure that are typical of low-altitude seasonal forests in the middle/upper Tocantins river basin. The floristic composition was more similar to that of a deciduous seasonal forest in the Paranã valley, and more dissimilar to other forests in this same valley. This result and a higher dissimilarity related to the southern forests in Goiás suggest limitations on dispersion of the woody flora and a particular flora in each fragment with relatively similar structure and diversity. These floristically heterogeneous forest fragments are the last remnants of that endangered forest physiognomy in this region of Goiás.

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### References

- APG III. 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. Botanical Journal of the Linnean Society 161: 105-121.
- Araújo, G.M. & Haridasan, M. 1997. Estrutura fitossociológica de duas matas mesófilas semidecíduas, em Uberlândia, triângulo mineiro. *Naturalia* 22: 115-129.
- BRASIL. 1981. Projeto Radambrasil. Folha SD-22 Goiás; geologia, geomorfologia, pedologia, vegetação e uso potencial da terra. Ministério de Minas e Energia, Rio de Janeiro. 28p.

- Botrel, R.T.; Oliveira-Filho, A.T.; Rodrigues, L.A. & Curi, N. 2002. Influência do solo e topografia sobre as variações da composição florística e estrutura da comunidade arbóreo-arbustiva de uma floresta estacional semidecidual em Ingaí, MG. *Revista Brasileira de Botânica* 25: 195-213.
- CDB. 2010. Panorama da Biodiversidade Global 3. Secretariado da Convenção sobre Diversidade Biológica. Ministério do Meio Ambiente, Brasília. 94p.
- Carvalho, W.A.C.; Oliveira-Filho, A.T.; Fontes, M.A.L. & Curi, N. 2007. Variação espacial da estrutura da comunidade arbórea de um fragmento de floresta semidecidual em Piedade do Rio Grande, MG, Brasil. *Revista Brasileira de Botânica* 30: 315-335.
- Cestaro, L.A. & Soares, J.J. 2004. Variações florística e estrutural e relações fitogeográficas de um fragmento de floresta decidual no Rio Grande do Norte, Brasil. *Acta Botanica Brasilica* 18: 203-218.
- CIENTEC. 2004. Mata nativa. Sistema para análise fitossociológica e elaboração de planos de manejo de florestas nativas. Viçosa.
- Espírito-Santo, M.M.; Sevilha, A.C.; Anaya, F.C.; Barbosa, R.; Fernandes, G.W.; Sanchez-Azofeifa, G.A.; Scariot, A.; Noronha, S.E. & Sampaio, C.A. 2009. Sustainability of tropical dry forests: two case studies in southeastern and central Brazil. *Forest Ecology and Management* 258: 922-930.
- Faissol, S. 1953. Alguns aspectos do mato grosso de Goiás. *Boletim Goiano de Geografia* 11: 63-83.
- Fonseca, R.C.B. & Rodrigues, R.R. 2000. Análise estrutural e aspectos do mosaico sucessional de uma floresta semidecidual em Botucatu, SP. *Scientia Forestalis* 57: 27-43.
- Fredericksen, T.S. & Mostacedo, B. 2000. Regeneration of timber species following selection logging in a Bolivian tropical dry forest. *Forest Ecology and Management* 131: 47-55.
- Garcia, P.O.; Valente, A.S.M.; Pifano, D.S.; Pessoa, J.F.S.; Busato, L.C.; Fontes, M.A.L. & Oliveira-Filho, A.T. 2011. Species composition and floristic relationship in southern Goiás forest enclaves. *Rodriguésia* 61: 123-137.
- Gillespie, T.W.; Grijalva, A. & Farris, C.N. 2000. Diversity, composition and structure of tropical dry forests in Central America. *Plant Ecology* 147: 37-47.
- Gotelli, N.J. & Colwell, R.K. 2001. Quantifying biodiversity: procedures and pitfalls in the measurement and comparison of species richness. *Ecology Letters* 4: 379-391.
- Haidar, R.F.; Felfili, J.M.; Pinto, J.R.R. & Fagg, C.W. 2005. Fitossociologia da vegetação arbórea em fragmentos de floresta estacional, no Parque Ecológico Altamiro de Moura Pacheco, GO. *Boletim do Herbário Ezechias Paulo Heringer* 15: 19-46.
- Hellmann, J.J. & Fowler, G.W. 1999. Bias, precision and accuracy of four measures of species richness. *Ecological Applications* 9: 824-834.
- IBGE. 2012. Manual técnico da vegetação brasileira. 2ª ed. Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro. 275p.
- Imaña-Encinas, J.; Macedo, L.A. & Paula, J.E. 2007. Florística e fitossociologia de um trecho de floresta estacional semidecidual na área do ecomuseu do Cerrado em Pirenópolis-Goiás. *Cerne* 13: 308-320.
- Ivanauskas, N.M. & Rodrigues, R.R. 2000. Florística e fitossociologia de remanescentes de floresta estacional decidual em Piracicaba, São Paulo, Brasil. *Revista Brasileira de Botânica* 23: 291-304.
- Ivanauskas, N.M.; Rodrigues, R.R. & Nave, A.G. 2002. Fitossociologia de um remanescente de floresta estacional semidecidual em Itatinga-SP, para fins de restauração de áreas degradadas. *Revista Árvore* 26: 43-57.
- Janzen, D.H. 1997. Florestas tropicais secas: o mais ameaçado dos grandes ecossistemas tropicais. *In*: Wilson, E.O. & Peter, F.M. (orgs.). *Biodiversidade*. Nova Fronteira, Rio de Janeiro. Pp. 166-176.
- Krebs, C.J. 1989. *Ecological methodology*. Addison Wesley Longman, Petaluma. 624p.
- Kunz, S.H.; Martins, V.A.; Ivanauskas, M.N.; Silva, E. & Stefanello, D. 2010. Estrutura fitossociológica de um trecho de Floresta Estacional Perenifolia, bacia do rio das Pacas, Querência – MT. *Cerne* 16: 115-122.
- Legendre, P. & Legendre, L. 2012. *Numerical ecology*. 2ª ed. Elsevier Science, Amsterdam. 1006p.
- Lima, M.S.; Damasceno-Junior, G.A. & Tanaka, M.O. 2010. Aspectos estruturais da comunidade arbórea em remanescentes de floresta estacional decidual em Corumbá, MS, Brasil. *Revista Brasileira de Botânica* 33: 437-453.
- Lopes, W.P.; Silva, A.F.; Souza, A.L. & Meira Neto, J.A.A. 2002. Estrutura fitossociológica de um trecho de vegetação arbórea no Parque Estadual do Rio Doce - Minas Gerais, Brasil. *Acta Botanica Brasilica* 16: 443-456.
- Magurran, A.E. & McGill, B.J. 2011. *Biological diversity: frontiers in measurement and assessment*. Oxford University Press, Oxford. 345p.
- Mueller-Dubois, D.Y. & Elleberg, M. 1974. *Aims and methods in vegetation ecology*. Willey and Sons, New York. 547p.
- Murphy, P.G. & Lugo, A.E. 1986. Ecology of tropical dry forest. *Annual Review of Ecology and Systematics* 17: 67-88.
- Nascimento, L.M. & Rodal, M.J.N. 2008. Fisionomia e estrutura de uma floresta estacional montana do maciço da Borborema, Pernambuco - Brasil. *Revista Brasileira de Botânica* 31: 27-39.

- Nascimento, A.T.; Felfili, J.M. & Meirelles, E.M. 2004. Florística e estrutura da comunidade arbórea de um remanescente de floresta estacional decidual de encosta, Monte Alegre, GO, Brasil. *Acta Botanica Brasilica* 18: 659-669.
- Oksanen, J. 2011. Vegan: community ecology package. R package version 1.17-11. Available in <<http://CRAN.R-project.org/package=vegan>>. Access on 10 Oct 2009.
- Oliveira-Filho, A.T.; Mello, J.M. & Scolforo, J.R. 1997. Effects of past disturbance and edges on tree community structure and dynamics within a fragment of tropical semideciduous forest in south-eastern Brazil over a five-year period (1987-1992). *Plant Ecology* 131: 45-66.
- Oliveira-Filho, A.T.; Jarenkow, J.A. & Rodal, M.J. 2006. Floristic relationships of seasonally dry forests of eastern south America based on tree species distribution patterns. *In: Pennington, R.T.; Lewis, G.P. & Ratter, J.A. (orgs.). Neotropical savannas and seasonally dry forests: plant diversity, biogeography, and conservation.* Taylor & Francis, New York. Pp. 159-192.
- Palmer, M.W. 1990. The estimation of species richness by extrapolation. *Ecology* 71: 1195-1198.
- Pennington, R.T.; Prado, D.E. & Pendry, C.A. 2000. Neotropical seasonally dry forests and quaternary vegetation changes. *Journal of Biogeography* 27: 261-273.
- Pennington, R.T.; Lewis, G.P. & Ratter, J.A. 2006. An overview of the plant diversity, biogeography and conservation of neotropical savannas and seasonally dry forests. *In: Pennington, R.T.; Lewis, G.P. & Ratter, J.A. (orgs.). Neotropical savannas and seasonally dry forests: plant diversity, biogeography and conservation.* Taylor & Francis, New York. Pp. 1-29.
- Pereira, I.M.; Andrade, L.A.; Barbosa, M.R.V. & Sampaio, E.V.S.B. 2002. Composição florística e análise fitossociológica do componente arbustivo-arbóreo de um remanescente florestal no agreste Paraibano. *Acta Botanica Brasilica* 16: 357-369.
- Prado, D.E. & Gibbs, P.E. 1993. Patterns of species distribution in the dry seasonal forests of South America. *Annals of the Missouri Botanical Garden* 80: 902-927.
- Prado, D.E. 2000. Seasonally dry forests of tropical south america: from forgotten ecosystem to a new phytogeographic unit. *Edinburgh Journal of Botany* 57: 437-461.
- R Development Core Team. 2011. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Viena.
- Ribeiro, J.F. & Walter, B.M.T. 2008. As principais fitofisionomias do bioma Cerrado. *In: Sano, S.M.; Almeida, S.P. & Ribeiro, J.F. (orgs.). Cerrado: ecologia e flora. Vol. 1.* Embrapa Cerrados/Embrapa Informação Tecnológica, Brasília. Pp. 151-212
- Salis, S.M.; Silva, M.P.; Mattos, P.P.; Silva, J.S.V.; Pott, V.J. & Pott, A. 2004. Fitossociologia de remanescentes de floresta estacional decidual em Corumbá, estado do Mato Grosso do Sul, Brasil. *Revista Brasileira de Botânica* 27: 671-684.
- Santos, M.R.; Oliveira-Filho, A.T.; Eisenlohr, P.V.; Queiroz, L.P.; Cardoso, D.B.O.S. & Rodal, M.J.N. 2012. Identity and relationships of the arboreal Caatinga among other floristic units of seasonally dry tropical forests (SDTFs) of north-eastern and Central Brazil. *Ecology and Evolution* 2: 409-428.
- Scariot, A. & Sevilha, A.C. 2000. Diversidade, estrutura e manejo de florestas decíduais e as estratégias para a conservação. *In: Cavalcanti, T.B. & Walter, B.M.T. (orgs.). Tópicos atuais em botânica. 51º Congresso Nacional de Botânica. Sociedade Botânica do Brasil. Embrapa Recursos Genéticos e Biotecnologia, Brasília.* Pp. 183-188.
- Scariot, A. & Sevilha, A.C. 2005. Biodiversidade, estrutura e conservação de florestas estacionais decíduais no Cerrado. *In: Scariot, A.; Souza-Filho, J.C. & Felfili, J.M. (orgs.). Cerrado: ecologia, biodiversidade e conservação.* Ministério do Meio Ambiente, Brasília. Pp. 121-140.
- Schnitzer, S.; Dalling, J. & Carson, W. 2000. The impact of lianas on tree regeneration in tropical forest canopy gaps: evidence for an alternative pathway of gap-phase regeneration. *Journal of Ecology* 88: 655-666.
- SEPLAN. 2008. Atlas do Tocantins: subsídios ao planejamento da gestão territorial. Secretaria de Planejamento, Palmas. 62p.
- SIEG. 2010. Sistema de Informações Estatística e Geográficas de Goiás. Available in <<http://www.sieg.go.gov.br>>. Access on 8 Nov 2010.
- Silva, A.F.; Oliveira, R.V.; Santos, N.R.L. & Paula, A. 2003. Composição florística e grupos ecológicos das espécies de um trecho de floresta semidecíduasubmontana da Fazenda São Geraldo, Viçosa, MG. *Revista Árvore* 27: 311-319.
- Silva, L.A. & Scariot, A.O. 2003. Composição florística, estrutura da comunidade arbórea em floresta estacional decidual em afloramento calcário (Fazenda São José, São Domingos, GO, bacia do rio Paranã). *Acta Botanica Brasilica* 17: 305-313.
- Silva, L.A. & Scariot, A.O. 2004. Comunidade arbórea de uma floresta estacional decídua sobre afloramento calcário na Bacia do rio Paranã. *Revista Árvore* 28: 61-67.
- Silva, L.A. & Scariot, A.O. 2004a. Composição e estrutura da comunidade arbórea de uma floresta estacional decidual sobre afloramento calcário no Brasil Central. *Revista Árvore* 28: 69-75.
- Silva, L.A. & Soares, J.J. 2002. Levantamento fitossociológico de um fragmento de floresta estacional semidecídua, no município de São Carlos, SP. *Acta Botanica Brasilica* 16: 205-216.

- Silva, F.A.M.; Assad, E.D. & Evangelista, B.A. 2008. Caracterização climática do bioma Cerrado. *In*: Sano, S.M.; Almeida, S.P. & Ribeiro, J.F. (orgs.) Cerrado: ecologia e flora. Vol. 1. Embrapa Cerrados/Embrapa Informação Tecnológica, Brasília. Pp. 70-88.
- Silva, M.R. & Araújo, G.M. 2009. Dinâmica da comunidade arbórea de uma floresta semidecidual em Uberlândia, MG, Brasil. *Acta Botanica Brasilica* 23: 49-56.
- Silva-Júnior, M.C.; Barros, N.F. & Cândido, J.F. 1987. Relações entre parâmetros de solo e da vegetação de cerrado na Estação Florestal de Experimentação de Paraopeba – MG. *Revista Brasileira de Botânica* 10: 125-137.
- Siqueira, A.S.; Araújo, G.M. & Schiavini, I. 2009. Estrutura do componente arbóreo e características edáficas de dois fragmentos de floresta estacional decidual no vale do rio Araguari, MG, Brasil. *Acta Botanica Brasilica* 23: 10-21.
- Sobral, M.; Proença, C.; Souza, M.; Mazine, F. & Lucas, E. 2012. Myrtaceae. *In*: Lista de espécies da flora do Brasil. Jardim Botânico do Rio de Janeiro. Disponível em <<http://floradobrasil.jbrj.gov.br/2012/FB010759>>. Acesso em 20 Mar 2012.
- Tabanez, A.A.J. & Viana, V.M. 2000. Path structure within Brazilian Atlantic forest fragments and implications for conservation. *Biotropica* 32: 925-933.
- Veloso, H.P. 1963. Os grandes climaxes do Brasil III: considerações gerais sobre a vegetação da região centro-oeste. *Memórias do Instituto Oswaldo Cruz* 61: 357-370.
- Vieira, D.L.M. & Scariot, A. 2006a. Principles of natural regeneration of tropical dry forest for restoration. *Restoration Ecology* 14: 11-20.
- Vieira, D.L.M. & Scariot, A. 2006b. Effects of logging, liana tangles and pasture on seed fate of dry forest tree species in Central Brazil. *Forest Ecology and Management* 230: 197-205.
- Whitmore, T.C. 1997. Tropical forest disturbance, disappearance and species loss. *In*: Laurance, W.F. & Bierregaard, R.O. (orgs.). Tropical forest remnants: ecology, management, and conservation of fragmented communities. The University of Chicago Press, Chicago. Pp. 3-12.