UNIVERSIDADE DE BRASÍLIA
INSTITUTO DE CIÊNCIAS BIOLÓGICAS
PROGRAMA DE PÓS-GRADUAÇÃO EM BOTÂNICA

# COBERTURA, RIQUEZA E DIVERSIDADE DAS ASSEMBLEIA DE PLANTAS DE SUB-BOSQUE EM MATA DE GALERIA NO BRASIL CENTRAL.

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BRASÍLIA-DF
2022

**UNIVERSIDADE DE BRASÍLIA**
**INSTITUTO DE CIÊNCIAS BIOLÓGICAS**
**PROGRAMA DE PÓS-GRADUAÇÃO EM BOTÂNICA**


Dissertação de mestrado apresentada à Coordenação do Programa de Pós-graduação em Botânica da Universidade de Brasília, como parte dos requisitos para obtenção do título de Mestre em Botânica.


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Trabalho realizado junto ao Programa de Pós-Graduação em Botânica da Universidade de Brasília, como requisito parcial para a obtenção do título de mestre em Botânica.

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**AGRADECIMENTOS**

Agradeço à minha família, em especial aos meus pais e meus irmãos, que mesmo em tempos tão difíceis permaneceram sorrindo e acreditando em mim. Cada conquista minha é fruto do amor e sacrifício de vocês, e é por vocês que continuarei caminhando! Espero o quanto antes retribuir todo esse amor e dedicação de vocês. Ao meu companheiro, Pedro, que me apoiou e apoia sempre. Sua companhia torna a caminhada mais leve e sempre serei grata pelas horas que passou sentado ao meu lado me incentivando a continuar. A minha querida amiga Eloisa, colega de curso e grande parceira na vida. Seu apoio incondicional em momentos bons e outros nem tanto foi o que me fez chegar até aqui, que nossa parceria se estenda por toda a vida! Agradeço a minha orientadora Micheline Carvalho-Silva, por todo ensinamento, por toda ajuda e pela paciência destinada a mim durante todo esse período de trabalho juntas. Agradeço pela oportunidade de aprender mais com você! À professora Cássia Munhoz, por toda ajuda durante a elaboração desse trabalho, foi uma honra aprender tanto com você! Obrigada pelo suporte prestado, que foi fundamental para que eu chegasse até aqui. Ao meu colega Eliel, pela parceria nos campos e pela ajuda do início ao fim! À todas as pessoas que ajudaram, com tanta disposição e paciência, na coleta, identificação e análises de dados. Agradeço também aos membros da banca por todas as preciosas contribuições. Por fim, agradeço a oportunidade de mestrado proporcionada pelo Departamento de Botânica da Universidade de Brasília; à Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) pela concessão parcial da bolsa de estudo; e à Fundação de Amparo à Pesquisa do Distrito Federal (FAPDF) pelo auxílio financeiro.

## SUMMARY

**RESUMO DA DISSERTAÇÃO**

O sub-bosque de mata de galeria apresenta vegetação bem diversa em termos de espécies e formas de crescimento devido à influência dos componentes físicos, químicos e edáficos atuando nesse tipo de floresta. Diversas formas de crescimento estão presentes no sub-bosque florestal, como árvores, arbustos, subarbustos, ervas e trepadeiras, o que contribui para uma riqueza elevada de espécies nesse estrato. Com o objetivo de descrever as assembleias de plantas do sub-bosque de trechos de mata de galeria, selecionamos dois trechos de mata de galeria no Distrito Federal, Brasil. Amostramos a cobertura e composição das espécies do sub-bosque, avaliamos a riqueza e a contribuição relativa das formas de crescimento para esse estrato. Foram amostradas 211 espécies dispostas em 67 famílias. As famílias mais ricas em espécies foram: Rubiaceae, Fabaceae, Myrtaceae, Melastomataceae, Apocynaceae, Bignoniaceae, Poaceae, Lauraceae, Asteraceae e Piperaceae. *Hildaea pallens* foi a espécie com o maior valor de importância em ambas as áreas, devido à sua alta cobertura relativa. A riqueza de espécies e os índices de diversidade foram maiores no sub-bosque transitório. As formas de crescimento mais ricas foram as plântulas de árvore, seguida dos arbustos e das lianas, respectivamente. O sub-bosque de mata de galeria é pouco estudado, mesmo sendo muito relevante para a riqueza e diversidade de espécies em florestas tropicais. A partir dos resultados obtidos no presente estudo, percebemos que o sub-bosque deve ser avaliado em levantamentos florísticos e fitossociológicos para a real compreensão desse estrato.

**Esta dissertação é apresentada em formato de artigo científico e na língua inglesa cumprindo as normas do Programa de Pós-Graduação em Botânica da UnB. O manuscrito foi submetido para a publicação no periódico Diversity.**

# Influence of the understory plant community in the diversity of gallery forests in Central Brazilian Cerrado


## Abstract

The understory of gallery forest presents considerable vegetation heterogeneity, caused by complex biotic interactions with the trees of the canopy and the abiotic factors acting with different intensity and frequency in these forests. Despite its high contribution to species richness in tropical forests, the gallery forest understory is poorly studied. In order to describe the understory plant assemblages of gallery forest, two gallery forest stretches were selected in the Federal District, Brazil. The line intersection method was used to determine the coverage and species composition of the understory and the richness and the relative contribution of the growth forms to this stratum was evaluated. A total of 211 species distributed in 67 families and 153 genera were sampled and the most species rich families were: Rubiaceae, Fabaceae, Myrtaceae, Melastomataceae, Apocynaceae, Bignoniaceae, Poaceae, Lauraceae, Asteraceae and Piperaceae. The Poaceae *Hildaea pallens* displayed the highest importance value in both forests, due to its high relative coverage. The best represented growth forms were tree seedlings, followed by shrubs and lianas. Our study is innovative in describing the community structure of the gallery forest understory, including all its forms of growth. Our results reveal the importance of understory vegetation when assessing the patterns of richness and diversity of tropical forests, additionally providing information of the role of permanent and transient species in this stratum.



**Keywords:** Coverage; Gallery Forest; Plant growth forms; Richness; Understory


## 1. Introduction

Gallery forests are narrow strips of forest vegetation that accompany small rivers and streams, forming closed corridors (galleries) over the watercourses in tropical savannas (Ribeiro and Walter 1998), often showing sharp boundaries with the neighboring open formations. (Oliveira-Filho & Ratter 1995). They occupy 5% of the Cerrado, a Brazilian savanna that originally occupied 25% of the Brazilian territory (over 2 million km²) (IBGE 2004). Despite their reduced representativity in terms of area, gallery forests, together with riparian forests known as "mata ciliar", forest vegetation that accompanies the medium and large rivers of the Cerrado region, in which the arboreal vegetation does not form galleries (Ribeiro and Walter 1998). in Brazil, contribute about 21.25% of the total number of flowering plant species known for the Cerrado (Flora do Brasil 2020), including endemic species (Flora do Brasil 2020). Gallery forests are evergreen forests with diverse flora (Felfili 1995, Veneklaas et al. 2005), and variable environmental characteristics, depending on topography, soil type, and variations in water table depth, which, as well as topography, determine variations in soil moisture (Ribeiro and Walter 2008). Due to its importance for the protection of water resources, landscape, geological stability, biodiversity, and soil, it is considered by Brazilian legislation as a Permanent Preservation Area (Brasil 2012). Gallery forests also provide resources for pollinators and seed dispersers, ensuring fauna maintenance (Pinheiro and Ribeiro 2001).

Tropical forests, with similar ecological characteristics in the arboreal component, can exhibit marked differences in the structure and composition of the understory (LaFrankie et al. 2006). The understory can be defined as the lowest stratum of the forest (Salles and Schiavani 2007) and is very relevant for understanding the dynamics of these communities, representing between 40% and 50% of the total species found in tropical forests (Gentry & Dodson 1987, Mayfield & Daily 2005, Linares-Palomino et al. 2009). The understory can be divided into two groups: the permanent understory, where the species are poorly developed in height and shade tolerant; and the transitional understory, where species remain only during their early developmental stage, reaching adulthood in the canopy (Finol 1971, Onofre et al. 2010, Lü et al. 2010). Composition and abundance of these two functional groups of species reflect the community maintenance process (Guariguata & Ostertag 2001) and can act as indicators of the successional stage of forests (Salles and Schiavini 2007). The understory can be a demonstrative of the floristic and structural composition of the community, as the composition of adult species in the canopy is closely linked to the ecology of natural regeneration seedlings (Deb & Sundriyal 2008).

Several growths form are present in the forest understory, including tree seedlings, small trees, shrubs, subshrubs, herbs, and vines, all contributing to high species richness in this stratum (Silva et al. 2004, Souza et al. 2009, Cicuzza et al. 2013). Herbaceous species are components of the permanent understory, they present a high richness and ground cover value playing, together with the shrubs, an important role in forest regeneration (Posada et al. 2000, Inácio & Jarenkow 2008, Lima & Gandolfi 2009). Among gallery forest herbs, grasses have morphological and physiological characteristics that are very distinct from the species found in the open environment of the adjacent cerrado (Amaral et al. 2021), which contribute to their typical flora (Fonseca et al. 2018). Vines are also of remarkable importance for species diversity of forest understory communities, contributing to diversity in tropical forests and being able to often increase tree mortality (Pérez-Salicrup et al. 2001, Rezende & Ranga 2005). Some studies have evaluated the composition and structure of gallery forest tree communities in Brazil (e.g., Lopes & Schiaviani 2007, Silva 2005, Souza et al. 2018), however, there are few studies focused on their understory (Silva et al 2004).

Considering the importance of the gallery forest understory for the conservation of Cerrado biodiversity, this work evaluated sections of gallery forest in the Federal District, in the central region of the Cerrado, and aimed to answer the following questions: 1 – What is the composition of the gallery forest understory? 2 - Are there differences in species composition and diversity between two nearby sites? 3 - What is the difference between permanent and transient understory in terms of coverage and diversity? 4 - What is the contribution of the understory growth forms?

## 2. Material and methods

### *Study area*

The study was carried out in two stretches of non-floodable gallery forests in Distrito Federal (DF), 6.5 km away from each other. The first stretch of gallery forest borders the Gama stream (Gama gallery forest) located at Fazenda Água Limpa - FAL (15°57'05.0"S, 47°58'04.5"W), part of the Environmental Protection Area of the streams of Gama and Cabeça-de-Veado (Fig. 1). The second stretch of gallery forest borders the Riacho Fundo stream (Riacho Fundo gallery forest), at the Fazenda Sucupira - FS, experimental farm of the Brazilian Agricultural Research Corporation -EMBRAPA

(15°54'12.9"S, 48°00'50.1"W), (Fig. 1). The sites are surrounded by urban areas and are under constant anthropic pressure, where only the stretches inside FS and FAL are preserved. The Riacho Fundo and the Gama streams are part of the Paranoá Lake sub-basin, which belongs to the Paraná River basin. The climate in the DF is of the Aw type, according to the Köppen classification, with two well-defined seasons: one hot, with rain from October to April, and another cold and dry, from May to September (Alvares et al. 2013). The average annual rainfall is 1,500 mm, with an average maximum and minimum temperature of 28.5 °C and 12.0 °C, respectively (Munhoz and Felfili 2007).

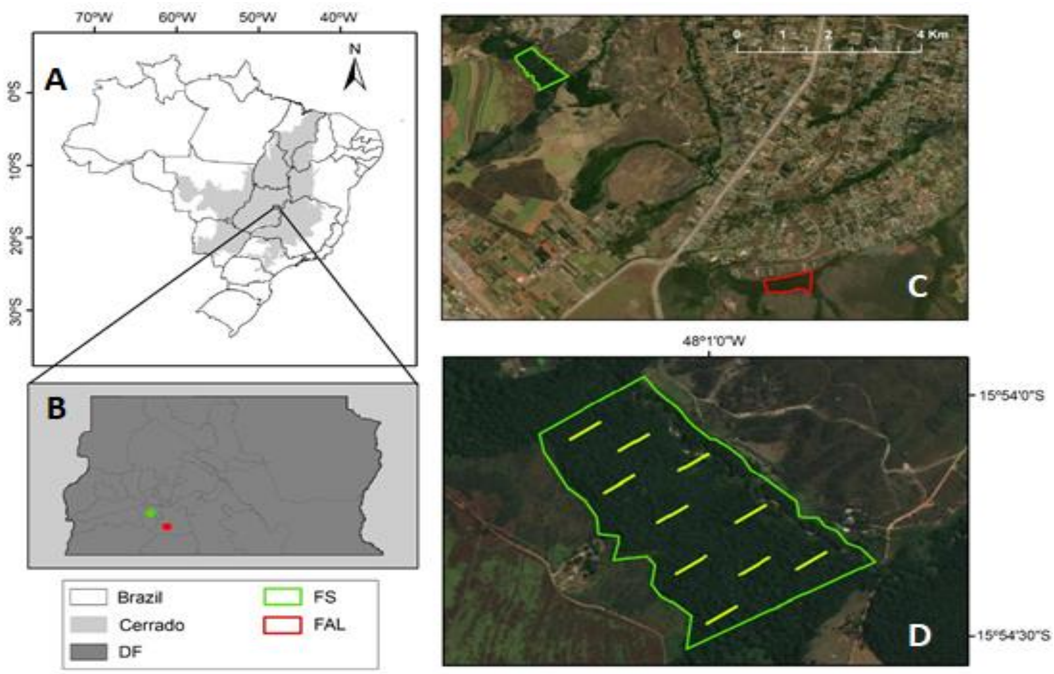


**Figure 1.** A - Map of Brazil with the Cerrado biome shaded in gray; B - delimitation of the Federal District with the position of the two study sites: FS- Fazenda Sucupira and FAL-Fazenda Água Limpa; C - Stretches of gallery forest sampled at Gama gallery forest - Fazenda Água Limpa (In green) and at Riacho Fundo gallery forest - Fazenda Sucupira (In red), Brasília, DF, Brazil; D – Sketch with the arrangement of sampling units in the gallery forest of Riacho Fundo.

*Vegetation sampling*

The sampling included plants that remain in the understory throughout their life cycle and also those that are transient in the understory, such as seedlings, young individuals of trees and woody lianas. The line intersection method (Canfield 1950 adapted by Munhoz & Araújo 2011) was used to determine the species composition and linear coverage. Ten lines of 30 meters (sampling units) were sampled in each forest stretch. The sampling units were systematically arranged at 50 m from each other, alternately between the two edges of the forests and their central position, to sample the gradient of the forest, from the margin of the stream, the center of the forest and its edge with the open vegetation adjacent to the forest (Fig. 1-D). For each sample unit, a measuring tape was used, attached at a height of 50 cm to two metal stakes, and the projection in meters (linear coverage) of all herbaceous-shrubs, regenerating individuals of the arboreal stratum and lianas (< 2 m in height) that intercepted the tape (below or above it) was recorded. The absolute cover value of each species was obtained from the sum of the linear projection of each one in the sample units (Munhoz & Felfili 2006). Relative cover was obtained by dividing the absolute cover of each species by the sum of the absolute cover of all species multiplied by 100. To calculate the relative frequency of species, coverage was replaced by the number of sampling units in which each species occurred (Munhoz & Araújo 2011). The species importance value was obtained from the sum of relative cover and relative frequency values.

The following growth forms (Dansereau 1951) were used for the permanent understory: herbs (including: ferns and graminoids), shrubs (including: caulescent ferns), undershrubs and vines; and for transient understory: trees (including: arboreal palms, young trees, tree seedlings and lianas). This information was obtained from Flora do Brasil (2020) and field observations. Specimen identification was carried out by comparison with the collections of the University of Brasilia Herbarium (UB), consultation of specific literature and specialists. The botanical nomenclature of families followed the system of the Angiosperm Phylogeny Group IV (Byng et al. 2016). The species names, families, and authors were checked and corrected using the "flora" package version 0.3.4 (Carvalho 2016) in the R program version 3.6.2 (R Development Core Team 2019), which contains all accepted botanical names and synonyms of Flora do Brasil (2020).

*Data Analysis*

The similarity between the two gallery forests, considering all species, and also the groups of transient and permanent species, was evaluated by the Chao-Jaccard and Chao-Sørensen similarity index (Chao et al. 2005, 2006). For this calculation, we used a matrix with the coverage of each species in both areas. The Chao-Sørensen and Chao-Jaccard similarity indices were calculated using the "fossil" package with the "chao.sorenson()" and "chao.jaccard()" functions in the R program version 3.3.1 (R Development Core Team 2019).

The floristic diversity was calculated using the Shannon Index (H') (more sensitive to rare species), and Simpson Index (S) (which gives greater weight to common species) (Tóthmérész 1995), through the "diversity" function, from the "vegan" package, version 2.4-0 (Oksanen et al. 2015) in the R program, version 3.3.1 (R Development Core Team 2019). For this, the species abundance matrix was used. We also performed the same analysis separately for the group of permanent and transient understory species. Pielou's equitability (J') was also calculated.

The total species richness, and the richness of the groups of transient and permanent species, were calculated by summing the number of species in the understory observed in all sampling units. To assess the completeness of the sampling, we compared these values with two estimates of species richness, Chao1 and ACE (Chao 1984; Chao and Lee 1992). To compare species richness between the permanent and transient understory groups, interpolated and extrapolated species accumulation curves were prepared (Chao 2005), for estimating the values of Chao1 we used the "Biodiversity" package in the R program version 3.3.1 (R Development Core Team 2019). Subsequently, comparisons of the curves between the transient and permanent species were prepared based on the overlap of the estimated confidence interval (95%)(Chao and Chiu, 2016).

We used the t test for two independent samples to analyze whether there is a significant difference ($P \leq 0.05$) in richness and relative coverage of groups of permanent and transient species in the gallery forest understory. We analyzed the data normality with the Shapiro-Wilk test, using the "shapiro.test" function in R program, version 3.3.1 (R Development Core Team 2019).

To test the difference in richness and relative cover between growth forms of gallery forest understory we used nested analysis of variance (nested ANOVA) (Quinn and Keough 2002). Data were log-transformed to stabilize variations. For nested ANOVA, we used a mixed effects model, where the growth forms were treated as a fixed factor and the transects of the two forests as random effects. The model was fitted using the "lme" function of the "nlme" package version 3.1-149 (Pinheiro et al. 2019) in the R program version 3.3.1 (R Development Core Team 2019), and the ANOVA was performed using the "anova.lme" function from the same package. Tukey test was used to compare mean values and implicit statistical significance ($P \leq 0.05$).

## 3. Results

*Composition, richness and diversity*

A total of 211 species were sampled, distributed in 67 families and 153 genera in the two gallery forests (Appendix 1, Table 1). Species with a single record in the sampling were considered rare and represented 20.75% of the total sampled species. The forests are floristically similar (Jaccard = 0.67 and Sorensen =0.80).

Rubiaceae was the richest family in both areas (17 species). About 39% of families were represented by a single species. The genus with the highest number of species was *Miconia* (8 species), followed by *Psychotria* (5) and *Piper* (5) (Appendix 1). Poaceae and Rubiaceae had the highest absolute cover values in the study sites. The most frequent species, occurring in all FAL sampling units were *Psychotria colorata* (Willd. ex Schult.) Müll.Arg. and *Machaerium aculeatum* Raddi., while in FS only *Cheiloclinium cognatum* (Miers) A.C.Sm. was recorded in all units. *Hildaea pallens* (Sw.) C.Silva & R.P.Oliveira was the species with the highest importance value (IV) in both forests (Fig. 2), due to its high relative cover value (12.95% in FS and 10.76 % in FAL), followed by *Bignonia corymbosa* (Vent.) L.G.Lohmann. and *Palicourea hoffmannseggiana* (Willd. ex Schult.) Borhidi, that showed the highest IV in FS, while *Homolepis glutinosa* (Sw.) Zuloaga & Soderstr. had the highest IV in FAL (Fig. 2).

Although the forest understory share dominant species, it was observed that some of the most important species were exclusive to each forest, being *Faramea occidentalis* (L.) A.Rich. exclusive to FS, while *Psychotria carthagenensis* Jacq. and *P. colorata* were exclusive to FAL. Only five species (*H. pallens*, *B. corymbosa*, *P. hoffmannseggiana*, *H. glutinosa*, and *Serjania reticulata* Cambess.) represent one third (about 33%) of the relative cover recorded in both sites. The values of Pielou, Shannon, and Simpson diversity indices for each forest were identical. (Table 1). However, the diversity of permanent understory species was higher in FS (Fazenda Sucupira), despite the greater evenness in the distribution of species in the transient component of FAL (Fazenda Água Limpa) (Table 1).

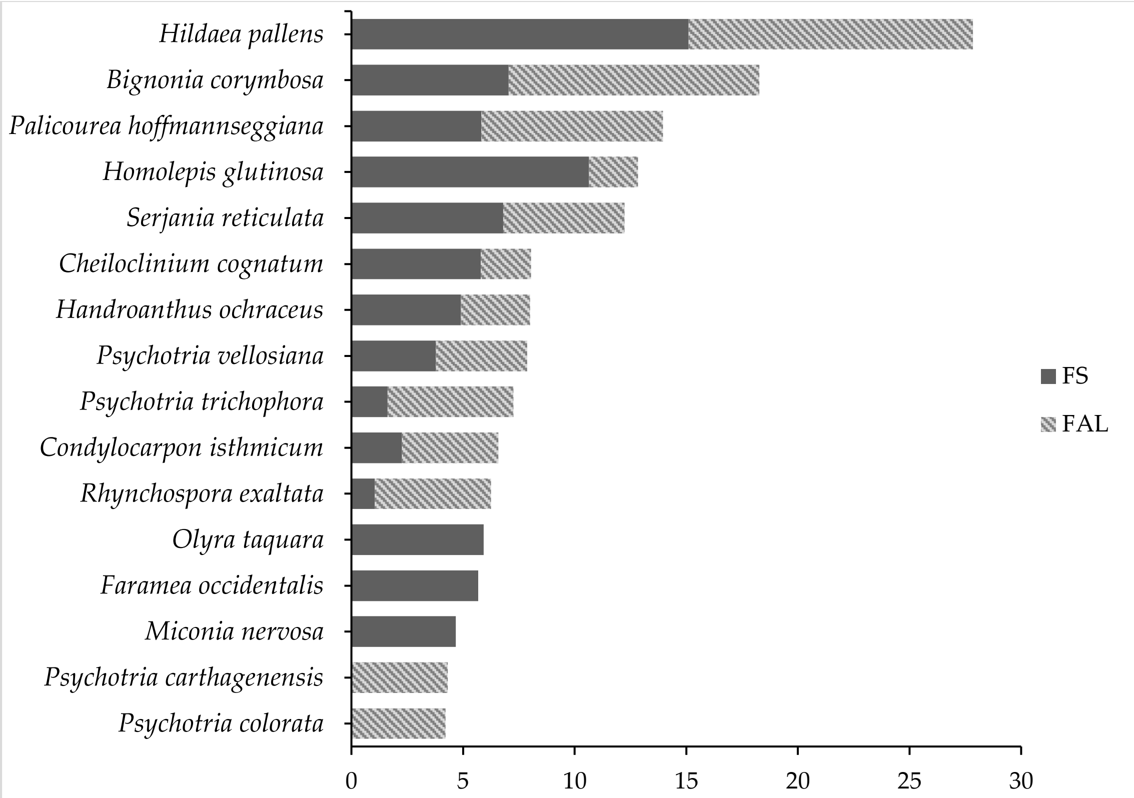


**Figure 2.** Ten species with the highest importance value (%) in the Gama gallery forest (Fazenda Água Limpa - FAL) and Riacho Fundo gallery forest (Fazenda Sucupira - FS), Brasília, DF, Brazil.

*Permanent and Transient understory*

The main families in terms of species richness in the permanent understory in both forests were: Rubiaceae (12 species), Poaceae (9), Piperaceae (6), Apocynaceae (5), and Asteraceae (5). While the richest families in the transient understory were Fabaceae (14 species), Myrtaceae (12), Bignoniaceae (10), Melastomaceae (8), and Lauraceae (7). The permanent understory species had the highest relative cover value in FS (56.9%), being lower in FAL (44.6%). However, we did not find significant differences in relative coverage between the groups of transient and permanent species present in the forests (t-test $t = 0.211$ $P<0.83$) (Fig. 3).

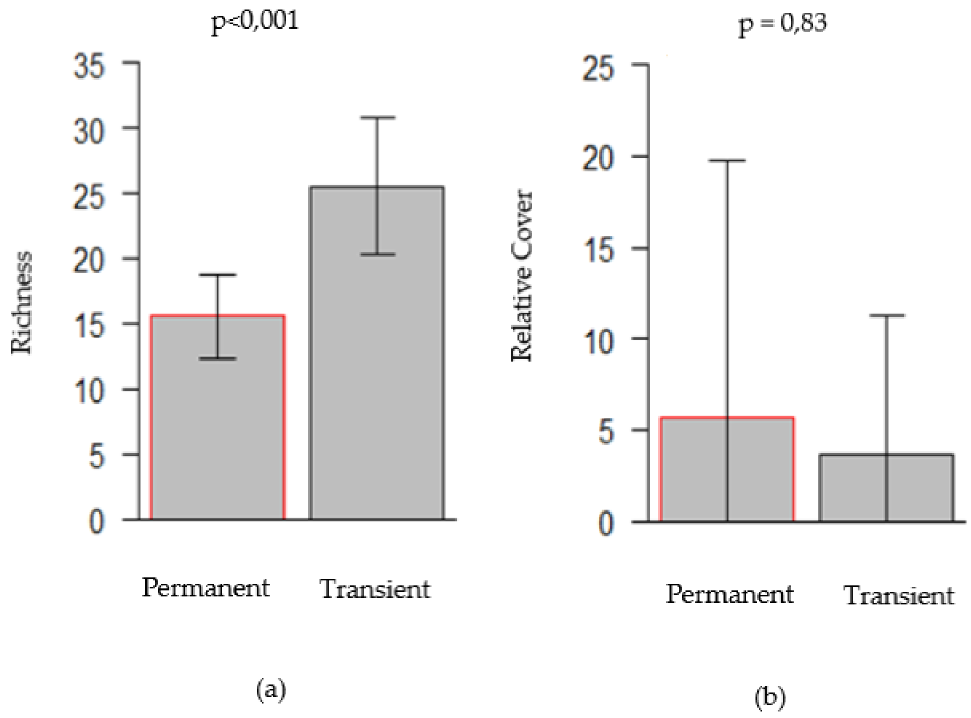


**Figure 3.** Boxplot with the means of species richness (a) and relative coverage (b) (N = 20) of the permanent and transient understory of the Gama gallery forest in Fazenda Água Limpa (FAL) and Riacho Fundo gallery forest at Fazenda Sucupira (FS), Brasília-DF.

Species richness was higher in the transient understory (FAL= 92, FS= 79) (Table 1), which also presented higher values for the richness estimates of ACE (FAL= 92.48, FS= 79) and Chao 1 (FAL=101.1; FS=88.6), differing significantly from the permanent understory (t-test $t = -7.24$ $P<0.001$) (Table 1, Fig. 3). The curves obtained for the Hill numbers revealed that the highest values for species richness (q=0), Shannon diversity (q=1) and Simpson diversity (q=2) are for the transient understory (Fig. 4).

**Table 1.** Richness and diversity of understory species sampled in Gama gallery forest at Fazenda Água Limpa (FAL) and in the Riacho Fundo gallery forest at Fazenda Sucupira (FS), Brasília-DF.

| | **FAL** | **FS** |
|---|---|---|
| Total species richness | 146 | 128 |
| Permanent species richness | 54 | 49 |
| Transient species richness | 92 | 79 |
| ACE - Permanent species | 54 | 49,57 |
| ACE - Transient species | 92,48 | 79 |
| Chao 1 - Transient species | 101,14 | 88,63 |
| Chao 1 - Permanent species | 70,33 | 56,14 |
| Total H’ | 4,15 | 4,15 |
| Transient H’ | 3,86 | 3,64 |
| Permanent H’ | 2,97 | 3,24 |
| Total J’ | 0,77 | 0,77 |
| Transient J’ | 0,79 | 0,74 |

| | | |
|---|---|---|
| Permanent J′ | 0,67 | 0,74 |
| Total S | 0,97 | 0,97 |
| Transient S | 0,96 | 0,95 |
| Permanent S | 0,91 | 0,93 |
| Relative cover of permanent species | 44,56 | 56,88 |
| Relative cover of transient species | 55,43 | 43,11 |

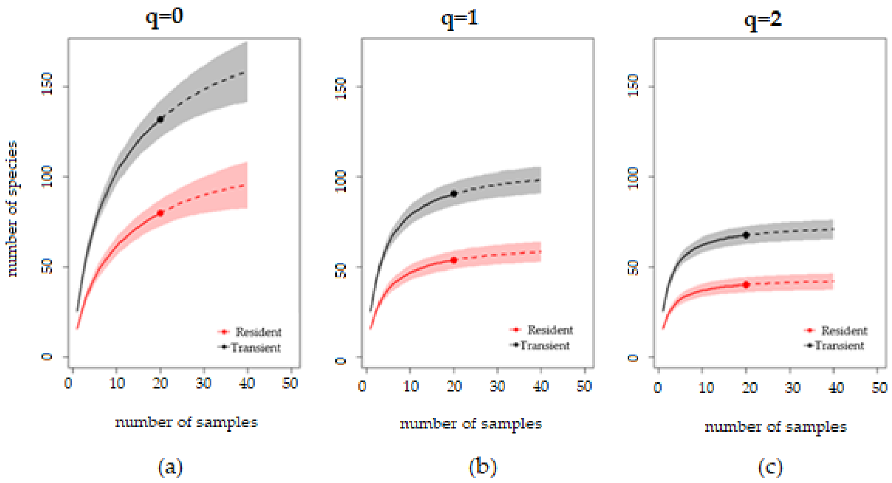


**Figure 4.** Curves of rarefaction (solid lines) and extrapolation (dashed lines) with 95% confidence intervals for Hill numbers (a) q = 0 (Richness), (b) q = 1 (Shannon's Diversity), and (c) q = 2 (Simpson's diversity), representing the number of species in the permanent and transient understory in the Gama gallery forest at Fazenda Água Limpa (FAL) and in the Riacho Fundo gallery forest at Fazenda Sucupira (FS), Brasília-DF. The 95% confidence intervals (the shaded area that follows the lines) were obtained using the bootstrap method.

*Cover and diversity in the understory by growth forms*

Tree species (seedlings and young individuals) had the highest mean values of relative cover and relative richness (Table 2). Subshrubs and vines obtained the lowest average values of relative cover, with no significant difference being identified between them, only in relation to other growth forms. In terms of relative richness, trees and shrubs differed significantly from other forms of growth, but there was no significant difference between subshrubs and vines, and also between lianas and herbs, both had approximately the same richness (Table 2). Comparatively, the understory of the two forests is very similar in terms of species richness when compared by growth forms (Table 2). All forms of growth occurred in 100% of the 20 sample units, except for subshrubs and vines, both occurring in 70% of the sample units. The trees had the highest Shannon (H'), Simpson (S), and Pielou (J') indices in both areas (Table 3).

**Table 3.** Relative cover, richness (mean and standard deviation) and number of species of the understory growth forms of the Gama gallery forest at Fazenda Água Limpa (FAL) and Riacho Fundo gallery forest at Fazenda Sucupira (FS), Brasília-DF, Brazil.

| Growth Forms | Relative cover % | Relative richness(%) | FAL richness | FS richness |
|---|---|---|---|---|
| Trees | 29,76± 11,49 a | 45.±6.54 a | 70 | 65 |
| Shrubs | 24,38± 8,40 a | 24.20±4.20 b | 24 | 22 |
| Herbs | 24,15± 13,65 a | 9.05±3.42 c | 15 | 16 |
| Lianas | 19,49± 8,96 a | 14.70±4.80 c | 22 | 14 |
| Vines | 1,55± 1,70 b | 4.38±4.06 d | 11 | 9 |
| Subshrubs | 0,68± 0,82 b | 1.88±1.72 d | 4 | 2 |
| F value | 117.57 | 108.95 | | |
| *P* | *** | *** | | |

Mean ± standard deviation (n = 20). Asterisks represent significant differences (P≤0.05) from nested ANOVA. Different letters after means in the same column indicate significant differences (P≤0.05) in Tukey's test. NS not significant; * Significant at P < 0.05; ** Significant at P <0.01; *** Significant at P < 0.001.

**Table 4.** Shannon (H'), Simpson's (S), and Pielou (*J*) diversity index of growth forms sampled in the understory of Gama gallery forests at Fazenda Água Limpa (FAL), Brasília-DF and Riacho Fundo gallery forest at Fazenda Sucupira (FS), Brasília-DF.

| Growth Forms | Simpson Index (S) | | Shannon Index (H') | | Pielou's Evenness(*J*) | |
|---|---|---|---|---|---|---|
| | FAL | FS | FAL | FS | FAL | FS |
| Trees | 0,96 | 0,95 | 3,79 | 3,55 | 0,81 | 0,76 |
| Shrubs | 0,86 | 0,92 | 2,37 | 2,75 | 0,66 | 0,77 |
| Herbs | 0,66 | 0,75 | 1,58 | 1,84 | 0,5 | 0,58 |
| Lianas | 0,85 | 0,79 | 2,33 | 1,89 | 0,7 | 0,4 |
| Vines | 0,86 | 0,77 | 2,19 | 1,77 | 0,77 | 0,62 |
| Subshrubs | 0,68 | 0,46 | 1,23 | 0,65 | 0,76 | 0,4 |

## 4. DISCUSSION

The transient component of the understory is the most relevant and is mainly represented by young tree specimens. However, in terms of species cover, both transient and permanent understory species contributed equally to the composition of the understory of the gallery forests studied, possibly due to the high cover of Poaceae species, especially in FS. The number of species recorded (211 species) in the gallery forests demonstrates the relevant species richness in the understory of the studied forest stretches. For tropical forests, the number of species in the understory ranged from 89 in Mixed Ombrophilous Forest in southern Brazil (Souza et al. 2009), to 309 in Floresta de Terra Firme in Central Amazonia (Oliveira & Amaral 2005) and 355 in Seasonal Tropical Forest in southwest China (Lü & Tang 2011). The evaluated gallery forests showed high diversity (H'= 4.15, S= 0.97) when compared to studies of the understory of other forests. In the understory of a Mixed Ombrophylous Forest in an Indian archipelago the Shannon diversity (H') was 1.80, and in an understory of a remnant of Mixed Ombrophylous Alluvial Forest in southern Brazil the Shannon diversity (H') was 2.49, and Simpson's diversity (S) ranged between 0.16 and 0.30 in the same places (Lacerda et al. 2004, Rasingam & Parthasarathy 2009, Marcuzzo et al. 2013). Evenness (J=0.77) for the two forests was higher than that recorded in the Dense Ombrophilous Forest understory in northern Brazil (J=0.60) (Braga & Jardim 2019) and lower than that recorded in subtropical Coastal Forest, which sampled only herbaceous and shrub species (J=0.84) (Müller & Waechter 2001). The gallery forests studied in the same basin showed high floristic similarity, probably due to the proximity between them.

In terms of species, the richest family in both areas was Rubiaceae, which stands out in the understory in tropical forest environments in Brazil and worldwide (e.g., Guaratini et al. 2008, Souza et al. 2009; Lü et al. 2010, Xiao-Tao et a. 2011). This family was recorded as the richest in species for the permanent understory, as seen in Mixed Ombrophilous Forest in northeastern Brazil (Gomes-Westphalen et al. 2012). However, the Rubiaceae is also highly relevant for the woody component of riparian, gallery (Ribeiro et al. 2001), and neotropical forests (Cupertino-Eisenlohr et al. 2021), being among the richest families in these studies. The Melastomataceae family was also one of the main families in the present study in terms of species richness, mainly in the transitional understory, as well as in neotropical forests that highlight the family as the fourth richest in species (Cupertino-Eisenlohr et al. al. 2021). In an Atlantic Forest in northeastern Brazil, Melastomataceae showed high richness for the permanent understory (Gomes-Westphalen et al. 2012).

The species richness recorded in the transient understory (63% in FAL and 61.71% in FS) was higher than that recorded for the permanent understory (36.9% in FAL and 38.2% in FS). A study in a Dense Ombrophilous Forest fragment in northeastern Brazil recorded similarly high richness in the transient understory, which represented 60.73% of the species sampled in the area (Gomes-Westphalen et al. 2012). This result was also found in tropical forest in northeastern Brazil, where trees and transient lianas in the understory accounted for 70.9% of the species richness (Lopes et al. 2015). Fontes et al. (2015) recorded 104 species of tree seedlings in a gallery forest near FS. There are few studies that sample permanent species in the understory of gallery forest in Central Brazil. In one of these few works, Chaves & Soares (2012) recorded 138 species in a gallery forest in the Brazilian Midwest, higher than the 80 species we sampled here, which we believe may be a result of the sampling effort, since in our case the richness analysis did not reach the plateau (Fig. 3a).

In general, the growth forms were similar in the two areas in terms of richness and diversity. The greater richness and diversity of transient species in the gallery forests was a result of the greater richness of trees in these areas. A similar result was found in Atlantic Forest in southern and southeastern Brazil (Narvaes et.al. 2005; Polisel 2011). The dominance of tree species is expected in the forest understory, due to the biotic influence exerted by seed dispersal from the trees that make up the canopy. Six tree species represent 33.91% of the total density of seedlings and young individuals of trees sampled at FAL *(Handroanthus umbellatus, Metrodorea stipularis, Astronium fraxinifolium, Inga alba, Amaioua guianensis e Myrsine coriacea)*. Among these species, *A. guianensis* was also more important in a study for the woody component for the same forest (Oliveira & Felfili 2005). Among the ten most important species in the FS gallery forest understory are *Faramea occidentalis* and *Cheiloclinium cognatum*, both were also among the most important for the arboreal component for the same forest (Sampaio et al. 2000). The richness and diversity of the seedlings are a reflection of the forest structure, as well as indicators of their maintenance. Tree seedling richness is significantly lower in heavily disturbed areas (Mayfield et al. 2013, Katovai et al. 2012), and the changes that occur in forests over time will depend not only on the influence of the canopy on the understory, but also of the human influence over these areas.

Shrubs represent approximately 16.6% of the species sampled in both gallery forests, this high richness is certainly related to the shade tolerance of these species. In an area of Atlantic Forest in southern Brazil, shrub richness was 11.82% (Canestraro & Kersten 2018) while in the Amazon Forest, shrubs represented 8.86% and lianas 12.79% (Braga & Jardim 2019). Herbs represented 10.90% of the sampled species in the present study, however, they had high relative cover in both study sites. Tropical forests present from 14 to 58% of herbaceous species in the understory (Costa 2004, Rasingam & Parthasarathy 2009). Subshrubs contributed little towards the richness and diversity of gallery forests, differing significantly from other growth forms. However, in other studies, subshrubs were quite representative, reaching 33% of the total species richness (Kozera et al. 2009).

In view of the contribution of understory species richness to tropical forests (Polisel et al. 2014), especially when evaluating permanent understory richness (Gentry & Dodson 1987), it is clear that the inclusion of these data is essential for ecological restoration projects, in order to effectively understand the structure of forest communities, allowing the effective restoration of ecological processes (Belloto et al. 2007). This knowledge also contributes to the maintenance of pollinating and dispersing agents, both important in the maintenance of forest processes (Castro et al. 2006).

Understory vegetation contributes to the natural regeneration of the arboreal stratum, and also promotes recovery from natural and anthropic disturbances (Gomes-Westphalen et al. 2012), however, there is limited knowledge about its contribution to gallery forests in the Cerrado. Our study is innovative in describing the plant community structure the gallery forest understory, including all forms of growth in this stratum. The high number of species sampled during the study in both areas demonstrates the richness of the gallery forests understory. The effective contribution of the species is high, both in numerical terms and in growth forms. Our results suggest that understory vegetation should be considered in assessments of richness and diversity patterns in tropical forests, in order to correctly understand the role of permanent and transient understory species. We realized the importance of understanding the influence of biotic factors, such as that exerted by species that are in the canopy, on the understory structure. However, we cannot ignore the importance of abiotic factors in these environments, such as the influence of soil (Meira-Neto et. al 2005) and light gradient (Meira-Neto and Martins 2003). Therefore, it is recommended for future works to incorporate analyzes of the influence that these components exert on the structure and composition of the gallery forest understory.

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| FAMILY/SPECIES | Growth form | FS | | | | | FAL | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AC | RC | AF | RF | IV | AC | RC | AF | RF | IV |
| ARECACEAE | | | | | | | | | | | |
| *Euterpe edulis* Mart. | Tree | 0.64 | 0.19 | 50 | 1.36 | 1.55 | - | - | - | - | - |
| ACANTHACEAE | | | | | | | | | | | |
| Acanthaceae 1 | Subshrub | 0.72 | 0.22 | 40 | 1.08 | 1.30 | - | - | - | - | - |
| *Aphelandra longiflora* (Lindl.) Profice | Shrub | 4.13 | 1.25 | 50 | 1.36 | 2.61 | - | - | - | - | - |
| *Justicia irwinii* Wassh. | Subshrub | - | - | - | - | - | 3.76 | 0.63 | 40 | 0.88 | 1.51 |
| *Ruellia jussieuoides* Schltdl. & Cham. | Subshrub | - | - | - | - | - | 0.39 | 0.07 | 10 | 0.22 | 0.28 |
| ANACARDIACEAE | | | | | | | | | | | |
| *Astronium fraxinifolium* Schott | Tree | 3.2 | 0.97 | 60 | 1.63 | 2.60 | 5.71 | 0.96 | 80 | 1.75 | 2.71 |
| *Tapirira guianensis* Aubl. | Tree | 0.74 | 0.22 | 30 | 0.81 | 1.04 | 2.42 | 0.41 | 20 | 0.44 | 0.84 |
| ANNONACEAE | | | | | | | | | | | |
| *Guatteria sellowiana* Schltdl. | Tree | - | - | - | - | - | 2.9 | 0.49 | 30 | 0.66 | 1.14 |
| *Xylopia sericea* A.St.-Hil. | Tree | 0.13 | 0.04 | 10 | 0.27 | 0.31 | 2.35 | 0.39 | 40 | 0.88 | 1.27 |
| APOCYNACEAE | | | | | | | | | | | |
| Apocynaceae 1 | Tree | - | - | - | - | - | 0.26 | 0.04 | 10 | 0.22 | 0.26 |
| Apocynaceae 2 | Vines | - | - | - | - | - | 1.01 | 0.17 | 10 | 0.22 | 0.39 |
| Apocynaceae 3 | Vines | - | - | - | - | - | 0.6 | 0.1 | 10 | 0.22 | 0.32 |
| *Aspidosperma brasiliense* A.S.S.Pereira & A.C.D.Castello | Tree | 01.07 | 0.33 | 30 | 0.81 | 1.14 | 0.29 | 0.05 | 10 | 0.22 | 0.27 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Aspidosperma melanocalyx* Müll.Arg. | Tree | 0.26 | 0.08 | 10 | 0.27 | 0.35 | - | - | - | - | - |
| *Aspidosperma subincanum* Mart. | Tree | 2.72 | 0.83 | 40 | 1.08 | 1.91 | - | - | - | - | - |
| *Condylocarpon isthmicum* (Vell.) A.DC. | Liana | 3 | 0.91 | 50 | 1.36 | 2.27 | 17.9 | 03.0 1 | 60 | 1.31 | 4.32 |
| *Jobinia lindbergii* E.Fourn. | Vines | 0.23 | 0.07 | 10 | 0.27 | 0.34 | - | - | - | - | - |
| *Prestonia tomentosa* R.Br. | Vines | 1.69 | 0.51 | 40 | 1.08 | 1.60 | - | - | - | - | - |
| *Temnadenia violacea* (Vell.) Miers | Vines | 0.27 | 0.08 | 10 | 0.27 | 0.35 | 0.18 | 0.03 | 10 | 0.22 | 0.25 |
| AQUIFOLIACEAE | | | | | | | | | | | |
| *Ilex affinis* Gardner | Tree | - | - | - | - | - | 1.6 | 0.27 | 10 | 0.22 | 0.49 |
| *Ilex lundii* Warm. | Tree | - | - | - | - | - | 0.08 | 0.01 | 10 | 0.22 | 0.23 |
| ASTERACEAE | | | | | | | | | | | |
| *Chromolaena maximiliani* (Schrad. ex DC.) R.M.King & H.Rob. | Shrub | 2.37 | 0.72 | 20 | 0.54 | 1.26 | - | - | - | - | - |
| *Dasyphyllum brasiliense* (Spreng.) Cabrera | Shrub | - | - | - | - | - | 1.04 | 0.17 | 20 | 0.44 | 0.61 |
| *Dasyphyllum lanceolatum* (Less.) Cabrera | Shrub | 3.84 | 1.17 | 20 | 0.54 | 1.71 | - | - | - | - | - |
| *Elephantopus riparius* Gardner | Herb | - | - | - | - | - | 0.03 | 0.01 | 10 | 0.22 | 0.22 |
| *Mikania glomerata* Spreng. | Liana | - | - | - | - | - | 1.06 | 0.18 | 10 | 0.22 | 0.40 |
| *Mikania populifolia* Gardner | Liana | 1.27 | 0.39 | 20 | 0.54 | 0.93 | - | - | - | - | - |
| *Mikania psilostachya* DC. | Liana | - | - | - | - | - | 1.29 | 0.22 | 20 | 0.44 | 0.65 |
| *Piptocarpha macropoda* (DC.) Baker | Tree | 1.16 | 0.35 | 30 | 0.81 | 1.17 | - | - | - | - | - |
| *Verbesina glabrata* Hook. & Arn. | Shrub | - | - | - | - | - | 0.6 | 0.10 | 20 | 0.44 | 0.54 |
| BIGNONIACEAE | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Amphilophium elongatum* (Vahl) L.G.Lohmann | Liana | - | - | - | - | - | 0.84 | 0.14 | 10 | 0.22 | 0.36 |
| *Anemopaegma* sp. | Liana | - | - | - | - | - | 0.64 | 0.11 | 20 | 0.44 | 0.55 |
| *Bignonia corymbosa* (Vent.) L.G.Lohmann | Liana | 15.14 | 4.60 | 90 | 2.44 | 7.04 | 55.1 | 9.26 | 90 | 1.97 | 11.2 |
| Bignoniaceae 1 | Liana | 0.09 | 0.03 | 10 | 0.27 | 0.30 | 3.26 | 0.55 | 20 | 0.44 | 0.99 |
| *Dolichandra unguis-cati* (L.) L.G.Lohmann | Liana | 0.16 | 0.05 | 20 | 0.54 | 0.59 | - | - | - | - | - |
| *Fridericia craterophora* (DC.) L.G.Lohmann | Liana | 1.98 | 0.60 | 40 | 1.08 | 1.69 | 0.82 | 0.14 | 30 | 0.66 | 0.79 |
| *Handroanthus umbellatus* (Sond.) Mattos | Tree | 8.12 | 2.47 | 90 | 2.44 | 4.91 | 6.74 | 1.13 | 90 | 1.97 | 3.10 |
| *Jacaranda puberula* Cham. | Tree | - | - | - | - | - | 1.21 | 0.20 | 10 | 0.22 | 0.42 |
| *Stizophyllum perforatum* (Cham.) Miers | Liana | | | | | | | | | | |
| BORAGINACEAE | | | | | | | | | | | |
| *Cordia sellowiana* Cham. | Tree | 1.13 | 0.34 | 10 | 0.27 | 0.61 | - | - | - | - | - |
| *Myriopus breviflorus* (DC.) Luebert | Liana | 0.17 | 0.05 | 10 | 0.27 | 0.32 | - | - | - | - | - |
| BURSERACEAE | | | | | | | | | | | |
| *Protium heptaphyllum* (Aubl.) Marchand | Tree | - | - | - | - | - | 3.85 | 0.65 | 30 | 0.66 | 1.30 |
| CELASTRACEAE | | | | | | | | | | | |
| *Cheiloclinium cognatum* (Miers) A.C.Sm. | Tree | 10.13 | 3.08 | 100 | 2.71 | 5.79 | 8.26 | 1.39 | 40 | 0.88 | 2.26 |
| *Hippocratea volubilis* L. | Liana | 0.94 | 0.29 | 30 | 0.81 | 1.10 | 1.24 | 0.21 | 10 | 0.22 | 0.43 |
| *Pristimera celastroides* (Kunth) A.C.Sm. | Shrub | 0.52 | 0.16 | 10 | 0.27 | 0.43 | - | - | - | - | - |
| CHLORANTHACEAE | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Hedyosmum brasiliense* Mart. ex Miq. | Tree | 0.16 | 0.05 | 10 | 0.27 | 0.32 | - | - | - | - | - |
| CHRYSOBALANACEAE | | | | | | | | | | | |
| *Hirtella martiana* Hook.f. | Tree | 0.69 | 0.21 | 10 | 0.27 | 0.48 | - | - | - | - | - |
| *Licania humilis* Cham. & Schltdl. | Shrub | - | - | - | - | - | 6.55 | 1.10 | 60 | 1.31 | 2.41 |
| *Licania octandra* (Hoffmanns. ex Roem. & Schult.) Kuntze | Tree | 0.91 | 0.28 | 10 | 0.27 | 0.55 | - | - | - | - | - |
| CLUSIACEAE | | | | | | | | | | | |
| *Garcinia gardneriana* (Planch. & Triana) Zappi | Tree | - | - | - | - | - | 1.89 | 0.32 | 30 | 0.66 | 0.97 |
| COMBRETACEAE | | | | | | | | | | | |
| *Terminalia glabrescens* Mart. | Tree | - | - | - | - | - | 4.11 | 0.69 | 20 | 0.44 | 1.13 |
| COMMELINACEAE | | | | | | | | | | | |
| *Callisia* sp. | Herb | 1.32 | 0.40 | 10 | 0.27 | 0.67 | - | - | - | - | - |
| CUCURBITACEAE | | | | | | | | | | | |
| *Melothrianthus smilacifolius* (Cogn.) Mart.Crov. | Vines | 0.41 | 0.12 | 20 | 0.54 | 0.67 | 2.74 | 0.46 | 50 | 1.09 | 1.55 |
| *Wilbrandia hibiscoides* Silva Manso | Vines | 0.23 | 0.07 | 10 | 0.27 | 0.34 | - | - | - | - | - |
| CUNONIACEAE | | | | | | | | | | | |
| *Lamanonia ternata* Vell. | Tree | - | - | - | - | - | 1.59 | 0.27 | 20 | 0.44 | 0.70 |
| CYATHEACEAE | | | | | | | | | | | |
| *Cyathea phalerata* Mart. | Shrub | 4.47 | 1.36 | 20 | 0.54 | 1.90 | - | - | - | - | - |
| CYPERACEAE | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Rhynchospora exaltata* Kunth | Herb | 0.98 | 0.30 | 40 | 1.08 | 1.38 | 21.9 | 3.69 | 70 | 1.53 | 5.22 |
| *Scleria gaertneri* Raddi | Herb | 3.65 | 1.11 | 30 | 0.81 | 1.92 | - | - | - | - | - |
| *Scleria latifolia* Sw. | Herb | 0.42 | 0.13 | 10 | 0.27 | 0.40 | 0.82 | 0.14 | 20 | 0.44 | 0.58 |
| DICHAPETALACEAE | | | | | | | | | | | |
| *Tapura amazonica* Poepp. & Endl. | Tree | 1.38 | 0.42 | 50 | 1.36 | 1.77 | 1.35 | 0.23 | 20 | 0.44 | 0.66 |
| DIOSCOREACEAE | | | | | | | | | | | |
| *Dioscorea amaranthoides* C.Presl | Vines | - | - | - | - | - | 0.71 | 0.12 | 20 | 0.44 | 0.56 |
| *Dioscorea multiflora Mart.* ex Griseb. | Vines | 0.35 | 0.11 | 20 | 0.54 | 0.65 | - | - | - | - | - |
| *Dioscorea* sp. | Vines | - | - | - | - | - | 0.08 | 0.01 | 10 | 0.22 | 0.23 |
| DRYOPTERIDACEAE | | | | | | | | | | | |
| *Elaphoglossum* sp. | Herb | - | - | - | - | - | 0,2 | 0,03 | 10 | 0,22 | 0,25 |
| EBENACEAE | | | | | | | | | | | |
| *Diospyros lasiocalyx* (Mart.) B.Walln. | Tree | - | - | - | - | - | 1 | 0.17 | 10 | 0.22 | 0.39 |
| ELAEOCARPACEAE | | | | | | | | | | | |
| *Sloanea lasiocoma* K.Schum. | Tree | - | - | - | - | - | 0.43 | 0.07 | 10 | 0.22 | 0.29 |
| ERYTHROXYLACEAE | | | | | | | | | | | |
| *Erythroxylum daphnites* Mart. | Tree | 0.1 | 0.03 | 10 | 0.27 | 0.30 | 0.5 | 0.08 | 20 | 0.44 | 0.52 |
| EUPHORBIACEAE | | | | | | | | | | | |
| *Croton* sp. | Tree | 0.6 | 0.18 | 10 | 0.27 | 0.45 | - | - | - | - | - |
| Euphorbiaceae 1 | Liana | - | - | - | - | - | 3.36 | 0.56 | 40 | 0.88 | 1.44 |
| FABACEAE | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Anadenanthera peregrina* (L.) Speg. | Tree | 1.91 | 0.58 | 30 | 0.81 | 1.39 | - | - | - | - | - |
| *Bauhinia rufa* (Bong.) Steud. | Tree | 01.08 | 0.33 | 40 | 1.08 | 1.41 | 1.61 | 0.27 | 30 | 0.66 | 0.93 |
| *Canavalia picta* Mart. ex Benth. | Vines | 0.23 | 0.07 | 10 | 0.27 | 0.34 | - | - | - | - | - |
| *Centrosema sagittatum* (Humb. & Bonpl. ex Willd.) Brandegee | Vines | - | - | - | - | - | 1.72 | 0.29 | 20 | 0.44 | 0.73 |
| *Copaifera langsdorffii* Desf. | Tree | 0.49 | 0.15 | 10 | 0.27 | 0.42 | - | - | - | - | - |
| *Dalbergia miscolobium* Benth. | Tree | - | - | - | - | - | 0.42 | 0.07 | 10 | 0.22 | 0.29 |
| *Enterolobium timbouva* Mart. | Tree | 0.58 | 0.18 | 10 | 0.27 | 0.45 | - | - | - | - | - |
| Fabaceae 1 | Tree | - | - | - | - | - | 0.52 | 0.09 | 20 | 0.44 | 0.53 |
| Fabaceae 2 | Liana | 0.39 | 0.12 | 10 | 0.27 | 0.39 | - | - | - | - | - |
| *Hymenaea courbaril* L. | Tree | 0.17 | 0.05 | 10 | 0.27 | 0.32 | 0.24 | 0.04 | 10 | 0.22 | 0.26 |
| *Inga alba* (Sw.) Willd. | Tree | 03.08 | 0.94 | 50 | 1.36 | 2.29 | 6.85 | 1.15 | 70 | 1.53 | 2.68 |
| *Inga marginata* Willd. | Tree | 0.59 | 0.18 | 50 | 1.36 | 1.53 | - | - | - | - | - |
| *Machaerium aculeatum* Raddi | Liana | 1.39 | 0.42 | 30 | 0.81 | 1.24 | 10.3 | 1.74 | 100 | 2.19 | 3.93 |
| *Piptadenia gonoacantha* (Mart.) J.F.Macbr. | Tree | 1.13 | 0.34 | 20 | 0.54 | 0.89 | - | - | - | - | - |
| Senegalia sp. | Liana | - | - | - | - | - | 2.68 | 0.45 | 20 | 0.44 | 0.89 |
| *Swartzia parvipetala* (R.S.Cowan) Mansano | Tree | 01.09 | 0.33 | 40 | 1.08 | 1.42 | - | - | - | - | - |
| LACISTEMATACEAE | | | | | | | | | | | |
| *Lacistema hasslerianum* Chodat | Tree | - | - | - | - | - | 0.34 | 0.06 | 10 | 0.22 | 0.28 |
| LAMIACEAE | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Vitex* sp. | Tree | - | - | - | - | - | 0.33 | 0.06 | 10 | 0.22 | 0.27 |
| LAURACEAE | | | | | | | | | | | |
| *Endlicheria paniculata* (Spreng.) J.F.Macbr. | Tree | - | - | - | - | - | 0.4 | 0.07 | 10 | 0.22 | 0.29 |
| *Nectandra hihua* (Ruiz & Pav.) Rohwer | Tree | - | - | - | - | - | 2.4 | 0.40 | 30 | 0.66 | 01.06 |
| *Ocotea aciphylla* (Nees & Mart.) Mez | Tree | - | - | - | - | - | 3.05 | 0.51 | 30 | 0.66 | 1.17 |
| *Ocotea glaziovii* Mez | Tree | 1.3 | 0.39 | 20 | 0.54 | 0.94 | - | - | - | - | - |
| *Ocotea nitida* (Meisn.) Rohwer | Tree | 1.63 | 0.50 | 30 | 0.81 | 1.31 | - | - | - | - | - |
| *Ocotea pulchella* (Nees & Mart.) Mez | Tree | - | - | - | - | - | 5.48 | 0.92 | 60 | 1.31 | 2.23 |
| *Ocotea spixiana* (Nees) Mez | Tree | - | - | - | - | - | 2.11 | 0.35 | 10 | 0.22 | 0.57 |
| LECYTHIDACEAE | | | | | | | | | | | |
| *Cariniana estrellensis* (Raddi) Kuntze | Tree | 0.2 | 0.06 | 10 | 0.27 | 0.33 | - | - | - | - | - |
| LINDSAEACEAE | | | | | | | | | | | |
| *Lindsaea lancea* (L.) Bedd. | Herb | 0.52 | 0.16 | 10 | 0.27 | 0.43 | - | - | - | - | - |
| LYTHRACEAE | | | | | | | | | | | |
| *Lafoensia pacari* A.St.-Hil. | Tree | 0.38 | 0.12 | 10 | 0.27 | 0.39 | - | - | - | - | - |
| MALPIGHIACEAE | | | | | | | | | | | |
| *Banisteriopsis oxyclada* (A.Juss.) B.Gates | Liana | 5.26 | 1.60 | 40 | 1.08 | 2.68 | - | - | - | - | - |
| *Byrsonima laxiflora* Griseb. | Tree | - | - | - | - | - | 0.02 | 0.00 | 10 | 0.22 | 0.22 |
| *Heteropterys* sp. | Liana | - | - | - | - | - | 0.12 | 0.02 | 10 | 0.22 | 0.24 |
| Malpighiaceae 1 | Liana | - | - | - | - | - | 0.04 | 0.01 | 10 | 0.22 | 0.23 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| MALVACEAE | | | | | | | | | | | |
| *Eriotheca pubescens* (Mart. & Zucc.) Schott & Endl. | Tree | - | - | - | - | - | 0.6 | 0.10 | 10 | 0.22 | 0.32 |
| *Triumfetta semitriloba* Jacq. | Shrub | 1.15 | 0.35 | 30 | 0.81 | 1.16 | - | - | - | - | - |
| MARANTACEAE | | | | | | | | | | | |
| *Goeppertia sellowii* (Körn.) Borchs. & S. Suárez | Herb | 0.57 | 0.17 | 10 | 0.27 | 0.44 | - | - | - | - | - |
| MELASTOMATACEAE | | | | | | | | | | | |
| *Clidemia hirta* (L.) D.Don | Shrub | - | - | - | - | - | 0.03 | 0.01 | 10 | 0.22 | 0.22 |
| *Leandra melastomoides* Raddi | Shrub | - | - | - | - | - | 6.57 | 1.10 | 70 | 1.53 | 2.64 |
| *Miconia chartacea* Triana | Tree | 1.29 | 0.39 | 30 | 0.81 | 1.20 | 1.7 | 0.29 | 20 | 0.44 | 0.72 |
| *Miconia cubatanensis* Hoehne | Tree | 0.82 | 0.25 | 10 | 0.27 | 0.52 | - | - | - | - | - |
| *Miconia ibaguensis* (Bonpl.) Triana | Tree | 1.7 | 0.52 | 40 | 8 | 1.60 | - | - | - | - | - |
| *Miconia minutiflora* (Bonpl.) DC. | Tree | - | - | - | - | - | 2.86 | 0.48 | 50 | 1.09 | 1.57 |
| *Miconia nervosa* (Sm.) Triana | Shrub | 11.85 | 3.60 | 40 | 1.08 | 4.68 | - | - | - | - | - |
| *Miconia pepericarpa* DC. | Tree | - | - | - | - | - | 06.09 | 01.02 | 70 | 1.53 | 2.56 |
| *Miconia sellowiana* Naudin | Tree | 0.48 | 0.15 | 10 | 0.27 | 0.42 | 1.75 | 0.29 | 40 | 0.88 | 1.17 |
| *Miconia stenostachya* DC. | Shrub | - | - | - | - | - | 0.12 | 0.02 | 10 | 0.22 | 0.24 |
| *Mouriri acutiflora* Naudin | Tree | 0.14 | 0.04 | 10 | 0.27 | 0.31 | - | - | - | - | - |
| *Mouriri glazioviana* Cogn. | Tree | - | - | - | - | - | 1.27 | 0.21 | 20 | 0.44 | 0.65 |
| MELIACEAE | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Trichilia catigua* A.Juss. | Tree | - | - | - | - | - | 2.17 | 0.36 | 30 | 0.66 | 1.02 |
| MENISPERMACEAE | | | | | | | | | | | |
| *Cissampelos glaberrima* A.St.-Hil. | Vines | 0.13 | 0.04 | 10 | 0.27 | 0.31 | 0.26 | 0.04 | 10 | 0.22 | 0.26 |
| MORACEAE | | | | | | | | | | | |
| *Maclura tinctoria* (L.) D.Don ex Steud. | Tree | 0.17 | 0.05 | 10 | 0.27 | 0.32 | - | - | - | - | - |
| *Pseudolmedia laevigata* Trécul | Tree | 0.76 | 0.23 | 20 | 0.54 | 0.77 | 1.8 | 0.30 | 40 | 0.88 | 1.18 |
| *Sorocea bonplandii* (Baill.) W.C.Burger et al. | Shrub | 4.36 | 1.32 | 70 | 1.90 | 3.22 | 2.62 | 0.44 | 60 | 1.31 | 1.75 |
| MYRISTICACEAE | | | | | | | | | | | |
| *Virola sebifera* Aubl. | Tree | 0.55 | 0.17 | 20 | 0.54 | 0.71 | 1.12 | 0.19 | 30 | 0.66 | 0.84 |
| MYRTACEAE | | | | | | | | | | | |
| *Campomanesia eugenioides* (Cambess.) D.Legrand ex Landrum | Tree | - | - | - | - | - | 1.17 | 0.20 | 20 | 0.44 | 0.63 |
| *Eugenia florida* DC. | Shrub | - | - | - | - | - | 0.75 | 0.13 | 20 | 0.44 | 0.56 |
| *Myrcia fenzliana* O.Berg | Tree | 1.55 | 0.47 | 40 | 1.08 | 1.55 | 4.15 | 0.70 | 60 | 1.31 | 02.01 |
| *Myrcia neoclusiifolia* A.R.Lourenço & E.Lucas | Tree | - | - | - | - | - | 2.59 | 0.44 | 30 | 0.66 | 01.09 |
| *Myrcia splendens* (Sw.) DC. | Tree | 1.17 | 0.36 | 20 | 0.54 | 0.90 | 0.22 | 0.04 | 20 | 0.44 | 0.47 |
| *Myrciaria* sp. | Tree | - | - | - | - | - | 1.64 | 0.28 | 20 | 0.44 | 0.71 |
| Myrtaceae 1 | Tree | 0.27 | 0.08 | 10 | 0.27 | 0.35 | - | - | - | - | - |
| Myrtaceae 2 | Tree | 0.42 | 0.13 | 10 | 0.27 | 0.40 | - | - | - | - | - |
| Myrtaceae 3 | Tree | 2.19 | 0.67 | 50 | 1.36 | 2.2 | - | - | - | - | - |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Psidium rufum* Mart. ex DC. | Tree | - | - | - | - | - | 1.35 | 0.23 | 20 | 0.44 | 0.66 |
| *Psidium* sp. | Tree | - | - | - | - | - | 2 | 0.17 | 10 | 0.22 | 0.39 |
| *Siphoneugena densiflora* O.Berg | Tree | 0.48 | 0.15 | 20 | 0.54 | 0.69 | 0.34 | 0.06 | 10 | 0.22 | 0.28 |
| *Syzygium jambos* (L.) Alston | Tree | 2.43 | 0.74 | 30 | 0.81 | 1.55 | 1.66 | 0.28 | 10 | 0.22 | 0.50 |
| NYCTAGINACEAE | | | | | | | | | | | |
| *Guapira* sp. | Shrub | - | - | - | - | - | 0.74 | 0.12 | 10 | 0.22 | 0.34 |
| *Guapira graciliflora* (Mart. ex Schmidt) Lundell | Tree | 0.35 | 0.11 | 10 | 0.27 | 0.38 | 1.21 | 0.20 | 10 | 0.22 | 0.42 |
| OCHNACEAE | | | | | | | | | | | |
| *Ouratea castaneifolia* (DC.) Engl. | Tree | - | - | - | - | - | 1.65 | 0.28 | 30 | 0.66 | 0.93 |
| *Ouratea salicifolia* (A.St.-Hil. & Tul.) Engl. | Tree | 4.1 | 1.25 | 40 | 1.08 | 2.33 | 2.52 | 0.42 | 20 | 0.44 | 0.86 |
| ORCHIDACEAE | | | | | | | | | | | |
| *Prescottia stachyodes* (Sw.) Lindl. | Herb | 0.06 | 0.02 | 10 | 0.27 | 0.29 | 0.11 | 0.02 | 10 | 0.22 | 0.24 |
| *Wullschlaegelia aphylla* (Sw.) Rchb.f. | Herb | 0.04 | 0.01 | 20 | 0.54 | 0.55 | - | - | - | - | - |
| PHYLLANTHACEAE | | | | | | | | | | | |
| *Margaritaria nobilis* L.f. | Tree | 0.2 | 0.06 | 10 | 0.27 | 0.33 | - | - | - | - | - |
| Phyllanthus sp. | Herb | 0.2 | 0.06 | 20 | 0.54 | 0.60 | 1.35 | 0.23 | 20 | 0.44 | 0.66 |
| PIPERACEAE | | | | | | | | | | | |
| *Peperomia campinasana C.DC.* | Herb | 0.13 | 0.04 | 10 | 0.27 | 0.31 | - | - | - | - | - |
| *Piper arboreum* Aubl. | Shrub | 3.93 | 1.19 | 60 | 1.63 | 2.82 | 1.8 | 0.30 | 20 | 0.44 | 0.74 |
| *Piper mollicomum* Kunth | Shrub | 0.4 | 0.12 | 10 | 0.27 | 0.39 | - | - | - | - | - |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Piper ovatum* Vahl | Shrub | 0.97 | 0.29 | 30 | 0.81 | 1.11 | 1.37 | 0.23 | 10 | 0.22 | 0.45 |
| *Piper tectoniifolium* Kunth | Shrub | - | - | - | - | - | 2.81 | 0.47 | 30 | 0.66 | 1.13 |
| *Piper xylosteoides* (Kunth) Steud. | Shrub | 04.06 | 1.23 | 30 | 0.81 | 2.05 | 6.95 | 1.17 | 60 | 1.31 | 2.48 |
| POACEAE | | | | | | | | | | | |
| *Hildaea pallens* (Sw.) C.Silva & R.P.Oliveira | Herb | 42.61 | 12.9 | 80 | 2.17 | 15.1 | 64 | 10.76 | 90 | 1.97 | 12.7 |
| *Homolepis glutinosa* (Sw.) Zuloaga & Soderstr. | Herb | 29.68 | 9.02 | 60 | 1.63 | 10.6 | 10.5 | 1.76 | 20 | 0.44 | 2.20 |
| *Ichnanthus calvescens (Nees ex Trin.) Döll* | Herb | 3.11 | 0.94 | 10 | 0.27 | 1.22 | 0.89 | 0.15 | 10 | 0.22 | 0.37 |
| *Olyra humilis* Nees | Herb | 0.97 | 0.29 | 10 | 0.27 | 0.57 | - | - | - | - | - |
| *Olyra latifolia* L. | Herb | - | - | - | - | - | 1.79 | 0.30 | 10 | 0.22 | 0.52 |
| *Olyra taquara* Swallen | Herb | 14.13 | 4.29 | 60 | 1.63 | 5.92 | - | - | - | - | - |
| *Oplismenus hirtellus* (L.) P.Beauv. | Herb | - | - | - | - | - | 2.44 | 0.41 | 30 | 0.66 | 1.07 |
| *Panicum sellowii* Nees | Herb | - | - | - | - | - | 2.3 | 0.39 | 30 | 0.66 | 1.04 |
| *Pharus lappulaceus* Aubl. | Herb | 3.58 | 1.09 | 10 | 0.27 | 1.36 | 0.73 | 0.12 | 10 | 0.22 | 0.34 |
| POLYGALACEAE | | | | | | | | | | | |
| *Bredemeyera floribunda* Willd. | Liana | 0.79 | 0.24 | 20 | 0.54 | 0.78 | 1.94 | 0.33 | 10 | 0.22 | 0.54 |
| *Bredemeyera hebeclada* (DC.) J.F.B.Pastore | Liana | - | - | - | - | - | 1.34 | 0.23 | 10 | 0.22 | 0.44 |
| POLYGONACEAE | | | | | | | | | | | |
| *Coccoloba scandens* Casar. | Liana | - | - | - | - | - | 4.76 | 0.80 | 30 | 0.66 | 1.46 |
| PRIMULACEAE | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Myrsine coriacea* (Sw.) R.Br. ex Roem. & Schult. | Tree | - | - | - | - | - | 4.28 | 0.72 | 70 | 1.53 | 2.25 |
| *Myrsine guianensis* (Aubl.) Kuntze | Shrub | 0.17 | 0.05 | 10 | 0.27 | 0.32 | - | - | - | - | - |
| *Myrsine leuconeura* Mart. | Tree | - | - | - | - | - | 1.58 | 0.27 | 30 | 0.66 | 0.92 |
| *Myrsine umbellata* Mart. | Tree | - | - | - | - | - | 0.4 | 0.07 | 10 | 0.22 | 0.29 |
| PROTEACEAE | | | | | | | | | | | |
| *Roupala montana* Aubl. | Tree | 0.99 | 0.30 | 20 | 0.54 | 0.84 | 3.05 | 0.51 | 40 | 0.88 | 1.39 |
| PTERIDACEAE | | | | | | | | | | | |
| *Adiantum* sp.1 | Herb | - | - | - | - | - | 0.34 | 0.06 | 10 | 0.22 | 0.28 |
| *Adiantum* sp.2 | Herb | - | - | - | - | - | 0.25 | 0.04 | 10 | 0.22 | 0.26 |
| ROSACEAE | | | | | | | | | | | |
| *Rubus brasiliensis* Mart. | Shrub | 0.62 | 0.19 | 30 | 0.81 | 1.00 | 0.34 | 0.06 | 10 | 0.22 | 0.28 |
| RUBIACEAE | | | | | | | | | | | |
| *Amaioua guianensis* Aubl. | Tree | 1.56 | 0.47 | 40 | 1.08 | 1.56 | 10.1 | 1.71 | 90 | 1.97 | 3.68 |
| *Coccocypselum aureum* (Spreng.) Cham. & Schltdl. | Subshrub | - | - | - | - | - | 1.4 | 0.24 | 30 | 0.66 | 0.89 |
| *Coccocypselum lanceolatum* (Ruiz & Pav.) Pers. | Subshrub | 0.67 | 0.20 | 30 | 0.81 | 1.02 | 0.45 | 0.08 | 20 | 0.44 | 0.51 |
| *Cordiera concolor* (Cham.) Kuntze | Shrub | 3.76 | 1.14 | 70 | 1.90 | 3.04 | - | - | - | - | - |
| *Cordiera sessilis* (Vell.) Kuntze | Tree | 1.84 | 0.56 | 30 | 0.81 | 1.37 | - | - | - | - | - |
| *Coutarea hexandra* (Jacq.) K.Schum. | Tree | 02.04 | 0.62 | 10 | 0.27 | 0.89 | - | - | - | - | - |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Faramea occidentalis* (L.) A.Rich. | Tree | 10.6 6 | 3.24 | 90 | 2.44 | 5.68 | 10.9 | 1.85 | 80 | 1.75 | 3.60 |
| *Ixora brevifolia* Benth. | Tree | 0.58 | 0.18 | 20 | 0.54 | 0.72 | 4.12 | 0.69 | 60 | 1.31 | 2.01 |
| *Palicourea colorata* (Willd. ex Roem. & Schult.) Delprete & J.H.Kirkbr. | Shrub | - | - | - | - | - | 12.1 | 02.0 3 | 100 | 2.19 | 4.22 |
| *Palicourea crocea* (Sw.) Roem. & Schult. | Shrub | 1.3 | 0.39 | 40 | 1.08 | 1.48 | - | - | - | - | - |
| *Palicourea hoffmannseggiana* (Willd. ex Schult.) Borhidi | Shrub | 12.0 6 | 3.66 | 80 | 2.17 | 5.83 | 36.6 | 6.16 | 90 | 1.97 | 8.13 |
| *Palicourea marcgravii* A.St.-Hil. | Shrub | - | - | - | - | - | 0.32 | 0.05 | 10 | 0.22 | 0.27 |
| *Palicourea racemosa* (Aubl.) G.Nicholson | Shrub | 4.51 | 1.37 | 30 | 0.81 | 2.18 | 1.44 | 0.24 | 30 | 0.66 | 0.90 |
| *Palicourea sessilis* (Vell.) C.M.Taylor | Shrub | 07.0 8 | 2.15 | 60 | 1.63 | 3.78 | 12.6 | 2.13 | 90 | 1.97 | 4.10 |
| *Psychotria carthagenensis* Jacq. | Shrub | - | - | - | - | - | 13.9 | 2.34 | 90 | 1.97 | 4.31 |
| *Psychotria prunifolia* (Kunth) Steyerm. | Shrub | 3.82 | 1.16 | 50 | 1.36 | 2.52 | 8.99 | 1.51 | 80 | 1.75 | 3.26 |
| *Psychotria trichophora* Müll.Arg. | Shrub | 1.76 | 0.53 | 40 | 1.08 | 1.62 | 21.8 | 3.67 | 90 | 1.97 | 5.64 |
| RUTACEAE | | | | | | | | | | | |
| *Metrodorea stipularis* Mart. | Tree | | | | | | | | | | |
| *Zanthoxylum rhoifolium* Lam. | Tree | 0.06 | 0.02 | 10 | 0.27 | 0.29 | - | - | - | - | - |
| SALICACEAE | | | | | | | | | | | |
| *Casearia rupestris* Eichler | Tree | - | - | - | - | - | 1.38 | 0.23 | 20 | 0.44 | 0.67 |
| *Casearia sylvestris* Sw. | Tree | 0.46 | 0.14 | 10 | 0.27 | 0.41 | 2.16 | 0.36 | 30 | 0.66 | 1.2 |
| SAPINDACEAE | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Cupania vernalis* Cambess | Tree | 1.95 | 0.59 | 30 | 0.81 | 1.41 | 6.37 | 01.07 | 70 | 1.53 | 2.60 |
| *Matayba guianensis* Aubl. | Tree | 1.62 | 0.49 | 40 | 1.08 | 1.58 | 2.36 | 0.40 | 40 | 0.88 | 1.27 |
| *Paullinia carpopoda* Cambess. | Liana | - | - | - | - | - | 1.8 | 0.30 | 30 | 0.66 | 0.96 |
| *Serjania lethalis* A.St.-Hil. | Liana | 15.25 | 4.63 | 80 | 2.17 | 6.80 | 13.8 | 2.33 | 80 | 1.75 | 4.08 |
| *Serjania reticulata* Cambess. | Liana | - | - | - | - | - | 20.6 | 3.56 | 100 | 2.19 | 5.75 |
| SAPOTACEAE | | | | | | | | | | | |
| *Chrysophyllum gonocarpum* (Mart. & Eichler ex Miq.) Engl. | Tree | - | - | - | - | - | 0.92 | 0.15 | 20 | 0.44 | 0.59 |
| *Micropholis gardneriana* (A.DC.) Pierre | Tree | 1.62 | 0.49 | 30 | 0.81 | 1.31 | - | - | - | - | - |
| *Micropholis venulosa* (Mart. & Eichler) Pierre | Tree | 1.99 | 0.60 | 60 | 1.63 | 2.23 | 0.34 | 0.06 | 10 | 0.22 | 0.28 |
| SIPARUNACEAE | | | | | | | | | | | |
| *Siparuna guianensis* Aubl. | Shrub | - | - | - | - | - | 1.68 | 0.28 | 10 | 0.22 | 0.50 |
| SMILACACEAE | | | | | | | | | | | |
| *Smilax elastica* Griseb. | Vines | - | - | - | - | - | 0.61 | 0.10 | 30 | 0.66 | 0.76 |
| *Smilax fluminensis* Steud. | Vines | - | - | - | - | - | 0.4 | 0.07 | 10 | 0.22 | 0.29 |
| *Smilax stenophylla* A.DC. | Vines | 1.99 | 0.60 | 50 | 1.36 | 1.96 | - | - | - | - | - |
| SOLANACEAE | | | | | | | | | | | |
| *Cestrum schlechtendalii* G.Don | Shrub | - | - | - | - | - | 0.3 | 0.05 | 10 | 0.22 | 0.27 |
| *Solanum didymum* Dunal | Shrub | 1 | 0.30 | 10 | 0.27 | 0.57 | - | - | - | - | - |
| STYRACACEAE | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Styrax camporum* Pohl | Tree | - | - | - | - | - | 5.53 | 0.93 | 70 | 1.53 | 2.46 |
| SYMPLOCACEAE | | | | | | | | | | | |
| *Symplocos nitens* (Pohl) Benth. | Tree | 0.48 | 0.15 | 20 | 0.54 | 0.69 | - | - | - | - | - |
| VITACEAE | | | | | | | | | | | |
| *Cissus erosa* Rich. | Vines | - | - | - | - | - | 0.68 | 0.11 | 10 | 0.22 | 0.33 |
| VOCHYSIACEAE | | | | | | | | | | | |
| *Callisthene major* Mart. | Tree | 0.47 | 0.14 | 10 | 0.27 | 0.41 | 0.47 | 0.08 | 20 | 0.44 | 0.52 |
| *Qualea dichotoma* (Mart.) Warm. | Tree | 0.13 | 0.04 | 10 | 0.27 | 0.31 | - | - | - | - | - |
| *Qualea multiflora* Mart. | Tree | - | - | - | - | - | 2.76 | 0.46 | 20 | 0.44 | 0.90 |

Riacho Fundo gallery forest at Fazenda Sucupira (FS) and Gama gallery forest at Fazenda água limpa (FAL), Brasília-DF with their respective phytosociological parameters, in alphabetical order. IV= importance value, AC (m)= absolute coverage; RC (%) = relative coverage; AF= absolute frequency; RF (%) = relative frequency. Seedling = young trees and palm trees.

## CONSIDERAÇÕES FINAIS

A contribuição das espécies de sub-bosque para riqueza e diversidade das matas de galeria é alta. A família mais rica nas duas áreas foi a Rubiaceae tanto para o sub-bosque transitório quanto para o permanente. Nossos resultados demonstram diferenças em termos de riqueza entre as duas categorias de sub-bosque, sendo o sub-bosque transitório mais rico em espécies do que o sub-bosque permanente em ambas as matas analisadas. As formas de crescimento mais rica em espécies e mais diversa foram as árvores, seguidas dos arbustos e ervas. Apesar de serem pouco estudadas, as espécies que compõem o sub-bosque devem ser incluídas em levantamentos florísticos e fitossociológicos em matas de galeria, para que a estrutura dessas florestas seja de fato compreendida.