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Fitogeografia, diversidade taxonômica e funcional do estrato inferior de mata de galeria e cerrado

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Resumo Geral

Esse trabalho busca estudar as relações florísticas, funcionais e ambientais de espécies de plantas do sub-bosque nos habitats de mata de galeria e cerrado sensu stricto dentro do bioma cerrado. As matas de galeria são formações florestais ligadas a cursos d'água que entremeiam o Bioma Cerrado, e geralmente ocorrem em solos mesotróficos, em faixas de floresta cujas copas das árvores se tocam entre as margens de estreitos cursos d'água, formando galerias (Ribeiro & Walter 2008). Importantes funções hidrológicas e ecológicas são desempenhadas por esses ambientes. Já o Cerrado sensu stricto é caracterizado por uma camada herbáceo-subarbustiva contínua e vegetação lenhosa brevi-decidua descontínua sobre solos distróficos e predominantemente profundos. Os ambientes de mata de galeria e cerrado sensu stricto são bastante distintos, o sombreamento na mata causa complexas implicações ecológicas, tanto bióticas quanto abióticas a nível de população, comunidade e ecossistemas, principalmente no seu sub-bosque, que é uma camada mais sensível a mudanças. Já no cerrado sensu stricto, além do solo, o fogo é um dos principais fatores moldadores. Esses ambientes contrastam também na disponibilidade de nutrientes e água no solo, com as matas de galeria sendo mais úmidas, férteis e com maior teor de matéria orgânica. Essas variações no ambiente funcionam como filtros, influenciando na composição e estrutura de comunidades ao selecionar assembleias de plantas adaptadas a cada um desses ambientes.

No capítulo um buscamos examinar os gradientes de composição de espécies e os preditores ambientais que influenciam a variação florística no sub-bosque de mata de galeria do Cerrado por meio de análises de gradientes e modelos lineares generalizadas. Além disso, investigamos a distribuição e o compartilhamento de suas espécies com outros biomas. Compilamos todas as espécies que compõem o sub-bosque de mata de galeria no Cerrado, totalizando 1.385 espécies. Encontramos que o sub-bosque de mata de galeria não apresenta um padrão consistente de diferenciação florística, se mostrando altamente conectado floristicamente, destoando dos padrões encontrados para o estrato arbóreo e de outros tipos de vegetação do Cerrado. Variáveis ambientais ligadas à disponibilidade de água como índice de aridez e estresse hídrico do solo foram os preditores mais importantes na determinação da variação florística em sub-bosque de mata de galeria no Cerrado. As maiores taxas de compartilhamento de espécies ocorreram com a Mata Atlântica (91%), a Caatinga (73%) e a Amazônia (65%), apresentando apenas 39 espécies endêmicas do sub-bosque de mata de galeria do Cerrado. Os resultados do

capítulo um mostram como o sub-bosque de mata de galeria apresenta alta conexão florística entre as ecorregiões, resultado das adaptações das espécies e das características ambientais das matas, que servem como corredores de dispersão sombreados e úmidos em meio à savana. Reforçamos que as estratégias de conservação devem considerar a singularidade da variação florística das florestas tropicais e dos determinantes de todos os estratos da vegetação sob o risco de perda de biodiversidade.

No capítulo dois nós amostramos e comparamos a riqueza, cobertura e formas de vida das espécies no estrato inferior dos ambientes contrastantes de mata de galeria e cerrado sensu stricto. E investigamos a influência da abertura do dossel, quantidade de serapilheira e de características edáficas na distribuição das espécies que habitam o sub-bosque desses ambientes. Encontramos um claro contraste entre os ambientes de mata de galeria e cerrado sensu stricto, com variações significativas na cobertura e riqueza das formas de vida em cada ambiente, apresentando baixo compartilhamento de espécies e gêneros entre si. As matas de galeria apresentaram maior cobertura e riqueza de espécies arbustivas, enquanto o cerrado sensu stricto apresentou maior cobertura de graminóides e maior riqueza de subarbustos. Também encontramos que áreas de mata de galeria são mais próximas floristicamente que áreas de cerrado sensu stricto. As matas de galeria apresentaram solos mais férteis, e maiores teores de areia e serrapilheira, enquanto o cerrado sensu stricto apresentou maior abertura de dossel e maiores teores de argila e silte no solo. Abertura de dossel e silte foram positivamente correlacionados com a cobertura de espécies no sub-bosque de cerrado sensu stricto, e P, Ca, Al e K foram correlacionados com a cobertura de espécies no sub-bosque de mata de galeria. Nesse trabalho visamos preencher lacunas no entendimento dos padrões da camada herbáceo-arbustiva do cerrado sensu stricto, e principalmente das matas de galeria, destacando suas diferenças em resposta ao ambiente, e subsidiando estudos mais completos que englobem todos os estratos da vegetação e que sejam voltados para a conservação e restauração do Cerrado.

No capítulo três exploramos a variação dos atributos funcionais foliares de espécies herbáceo-arbustivas dos ambientes contrastantes de mata de galeria e cerrado sensu stricto para avaliar se esses ambientes selecionam espécies com diferentes estratégias ecológicas e geram comunidades com estrutura funcional diferentes. Encontramos que espécies de savana possuem atributos funcionais mais ligados a estratégias conservativas, enquanto espécies florestais possuem atributos associados a estratégias aquisitivas e que o ambiente de mata de galeria seleciona espécies com atributos principalmente ligados à

competição, portanto gerando uma comunidade funcionalmente mais agrupada, enquanto o cerrado apresenta espécies com conjunto de atributos voltados principalmente para adaptação gerando comunidades funcionalmente mais dispersas. Encontramos também que os ambientes de mata de galeria e cerrado sensu stricto apresentam características edáficas e de disponibilidade de luz distintas que influenciam a seleção de atributos foliares nesses ambientes.

Palavras-chave: padrões florísticos, sub-bosque, florestas ripárias, florestas tropicais, savana, formas de vida, solo, atributos foliares.

General Abstract

This study aims to investigate the floristic, functional, and environmental relationships of understory plant species in gallery forest and cerrado sensu stricto habitats within the Cerrado biome. Gallery forests are forest formations linked to water courses that intersperse the Cerrado Biome and generally occur in mesotrophic soils, in forest strips whose tree canopies touch between the margins of narrow water courses, forming galleries (Ribeiro & Walter 2008). These environments play important hydrological and ecological roles. The cerrado sensu stricto is characterized by a continuous herbaceous-subshrub layer and discontinuous brevi-deciduous woody vegetation on dystrophic and predominantly deep soils. The environments of gallery forest and cerrado sensu stricto are quite different, shading in the forest causes complex ecological implications, both biotic and abiotic at the population, community, and ecosystem levels, mainly in its understory, which is a layer more sensitive to changes. In the cerrado sensu stricto, in addition to the soil, fire is one of the main shaping factors. These environments also contrast in the availability of nutrients and water in the soil, with gallery forests being more humid, fertile, and with a higher content of organic matter. These variations in the environment act as filters, influencing the composition and structure of communities by selecting plant assemblages adapted to each of these environments.

In chapter one, we sought to examine species composition gradients and environmental predictors that influence floristic variation in the Cerrado gallery forest understory through gradient analyses and generalized linear models. Furthermore, we investigated the distribution and sharing of its species with other biomes. We compiled all the species that make up the gallery forest understory in the Cerrado, totaling 1,385 species. We found that the gallery forest understory does not present a consistent pattern of floristic differentiation, showing itself to be highly floristically connected, differing from the patterns found for the arboreal stratum and other types of Cerrado vegetation. Environmental variables linked to water availability such as aridity index and soil water stress were the most important predictors in determining floristic variation in gallery forest understory in the Cerrado. The highest rates of species sharing occurred with the Atlantic Forest (91%), the Caatinga (73%), and the Amazon (65%), presenting only 39 species endemic to the Cerrado gallery forest understory. The results of chapter one show how the gallery forest understory presents a high floristic connection between ecoregions, a result of species adaptations, and the environmental characteristics of the forests, which

serve as shaded and humid dispersal corridors in the middle of the savannah. We reinforce that conservation strategies must consider the uniqueness of the floristic variation of tropical forests and the determinants of all vegetation strata at risk of biodiversity loss.

In chapter two, we sampled and compared the richness, cover, and life forms of species in the lower stratum of the contrasting environments of gallery forest and cerrado sensu stricto. We investigated the influence of canopy openness, amount of litter, and soil variables on the distribution of species that inhabit the understory of these environments. We found a clear contrast between the gallery forest and cerrado sensu stricto environments, with significant variations in the coverage and richness of life forms in each environment, showing low sharing of species and genera between them. The gallery forests presented greater coverage and richness of shrub species, while the cerrado sensu stricto presented greater coverage of graminoids and greater richness of subshrubs. We also found that areas of gallery forest are closer floristically than areas of cerrado sensu stricto. The gallery forests had more fertile soils and higher levels of sand and litter, while the cerrado sensu stricto had greater canopy opening and higher levels of clay and silt in the soil. Canopy openness and silt were positively correlated with species cover in the cerrado sensu stricto understory, and P, Ca, Al, and K were correlated with species cover in the gallery forest understory. In this work, we aim to fill gaps in the understanding of the patterns of the herbaceous-shrub layer of the cerrado sensu stricto, and mainly of the gallery forests, highlighting their differences in response to the environment, and supporting more complete studies that encompass all strata of the vegetation and that are aimed at for the conservation and restoration of the Cerrado.

In chapter three, we explore the variation in leaf functional attributes of herbaceous-shrub species from the contrasting environments of gallery forest and cerrado sensu stricto to assess whether these environments select species with different ecological strategies and generate communities with different functional structures. We found that savanna species have functional attributes more linked to conservation strategies, while forest species have attributes associated with acquisitive strategies and that the gallery forest environment selects species with attributes mainly linked to competition, therefore generating a functionally more dispersed community, while the cerrado presents species with a set of attributes aimed mainly at adaptation, generating functionally more grouped communities. We also found that the gallery forest and cerrado sensu stricto environments

present distinct edaphic and light availability characteristics that influence the selection of leaf attributes in these environments.

Keywords: floristic patterns, forest floor plants, riparian forests, tropical forests, savanna, life forms, soil, leaf traits.

CAPÍTULO 1. O sub-bosque das florestas tropicais apresenta padrões de variação florística diferentes do componente arbóreo? As matas de galeria do Cerrado nos mostram que sim

Does the understory of tropical forests show patterns of floristic variation that differ from the tree component? The gallery forests of the Cerrado show us that it does

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Abstract

Understanding patterns of floristic variation and their determinants is important to support biodiversity conservation. Gallery forests (GF) are narrow strips of forest associated with water courses in the Cerrado and play important hydrological, ecological, and climatic roles, harboring a diverse and endemic flora. However, the understory of tropical forest environments remains poorly studied. Using gradient analyses and generalized linear models, we sought to examine species composition gradients and the environmental predictors that influence floristic variation in the understory of GF in the Cerrado. Furthermore, we investigated the distribution and sharing of its species with other biomes. We compiled all the species that make up the GF understory in the Cerrado, totaling 1,385 species. The GF understory does not show a consistent pattern of floristic differentiation, being highly connected floristically. Thus, the floristic variation of the GF understory behaves differently from the tree stratum and other types of vegetation in the Cerrado. Environmental variables linked to water availability such as aridity index and soil moisture stress were the most important predictors of floristic variation in GF understory. The highest rates of species sharing occurred with the Atlantic Forest (91%), the Caatinga (73%), and the Amazon (65%), with only 39 endemic species to the Cerrado GF understory. Our results show how the GF understory presents a high floristic connection between the ecoregions, due to species adaptations and the environmental characteristics of the GF, which serve as shaded and humid dispersal corridors crossing the savanna. Moreover, conservation strategies must consider the uniqueness of the floristic variation of tropical forests and the determinants of all vegetation strata under the risk of biodiversity loss.

Keywords: Cerrado ecoregions, floristic patterns, forest floor plants, riparian forest, tropical forests.

Introduction

Gallery forests are forest formations linked to watercourses that intertwine the Brazilian savanna, the Cerrado biome, and generally occur in mesotrophic soils. They are forest strips with treetops that connect over narrow watercourses, forming galleries (Ribeiro and Walter 2008). These forests perform important hydrological and ecological functions (Riis et al. 2020), being essential for the maintenance of basins and micro-basins. They act in the interception of rainwater, stabilizing the banks of rivers and streams, and in the thermal balance of the water, in addition to forming ecological corridors and providing shelter and food for animal species that are important for seed dispersal, including adjacent non-forest ecosystems (Johnson et al. 1999, Agnew et al. 2006, Cáceres et al. 2007, Allan et al. 2008, Pert et al. 2010). Gallery forests, like most tropical forests, also act as carbon sinks, removing and storing CO2 from the atmosphere (González-Abella et al. 2021). Despite occupying a small area of the Cerrado (Felfili et al. 2001), they are responsible for more than 20% of the richness of vascular plants in the biome (Flora e Funga do Brasil 2022), harboring a diverse and endemic flora (Felfili et al. 2001, Veneklaas et al. 2005, Lenza et al. 2015, Apodaca et al. 2019).

The Cerrado is located in the central region of Brazil and corresponds to the largest and richest savanna in the world, occupying approximately 2 million km² and covering approximately 24% of the Brazilian territory (Silva and Bates 2001, IBGE 2004, Flora e Funga do Brasil 2022). The diversity of plant communities in the Cerrado is associated with regional factors such as climate and altitude variations and contact zones with other biomes (Amaral et al. 2017, Françoso et al. 2019). In addition, local factors such as variations in relief, topography, as well as soil depth, moisture, and physicochemical conditions are determinants in structuring the Cerrado plant mosaics, composed of forests, savannas, and grasslands (Furley and Ratter 1988, Oliveira-Filho et al. 1989, Ribeiro and Walter 2008, Rodrigues et al. 2019). The large latitudinal and longitudinal variation (approximately 20º) also contributes to the environmental heterogeneity of the Cerrado. The variations due to climate, soil, and proximity to other biomes contributed to the classification of 19 Cerrado ecoregions, which are ecologically and geographically defined regions with similar environmental conditions (Sano et al. 2019, Arruda et al. 2008).

In the Cerrado, gallery forests share tree species with open vegetation formations, such as cerrado *sensu stricto*, which is the savanna vegetation predominant in the biome (Lenza et al. 2015). However, there are species that occur exclusively in gallery forests and do not occur in other types of vegetation in the Cerrado (Oliveira-Filho and Ratter 1995, Lenza et al. 2015). Evidence indicates cyclic expansions of neotropical forests over the Cerrado, connecting the Andean region to the Atlantic region in interglacial periods (Prance 1987, Sobral-Souza et al. 2015). Thus, gallery forests would be remnants of those neotropical forests which, in the last glaciation, which occurred 21–18,000 years ago, retreated to more humid areas associated with watercourses, while the Cerrado savanna expanded (Ledru 1993, Vicentini and Salgado-Labouriau 1996, Arruda et al. 2018). The fact that the Amazon and Atlantic forests, currently separated by the Cerrado, share closely related species and lineages and that gallery forests in the Cerrado have species present in both biomes, supports the connection of these two large blocks of neotropical humid forest in the past (Prance 1987, Terra-Araujo et al. 2015, Ledo and Colli 2017). In this sense, the woody flora of gallery forests in the West and North of the Cerrado have a stronger floristic connection with the forests of the Amazon, while those in the Center-South have a greater floristic connection with the montane semideciduous forests of southeastern Brazil (Oliveira-Filho and Ratter 1995). However, patterns of variation and floristic connection to the understory of gallery forests remain unclear.

The understory of forests is composed of permanent flora as well as seedlings and young individuals of trees that occur transiently as they grow (Gentry and Dodson 1987, Gilliam 2007, Tavora et al. 2023). The understory performs important ecological functions (Deng et al. 2023), including competitive interactions that determine the initial success of tree species and dominant forest species (Gilliam 2007). It also acts in competition with invasive species, contributing to ecosystem stability (Hoffmann et al. 2004), and works as an indicator of the state of the ecosystem as a whole, as it is more sensitive to the occurrence of disturbances (Rasingam and Parthasarathy 2009). Evidence also indicates that the tree and non-tree communities show uncorrelated diversity patterns at the local level, suggesting that different processes shape their diversity and composition (Murphy et al. 2016). In this sense, research focused on the non-tree component of tropical forests has increased in recent decades, but when compared to the tree component, it is still neglected (e.g., Lafrankie et al. 2006, Cicuzza et al. 2013, Spicer et al. 2020, Gallo et al. 2022, Perea et al. 2022, Spicer et al. 2022, Deng et al. 2023).

Plant distribution patterns in the understory of forests can vary due to factors such as climate and historical and evolutionary events (Cicuzza et al. 2013). At the local level, this variation can be influenced by dispersal capacity, edaphic factors, and resource availability (Murphy et al. 2016). The knowledge of composition patterns of understory plant communities is fundamental for the conservation and establishment of restoration goals for different phytogeographic regions that are important for the balance and maintenance of the high diversity of the Cerrado (Verdone and Seidl 2017, Bustamente et al. 2019). In addition, different life forms may require different management and conservation strategies, even within the same community (Murphy et al. 2016).

Approximately 12,700 species of vascular plants occur in the Cerrado (Flora e Funga do Brasil 2022), with non-tree species representing most of this richness, since estimates indicate that there are six non-tree species for each tree species in the Cerrado (Mendonça et al. 2008; Flora and Funga do Brasil 2022). For Cerrado gallery forests, a proportion of four non-tree species for each tree species is estimated (Flora e Funga do Brasil 2022). Given the importance of understanding patterns of species composition and distribution in the permanent understory of Cerrado gallery forests, this work sought to 1) examine species composition gradients and identify the environmental predictors that most influence floristic variation; and 2) investigate the distribution and sharing of understory species in Cerrado gallery forests with other Brazilian biomes.

Considering that Cerrado ecoregions (*sensu* Sano et al. 2019) are characterized by environmental differences, we expected that floristic variation of the understory in Cerrado gallery forests would show overlap patterns consistent with the Cerrado ecoregions *sensu* Sano et al. (2019), as well as the overlap already demonstrated for the herbaceous and tree stratum of cerrado *sensu lato* (Amaral et al. 2017, Françoso et al. 2019). In turn, considering the influence of the Atlantic and Amazon flora on the arboreal component of gallery forests in the Cerrado (Oliveira-Filho and Ratter 1995), we expected that proximity to other biomes would influence floristic variation patterns of the understory in gallery forests, with floristic gradients more associated with the Atlantic Forest and the Amazon. Finally, assuming that soil-related and topographic variables are commonly associated with tree floristic variation in gallery forests (Bueno et al. 2018), we expected that variables linked to soil and water availability would also be important environmental predictors of floristic variation in the understory of Cerrado gallery forests.

Material and methods

Obtaining floristic data

To compile a list of vascular plant species that occur in the understory of Cerrado gallery forests, we consulted the online database of the official Brazilian flora website (Flora e Funga do Brasil 2022, available at: http://floradobrasil.jbrj.gov.br) and the species checklist for the Cerrado (Mendonça et al. 2008). We filtered the databases only for non-tree species that occur in gallery forests in the Cerrado biome. In the Flora e Funga do Brasil platform (2022), we filtered using the option “Ciliary or Gallery Forest”. The ciliary forest understory is less species-rich than the gallery understory (Mendonça et al. 2008); ciliary forest species were afterwards removed with the help of specialists in the flora of the Cerrado and based on the literature. In addition to trees, we also removed exclusively epiphytic plants, aquatic macrophytes, woody vines, and plants classified as “tree/shrub” according to Flora and Funga do Brasil (2022), to limit the list to permanent understory species only. To remove tree species that still remained in the database, we compared our list with species lists from studies published only for the tree stratum in gallery forests in the Cerrado (e.g. Silva Júnior et al. 2001, Marimon et al. 2002, Lopes and Schiavini 2007, Darosci et al. 2021). Species remaining in the “shrub/tree” category were maintained if they had more than 80% of records as shrubs in the SpeciesLink database (www.splink.org.br). This list was also evaluated by botanists who are specialists in the flora of the Cerrado, who contributed to determining which species with dubious information should be kept or not. We also excluded infra-specific taxa (variety, subspecies, form) and alien species. We also included in this dataset species recorded in our own inventories carried out in the understory of gallery forests in the state of Goiás and the Federal District. All species names from different sources were checked (synonyms, non-accepted names, names with more than one status, etc.) using the 'flora' package v.0.3.4 (Carvalho 2020), which contains all names and synonyms accepted in Flora and Funga do Brasil (2022).

From the list of permanent species of the gallery forest understory in the Cerrado, we compiled all the records of their occurrence available for Brazil in the Global Biodiversity Information Facility repository (Available at: www.gbif.org), on the Distributed Information System for Biological Collections or speciesLink (Available at: https://specieslink.net/) and in the database of the Botanical Garden of Rio de Janeiro - JABOT (Available at: http://rb.jbrj.gov.br). The matrix of records from the three databases totaled 834,899 occurrences, for which the following information was available: species names, localities, collectors, collection number, and geographic coordinates. In the first stage of data cleaning, we excluded all duplicates and collections with uncertain identifications (*cf* and *aff*). Subsequently, to clean up biased geographic coordinates, such as inaccurate coordinates located at the centroid of the country or states, located at sea or missing coordinates, we used the package 'CoordinateCleaner' v.2.0-18 (Zizka et al. 2019) in R software v.3.6.0 (R Core Team, 2019). In the end, we obtained records of the occurrence of understory species in Cerrado gallery forests that occur in other Brazilian biomes by overlapping the records with the polygon of biomes *sensu* IBGE (2012). Finally, the occurrence records of understory species in the Cerrado gallery forests in the other Brazilian biomes made up matrix 1.

Construction of the species occurrence grid by Cerrado ecoregions

We related the records of occurrence of understory species of Cerrado gallery forests to the 19 Cerrado ecoregions using the map *sensu* Sano et al. (2019). The Cerrado ecoregion classification spatial layer was divided into grids with cells of ~9.3x9.3 km (5 arc-min). Each grid cell was considered a sampling unit (SU), henceforth called a site. Then, the species occurrence data were overlapped with this polygon, resulting in 5,257 sites that contained species occurrences. This step was carried out in ArcGIS v.10.2.1. We only considered species that had more than one record per site, as there is a high possibility that species with a single record at a site could be a specimen with erroneous identification. Species with more than one record, but which occurred in only one site (unicates) were not removed, as they may represent endemic species. Subsequently, the number of sites in the Cerrado ecoregions with species occurrence reduced from 5,257 to 1,656 sites. And finally, we generated matrix 2 of presence and absence of 1,385 species and 83,602 occurrences for the Cerrado ecoregions. The sites coordinates and number of species found in each one are available in Appendix S1.

Environmental data selection

We selected 20 environmental variables (Appendix S2) that, according to the literature, are important predictors of floristic variation in gallery forests in the Cerrado (Bueno et al. 2018). These included: four soil variables obtained from the “Soil Grids” database (Hengl et al. 2014); three soil moisture stress measures obtained from the Global High-Resolution Soil-Water Balance database (Trabucco and Zomer 2010); a topographic variable (Topographic Moisture Index; TWI) obtained from the ENVIREM database - Environmental Rasters for Ecological Modeling (http://envirem.github.io/#varTable). Also, 12 bioclimatic variables were used, including mean annual temperature and seven precipitation variables, from the “CHELSA” database (Karger et al. 2017); water vapor pressure from “WorldClim 2.0” (Fick and Hijmans 2017); aridity index and two variables of evapotranspiration obtained from the "Global Aridity and PET Database" (Trabucco and Zomer 2009). We extracted the variable values for each site at a distance of ~10 km from its centroid. Means and standard deviations for these variables by ecoregion are presented in Appendix S3.

Data analyses

To verify the species composition gradients of the understory of Cerrado gallery forests, we performed an ordination based on the Non-Metric Multidimensional Scaling (NMDS) using matrix 2. Here we used Simpson's dissimilarity index and trymax = 100, which is indicated when the data show great variation in species richness between communities (Baselga et al. 2007), as occurs with our data. To perform NMDS, we used the 'metaMDS' function, in the 'vegan' package version 2.5-6 (Oksanen et al. 2019).

In order to investigate the variables with the highest correlation with floristic composition (the two NMDS axes), we ran a correlation analysis using the 'corrplot' package (Wei et al. 2017) and excluded those variables that presented $r<0.3$ and $P<0.05$. This step selected the variables pH, soil water stress (min), precipitation of wettest quarter, precipitation of coldest quarter, seasonal potential evapotranspiration, and aridity index. We verified the presence of collinearity between the remaining variables based on the Variance Inflation Factor – VIF (Quinn and Keough 2002) applying a cutoff threshold of 10 through the 'vifstep' function of the 'usdm' package (Naimi 2015), as recommended for ecological data (e.g., Borcard et al. 2011).

Then, to identify the environmental variables that determine the floristic variation of the understory of gallery forests in the Cerrado, we constructed Generalized Linear Models (GLM) using the Gaussian family. We used the two NMDS axes as response variables and the six environmental variables selected in the previous step as candidate predictor variables. To select the best model for each NMDS axis, we used the "dredge" function from the "MuMIn" package (Barton, 2022). Here, the models were ranked by the Akaike Information Criterion (AICc) and delta < 2. We confirmed the assumption of normality of the residuals (Appendix S4). We checked the spatial autocorrelation of the residuals using Moran's correlogram through the 'correlog' function in the 'pgirmess' package, applying a Bonferroni correction. To control the spatial autocorrelation in the GLM we included spatial filters in the model (Moran's Eigenvector Maps; Peres-Neto and Legendre 2010), which were progressively selected using the 'spdep' package.

Subsequently, we analyzed the GLM containing both the environmental variables and the selected spatial filters. We plotted the environmental variables selected in the GLM onto the NMDS ordering space in order to understand how these environmental predictors influence the floristic variation gradient.

Finally, we used matrix 1 composed of all occurrence records of understory species in Cerrado gallery forests by biome to verify their overlap with other Brazilian biomes.

Results

We compiled 1,988 species for the Cerrado gallery forest understory, 1,742 of which were obtained from the Flora e Funga platform in Brazil (2022), 203 from the work of Mendonça et al. (2008), and 43 species added from our floristic field surveys. After all cleaning steps, the number of species was reduced to 1,385.

The Cerrado ecoregions have a wide range of extensions, so Alto Parnaíba, presented 64 sites; Alto São Francisco 116 sites; Araguaia Tocantins 169 sites; Bananal 20 sites; Basaltos do Paraná 224 sites; Bico de Papagaio 39 sites; Chapada dos Parecis 36 sites; Chapadão do São Francisco 71 sites; Complexo Bodoquena 55 sites; Costeiro 12 sites; Depressão Cárstica do São Francisco 49 sites; Depressão Cuiabana 26 sites; Floresta de Cocais 43 sites; Jequitinhonha 63 sites; Paracatu 69 sites; Paraná Guimarães 216 sites; Parnaguá 26 sites; Planalto Central 303 sites; and Vão do Paranã 35 sites (Table 1).

Table 1. Cerrado ecoregions and number of sites, species, and occurrences surveyed in this work.

Ecoregion	**Number of sites**	**Number of species**	**Number of occurrences**
Alto Parnaíba	64	372	1,281
Alto São Francisco	116	881	7,612
Araguaia Tocantins	169	756	5,920
Bananal	20	225	510
Basaltos do Paraná	224	981	18,255
Bico do Papagaio	39	325	1,014
Chapada dos Parecis	36	347	1,042
Chapadão do São Francisco	71	417	1,468
Complexo Bodoquena	55	511	2,782

Costeiro	12	136	483
Depressão Cárstica do São Francisco	49	413	1,152
Depressão Cuiabana	26	361	1,247
Floresta de Cocais	43	268	792
Jequitinhonha	63	609	3,774
Paracatu	69	848	2,577
Paraná Guimarães	216	675	9,034
Parnaguá	26	203	446
Planalto Central	303	1.088	23,332
Vão do Paranã	35	373	881

The recorded species belong to 497 genera and 115 families, the families with the highest species richness are Fabaceae (157 species), Poaceae (111), and Rubiaceae (97). The three richest genera were *Piper* (29 species), *Psychotria* (22), and *Chamaecrista* (21; Table 2). The species with the greatest distribution in the sites were *Cordiera sessilis* (Vell.) Kuntze (149 sites), *Psychotria carthagenensis* Jacq. (133), *Siparuna guianensis* Aubl. (122), *Macairea radula* (Bonpl.) DC. (115), and *Tocoyena formosa* (Cham. and Schltdl.) K. Schum. (105). The most frequent genera in the sites were *Piper* (453 sites), *Palicourea* (289), *Miconia* (282), *Ludwigia* (227), and *Aeschynomene* (225), and the most frequent families were Fabaceae (1,619 sites), Rubiaceae (1,441), Poaceae (907), Melastomataceae (697), and Asteraceae (535). We found 101 species occurring in more than 80% of the Cerrado ecoregions (Appendix S5), including *Aeschynomene paniculata* Willd. ex Vogel, *Chiococca alba* (L.) Hitchc., *Cordiera sessilis* (Vell.) Kuntze, *Cyperus laxus* Lam., *Marsypianthes chamaedrys* (Vahl) Kuntze, and *Commelina erecta* L.

Table 2. The ten richest families and genera in the understory of gallery forests in the Cerrado, and the number of sites where they occurred.

Families	Number of species	Number of sites	Genera	Number of species	Number of sites
Fabaceae	157	1,619	*Piper*	29	453
Poaceae	111	907	*Psychotria*	22	212
Rubiaceae	97	1,441	*Chamaecrista*	21	200
Asteraceae	75	535	*Habenaria*	21	124
Orchidaceae	62	320	*Serjania*	18	205
Malvaceae	46	461	*Cyperus*	17	132
Cyperaceae	45	384	*Desmodium*	17	224
Lamiaceae	40	381	*Ludwigia*	17	227

Apocynaceae	39	255	*Ipomoea*	16	79
Melastomataceae	37	697	*Turnera*	16	131

The ordination analysis showed that there are no clear gradients of floristic differentiation along the gallery forests of the Cerrado (Fig. 1), i.e., sites located in geographically distant ecoregions were floristically close in the multidimensional space (Fig. 1). In addition, it was not possible to visualize a separation of gradients associated with proximity to the biomes adjacent to the Cerrado.

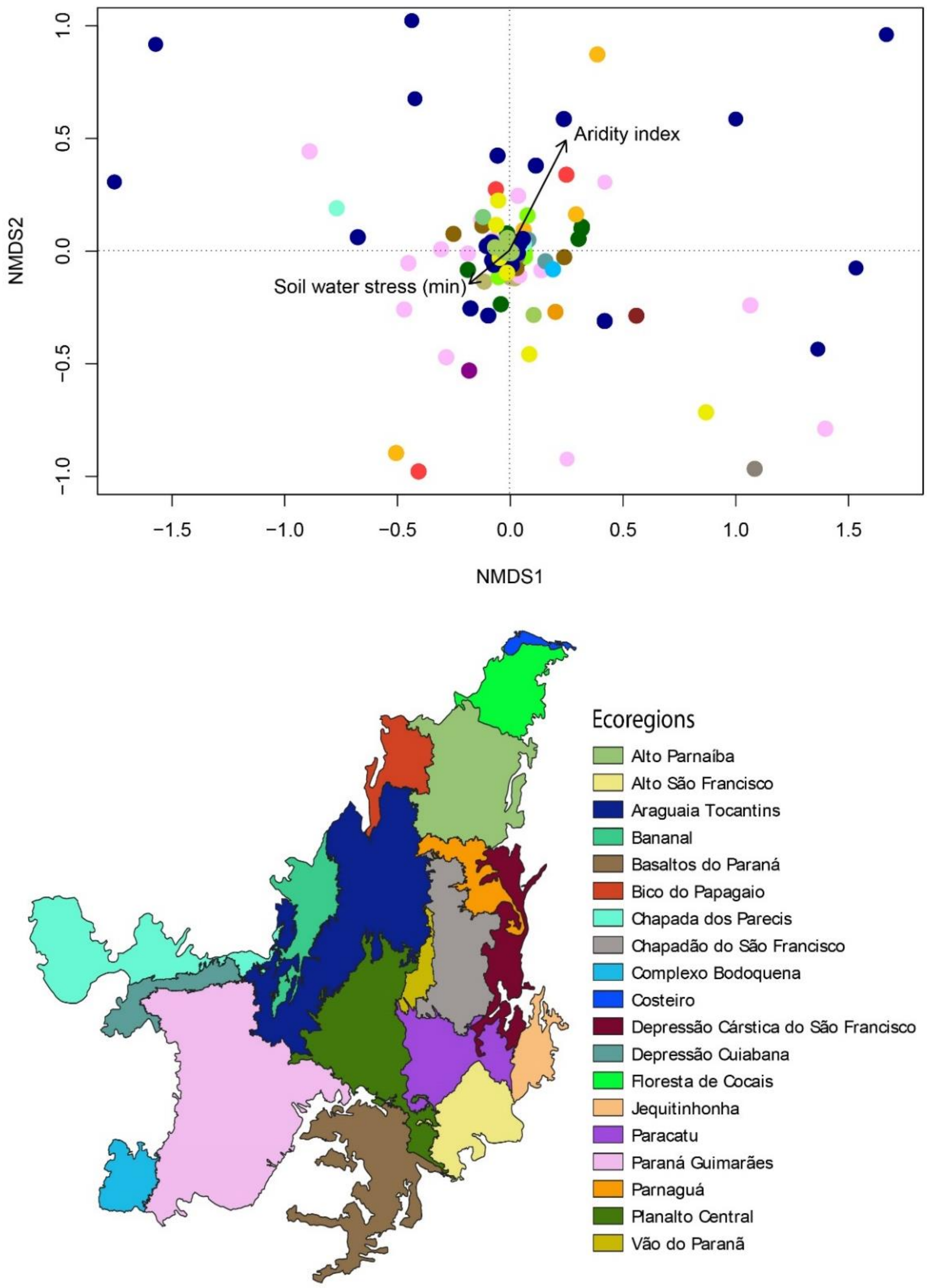

Figure 1. Non-metric multidimensional scaling (NMDS; K = 2; stress = 0.02) of gallery forest species composition at the 1,656 sites in the Cerrado, and their overlap with the environmental predictors that most influenced the selected floristic variation gradient, according to the generalized linear models.

In the GLM for axis 1 of the NMDS, aridity index, and soil moisture stress (min) were the most important environmental predictors in determining floristic variation in the Cerrado gallery forest understory (Fig. 1; Table 3). As for the GLM of the second NMDS axis, no environmental predictor was significantly associated with floristic variation.

Table 3. Generalized linear model (GLM) fit to the understory floristic variation in gallery forests in the Cerrado, and its relationship with selected environmental variables. Values in bold indicate P=<0.05. MEM: Moran's eigenvector maps selected for controlling spatial autocorrelation.

	Estimate	**Stand. Error**	**t-value**	**P-value**
(Intercept)	2.70e-17	3.36e-03	0.000	1.0000
Aridity	-1.42e-02	5.58e-03	-2.551	**0.0108***
Seasonal potential evapotranspiration	5.47e-03	3.74e-03	1.462	0.1439
Soil water stress (min)	-1.31e-02	5.73e-03	-2.288	**0.0223***
MEM5	5.80e-03	3.64e-03	1.592	0.1115
pH	3.35e-02	2.161e-02	1.552	0.1211

The understory species of Cerrado gallery forests are widely distributed in other biomes in Brazil. The highest sharing rates occurred with the Atlantic Forest (91%), Caatinga (73%), and the Amazon (65%) (Fig. 2). Of the 1,385 species surveyed, we recorded only 39 species endemic to Cerrado gallery forests, such as *Ditassa obscura* (E.Fourn.) Farinaccio and T.U.P.Konno, *Galium espiniacicum* Dempster, *Isachne goiasensis* Renvoize, *Justicia irwinii* Wassh., and *Selaginella saltuicola* Valdespino (Appendix S6).

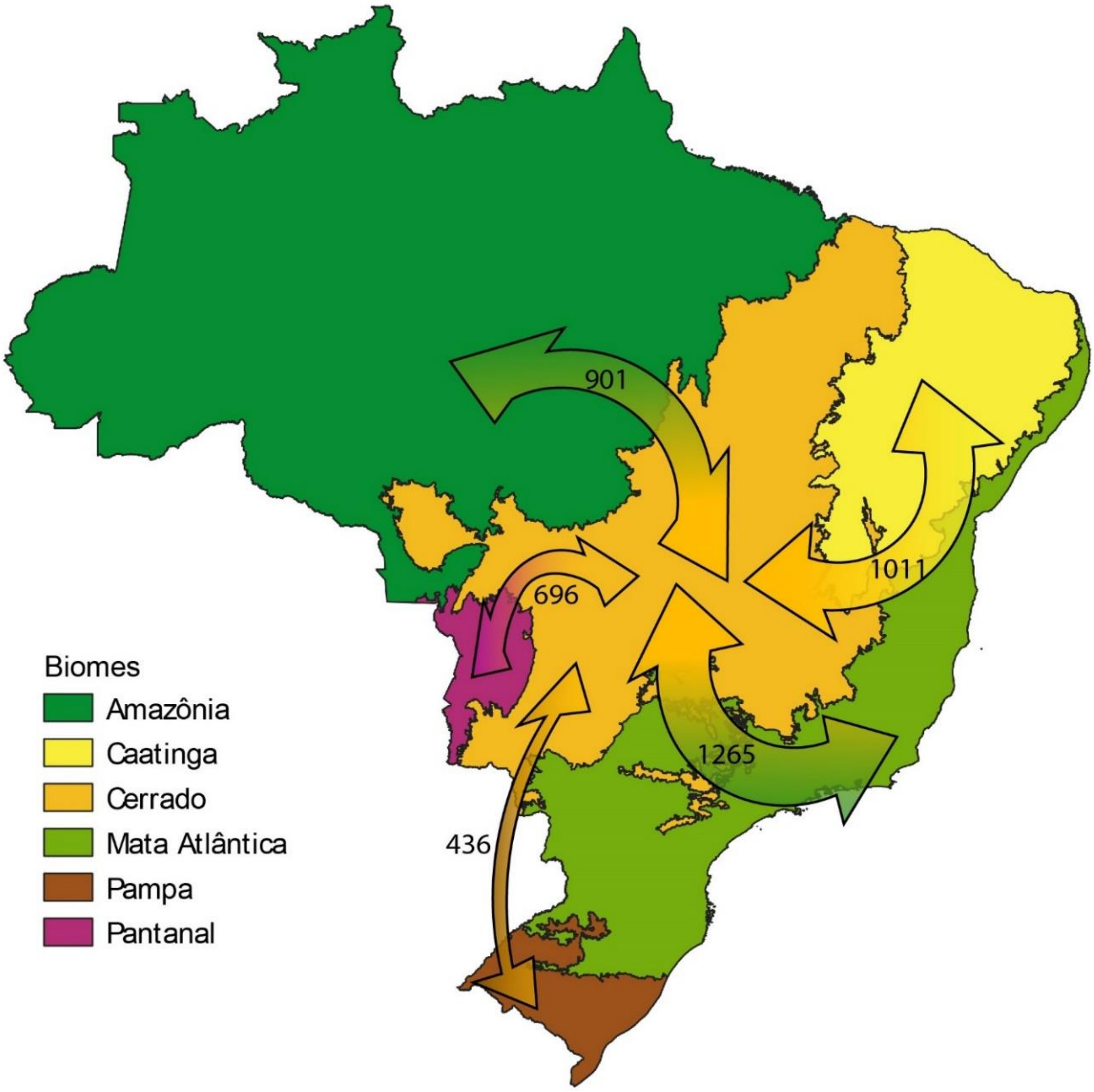

Figure 2. Sharing of the 1,385 species of the Cerrado gallery forest understory with the other Brazilian biomes (*sensu* IBGE 2012). The width of the connections (arrows) is proportional to the number of shared species.

Discussion

Floristic gradients in the understory of Cerrado Gallery forests

Our study is a pioneer in investigating the permanent flora of the Cerrado gallery forest understory, revealing its floristic variation gradients, as well as its environmental predictors, and its floristic connections with adjacent biomes. We provided an unprecedented database of species occurrence for the understory of Cerrado gallery forests (Appendix S7) and showed that the gradients of floristic variation in the understory differ from those observed for the other strata of Cerrado gallery forests. We thus reinforce the importance of investigating other vegetation strata of tropical forests to outline more comprehensive conservation strategies.

In this sense, the permanent species of the understory of gallery forests in the Cerrado represent 16% of the entire flora of the biome and are widely distributed, not presenting floristic districts corresponding to those proposed by Sano et al. (2019). In addition, these species occur throughout the Brazilian territory, i.e., the sharing of species occurs with all biomes, but predominantly with the Atlantic Forest, Caatinga, and the Amazon (Fig. 2). However, it was possible to record 39 species endemic to the gallery forests of the Cerrado. This is a low number compared to the core regions of the Cerrado, which can present a high level of endemism, especially in regions of higher elevation (Vidal Júnior et al. 2019). This reinforces our results that, in the Cerrado, the understory of gallery forests is mostly composed of widely distributed species. We also show for the first time that the understory flora of Cerrado gallery forests does not show consistent patterns of floristic variation, as it was not possible to register the association of floristic gradients with the Cerrado ecoregions as well as with the proximity of other biomes.

The absence of floristic patterns seems to be associated with the expressive sharing of species. Thus, our results indicate that plant communities in the understory of Cerrado gallery forests are predominantly floristically interconnected and that their species are probably dispersed across different ecoregions. The Araguaia-Tocantins and Paraná-Guimarães ecoregions had more dispersed sites than the other ecoregions (Fig. 1). Here, the dispersion of sites may be related to the fact that these ecoregions have been classified as areas of high richness and endemism (Ratter et al. 2006, Françoso et al. 2019, Amaral et al. 2017), which may have influenced this separation since some of the 39 endemic species of the Cerrado gallery forest understory occur there. In addition, the Araguaia-Tocantins and Paraná-Guimarães ecoregions are also closer to the Amazon and are the two largest ecoregions, with Paraná-Guimarães occupying 17.9% and Araguaia-Tocantins, 14% of the Cerrado. Therefore, the number of sites, the sampling effort, the diversity, and the endemism of these regions may have influenced their more dispersed patterns.

The Central Plateau is the third largest ecoregion in the Cerrado, occupying 8.9% of the biome's area, and is also the area that presented the greatest sampling effort, with a high number of occurrence records (23,332 records), and the highest number of sites with species occurrence records (303 sites). This ecoregion is one of the best-studied areas of the Cerrado, and most of the vascular species recorded for the biome (more than 40%) occur there (Proença et al. 2001, Flora and Funga do Brasil 2022). The Central Plateau was also one of the ecoregions whose sites were most concentrated in the NMDS, exerting a strong influence on the formation of the floristic interconnection gradient. In fact, this was the ecoregion with the highest number of shared species, with 1,088 of the 1,385 species occurring in some other Cerrado ecoregion.

There is evidence of floristic connections of tree species between gallery forests of the western and northern Cerrado with the rainforests of the Amazon and between gallery forests of the central-southern Cerrado and the Atlantic Forest (Oliveira-Filho and Ratter 1995). This same pattern of floristic connection also occurs for the cerrado *sensu lato* (Françoso et al. 2019) and for the herbaceous-shrub communities (Amaral et al. 2017), where the vegetation further south in the Cerrado is influenced by the Atlantic Forest while the vegetation to the northwest of the Cerrado is influenced by the Amazon rainforest (Françoso et al. 2019). However, we did not find this pattern for the understory of gallery forests. Here, the northernmost ecoregions are ordered together with the southernmost ecoregions, indicating an interconnection even between distant areas bordering different biomes.

In fact, soils from gallery forests present chemical and physical differences in relation to soils from savanna formations, mainly due to the hydrographic regime and topography (Haridasan 1998). In gallery forests, there are soils with higher levels of organic matter (Reatto et al. 2008), nutrients (Silva et al. 2008), and water availability (Furley 1992, Oliveras et al. 2016). The availability of water in the soil is one of the most important factors for the occurrence of gallery forests in the Cerrado (Bueno et al. 2018). This pattern of greater availability of water and nutrients in forests than in savannas has been reported for other savannas and adjacent forests in tropical regions (Singh et al. 2017). At the same time, shading also creates a milder microclimate in the understory of gallery forests, in contrast to the drier and windier environments of cerrado. Fire events in gallery forests are also less frequent (Biddulph and Kellman 1998) and less intense than in the open cerrado (Hoffmann et al. 2012) since the understory has fewer grasses and fuel material (Hoffmann et al. 2012). All this contributes to the understory environment being a less stressful environment than the open cerrado. Light availability is one of the main limiting factors in the understory, which selects specific acquisition strategies in herbaceous species, such as greater leaf area, and larger leaves, with higher concentrations of chlorophyll and nitrogen (Amaral et al. 2021). Since species are shade-tolerant, other environmental factors such as nutrient and water availability may be less limiting in the selection of species in the understory of gallery forests. Thus, we believe that the understory may present different distribution patterns when compared to the tree stratum, as it responds differently to light, nutrient, and temperature gradients (Murphy et al. 2016).

Determinants of floristic variation in gallery forest understory

Soil moisture stress and the aridity index were the main factors related to the floristic variation of gallery forest understory in the Cerrado. This is in line with the evidence that the flora of gallery forests in the Cerrado is influenced mainly by environmental factors linked to water availability and soil fertility (Oliveras et al. 2016, Bueno et al. 2018). In this sense, evidence indicates that gallery forests located in areas with lower rainfall and seasonal water supply may not sustain a closed tree canopy (Oliveras et al. 2016), which influences the colonization of partially shade-tolerant species. In turn, a more regular water regime and a shallower water table allow gallery forests to persist in savanna landscapes. However, gallery forests in the Cerrado can also be seasonally flooded, depending on the water regime and the depth of the water table (Correia et al. 2001), which influences the selection and diversity of species in their communities (Ribeiro and Walter 2008). In addition, variables related to the hydrographic regime are related to the variation in species richness in gallery forests, i.e., areas that are seasonally flooded due to a shallow water table tend to have less richness of herbaceous species due to the limiting effect of flooding on the selection and development of herbaceous plants (Xavier et al. 2019).

The low number of endemic gallery forest species in the Cerrado confirms that this environment works as a dispersal corridor between the Cerrado and other biomes. These results contrast with what is observed in open cerrado environments, where high environmental variation and extreme conditions cause a high rate of endemism, especially in relation to altitude, which also promotes distinct climatic niches, as occurs with rocky fields (Simon and Proença 2000, Martinelli 2007, Amaral et al. 2017). We expected that the Cerrado gallery forest understory would share more species with the Amazon than with the Caatinga. However, the Caatinga was the second biome to share more species with the Cerrado, after the Atlantic Forest. Ecoregions such as the Depressão Cárstica do

São Francisco, which shares 361 gallery forest understory species with the Caatinga, may have contributed to this result, as there are authors who defend the inclusion of the Depressão Cárstica do São Francisco in the Caatinga biome, not in the Cerrado (Silva et al. 2017). The Depressão Cárstica do São Francisco is an area of sedimentary plateaus, which concentrates a large part of the dry seasonal tropical forest that occurs along the middle valley of the São Francisco River (Silva et al. 2017). It presents a dry environment, with the lowest average annual precipitation in the Cerrado (890 mm), and unique biophysical characteristics (Sano et al. 2019), very similar to the Caatinga. Additionally, studies show that about 50% of the flora in the Amazon is undersampled and poorly represented in herbaria (Brazil Flora Group et al. 2022), which may help explain the lower overlap with Cerrado gallery forests, found in our study.

Perspectives

The permanent understory species of gallery forests can represent up to 39% of the understory richness in Cerrado areas (Tavora et al. 2023). In other tropical forests, they can represent 40 to 50% of the total number of species (Gentry and Dodson 1987, Mayfield and Daily 2005;,Linares-Palomino et al. 2009). Even so, this vegetation component is still poorly studied and sampled in studies, where most of the effort is still focused on the tree stratum. Brazilian environmental legislation classifies gallery forests as permanent protection areas (Brasil 2012). However, changes in land use, mainly due to the expansion of agriculture and livestock in areas of the Cerrado, have jeopardized these ecosystems and increased disturbances (Sano et al. 2009). This increase in disturbances especially affects understory species in gallery forests. These species are a sensitive component of the vegetation, being one of the first to respond to the occurrence of disturbances (Gilliam 2007). In these altered environments, species replacement and suppression by invasive species may occur (Rasingam and Parthasarathy 2009), affecting the regulation of important ecosystem processes performed by this stratum, such as nutrient cycling and tree regeneration (Gilliam 2007). Our work shows that the stratum formed by permanent species of the understory of gallery forests in the Cerrado is interconnected. We believe that these forests are refuges for these small plants, highly dependent on this shaded and humid environment, which are connected in these forest strips. These gradients, however, deserve to be revisited in studies using abundance data, given the limitations of working with occurrence data only. This reinforces the need for more inventories in the understory of gallery forests. We also reaffirm the importance of gallery forests as dispersal corridors and maintainers of biodiversity, and their inclusion in public policies for vegetation management is important to allow the creation of conservation plans that support more diverse and resilient communities. Finally, we draw attention to the fact that the uniqueness of floristic variation in the different strata of tropical forests and its determinants must be considered in biodiversity conservation strategies.

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Data archiving statement

The floristic data that support the findings of this study are openly available in the Brazilian flora database (Available at: http://floradobrasil.jbrj.gov.br), in the Global Biodiversity Information Facility repository (Available at: www.gbif.org), in the database of the Botanical Garden of Rio de Janeiro - JABOT (Available at: http://rb.jbrj.gov.br) and SpeciesLink database (Available at https://specieslink.net/). Other data are available in the Supplementary Material of this article.

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SUPPORTING INFORMATION

Appendix S1 - Geographic coordinates and species richness for 1,656 sites belonging to 19 Cerrado ecoregions analyzed in this study.

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Alto Parnaíba	BG179	-45.1041	-7.3801	27
Alto Parnaíba	BI168	-46.0241	-7.5474	23
Alto Parnaíba	BI177	-45.2714	-7.5474	15
Alto Parnaíba	AU188	-44.3514	-6.3764	13
Alto Parnaíba	BC179	-45.1041	-7.0455	12
Alto Parnaíba	AK177	-45.2714	-5.5401	9
Alto Parnaíba	AZ204	-43.0132	-6.7946	7
Alto Parnaíba	BM178	-45.1878	-7.8819	7
Alto Parnaíba	BE186	-44.5187	-7.2128	6
Alto Parnaíba	BI167	-46.1078	-7.5474	6
Alto Parnaíba	CA188	-44.3514	-9.0528	6
Alto Parnaíba	BH179	-45.1041	-7.4637	5
Alto Parnaíba	BY199	-43.4314	-8.8855	4
Alto Parnaíba	AI178	-45.1878	-5.3728	3
Alto Parnaíba	AQ189	-44.2678	-6.0419	3
Alto Parnaíba	AG174	-45.5223	-5.2055	2
Alto Parnaíba	AI179	-45.1041	-5.3728	2
Alto Parnaíba	AM177	-45.2714	-5.7073	2
Alto Parnaíba	AN167	-46.1078	-5.7910	2
Alto Parnaíba	AP161	-46.6096	-5.9583	2
Alto Parnaíba	AV196	-43.6823	-6.4601	2
Alto Parnaíba	BC182	-44.8532	-7.0455	2
Alto Parnaíba	BV160	-46.6932	-8.6346	2
Alto Parnaíba	BZ199	-43.4314	-8.9692	2
Alto Parnaíba	CE165	-46.2751	-9.3874	2
Alto Parnaíba	CE189	-44.2678	-9.3874	2
Alto Parnaíba	AC176	-45.3550	-4.8710	1
Alto Parnaíba	AG172	-45.6896	-5.2055	1
Alto Parnaíba	AG182	-44.8532	-5.2055	1
Alto Parnaíba	AK154	-47.1951	-5.5401	1
Alto Parnaíba	AK163	-46.4423	-5.5401	1
Alto Parnaíba	AK167	-46.1078	-5.5401	1
Alto Parnaíba	AM156	-47.0278	-5.7073	1
Alto Parnaíba	AM176	-45.3550	-5.7073	1
Alto Parnaíba	AO194	-43.8496	-5.8746	1
Alto Parnaíba	AP163	-46.4423	-5.9583	1
Alto Parnaíba	AP188	-44.3514	-5.9583	1
Alto Parnaíba	AP193	-43.9332	-5.9583	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Alto Parnaíba	AS195	-43.7659	-6.2092	1
Alto Parnaíba	AV165	-46.2751	-6.4601	1
Alto Parnaíba	AV182	-44.8532	-6.4601	1
Alto Parnaíba	AV202	-43.1805	-6.4601	1
Alto Parnaíba	BA182	-44.8532	-6.8783	1
Alto Parnaíba	BD179	-45.1041	-7.1292	1
Alto Parnaíba	BD188	-44.3514	-7.1292	1
Alto Parnaíba	BE163	-46.4423	-7.2128	1
Alto Parnaíba	BF179	-45.1041	-7.2964	1
Alto Parnaíba	BG176	-45.3550	-7.3801	1
Alto Parnaíba	BG178	-45.1878	-7.3801	1
Alto Parnaíba	BJ166	-46.1914	-7.6310	1
Alto Parnaíba	BJ193	-43.9332	-7.6310	1
Alto Parnaíba	BM197	-43.5987	-7.8819	1
Alto Parnaíba	BP196	-43.6823	-8.1328	1
Alto Parnaíba	BT172	-45.6896	-8.4674	1
Alto Parnaíba	BU160	-46.6932	-8.5510	1
Alto Parnaíba	BU161	-46.6096	-8.5510	1
Alto Parnaíba	BW177	-45.2714	-8.7183	1
Alto Parnaíba	BX190	-44.1841	-8.8019	1
Alto Parnaíba	BY180	-45.0205	-8.8855	1
Alto Parnaíba	BY181	-44.9369	-8.8855	1
Alto Parnaíba	BY193	-43.9332	-8.8855	1
Alto Parnaíba	BZ163	-46.4423	-8.9692	1
Alto Parnaíba	CA189	-44.2678	-9.0528	1
Alto Parnaíba	CB169	-45.9405	-9.1365	1
Alto São Francisco	GR196	-43.6823	-19.1729	196
Alto São Francisco	HE164	-46.3587	-20.2602	113
Alto São Francisco	GV195	-43.7659	-19.5074	104
Alto São Francisco	GS198	-43.5150	-19.2565	63
Alto São Francisco	GS187	-44.4350	-19.2565	58
Alto São Francisco	GT197	-43.5987	-19.3402	44
Alto São Francisco	GY194	-43.8496	-19.7583	42
Alto São Francisco	GZ196	-43.6823	-19.8420	42
Alto São Francisco	GW194	-43.8496	-19.5911	40
Alto São Francisco	GP195	-43.7659	-19.0056	37
Alto São Francisco	GI196	-43.6823	-18.4202	23
Alto São Francisco	GP196	-43.6823	-19.0056	23
Alto São Francisco	GS197	-43.5987	-19.2565	23
Alto São Francisco	GV192	-44.0169	-19.5074	22
Alto São Francisco	GI195	-43.7659	-18.4202	21
Alto São Francisco	FV181	-44.9369	-17.3329	18

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Alto São Francisco	GV189	-44.2678	-19.5074	17
Alto São Francisco	GG196	-43.6823	-18.2529	15
Alto São Francisco	GI187	-44.4350	-18.4202	15
Alto São Francisco	GO195	-43.7659	-18.9220	15
Alto São Francisco	GD192	-44.0169	-18.0020	14
Alto São Francisco	GQ197	-43.5987	-19.0893	13
Alto São Francisco	GW192	-44.0169	-19.5911	12
Alto São Francisco	GB190	-44.1841	-17.8347	11
Alto São Francisco	HE172	-45.6896	-20.2602	11
Alto São Francisco	HF172	-45.6896	-20.3438	11
Alto São Francisco	GM175	-45.4387	-18.7547	10
Alto São Francisco	GW191	-44.1005	-19.5911	10
Alto São Francisco	GQ196	-43.6823	-19.0893	9
Alto São Francisco	GZ192	-44.0169	-19.8420	9
Alto São Francisco	HE174	-45.5223	-20.2602	9
Alto São Francisco	GM187	-44.4350	-18.7547	8
Alto São Francisco	GU199	-43.4314	-19.4238	8
Alto São Francisco	GG190	-44.1841	-18.2529	7
Alto São Francisco	GO193	-43.9332	-18.9220	7
Alto São Francisco	GP192	-44.0169	-19.0056	7
Alto São Francisco	GS200	-43.3478	-19.2565	7
Alto São Francisco	GC189	-44.2678	-17.9183	6
Alto São Francisco	GZ193	-43.9332	-19.8420	6
Alto São Francisco	GH170	-45.8569	-18.3365	5
Alto São Francisco	GN195	-43.7659	-18.8383	5
Alto São Francisco	GQ188	-44.3514	-19.0893	5
Alto São Francisco	GQ195	-43.7659	-19.0893	5
Alto São Francisco	GR165	-46.2751	-19.1729	5
Alto São Francisco	GV199	-43.4314	-19.5074	5
Alto São Francisco	GW199	-43.4314	-19.5911	5
Alto São Francisco	FY183	-44.7696	-17.5838	4
Alto São Francisco	GR198	-43.5150	-19.1729	4
Alto São Francisco	GT198	-43.5150	-19.3402	4
Alto São Francisco	HO173	-45.6060	-21.0965	4
Alto São Francisco	HP173	-45.6060	-21.1802	4
Alto São Francisco	GF177	-45.2714	-18.1692	3
Alto São Francisco	GH190	-44.1841	-18.3365	3
Alto São Francisco	GK194	-43.8496	-18.5874	3
Alto São Francisco	GO196	-43.6823	-18.9220	3
Alto São Francisco	GW193	-43.9332	-19.5911	3
Alto São Francisco	HF167	-46.1078	-20.3438	3
Alto São Francisco	HG172	-45.6896	-20.4274	3

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Alto São Francisco	GB189	-44.2678	-17.8347	2
Alto São Francisco	GC185	-44.6023	-17.9183	2
Alto São Francisco	GC194	-43.8496	-17.9183	2
Alto São Francisco	GE195	-43.7659	-18.0856	2
Alto São Francisco	GG194	-43.8496	-18.2529	2
Alto São Francisco	GG195	-43.7659	-18.2529	2
Alto São Francisco	GH194	-43.8496	-18.3365	2
Alto São Francisco	GK169	-45.9405	-18.5874	2
Alto São Francisco	GM182	-44.8532	-18.7547	2
Alto São Francisco	GR181	-44.9369	-19.1729	2
Alto São Francisco	GS196	-43.6823	-19.2565	2
Alto São Francisco	GT177	-45.2714	-19.3402	2
Alto São Francisco	GT200	-43.3478	-19.3402	2
Alto São Francisco	GU192	-44.0169	-19.4238	2
Alto São Francisco	GU198	-43.5150	-19.4238	2
Alto São Francisco	GX191	-44.1005	-19.6747	2
Alto São Francisco	GX193	-43.9332	-19.6747	2
Alto São Francisco	GX197	-43.5987	-19.6747	2
Alto São Francisco	HB169	-45.9405	-20.0093	2
Alto São Francisco	HD172	-45.6896	-20.1765	2
Alto São Francisco	HH171	-45.7732	-20.5111	2
Alto São Francisco	GC193	-43.9332	-17.9183	1
Alto São Francisco	GD195	-43.7659	-18.0020	1
Alto São Francisco	GE188	-44.3514	-18.0856	1
Alto São Francisco	GG186	-44.5187	-18.2529	1
Alto São Francisco	GH171	-45.7732	-18.3365	1
Alto São Francisco	GH177	-45.2714	-18.3365	1
Alto São Francisco	GH186	-44.5187	-18.3365	1
Alto São Francisco	GJ193	-43.9332	-18.5038	1
Alto São Francisco	GK176	-45.3550	-18.5874	1
Alto São Francisco	GK193	-43.9332	-18.5874	1
Alto São Francisco	GK195	-43.7659	-18.5874	1
Alto São Francisco	GL193	-43.9332	-18.6711	1
Alto São Francisco	GM181	-44.9369	-18.7547	1
Alto São Francisco	GN194	-43.8496	-18.8383	1
Alto São Francisco	GP177	-45.2714	-19.0056	1
Alto São Francisco	GQ166	-46.1914	-19.0893	1
Alto São Francisco	GQ198	-43.5150	-19.0893	1
Alto São Francisco	GR175	-45.4387	-19.1729	1
Alto São Francisco	GR200	-43.3478	-19.1729	1
Alto São Francisco	GS174	-45.5223	-19.2565	1
Alto São Francisco	GS199	-43.4314	-19.2565	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Alto São Francisco	GT196	-43.6823	-19.3402	1
Alto São Francisco	GU188	-44.3514	-19.4238	1
Alto São Francisco	GU191	-44.1005	-19.4238	1
Alto São Francisco	GV197	-43.5987	-19.5074	1
Alto São Francisco	GX166	-46.1914	-19.6747	1
Alto São Francisco	GY177	-45.2714	-19.7583	1
Alto São Francisco	GY188	-44.3514	-19.7583	1
Alto São Francisco	GY193	-43.9332	-19.7583	1
Alto São Francisco	GY196	-43.6823	-19.7583	1
Alto São Francisco	GZ169	-45.9405	-19.8420	1
Alto São Francisco	GZ197	-43.5987	-19.8420	1
Alto São Francisco	HB168	-46.0241	-20.0093	1
Alto São Francisco	HB174	-45.5223	-20.0093	1
Alto São Francisco	HF170	-45.8569	-20.3438	1
Alto São Francisco	HL174	-45.5223	-20.8456	1
Alto São Francisco	HM173	-45.6060	-20.9293	1
Araguaia Tocantins	EP92	-52.3806	-14.6565	79
Araguaia Tocantins	EF151	-47.4460	-13.8201	71
Araguaia Tocantins	FE93	-52.2969	-15.9110	47
Araguaia Tocantins	EP94	-52.2133	-14.6565	40
Araguaia Tocantins	EQ93	-52.2969	-14.7401	24
Araguaia Tocantins	CO140	-48.3660	-10.2237	23
Araguaia Tocantins	CU139	-48.4496	-10.7256	23
Araguaia Tocantins	CS163	-46.4423	-10.5583	17
Araguaia Tocantins	DU157	-46.9442	-12.9001	17
Araguaia Tocantins	DF158	-46.8605	-11.6456	14
Araguaia Tocantins	DW159	-46.7769	-13.0674	13
Araguaia Tocantins	FE94	-52.2133	-15.9110	12
Araguaia Tocantins	DG148	-47.6969	-11.7292	11
Araguaia Tocantins	DR146	-47.8642	-12.6492	10
Araguaia Tocantins	EP93	-52.2969	-14.6565	10
Araguaia Tocantins	CQ141	-48.2823	-10.3910	9
Araguaia Tocantins	EE153	-47.2787	-13.7365	9
Araguaia Tocantins	CQ142	-48.1987	-10.3910	8
Araguaia Tocantins	DY158	-46.8605	-13.2347	8
Araguaia Tocantins	EJ128	-49.3696	-14.1547	8
Araguaia Tocantins	EK129	-49.2860	-14.2383	8
Araguaia Tocantins	EP91	-52.4642	-14.6565	8
Araguaia Tocantins	EQ92	-52.3806	-14.7401	8
Araguaia Tocantins	EX94	-52.2133	-15.3256	8
Araguaia Tocantins	DU149	-47.6132	-12.9001	7
Araguaia Tocantins	EA131	-49.1187	-13.4019	7

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Araguaia Tocantins	ER93	-52.2969	-14.8238	7
Araguaia Tocantins	CP142	-48.1987	-10.3074	6
Araguaia Tocantins	FB93	-52.2969	-15.6601	6
Araguaia Tocantins	DX142	-48.1987	-13.1510	5
Araguaia Tocantins	ED134	-48.8678	-13.6529	5
Araguaia Tocantins	EP95	-52.1296	-14.6565	5
Araguaia Tocantins	CN134	-48.8678	-10.1401	4
Araguaia Tocantins	EM100	-51.7115	-14.4056	4
Araguaia Tocantins	EO92	-52.3806	-14.5729	4
Araguaia Tocantins	CN141	-48.2823	-10.1401	3
Araguaia Tocantins	CV125	-49.6205	-10.8092	3
Araguaia Tocantins	CV140	-48.3660	-10.8092	3
Araguaia Tocantins	DM153	-47.2787	-12.2310	3
Araguaia Tocantins	DT141	-48.2823	-12.8165	3
Araguaia Tocantins	DT162	-46.5260	-12.8165	3
Araguaia Tocantins	EH90	-52.5478	-13.9874	3
Araguaia Tocantins	EN99	-51.7951	-14.4892	3
Araguaia Tocantins	ES108	-51.0424	-14.9074	3
Araguaia Tocantins	EW94	-52.2133	-15.2420	3
Araguaia Tocantins	FD94	-52.2133	-15.8274	3
Araguaia Tocantins	FK99	-51.7951	-16.4129	3
Araguaia Tocantins	BK153	-47.2787	-7.7146	2
Araguaia Tocantins	BM144	-48.0314	-7.8819	2
Araguaia Tocantins	BM145	-47.9478	-7.8819	2
Araguaia Tocantins	BS143	-48.1151	-8.3837	2
Araguaia Tocantins	BX146	-47.8642	-8.8019	2
Araguaia Tocantins	BZ142	-48.1987	-8.9692	2
Araguaia Tocantins	CO141	-48.2823	-10.2237	2
Araguaia Tocantins	CP143	-48.1151	-10.3074	2
Araguaia Tocantins	CP163	-46.4423	-10.3074	2
Araguaia Tocantins	CQ143	-48.1151	-10.3910	2
Araguaia Tocantins	CR130	-49.2023	-10.4746	2
Araguaia Tocantins	CS159	-46.7769	-10.5583	2
Araguaia Tocantins	CS161	-46.6096	-10.5583	2
Araguaia Tocantins	CS162	-46.5260	-10.5583	2
Araguaia Tocantins	CU150	-47.5296	-10.7256	2
Araguaia Tocantins	CZ155	-47.1114	-11.1437	2
Araguaia Tocantins	DE154	-47.1951	-11.5619	2
Araguaia Tocantins	DG132	-49.0351	-11.7292	2
Araguaia Tocantins	DU104	-51.3769	-12.9001	2
Araguaia Tocantins	DV141	-48.2823	-12.9838	2
Araguaia Tocantins	DW140	-48.3660	-13.0674	2

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Araguaia Tocantins	DX143	-48.1151	-13.1510	2
Araguaia Tocantins	EA143	-48.1151	-13.4019	2
Araguaia Tocantins	EB141	-48.2823	-13.4856	2
Araguaia Tocantins	EB143	-48.1151	-13.4856	2
Araguaia Tocantins	EB154	-47.1951	-13.4856	2
Araguaia Tocantins	EI129	-49.2860	-14.0710	2
Araguaia Tocantins	EY94	-52.2133	-15.4092	2
Araguaia Tocantins	FJ110	-50.8751	-16.3292	2
Araguaia Tocantins	FK107	-51.1260	-16.4129	2
Araguaia Tocantins	BK149	-47.6132	-7.7146	1
Araguaia Tocantins	BS147	-47.7805	-8.3837	1
Araguaia Tocantins	BS150	-47.5296	-8.3837	1
Araguaia Tocantins	BU149	-47.6132	-8.5510	1
Araguaia Tocantins	BU150	-47.5296	-8.5510	1
Araguaia Tocantins	BV133	-48.9514	-8.6346	1
Araguaia Tocantins	BX144	-48.0314	-8.8019	1
Araguaia Tocantins	BY125	-49.6205	-8.8855	1
Araguaia Tocantins	CB125	-49.6205	-9.1365	1
Araguaia Tocantins	CC128	-49.3696	-9.2201	1
Araguaia Tocantins	CD121	-49.9551	-9.3037	1
Araguaia Tocantins	CG137	-48.6169	-9.5546	1
Araguaia Tocantins	CG140	-48.3660	-9.5546	1
Araguaia Tocantins	CI140	-48.3660	-9.7219	1
Araguaia Tocantins	CK131	-49.1187	-9.8892	1
Araguaia Tocantins	CK135	-48.7842	-9.8892	1
Araguaia Tocantins	CL132	-49.0351	-9.9728	1
Araguaia Tocantins	CL140	-48.3660	-9.9728	1
Araguaia Tocantins	CL141	-48.2823	-9.9728	1
Araguaia Tocantins	CL151	-47.4460	-9.9728	1
Araguaia Tocantins	CN142	-48.1987	-10.1401	1
Araguaia Tocantins	CO135	-48.7842	-10.2237	1
Araguaia Tocantins	CO142	-48.1987	-10.2237	1
Araguaia Tocantins	CP137	-48.6169	-10.3074	1
Araguaia Tocantins	CQ139	-48.4496	-10.3910	1
Araguaia Tocantins	CQ140	-48.3660	-10.3910	1
Araguaia Tocantins	CQ155	-47.1114	-10.3910	1
Araguaia Tocantins	CS160	-46.6932	-10.5583	1
Araguaia Tocantins	CT130	-49.2023	-10.6419	1
Araguaia Tocantins	CT140	-48.3660	-10.6419	1
Araguaia Tocantins	CV143	-48.1151	-10.8092	1
Araguaia Tocantins	CW140	-48.3660	-10.8928	1
Araguaia Tocantins	CX159	-46.7769	-10.9765	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Araguaia Tocantins	CY138	-48.5333	-11.0601	1
Araguaia Tocantins	CZ150	-47.5296	-11.1437	1
Araguaia Tocantins	DA139	-48.4496	-11.2274	1
Araguaia Tocantins	DA158	-46.8605	-11.2274	1
Araguaia Tocantins	DC134	-48.8678	-11.3947	1
Araguaia Tocantins	DD148	-47.6969	-11.4783	1
Araguaia Tocantins	DE153	-47.2787	-11.5619	1
Araguaia Tocantins	DE156	-47.0278	-11.5619	1
Araguaia Tocantins	DF148	-47.6969	-11.6456	1
Araguaia Tocantins	DF159	-46.7769	-11.6456	1
Araguaia Tocantins	DG149	-47.6132	-11.7292	1
Araguaia Tocantins	DG158	-46.8605	-11.7292	1
Araguaia Tocantins	DH126	-49.5369	-11.8128	1
Araguaia Tocantins	DI125	-49.6205	-11.8965	1
Araguaia Tocantins	DJ149	-47.6132	-11.9801	1
Araguaia Tocantins	DP130	-49.2023	-12.4819	1
Araguaia Tocantins	DP154	-47.1951	-12.4819	1
Araguaia Tocantins	DQ123	-49.7878	-12.5656	1
Araguaia Tocantins	DR144	-48.0314	-12.6492	1
Araguaia Tocantins	DT107	-51.1260	-12.8165	1
Araguaia Tocantins	DT155	-47.1114	-12.8165	1
Araguaia Tocantins	DT160	-46.6932	-12.8165	1
Araguaia Tocantins	DU122	-49.8714	-12.9001	1
Araguaia Tocantins	DU156	-47.0278	-12.9001	1
Araguaia Tocantins	DV142	-48.1987	-12.9838	1
Araguaia Tocantins	DV157	-46.9442	-12.9838	1
Araguaia Tocantins	DV158	-46.8605	-12.9838	1
Araguaia Tocantins	DW142	-48.1987	-13.0674	1
Araguaia Tocantins	DX141	-48.2823	-13.1510	1
Araguaia Tocantins	DX155	-47.1114	-13.1510	1
Araguaia Tocantins	EB142	-48.1987	-13.4856	1
Araguaia Tocantins	ED133	-48.9514	-13.6529	1
Araguaia Tocantins	EF131	-49.1187	-13.8201	1
Araguaia Tocantins	EH120	-50.0387	-13.9874	1
Araguaia Tocantins	EI117	-50.2896	-14.0710	1
Araguaia Tocantins	EJ116	-50.3733	-14.1547	1
Araguaia Tocantins	EK97	-51.9624	-14.2383	1
Araguaia Tocantins	EL93	-52.2969	-14.3219	1
Araguaia Tocantins	EM126	-49.5369	-14.4056	1
Araguaia Tocantins	EN98	-51.8787	-14.4892	1
Araguaia Tocantins	EO98	-51.8787	-14.5729	1
Araguaia Tocantins	EQ114	-50.5405	-14.7401	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Araguaia Tocantins	EQ118	-50.2060	-14.7401	1
Araguaia Tocantins	EQ91	-52.4642	-14.7401	1
Araguaia Tocantins	ER92	-52.3806	-14.8238	1
Araguaia Tocantins	ER95	-52.1296	-14.8238	1
Araguaia Tocantins	ES93	-52.2969	-14.9074	1
Araguaia Tocantins	ET92	-52.3806	-14.9910	1
Araguaia Tocantins	EZ111	-50.7914	-15.4929	1
Araguaia Tocantins	EZ112	-50.7078	-15.4929	1
Araguaia Tocantins	EZ94	-52.2133	-15.4929	1
Araguaia Tocantins	FC99	-51.7951	-15.7438	1
Araguaia Tocantins	FD93	-52.2969	-15.8274	1
Araguaia Tocantins	FE102	-51.5442	-15.9110	1
Araguaia Tocantins	FE98	-51.8787	-15.9110	1
Araguaia Tocantins	FF104	-51.3769	-15.9947	1
Araguaia Tocantins	FJ103	-51.4605	-16.3292	1
Araguaia Tocantins	FK102	-51.5442	-16.4129	1
Araguaia Tocantins	FK98	-51.8787	-16.4129	1
Bananal	DF112	-50.7078	-11.6456	22
Bananal	CR114	-50.5405	-10.4746	7
Bananal	EM109	-50.9587	-14.4056	6
Bananal	DA112	-50.7078	-11.2274	5
Bananal	CL119	-50.1224	-9.9728	4
Bananal	CQ115	-50.4569	-10.3910	4
Bananal	CP106	-51.2096	-10.3074	2
Bananal	CR115	-50.4569	-10.4746	2
Bananal	CT122	-49.8714	-10.6419	2
Bananal	CZ101	-51.6278	-11.1437	2
Bananal	DE112	-50.7078	-11.5619	2
Bananal	DF123	-49.7878	-11.6456	2
Bananal	DG112	-50.7078	-11.7292	2
Bananal	DQ109	-50.9587	-12.5656	2
Bananal	CN116	-50.3733	-10.1401	1
Bananal	CZ112	-50.7078	-11.1437	1
Bananal	DF110	-50.8751	-11.6456	1
Bananal	DI124	-49.7042	-11.8965	1
Bananal	DJ124	-49.7042	-11.9801	1
Bananal	DO112	-50.7078	-12.3983	1
Basaltos do Paraná	GO141	-48.2823	-18.9220	264
Basaltos do Paraná	IJ139	-48.4496	-22.8529	170
Basaltos do Paraná	ID157	-46.9442	-22.3511	147
Basaltos do Paraná	IY128	-49.3696	-24.1075	130
Basaltos do Paraná	JA124	-49.7042	-24.2747	107

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Basaltos do Paraná	JD116	-50.3733	-24.5257	107
Basaltos do Paraná	GT153	-47.2787	-19.3402	96
Basaltos do Paraná	IC147	-47.7805	-22.2675	95
Basaltos do Paraná	HL128	-49.3696	-20.8456	91
Basaltos do Paraná	GP127	-49.4533	-19.0056	68
Basaltos do Paraná	HF158	-46.8605	-20.3438	61
Basaltos do Paraná	ID132	-49.0351	-22.3511	54
Basaltos do Paraná	HE151	-47.4460	-20.2602	52
Basaltos do Paraná	IC143	-48.1151	-22.2675	49
Basaltos do Paraná	HZ146	-47.8642	-22.0165	43
Basaltos do Paraná	IE133	-48.9514	-22.4347	41
Basaltos do Paraná	IY127	-49.4533	-24.1075	41
Basaltos do Paraná	IH116	-50.3733	-22.6856	37
Basaltos do Paraná	IA148	-47.6969	-22.1002	33
Basaltos do Paraná	IS144	-48.0314	-23.6056	33
Basaltos do Paraná	IY132	-49.0351	-24.1075	30
Basaltos do Paraná	HM156	-47.0278	-20.9293	29
Basaltos do Paraná	HW142	-48.1987	-21.7656	28
Basaltos do Paraná	GY145	-47.9478	-19.7583	27
Basaltos do Paraná	IR135	-48.7842	-23.5220	27
Basaltos do Paraná	HT148	-47.6969	-21.5147	26
Basaltos do Paraná	HU140	-48.3660	-21.5984	26
Basaltos do Paraná	II139	-48.4496	-22.7693	24
Basaltos do Paraná	IE157	-46.9442	-22.4347	23
Basaltos do Paraná	II136	-48.7005	-22.7693	23
Basaltos do Paraná	HD151	-47.4460	-20.1765	21
Basaltos do Paraná	II141	-48.2823	-22.7693	21
Basaltos do Paraná	IX132	-49.0351	-24.0238	21
Basaltos do Paraná	II143	-48.1151	-22.7693	20
Basaltos do Paraná	HZ150	-47.5296	-22.0165	19
Basaltos do Paraná	IF145	-47.9478	-22.5184	19
Basaltos do Paraná	HV151	-47.4460	-21.6820	18
Basaltos do Paraná	GR148	-47.6969	-19.1729	17
Basaltos do Paraná	IB149	-47.6132	-22.1838	17
Basaltos do Paraná	IB155	-47.1114	-22.1838	17
Basaltos do Paraná	IV131	-49.1187	-23.8566	17
Basaltos do Paraná	HQ141	-48.2823	-21.2638	16
Basaltos do Paraná	IF152	-47.3623	-22.5184	16
Basaltos do Paraná	IA128	-49.3696	-22.1002	15
Basaltos do Paraná	II146	-47.8642	-22.7693	15
Basaltos do Paraná	IW134	-48.8678	-23.9402	15
Basaltos do Paraná	GV127	-49.4533	-19.5074	14

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Basaltos do Paraná	IM137	-48.6169	-23.1038	14
Basaltos do Paraná	IY131	-49.1187	-24.1075	14
Basaltos do Paraná	GZ151	-47.4460	-19.8420	13
Basaltos do Paraná	II155	-47.1114	-22.7693	13
Basaltos do Paraná	IJ130	-49.2023	-22.8529	13
Basaltos do Paraná	HS150	-47.5296	-21.4311	12
Basaltos do Paraná	IC155	-47.1114	-22.2675	12
Basaltos do Paraná	II153	-47.2787	-22.7693	12
Basaltos do Paraná	JA130	-49.2023	-24.2747	12
Basaltos do Paraná	HN152	-47.3623	-21.0129	11
Basaltos do Paraná	IJ144	-48.0314	-22.8529	10
Basaltos do Paraná	HB133	-48.9514	-20.0093	9
Basaltos do Paraná	IE158	-46.8605	-22.4347	9
Basaltos do Paraná	IJ135	-48.7842	-22.8529	9
Basaltos do Paraná	IJ140	-48.3660	-22.8529	9
Basaltos do Paraná	IK138	-48.5333	-22.9366	9
Basaltos do Paraná	JE117	-50.2896	-24.6093	9
Basaltos do Paraná	GP141	-48.2823	-19.0056	8
Basaltos do Paraná	GQ143	-48.1151	-19.0893	8
Basaltos do Paraná	HE157	-46.9442	-20.2602	8
Basaltos do Paraná	HI125	-49.6205	-20.5947	8
Basaltos do Paraná	HP147	-47.7805	-21.1802	8
Basaltos do Paraná	HW155	-47.1114	-21.7656	8
Basaltos do Paraná	IJ138	-48.5333	-22.8529	8
Basaltos do Paraná	IM133	-48.9514	-23.1038	8
Basaltos do Paraná	IQ140	-48.3660	-23.4384	8
Basaltos do Paraná	JA129	-49.2860	-24.2747	8
Basaltos do Paraná	HG121	-49.9551	-20.4274	7
Basaltos do Paraná	HQ139	-48.4496	-21.2638	7
Basaltos do Paraná	IF147	-47.7805	-22.5184	7
Basaltos do Paraná	GN134	-48.8678	-18.8383	6
Basaltos do Paraná	GO140	-48.3660	-18.9220	6
Basaltos do Paraná	GP139	-48.4496	-19.0056	6
Basaltos do Paraná	HH123	-49.7878	-20.5111	6
Basaltos do Paraná	HL164	-46.3587	-20.8456	6
Basaltos do Paraná	HU138	-48.5333	-21.5984	6
Basaltos do Paraná	HY135	-48.7842	-21.9329	6
Basaltos do Paraná	HZ157	-46.9442	-22.0165	6
Basaltos do Paraná	IE114	-50.5405	-22.4347	6
Basaltos do Paraná	IK136	-48.7005	-22.9366	6
Basaltos do Paraná	GS143	-48.1151	-19.2565	5
Basaltos do Paraná	GT133	-48.9514	-19.3402	5

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Basaltos do Paraná	HD153	-47.2787	-20.1765	5
Basaltos do Paraná	HI129	-49.2860	-20.5947	5
Basaltos do Paraná	HY146	-47.8642	-21.9329	5
Basaltos do Paraná	IA147	-47.7805	-22.1002	5
Basaltos do Paraná	IC154	-47.1951	-22.2675	5
Basaltos do Paraná	II138	-48.5333	-22.7693	5
Basaltos do Paraná	IW125	-49.6205	-23.9402	5
Basaltos do Paraná	IX131	-49.1187	-24.0238	5
Basaltos do Paraná	HA140	-48.3660	-19.9256	4
Basaltos do Paraná	HG120	-50.0387	-20.4274	4
Basaltos do Paraná	HJ146	-47.8642	-20.6784	4
Basaltos do Paraná	HJ162	-46.5260	-20.6784	4
Basaltos do Paraná	HK128	-49.3696	-20.7620	4
Basaltos do Paraná	HP146	-47.8642	-21.1802	4
Basaltos do Paraná	HR157	-46.9442	-21.3475	4
Basaltos do Paraná	HS156	-47.0278	-21.4311	4
Basaltos do Paraná	HU153	-47.2787	-21.5984	4
Basaltos do Paraná	HX158	-46.8605	-21.8493	4
Basaltos do Paraná	IG146	-47.8642	-22.6020	4
Basaltos do Paraná	IH154	-47.1951	-22.6856	4
Basaltos do Paraná	IR136	-48.7005	-23.5220	4
Basaltos do Paraná	JA131	-49.1187	-24.2747	4
Basaltos do Paraná	GO142	-48.1987	-18.9220	3
Basaltos do Paraná	GP145	-47.9478	-19.0056	3
Basaltos do Paraná	GR140	-48.3660	-19.1729	3
Basaltos do Paraná	HD136	-48.7005	-20.1765	3
Basaltos do Paraná	HF139	-48.4496	-20.3438	3
Basaltos do Paraná	HH129	-49.2860	-20.5111	3
Basaltos do Paraná	HH152	-47.3623	-20.5111	3
Basaltos do Paraná	HI151	-47.4460	-20.5947	3
Basaltos do Paraná	HP153	-47.2787	-21.1802	3
Basaltos do Paraná	HQ146	-47.8642	-21.2638	3
Basaltos do Paraná	HU149	-47.6132	-21.5984	3
Basaltos do Paraná	HU150	-47.5296	-21.5984	3
Basaltos do Paraná	HX157	-46.9442	-21.8493	3
Basaltos do Paraná	HY149	-47.6132	-21.9329	3
Basaltos do Paraná	HZ132	-49.0351	-22.0165	3
Basaltos do Paraná	IB129	-49.2860	-22.1838	3
Basaltos do Paraná	IB146	-47.8642	-22.1838	3
Basaltos do Paraná	IC145	-47.9478	-22.2675	3
Basaltos do Paraná	ID114	-50.5405	-22.3511	3
Basaltos do Paraná	IE142	-48.1987	-22.4347	3

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Basaltos do Paraná	IF111	-50.7914	-22.5184	3
Basaltos do Paraná	IG116	-50.3733	-22.6020	3
Basaltos do Paraná	IG136	-48.7005	-22.6020	3
Basaltos do Paraná	II130	-49.2023	-22.7693	3
Basaltos do Paraná	IK140	-48.3660	-22.9366	3
Basaltos do Paraná	IL135	-48.7842	-23.0202	3
Basaltos do Paraná	IM134	-48.8678	-23.1038	3
Basaltos do Paraná	JC120	-50.0387	-24.4420	3
Basaltos do Paraná	JD117	-50.2896	-24.5257	3
Basaltos do Paraná	JE118	-50.2060	-24.6093	3
Basaltos do Paraná	GK136	-48.7005	-18.5874	2
Basaltos do Paraná	GL126	-49.5369	-18.6711	2
Basaltos do Paraná	GO126	-49.5369	-18.9220	2
Basaltos do Paraná	GR123	-49.7878	-19.1729	2
Basaltos do Paraná	HB147	-47.7805	-20.0093	2
Basaltos do Paraná	HE130	-49.2023	-20.2602	2
Basaltos do Paraná	HF130	-49.2023	-20.3438	2
Basaltos do Paraná	HF149	-47.6132	-20.3438	2
Basaltos do Paraná	HH117	-50.2896	-20.5111	2
Basaltos do Paraná	HP148	-47.6969	-21.1802	2
Basaltos do Paraná	HQ138	-48.5333	-21.2638	2
Basaltos do Paraná	HR145	-47.9478	-21.3475	2
Basaltos do Paraná	HS153	-47.2787	-21.4311	2
Basaltos do Paraná	HU132	-49.0351	-21.5984	2
Basaltos do Paraná	HV143	-48.1151	-21.6820	2
Basaltos do Paraná	HW135	-48.7842	-21.7656	2
Basaltos do Paraná	HW157	-46.9442	-21.7656	2
Basaltos do Paraná	HX139	-48.4496	-21.8493	2
Basaltos do Paraná	IA151	-47.4460	-22.1002	2
Basaltos do Paraná	IB139	-48.4496	-22.1838	2
Basaltos do Paraná	IB142	-48.1987	-22.1838	2
Basaltos do Paraná	IB147	-47.7805	-22.1838	2
Basaltos do Paraná	IC146	-47.8642	-22.2675	2
Basaltos do Paraná	IE113	-50.6242	-22.4347	2
Basaltos do Paraná	IE141	-48.2823	-22.4347	2
Basaltos do Paraná	IE144	-48.0314	-22.4347	2
Basaltos do Paraná	IE148	-47.6969	-22.4347	2
Basaltos do Paraná	IF142	-48.1987	-22.5184	2
Basaltos do Paraná	IG115	-50.4569	-22.6020	2
Basaltos do Paraná	IG145	-47.9478	-22.6020	2
Basaltos do Paraná	IH140	-48.3660	-22.6856	2
Basaltos do Paraná	IK139	-48.4496	-22.9366	2

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Basaltos do Paraná	IL139	-48.4496	-23.0202	2
Basaltos do Paraná	IP136	-48.7005	-23.3547	2
Basaltos do Paraná	IS145	-47.9478	-23.6056	2
Basaltos do Paraná	IW126	-49.5369	-23.9402	2
Basaltos do Paraná	IX130	-49.2023	-24.0238	2
Basaltos do Paraná	JB122	-49.8714	-24.3584	2
Basaltos do Paraná	JE116	-50.3733	-24.6093	2
Basaltos do Paraná	GM139	-48.4496	-18.7547	1
Basaltos do Paraná	GM150	-47.5296	-18.7547	1
Basaltos do Paraná	GO127	-49.4533	-18.9220	1
Basaltos do Paraná	GQ126	-49.5369	-19.0893	1
Basaltos do Paraná	GQ128	-49.3696	-19.0893	1
Basaltos do Paraná	GQ144	-48.0314	-19.0893	1
Basaltos do Paraná	GR144	-48.0314	-19.1729	1
Basaltos do Paraná	GS145	-47.9478	-19.2565	1
Basaltos do Paraná	GS147	-47.7805	-19.2565	1
Basaltos do Paraná	GT146	-47.8642	-19.3402	1
Basaltos do Paraná	GT150	-47.5296	-19.3402	1
Basaltos do Paraná	GX131	-49.1187	-19.6747	1
Basaltos do Paraná	HA150	-47.5296	-19.9256	1
Basaltos do Paraná	HC151	-47.4460	-20.0929	1
Basaltos do Paraná	HD121	-49.9551	-20.1765	1
Basaltos do Paraná	HD148	-47.6969	-20.1765	1
Basaltos do Paraná	HE126	-49.5369	-20.2602	1
Basaltos do Paraná	HF122	-49.8714	-20.3438	1
Basaltos do Paraná	HG134	-48.8678	-20.4274	1
Basaltos do Paraná	HH119	-50.1224	-20.5111	1
Basaltos do Paraná	HH138	-48.5333	-20.5111	1
Basaltos do Paraná	HH147	-47.7805	-20.5111	1
Basaltos do Paraná	HH148	-47.6969	-20.5111	1
Basaltos do Paraná	HH151	-47.4460	-20.5111	1
Basaltos do Paraná	HI146	-47.8642	-20.5947	1
Basaltos do Paraná	HI163	-46.4423	-20.5947	1
Basaltos do Paraná	HJ128	-49.3696	-20.6784	1
Basaltos do Paraná	HJ161	-46.6096	-20.6784	1
Basaltos do Paraná	HM139	-48.4496	-20.9293	1
Basaltos do Paraná	HM149	-47.6132	-20.9293	1
Basaltos do Paraná	HN153	-47.2787	-21.0129	1
Basaltos do Paraná	HO147	-47.7805	-21.0965	1
Basaltos do Paraná	HO155	-47.1114	-21.0965	1
Basaltos do Paraná	HP149	-47.6132	-21.1802	1
Basaltos do Paraná	HQ147	-47.7805	-21.2638	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Basaltos do Paraná	HR142	-48.1987	-21.3475	1
Basaltos do Paraná	HS136	-48.7005	-21.4311	1
Basaltos do Paraná	HT147	-47.7805	-21.5147	1
Basaltos do Paraná	HV146	-47.8642	-21.6820	1
Basaltos do Paraná	HY159	-46.7769	-21.9329	1
Basaltos do Paraná	HZ140	-48.3660	-22.0165	1
Basaltos do Paraná	IA138	-48.5333	-22.1002	1
Basaltos do Paraná	IB145	-47.9478	-22.1838	1
Basaltos do Paraná	IB156	-47.0278	-22.1838	1
Basaltos do Paraná	IC140	-48.3660	-22.2675	1
Basaltos do Paraná	ID154	-47.1951	-22.3511	1
Basaltos do Paraná	IF133	-48.9514	-22.5184	1
Basaltos do Paraná	IG118	-50.2060	-22.6020	1
Basaltos do Paraná	IG147	-47.7805	-22.6020	1
Basaltos do Paraná	IG152	-47.3623	-22.6020	1
Basaltos do Paraná	IG154	-47.1951	-22.6020	1
Basaltos do Paraná	IH128	-49.3696	-22.6856	1
Basaltos do Paraná	IH134	-48.8678	-22.6856	1
Basaltos do Paraná	II142	-48.1987	-22.7693	1
Basaltos do Paraná	II144	-48.0314	-22.7693	1
Basaltos do Paraná	II152	-47.3623	-22.7693	1
Basaltos do Paraná	IJ136	-48.7005	-22.8529	1
Basaltos do Paraná	IP138	-48.5333	-23.3547	1
Basaltos do Paraná	IQ138	-48.5333	-23.4384	1
Basaltos do Paraná	IZ125	-49.6205	-24.1911	1
Basaltos do Paraná	IZ128	-49.3696	-24.1911	1
Basaltos do Paraná	IZ130	-49.2023	-24.1911	1
Basaltos do Paraná	JB119	-50.1224	-24.3584	1
Basaltos do Paraná	JB123	-49.7878	-24.3584	1
Bico do Papagaio	AW151	-47.4460	-6.5437	11
Bico do Papagaio	AX151	-47.4460	-6.6273	11
Bico do Papagaio	BF151	-47.4460	-7.2964	11
Bico do Papagaio	BB152	-47.3623	-6.9619	9
Bico do Papagaio	BC151	-47.4460	-7.0455	9
Bico do Papagaio	AU152	-47.3623	-6.3764	5
Bico do Papagaio	BE142	-48.1987	-7.2128	5
Bico do Papagaio	BE151	-47.4460	-7.2128	5
Bico do Papagaio	AK150	-47.5296	-5.5401	4
Bico do Papagaio	AX150	-47.5296	-6.6273	4
Bico do Papagaio	AV150	-47.5296	-6.4601	3
Bico do Papagaio	BD151	-47.4460	-7.1292	3
Bico do Papagaio	BG151	-47.4460	-7.3801	3

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Bico do Papagaio	AK151	-47.4460	-5.5401	2
Bico do Papagaio	BF150	-47.5296	-7.2964	2
Bico do Papagaio	BG161	-46.6096	-7.3801	2
Bico do Papagaio	AI146	-47.8642	-5.3728	1
Bico do Papagaio	AN152	-47.3623	-5.7910	1
Bico do Papagaio	AR152	-47.3623	-6.1255	1
Bico do Papagaio	AS152	-47.3623	-6.2092	1
Bico do Papagaio	AT146	-47.8642	-6.2928	1
Bico do Papagaio	AT151	-47.4460	-6.2928	1
Bico do Papagaio	AT153	-47.2787	-6.2928	1
Bico do Papagaio	AV151	-47.4460	-6.4601	1
Bico do Papagaio	AX145	-47.9478	-6.6273	1
Bico do Papagaio	AY149	-47.6132	-6.7110	1
Bico do Papagaio	AY150	-47.5296	-6.7110	1
Bico do Papagaio	AZ141	-48.2823	-6.7946	1
Bico do Papagaio	BD152	-47.3623	-7.1292	1
Bico do Papagaio	BE147	-47.7805	-7.2128	1
Bico do Papagaio	BE154	-47.1951	-7.2128	1
Bico do Papagaio	BF148	-47.6969	-7.2964	1
Bico do Papagaio	BF149	-47.6132	-7.2964	1
Bico do Papagaio	BH144	-48.0314	-7.4637	1
Bico do Papagaio	BH149	-47.6132	-7.4637	1
Bico do Papagaio	BI161	-46.6096	-7.5474	1
Bico do Papagaio	BJ156	-47.0278	-7.6310	1
Bico do Papagaio	BO139	-48.4496	-8.0492	1
Bico do Papagaio	CB138	-48.5333	-9.1365	1
Chapada dos Parecis	DT99	-51.7951	-12.8165	85
Chapada dos Parecis	DT100	-51.7115	-12.8165	16
Chapada dos Parecis	EI95	-52.1296	-14.0710	13
Chapada dos Parecis	EC93	-52.2969	-13.5692	6
Chapada dos Parecis	EF43	-56.4788	-13.8201	3
Chapada dos Parecis	DQ52	-55.7260	-12.5656	2
Chapada dos Parecis	DR45	-56.3115	-12.6492	2
Chapada dos Parecis	DV58	-55.2242	-12.9838	2
Chapada dos Parecis	DX50	-55.8933	-13.1510	2
Chapada dos Parecis	EB40	-56.7297	-13.4856	2
Chapada dos Parecis	EB45	-56.3115	-13.4856	2
Chapada dos Parecis	ED26	-57.9006	-13.6529	2
Chapada dos Parecis	EU19	-58.4860	-15.0747	2
Chapada dos Parecis	DE16	-58.7370	-11.5619	1
Chapada dos Parecis	DI8	-59.4061	-11.8965	1
Chapada dos Parecis	DM48	-56.0606	-12.2310	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Chapada dos Parecis	DN48	-56.0606	-12.3147	1
Chapada dos Parecis	DP46	-56.2279	-12.4819	1
Chapada dos Parecis	DR44	-56.3951	-12.6492	1
Chapada dos Parecis	DS99	-51.7951	-12.7328	1
Chapada dos Parecis	DV16	-58.7370	-12.9838	1
Chapada dos Parecis	DW25	-57.9842	-13.0674	1
Chapada dos Parecis	DW50	-55.8933	-13.0674	1
Chapada dos Parecis	DX10	-59.2388	-13.1510	1
Chapada dos Parecis	DZ40	-56.7297	-13.3183	1
Chapada dos Parecis	DZ90	-52.5478	-13.3183	1
Chapada dos Parecis	EF4	-59.7406	-13.8201	1
Chapada dos Parecis	EF92	-52.3806	-13.8201	1
Chapada dos Parecis	EG42	-56.5624	-13.9038	1
Chapada dos Parecis	EG96	-52.0460	-13.9038	1
Chapada dos Parecis	EI43	-56.4788	-14.0710	1
Chapada dos Parecis	EI47	-56.1442	-14.0710	1
Chapada dos Parecis	EJ44	-56.3951	-14.1547	1
Chapada dos Parecis	EJ95	-52.1296	-14.1547	1
Chapada dos Parecis	EK43	-56.4788	-14.2383	1
Chapada dos Parecis	EL16	-58.7370	-14.3219	1
Chapadão do São Francisco	DL180	-45.0205	-12.1474	45
Chapadão do São Francisco	EA164	-46.3587	-13.4019	24
Chapadão do São Francisco	DO181	-44.9369	-12.3983	11
Chapadão do São Francisco	EY169	-45.9405	-15.4092	7
Chapadão do São Francisco	DF168	-46.0241	-11.6456	6
Chapadão do São Francisco	DP179	-45.1041	-12.4819	6
Chapadão do São Francisco	DI173	-45.6060	-11.8965	4
Chapadão do São Francisco	DM187	-44.4350	-12.2310	4
Chapadão do São Francisco	EA166	-46.1914	-13.4019	4
Chapadão do São Francisco	EV171	-45.7732	-15.1583	4
Chapadão do São Francisco	EX183	-44.7696	-15.3256	4
Chapadão do São Francisco	CQ161	-46.6096	-10.3910	3
Chapadão do São Francisco	DL179	-45.1041	-12.1474	3
Chapadão do São Francisco	DQ182	-44.8532	-12.5656	3
Chapadão do São Francisco	EB178	-45.1878	-13.4856	3
Chapadão do São Francisco	CY169	-45.9405	-11.0601	2
Chapadão do São Francisco	DI169	-45.9405	-11.8965	2
Chapadão do São Francisco	DK189	-44.2678	-12.0637	2
Chapadão do São Francisco	DL178	-45.1878	-12.1474	2
Chapadão do São Francisco	DR180	-45.0205	-12.6492	2
Chapadão do São Francisco	DS171	-45.7732	-12.7328	2
Chapadão do São Francisco	ED165	-46.2751	-13.6529	2

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Chapadão do São Francisco	EF181	-44.9369	-13.8201	2
Chapadão do São Francisco	EN167	-46.1078	-14.4892	2
Chapadão do São Francisco	EO180	-45.0205	-14.5729	2
Chapadão do São Francisco	ES170	-45.8569	-14.9074	2
Chapadão do São Francisco	EV159	-46.7769	-15.1583	2
Chapadão do São Francisco	CQ162	-46.5260	-10.3910	1
Chapadão do São Francisco	CR163	-46.4423	-10.4746	1
Chapadão do São Francisco	CV164	-46.3587	-10.8092	1
Chapadão do São Francisco	CV166	-46.1914	-10.8092	1
Chapadão do São Francisco	CZ174	-45.5223	-11.1437	1
Chapadão do São Francisco	DA169	-45.9405	-11.2274	1
Chapadão do São Francisco	DA171	-45.7732	-11.2274	1
Chapadão do São Francisco	DH164	-46.3587	-11.8128	1
Chapadão do São Francisco	DI170	-45.8569	-11.8965	1
Chapadão do São Francisco	DK173	-45.6060	-12.0637	1
Chapadão do São Francisco	DK182	-44.8532	-12.0637	1
Chapadão do São Francisco	DL177	-45.2714	-12.1474	1
Chapadão do São Francisco	DM180	-45.0205	-12.2310	1
Chapadão do São Francisco	DM185	-44.6023	-12.2310	1
Chapadão do São Francisco	DP178	-45.1878	-12.4819	1
Chapadão do São Francisco	DR182	-44.8532	-12.6492	1
Chapadão do São Francisco	DS179	-45.1041	-12.7328	1
Chapadão do São Francisco	DT185	-44.6023	-12.8165	1
Chapadão do São Francisco	DX176	-45.3550	-13.1510	1
Chapadão do São Francisco	DX183	-44.7696	-13.1510	1
Chapadão do São Francisco	DZ166	-46.1914	-13.3183	1
Chapadão do São Francisco	DZ182	-44.8532	-13.3183	1
Chapadão do São Francisco	EC176	-45.3550	-13.5692	1
Chapadão do São Francisco	EC186	-44.5187	-13.5692	1
Chapadão do São Francisco	ED164	-46.3587	-13.6529	1
Chapadão do São Francisco	EF168	-46.0241	-13.8201	1
Chapadão do São Francisco	EG185	-44.6023	-13.9038	1
Chapadão do São Francisco	EH164	-46.3587	-13.9874	1
Chapadão do São Francisco	EH168	-46.0241	-13.9874	1
Chapadão do São Francisco	EI165	-46.2751	-14.0710	1
Chapadão do São Francisco	EI180	-45.0205	-14.0710	1
Chapadão do São Francisco	EJ176	-45.3550	-14.1547	1
Chapadão do São Francisco	EK184	-44.6860	-14.2383	1
Chapadão do São Francisco	EL166	-46.1914	-14.3219	1
Chapadão do São Francisco	EN166	-46.1914	-14.4892	1
Chapadão do São Francisco	EO167	-46.1078	-14.5729	1
Chapadão do São Francisco	EP173	-45.6060	-14.6565	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Chapadão do São Francisco	EQ169	-45.9405	-14.7401	1
Chapadão do São Francisco	EQ170	-45.8569	-14.7401	1
Chapadão do São Francisco	ER169	-45.9405	-14.8238	1
Chapadão do São Francisco	ES166	-46.1914	-14.9074	1
Chapadão do São Francisco	ES168	-46.0241	-14.9074	1
Chapadão do São Francisco	EY176	-45.3550	-15.4092	1
Chapadão do São Francisco	EZ176	-45.3550	-15.4929	1
Complexo Bodoquena	HH51	-55.8097	-20.5111	131
Complexo Bodoquena	HE44	-56.3951	-20.2602	76
Complexo Bodoquena	HO43	-56.4788	-21.0965	51
Complexo Bodoquena	HK52	-55.7260	-20.7620	27
Complexo Bodoquena	HV29	-57.6497	-21.6820	19
Complexo Bodoquena	HH40	-56.7297	-20.5111	18
Complexo Bodoquena	HO40	-56.7297	-21.0965	13
Complexo Bodoquena	HQ42	-56.5624	-21.2638	12
Complexo Bodoquena	HG51	-55.8097	-20.4274	11
Complexo Bodoquena	HO39	-56.8133	-21.0965	11
Complexo Bodoquena	HM40	-56.7297	-20.9293	9
Complexo Bodoquena	HO51	-55.8097	-21.0965	8
Complexo Bodoquena	HP42	-56.5624	-21.1802	7
Complexo Bodoquena	HD45	-56.3115	-20.1765	6
Complexo Bodoquena	HF52	-55.7260	-20.3438	6
Complexo Bodoquena	HP43	-56.4788	-21.1802	6
Complexo Bodoquena	HC40	-56.7297	-20.0929	5
Complexo Bodoquena	HO41	-56.6460	-21.0965	5
Complexo Bodoquena	HQ40	-56.7297	-21.2638	5
Complexo Bodoquena	HN43	-56.4788	-21.0129	4
Complexo Bodoquena	HZ36	-57.0642	-22.0165	4
Complexo Bodoquena	HJ39	-56.8133	-20.6784	3
Complexo Bodoquena	HT47	-56.1442	-21.5147	3
Complexo Bodoquena	HD38	-56.8969	-20.1765	2
Complexo Bodoquena	HI39	-56.8133	-20.5947	2
Complexo Bodoquena	HI41	-56.6460	-20.5947	2
Complexo Bodoquena	HK40	-56.7297	-20.7620	2
Complexo Bodoquena	HN39	-56.8133	-21.0129	2
Complexo Bodoquena	HO42	-56.5624	-21.0965	2
Complexo Bodoquena	HR42	-56.5624	-21.3475	2
Complexo Bodoquena	HS44	-56.3951	-21.4311	2
Complexo Bodoquena	HS47	-56.1442	-21.4311	2
Complexo Bodoquena	HT40	-56.7297	-21.5147	2
Complexo Bodoquena	HA46	-56.2279	-19.9256	1
Complexo Bodoquena	HC36	-57.0642	-20.0929	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Complexo Bodoquena	HD40	-56.7297	-20.1765	1
Complexo Bodoquena	HE46	-56.2279	-20.2602	1
Complexo Bodoquena	HH38	-56.8969	-20.5111	1
Complexo Bodoquena	HL39	-56.8133	-20.8456	1
Complexo Bodoquena	HM39	-56.8133	-20.9293	1
Complexo Bodoquena	HM41	-56.6460	-20.9293	1
Complexo Bodoquena	HM42	-56.5624	-20.9293	1
Complexo Bodoquena	HN42	-56.5624	-21.0129	1
Complexo Bodoquena	HO44	-56.3951	-21.0965	1
Complexo Bodoquena	HP44	-56.3951	-21.1802	1
Complexo Bodoquena	HP45	-56.3115	-21.1802	1
Complexo Bodoquena	HQ44	-56.3951	-21.2638	1
Complexo Bodoquena	HQ49	-55.9769	-21.2638	1
Complexo Bodoquena	HS42	-56.5624	-21.4311	1
Complexo Bodoquena	HS43	-56.4788	-21.4311	1
Complexo Bodoquena	HT46	-56.2279	-21.5147	1
Complexo Bodoquena	HU41	-56.6460	-21.5984	1
Complexo Bodoquena	HV39	-56.8133	-21.6820	1
Complexo Bodoquena	HW31	-57.4824	-21.7656	1
Complexo Bodoquena	HW34	-57.2315	-21.7656	1
Costeiro	E219	-41.7587	-2.8637	46
Costeiro	E220	-41.6750	-2.8637	14
Costeiro	E218	-41.8423	-2.8637	10
Costeiro	D206	-42.8459	-2.7800	6
Costeiro	D207	-42.7623	-2.7800	4
Costeiro	D218	-41.8423	-2.7800	4
Costeiro	F219	-41.7587	-2.9473	3
Costeiro	C195	-43.7659	-2.6964	1
Costeiro	C197	-43.5987	-2.6964	1
Costeiro	C200	-43.3478	-2.6964	1
Costeiro	C202	-43.1805	-2.6964	1
Costeiro	E193	-43.9332	-2.8637	1
Depressão Cárstica do São Francisco	DZ185	-44.6023	-13.3183	37
Depressão Cárstica do São Francisco	DY199	-43.4314	-13.2347	21
Depressão Cárstica do São Francisco	CV206	-42.8459	-10.8092	14
Depressão Cárstica do São Francisco	EL195	-43.7659	-14.3219	11
Depressão Cárstica do São Francisco	EV189	-44.2678	-15.1583	11
Depressão Cárstica do São Francisco	CY202	-43.1805	-11.0601	7
Depressão Cárstica do São Francisco	EA185	-44.6023	-13.4019	7
Depressão Cárstica do São Francisco	EK190	-44.1841	-14.2383	7
Depressão Cárstica do São Francisco	EJ186	-44.5187	-14.1547	6
Depressão Cárstica do São Francisco	DY184	-44.6860	-13.2347	4

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Depressão Cárstica do São Francisco	DL202	-43.1805	-12.1474	3
Depressão Cárstica do São Francisco	DR192	-44.0169	-12.6492	3
Depressão Cárstica do São Francisco	EK186	-44.5187	-14.2383	3
Depressão Cárstica do São Francisco	FB185	-44.6023	-15.6601	3
Depressão Cárstica do São Francisco	FD200	-43.3478	-15.8274	3
Depressão Cárstica do São Francisco	FJ196	-43.6823	-16.3292	3
Depressão Cárstica do São Francisco	CV207	-42.7623	-10.8092	2
Depressão Cárstica do São Francisco	EA183	-44.7696	-13.4019	2
Depressão Cárstica do São Francisco	EC198	-43.5150	-13.5692	2
Depressão Cárstica do São Francisco	ED187	-44.4350	-13.6529	2
Depressão Cárstica do São Francisco	EK185	-44.6023	-14.2383	2
Depressão Cárstica do São Francisco	EL197	-43.5987	-14.3219	2
Depressão Cárstica do São Francisco	EU189	-44.2678	-15.0747	2
Depressão Cárstica do São Francisco	EZ186	-44.5187	-15.4929	2
Depressão Cárstica do São Francisco	CI197	-43.5987	-9.7219	1
Depressão Cárstica do São Francisco	CM188	-44.3514	-10.0565	1
Depressão Cárstica do São Francisco	CR200	-43.3478	-10.4746	1
Depressão Cárstica do São Francisco	CV185	-44.6023	-10.8092	1
Depressão Cárstica do São Francisco	CV187	-44.4350	-10.8092	1
Depressão Cárstica do São Francisco	CV197	-43.5987	-10.8092	1
Depressão Cárstica do São Francisco	CX204	-43.0132	-10.9765	1
Depressão Cárstica do São Francisco	DI195	-43.7659	-11.8965	1
Depressão Cárstica do São Francisco	DR202	-43.1805	-12.6492	1
Depressão Cárstica do São Francisco	DT191	-44.1005	-12.8165	1
Depressão Cárstica do São Francisco	DW190	-44.1841	-13.0674	1
Depressão Cárstica do São Francisco	DY189	-44.2678	-13.2347	1
Depressão Cárstica do São Francisco	DY191	-44.1005	-13.2347	1
Depressão Cárstica do São Francisco	EA190	-44.1841	-13.4019	1
Depressão Cárstica do São Francisco	EB184	-44.6860	-13.4856	1
Depressão Cárstica do São Francisco	EB190	-44.1841	-13.4856	1
Depressão Cárstica do São Francisco	EC188	-44.3514	-13.5692	1
Depressão Cárstica do São Francisco	ED188	-44.3514	-13.6529	1
Depressão Cárstica do São Francisco	EF187	-44.4350	-13.8201	1
Depressão Cárstica do São Francisco	EK188	-44.3514	-14.2383	1
Depressão Cárstica do São Francisco	EK189	-44.2678	-14.2383	1
Depressão Cárstica do São Francisco	EK195	-43.7659	-14.2383	1
Depressão Cárstica do São Francisco	EL194	-43.8496	-14.3219	1
Depressão Cárstica do São Francisco	EM197	-43.5987	-14.4056	1
Depressão Cárstica do São Francisco	ES195	-43.7659	-14.9074	1
Depressão Cuiabana	FA48	-56.0606	-15.5765	92
Depressão Cuiabana	EQ45	-56.3115	-14.7401	9
Depressão Cuiabana	EM43	-56.4788	-14.4056	8

Ecoregion	**Site Code**	**Longitude**	**Latitude**	**Species Richness**
Depressão Cuiabana	FB34	-57.2315	-15.6601	8
Depressão Cuiabana	EN43	-56.4788	-14.4892	7
Depressão Cuiabana	ER44	-56.3951	-14.8238	7
Depressão Cuiabana	EW43	-56.4788	-15.2420	6
Depressão Cuiabana	FB47	-56.1442	-15.6601	5
Depressão Cuiabana	FC45	-56.3115	-15.7438	5
Depressão Cuiabana	FG30	-57.5660	-16.0783	5
Depressão Cuiabana	EZ34	-57.2315	-15.4929	4
Depressão Cuiabana	EP58	-55.2242	-14.6565	3
Depressão Cuiabana	FD32	-57.3988	-15.8274	3
Depressão Cuiabana	EO42	-56.5624	-14.5729	2
Depressão Cuiabana	EX34	-57.2315	-15.3256	2
Depressão Cuiabana	EO46	-56.2279	-14.5729	1
Depressão Cuiabana	ET37	-56.9806	-14.9910	1
Depressão Cuiabana	EV38	-56.8969	-15.1583	1
Depressão Cuiabana	EV39	-56.8133	-15.1583	1
Depressão Cuiabana	EW38	-56.8969	-15.2420	1
Depressão Cuiabana	EY47	-56.1442	-15.4092	1
Depressão Cuiabana	FA33	-57.3151	-15.5765	1
Depressão Cuiabana	FE41	-56.6460	-15.9110	1
Depressão Cuiabana	FF30	-57.5660	-15.9947	1
Depressão Cuiabana	FH32	-57.3988	-16.1620	1
Depressão Cuiabana	FH39	-56.8133	-16.1620	1
Floresta de Cocais	AF207	-42.7623	-5.1219	32
Floresta de Cocais	AC200	-43.3478	-4.8710	19
Floresta de Cocais	AF206	-42.8459	-5.1219	11
Floresta de Cocais	AA195	-43.7659	-4.7037	6
Floresta de Cocais	I218	-41.8423	-3.1982	6
Floresta de Cocais	X194	-43.8496	-4.4528	3
Floresta de Cocais	Z206	-42.8459	-4.6201	3
Floresta de Cocais	AC185	-44.6023	-4.8710	2
Floresta de Cocais	AC199	-43.4314	-4.8710	2
Floresta de Cocais	AE207	-42.7623	-5.0382	2
Floresta de Cocais	AH184	-44.6860	-5.2892	2
Floresta de Cocais	E200	-43.3478	-2.8637	2
Floresta de Cocais	J215	-42.0932	-3.2819	2
Floresta de Cocais	P193	-43.9332	-3.7837	2
Floresta de Cocais	T202	-43.1805	-4.1182	2
Floresta de Cocais	V193	-43.9332	-4.2855	2
Floresta de Cocais	AC180	-45.0205	-4.8710	1
Floresta de Cocais	AC193	-43.9332	-4.8710	1
Floresta de Cocais	AC197	-43.5987	-4.8710	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Floresta de Cocais	AC202	-43.1805	-4.8710	1
Floresta de Cocais	AD199	-43.4314	-4.9546	1
Floresta de Cocais	AD200	-43.3478	-4.9546	1
Floresta de Cocais	AG187	-44.4350	-5.2055	1
Floresta de Cocais	AG195	-43.7659	-5.2055	1
Floresta de Cocais	AH187	-44.4350	-5.2892	1
Floresta de Cocais	AI188	-44.3514	-5.3728	1
Floresta de Cocais	AI193	-43.9332	-5.3728	1
Floresta de Cocais	AK197	-43.5987	-5.5401	1
Floresta de Cocais	E206	-42.8459	-2.8637	1
Floresta de Cocais	I200	-43.3478	-3.1982	1
Floresta de Cocais	I202	-43.1805	-3.1982	1
Floresta de Cocais	I210	-42.5114	-3.1982	1
Floresta de Cocais	K188	-44.3514	-3.3655	1
Floresta de Cocais	K198	-43.5150	-3.3655	1
Floresta de Cocais	L191	-44.1005	-3.4491	1
Floresta de Cocais	N203	-43.0969	-3.6164	1
Floresta de Cocais	P191	-44.1005	-3.7837	1
Floresta de Cocais	V184	-44.6860	-4.2855	1
Floresta de Cocais	V187	-44.4350	-4.2855	1
Floresta de Cocais	V189	-44.2678	-4.2855	1
Floresta de Cocais	W184	-44.6860	-4.3692	1
Floresta de Cocais	Y187	-44.4350	-4.5364	1
Floresta de Cocais	Y193	-43.9332	-4.5364	1
Jequitinhonha	GG197	-43.5987	-18.2529	139
Jequitinhonha	FM205	-42.9296	-16.5801	91
Jequitinhonha	GD199	-43.4314	-18.0020	34
Jequitinhonha	GF197	-43.5987	-18.1692	32
Jequitinhonha	GF198	-43.5150	-18.1692	25
Jequitinhonha	GE200	-43.3478	-18.0856	23
Jequitinhonha	GF200	-43.3478	-18.1692	18
Jequitinhonha	FP204	-43.0132	-16.8311	16
Jequitinhonha	FL198	-43.5150	-16.4965	13
Jequitinhonha	FM206	-42.8459	-16.5801	12
Jequitinhonha	FS200	-43.3478	-17.0820	11
Jequitinhonha	FL206	-42.8459	-16.4965	10
Jequitinhonha	GG200	-43.3478	-18.2529	10
Jequitinhonha	FP206	-42.8459	-16.8311	9
Jequitinhonha	GF201	-43.2641	-18.1692	8
Jequitinhonha	EV206	-42.8459	-15.1583	7
Jequitinhonha	FQ211	-42.4278	-16.9147	7
Jequitinhonha	FC204	-43.0132	-15.7438	6

Ecoregion	**Site Code**	**Longitude**	**Latitude**	**Species Richness**
Jequitinhonha	FU209	-42.5950	-17.2492	6
Jequitinhonha	FP197	-43.5987	-16.8311	5
Jequitinhonha	GG198	-43.5150	-18.2529	5
Jequitinhonha	GH196	-43.6823	-18.3365	5
Jequitinhonha	EQ208	-42.6787	-14.7401	4
Jequitinhonha	FQ204	-43.0132	-16.9147	4
Jequitinhonha	GH198	-43.5150	-18.3365	4
Jequitinhonha	EW207	-42.7623	-15.2420	3
Jequitinhonha	FA210	-42.5114	-15.5765	3
Jequitinhonha	GE199	-43.4314	-18.0856	3
Jequitinhonha	FD206	-42.8459	-15.8274	2
Jequitinhonha	FE210	-42.5114	-15.9110	2
Jequitinhonha	FL205	-42.9296	-16.4965	2
Jequitinhonha	FL207	-42.7623	-16.4965	2
Jequitinhonha	FO205	-42.9296	-16.7474	2
Jequitinhonha	FT207	-42.7623	-17.1656	2
Jequitinhonha	GD200	-43.3478	-18.0020	2
Jequitinhonha	GE198	-43.5150	-18.0856	2
Jequitinhonha	GI198	-43.5150	-18.4202	2
Jequitinhonha	EY210	-42.5114	-15.4092	1
Jequitinhonha	EY211	-42.4278	-15.4092	1
Jequitinhonha	FD215	-42.0932	-15.8274	1
Jequitinhonha	FE211	-42.4278	-15.9110	1
Jequitinhonha	FE218	-41.8423	-15.9110	1
Jequitinhonha	FF208	-42.6787	-15.9947	1
Jequitinhonha	FG208	-42.6787	-16.0783	1
Jequitinhonha	FI210	-42.5114	-16.2456	1
Jequitinhonha	FJ204	-43.0132	-16.3292	1
Jequitinhonha	FJ206	-42.8459	-16.3292	1
Jequitinhonha	FK205	-42.9296	-16.4129	1
Jequitinhonha	FK206	-42.8459	-16.4129	1
Jequitinhonha	FL204	-43.0132	-16.4965	1
Jequitinhonha	FM204	-43.0132	-16.5801	1
Jequitinhonha	FN205	-42.9296	-16.6638	1
Jequitinhonha	FQ197	-43.5987	-16.9147	1
Jequitinhonha	FR198	-43.5150	-16.9983	1
Jequitinhonha	FS212	-42.3441	-17.0820	1
Jequitinhonha	FU203	-43.0969	-17.2492	1
Jequitinhonha	FU207	-42.7623	-17.2492	1
Jequitinhonha	FX203	-43.0969	-17.5002	1
Jequitinhonha	FX204	-43.0132	-17.5002	1
Jequitinhonha	FY198	-43.5150	-17.5838	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Jequitinhonha	GC201	-43.2641	-17.9183	1
Jequitinhonha	GE201	-43.2641	-18.0856	1
Jequitinhonha	GH200	-43.3478	-18.3365	1
Paracatu	FO194	-43.8496	-16.7474	61
Paracatu	GA190	-44.1841	-17.7511	57
Paracatu	FJ157	-46.9442	-16.3292	45
Paracatu	FA152	-47.3623	-15.5765	41
Paracatu	FU158	-46.8605	-17.2492	27
Paracatu	GC195	-43.7659	-17.9183	15
Paracatu	GF159	-46.7769	-18.1692	14
Paracatu	EY150	-47.5296	-15.4092	10
Paracatu	EZ150	-47.5296	-15.4929	7
Paracatu	FZ190	-44.1841	-17.6674	7
Paracatu	GK162	-46.5260	-18.5874	7
Paracatu	FA150	-47.5296	-15.5765	6
Paracatu	FR168	-46.0241	-16.9983	6
Paracatu	FT155	-47.1114	-17.1656	6
Paracatu	FZ189	-44.2678	-17.6674	6
Paracatu	EX155	-47.1114	-15.3256	5
Paracatu	EZ149	-47.6132	-15.4929	5
Paracatu	FE167	-46.1078	-15.9110	5
Paracatu	GF196	-43.6823	-18.1692	5
Paracatu	EX154	-47.1951	-15.3256	4
Paracatu	FJ179	-45.1041	-16.3292	4
Paracatu	EZ151	-47.4460	-15.4929	3
Paracatu	FN188	-44.3514	-16.6638	3
Paracatu	GA166	-46.1914	-17.7511	3
Paracatu	GD157	-46.9442	-18.0020	3
Paracatu	GJ154	-47.1951	-18.5038	3
Paracatu	EY151	-47.4460	-15.4092	2
Paracatu	FA151	-47.4460	-15.5765	2
Paracatu	FB151	-47.4460	-15.6601	2
Paracatu	FD152	-47.3623	-15.8274	2
Paracatu	FH167	-46.1078	-16.1620	2
Paracatu	FS190	-44.1841	-17.0820	2
Paracatu	FS194	-43.8496	-17.0820	2
Paracatu	FU159	-46.7769	-17.2492	2
Paracatu	FU187	-44.4350	-17.2492	2
Paracatu	FV189	-44.2678	-17.3329	2
Paracatu	GD158	-46.8605	-18.0020	2
Paracatu	GF195	-43.7659	-18.1692	2
Paracatu	EV149	-47.6132	-15.1583	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Paracatu	EW154	-47.1951	-15.2420	1
Paracatu	EY157	-46.9442	-15.4092	1
Paracatu	EZ183	-44.7696	-15.4929	1
Paracatu	FA153	-47.2787	-15.5765	1
Paracatu	FA163	-46.4423	-15.5765	1
Paracatu	FC152	-47.3623	-15.7438	1
Paracatu	FC153	-47.2787	-15.7438	1
Paracatu	FD157	-46.9442	-15.8274	1
Paracatu	FE159	-46.7769	-15.9110	1
Paracatu	FE163	-46.4423	-15.9110	1
Paracatu	FF155	-47.1114	-15.9947	1
Paracatu	FF156	-47.0278	-15.9947	1
Paracatu	FG156	-47.0278	-16.0783	1
Paracatu	FG164	-46.3587	-16.0783	1
Paracatu	FI153	-47.2787	-16.2456	1
Paracatu	FK155	-47.1114	-16.4129	1
Paracatu	FL158	-46.8605	-16.4965	1
Paracatu	FM193	-43.9332	-16.5801	1
Paracatu	FP168	-46.0241	-16.8311	1
Paracatu	FR156	-47.0278	-16.9983	1
Paracatu	FR194	-43.8496	-16.9983	1
Paracatu	FW160	-46.6932	-17.4165	1
Paracatu	FW190	-44.1841	-17.4165	1
Paracatu	FW191	-44.1005	-17.4165	1
Paracatu	FZ188	-44.3514	-17.6674	1
Paracatu	GB195	-43.7659	-17.8347	1
Paracatu	GF171	-45.7732	-18.1692	1
Paracatu	GL160	-46.6932	-18.6711	1
Paracatu	GM159	-46.7769	-18.7547	1
Paracatu	GN157	-46.9442	-18.8383	1
Paraná Guimarães	HG65	-54.6387	-20.4274	123
Paraná Guimarães	EZ52	-55.7260	-15.4929	89
Paraná Guimarães	GC100	-51.7115	-17.9183	76
Paraná Guimarães	GI97	-51.9624	-18.4202	71
Paraná Guimarães	HG64	-54.7224	-20.4274	59
Paraná Guimarães	FV82	-53.2169	-17.3329	37
Paraná Guimarães	GA119	-50.1224	-17.7511	35
Paraná Guimarães	HF103	-51.4605	-20.3438	34
Paraná Guimarães	HI63	-54.8060	-20.5947	33
Paraná Guimarães	HH65	-54.6387	-20.5111	31
Paraná Guimarães	FR99	-51.7951	-16.9983	27
Paraná Guimarães	HG55	-55.4751	-20.4274	27

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Paraná Guimarães	HI68	-54.3878	-20.5947	24
Paraná Guimarães	HV92	-52.3806	-21.6820	24
Paraná Guimarães	FY90	-52.5478	-17.5838	23
Paraná Guimarães	FZ119	-50.1224	-17.6674	22
Paraná Guimarães	HM61	-54.9733	-20.9293	20
Paraná Guimarães	GJ64	-54.7224	-18.5038	19
Paraná Guimarães	FL65	-54.6387	-16.4965	17
Paraná Guimarães	GZ63	-54.8060	-19.8420	17
Paraná Guimarães	EY51	-55.8097	-15.4092	16
Paraná Guimarães	GQ85	-52.9660	-19.0893	16
Paraná Guimarães	GA120	-50.0387	-17.7511	14
Paraná Guimarães	GP97	-51.9624	-19.0056	14
Paraná Guimarães	GY58	-55.2242	-19.7583	13
Paraná Guimarães	HK63	-54.8060	-20.7620	13
Paraná Guimarães	EQ89	-52.6315	-14.7401	12
Paraná Guimarães	FW120	-50.0387	-17.4165	12
Paraná Guimarães	GF80	-53.3842	-18.1692	12
Paraná Guimarães	HD66	-54.5551	-20.1765	12
Paraná Guimarães	GT107	-51.1260	-19.3402	11
Paraná Guimarães	HH68	-54.3878	-20.5111	11
Paraná Guimarães	GB100	-51.7115	-17.8347	10
Paraná Guimarães	GB81	-53.3006	-17.8347	10
Paraná Guimarães	GH97	-51.9624	-18.3365	10
Paraná Guimarães	EN86	-52.8824	-14.4892	9
Paraná Guimarães	FU99	-51.7951	-17.2492	9
Paraná Guimarães	HD68	-54.3878	-20.1765	9
Paraná Guimarães	IB49	-55.9769	-22.1838	9
Paraná Guimarães	ER91	-52.4642	-14.8238	8
Paraná Guimarães	FY64	-54.7224	-17.5838	8
Paraná Guimarães	HG62	-54.8897	-20.4274	8
Paraná Guimarães	FZ120	-50.0387	-17.6674	7
Paraná Guimarães	GE76	-53.7187	-18.0856	7
Paraná Guimarães	GL86	-52.8824	-18.6711	7
Paraná Guimarães	GO63	-54.8060	-18.9220	7
Paraná Guimarães	HG66	-54.5551	-20.4274	7
Paraná Guimarães	ET61	-54.9733	-14.9910	6
Paraná Guimarães	FT99	-51.7951	-17.1656	6
Paraná Guimarães	GD96	-52.0460	-18.0020	6
Paraná Guimarães	GG81	-53.3006	-18.2529	6
Paraná Guimarães	EP90	-52.5478	-14.6565	5
Paraná Guimarães	GM104	-51.3769	-18.7547	5
Paraná Guimarães	HF53	-55.6424	-20.3438	5

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Paraná Guimarães	EP85	-52.9660	-14.6565	4
Paraná Guimarães	EX50	-55.8933	-15.3256	4
Paraná Guimarães	FT110	-50.8751	-17.1656	4
Paraná Guimarães	FU71	-54.1369	-17.2492	4
Paraná Guimarães	GB109	-50.9587	-17.8347	4
Paraná Guimarães	GJ83	-53.1333	-18.5038	4
Paraná Guimarães	GL104	-51.3769	-18.6711	4
Paraná Guimarães	GP82	-53.2169	-19.0056	4
Paraná Guimarães	GU61	-54.9733	-19.4238	4
Paraná Guimarães	HJ57	-55.3078	-20.6784	4
Paraná Guimarães	EQ85	-52.9660	-14.7401	3
Paraná Guimarães	ES84	-53.0496	-14.9074	3
Paraná Guimarães	EW50	-55.8933	-15.2420	3
Paraná Guimarães	FU98	-51.8787	-17.2492	3
Paraná Guimarães	FW122	-49.8714	-17.4165	3
Paraná Guimarães	GC85	-52.9660	-17.9183	3
Paraná Guimarães	GE66	-54.5551	-18.0856	3
Paraná Guimarães	GE77	-53.6351	-18.0856	3
Paraná Guimarães	GH114	-50.5405	-18.3365	3
Paraná Guimarães	GI90	-52.5478	-18.4202	3
Paraná Guimarães	GJ110	-50.8751	-18.5038	3
Paraná Guimarães	GS108	-51.0424	-19.2565	3
Paraná Guimarães	GV72	-54.0533	-19.5074	3
Paraná Guimarães	HG53	-55.6424	-20.4274	3
Paraná Guimarães	HH63	-54.8060	-20.5111	3
Paraná Guimarães	HJ62	-54.8897	-20.6784	3
Paraná Guimarães	HQ96	-52.0460	-21.2638	3
Paraná Guimarães	IF52	-55.7260	-22.5184	3
Paraná Guimarães	EQ90	-52.5478	-14.7401	2
Paraná Guimarães	FA85	-52.9660	-15.5765	2
Paraná Guimarães	FF61	-54.9733	-15.9947	2
Paraná Guimarães	FN67	-54.4715	-16.6638	2
Paraná Guimarães	FO71	-54.1369	-16.7474	2
Paraná Guimarães	FY119	-50.1224	-17.5838	2
Paraná Guimarães	GB101	-51.6278	-17.8347	2
Paraná Guimarães	GB89	-52.6315	-17.8347	2
Paraná Guimarães	GD128	-49.3696	-18.0020	2
Paraná Guimarães	GE80	-53.3842	-18.0856	2
Paraná Guimarães	GF74	-53.8860	-18.1692	2
Paraná Guimarães	GH80	-53.3842	-18.3365	2
Paraná Guimarães	GH85	-52.9660	-18.3365	2
Paraná Guimarães	GK111	-50.7914	-18.5874	2

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Paraná Guimarães	GO62	-54.8897	-18.9220	2
Paraná Guimarães	GQ100	-51.7115	-19.0893	2
Paraná Guimarães	GS103	-51.4605	-19.2565	2
Paraná Guimarães	GT108	-51.0424	-19.3402	2
Paraná Guimarães	GU104	-51.3769	-19.4238	2
Paraná Guimarães	GV73	-53.9697	-19.5074	2
Paraná Guimarães	GZ58	-55.2242	-19.8420	2
Paraná Guimarães	HF54	-55.5588	-20.3438	2
Paraná Guimarães	HH54	-55.5588	-20.5111	2
Paraná Guimarães	HH64	-54.7224	-20.5111	2
Paraná Guimarães	HI64	-54.7224	-20.5947	2
Paraná Guimarães	HI77	-53.6351	-20.5947	2
Paraná Guimarães	HJ69	-54.3042	-20.6784	2
Paraná Guimarães	HL99	-51.7951	-20.8456	2
Paraná Guimarães	HM62	-54.8897	-20.9293	2
Paraná Guimarães	HP53	-55.6424	-21.1802	2
Paraná Guimarães	HZ80	-53.3842	-22.0165	2
Paraná Guimarães	EN76	-53.7187	-14.4892	1
Paraná Guimarães	EP53	-55.6424	-14.6565	1
Paraná Guimarães	EQ61	-54.9733	-14.7401	1
Paraná Guimarães	ER89	-52.6315	-14.8238	1
Paraná Guimarães	ES55	-55.4751	-14.9074	1
Paraná Guimarães	ES90	-52.5478	-14.9074	1
Paraná Guimarães	ET91	-52.4642	-14.9910	1
Paraná Guimarães	EW93	-52.2969	-15.2420	1
Paraná Guimarães	EY48	-56.0606	-15.4092	1
Paraná Guimarães	EY52	-55.7260	-15.4092	1
Paraná Guimarães	EY68	-54.3878	-15.4092	1
Paraná Guimarães	EZ51	-55.8097	-15.4929	1
Paraná Guimarães	FA69	-54.3042	-15.5765	1
Paraná Guimarães	FC77	-53.6351	-15.7438	1
Paraná Guimarães	FC88	-52.7151	-15.7438	1
Paraná Guimarães	FD55	-55.4751	-15.8274	1
Paraná Guimarães	FD56	-55.3915	-15.8274	1
Paraná Guimarães	FD91	-52.4642	-15.8274	1
Paraná Guimarães	FF68	-54.3878	-15.9947	1
Paraná Guimarães	FH59	-55.1406	-16.1620	1
Paraná Guimarães	FJ76	-53.7187	-16.3292	1
Paraná Guimarães	FL66	-54.5551	-16.4965	1
Paraná Guimarães	FO93	-52.2969	-16.7474	1
Paraná Guimarães	FQ99	-51.7951	-16.9147	1
Paraná Guimarães	FS100	-51.7115	-17.0820	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Paraná Guimarães	FS102	-51.5442	-17.0820	1
Paraná Guimarães	FS73	-53.9697	-17.0820	1
Paraná Guimarães	FS99	-51.7951	-17.0820	1
Paraná Guimarães	FT71	-54.1369	-17.1656	1
Paraná Guimarães	FV89	-52.6315	-17.3329	1
Paraná Guimarães	FV99	-51.7951	-17.3329	1
Paraná Guimarães	FW116	-50.3733	-17.4165	1
Paraná Guimarães	FW95	-52.1296	-17.4165	1
Paraná Guimarães	FX120	-50.0387	-17.5002	1
Paraná Guimarães	FY61	-54.9733	-17.5838	1
Paraná Guimarães	FY62	-54.8897	-17.5838	1
Paraná Guimarães	FZ109	-50.9587	-17.6674	1
Paraná Guimarães	GB110	-50.8751	-17.8347	1
Paraná Guimarães	GB64	-54.7224	-17.8347	1
Paraná Guimarães	GB95	-52.1296	-17.8347	1
Paraná Guimarães	GC101	-51.6278	-17.9183	1
Paraná Guimarães	GD100	-51.7115	-18.0020	1
Paraná Guimarães	GD116	-50.3733	-18.0020	1
Paraná Guimarães	GD130	-49.2023	-18.0020	1
Paraná Guimarães	GD82	-53.2169	-18.0020	1
Paraná Guimarães	GF103	-51.4605	-18.1692	1
Paraná Guimarães	GF107	-51.1260	-18.1692	1
Paraná Guimarães	GF76	-53.7187	-18.1692	1
Paraná Guimarães	GF88	-52.7151	-18.1692	1
Paraná Guimarães	GG80	-53.3842	-18.2529	1
Paraná Guimarães	GG86	-52.8824	-18.2529	1
Paraná Guimarães	GG97	-51.9624	-18.2529	1
Paraná Guimarães	GI130	-49.2023	-18.4202	1
Paraná Guimarães	GI62	-54.8897	-18.4202	1
Paraná Guimarães	GI96	-52.0460	-18.4202	1
Paraná Guimarães	GJ126	-49.5369	-18.5038	1
Paraná Guimarães	GJ95	-52.1296	-18.5038	1
Paraná Guimarães	GK97	-51.9624	-18.5874	1
Paraná Guimarães	GL106	-51.2096	-18.6711	1
Paraná Guimarães	GM82	-53.2169	-18.7547	1
Paraná Guimarães	GM92	-52.3806	-18.7547	1
Paraná Guimarães	GN107	-51.1260	-18.8383	1
Paraná Guimarães	GN65	-54.6387	-18.8383	1
Paraná Guimarães	GO103	-51.4605	-18.9220	1
Paraná Guimarães	GO97	-51.9624	-18.9220	1
Paraná Guimarães	GQ102	-51.5442	-19.0893	1
Paraná Guimarães	GR86	-52.8824	-19.1729	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Paraná Guimarães	GS87	-52.7987	-19.2565	1
Paraná Guimarães	GU66	-54.5551	-19.4238	1
Paraná Guimarães	GW98	-51.8787	-19.5911	1
Paraná Guimarães	GX106	-51.2096	-19.6747	1
Paraná Guimarães	GY59	-55.1406	-19.7583	1
Paraná Guimarães	GY60	-55.0569	-19.7583	1
Paraná Guimarães	GY97	-51.9624	-19.7583	1
Paraná Guimarães	GZ102	-51.5442	-19.8420	1
Paraná Guimarães	GZ61	-54.9733	-19.8420	1
Paraná Guimarães	GZ80	-53.3842	-19.8420	1
Paraná Guimarães	HA62	-54.8897	-19.9256	1
Paraná Guimarães	HB71	-54.1369	-20.0093	1
Paraná Guimarães	HC107	-51.1260	-20.0929	1
Paraná Guimarães	HE60	-55.0569	-20.2602	1
Paraná Guimarães	HE96	-52.0460	-20.2602	1
Paraná Guimarães	HF66	-54.5551	-20.3438	1
Paraná Guimarães	HG57	-55.3078	-20.4274	1
Paraná Guimarães	HG58	-55.2242	-20.4274	1
Paraná Guimarães	HG76	-53.7187	-20.4274	1
Paraná Guimarães	HH55	-55.4751	-20.5111	1
Paraná Guimarães	HH66	-54.5551	-20.5111	1
Paraná Guimarães	HI67	-54.4715	-20.5947	1
Paraná Guimarães	HI92	-52.3806	-20.5947	1
Paraná Guimarães	HJ68	-54.3878	-20.6784	1
Paraná Guimarães	HL63	-54.8060	-20.8456	1
Paraná Guimarães	HM67	-54.4715	-20.9293	1
Paraná Guimarães	HN61	-54.9733	-21.0129	1
Paraná Guimarães	HO88	-52.7151	-21.0965	1
Paraná Guimarães	HP54	-55.5588	-21.1802	1
Paraná Guimarães	HQ67	-54.4715	-21.2638	1
Paraná Guimarães	HQ87	-52.7987	-21.2638	1
Paraná Guimarães	HT69	-54.3042	-21.5147	1
Paraná Guimarães	HV64	-54.7224	-21.6820	1
Paraná Guimarães	IA80	-53.3842	-22.1002	1
Paraná Guimarães	IC63	-54.8060	-22.2675	1
Paraná Guimarães	IG54	-55.5588	-22.6020	1
Parnaguá	CY178	-45.1878	-11.0601	18
Parnaguá	CJ176	-45.3550	-9.8056	8
Parnaguá	CY177	-45.2714	-11.0601	8
Parnaguá	CZ175	-45.4387	-11.1437	5
Parnaguá	DG181	-44.9369	-11.7292	3
Parnaguá	DI175	-45.4387	-11.8965	3

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Parnaguá	DK180	-45.0205	-12.0637	3
Parnaguá	CR178	-45.1878	-10.4746	2
Parnaguá	DJ181	-44.9369	-11.9801	2
Parnaguá	CG160	-46.6932	-9.5546	1
Parnaguá	CG182	-44.8532	-9.5546	1
Parnaguá	CG183	-44.7696	-9.5546	1
Parnaguá	CI163	-46.4423	-9.7219	1
Parnaguá	CI177	-45.2714	-9.7219	1
Parnaguá	CK175	-45.4387	-9.8892	1
Parnaguá	CK180	-45.0205	-9.8892	1
Parnaguá	CN182	-44.8532	-10.1401	1
Parnaguá	CW178	-45.1878	-10.8928	1
Parnaguá	CX177	-45.2714	-10.9765	1
Parnaguá	CY175	-45.4387	-11.0601	1
Parnaguá	CZ173	-45.6060	-11.1437	1
Parnaguá	CZ176	-45.3550	-11.1437	1
Parnaguá	DA175	-45.4387	-11.2274	1
Parnaguá	DD193	-43.9332	-11.4783	1
Parnaguá	DD195	-43.7659	-11.4783	1
Parnaguá	DH178	-45.1878	-11.8128	1
Planalto Central	FC145	-47.9478	-15.7438	563
Planalto Central	FD146	-47.8642	-15.8274	139
Planalto Central	FN129	-49.2860	-16.6638	124
Planalto Central	FE146	-47.8642	-15.9110	122
Planalto Central	EJ150	-47.5296	-14.1547	106
Planalto Central	EN139	-48.4496	-14.4892	106
Planalto Central	FE145	-47.9478	-15.9110	91
Planalto Central	FD133	-48.9514	-15.8274	90
Planalto Central	FI145	-47.9478	-16.2456	75
Planalto Central	GA137	-48.6169	-17.7511	74
Planalto Central	FC146	-47.8642	-15.7438	61
Planalto Central	EJ149	-47.6132	-14.1547	57
Planalto Central	FE119	-50.1224	-15.9110	57
Planalto Central	FH118	-50.2060	-16.1620	54
Planalto Central	FO149	-47.6132	-16.7474	54
Planalto Central	FD135	-48.7842	-15.8274	52
Planalto Central	EJ143	-48.1151	-14.1547	51
Planalto Central	FC149	-47.6132	-15.7438	47
Planalto Central	FD145	-47.9478	-15.8274	45
Planalto Central	FE144	-48.0314	-15.9110	45
Planalto Central	FD134	-48.8678	-15.8274	39
Planalto Central	FD147	-47.7805	-15.8274	37

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Planalto Central	HI168	-46.0241	-20.5947	33
Planalto Central	GO156	-47.0278	-18.9220	32
Planalto Central	EZ145	-47.9478	-15.4929	30
Planalto Central	FE143	-48.1151	-15.9110	29
Planalto Central	FF144	-48.0314	-15.9947	29
Planalto Central	EQ150	-47.5296	-14.7401	28
Planalto Central	FE135	-48.7842	-15.9110	27
Planalto Central	FF146	-47.8642	-15.9947	26
Planalto Central	FC143	-48.1151	-15.7438	24
Planalto Central	DT142	-48.1987	-12.8165	23
Planalto Central	FB147	-47.7805	-15.6601	22
Planalto Central	GF145	-47.9478	-18.1692	21
Planalto Central	EJ147	-47.7805	-14.1547	20
Planalto Central	FF145	-47.9478	-15.9947	20
Planalto Central	GA142	-48.1987	-17.7511	20
Planalto Central	FA149	-47.6132	-15.5765	19
Planalto Central	FJ133	-48.9514	-16.3292	19
Planalto Central	FA145	-47.9478	-15.5765	17
Planalto Central	FC133	-48.9514	-15.7438	17
Planalto Central	FC144	-48.0314	-15.7438	17
Planalto Central	FD144	-48.0314	-15.8274	17
Planalto Central	GA131	-49.1187	-17.7511	17
Planalto Central	FA146	-47.8642	-15.5765	16
Planalto Central	FN137	-48.6169	-16.6638	16
Planalto Central	EM139	-48.4496	-14.4056	15
Planalto Central	FR135	-48.7842	-16.9983	15
Planalto Central	GW157	-46.9442	-19.5911	15
Planalto Central	EU132	-49.0351	-15.0747	14
Planalto Central	FA148	-47.6969	-15.5765	14
Planalto Central	FB146	-47.8642	-15.6601	13
Planalto Central	FC147	-47.7805	-15.7438	13
Planalto Central	FG118	-50.2060	-16.0783	13
Planalto Central	FG144	-48.0314	-16.0783	13
Planalto Central	EJ146	-47.8642	-14.1547	12
Planalto Central	FL127	-49.4533	-16.4965	12
Planalto Central	EK145	-47.9478	-14.2383	11
Planalto Central	EL140	-48.3660	-14.3219	11
Planalto Central	FD132	-49.0351	-15.8274	11
Planalto Central	FF150	-47.5296	-15.9947	11
Planalto Central	GF138	-48.5333	-18.1692	11
Planalto Central	EI150	-47.5296	-14.0710	10
Planalto Central	EV141	-48.2823	-15.1583	10

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Planalto Central	EX137	-48.6169	-15.3256	10
Planalto Central	FB145	-47.9478	-15.6601	10
Planalto Central	FP130	-49.2023	-16.8311	10
Planalto Central	FR134	-48.8678	-16.9983	10
Planalto Central	EF141	-48.2823	-13.8201	9
Planalto Central	EX127	-49.4533	-15.3256	9
Planalto Central	FB148	-47.6969	-15.6601	9
Planalto Central	FG138	-48.5333	-16.0783	9
Planalto Central	FR133	-48.9514	-16.9983	9
Planalto Central	EN131	-49.1187	-14.4892	8
Planalto Central	ET147	-47.7805	-14.9910	8
Planalto Central	EZ137	-48.6169	-15.4929	8
Planalto Central	FR144	-48.0314	-16.9983	8
Planalto Central	GD143	-48.1151	-18.0020	8
Planalto Central	HF159	-46.7769	-20.3438	8
Planalto Central	EC142	-48.1987	-13.5692	7
Planalto Central	EP139	-48.4496	-14.6565	7
Planalto Central	EZ146	-47.8642	-15.4929	7
Planalto Central	FC148	-47.6969	-15.7438	7
Planalto Central	FF142	-48.1987	-15.9947	7
Planalto Central	FQ130	-49.2023	-16.9147	7
Planalto Central	GA136	-48.7005	-17.7511	7
Planalto Central	GF146	-47.8642	-18.1692	7
Planalto Central	EJ148	-47.6969	-14.1547	6
Planalto Central	EK146	-47.8642	-14.2383	6
Planalto Central	FC128	-49.3696	-15.7438	6
Planalto Central	FC134	-48.8678	-15.7438	6
Planalto Central	FO131	-49.1187	-16.7474	6
Planalto Central	FO148	-47.6969	-16.7474	6
Planalto Central	GA135	-48.7842	-17.7511	6
Planalto Central	ED146	-47.8642	-13.6529	5
Planalto Central	ED147	-47.7805	-13.6529	5
Planalto Central	EH141	-48.2823	-13.9874	5
Planalto Central	EJ140	-48.3660	-14.1547	5
Planalto Central	FA144	-48.0314	-15.5765	5
Planalto Central	FB144	-48.0314	-15.6601	5
Planalto Central	FC135	-48.7842	-15.7438	5
Planalto Central	FE141	-48.2823	-15.9110	5
Planalto Central	GV162	-46.5260	-19.5074	5
Planalto Central	ED151	-47.4460	-13.6529	4
Planalto Central	EG150	-47.5296	-13.9038	4
Planalto Central	EM140	-48.3660	-14.4056	4

Ecoregion	**Site Code**	**Longitude**	**Latitude**	**Species Richness**
Planalto Central	EO139	-48.4496	-14.5729	4
Planalto Central	FA143	-48.1151	-15.5765	4
Planalto Central	FD136	-48.7005	-15.8274	4
Planalto Central	FG153	-47.2787	-16.0783	4
Planalto Central	FL144	-48.0314	-16.4965	4
Planalto Central	GC138	-48.5333	-17.9183	4
Planalto Central	GD147	-47.7805	-18.0020	4
Planalto Central	HG160	-46.6932	-20.4274	4
Planalto Central	DV143	-48.1151	-12.9838	3
Planalto Central	EF143	-48.1151	-13.8201	3
Planalto Central	EH140	-48.3660	-13.9874	3
Planalto Central	EI149	-47.6132	-14.0710	3
Planalto Central	EI151	-47.4460	-14.0710	3
Planalto Central	EL139	-48.4496	-14.3219	3
Planalto Central	EZ142	-48.1987	-15.4929	3
Planalto Central	FF143	-48.1151	-15.9947	3
Planalto Central	FG145	-47.9478	-16.0783	3
Planalto Central	FI142	-48.1987	-16.2456	3
Planalto Central	FJ131	-49.1187	-16.3292	3
Planalto Central	FL131	-49.1187	-16.4965	3
Planalto Central	FO145	-47.9478	-16.7474	3
Planalto Central	FV132	-49.0351	-17.3329	3
Planalto Central	GB138	-48.5333	-17.8347	3
Planalto Central	HE158	-46.8605	-20.2602	3
Planalto Central	HI165	-46.2751	-20.5947	3
Planalto Central	DW143	-48.1151	-13.0674	2
Planalto Central	EC144	-48.0314	-13.5692	2
Planalto Central	EE134	-48.8678	-13.7365	2
Planalto Central	EE157	-46.9442	-13.7365	2
Planalto Central	EF140	-48.3660	-13.8201	2
Planalto Central	EG153	-47.2787	-13.9038	2
Planalto Central	EI141	-48.2823	-14.0710	2
Planalto Central	EI148	-47.6969	-14.0710	2
Planalto Central	EI153	-47.2787	-14.0710	2
Planalto Central	EL132	-49.0351	-14.3219	2
Planalto Central	EM132	-49.0351	-14.4056	2
Planalto Central	EN140	-48.3660	-14.4892	2
Planalto Central	EN150	-47.5296	-14.4892	2
Planalto Central	EO132	-49.0351	-14.5729	2
Planalto Central	EV140	-48.3660	-15.1583	2
Planalto Central	EY134	-48.8678	-15.4092	2
Planalto Central	EZ143	-48.1151	-15.4929	2

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Planalto Central	FB142	-48.1987	-15.6601	2
Planalto Central	FB149	-47.6132	-15.6601	2
Planalto Central	FC132	-49.0351	-15.7438	2
Planalto Central	FD143	-48.1151	-15.8274	2
Planalto Central	FE124	-49.7042	-15.9110	2
Planalto Central	FE137	-48.6169	-15.9110	2
Planalto Central	FE147	-47.7805	-15.9110	2
Planalto Central	FF120	-50.0387	-15.9947	2
Planalto Central	FF149	-47.6132	-15.9947	2
Planalto Central	FH126	-49.5369	-16.1620	2
Planalto Central	FI136	-48.7005	-16.2456	2
Planalto Central	FJ138	-48.5333	-16.3292	2
Planalto Central	FJ139	-48.4496	-16.3292	2
Planalto Central	FK130	-49.2023	-16.4129	2
Planalto Central	FL129	-49.2860	-16.4965	2
Planalto Central	FM122	-49.8714	-16.5801	2
Planalto Central	FM129	-49.2860	-16.5801	2
Planalto Central	FM131	-49.1187	-16.5801	2
Planalto Central	FM137	-48.6169	-16.5801	2
Planalto Central	FO150	-47.5296	-16.7474	2
Planalto Central	FP149	-47.6132	-16.8311	2
Planalto Central	FR113	-50.6242	-16.9983	2
Planalto Central	FR130	-49.2023	-16.9983	2
Planalto Central	FV121	-49.9551	-17.3329	2
Planalto Central	FY139	-48.4496	-17.5838	2
Planalto Central	FZ147	-47.7805	-17.6674	2
Planalto Central	GA143	-48.1151	-17.7511	2
Planalto Central	GB135	-48.7842	-17.8347	2
Planalto Central	GE148	-47.6969	-18.0856	2
Planalto Central	HD160	-46.6932	-20.1765	2
Planalto Central	HE163	-46.4423	-20.2602	2
Planalto Central	HF162	-46.5260	-20.3438	2
Planalto Central	DS142	-48.1987	-12.7328	1
Planalto Central	DU142	-48.1987	-12.9001	1
Planalto Central	DY144	-48.0314	-13.2347	1
Planalto Central	EA144	-48.0314	-13.4019	1
Planalto Central	EC143	-48.1151	-13.5692	1
Planalto Central	EC150	-47.5296	-13.5692	1
Planalto Central	EC151	-47.4460	-13.5692	1
Planalto Central	ED150	-47.5296	-13.6529	1
Planalto Central	EE140	-48.3660	-13.7365	1
Planalto Central	EE150	-47.5296	-13.7365	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Planalto Central	EF138	-48.5333	-13.8201	1
Planalto Central	EF153	-47.2787	-13.8201	1
Planalto Central	EF156	-47.0278	-13.8201	1
Planalto Central	EG141	-48.2823	-13.9038	1
Planalto Central	EG143	-48.1151	-13.9038	1
Planalto Central	EG151	-47.4460	-13.9038	1
Planalto Central	EG152	-47.3623	-13.9038	1
Planalto Central	EG156	-47.0278	-13.9038	1
Planalto Central	EH142	-48.1987	-13.9874	1
Planalto Central	EH150	-47.5296	-13.9874	1
Planalto Central	EH151	-47.4460	-13.9874	1
Planalto Central	EI140	-48.3660	-14.0710	1
Planalto Central	EI144	-48.0314	-14.0710	1
Planalto Central	EJ145	-47.9478	-14.1547	1
Planalto Central	EJ151	-47.4460	-14.1547	1
Planalto Central	EJ152	-47.3623	-14.1547	1
Planalto Central	EK144	-48.0314	-14.2383	1
Planalto Central	EK150	-47.5296	-14.2383	1
Planalto Central	EL131	-49.1187	-14.3219	1
Planalto Central	EL146	-47.8642	-14.3219	1
Planalto Central	EL151	-47.4460	-14.3219	1
Planalto Central	EM142	-48.1987	-14.4056	1
Planalto Central	EN130	-49.2023	-14.4892	1
Planalto Central	EN138	-48.5333	-14.4892	1
Planalto Central	EN143	-48.1151	-14.4892	1
Planalto Central	EO135	-48.7842	-14.5729	1
Planalto Central	EO138	-48.5333	-14.5729	1
Planalto Central	EO140	-48.3660	-14.5729	1
Planalto Central	EP133	-48.9514	-14.6565	1
Planalto Central	EP149	-47.6132	-14.6565	1
Planalto Central	EP150	-47.5296	-14.6565	1
Planalto Central	EP151	-47.4460	-14.6565	1
Planalto Central	EQ127	-49.4533	-14.7401	1
Planalto Central	EQ132	-49.0351	-14.7401	1
Planalto Central	ER126	-49.5369	-14.8238	1
Planalto Central	ER145	-47.9478	-14.8238	1
Planalto Central	ES133	-48.9514	-14.9074	1
Planalto Central	ES149	-47.6132	-14.9074	1
Planalto Central	ET133	-48.9514	-14.9910	1
Planalto Central	EU144	-48.0314	-15.0747	1
Planalto Central	EV131	-49.1187	-15.1583	1
Planalto Central	EV142	-48.1987	-15.1583	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Planalto Central	EW147	-47.7805	-15.2420	1
Planalto Central	EW149	-47.6132	-15.2420	1
Planalto Central	EX131	-49.1187	-15.3256	1
Planalto Central	EZ144	-48.0314	-15.4929	1
Planalto Central	EZ147	-47.7805	-15.4929	1
Planalto Central	FA137	-48.6169	-15.5765	1
Planalto Central	FA142	-48.1987	-15.5765	1
Planalto Central	FB137	-48.6169	-15.6601	1
Planalto Central	FB140	-48.3660	-15.6601	1
Planalto Central	FB143	-48.1151	-15.6601	1
Planalto Central	FC141	-48.2823	-15.7438	1
Planalto Central	FC142	-48.1987	-15.7438	1
Planalto Central	FC150	-47.5296	-15.7438	1
Planalto Central	FD126	-49.5369	-15.8274	1
Planalto Central	FD128	-49.3696	-15.8274	1
Planalto Central	FD149	-47.6132	-15.8274	1
Planalto Central	FE120	-50.0387	-15.9110	1
Planalto Central	FE140	-48.3660	-15.9110	1
Planalto Central	FF123	-49.7878	-15.9947	1
Planalto Central	FF134	-48.8678	-15.9947	1
Planalto Central	FF147	-47.7805	-15.9947	1
Planalto Central	FF151	-47.4460	-15.9947	1
Planalto Central	FF153	-47.2787	-15.9947	1
Planalto Central	FG135	-48.7842	-16.0783	1
Planalto Central	FG146	-47.8642	-16.0783	1
Planalto Central	FG152	-47.3623	-16.0783	1
Planalto Central	FH116	-50.3733	-16.1620	1
Planalto Central	FH137	-48.6169	-16.1620	1
Planalto Central	FH138	-48.5333	-16.1620	1
Planalto Central	FI129	-49.2860	-16.2456	1
Planalto Central	FI130	-49.2023	-16.2456	1
Planalto Central	FI152	-47.3623	-16.2456	1
Planalto Central	FJ135	-48.7842	-16.3292	1
Planalto Central	FK128	-49.3696	-16.4129	1
Planalto Central	FL121	-49.9551	-16.4965	1
Planalto Central	FM116	-50.3733	-16.5801	1
Planalto Central	FM124	-49.7042	-16.5801	1
Planalto Central	FM135	-48.7842	-16.5801	1
Planalto Central	FM144	-48.0314	-16.5801	1
Planalto Central	FM149	-47.6132	-16.5801	1
Planalto Central	FN127	-49.4533	-16.6638	1
Planalto Central	FN136	-48.7005	-16.6638	1

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Planalto Central	FN144	-48.0314	-16.6638	1
Planalto Central	FN149	-47.6132	-16.6638	1
Planalto Central	FP129	-49.2860	-16.8311	1
Planalto Central	FP148	-47.6969	-16.8311	1
Planalto Central	FQ115	-50.4569	-16.9147	1
Planalto Central	FQ146	-47.8642	-16.9147	1
Planalto Central	FS125	-49.6205	-17.0820	1
Planalto Central	FV128	-49.3696	-17.3329	1
Planalto Central	FV141	-48.2823	-17.3329	1
Planalto Central	FZ127	-49.4533	-17.6674	1
Planalto Central	FZ138	-48.5333	-17.6674	1
Planalto Central	GA139	-48.4496	-17.7511	1
Planalto Central	GD137	-48.6169	-18.0020	1
Planalto Central	GD138	-48.5333	-18.0020	1
Planalto Central	GE141	-48.2823	-18.0856	1
Planalto Central	GG143	-48.1151	-18.2529	1
Planalto Central	GJ142	-48.1987	-18.5038	1
Planalto Central	GR155	-47.1114	-19.1729	1
Planalto Central	HD161	-46.6096	-20.1765	1
Planalto Central	HE159	-46.7769	-20.2602	1
Planalto Central	HE162	-46.5260	-20.2602	1
Planalto Central	HG161	-46.6096	-20.4274	1
Planalto Central	HG162	-46.5260	-20.4274	1
Planalto Central	HH162	-46.5260	-20.5111	1
Planalto Central	HH163	-46.4423	-20.5111	1
Planalto Central	HI164	-46.3587	-20.5947	1
Planalto Central	HI166	-46.1914	-20.5947	1
Planalto Central	HJ166	-46.1914	-20.6784	1
Planalto Central	HM169	-45.9405	-20.9293	1
Vão do Paranã	EI164	-46.3587	-14.0710	14
Vão do Paranã	EH156	-47.0278	-13.9874	9
Vão do Paranã	EN156	-47.0278	-14.4892	8
Vão do Paranã	EE158	-46.8605	-13.7365	6
Vão do Paranã	DS163	-46.4423	-12.7328	5
Vão do Paranã	EN162	-46.5260	-14.4892	5
Vão do Paranã	ED159	-46.7769	-13.6529	4
Vão do Paranã	EU156	-47.0278	-15.0747	4
Vão do Paranã	EX151	-47.4460	-15.3256	4
Vão do Paranã	EN158	-46.8605	-14.4892	3
Vão do Paranã	EJ164	-46.3587	-14.1547	2
Vão do Paranã	EV156	-47.0278	-15.1583	2
Vão do Paranã	EW152	-47.3623	-15.2420	2

Ecoregion	Site Code	Longitude	Latitude	Species Richness
Vão do Paranã	DS164	-46.3587	-12.7328	1
Vão do Paranã	DT164	-46.3587	-12.8165	1
Vão do Paranã	DU163	-46.4423	-12.9001	1
Vão do Paranã	DV161	-46.6096	-12.9838	1
Vão do Paranã	DV162	-46.5260	-12.9838	1
Vão do Paranã	DX160	-46.6932	-13.1510	1
Vão do Paranã	DZ164	-46.3587	-13.3183	1
Vão do Paranã	EB162	-46.5260	-13.4856	1
Vão do Paranã	EC159	-46.7769	-13.5692	1
Vão do Paranã	EF158	-46.8605	-13.8201	1
Vão do Paranã	EF160	-46.6932	-13.8201	1
Vão do Paranã	EF162	-46.5260	-13.8201	1
Vão do Paranã	EG162	-46.5260	-13.9038	1
Vão do Paranã	EI152	-47.3623	-14.0710	1
Vão do Paranã	EK156	-47.0278	-14.2383	1
Vão do Paranã	EK164	-46.3587	-14.2383	1
Vão do Paranã	EL157	-46.9442	-14.3219	1
Vão do Paranã	EN159	-46.7769	-14.4892	1
Vão do Paranã	EN161	-46.6096	-14.4892	1
Vão do Paranã	EN163	-46.4423	-14.4892	1
Vão do Paranã	EO160	-46.6932	-14.5729	1
Vão do Paranã	EV151	-47.4460	-15.1583	1

Appendix S2 – Bioclimatic variables used for the analysis of generalized linear models.

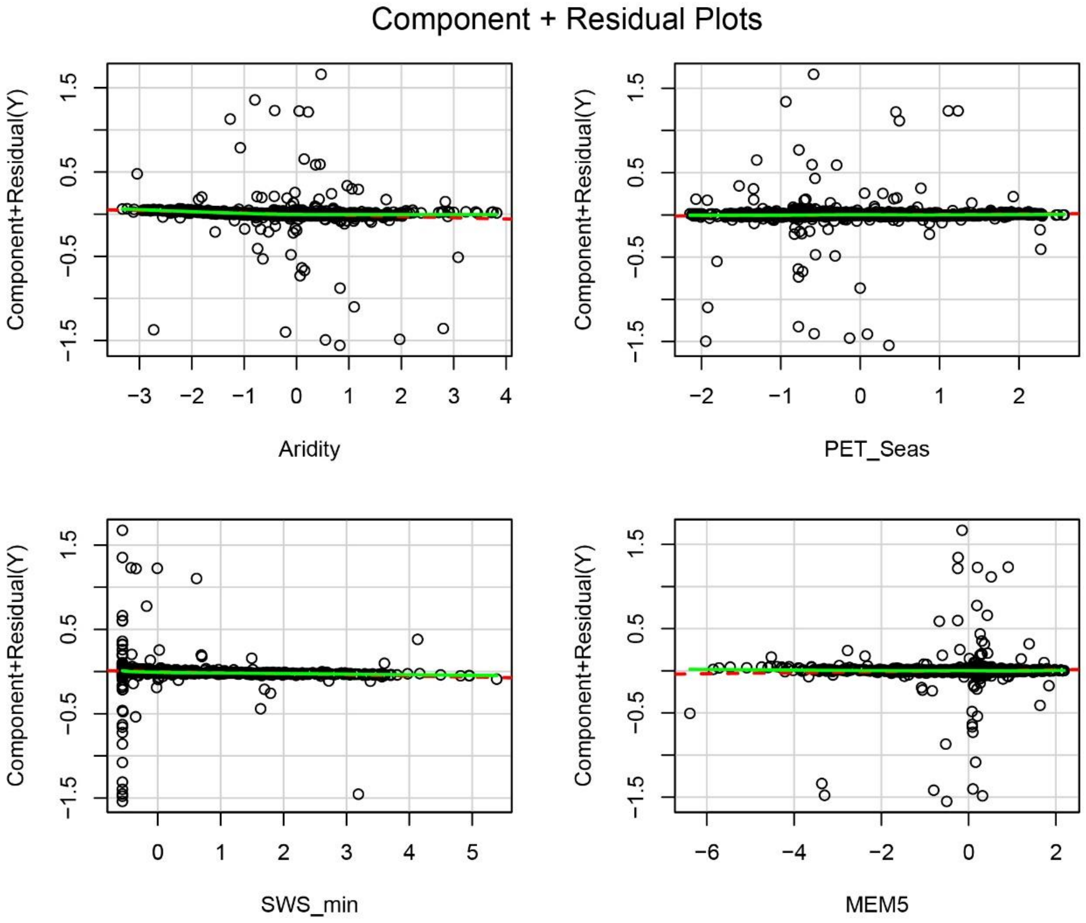
Environmental variables	Code	Source
Bioclimatic Variables		
Annual Mean Temperature	bio_1	CHELSA (Karger et al., 2017)
Annual Precipitation	bio_12	CHELSA (Karger et al., 2017)
Precipitation of Driest Month	bio_14	CHELSA (Karger et al., 2017)
Precipitation Seasonality	bio_15	CHELSA (Karger et al., 2017)
Precipitation of Wettest Quarter	bio_16	CHELSA (Karger et al., 2017)
Precipitation of Driest Quarter	bio_17	CHELSA (Karger et al., 2017)
Precipitation of Warmest Quarter	bio_18	CHELSA (Karger et al., 2017)
Precipitation of Coldest Quarter	bio_19	CHELSA (Karger et al., 2017)
Water vapor pressure (mean)	Water.Vapor.Press_Mean	WorldClim 2.0 (Fick and Hijmans, 2017)
Annual mean potential evapotranspiration	Annual.PET	Global Aridity and PET Database (Trabucco and Zomer, 2009)
Seasonal potential evapotranspiration	PET_Seas	Global Aridity and PET Database (Trabucco and Zomer, 2009)
Aridity index	Aridity	Global Aridity and PET Database (Trabucco and Zomer, 2009)
Topographic Variables		
Topographic Wetness Index	TopoWet	ENVIREM - ENVIronmental Rasters for Ecological Modeling (http://envirem.github.io/#varTable)
Soil Variables		
Soil water stress (annual mean)	SWS_mean	Global High-Resolution Soil-Water Balance (Trabucco and Zomer, 2010)
Soil water stress (min)	SWS_min	Global High-Resolution Soil-Water Balance (Trabucco and Zomer, 2010)
Soil water stress (max)	SWS_max	Global High-Resolution Soil-Water Balance (Trabucco and Zomer, 2010)
Coarse fragments	Coarse	Soil Grids (Hengl et al., 2014)
Sand content	Sand	Soil Grids (Hengl et al., 2014)
Soil organic carbon stock	CARBON	Soil Grids (Hengl et al., 2014)
pH index (H2O solution)	pH_H20	Soil Grids (Hengl et al., 2014)

Appendix S3 - Mean value and standard deviation (SD) for 20 environmental variables used in this study for each of the 19 Cerrado ecoregions. AP: Alto Parnaíba; ASF: Alto São Francisco; AT: Araguaia Tocantins; Ban: Bananal; BP: Basaltos do Paraná; BPap: Bico do Papagaio; CP: Chapada dos Parecis; CSF: Chapadão do São Francisco; CB: Complexo Bodoquena; Cost: Costeiro; DCSF: Depressão Cárstica do São Francisco; DC: Depressão Cuiabana; FC: Floresta de Cocais; Jeq: Jequitinhonha; Par: Paracatu; PG: Paraná Guimarães; Parna: Parnaguá; PC: Planalto Central; VP: Vão do Paranã.

Ecoregion		AP	ASF	AT	Ban	BP	BPap	CP	CSF	CB	Cost	DCSF	DC	FC	Jeq	Par	PG	Parna	PC	VP
bio_1 (°C)	**Mean**	25.59	20.47	24.90	26.56	20.69	25.51	24.43	23.43	23.50	27.36	24.23	24.53	27.07	20.72	21.53	23.10	24.34	22.14	24.44
	SD	0.62	1.29	0.65	0.43	1.47	0.37	0.52	0.59	0.69	0.34	0.82	0.53	0.35	1.31	1.16	0.78	0.66	1.44	0.79
bio_12 (mm)	**Mean**	1146.61	1349.21	1559.62	1673.30	1364.16	1618.59	1847.64	1227.25	1333.35	1568.00	909.78	1411.15	1537.93	1070.63	1337.13	1518.06	1025.65	1554.02	1392.17
	SD	153.50	151.50	102.74	77.88	125.88	119.52	206.41	184.59	51.86	304.31	104.89	115.02	180.55	187.12	159.99	104.17	99.13	72.21	78.79
bio_14 (mm)	**Mean**	5.03	10.17	4.02	4.10	25.47	10.62	3.94	1.69	37.67	5.42	0.86	16.54	11.60	5.43	5.87	22.21	0.46	7.69	3.37
	SD	3.75	4.63	2.06	1.17	13.44	2.96	3.05	0.84	3.84	4.87	0.58	4.47	3.92	2.40	1.56	11.89	0.65	3.32	0.94
bio_15 (mm)	**Mean**	81.84	87.52	82.12	84.22	68.43	73.70	79.38	89.05	45.22	99.76	93.91	66.60	91.79	92.10	87.63	67.06	89.27	81.63	85.23
	SD	3.85	4.81	3.71	3.33	13.41	2.73	3.37	3.95	4.19	9.80	3.78	4.87	3.30	3.87	3.64	11.75	3.06	3.09	0.87
bio_16 (mm)	**Mean**	572.00	750.18	761.25	829.60	659.43	780.36	903.39	647.31	519.71	924.00	507.53	628.23	869.86	619.10	718.54	704.67	528.50	771.51	703.91
	SD	88.55	69.54	36.76	22.04	95.63	53.46	95.75	108.70	29.86	109.86	67.54	69.36	94.52	94.75	65.16	85.64	44.97	36.10	35.71
bio_17 (mm)	**Mean**	23.08	35.59	18.92	16.50	93.91	52.41	34.89	9.79	138.64	19.58	4.80	69.15	44.84	20.63	22.14	79.96	4.15	28.02	15.66
	SD	14.26	14.31	8.47	3.78	46.67	12.58	14.23	4.16	11.31	17.19	2.40	15.43	12.77	8.32	5.07	40.14	2.44	11.77	2.20
bio_18 (mm)	**Mean**	159.92	577.24	374.58	422.55	608.12	226.03	584.75	320.65	509.78	44.08	262.35	562.08	96.00	431.32	447.14	571.27	253.23	467.98	359.37
	SD	53.25	55.86	76.89	24.26	75.15	42.69	164.16	55.78	38.01	31.05	52.65	56.36	28.40	90.50	113.89	81.62	23.80	84.78	92.55
bio_19 (mm)	**Mean**	132.95	36.41	95.78	33.20	110.64	560.87	51.31	21.48	151.95	905.00	10.12	73.31	641.02	20.63	32.86	114.06	11.15	45.92	28.00
	SD	193.89	14.58	195.47	10.50	48.02	323.87	23.69	9.44	23.03	128.54	5.08	14.83	355.68	8.32	11.31	59.22	10.85	11.21	4.49
Water.Vapor.Press_Mean (kPa)	**Mean**	2.31	1.83	2.33	2.62	1.82	2.47	2.35	1.96	2.11	2.67	1.98	2.33	2.54	1.81	1.87	2.07	2.08	1.93	2.06
	SD	0.13	0.12	0.15	0.07	0.12	0.06	0.07	0.08	0.09	0.02	0.05	0.06	0.08	0.10	0.11	0.10	0.08	0.14	0.07
Annual.PET (mm yr^{-1})	**Mean**	1817.98	1579.47	1797.48	1871.16	1530.24	1791.18	1849.35	1763.61	1654.71	1672.36	1821.97	1756.88	1766.38	1584.19	1617.50	1688.35	1907.55	1580.28	1669.94
	SD	38.10	93.21	60.72	30.40	95.18	26.13	45.87	77.02	28.54	75.34	72.59	54.42	62.14	92.77	94.64	65.90	36.69	83.42	45.86
PET_Seas (mm month^{-1})	**Mean**	1135.26	2421.49	1299.19	1497.97	2835.28	757.94	1574.22	1560.08	3562.92	1059.98	1865.14	1967.50	1327.01	2478.16	1963.15	2430.01	1581.15	1642.58	1469.06
	SD	172.86	100.18	361.63	208.18	378.49	208.76	120.76	172.99	76.58	94.57	194.17	220.65	213.79	126.42	305.08	432.45	177.45	269.73	69.76
Aridity	**Mean**	7204.75	9711.45	9837.28	10700.22	9394.71	10619.50	12681.87	7250.81	7858.90	9318.96	5205.27	9531.91	9453.85	7588.57	8790.77	9497.75	5980.74	9923.37	8216.84
	SD	1187.69	1417.68	943.25	692.66	966.98	810.34	1832.92	1208.99	360.93	2279.41	690.74	825.79	1188.44	1800.30	1122.16	1015.02	682.03	644.71	534.79

Ecoregion		AP	AF	AT	Ban	BP	BPap	CP	CSF	CB	Cost	DCSF	DC	FC	Jeq	Par	PG	Parna	PC	VP
TopoWet	**Mean**	11.43	10.43	11.53	13.47	11.06	11.73	11.94	11.90	11.61	13.23	12.03	11.41	12.08	9.96	10.80	11.31	11.61	10.50	11.39
	SD	0.55	0.83	0.89	0.54	0.46	0.58	0.37	0.77	0.79	0.41	0.87	0.90	0.45	0.76	0.64	0.61	0.63	0.62	1.17
SWS_mean (%)	**Mean**	52.18	67.41	65.76	67.11	70.62	66.12	69.00	57.07	69.14	58.59	39.27	65.77	58.72	54.52	64.80	71.10	46.07	70.34	64.56
	SD	6.44	5.77	2.52	1.74	5.95	2.94	3.12	7.18	1.98	6.60	5.33	3.90	3.64	11.54	6.86	3.70	6.11	3.47	3.30
SWS_min (%)	**Mean**	90.28	98.24	99.86	100.00	94.73	99.88	100.00	89.09	80.23	100.00	64.02	94.16	100.00	82.68	95.87	96.62	75.07	99.82	98.44
	SD	10.81	3.49	0.61	0.00	6.03	0.42	0.00	9.67	2.59	0.00	7.91	4.85	0.00	11.81	6.36	5.37	9.61	0.67	2.17
SWS_max (%)	**Mean**	19.31	30.88	23.02	24.04	45.17	28.01	28.25	19.24	53.62	19.33	11.67	34.17	22.15	23.20	27.18	40.06	13.36	30.60	22.96
	SD	3.81	5.52	2.49	1.79	12.50	2.45	4.03	3.78	4.30	5.76	1.94	3.00	2.60	8.18	6.18	9.37	2.76	4.25	2.37
Coarse (cm^3/dm^3)	**Mean**	1.41	2.35	1.05	0.24	1.57	1.12	0.52	1.01	1.83	1.20	1.50	1.17	1.22	2.57	1.25	0.94	1.65	1.87	1.17
	SD	0.54	1.27	1.00	0.20	0.76	0.81	0.31	0.55	0.80	0.97	0.90	0.58	0.67	0.98	0.76	0.63	0.48	1.27	0.71
Sand (g/kg)	**Mean**	61.65	47.50	59.68	54.75	48.77	56.69	62.95	57.82	56.90	49.21	54.21	61.44	58.23	50.89	47.60	57.85	58.31	48.81	44.24
	SD	3.99	4.11	4.31	4.08	6.92	5.22	5.12	5.75	6.63	5.81	5.96	2.18	3.95	3.07	4.16	8.37	4.44	3.96	4.13
CARBON (t*ha^{-1})	**Mean**	89.84	187.92	108.42	152.63	136.24	109.41	117.46	109.37	120.24	138.50	95.72	105.91	78.22	159.60	138.88	116.30	98.88	122.86	108.93
	SD	10.57	80.48	19.71	28.46	23.38	16.39	15.29	11.22	11.37	55.65	12.47	9.07	13.73	96.57	63.14	13.65	8.81	20.19	10.41
pH_H20 (pH*10)	**Mean**	5.32	5.37	5.38	5.21	5.35	5.18	5.03	5.51	5.69	5.53	5.82	5.28	5.35	5.50	5.44	5.41	5.56	5.39	5.67
	SD	0.11	0.13	0.17	0.17	0.11	0.09	0.15	0.15	0.14	0.35	0.28	0.08	0.14	0.25	0.16	0.14	0.13	0.14	0.13

Appendix S4 – Residuals normality analysis for GLM.



Appendix S5 – Species occurring in more than 80% of Cerrado ecoregions (occurred in at least 15 out of 19 ecoregions).

Ecoregion	Number of ecoregions where it occurs
Aeschynomene paniculata	19
Chiococca alba	19
Cissus erosa	19
Cordiera sessilis	19
Cyperus laxus	19
Marsypianthes chamaedrys	19
Scoparia dulcis	19
Setaria parviflora	19
Tocoyena formosa	19
Waltheria indica	19
Aeschynomene brasiliana	18
Bredemeyera floribunda	18
Commelina erecta	18
Erythroxylum pelleterianum	18
Helicteres brevispira	18
Hydrolea spinosa	18
Lippia origanoides	18
Ludwigia nervosa	18
Ludwigia octovalvis	18
Mesosphaerum suaveolens	18
Palicourea hoffmannseggiana	18
Piper tuberculatum	18
Psychotria carthagenensis	18
Sauvagesia erecta	18
Secondatia densiflora	18
Alternanthera brasiliana	17
Alternanthera tenella	17
Axonopus chrysoblepharis	17
Calliandra parviflora	17
Cenchrus echinatus	17
Centrosema brasilianum	17
Chamaecrista ramosa	17
Cissus verticillata	17
Cyperus surinamensis	17
Desmodium barbatum	17
Elephantopus mollis	17
Lasiacis ligulata	17
Macairea radula	17
Melochia pyramidata	17
Mimosa somnians	17
Siparuna guianensis	17
Stachytarpheta cayennensis	17
Anthaenantia lanata	16
Bauhinia ungulata	16

Ecoregion	Number of ecoregions where it occurs
Canavalia brasiliensis	16
Chamaecrista fagonioides	16
Chomelia ribesioides	16
Cordiera elliptica	16
Coutarea hexandra	16
Cuphea melvilla	16
Cyperus luzulae	16
Eugenia florida	16
Galactia striata	16
Indigofera lespedezioides	16
Jatropha elliptica	16
Lantana camara	16
Ludwigia leptocarpa	16
Lygodium venustum	16
Manihot anomala	16
Miconia ibaguensis	16
Miconia stenostachya	16
Olyra ciliatifolia	16
Piper arboreum	16
Pityrogramma calomelanos	16
Rhynchanthera grandiflora	16
Acalypha communis	15
Albizia niopoides	15
Asclepias curassavica	15
Byrsonima lancifolia	15
Chromolaena maximiliani	15
Cordiera concolor	15
Crotalaria micans	15
Croton lundianus	15
Desmodium incanum	15
Dichorisandra hexandra	15
Euploca procumbens	15
Hippocratea volubilis	15
Humiria balsamifera	15
Hyparrhenia rufa	15
Hyptis lutescens	15
Ipomoea hederifolia	15
Jatropha gossypiifolia	15
Lasiacis sorghoidea	15
Lippia alba	15
Ludwigia tomentosa	15
Macroptilium lathyroides	15
Maranta pohliana	15
Melochia villosa	15
Mikania cordifolia	15
Mimosa pigra	15
Palicourea marcgravii	15

Ecoregion	Number of ecoregions where it occurs
Pavonia malacophylla	15
Piper aduncum	15
Piper fuligineum	15
Rhynchosia minima	15
Rhynchospora cephalotes	15
Rhynchospora rugosa	15
Serjania hebecarpa	15
Smilax fluminensis	15
Strychnos parvifolia	15
Turnera melochioides	15

Appendix S6 – Endemic species of the gallery forest understory in the Cerrado.

Anthaenantiopsis perforata
Aspilia pseudoyedaea
Byttneria glazioui
Byttneria jaculifolia
Canastra lanceolata
Cantinoa multiseta
Centrosema fasciculatum
Chamaecrista chrysosepala
Chamaecrista imbricans
Chamaecrista longicuspis
Chamaecrista mollicaulis
Cienfuegosia lanceolata
Crotalaria goiasensis
Cuphea cunninghamiifolia
Cuphea potamophila
Cyanocephalus cuneatus
Desmodium membranifolium
Ditassa obscura
Galium espiniacicum
Gymneia interrupta
Habenaria heringeri
Harpalyce lepidota
Hypenia calycina
Hyptis orbiculata
Isachne goiasensis
Justicia burchellii
Justicia irwinii
Mikania populifolia
Moutabea excoriata
Periandra gracilis
Polygala hygrophila
Polygala stephaniana
Salvia calcicola
Salvia tomentella
Selaginella saltuicola
Stomatanthes hirsutus
Thryallis parviflora
Turnera trigona
Wedelia souzae

Appendix S7 – List of Cerrado gallery forest understory species and their respective families.

Species	**Family**
Abrus precatorius L.	Fabaceae
Acalypha amblyodonta (Müll.Arg.) Müll.Arg.	Euphorbiaceae
Acalypha brasiliensis Müll.Arg.	Euphorbiaceae
Acalypha communis Müll.Arg.	Euphorbiaceae
Acalypha diversifolia Jacq.	Euphorbiaceae
Acalypha macrostachya Jacq.	Euphorbiaceae
Acalypha multicaulis Müll.Arg.	Euphorbiaceae
Acalypha villosa Jacq.	Euphorbiaceae
Acmella ciliata (Kunth) Cass.	Asteraceae
Acroceras zizanioides (Kunth) Dandy	Poaceae
Actinocephalus divaricatus (Körn.) Sano	Eriocaulaceae
Actinostachys pennula (Sw.) Hook.	Schizaeaceae
Actinostemon concepcionis (Chodat & Hassl.) Hochr.	Euphorbiaceae
Adenocalymma bracteatum (Cham.) DC.	Bignoniaceae
Adenostemma suffruticosum Gardner	Asteraceae
Adiantum curvatum Kaulf.	Pteridaceae
Adiantum diogoanum Glaz. ex Baker	Pteridaceae
Adiantum gracile Fée	Pteridaceae
Adiantum intermedium Sw.	Pteridaceae
Adiantum petiolatum Desv.	Pteridaceae
Adiantum pulverulentum L.	Pteridaceae
Aechmea bromeliifolia (Rudge) Baker	Bromeliaceae
Aechmea distichantha Lem.	Bromeliaceae
Aegiphila laevis (Aubl.) Gmel.	Lamiaceae
Aegiphila obducta Vell.	Lamiaceae
Aegiphila vitelliniflora Walp.	Lamiaceae
Ctenodon brasilianus (Poir.) D.B.O.S.Cardoso, P.L.R.Moraes & H.C.Lima	Fabaceae
Ctenodon brevipes (Benth.) D.B.O.S.Cardoso, P.L.R.Moraes & H.C.Lima	Fabaceae
Aeschynomene denticulata Rudd	Fabaceae
Ctenodon elegans (Schltdl. & Cham.) D.B.O.S.Cardoso & A.Delgado	Fabaceae
Aeschynomene evenia C.Wright & Sauvalle	Fabaceae
Ctenodon falcatus (Poir.) D.B.O.S.Cardoso, P.L.R.Moraes & H.C.Lima	Fabaceae
Aeschynomene fluminensis Vell.	Fabaceae
Aeschynomene fluvialis Antunes, L.L.C. & Silva, M.J.	Fabaceae
Aeschynomene montevidensis Vogel	Fabaceae
Aeschynomene paniculata Willd. ex Vogel	Fabaceae
Aeschynomene paucifolia Vogel	Fabaceae
Aeschynomene racemosa Vogel	Fabaceae
Aeschynomene riedeliana Taub.	Fabaceae
Aeschynomene rudis Benth.	Fabaceae
Aeschynomene sensitiva Sw.	Fabaceae
Albizia niopoides (Spruce ex Benth.) Burkart	Fabaceae

Species	Family
Aldama kunthiana (Gardner) E.E.Schill. & Panero	Asteraceae
Aldama robusta (Gardner) E.E.Schill. & Panero	Asteraceae
Allagoptera leucocalyx (Drude) Kuntze	Arecaceae
Allamanda doniana Müll.Arg.	Apocynaceae
Allophylus pauciflorus Radlk.	Sapindaceae
Aloysia gratissima (Gillies & Hook.) Tronc.	Verbenaceae
Aloysia virgata (Ruiz & Pav.) Juss.	Verbenaceae
Alstroemeria viridiflora Warm.	Alstroemeriaceae
Alternanthera brasiliana (L.) Kuntze	Amaranthaceae
Alternanthera dentata (Moench) Stuchlík ex R.E.Fr.	Amaranthaceae
Alternanthera puberula D.Dietr.	Amaranthaceae
Alternanthera sessilis (L.) R.Br.	Amaranthaceae
Alternanthera tenella Colla	Amaranthaceae
Amauropelta cheilanthoides (Kunze) Á.Löve & D.Löve	Thelypteridaceae
Amauropelta heineri (C. Chr.) Salino & T.E.Almeida	Thelypteridaceae
Amauropelta opposita (Vahl) Pic. Serm.	Thelypteridaceae
Amauropelta pachyrhachis (Kunze ex Mett.) Salino & T.E.Almeida	Thelypteridaceae
Amauropelta patula (Fée) Salino & T.E.Almeida	Thelypteridaceae
Amauropelta rivularioides (Fée) Salino & T.E.Almeida	Thelypteridaceae
Ambrosia polystachya DC.	Asteraceae
Amorimia pubiflora (A.Juss.) W.R.Anderson	Malpighiaceae
Ananas bracteatus (Lindl.) Schult. & Schult.f.	Bromeliaceae
Anchietea exalata Eichler	Violaceae
Anchietea pyrifolia (Mart.) G.Don	Violaceae
Anemopaegma chamberlaynii (Sims) Bureau & K.Schum.	Bignoniaceae
Aniseia cernua Moric.	Convolvulaceae
Aniseia martinicensis (Jacq.) Choisy	Convolvulaceae
Annona nutans (R.E.Fr.) R.E.Fr.	Annonaceae
Anredera cordifolia (Ten.) Steenis	Basellaceae
Anthaenantia lanata (Kunth) Benth.	Poaceae
Anthaenantiopsis perforata (Nees) Parodi	Poaceae
Anthurium clavigerum Poepp.	Araceae
Anthurium megapetiolatum E.G.Gonç.	Araceae
Anthurium pentaphyllum (Aubl.) G.Don	Araceae
Anthurium sinuatum Benth. ex Schott	Araceae
Aphelandra longiflora (Lindl.) Profice	Acanthaceae
Apteria aphylla (Nutt.) Barnhart ex Small	Burmanniaceae
Arachis benthamii Handro	Fabaceae
Arachis burchellii Krapov. & W.C.Greg.	Fabaceae
Arachis cryptopotamica Krapov. & W.C.Greg.	Fabaceae
Arachis decora Krapov. et al.	Fabaceae
Arachis glabrata Benth.	Fabaceae
Arachis kuhlmannii Krapov. & W.C.Greg.	Fabaceae
Arachis macedoi Krapov. & W.C.Greg.	Fabaceae
Arachis pintoi Krapov. & W.C.Greg.	Fabaceae
Arachis sylvestris (A.Chev.) A.Chev.	Fabaceae
Arachis veigae S.H. Santana & Valls	Fabaceae

Species	**Family**
Araujia sericifera Brot.	Apocynaceae
Aristolochia labiata Willd.	Aristolochiaceae
Aristolochia melastoma Silva Manso ex Duch.	Aristolochiaceae
Aristolochia urupaensis Hoehne	Aristolochiaceae
Aristolochia warmingii Mast.	Aristolochiaceae
Arundinella hispida (Humb. & Bonpl. ex Willd.) Kuntze	Poaceae
Asclepias curassavica L.	Apocynaceae
Aspidogyne juruenensis (Hoehne) Meneguzzo	Orchidaceae
Aspilia clausseniana Baker	Asteraceae
Aspilia floribunda (Gardner) Baker	Asteraceae
Aspilia fruticosa (Gardner) Baker	Asteraceae
Aspilia phyllostachya Baker	Asteraceae
Aspilia pseudoyedaea H.Rob.	Asteraceae
Aspilia riedelii Baker	Asteraceae
Asplenium abscissum Willd.	Aspleniaceae
Asplenium auritum Sw.	Aspleniaceae
Asplenium balansae (Baker) Sylvestre	Aspleniaceae
Asplenium cristatum Lam.	Aspleniaceae
Asplenium dimidiatum Sw.	Aspleniaceae
Asplenium formosum Willd.	Aspleniaceae
Asplenium otites Link	Aspleniaceae
Asplenium serra Langsd. & Fisch.	Aspleniaceae
Asplenium stuebelianum Hieron.	Aspleniaceae
Asterostigma cryptostylum Bogner	Araceae
Astraea comosa (Müll.Arg.) B.W.van Ee	Euphorbiaceae
Astraea lobata (L.) Klotzsch	Euphorbiaceae
Astraea paulina Didr.	Euphorbiaceae
Astraea subcomosa (Müll.Arg) Caruzo	Euphorbiaceae
Athenaea velutina (Sendtn.) D'Arcy	Solanaceae
Attalea brasiliensis Glassman	Arecaceae
Attalea compta Mart.	Arecaceae
Attalea speciosa Mart. ex Spreng.	Arecaceae
Augusta longifolia (Spreng.) Rehder	Rubiaceae
Aulonemia aristulata (Döll) McClure	Poaceae
Aulonemia effusa (Hack.) McClure	Poaceae
Axonopus capillaris (Lam.) Chase	Poaceae
Axonopus chrysoblepharis (Lag.) Chase	Poaceae
Axonopus comans (Trin. ex Döll) Kuhlm.	Poaceae
Axonopus compressus (Sw.) P. Beauv.	Poaceae
Axonopus fissifolius (Raddi) Kuhlm.	Poaceae
Axonopus grandifolius Renvoize	Poaceae
Axonopus marginatus (Trin.) Chase	Poaceae
Axonopus obtusifolius (Raddi) Chase	Poaceae
Axonopus polydactylus (Steud.) Dedecca	Poaceae
Axonopus polystachyus G.A. Black	Poaceae
Axonopus purpusii (Mez) Chase	Poaceae
Axonopus scoparius (Flüggé) Kuhlm.	Poaceae

Species	**Family**
Axonopus singularis (Swallen) A. López & Morrone	Poaceae
Axonopus suffultus (Mikan ex Trin.) Parodi	Poaceae
Ayenia tomentosa L.	Malvaceae
Baccharis glutinosa Pers.	Asteraceae
Baccharis junciformis DC.	Asteraceae
Baccharis lychnophora Gardner	Asteraceae
Baccharis myricifolia DC.	Asteraceae
Baccharis myriocephala DC.	Asteraceae
Baccharis oxyodonta DC.	Asteraceae
Baccharis rivularis Gardner	Asteraceae
Baccharis sagittalis (Less.) DC.	Asteraceae
Baccharis salicifolia (Ruiz & Pav.) Pers.	Asteraceae
Baccharis serrulata (Lam.) Pers.	Asteraceae
Baccharis trinervis Pers.	Asteraceae
Baccharis vismioides DC.	Asteraceae
Baccharis vulneraria Baker	Asteraceae
Bauhinia burchellii Benth.	Fabaceae
Bauhinia cupulata Benth.	Fabaceae
Bauhinia mollis (Bong.) D.Dietr.	Fabaceae
Bauhinia pentandra (Bong.) D.Dietr.	Fabaceae
Bauhinia platypetala Burch. ex Benth.	Fabaceae
Bauhinia ungulata L.	Fabaceae
Begonia cucullata Willd.	Begoniaceae
Begonia grisea A.DC.	Begoniaceae
Begonia reniformis Dryand.	Begoniaceae
Bidens cynapiifolia Kunth	Asteraceae
Bidens gardneri Baker	Asteraceae
Bidens segetum Mart. ex Colla	Asteraceae
Bidens subalternans DC.	Asteraceae
Bixa orellana L.	Bixaceae
Blechnum lanceola Sw.	Blechnaceae
Blechnum occidentale L.	Blechnaceae
Blechnum polypodioides Raddi	Blechnaceae
Blepharodon lineare (Decne.) Decne.	Apocynaceae
Blepharodon pictum (Vahl) W.D.Stevens	Apocynaceae
Bletia catenulata Ruiz & Pav.	Orchidaceae
Boehmeria caudata Sw.	Urticaceae
Boehmeria cylindrica (L.) Sw.	Urticaceae
Bomarea edulis (Tussac) Herb.	Alstroemeriaceae
Bonamia agrostopolis (Vell.) Hallier f.	Convolvulaceae
Borreria cupularis DC.	Rubiaceae
Borreria latifolia (Aubl.) K.Schum.	Rubiaceae
Borreria multiflora (DC.) Bacigalupo & E.L.Cabral	Rubiaceae
Borreria scabiosoides Cham. & Schltdl.	Rubiaceae
Borreria wunschmannii K.Schum.	Rubiaceae
Bouchea fluminensis (Vell.) Moldenke	Verbenaceae
Bredemeyera floribunda Willd.	Polygalaceae

Species	Family
Bredemeyera hebeclada (DC.) J.F.B.Pastore	Polygalaceae
Brunfelsia brasiliensis (Spreng.) L.B.Sm. & Downs	Solanaceae
Brunfelsia obovata Benth.	Solanaceae
Bulbophyllum exaltatum Lindl.	Orchidaceae
Byrsonima lancifolia A.Juss.	Malpighiaceae
Byttneria aculeata (Jacq.) Jacq.	Malvaceae
Byttneria australis A.St.-Hil.	Malvaceae
Byttneria benensis Britton	Malvaceae
Byttneria dentata Pohl	Malvaceae
Byttneria divaricata Benth.	Malvaceae
Byttneria genistella Triana & Planch.	Malvaceae
Byttneria glazioui Hochr.	Malvaceae
Byttneria jaculifolia Pohl	Malvaceae
Byttneria melastomaefolia A.St.-Hil.	Malvaceae
Byttneria oblongata Pohl	Malvaceae
Byttneria palustris Cristóbal	Malvaceae
Byttneria petiolata Cristóbal	Malvaceae
Byttneria scabra L.	Malvaceae
Calea verticillata (Klatt) Pruski	Asteraceae
Callaeum psilophyllum (A.Juss.) D.M.Johnson	Malpighiaceae
Calliandra fasciculata Benth.	Fabaceae
Calliandra parviflora Benth.	Fabaceae
Calliandra parvifolia (Hook. & Arn.) Speg.	Fabaceae
Calliandra tweedii Benth.	Fabaceae
Calopogonium mucunoides Desv.	Fabaceae
Calyptrocarya glomerulata (Brongn.) Urb.	Cyperaceae
Calyptrocarya irwiniana T.Koyama	Cyperaceae
Camonea umbellata (L.) A.R. Simões & Staples	Convolvulaceae
Betencourtia scarlatina (Mart. ex Benth.) L.P.Queiroz	Fabaceae
Camptosema spectabile (Tul.) Burkart	Fabaceae
Campyloneurum nitidum (Kaulf.) C.Presl	Polypodiaceae
Canastra lanceolata (Filg.) Morrone et al.	Poaceae
Canavalia brasiliensis Mart. ex Benth.	Fabaceae
Canavalia grandiflora Benth.	Fabaceae
Canavalia mattogrossensis (Barb.Rodr.) Malme	Fabaceae
Canavalia parviflora Benth.	Fabaceae
Canavalia picta Mart. ex Benth.	Fabaceae
Canna glauca L.	Cannaceae
Cantinoa americana (Aubl.) Harley & J.F.B. Pastore	Lamiaceae
Cantinoa carpinifolia (Benth.) Harley & J.F.B.Pastore	Lamiaceae
Cantinoa multiseta (Benth.) Harley & J.F.B.Pastore	Lamiaceae
Cantinoa mutabilis (Rich.) Harley & J.F.B.Pastore	Lamiaceae
Cantinoa plectranthoides (Benth.) Harley & J.F.B.Pastore	Lamiaceae
Caperonia palustris (L.) A.St.-Hil.	Euphorbiaceae
Capsicum baccatum L.	Solanaceae
Capsicum praetermissum Heiser & P. G. Sm.	Solanaceae
Cardiospermum corindum L.	Sapindaceae

Species	Family
Cardiospermum halicacabum L.	Sapindaceae
Carolus chlorocarpus (A.Juss.) W.R.Anderson	Malpighiaceae
Casselia chamaedryfolia Cham.	Verbenaceae
Cenchrus brownii Roem. & Schult.	Poaceae
Cenchrus echinatus L.	Poaceae
Centella asiatica (L.) Urb.	Apiaceae
Centropogon cornutus (L.) Druce	Campanulaceae
Centrosema arenarium Benth.	Fabaceae
Centrosema bifidum Benth.	Fabaceae
Centrosema bracteosum Benth.	Fabaceae
Centrosema brasilianum (L.) Benth.	Fabaceae
Centrosema coriaceum Benth.	Fabaceae
Centrosema fasciculatum Benth.	Fabaceae
Centrosema grandiflorum Benth.	Fabaceae
Centrosema macrocarpum Benth.	Fabaceae
Centrosema pascuorum Mart. ex Benth.	Fabaceae
Centrosema platycarpum Benth.	Fabaceae
Centrosema plumieri (Turpin ex Pers.) Benth.	Fabaceae
Centrosema pubescens Benth.	Fabaceae
Centrosema sagittatum (Humb. & Bonpl. ex Willd.) Brandegee	Fabaceae
Centrosema vetulum Mart. ex Benth.	Fabaceae
Cestrum latifolium Lam.	Solanaceae
Cestrum mariquitense Kunth	Solanaceae
Cestrum obovatum Sendtn.	Solanaceae
Cestrum pedicellatum Sendtn.	Solanaceae
Cestrum retrofractum Dunal	Solanaceae
Cestrum schlechtendalii G.Don	Solanaceae
Cestrum strigilatum Ruiz & Pav.	Solanaceae
Cestrum tubulosum Sendtn.	Solanaceae
Chaetocalyx longiflora Benth. ex A.Gray	Fabaceae
Chaetogastra parviflora (Cogn.) P.J.F.Guim. & Michelang.	Melastomataceae
(Cogn.) P.J.F.Guim. & Michelang.	Costaceae
Chamaecrista acosmifolia (Mart. ex Benth.) H.S.Irwin & Barneby	Fabaceae
Chamaecrista chrysosepala (H.S.Irwin & Barneby) H.S.Irwin & Barneby	Fabaceae
Chamaecrista ciliolata (Benth.) H.S.Irwin & Barneby	Fabaceae
Chamaecrista cinerascens (Vogel) H.S.Irwin & Barneby	Fabaceae
Chamaecrista cotinifolia (G.Don) H.S.Irwin & Barneby	Fabaceae
Chamaecrista dalbergiifolia (Benth.) H.S.Irwin & Barneby	Fabaceae
Chamaecrista diphylla (L.) Greene	Fabaceae
Chamaecrista fagonioides (Vogel) H.S.Irwin & Barneby	Fabaceae
Chamaecrista foederalis (H.S.Irwin & Barneby) H.S.Irwin & Barneby	Fabaceae
Chamaecrista glaziovii (Taub. ex Harms) H.S.Irwin & Barneby	Fabaceae
Chamaecrista imbricans (H.S.Irwin & Barneby) H.S.Irwin & Barneby	Fabaceae
Chamaecrista isidorea (Benth.) H.S.Irwin & Barneby	Fabaceae
Chamaecrista itambana (Mart. ex Benth.) H.S.Irwin & Barneby	Fabaceae
Chamaecrista longicuspis (Benth.) H.S.Irwin & Barneby	Fabaceae

Species	Family
Chamaecrista mollicaulis (Harms) H.S.Irwin & Barneby	Fabaceae
Chamaecrista potentilla (Mart. ex Benth.) H.S.Irwin & Barneby	Fabaceae
Chamaecrista ramosa (Vogel) H.S.Irwin & Barneby	Fabaceae
Chamaecrista roraimae (Benth.) Gleason	Fabaceae
Chamaecrista setosa (Vogel) H.S.Irwin & Barneby	Fabaceae
Chamaecrista ursina (Mart. ex Benth.) H.S.Irwin & Barneby	Fabaceae
Chamaecrista viscosa (Kunth) H.S.Irwin & Barneby	Fabaceae
Chamissoa altissima (Jacq.) Kunth	Amaranthaceae
Chelonanthus purpurascens (Aubl.) Struwe et al.	Gentianaceae
Chiococca alba (L.) Hitchc.	Rubiaceae
Chiropetalum anisotrichum (Müll.Arg.) Pax & K.Hoffm.	Euphorbiaceae
Chloris orthonoton Döll	Poaceae
Chomelia anisomeris Müll.Arg.	Rubiaceae
Chomelia pohliana Müll.Arg.	Rubiaceae
Chomelia ribesioides Benth. ex A.Gray	Rubiaceae
Christella berroi (C. Chr) Salino & A.R. Sm.	Thelypteridaceae
Chromolaena maximiliani (Schrad. ex DC.) R.M.King & H.Rob.	Asteraceae
Chusquea pinifolia (Nees) Nees	Poaceae
Cienfuegosia lanceolata (A.St.-Hil.) Krapov.	Malvaceae
Cissampelos andromorpha DC.	Menispermaceae
Cissampelos glaberrima A.St.-Hil.	Menispermaceae
Cissampelos pareira L.	Menispermaceae
Cissus albida Cambess.	Vitaceae
Cissus erosa Rich.	Vitaceae
Cissus palmata Poir.	Vitaceae
Cissus spinosa Cambess.	Vitaceae
Cissus subrhomboidea (Baker) Planch.	Vitaceae
Cissus verticillata (L.) Nicolson & C.E.Jarvis	Vitaceae
Clavija nutans (Vell.) B.Ståhl	Primulaceae
Clematicissus simsiana (Schult. & Schult.f.) Lombardi	Vitaceae
Clematis brasiliana DC.	Ranunculaceae
Clibadium armani (Balb.) Sch.Bip. ex O.E.Schulz	Asteraceae
Clidemia hirta (L.) D.Don	Melastomataceae
Clitoria falcata Lam.	Fabaceae
Clitoria laurifolia Poir.	Fabaceae
Coccocypselum aureum (Spreng.) Cham. & Schltdl.	Rubiaceae
Coccocypselum erythrocephalum Cham. & Schltdl.	Rubiaceae
Coccocypselum hasslerianum Chodat	Rubiaceae
Coccocypselum hirsutum Bartl. ex DC.	Rubiaceae
Coccocypselum lanceolatum (Ruiz & Pav.) Pers.	Rubiaceae
Coccocypselum pedunculare Cham. & Schltdl.	Rubiaceae
Coccoloba acrostichoides Cham.	Polygonaceae
Coccoloba ascendens Duss ex Lindau	Polygonaceae
Coccoloba densifrons Mart. ex Meisn.	Polygonaceae
Coccoloba lucidula Benth.	Polygonaceae
Coccoloba obtusifolia Jacq.	Polygonaceae
Coccoloba parimensis Benth.	Polygonaceae

Species	Family
Cochlidium serrulatum (Sw.) L.E.Bishop	Polypodiaceae
Collaea speciosa (Loisel.) DC.	Fabaceae
Commelina diffusa Burm.f.	Commelinaceae
Commelina erecta L.	Commelinaceae
Commelina longicaulis Jacq.	Commelinaceae
Commelina obliqua Vahl	Commelinaceae
Condylocarpon isthmicum (Vell.) A.DC.	Apocynaceae
Condylostylis candida (Vell.) A. Delgado	Fabaceae
Corchorus hirtus L.	Malvaceae
Cordiera concolor (Cham.) Kuntze	Rubiaceae
Cordiera elliptica (Cham.) Kuntze	Rubiaceae
Cordiera myrciifolia (K.Schum.) C.H.Perss. & Delprete	Rubiaceae
Cordiera obtusa (K.Schum.) Kuntze	Rubiaceae
Cordiera sessilis (Vell.) Kuntze	Rubiaceae
Costus arabicus L.	Costaceae
Costus spiralis (Jacq.) Roscoe	Costaceae
Coussarea platyphylla Müll.Arg.	Rubiaceae
Coutarea hexandra (Jacq.) K.Schum.	Rubiaceae
Cranichis candida (Barb.Rodr.) Cogn.	Orchidaceae
Cratylia argentea (Desv.) Kuntze	Fabaceae
Crotalaria goiasensis Windler & S.G.Skinner	Fabaceae
Crotalaria grandiflora Benth.	Fabaceae
Crotalaria incana L.	Fabaceae
Crotalaria micans Link	Fabaceae
Crotalaria otoptera Benth.	Fabaceae
Crotalaria paulina Schrank	Fabaceae
Crotalaria vespertilio Benth.	Fabaceae
Croton argenteus L.	Euphorbiaceae
Croton julopsidium Baill.	Euphorbiaceae
Croton lundianus (Didr.) Müll.Arg.	Euphorbiaceae
Croton pseudoadipatus Croizat	Euphorbiaceae
Croton trinitatis Millsp.	Euphorbiaceae
Croton triqueter Lam.	Euphorbiaceae
Ctenitis submarginalis (Langsd. & Fisch.) Ching	Dryopteridaceae
Cuphea calophylla Cham. & Schltdl.	Lythraceae
Cuphea cunninghamiifolia T.B.Cavalc.	Lythraceae
Cuphea grandiflora Pohl ex Koehne	Lythraceae
Cuphea melvilla Lindl.	Lythraceae
Cuphea potamophila T.B.Cavalc. & S.A.Graham	Lythraceae
Cuphea racemosa (L.f.) Spreng.	Lythraceae
Cuphea strigulosa Kunth	Lythraceae
Cyanocephalus cuneatus (Pohl ex Benth.) Harley & J.F.B.Pastore	Lamiaceae
Cyanocephalus rugosus (Benth.) Harley & J.F.B.Pastore	Lamiaceae
Cybianthus densicomus Mart.	Primulaceae
Cybianthus gardneri (A.DC.) G.Agostini	Primulaceae
Cybianthus psychotriifolius (Rusby) Rusby ex Mez	Primulaceae
Cyclodium meniscioides (Willd.) C.Presl	Dryopteridaceae

Species	Family
Cyclopogon elatus (Sw.) Schltr.	Orchidaceae
Cyclosorus interruptus (Willd.) H. Ito	Thelypteridaceae
Cyperus friburgensis Boeckeler	Cyperaceae
Cyperus hermaphroditus (Jacq.) Standl.	Cyperaceae
Cyperus intricatus Schrad. ex Schult.	Cyperaceae
Cyperus iria L.	Cyperaceae
Cyperus lanceolatus Poir.	Cyperaceae
Cyperus laxus Lam.	Cyperaceae
Cyperus ligularis L.	Cyperaceae
Cyperus luzulae (L.) Retz.	Cyperaceae
Cyperus megapotamicus Kunth	Cyperaceae
Cyperus obtusatus (J.Presl & C.Presl) Mattf. & Kük.	Cyperaceae
Cyperus ochraceus Vahl	Cyperaceae
Cyperus odoratus L.	Cyperaceae
Cyperus polystachyos Rottb.	Cyperaceae
Cyperus rotundus L.	Cyperaceae
Cyperus simplex Kunth	Cyperaceae
Cyperus surinamensis Rottb.	Cyperaceae
Cyperus uncinulatus Schrad. ex Nees	Cyperaceae
Cyrtopodium hatschbachii Pabst	Orchidaceae
Cyrtopodium lissochiloides Hoehne & Schltr.	Orchidaceae
Cyrtopodium paludicolum Hoehne	Orchidaceae
Dalbergia cuiabensis Benth.	Fabaceae
Dalbergia frutescens (Vell.) Britton	Fabaceae
Dalechampia pentaphylla Lam.	Euphorbiaceae
Dalechampia scandens L.	Euphorbiaceae
Dalechampia stenosepala Müll.Arg.	Euphorbiaceae
Dalechampia tenuiramea Müll. Arg.	Euphorbiaceae
Dasyphyllum brasiliense (Spreng.) Cabrera	Asteraceae
Dasyphyllum donianum (Gardner) Cabrera	Asteraceae
Dasyphyllum flagellare (Casar.) Cabrera	Asteraceae
Dasyphyllum sprengelianum (Gardner) Cabrera	Asteraceae
Dasyphyllum vagans (Gardner) Cabrera	Asteraceae
Dasyphyllum varians (Gardner) Cabrera	Asteraceae
Deianira erubescens Cham. & Schltdl.	Gentianaceae
Deianira pallescens Cham. & Schltdl.	Gentianaceae
Desmodium adscendens (Sw.) DC.	Fabaceae
Desmodium affine Schltdl.	Fabaceae
Desmodium album (Schindl.) J.F. Macbr.	Fabaceae
Desmodium axillare (Sw.) DC.	Fabaceae
Desmodium barbatum (L.) Benth.	Fabaceae
Desmodium cajanifolium (Kunth) DC.	Fabaceae
Desmodium distortum (Aubl.) J.F.Macbr.	Fabaceae
Desmodium glabrum (Mill.) DC.	Fabaceae
Desmodium incanum (Sw.) DC.	Fabaceae
Desmodium leiocarpum (Spreng.) G.Don	Fabaceae
Desmodium membranifolium LC Lima, AMG Azevedo & LP Queiroz	Fabaceae

Species	**Family**
Desmodium procumbens (Mill.) Hitchc.	Fabaceae
Desmodium subsecundum Vogel	Fabaceae
Desmodium subsericeum Malme	Fabaceae
Desmodium tortuosum (Sw.) DC.	Fabaceae
Desmodium triflorum (L.) DC.	Fabaceae
Desmodium uncinatum (Jacq.) DC.	Fabaceae
Desmoncus leptoclonos Drude	Arecaceae
Dichanthelium sabulorum (Lam.) Gould & C.A. Clark	Poaceae
Dichanthelium superatum (Hack.) Zuloaga	Poaceae
Dichanthelium surrectum (Chase ex Zuloaga & Morrone) Zuloaga	Poaceae
Dichorisandra hexandra (Aubl.) C.B.Clarke	Commelinaceae
Dichorisandra perforans C.B.Clarke	Commelinaceae
Dictyostega orobanchoides (Hook.) Miers	Burmanniaceae
Didymoglossum hymenoides (Hedw.) Desv.	Hymenophyllaceae
Digitaria ciliaris (Retz.) Koeler	Poaceae
Digitaria fuscescens (J.Presl) Henrard	Poaceae
Digitaria horizontalis Willd.	Poaceae
Digitaria insularis (L.) Fedde	Poaceae
Digitaria nuda Schumach.	Poaceae
Digitaria violascens Link	Poaceae
Dioclea glabra Benth.	Fabaceae
Diodia kuntzei K.Schum.	Rubiaceae
Diodia saponariifolia (Cham. & Schltdl.) K.Schum.	Rubiaceae
Dioscorea acanthogene Rusby	Dioscoreaceae
Dioscorea amaranthoides C.Presl	Dioscoreaceae
Dioscorea asperula Pedralli	Dioscoreaceae
Dioscorea campestris Griseb.	Dioscoreaceae
Dioscorea ceratandra R.Knuth	Dioscoreaceae
Dioscorea corumbensis R.Knuth	Dioscoreaceae
Dioscorea grandiflora Mart. ex Griseb.	Dioscoreaceae
Dioscorea marginata Griseb.	Dioscoreaceae
Dioscorea multiflora Mart. ex Griseb.	Dioscoreaceae
Dioscorea scabra Humb. & Bonpl. ex Willd.	Dioscoreaceae
Dioscorea subhastata Vell.	Dioscoreaceae
Dioscorea trisecta Griseb.	Dioscoreaceae
Diplacrum capitatum (Willd.) Boeckeler	Cyperaceae
Distimake cissoides (Lam.) A.R. Simões & Staples	Convolvulaceae
Distimake dissectus (Jacq.) A.R. Simões & Staples	Convolvulaceae
Distimake macrocalyx (Ruiz & Pav.) A.R. Simões & Staples	Convolvulaceae
Ditassa capillaris E.Fourn.	Apocynaceae
Ditassa obscura (E.Fourn.) Farinaccio & T.U.P.Konno	Apocynaceae
Ditassa pohliana E.Fourn.	Apocynaceae
Ditassa tomentosa (Decne.) Fontella	Apocynaceae
Doliocarpus brevipedicellatus Garcke	Dilleniaceae
Doliocarpus dentatus (Aubl.) Standl.	Dilleniaceae
Doliocarpus elegans Eichler	Dilleniaceae
Dorstenia asaroides Gardner	Moraceae

Species	**Family**
Dorstenia cayapia Vell.	Moraceae
Dorstenia vitifolia Gardner	Moraceae
Drosera latifolia (Eichler) Gonella & Rivadavia	Droseraceae
Dryopteris patula (Sw.) Underw.	Dryopteridaceae
Echinochloa polystachya (Kunth) Hitchc.	Poaceae
Echinocoryne holosericea (Mart. ex DC.) H.Rob.	Asteraceae
Echinocoryne schwenkiifolia (Mart. ex DC.) H.Rob.	Asteraceae
Echinocoryne subulata (Baker) H.Rob.	Asteraceae
Echinodorus floribundus (Seub.) Seub.	Alismataceae
Elaphoglossum burchellii (Baker) C.Chr.	Dryopteridaceae
Elaphoglossum horridulum (Kaulf.) J.Sm.	Dryopteridaceae
Elaphoglossum hymenodiastrum (Fée) Brade	Dryopteridaceae
Elaphoglossum langsdorffii (Hook. & Grev.) T.Moore	Dryopteridaceae
Elaphoglossum luridum (Fée) Christ	Dryopteridaceae
Elaphoglossum macrophyllum (Mett. ex Kuhn) Christ	Dryopteridaceae
Elephantopus mollis Kunth	Asteraceae
Elephantopus riparius Gardner	Asteraceae
Emmeorhiza umbellata (Spreng.) K.Schum.	Rubiaceae
Epidendrum dendrobioides Thunb.	Orchidaceae
Epidendrum denticulatum Barb.Rodr.	Orchidaceae
Epidendrum martianum Lindl.	Orchidaceae
Epidendrum secundum Jacq.	Orchidaceae
Epistephium lucidum Cogn.	Orchidaceae
Epistephium williamsii Hook.f.	Orchidaceae
Eragrostis acutiflora (Kunth) Nees	Poaceae
Erechtites valerianifolius (Wolf) DC.	Asteraceae
Eriope arenaria Harley	Lamiaceae
Eriope glandulosa (Harley) Harley	Lamiaceae
Eriope hypenioides Mart. ex Benth.	Lamiaceae
Eriope macrostachya Mart. ex Benth.	Lamiaceae
Eriosema brevipes Grear	Fabaceae
Eriosema simplicifolium (Kunth) G.Don	Fabaceae
Eryngium horridum Malme	Apiaceae
Eryngium pandanifolium Cham. & Schltdl.	Apiaceae
Erythroxylum buxus Peyr.	Erythroxylaceae
Erythroxylum citrifolium A.St.-Hil.	Erythroxylaceae
Erythroxylum daphnites Mart.	Erythroxylaceae
Erythroxylum gonoclados (Mart.) O.E.Schulz	Erythroxylaceae
Erythroxylum microphyllum A.St.-Hil.	Erythroxylaceae
Erythroxylum pelleterianum A.St.-Hil.	Erythroxylaceae
Erythroxylum squamatum Sw.	Erythroxylaceae
Erythroxylum strobilaceum Peyr.	Erythroxylaceae
Erythroxylum subracemosum Turcz.	Erythroxylaceae
Erythroxylum subrotundum A.St.-Hil.	Erythroxylaceae
Escallonia bifida Link & Otto	Escalloniaceae
Eugenia florida DC.	Myrtaceae
Eugenia pyrifera Faria & ProenÃ§a	Myrtaceae

Species	Family
Eumachia cephalantha (Müll. Arg.) Delprete & J.H. Kirkbr.	Rubiaceae
Euphorbia sciadophila Boiss.	Euphorbiaceae
Euphorbia zonosperma Müll.Arg.	Euphorbiaceae
Euploca filiformis (Lehm.) J.I.M.Melo & Semir	Boraginaceae
Euploca procumbens (Mill.) Diane & Hilger	Boraginaceae
Evolvulus latifolius Ker Gawl.	Convolvulaceae
Evolvulus ovatus Fernald	Convolvulaceae
Evolvulus sericeus Sw.	Convolvulaceae
Exostigma rivulare (Gardner) G.Sancho	Asteraceae
Faramea bracteata Benth.	Rubiaceae
Faramea montevidensis (Cham. & Schltdl.) DC.	Rubiaceae
Faramea multiflora A.Rich. ex DC.	Rubiaceae
Faramea nitida Benth.	Rubiaceae
Faramea sessiliflora Aubl.	Rubiaceae
Faramea sessilifolia (Kunth) DC.	Rubiaceae
Fimbristylis spadicea (L.) Vahl	Cyperaceae
Fischeria stellata (Vell.) E.Fourn.	Apocynaceae
Fleischmannia laxa (Gardner) R.M.King & H.Rob.	Asteraceae
Floscopa glabrata (Kunth) Hassk.	Commelinaceae
Forsteronia glabrescens Müll.Arg.	Apocynaceae
Forsteronia rufa Müll.Arg.	Apocynaceae
Fridericia leucopogon (Cham.) L.G.Lohmann	Bignoniaceae
Fridericia speciosa Mart.	Bignoniaceae
Fuchsia regia (Vell.) Munz	Onagraceae
Funastrum clausum (Jacq.) Schltr.	Apocynaceae
Galactia striata (Jacq.) Urb.	Fabaceae
Galeandra beyrichii Rchb.f.	Orchidaceae
Galeottia ciliata (Morel) Dressler & Christenson	Orchidaceae
Galianthe brasiliensis (Spreng.) E.L.Cabral & Bacigalupo	Rubiaceae
Galianthe valerianoides (Cham. & Schltdl.) E.L.Cabral	Rubiaceae
Galium espiniacicum Dempster	Rubiaceae
Galium hypocarpium (L.) Endl. ex Griseb.	Rubiaceae
Galium noxium (A.St.-Hil.) Dempster	Rubiaceae
Geissanthus ambiguus (Mart.) G.Agostini	Primulaceae
Genlisea violacea A.St.-Hil.	Lentibulariaceae
Geonoma brevispatha Barb.Rodr.	Arecaceae
Geonoma pohliana Mart.	Arecaceae
Geonoma schottiana Mart.	Arecaceae
Geophila repens (L.) I.M.Johnst.	Rubiaceae
Gleichenella pectinata (Willd.) Ching	Gleicheniaceae
Gloxinia erinoides (DC.) Roalson & Boggan	Gesneriaceae
Goeppertia barbata (Petersen) Borchs. & S.Suárez	Marantaceae
Goeppertia effusa Saka & Lombardi	Marantaceae
Goeppertia eichleri (Petersen) Borchs. & S.Suárez	Marantaceae
Goeppertia sellowii (Körn.) Borchs. & S. Suárez	Marantaceae
Gomphrena vaga Mart.	Amaranthaceae
Gouania inornata Reissek	Rhamnaceae

Species	Family
Gouania latifolia Reissek	Rhamnaceae
Gouania virgata Reissek	Rhamnaceae
Guapira hirsuta (Choisy) Lundell	Nyctaginaceae
Guettarda pohliana Müll.Arg.	Rubiaceae
Guettarda uruguensis Cham. & Schltdl.	Rubiaceae
Gurania lobata (L.) Pruski	Cucurbitaceae
Gymnanthes schottiana Müll.Arg.	Euphorbiaceae
Gymneia interrupta (Pohl ex Benth.) Harley & J.F.B.Pastore	Lamiaceae
Gynerium sagittatum (Aubl.) P.Beauv.	Poaceae
Habenaria balansae Cogn.	Orchidaceae
Habenaria cryptophila Barb.Rodr.	Orchidaceae
Habenaria curvilabra Barb.Rodr.	Orchidaceae
Habenaria glaucophylla Barb.Rodr.	Orchidaceae
Habenaria gourlieana Gill. ex Lindl.	Orchidaceae
Habenaria goyazensis Cogn.	Orchidaceae
Habenaria heringeri Pabst	Orchidaceae
Habenaria hexaptera Lindl.	Orchidaceae
Habenaria johannensis Barb.Rodr.	Orchidaceae
Habenaria juruenensis Hoehne	Orchidaceae
Habenaria leprieuri Rchb.f.	Orchidaceae
Habenaria longicauda Hook.	Orchidaceae
Habenaria nuda Lindl.	Orchidaceae
Habenaria obtusa Lindl.	Orchidaceae
Habenaria parviflora Lindl.	Orchidaceae
Habenaria petalodes Lindl.	Orchidaceae
Habenaria pratensis (Salzm. ex Lindl.) Rchb.f.	Orchidaceae
Habenaria repens Nutt.	Orchidaceae
Habenaria schenckii Cogn.	Orchidaceae
Habenaria secundiflora Barb.Rodr.	Orchidaceae
Habenaria tamanduensis Schltr.	Orchidaceae
Hamelia patens Jacq.	Rubiaceae
Harpalyce lepidota Taub.	Fabaceae
Hedychium coronarium J.Koenig	Zingiberaceae
Heliconia psittacorum L.f.	Heliconiaceae
Helicteres baruensis Jacq.	Malvaceae
Helicteres brevispira A.St.-Hil.	Malvaceae
Helicteres corylifolia Nees & Mart.	Malvaceae
Helicteres gardneriana A.St.-Hil. & Naudin	Malvaceae
Helicteres guazumifolia Kunth	Malvaceae
Helicteres lenta Mart.	Malvaceae
Helicteres lhotzkyana (Schott & Endl.) K.Schum.	Malvaceae
Helicteres ovata Lam.	Malvaceae
Helicteres pilgeri R.E.Fr.	Malvaceae
Helietta glaziovii (Engl.) Pirani	Rutaceae
Heliotropium elongatum (Lehm.) I.M.Johnst.	Boraginaceae
Heliotropium transalpinum Vell.	Boraginaceae
Hemionitis tomentosa (Lam.) Raddi	Pteridaceae

Species	**Family**
Henriettea ovata (Cogn.) Penneys, F.A. Michelangeli, Judd et Almeda	Melastomataceae
Herreria interrupta Griseb.	Asparagaceae
Herreria salsaparilha Mart.	Asparagaceae
Heteropterys dumetorum (Griseb.) Nied.	Malpighiaceae
Hildaea pallens (Sw.) C.Silva & R.P.Oliveira	Poaceae
Hildaea ruprechtii (Döll) C.Silva & R.P.Oliveira	Poaceae
Hillia parasitica Jacq.	Rubiaceae
Hippeastrum glaucescens (Mart.) Herb.	Amaryllidaceae
Hippeastrum puniceum (Lam.) Kuntze	Amaryllidaceae
Hippocratea volubilis L.	Celastraceae
Hirtella hoehnei Pilg.	Chrysobalanaceae
Hololepis pedunculata (DC. ex Pers.) DC.	Asteraceae
Homolepis glutinosa (Sw.) Zuloaga & Soderstr.	Poaceae
Houlletia odoratissima Linden ex Lindl. & Paxton	Orchidaceae
Humiria balsamifera (Aubl.) A.St.-Hil.	Humiriaceae
Hydrocotyle leucocephala Cham. & Schltdl.	Araliaceae
Hydrocotyle pusilla A.Rich.	Araliaceae
Hydrolea spinosa L.	Hydroleaceae
Hygrophila costata Nees	Acanthaceae
Hymenachne amplexicaulis (Rudge) Nees	Poaceae
Hymenachne donacifolia (Raddi) Chase	Poaceae
Hymenachne pernambucensis (Spreng.) Zuloaga	Poaceae
Hymenasplenium laetum (Sw.) L. Regalado & Prada	Aspleniaceae
Hyparrhenia bracteata (Humb. & Bonpl. ex Willd.) Stapf	Poaceae
Hyparrhenia rufa (Nees) Stapf	Poaceae
Hypenia calycina (Pohl ex Benth.) Harley	Lamiaceae
Hypenia macrantha (A.St.-Hil. ex Benth.) Harley	Lamiaceae
Hypenia paniculata (Benth.) Harley	Lamiaceae
Hypenia salzmannii (Benth.) Harley	Lamiaceae
Hypericum brasiliense Choisy	Hypericaceae
Hypoxis decumbens L.	Hypoxidaceae
Hyptis brevipes Poit.	Lamiaceae
Hyptis longifolia Pohl ex Benth.	Lamiaceae
Hyptis lorentziana O.Hoffm.	Lamiaceae
Hyptis lutescens Pohl ex Benth.	Lamiaceae
Hyptis marrubioides Epling	Lamiaceae
Hyptis orbiculata Pohl ex Benth.	Lamiaceae
Hyptis recurvata Poit.	Lamiaceae
Hyptis rubiginosa Benth.	Lamiaceae
Hyptis sinuata Pohl ex Benth.	Lamiaceae
Ichnanthus bambusiflorus (Trin.) Döll	Poaceae
Ichnanthus calvescens (Nees ex Trin.) Döll	Poaceae
Ichnanthus inconstans (Trin. ex Nees) Döll	Poaceae
Ichnanthus longiglumis Mez	Poaceae
Ichnanthus mollis Ekman	Poaceae
Ichnanthus nemoralis (Schrad. ex Schult.) Hitchc. & Chase	Poaceae
Ichthyothere cunabi Mart.	Asteraceae

Species	**Family**
Ichthyothere terminalis (Spreng.) S.F.Blake	Asteraceae
Ilex asperula Reissek	Aquifoliaceae
Impatiens walleriana Hook.f.	Balsaminaceae
Indigofera lespedezioides Kunth	Fabaceae
Indigofera pascuorum Benth.	Fabaceae
Ipomoea alba L.	Convolvulaceae
Ipomoea batatoides Choisy	Convolvulaceae
Ipomoea cairica (L.) Sweet	Convolvulaceae
Ipomoea carnea Jacq.	Convolvulaceae
Ipomoea decora Meisn.	Convolvulaceae
Ipomoea grandifolia (Dammer) O'Donell	Convolvulaceae
Ipomoea hederifolia L.	Convolvulaceae
Ipomoea indica (Burm.) Merr.	Convolvulaceae
Ipomoea megapotamica Choisy	Convolvulaceae
Ipomoea purpurea (L.) Roth	Convolvulaceae
Ipomoea reticulata O'Donell	Convolvulaceae
Ipomoea rubens Choisy	Convolvulaceae
Ipomoea sericophylla Meisn.	Convolvulaceae
Ipomoea setifera Poir.	Convolvulaceae
Ipomoea sidifolia Schrad.	Convolvulaceae
Ipomoea squamosa Choisy	Convolvulaceae
Isachne goiasensis Renvoize	Poaceae
Isachne polygonoides (Lam.) Döll	Poaceae
Iseia luxurians (Moric.) O'Donell	Convolvulaceae
Jacaratia corumbensis Kuntze	Caricaceae
Jacquemontia martii Choisy	Convolvulaceae
Jacquemontia tamnifolia (L.) Griseb.	Convolvulaceae
Jacquemontia velutina Choisy	Convolvulaceae
Janusia anisandra (A.Juss.) Griseb.	Malpighiaceae
Janusia guaranitica (A.St.-Hil.) A.Juss.	Malpighiaceae
Janusia janusioides (A.Juss.) W.R.Anderson	Malpighiaceae
Janusia mediterranea (Vell.) W.R.Anderson	Malpighiaceae
Janusia occhionii W.R.Anderson	Malpighiaceae
Jatropha elliptica (Pohl) Oken	Euphorbiaceae
Jatropha gossypiifolia L.	Euphorbiaceae
Jobinia lindbergii E.Fourn.	Apocynaceae
Jungia floribunda Less.	Asteraceae
Jungia selowii Less.	Asteraceae
Justicia asclepiadea (Nees) Wassh. & C.Ezcurra	Acanthaceae
Justicia brasiliana Roth	Acanthaceae
Justicia burchellii Hiern	Acanthaceae
Justicia chapadensis S.Moore	Acanthaceae
Justicia clivalis Wassh.	Acanthaceae
Justicia comata (L.) Lam.	Acanthaceae
Justicia irwinii Wassh.	Acanthaceae
Justicia nodicaulis (Nees) Leonard	Acanthaceae
Justicia riparia Kameyama	Acanthaceae

Species	Family
Justicia serrana Kameyama	Acanthaceae
Justicia tocantina (Nees) V.A.W.Graham	Acanthaceae
Koellensteinia tricolor (Lindl.) Rchb.f.	Orchidaceae
Koernickanthe orbiculata (Körn.) L.Andersson	Marantaceae
Langsdorffia hypogaea Mart.	Balanophoraceae
Lantana camara L.	Verbenaceae
Lantana canescens Kunth	Verbenaceae
Lantana cujabensis Schauer	Verbenaceae
Lantana fucata Lindl.	Verbenaceae
Lantana hypoleuca Briq.	Verbenaceae
Lantana lundiana Schauer	Verbenaceae
Lantana pohliana Schauer	Verbenaceae
Lantana trifolia L.	Verbenaceae
Lantana viscosa Pohl ex Schauer	Verbenaceae
Lasiacis ligulata Hitchc. & Chase	Poaceae
Lasiacis sorghoidea (Desv. ex Ham.) Hitchc. & Chase	Poaceae
Lastreopsis amplissima (C.Presl) Tindale	Dryopteridaceae
Lastreopsis effusa (Sw.) Tindale	Dryopteridaceae
Leandra acutiflora (Naudin) Cogn.	Melastomataceae
Leandra adenothrix Cogn.	Melastomataceae
Leandra aurea (Cham.) Cogn.	Melastomataceae
Leandra cancellata Cogn.	Melastomataceae
Leandra melastomoides Raddi	Melastomataceae
Leandra polystachya (Naudin) Cogn.	Melastomataceae
Leandra purpurascens (DC.) Cogn.	Melastomataceae
Leandra salicina (DC.) Cogn.	Melastomataceae
Leandra subobruta Wurdack	Melastomataceae
Leandra viscosa Cogn.	Melastomataceae
Leersia ligularis Trin.	Poaceae
Leonotis nepetifolia (L.) R.Br.	Lamiaceae
Lepidagathis floribunda (Pohl) Kameyama	Acanthaceae
Lepidagathis montana (Nees) Kameyama	Acanthaceae
Licania blackii Prance	Chrysobalanaceae
Lindsaea arcuata Kunze	Lindsaeaceae
Lindsaea divaricata Klotzsch	Lindsaeaceae
Lindsaea guianensis (Aubl.) Dryand.	Lindsaeaceae
Liparis nervosa (Thumb.) Lindl.	Orchidaceae
Lippia alba (Mill.) N.E.Br. ex P. Wilson	Verbenaceae
Lippia aristata Schauer	Verbenaceae
Lippia lacunosa Mart. & Schauer	Verbenaceae
Lippia lasiocalycina Cham.	Verbenaceae
Lippia lippioides (Cham.) Rusby	Verbenaceae
Lippia origanoides Kunth	Verbenaceae
Lippia rotundifolia Cham.	Verbenaceae
Lippia thymoides Mart. & Schauer	Verbenaceae
Lophophytum mirabile Schott & Endl.	Balanophoraceae
Loudetia flammida (Trin.) C.E.Hubb.	Poaceae

Species	Family
Ludwigia affinis (DC.) H.Hara	Onagraceae
Ludwigia brachyphylla (Micheli) H.Hara	Onagraceae
Ludwigia bullata (Hassl.) H.Hara	Onagraceae
Ludwigia decurrens Walter	Onagraceae
Ludwigia elegans (Cambess.) H.Hara	Onagraceae
Ludwigia erecta (L.) H.Hara	Onagraceae
Ludwigia irwinii Ramamoorthy	Onagraceae
Ludwigia laruotteana (Cambess.) H.Hara	Onagraceae
Ludwigia leptocarpa (Nutt.) H.Hara	Onagraceae
Ludwigia longifolia (DC.) H.Hara	Onagraceae
Ludwigia martii (Micheli) Ramamoorthy	Onagraceae
Ludwigia myrtifolia (Cambess.) H.Hara	Onagraceae
Ludwigia nervosa (Poir.) H.Hara	Onagraceae
Ludwigia octovalvis (Jacq.) P.H.Raven	Onagraceae
Ludwigia rigida (Miq.) Sandwith	Onagraceae
Ludwigia sericea (Cambess.) H.Hara	Onagraceae
Ludwigia tomentosa (Cambess.) H.Hara	Onagraceae
Luffa operculata (L.) Cogn.	Cucurbitaceae
Lundia nitidula DC.	Bignoniaceae
Lygodium venustum Sw.	Lygodiaceae
Lygodium volubile Sw.	Lygodiaceae
Lyroglossa grisebachii (Cogn.) Schltr.	Orchidaceae
Macairea pachyphylla Benth.	Melastomataceae
Macairea radula (Bonpl.) DC.	Melastomataceae
Machaerium isadelphum (E.Mey.) Amshoff	Fabaceae
Machaerium lanceolatum (Vell.) J.F.Macbr.	Fabaceae
Machaerium oblongifolium Vogel	Fabaceae
Machaonia acuminata Bonpl.	Rubiaceae
Macropharynx macrocalyx (Müll.Arg.) J.F.Morales & M.E.Endress	Apocynaceae
Macropharynx peltata (Vell.) J.F.Morales & M.E. Endress	Apocynaceae
Macroptilium lathyroides (L.) Urb.	Fabaceae
Macroptilium sabaraense (Hoehne) V.P.Barbosa	Fabaceae
Macrothelypteris torresiana (Gaudich.) Ching	Thelypteridaceae
Malanea macrophylla Bartl. ex Griseb.	Rubiaceae
Malaxis excavata (Lindl.) Kuntze	Orchidaceae
Manihot anomala Pohl	Euphorbiaceae
Maranta bracteosa Petersen	Marantaceae
Maranta incrassata L.Andersson	Marantaceae
Maranta parvifolia Petersen	Marantaceae
Maranta pluriflora (Petersen) K.Schum.	Marantaceae
Maranta pohliana Körn.	Marantaceae
Maranta polystachya (K.Schum.) J.M.A.Braga	Marantaceae
Maranta pulchra S.Vieira & V.C.Souza	Marantaceae
Maranta ruiziana Körn.	Marantaceae
Marsdenia hilariana E.Fourn.	Apocynaceae
Marsdenia macrophylla (Humb. & Bonpl. ex Schult.) E.Fourn.	Apocynaceae
Marsdenia suberosa (E.Fourn.) Malme	Apocynaceae

Species	**Family**
Marsypianthes chamaedrys (Vahl) Kuntze	Lamiaceae
Marsypianthes foliolosa Benth.	Lamiaceae
Marsypianthes montana Benth.	Lamiaceae
Matayba marginata Radlk.	Sapindaceae
Matayba mollis Radlk.	Sapindaceae
Matelea pedalis (E.Fourn.) Fontella & E.A.Schwarz	Apocynaceae
Medusantha martiusii (Benth.) Harley & J.F.B.Pastore	Lamiaceae
Megathyrsus maximus (Jacq.) B.K.Simon & S.W.L.Jacobs	Poaceae
Melidiscus giganteus (L.) Raf.	Cleomaceae
Melochia arenosa Benth.	Malvaceae
Melochia graminifolia A.St.-Hil.	Malvaceae
Melochia pyramidata L.	Malvaceae
Melochia simplex A.St.-Hil.	Malvaceae
Melochia villosa (Mill.) Fawc. & Rendle	Malvaceae
Melothria hirsuta Cogn.	Cucurbitaceae
Melothria pendula L.	Cucurbitaceae
Melothrianthus smilacifolius (Cogn.) Mart.Crov.	Cucurbitaceae
Mendoncia mollis Lindau	Acanthaceae
Mendoncia velloziana Mart.	Acanthaceae
Meniscium angustifolium Willd.	Thelypteridaceae
Meniscium arborescens Humb. & Bonpl. ex Willd.	Thelypteridaceae
Meniscium chrysodioides Fée	Thelypteridaceae
Meniscium longifolium Desv.	Thelypteridaceae
Meniscium maxonianum (A.R.Sm.) R.S.Fernandes & Salino	Thelypteridaceae
Mesadenella cuspidata (Lindl.) Garay	Orchidaceae
Mesosphaerum suaveolens (L.) Kuntze	Lamiaceae
Miconia affinis DC.	Melastomataceae
Miconia ciliata (Rich.) DC.	Melastomataceae
Miconia collatata Wurdack	Melastomataceae
Miconia cyathanthera Triana	Melastomataceae
Miconia heliotropoides Triana	Melastomataceae
Miconia ibaguensis (Bonpl.) Triana	Melastomataceae
Miconia lanata (DC.) Triana	Melastomataceae
Miconia macrothyrsa Benth.	Melastomataceae
Miconia nervosa (Sm.) Triana	Melastomataceae
Miconia rimalis Naudin	Melastomataceae
Miconia staminea (Desr.) DC.	Melastomataceae
Miconia stenostachya DC.	Melastomataceae
Microchilus arietinus (Rchb.f. & Warm.) Ormerod	Orchidaceae
Microgramma squamulosa (Kaulf.) de la Sota	Polypodiaceae
Microstachys daphnoides (Mart. & Zucc.) Müll.Arg.	Euphorbiaceae
Mikania acuminata DC.	Asteraceae
Mikania banisteriae DC.	Asteraceae
Mikania campanulata Gardner	Asteraceae
Mikania capricorni B.L.Rob.	Asteraceae
Mikania cordifolia (L.f.) Willd.	Asteraceae
Mikania cynanchifolia Hook. & Arn. ex B.L.Rob.	Asteraceae

Species	**Family**
Mikania glomerata Spreng.	Asteraceae
Mikania hemisphaerica Sch.Bip. ex Baker	Asteraceae
Mikania hirsutissima DC.	Asteraceae
Mikania laevigata Sch.Bip. ex Baker	Asteraceae
Mikania micrantha Kunth	Asteraceae
Mikania microcephala DC.	Asteraceae
Mikania populifolia Gardner	Asteraceae
Mikania psilostachya DC.	Asteraceae
Mikania sessilifolia DC.	Asteraceae
Mimosa invisa Mart. ex Colla	Fabaceae
Mimosa pigra L.	Fabaceae
Mimosa polycarpa Kunth	Fabaceae
Mimosa pudica L.	Fabaceae
Mimosa skinneri Benth.	Fabaceae
Mimosa somnians Humb. & Bonpl. ex Willd.	Fabaceae
Monotagma densiflorum (Körn.) K.Schum.	Marantaceae
Monteverdia ilicifolia (Mart. ex Reissek) Biral	Celastraceae
Moutabea excoriata Mart. ex Miq.	Polygalaceae
Myrcia capitata O.Berg	Myrtaceae
Myrcia multipunctata Mazine	Myrtaceae
Myrcia nitida Cambess.	Myrtaceae
Myrcia subavenia (O.Berg) N.Silveira	Myrtaceae
Myrcia subcordata DC.	Myrtaceae
Myrcia venulosa DC.	Myrtaceae
Myriopus breviflorus (DC.) Luebert	Boraginaceae
Myrosma cannifolia L.f.	Marantaceae
Neea hermaphrodita S.Moore	Nyctaginaceae
Nelsonia canescens (Lam.) Spreng.	Acanthaceae
Neoblechnum brasiliense (Desv.) Gasper & V.A.O. Dittrich	Blechnaceae
Neomarica glauca (Seub. ex Klatt) Sprague	Iridaceae
Nephrolepis biserrata (Sw.) Schott	Lomariopsidaceae
Nephrolepis pectinata (Willd.) Schott	Lomariopsidaceae
Nephrolepis rivularis (Vahl) Mett. ex Krug	Lomariopsidaceae
Niedenzuella multiglandulosa (A.Juss.) W.R.Anderson	Malpighiaceae
Niphidium crassifolium (L.) Lellinger	Polypodiaceae
Ocellochloa stolonifera (Poir.) Zuloaga & Morrone	Poaceae
Ocimum gratissimum L.	Lamiaceae
Odonellia eriocephala (Moric.) K.R.Robertson	Convolvulaceae
Odontocarya tamoides (DC.) Miers	Menispermaceae
Oeceoclades maculata (Lindl.) Lindl.	Orchidaceae
Oldenlandia salzmannii (DC.) Benth. & Hook.f. ex B.D.Jacks.	Rubiaceae
Olyra ciliatifolia Raddi	Poaceae
Olyra fasciculata Trin.	Poaceae
Olyra glaberrima Raddi	Poaceae
Olyra humilis Nees	Poaceae
Olyra latifolia L.	Poaceae
Olyra taquara Swallen	Poaceae

Species	**Family**
Operculina hamiltonii (G.Don) D.F.Austin & Staples	Convolvulaceae
Operculina macrocarpa (L.) Urb.	Convolvulaceae
Operculina pteripes (G.Don) O'Donell	Convolvulaceae
Ophioglossum crotalophoroides Walter	Ophioglossaceae
Ophioglossum reticulatum L.	Ophioglossaceae
Oplismenus burmannii (Retz.) P.Beauv.	Poaceae
Oplismenus hirtellus (L.) P.Beauv.	Poaceae
Osmunda spectabilis Willd.	Osmundaceae
Ossaea amygdaloides (DC.) Triana	Melastomataceae
Otachyrium succisum (Swallen) Send. & Soderstr.	Poaceae
Otachyrium seminudum Hack. ex Send. & Soderstr.	Poaceae
Ouratea caudata Engl.	Ochnaceae
Ouratea parvifolia (A.St.-Hil.) Engl.	Ochnaceae
Oxalis cratensis Oliv. ex Hook.	Oxalidaceae
Oxalis hedysarifolia Raddi	Oxalidaceae
Oxalis riparia Norlind	Oxalidaceae
Oxalis sepium A.St.-Hil.	Oxalidaceae
Oxalis umbraticola A.St.-Hil.	Oxalidaceae
Oxypetalum appendiculatum Mart.	Apocynaceae
Oxypetalum erianthum Decne.	Apocynaceae
Oxypetalum helios Farinaccio	Apocynaceae
Oxypetalum insigne (Decne.) Malme	Apocynaceae
Oxypetalum pachygynum Decne.	Apocynaceae
Oxypetalum wightianum Hook. & Arn.	Apocynaceae
Paepalanthus lamarckii Kunth	Eriocaulaceae
Paepalanthus scandens Ruhland	Eriocaulaceae
Paepalanthus tortilis (Bong.) Mart.	Eriocaulaceae
Palicourea colorata (Willd. ex Roem. & Schult.) Delprete & J.H.Kirkbr.	Rubiaceae
Palicourea coriacea (Cham.) K.Schum.	Rubiaceae
Palicourea crocea (Sw.) Roem. & Schult.	Rubiaceae
Palicourea croceoides Ham.	Rubiaceae
Palicourea guianensis Aubl.	Rubiaceae
Palicourea hoffmannseggiana (Schult.) Borhidi	Rubiaceae
Palicourea justiciifolia (Rudge) Delprete & J.H.Kirkbr.	Rubiaceae
Palicourea macrobotrys (Ruiz & Pav.) Schult.	Rubiaceae
Palicourea marcgravii A.St.-Hil.	Rubiaceae
Palicourea racemosa (Aubl.) Borhidi	Rubiaceae
Palicourea sessilis (Vell.) C.M.Taylor	Rubiaceae
Palicourea tetraphylla Cham. & Schltdl.	Rubiaceae
Palicourea tomentosa (Aubl.) Borhidi	Rubiaceae
Palicourea violacea (Aubl.) A.Rich.	Rubiaceae
Panicum campestre Nees ex Trin.	Poaceae
Panicum haenkeanum J.Presl	Poaceae
Panicum ligulare Nees ex Trin.	Poaceae
Panicum millegrana Poir.	Poaceae
Panicum sellowii Nees	Poaceae

Species	Family
Panicum trichanthum Nees	Poaceae
Panicum trichoides Sw.	Poaceae
Parablechnum cordatum (Desv.) Gasper & Salino	Blechnaceae
Parodiolyra micrantha (Kunth) Davidse & Zuloaga	Poaceae
Parodiophyllochloa ovulifera (Trin.) Zuloaga & Morrone	Poaceae
Parodiophyllochloa pantricha (Hack.) Zuloaga & Morrone	Poaceae
Parodiophyllochloa penicillata (Nees ex Trin.) Zuloaga & Morrone	Poaceae
Paspalum conjugatum P.J.Bergius	Poaceae
Paspalum decumbens Sw.	Poaceae
Paspalum lineare Trin.	Poaceae
Paspalum malacophyllum Trin.	Poaceae
Paspalum mandiocanum Trin.	Poaceae
Paspalum melanospermum Desv. ex Poir.	Poaceae
Paspalum millegrana Schrad. ex Schult.	Poaceae
Paspalum notatum Flüggé	Poaceae
Paspalum paniculatum L.	Poaceae
Paspalum riparium Nees	Poaceae
Paspalum robustum (Hitchc. & Chase) S.Denham	Poaceae
Paspalum scalare Trin.	Poaceae
Paspalum urvillei Steud.	Poaceae
Paspalum veredense G.H.Rua et al.	Poaceae
Passiflora amethystina J.C.Mikan	Passifloraceae
Passiflora capsularis L.	Passifloraceae
Passiflora edulis Sims	Passifloraceae
Passiflora misera Kunth	Passifloraceae
Passiflora morifolia Mast.	Passifloraceae
Passiflora suberosa L.	Passifloraceae
Passiflora tricuspis Mast.	Passifloraceae
Passiflora urnifolia Rusby	Passifloraceae
Paullinia carpopoda Cambess.	Sapindaceae
Paullinia rhomboidea Radlk.	Sapindaceae
Paullinia spicata Benth.	Sapindaceae
Pavonia angustifolia Benth.	Malvaceae
Pavonia garckeana Gürke	Malvaceae
Pavonia hexaphylla (S.Moore) Krapov.	Malvaceae
Pavonia humifusa A.St.-Hil.	Malvaceae
Pavonia malacophylla (Link & Otto) Garcke	Malvaceae
Pavonia sagittata A.St.-Hil.	Malvaceae
Pavonia schrankii Spreng.	Malvaceae
Pavonia sidifolia Kunth	Malvaceae
Pecluma pectinatiformis (Lindm.) M.G.Price	Polypodiaceae
Pectis brevipedunculata (Gardner) Sch.Bip.	Asteraceae
Peixotoa parviflora A.Juss.	Malpighiaceae
Pelexia novofriburgensis (Rchb.f.) Garay	Orchidaceae
Pelexia pterygantha (Rchb.f. & Warm.) Schltr.	Orchidaceae
Peperomia arifolia Miq.	Piperaceae
Peperomia blanda (Jacq.) Kunth	Piperaceae

Species	**Family**
Peperomia calophylla Yunck.	Piperaceae
Peperomia campinasana C.DC.	Piperaceae
Peperomia gardneriana Miq.	Piperaceae
Peperomia pellucida (L.) Kunth	Piperaceae
Peperomia urocarpa Fisch. & C.A.Mey.	Piperaceae
Peperomia velloziana Miq.	Piperaceae
Peplonia adnata (E.Fourn.) U.C.S.Silva & Rapini	Apocynaceae
Peplonia organensis (E.Fourn.) Fontella & Rapini	Apocynaceae
Periandra coccinea (Schrad.) Benth.	Fabaceae
Periandra gracilis H.S.Irwin & Arroyo	Fabaceae
Peritassa laevigata (Hoffmanns. ex Link) A.C. Sm.	Celastraceae
Petalostelma bracteolatum (E.Fourn.) Fontella	Apocynaceae
Petalostelma martianum (Decne.) E.Fourn.	Apocynaceae
Petrea volubilis L.	Verbenaceae
Pfaffia glomerata (Spreng.) Pedersen	Amaranthaceae
Pharus lappulaceus Aubl.	Poaceae
Philodendron acutatum Schott	Araceae
Philodendron camposportoanum G.M.Barroso	Araceae
Philodendron flumineum E.G.Gonç.	Araceae
Philodendron guaraense E.G.Gonç.	Araceae
Philodendron mayoi E.G.Gonç.	Araceae
Philodendron minarum Engl.	Araceae
Philodendron wullschlaegelii Schott	Araceae
Philyra brasiliensis Klotzsch	Euphorbiaceae
Phlebodium aureum (L.) J.Sm.	Polypodiaceae
Phragmipedium vittatum (Vell.) Rolfe	Orchidaceae
Phyllanthus acuminatus Vahl	Phyllanthaceae
Phyllanthus arenicola Casar.	Phyllanthaceae
Phyllanthus choretroides Müll.Arg.	Phyllanthaceae
Phyllanthus minutulus Müll.Arg.	Phyllanthaceae
Phyllanthus spartioides Pax & K.Hoffm.	Phyllanthaceae
Phyllanthus subemarginatus Müll.Arg.	Phyllanthaceae
Phyllanthus tenellus Roxb.	Phyllanthaceae
Phyllanthus urinaria L.	Phyllanthaceae
Phyllanthus websterianus Steyerm.	Phyllanthaceae
Physostemon guianense (Aubl.) Malme	Cleomaceae
Pilea microphylla (L.) Liebm.	Urticaceae
Pilea pubescens Liebm.	Urticaceae
Piper aduncum L.	Piperaceae
Piper amalago L.	Piperaceae
Piper amplum Kunth	Piperaceae
Piper anisum (Spreng.) Angely	Piperaceae
Piper arboreum Aubl.	Piperaceae
Piper caldense C.DC.	Piperaceae
Piper cernuum Vell.	Piperaceae
Piper coccoloboides Kunth	Piperaceae
Piper corcovadensis (Miq.) C.DC.	Piperaceae

Species	**Family**
Piper corintoanum Yunck.	Piperaceae
Piper cuyabanum C.DC.	Piperaceae
Piper dilatatum Rich.	Piperaceae
Piper flavicans C.DC.	Piperaceae
Piper fuligineum Kunth	Piperaceae
Piper gaudichaudianum Kunth	Piperaceae
Piper glabratum Kunth	Piperaceae
Piper hispidum Sw.	Piperaceae
Piper lagoaense C.DC.	Piperaceae
Piper lhotzkyanum Kunth	Piperaceae
Piper macedoi Yunck.	Piperaceae
Piper malacophyllum (C.Presl) C.DC.	Piperaceae
Piper mollicomum Kunth	Piperaceae
Piper ovatum Vahl	Piperaceae
Piper regnellii (Miq.) C.DC.	Piperaceae
Piper tectoniifolium Kunth	Piperaceae
Piper tuberculatum Jacq.	Piperaceae
Piper umbellatum L.	Piperaceae
Piper vermiculatum C.DC.	Piperaceae
Piper xylosteoides (Kunth) Steud.	Piperaceae
Piriqueta cistoides (L.) Griseb.	Turneraceae
Pityrogramma calomelanos (L.) Link	Pteridaceae
Plantago australis Lam.	Plantaginaceae
Pleopeltis astrolepis (Liebm.) E.Fourn.	Polypodiaceae
Pleopeltis hirsutissima (Raddi) de la Sota	Polypodiaceae
Pleopeltis macrocarpa (Bory ex Willd.) Kaulf.	Polypodiaceae
Pleroma aemulum (Schrank et Mart ex DC.) Triana	Melastomataceae
Poecilanthe subcordata Benth.	Fabaceae
Poiretia punctata (Willd.) Desv.	Fabaceae
Polygala appressa Benth.	Polygalaceae
Polygala asperuloides Kunth	Polygalaceae
Polygala cuspidata DC.	Polygalaceae
Polygala hygrophila Kunth	Polygalaceae
Polygala nudicaulis A.W.Benn.	Polygalaceae
Polygala pseudosericea Chodat	Polygalaceae
Polygala stephaniana Marques	Polygalaceae
Polygonum ferrugineum Wedd.	Polygonaceae
Polystichum platylepis Fée	Dryopteridaceae
Pombalia atropurpurea (A.St.-Hil.) Paula-Souza	Violaceae
Pombalia bigibbosa (A.St.Hil.) Paula-Souza	Violaceae
Pombalia calceolaria (L.) Paula-Souza	Violaceae
Pombalia communis (A.St.-Hil.) Paula-Souza	Violaceae
Pombalia setigera (A.St.Hil.) Paula-Souza	Violaceae
Ponthieva pubescens (C.Presl) C.Schweinf.	Orchidaceae
Portulaca grandiflora Hook.	Portulacaceae
Posoqueria longiflora Aubl.	Rubiaceae
Prescottia oligantha (Sw.) Lindl.	Orchidaceae

Species	Family
Prescottia stachyodes (Sw.) Lindl.	Orchidaceae
Prestonia bahiensis Müll.Arg.	Apocynaceae
Prestonia lagoensis (Müll.Arg.) Woodson	Apocynaceae
Prestonia quinquangularis (Jacq.) Spreng.	Apocynaceae
Prestonia tomentosa R.Br.	Apocynaceae
Pristimera celastroides (Kunth) A.C.Sm.	Celastraceae
Priva lappulacea (L.) Pers.	Verbenaceae
Prockia crucis P.Browne ex L.	Salicaceae
Pseudechinolaena polystachya (Kunth) Stapf	Poaceae
Pseudogynoxys cabrerae H.Rob. & Cuatrec.	Asteraceae
Psilotum nudum (L.) P.Beauv.	Psilotaceae
Psychotria anceps Kunth	Rubiaceae
Psychotria bahiensis DC.	Rubiaceae
Psychotria carthagenensis Jacq.	Rubiaceae
Psychotria hastisepala Müll.Arg.	Rubiaceae
Psychotria lagoensis Müll.Arg.	Rubiaceae
Psychotria leiocarpa Cham. & Schltdl.	Rubiaceae
Psychotria microcarpa Müll.Arg.	Rubiaceae
Psychotria nemorosa Gardner	Rubiaceae
Psychotria officinalis (Aubl.) Raeusch. ex Sandwith	Rubiaceae
Psychotria paludosa Müll.Arg.	Rubiaceae
Psychotria platypoda DC.	Rubiaceae
Psychotria prunifolia (Kunth) Steyerm.	Rubiaceae
Psychotria rupestris Müll.Arg.	Rubiaceae
Psychotria spathicalyx Müll.Arg.	Rubiaceae
Psychotria sphaerocephala Müll.Arg.	Rubiaceae
Psychotria stachyoides Benth.	Rubiaceae
Psychotria subtriflora Müll.Arg.	Rubiaceae
Psychotria tenerior (Cham.) Müll.Arg.	Rubiaceae
Psychotria tricephala (Müll.Arg.) Zappi	Rubiaceae
Psychotria trichophora Müll.Arg.	Rubiaceae
Psychotria turbinella Müll.Arg.	Rubiaceae
Psychotria warmingii Müll.Arg.	Rubiaceae
Pteris denticulata Sw.	Pteridaceae
Pteris propinqua J.Agardh	Pteridaceae
Pteroglossa macrantha (Rchb.f.) Schltr.	Orchidaceae
Pteroglossa roseoalba (Rchb.f.) Salazar & M.W.Chase	Orchidaceae
Raddiella esenbeckii (Steud.) C.E.Calderón & Soderstr.	Poaceae
Randia calycina Cham.	Rubiaceae
Renealmia alpinia (Rottb.) Maas	Zingiberaceae
Renealmia brasiliensis K.Schum.	Zingiberaceae
Renealmia dermatopetala K.Schum.	Zingiberaceae
Renealmia matogrossensis Maas	Zingiberaceae
Retiniphyllum kuhlmannii Standl.	Rubiaceae
Rhipidocladum parviflorum (Trin.) McClure	Poaceae
Rhynchanthera dichotoma (Desr.) DC.	Melastomataceae
Rhynchanthera gardneri Naudin	Melastomataceae

Species	**Family**
Rhynchanthera grandiflora (Aubl.) DC.	Melastomataceae
Rhynchanthera hispida Naudin	Melastomataceae
Rhynchanthera novemnervia DC.	Melastomataceae
Rhynchosia melanocarpa Grear	Fabaceae
Rhynchosia minima (L.) DC.	Fabaceae
Rhynchosia phaseoloides (Sw.) DC.	Fabaceae
Rhynchosia reticulata (Sw.) DC.	Fabaceae
Rhynchospora caesionux T.Koyama	Cyperaceae
Rhynchospora cephalotes (L.) Vahl	Cyperaceae
Rhynchospora contracta (Nees) J.Raynal	Cyperaceae
Rhynchospora corymbosa (L.) Britton	Cyperaceae
Rhynchospora exaltata Kunth	Cyperaceae
Rhynchospora lapensis C.B.Clarke	Cyperaceae
Rhynchospora polyantha Steud.	Cyperaceae
Rhynchospora ridleyi C.B.Clarke	Cyperaceae
Rhynchospora rugosa (Vahl) Gale	Cyperaceae
Romanoa tamnoides (A.Juss.) Radcl.-Sm.	Euphorbiaceae
Rourea puberula Baker	Connaraceae
Rubus erythroclados Mart. ex Hook.f.	Rosaceae
Rubus urticifolius Poir.	Rosaceae
Rudgea corymbulosa Benth.	Rubiaceae
Rudgea crassiloba (Benth.) B.L.Rob.	Rubiaceae
Rudgea erioloba Benth.	Rubiaceae
Rudgea jasminoides (Cham.) Müll.Arg.	Rubiaceae
Rudgea longiflora Benth.	Rubiaceae
Rudgea palicoureoides (Mart.) Müll.Arg.	Rubiaceae
Rudgea sessilis (Vell.) Müll.Arg.	Rubiaceae
Ruellia costata (Nees) Hiern	Acanthaceae
Ruellia erythropus (Nees) Lindau	Acanthaceae
Ruellia eurycodon Lindau	Acanthaceae
Ruellia jussieuoides Schltdl. & Cham.	Acanthaceae
Ruellia macrantha (Mart. ex Nees) Hiern	Acanthaceae
Ruellia simplex C. Wright	Acanthaceae
Rugoloa hylaeica (Mez) Zuloaga	Poaceae
Rugoloa pilosa (Sw.) Zuloaga	Poaceae
Sabicea villosa Willd. ex Schult.	Rubiaceae
Sacoila lanceolata (Aubl.) Garay	Orchidaceae
Salpichlaena volubilis (Kaulf.) J.Sm.	Blechnaceae
Salvia calcicola Harley	Lamiaceae
Salvia harleyana E.P.Santos	Lamiaceae
Salvia secunda Benth.	Lamiaceae
Salvia tomentella Pohl	Lamiaceae
Sapium haematospermum Müll.Arg.	Euphorbiaceae
Sarcoglottis curvisepala Szlach. & Rutk.	Orchidaceae
Sarcoglottis homalogastra (Rchb.f. & Warm.) Schltr.	Orchidaceae
Sauroglossum elatum Lindl.	Orchidaceae
Sauvagesia erecta L.	Ochnaceae

Species	Family
Scaphispatha gracilis Brongn. ex Schott	Araceae
Scaphispatha robusta E.G.Gonç.	Araceae
Schiekia orinocensis (Kunth) Meisn.	Haemodoraceae
Schizaea elegans (Vahl) Sw.	Schizaeaceae
Schnella glabra (Jacq.) Dugand	Fabaceae
Schnella outimouta (Aubl.) Wunderlin	Fabaceae
Schnella riedeliana (Bong.) Wunderlin	Fabaceae
Schultesia aptera Cham.	Gentianaceae
Schultesia guianensis (Aubl.) Malme	Gentianaceae
Schultesia heterophylla Miq.	Gentianaceae
Schultesia pohliana Progel	Gentianaceae
Scleria bracteata Cav.	Cyperaceae
Scleria comosa (Nees) Steud.	Cyperaceae
Scleria distans Poir.	Cyperaceae
Scleria eggersiana Boeckeler	Cyperaceae
Scleria gaertneri Raddi	Cyperaceae
Scleria hirtella Sw.	Cyperaceae
Scleria latifolia Sw.	Cyperaceae
Scleria macrophylla J.Presl & C.Presl	Cyperaceae
Scleria martii (Nees) Steud.	Cyperaceae
Scleria microcarpa Nees ex Kunth	Cyperaceae
Scleria mitis P.J.Bergius	Cyperaceae
Scleria panicoides Kunth	Cyperaceae
Scleria reticularis Michx. ex Willd.	Cyperaceae
Scleria secans (L.) Urb.	Cyperaceae
Scleria sprucei C.B.Clarke	Cyperaceae
Scoparia dulcis L.	Plantaginaceae
Scutellaria racemosa Pers.	Lamiaceae
Scybalium fungiforme Schott & Endl.	Balanophoraceae
Secondatia densiflora A.DC.	Apocynaceae
Securidaca rivinifolia A.St.-Hil. & Moq.	Polygalaceae
Securidaca tomentosa A.St.-Hil. & Moq.	Polygalaceae
Seemannia sylvatica (Kunth) Hanst.	Gesneriaceae
Selaginella convoluta (Arn.) Spring	Selaginellaceae
Selaginella erectifolia Spring	Selaginellaceae
Selaginella muscosa Spring	Selaginellaceae
Selaginella saltuicola Valdespino	Selaginellaceae
Senecio emiliopsis C.Jeffrey	Asteraceae
Senna aculeata (Pohl ex Benth.) H.S.Irwin & Barneby	Fabaceae
Senna cana (Nees & Mart.) H.S.Irwin & Barneby	Fabaceae
Senna macranthera (DC. ex Collad.) H.S.Irwin & Barneby	Fabaceae
Senna oblongifolia (Vogel) H.S.Irwin & Barneby	Fabaceae
Senna pendula (Humb.& Bonpl.ex Willd.) H.S.Irwin & Barneby	Fabaceae
Senna pilifera (Vogel) H.S.Irwin & Barneby	Fabaceae
Senna reniformis (G.Don) H.S.Irwin & Barneby	Fabaceae
Senna splendida (Vogel) H.S.Irwin & Barneby	Fabaceae
Serjania acutidentata Radlk.	Sapindaceae

Species	**Family**
Serjania clematidifolia Cambess.	Sapindaceae
Serjania comata Radlk.	Sapindaceae
Serjania confertiflora Radlk.	Sapindaceae
Serjania glutinosa Radlk.	Sapindaceae
Serjania hebecarpa Benth.	Sapindaceae
Serjania laruotteana Cambess.	Sapindaceae
Serjania mansiana Mart.	Sapindaceae
Serjania marginata Casar.	Sapindaceae
Serjania meridionalis Cambess.	Sapindaceae
Serjania multiflora Cambess.	Sapindaceae
Serjania obtusidentata Radlk.	Sapindaceae
Serjania ovalifolia Radlk.	Sapindaceae
Serjania paradoxa Radlk.	Sapindaceae
Serjania pinnatifolia Radlk.	Sapindaceae
Serjania purpurascens Radlk.	Sapindaceae
Serjania reticulata Cambess.	Sapindaceae
Serjania velutina Cambess.	Sapindaceae
Sesbania exasperata Kunth	Fabaceae
Sesbania virgata (Cav.) Pers.	Fabaceae
Setaria parviflora (Poir.) Kerguélen	Poaceae
Setaria scandens Schrad.	Poaceae
Setaria tenacissima Schrad. ex Schult.	Poaceae
Setaria vulpiseta (Lam.) Roem. & Schult.	Poaceae
Sida luschnathiana Steud.	Malvaceae
Sida rufescens A.St.-Hil.	Malvaceae
Sipanea hispida Benth. ex Wernham	Rubiaceae
Siparuna guianensis Aubl.	Siparunaceae
Siphocampylus corymbifer Pohl	Campanulaceae
Siphocampylus macropodus (Thunb.) G.Don	Campanulaceae
Sisyrinchium rectivalvatum Ravenna	Iridaceae
Skeptrostachys gigantea (Cogn.) Garay	Orchidaceae
Smilax campestris Griseb.	Smilacaceae
Smilax elastica Griseb.	Smilacaceae
Smilax fluminensis Steud.	Smilacaceae
Smilax goyazana A.DC.	Smilacaceae
Smilax hilariana A.DC.	Smilacaceae
Smilax minarum A.DC.	Smilacaceae
Smilax polyantha Griseb.	Smilacaceae
Smilax remotinervis Hand.-Mazz.	Smilacaceae
Smilax staminea Griseb.	Smilacaceae
Smilax stenophylla A.DC.	Smilacaceae
Smilax verrucosa Griseb.	Smilacaceae
Soemmeringia semperflorens Mart.	Fabaceae
Solanum asperum Rich.	Solanaceae
Solanum cladotrichum Dunal	Solanaceae
Solanum didymum Dunal	Solanaceae
Solanum incarceratum Ruiz & Pav.	Solanaceae

Species	Family
Solanum leucocarpon Dunal	Solanaceae
Solanum oocarpum Sendtn.	Solanaceae
Solanum schlechtendalianum Walp.	Solanaceae
Solanum scuticum M.Nee	Solanaceae
Solanum subinerme Jacq.	Solanaceae
Solanum turneroides Chodat	Solanaceae
Solidago chilensis Meyen	Asteraceae
Sorghum halepense (L.) Pers.	Poaceae
Sorocea bonplandii (Baill.) W.C.Burger et al.	Moraceae
Spathicarpa gardneri Schott	Araceae
Spathiphyllum gardneri Schott	Araceae
Sphaeropteris gardneri (Hook.) R.M.Tryon	Cyatheaceae
Sphaerorrhiza sarmentiana (Gardner ex Hook.) Roalson & Boggan	Gesneriaceae
Spigelia anthelmia L.	Loganiaceae
Spigelia scabra Cham. & Schltdl.	Loganiaceae
Sporobolus pyramidatus (Lam.) Hitchc.	Poaceae
Stachyarrhena reflexa Standl.	Rubiaceae
Stachytarpheta angustifolia (Mill.) Vahl	Verbenaceae
Stachytarpheta bicolor Hook.f.	Verbenaceae
Stachytarpheta cayennensis (Rich.) Vahl	Verbenaceae
Stachytarpheta mexiae Moldenke	Verbenaceae
Staurogyne diantheroides Lindau	Acanthaceae
Staurogyne hirsuta (Nees) Kuntze	Acanthaceae
Stenodon suberosus Naudin	Melastomataceae
Stigmaphyllon lalandianum A.Juss.	Malpighiaceae
Stigmaphyllon paraense C.E.Anderson	Malpighiaceae
Stomatanthes hirsutus H.Rob.	Asteraceae
Strychnos bicolor Progel	Loganiaceae
Strychnos brasiliensis Mart.	Loganiaceae
Strychnos gardneri A.DC.	Loganiaceae
Strychnos parvifolia A.DC.	Loganiaceae
Strychnos peckii B.L.Rob.	Loganiaceae
Stryphnodendron gracile Heringer & Rizzini	Fabaceae
Stylosanthes grandifolia M.B.Ferreira & Sousa Costa	Fabaceae
Styrax maninul B.Walln.	Styracaceae
Symplocos celastrinea Mart.	Symplocaceae
Symplocos oblongifolia Casar.	Symplocaceae
Symplocos pentandra (Mattos) Occhioni ex Aranha	Symplocaceae
Symplocos tenuifolia Brand	Symplocaceae
Symplocos uniflora (Pohl) Benth.	Symplocaceae
Syngonanthus densiflorus (Körn.) Ruhland	Eriocaulaceae
Tamonea curassavica (L.) Pers.	Verbenaceae
Tarenaya aculeata (L.) Soares Neto & Roalson	Cleomaceae
Tarenaya hassleriana (Chodat) Iltis	Cleomaceae
Tassadia burchellii E.Fourn.	Apocynaceae
Tassadia propinqua Decne.	Apocynaceae
Temnadenia violacea (Vell.) Miers	Apocynaceae

Species	**Family**
Tephrosia domingensis (Willd.) Pers.	Fabaceae
Teramnus uncinatus (L.) Sw.	Fabaceae
Teramnus volubilis Sw.	Fabaceae
Tetracera empedoclea Gilg	Dilleniaceae
Tetrapterys crispa A.Juss.	Malpighiaceae
Tetrapterys discolor (G.Mey.) DC.	Malpighiaceae
Tetrapterys mucronata Cav.	Malpighiaceae
Tetrapterys phlomoides (Spreng.) Nied.	Malpighiaceae
Thryallis parviflora C.Anderson	Malpighiaceae
Tococa guianensis Aubl.	Melastomataceae
Tococa subciliata (DC.) Triana	Melastomataceae
Tocoyena formosa (Cham. & Schltdl.) K.Schum.	Rubiaceae
Tradescantia zanonia (L.) Sw.	Commelinaceae
Trichanthecium cyanescens (Nees ex Trin.) Zuloaga & Morrone	Poaceae
Trichanthecium distichophyllum (Spreng.) Zuloaga & Morrone	Poaceae
Trichanthecium parvifolium (Lam.) Zuloaga & Morrone	Poaceae
Trichanthecium schwackeanum (Mez) Zuloaga & Morrone	Poaceae
Trichomanes accedens C.Presl	Hymenophyllaceae
Trichomanes arbuscula Desv.	Hymenophyllaceae
Trichomanes cristatum Kaulf.	Hymenophyllaceae
Trichomanes hostmannianum (Klotzsch) Kunze	Hymenophyllaceae
Trichomanes pilosum Raddi	Hymenophyllaceae
Trichomanes pinnatum Hedw.	Hymenophyllaceae
Trigonia nivea Cambess.	Trigoniaceae
Trigonia paniculata Warm.	Trigoniaceae
Tripogandra diuretica (Mart.) Handlos	Commelinaceae
Triumfetta semitriloba Jacq.	Malvaceae
Tropaeolum warmingianum Rohrb.	Tropaeolaceae
Turbina cordata (Choisy) D.F.Austin & Staples	Convolvulaceae
Turbina corymbosa (L.) Raf.	Convolvulaceae
Turnera bahiensis Urb.	Turneraceae
Turnera blanchetiana Urb.	Turneraceae
Turnera candida Arbo	Turneraceae
Turnera coerulea DC.	Turneraceae
Turnera dichotoma Gardner	Turneraceae
Turnera diffusa Willd. ex Schult.	Turneraceae
Turnera foliosa Urb.	Turneraceae
Turnera hermannioides Cambess.	Turneraceae
Turnera hilaireana Urb.	Turneraceae
Turnera longiflora Cambess.	Turneraceae
Turnera melochioides Cambess.	Turneraceae
Turnera oblongifolia Cambess.	Turneraceae
Turnera opifera Mart.	Turneraceae
Turnera orientalis (Urb.) Arbo	Turneraceae
Turnera trigona Urb.	Turneraceae
Turnera weddelliana Urb. & Rolfe	Turneraceae
Uncaria guianensis (Aubl.) J.F.Gmel.	Rubiaceae

Species	**Family**
Urera caracasana (Jacq.) Griseb.	Urticaceae
Urospatha edwallii Engl.	Araceae
Urospatha sagittifolia (Rudge) Schott	Araceae
Utricularia laciniata A.St.-Hil. & Girard	Lentibulariaceae
Utricularia trichophylla Spruce ex Oliv.	Lentibulariaceae
Utricularia tricolor A.St.-Hil.	Lentibulariaceae
Vanilla chamissonis Klotzsch	Orchidaceae
Vanilla edwallii Hoehne	Orchidaceae
Vanilla palmarum (Salzm. ex Lindl.) Lindl.	Orchidaceae
Varronia polycephala Lam.	Boraginaceae
Verbesina glabrata Hook. & Arn.	Asteraceae
Verbesina sordescens DC.	Asteraceae
Vernonanthura beyrichii (Less.) H.Rob.	Asteraceae
Vernonanthura montevidensis (Spreng.) H.Rob.	Asteraceae
Vismia brasiliensis Choisy	Hypericaceae
Vismia micrantha A.St.-Hil.	Hypericaceae
Voyria aphylla (Jacq.) Pers.	Gentianaceae
Waltheria communis A.St.-Hil.	Malvaceae
Waltheria indica L.	Malvaceae
Waltheria operculata Rose	Malvaceae
Waltheria vernonioides R.E.Fr.	Malvaceae
Waltheria viscosissima A.St.-Hil.	Malvaceae
Wedelia souzae H.Rob.	Asteraceae
Wilbrandia hibiscoides Silva Manso	Cucurbitaceae
Wullschlaegelia aphylla (Sw.) Rchb.f.	Orchidaceae
Xanthosoma riparium E.G.Gonç.	Araceae
Xanthosoma syngoniifolium Rusby	Araceae
Xylophragma myrianthum (Cham.) Sprague	Bignoniaceae
Zizaniopsis microstachya (Nees ex Trin.) Döll & Asch.	Poaceae

CAPÍTULO 2. Fatores ambientais, composição, diversidade e estrutura de comunidades vegetais de sub-bosque em matas de galeria e cerrado *sensu stricto*

Environmental factors, composition, diversity, and structure of understory plant communities in gallery forests and the cerrado vegetation

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Abstract

The Cerrado biome exhibits diverse vegetation influenced by different environmental factors, including topography, soil water availability, physicochemical soil properties, and soil depth. These variables affect the richness and abundance of woody and herbaceous shrub species in different habitats, shaping their structure. In this study, we compared species richness, cover, and life form in the understory of two contrasting Cerrado habitats, gallery forests and cerrado *sensu stricto*. Additionally, we investigated the influence of canopy openness, litter quantity, and physicochemical soil properties on species distribution. We found a contrast between gallery forest and cerrado *sensu stricto* habitats, with significant variations in species composition, richness, and life form cover. Gallery forests exhibited higher shrub species cover and richness, whereas cerrado *sensu stricto* showed greater grass cover and subshrub richness. Furthermore, gallery forests displayed higher floristic similarity, more fertile soils, and higher sand and litter content. In contrast, cerrado *sensu stricto* sites were floristically more distinct among them and presented greater canopy openness and clay and silt soil content. Canopy openness and silt were positively correlated with species cover in the understory of cerrado *sensu stricto*. In contrast, phosphorus, calcium, aluminum, and potassium were correlated with species cover in gallery forests. This research contributes to filling gaps in the understanding of patterns of the Cerrado herbaceous-shrub layer, particularly gallery forests' floor plants, highlighting their differences in composition and environmental responses. Our findings underscore the importance of comprehensive studies encompassing all vegetation strata to guide Cerrado conservation and restoration initiatives.

Keywords: Forest floor plants, life forms, riparian forest, tropical forests, savanna, soil.

INTRODUCTION

Environmental factors are among the main drivers shaping the diversity and structure of plant communities globally (Tilman et al. 1997; Hubbell 2001). These factors can be linked to variations in climate, topography, and soil characteristics, acting as environmental filters that influence species distribution at different spatial scales (Huston

1999; John et al. 2007; Sagar et al. 2012; Azihou et al. 2013; Rodrigues et al. 2019). The Cerrado, located in the central region of Brazil, is one of the world's richest savannas (Mendonça et al. 2008). Its diversity is associated with regional and local factors, such as soil type, climatic gradients, and contact with other biomes at the regional level (Amaral et al. 2017; Françoso et al. 2019) and, at the local level, factors such as variations in soil physicochemical conditions, soil moisture, relief, and topography are the main drivers generating the mosaic of vegetation types in the Cerrado (Furley and Ratter 1988; Oliveira-Filho et al. 1989; Ribeiro and Walter 2008). Fire and canopy cover also play a significant role in shaping vegetation types, acting mainly on the boundaries between forests and savannas in the Cerrado (Hoffmann et al. 2012). The vegetation gradient of the Cerrado includes open savannas, primarily represented by cerrado *sensu stricto* (hereafter called simply cerrado), with tree cover ranging from 5 to 20%. Interspersed within the open vegetation formations are narrow strips of gallery forests with tree cover ranging from 70% to 95% (Ribeiro and Walter 2008). Transitions between savanna and forest formations can occur abruptly, leading to changes in species composition and vegetation structure (Felfili and Silva Júnior 1992; Lenza et al. 2015).

Gallery forests are evergreen forests associated with small rivers and streams and grow on mesotrophic soils (Veneklaas et al. 2005; Ribeiro and Walter 2008). They play a fundamental role in the conservation of soil, water, and biogeochemical cycles in the Cerrado (Parron et al. 2011). The species composition of this ecosystem is primarily influenced by soil organic matter, bulk density, topography, and annual fluctuation in the water table depth, which directly impacts soil drainage and water regime (Sampaio et al. 2000; Veneklaas et al. 2005). Cerrado *sensu stricto* is characterized by a continuous herbaceous-subshrub layer and a discontinuous brevi-deciduous woody vegetation over dystrophic and predominantly deep and drier soils (Ribeiro and Walter 2008). Gallery forest and cerrado *sensu stricto* habitats are quite distinct; shading in the forest causes complex ecological implications, both biotic and abiotic, at the plant community and ecosystem levels (Sampaio et al. 2000; Hoffmann et al. 2012; Valladares et al. 2016). In the cerrado, in addition to soil, fire is one of the main shaping factors (Hoffmann et al. 2012). Gallery forests are more humid and fertile and have a higher organic matter content than the cerrado (Furley 1992; Haridasan 1998; Silva et al. 2008). These environmental variations act as filters, influencing the composition and structure of communities by selecting plant assemblages adapted to each of these habitats (Amaral et al. 2021; Lenza et al. 2022).

Studies conducted in the Cerrado indicate that variations in the structure and species composition of tree communities between savanna and forested vegetation types are primarily associated with changes in soil physicochemical properties, water availability, relief, and topography (e.g., Moreno and Schiavini 2001; Carvalho et al. 2005; Gonçalves et al. 2011; Carvalho et al. 2013; Loschi et al. 2013). However, assessments of environmental factors that determine the differentiation of the composition and structure of the herbaceous-shrub layer in gallery forests are scarce (Tavora et al. 2023). In the cerrado, the diversity and distribution of the herbaceous-shrub layer are closely linked to soil and spatial components, as well as to fire (Simon et al. 2009; Amaral et al. 2022). In gallery forests, the herbaceous-shrub understory plays crucial roles, encompassing interactions and maintenance of tree species and conservation of soil nutrients. Additionally, it is a stratum more sensitive to environmental disturbances (Gilliam 2007), so it can serve as an indicator of the conservation status of the forest habitat as a whole.

In 2019, the United Nations (UN) declared the period from 2021 to 2030 as the decade of ecosystem restoration, with the primary objective of urgently accelerating global efforts to restore degraded ecosystems. This initiative aims to address the pressing challenges of global warming and safeguard the planet's biodiversity (Seddon et al. 2020; Fuchs and Noebel 2022). For the open vegetation of the Cerrado, research focusing on the herbaceous-shrub layer has gained increased importance in recent decades, emphasizing the significance of this component, particularly for restoration efforts (Buisson et al. 2019; Pilon et al. 2023). However, in the Cerrado, studies specifically targeting the understory of gallery forests are rare (Tavora et al. 2023). Improving research on the composition and structure patterns of this vegetation stratum is crucial for developing conservation strategies and establishing restoration and management goals. These efforts play a pivotal role in maintaining ecosystem balance and preserving the high diversity of the Cerrado. This approach aligns with the goals set by the UN (Verdone and Seidl 2017; Bustamante et al. 2019). The different life forms may also require tailored management and conservation strategies, even within the same community (Murphy et al. 2016). This emphasizes the imperative to study non-arboreal strata, to understand their functioning, and to incorporate them into holistic management and conservation strategies.

This study aimed to describe and compare the environmental properties, richness, diversity, composition, cover, and life forms of species in the lower stratum of the contrasting gallery forest and cerrado vegetation types. We also assessed the influence of edaphic factors, canopy openness, and litter quantity on the distribution of plant species inhabiting the understory in these habitats. Gallery forests and cerrado often occur adjacent to each other but exhibit significant differences in the amount of light reaching the understory and in the physicochemical characteristics of the soil (Rodrigues et al. 2019). This environmental variation selects distinct species adapted to each vegetation type (Tilman et al. 1997; Amaral et al. 2021). Therefore, we expected environmental variables to affect the composition and structure of communities differently, as well as the selection of the predominant life forms of the herbaceous-shrub layer in each vegetation type.

MATERIAL AND METHODS

Study areas

This study was conducted in adjacent pairs of gallery forest and cerrado sites located in different areas in central Brazil (Fig. 1). In the Federal District, they are located at Fazenda Água Limpa (FAL), which is part of the Environmental Protection Area of the Gama and Cabeça de Veado basins (15°57'05.0" S, 47°58'04.5"W), and the Fazenda Sucupira (SUC), which belongs to the scientific and technological center of the Brazilian Agricultural Research Corporation (Embrapa) (15°54'12.9" S, 48°00'50.1" W). In the state of Goiás, the sites are located in the Silvânia National Forest (SIL) (16°38'02.7"S 48°40'03.1"W), and the Fazenda Oréades (ORE) private landholding (14°13'26.0"S 47°54'54.9"W), where native vegetation is preserved by the owner. The climate of the studied areas is seasonal tropical of the Aw type, according to the Köppen classification, with well-defined seasons marked by a hot and rainy season occurring from October to April and a cold and dry season from May to September. Annual rainfall is between 1,500 and 1,790 mm on average (INMET 2020).

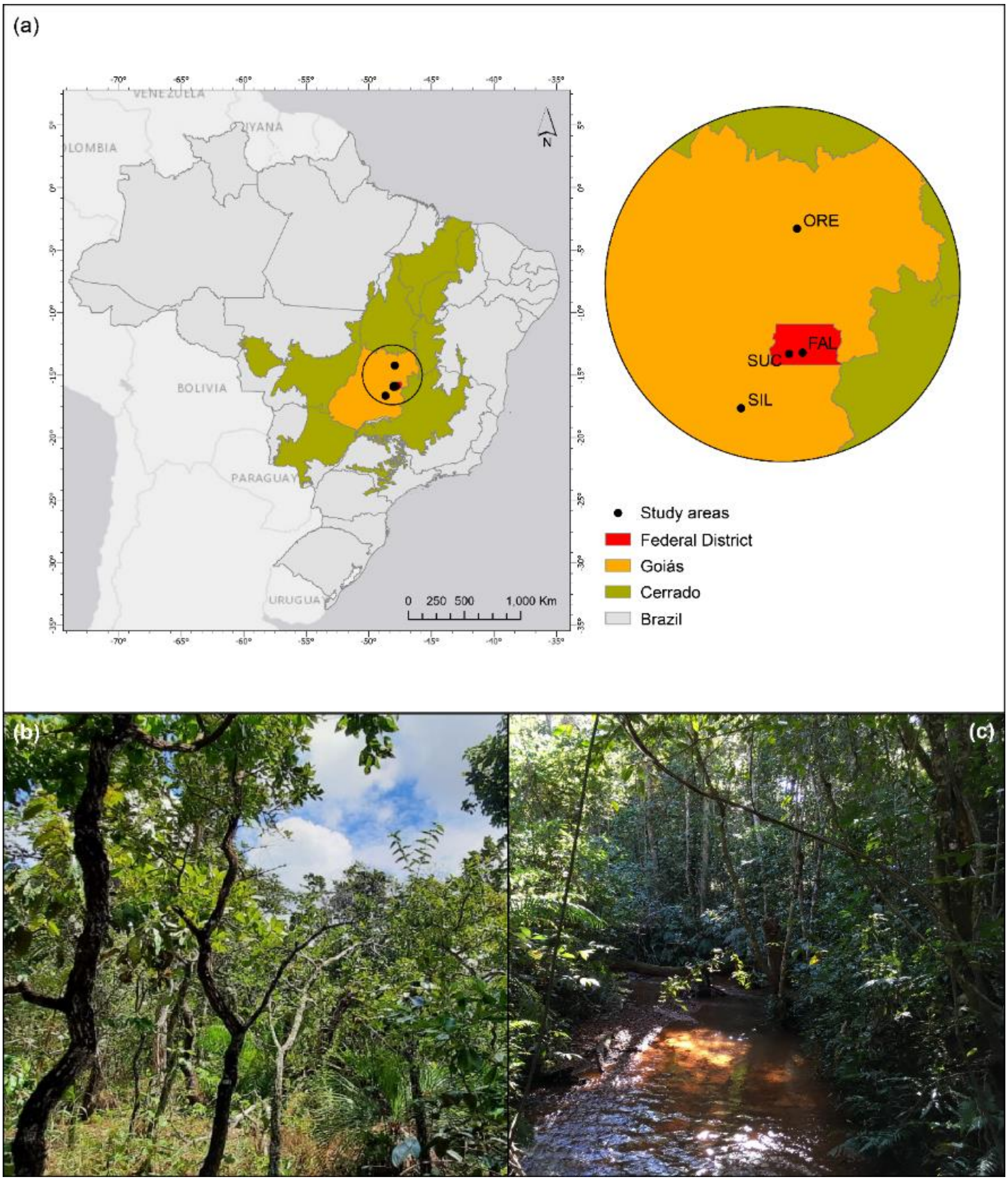

Fig. 1 (a) Locations of adjacent pairs of cerrado (b) and gallery forest (c) in the state of Goiás and the Federal District. FAL: Fazenda Água Limpa; SUC: Fazenda Sucupira; SIL: Silvânia National Forest; ORE: Fazenda Oréades.

Vegetation Sampling

Vegetation sampling was conducted in 2019 and 2020 during the rainy season. We determined the composition and horizontal projection of the herbaceous-shrub species of the understory in gallery forests and cerrado using the line intersection method (Canfield

1941; Munhoz and Araújo 2011). We installed 20 30-m line transects in all areas, ten in the cerrado and ten in the adjacent gallery forest. The transects were systematically distributed in uniform plots of gallery forest and cerrado vegetation, with the first line randomly drawn and the subsequent ones placed at a minimum distance of 50 m from each other (Appendix Fig. S1). Each transect was considered a sampling unit, where a millimeter measuring tape was extended and placed 50 cm above the ground. The horizontal projection of each species' intersection length was recorded below and above the tape (Cummings and Smith 2000). In the gallery forest, the lines were alternately arranged between the two outer edges and the middle, aiming to equally represent the vegetation gradient from the stream margins to the forest edge (Appendix Fig. S1). In total, 80 30-m line transects were sampled, 40 in each vegetation type.

Only species that remain in the understory throughout their life cycle, including shrubs, subshrubs, herbs, vines, and non-woody bamboo, were considered during sampling. Tree species at the seedling stage were excluded after taxonomic identification and confirmation of their life form by consulting botanical experts and the Flora e Funga do Brasil (2023) database. Records of the horizontal projection of each species were used to calculate absolute and relative cover (Cummings and Smith 2000; Munhoz and Araújo 2011). Absolute cover was calculated by summing the total length intercepted by the species in the ten line transects of each sampling site. Relative cover of each species was estimated by dividing the absolute cover of the species by the sum of the absolute cover of all species in the ten line transects, multiplied by 100. Absolute and relative richness were calculated following the same principle but based on the number of line transects where each species occurred.

Species identification was carried out using specific literature, consultation with botanical family experts, and comparison with specimens identified by experts on an online repository (https://specieslink.net/). The botanical material was collected and deposited in the UB Herbarium. Names of species, families, and authors were corrected and synonymized using the “flora” package version 0.3.4 (Carvalho 2020) in the R environment v.4.2.2 (R Core Team 2022), which contains all accepted botanical names and their synonyms from Flora e Funga do Brasil (2020).

We classified the life forms of the sampled species into six categories (adapted from Dansereau 1951), based on plant architecture and environmental occupation, as follows: shrubs (including small palms and caulescent ferns), subshrubs, herbs (including non-caulescent ferns), graminoids (Poaceae and Cyperaceae), bamboo (medium-sized

Poaceae from the Bambusoideae subfamily), and vines (including non-woody or semi-woody herbaceous climbing plants).

Environmental variables

We collected soil samples (0 to 20 cm deep) at the center of each 30-m line transect. Soil texture was determined using the Bouyoucos densimetric method. Soil pH was measured using a 0.01 mol L^{-1} $CaCl_2$ solution ($CaCl_2$ pH), and the percentage of organic matter was determined using the Walkley–Black method (% organic C × 1.724). The cations Ca^{2+}, Mg^{2+}, and Al^{3+} were extracted with a 1 mol L^{-1} KCl solution, while K^+, Na^+, and P^+ were extracted with a $Mehlich^{-1}$ solution (0.0125 mol L^{-1} H_2SO_4 + 0.05 mol L^{-1} HCl). Soil samples were analyzed following the Embrapa protocol (2017).

Canopy openness proportion was calculated from hemispherical photographs taken with a fisheye lens and a digital camera. On cloudy days, photographs were taken in the morning at the center of each 30-m line transect. The images were analyzed using the gap light analyzer, Version 2.0 (Frazer et al. 1999), which provides canopy structure data regarding openness percentage. The Marimon-Hay collector-meter (Marimon-Junior and Hay 2008) was used to measure litter layer thickness. This device collects a litter sample on the ground and determines its thickness, which we used as an estimate of litter quantity. We used the average of the samples collected at three points (5 m, 15 m, and 25 m) within each line transect. All environmental variables were collected at the beginning of the rainy season when the litter layer had not yet decomposed, and most deciduous tree species had regrown leaves lost during the dry season.

Data analysis

We used a Venn diagram to visualize the sharing of families, genera, and species of the herbaceous-shrub layer between the forest and cerrado habitats. For this analysis, we used a species presence and absence matrix per sampling unit in each studied site. To assess the difference in cover and richness of life forms both between gallery forest and cerrado habitats and among the four gallery forest sites and the four cerrado sites, we applied a nested ANOVA (Zar 2010) to account for the nested effect of sampling units within each vegetation type. We fitted the nested ANOVA using linear mixed models where life forms were treated as fixed factors within each vegetation type, and sampling units as random effect factors. We applied a log-transformation [log(x+1.1)] to the data to meet assumptions of variance stability and normality. To compare values and determine the significance of differences, we applied a Tukey test. We utilized the ‘lme’ function to run the model, and for the nested ANOVA, we used the 'anova.lme' function, both available in the “nlme” package version 3.1 (Pinheiro et al. 2022).

To capture the gradient of species composition and floristic distances between sites in a multidimensional space, we performed a principal coordinate analysis (PCoA). We used the Bray-Curtis dissimilarity index (Legendre and Legendre 2012) with trymax = 100 and the matrix of absolute species cover per sampling unit for each site. For this analysis, we employed the ‘cmdscale’ function from the “vegan” package (Oksanen et al. 2022).

To compare the physicochemical properties of the soil, canopy openness proportion, and litter thickness between gallery forest and cerrado sites, we utilized the Kruskal-Wallis test after confirming that the data did not meet the assumptions of homogeneity and normality of residuals. We used regression models to understand how soil physicochemical properties, litter quantity, and canopy openness affect species richness and cover between vegetation types. We used as response variables the species absolute cover per sampling unit translated into scores of the first axis of the PCoA and calculated the correlation matrix with environmental variables (Appendix Fig. S2; Tables S1 and S2) using the ‘rquery.cormat’ function from the “corrplot” package (Wei and Simko 2021). We excluded variables with low values of statistical correlation ($P<0.05$) and biological correlation ($r<0.3$) from this matrix. At this step, soil pH and litter variables were excluded (Tables S1 and S2). Next, we checked for the presence of collinearity among the remaining variables based on the variance inflation factor (VIF) (Quinn and Keough 2002), applying a cutoff threshold of 10 using the ‘vifstep’ function from the “usdm” package (e.g., Borcard et al. 2011). The variables removed due to collinearity were clay, sand, base saturation, and magnesium. The remaining variables (Table S3) were used in the generalized linear model (GLM) using the Gaussian family, which is recommended for continuous data (Zuur et al. 2009). We used the first axis of the PCoA as the response variable and the selected environmental variables as predictor variables. We used the ‘dredge’ function from the “MuMIn” package to select the best model. Models were ranked by the Akaike Information Criterion (AICc) and delta AICc < 2. We confirmed the assumption of residual normality visually (Appendix Fig. S3) and by a Shapiro-Wilk test ($P = 0.949$). The model exhibited an $R^2 = 0.82$. We checked for spatial autocorrelation in the residuals using the Moran correlogram using the ‘correlog’ function from the “pgirmess” package, applying a Bonferroni correction. None of the value classes showed significant autocorrelation after the Bonferroni correction for p-values ($P >$ 0.025) (Table S4). To fit the model’s selected environmental variables to the PCoA, we used the ‘envfit’ function from the “vegan” package (Oksanen et al. 2022), using the matrix with score values for each axis per sampling unit and the matrix with values of the selected environmental variables.

All analyses were conducted in the R environment (version 4.2.2; R Core Team 2022). A significance level of 5% was considered for all statistical tests.

RESULTS

We sampled 535 species, 258 genera, and 75 families, with 377 species (177 genera, 55 families) in the cerrado and 170 species (115 genera, 53 families) in the gallery forest. The sharing of species and genera is low between vegetation types (2.2% and 13.2%, respectively), but they exhibited more shared families than exclusive ones (Fig. 2).

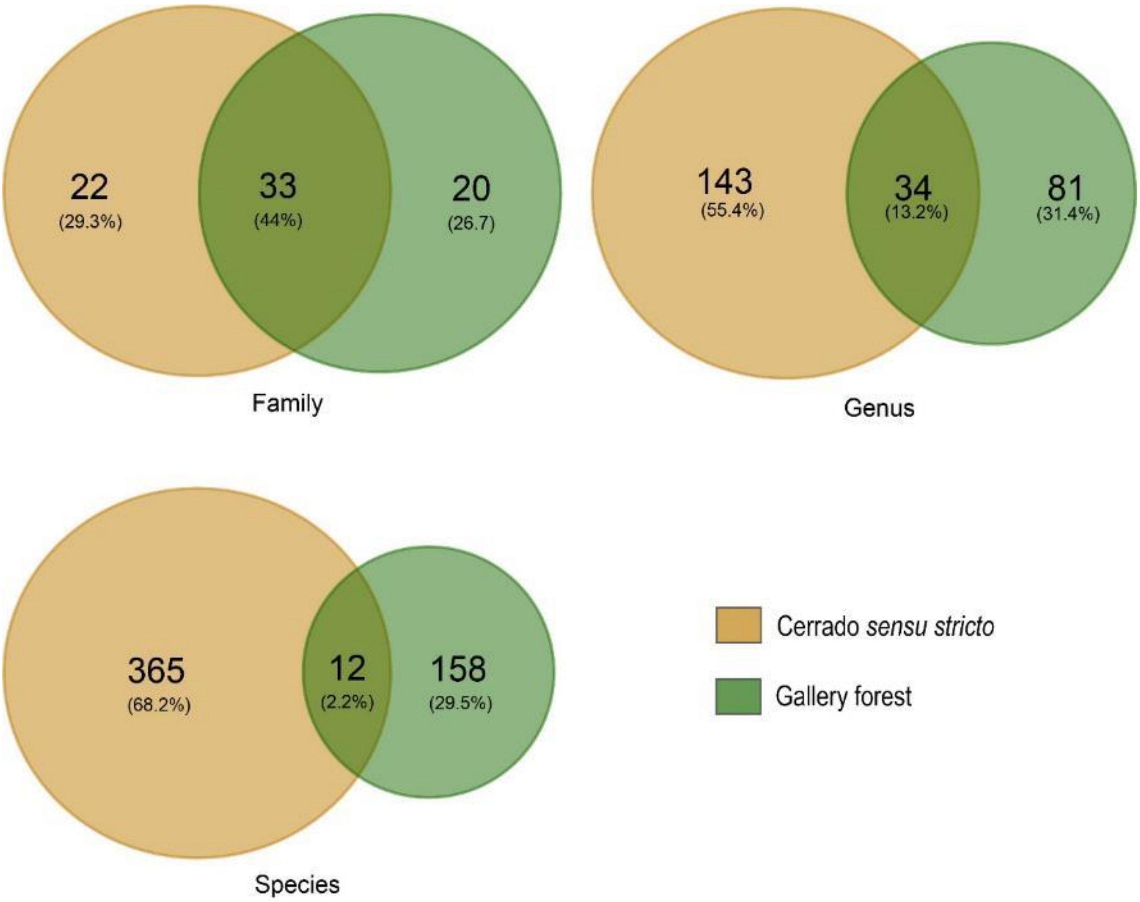

Fig. 2 Sharing of species, genera, and families between gallery forest and cerrado *sensu stricto* habitats.

Bamboo was exclusive to gallery forests, while graminoid species and subshrubs showed significantly higher cover and relative richness in cerrado *sensu stricto*. Despite having higher relative cover in gallery forests, shrubs differed between habitats only in terms of richness (Table 1). Herbs and vines did not show significant differences in richness and cover between the gallery forest and the cerrado (Table 1). Subshrubs exhibited higher relative richness in cerrado *sensu stricto* (42%), while in gallery forests, shrubs dominated, with 52% of the richness (Table 1).

Table 1 Relative cover and relative richness of life forms in gallery forest and cerrado *sensu stricto* habitats

	cerrado *sensu stricto*	gallery forest	F value	*P*-value
Relative cover				
Shrubs	23.72±542.52	49.84±584.06	0.151	0.69
Bamboos	0.00±0.00	0.46±30.64	4.91	**0.03**

Herbs	0.51±29.69	5.61±215.86	2.71	0.11
Graminoids	56.01±797.97	34.17±628.55	45.03	**0.00**
Subshrubs	16.43±485.27	2.74±94.65	192.55	**0.00**
Vines	3.29±152.10	7.15±177.71	2.22	0.14
Relative richness				
Shrubs	34.01±4.00	52.25±2.81	55.36	**0.00**
Bamboos	0.00±0.00	0.72±0.33	5.57	**0.02**
Herbs	2.59±0.80	10.48±2.07	0.74	0.39
Graminoids	15.53±1.83	16.59±1.46	123.78	**0.00**
Subshrubs	42.15±6.50	5.67±1.00	995.48	**0.00**
Vines	5.71±2.20	14.26±1.58	0.33	0.56

Cover/Relative richness ± standard deviation (cerrado *sensu stricto* n=40, gallery forest n=40). Significance obtained from a Kruskal–Wallis test ($P < 0.05$).

When comparing gallery forest sites, we found that graminoids and vines were the only life forms not to show significant differences in species richness. On the other hand, among cerrado sites, only herbs exhibited no difference, both in cover and richness. All other life forms showed significant differences in the average values of cover and richness between sites (Tables 2 and 3).

Table 2 Cover and relative richness of life forms in gallery forest sites

	FAL	SUC	SIL	ORE	F value	*P*-value
Relative cover						
Shrubs	53.76±1.87^{a}	40.05±1.17^{b}	69.27±2.36^{ab}	33.32±2.23^{c}	17.29	**0.00**
Bamboos	0.00±0.00^{b}	0.26±0.08^{a}	2.29±0.45^{a}	0.00±0.00^{b}	3.31	**0.03**
Herbs	0.30±0.06^{b}	1.41±0.23^{b}	9.30±2.30^{b}	23.69±2.52^{a}	11.11	**0.00**
Graminoids	34.55±2.00^{a}	52.59±3.75^{ab}	14.00±1.98^{c}	24.50±2.34^{bc}	5.93	**0.00**
Subshrubs	2.69±0.28^{a}	0.46±0.06^{b}	0.29±0.04^{b}	9.67±1.40^{a}	5.68	**0.00**
Vines	8.70±0.98^{a}	5.22±0.52^{b}	4.85±0.60^{b}	8.82±0.63^{ab}	4.28	**0.01**
Relative richness						
Shrubs	62.11±1.05^{a}	54.05±1.15^{bc}	60.76±1.04^{ab}	34.03±1.44^{c}	9.26	**0.00**
Bamboos	0.00±0.00^{b}	0.68±0.21^{a}	2.53±0.33^{a}	0.00±0.00^{b}	4.44	**0.01**
Herbs	2.11±0.37^{b}	4.73±0.33^{b}	8.86±0.80^{b}	24.61±0.93^{a}	22.85	**0.00**
Graminoids	15.26±0.58^{a}	20.27±0.90^{a}	12.66±0.73^{a}	18.32±0.99^{a}	2.23	0.11
Subshrubs	8.42±0.62^{a}	3.38±0.48^{b}	3.16±0.45^{b}	6.81±0.50^{ab}	3.83	**0.02**

Vines	12.11±0.66^{a}	16.89±1.20^{a}	12.03±1.17^{a}	16.23±0.72^{a}	1.64	0.21

Cover/Relative richness ± standard deviation. Significance obtained from a Kruskal-Wallis test ($P < 0.05$). Cerrado *sensu stricto* n=40, gallery forest n=40. Different letters following values in the same row indicate significant differences ($P \leq 0.05$) in a Tukey's *post hoc* test.

Table 3 Cover and relative richness of life forms in cerrado *sensu stricto* sites

	FAL	SUC	SIL	ORE	F value	*P*-value
Relative cover						
Shrubs	19.89±0.96^{b}	27.91±0.45^{b}	16.17±0.81^{c}	26.95±0.73^{a}	27.21	**0.00**
Herbs	0.19±0.02^{a}	0.25±1.50^{a}	0.63±1.50^{a}	0.79±1.50^{a}	1.95	0.14
Graminoids	63.06±2.02^{ab}	57.38±1.50^{b}	68.49±2.79^{b}	46.10±1.46^{a}	3.71	**0.02**
Subshrubs	16.77±0.86^{b}	13.72±0.54^{b}	7.24±0.32^{c}	21.52±0.59^{a}	37.87	**0.00**
Vines	0.08±0.00^{c}	0.74±0.10^{b}	7.47±0.19^{a}	4.64±0.32^{a}	48.57	**0.00**
Relative richness						
Shrubs	29.53±0.66^{bc}	43.62±0.75^{a}	36.41±0.86^{bc}	27.78±0.27^{b}	15.09	**0.00**
Herbs	2.33±0.19^{a}	2.24±0.15^{a}	3.43±0.22^{a}	2.51±0.17^{a}	0.59	0.62
Graminoids	19.69±0.39^{ab}	11.86±0.35^{c}	16.62±0.33^{bc}	14.87±0.27^{a}	8.93	**0.00**
Subshrubs	47.67±0.95^{b}	39.82±0.65^{b}	31.13±0.93^{c}	47.67±0.91^{a}	26.65	**0.00**
Vines	0.78±0.13^{c}	2.46±0.20^{b}	12.40±0.18^{a}	7.17±0.36^{a}	38.18	**0.00**

Cover/Relative richness ± standard deviation. Significance obtained from a nested ANOVA test ($P < 0.05$). Cerrado *sensu stricto* n=40, gallery forest n=40. Different letters following values in the same row indicate significant differences ($P \leq 0.05$) in a Tukey's post hoc test.

The environmental variables from gallery forest and cerrado habitats showed significant differences, apart from aluminum and pH (Fig. 3). Gallery forest soils exhibited higher values of nutrients (Ca, K, P, and cation exchange capacity), organic matter, sand, and litter. In contrast, cerrado showed higher values of clay, silt, and canopy openness (Fig. 3).

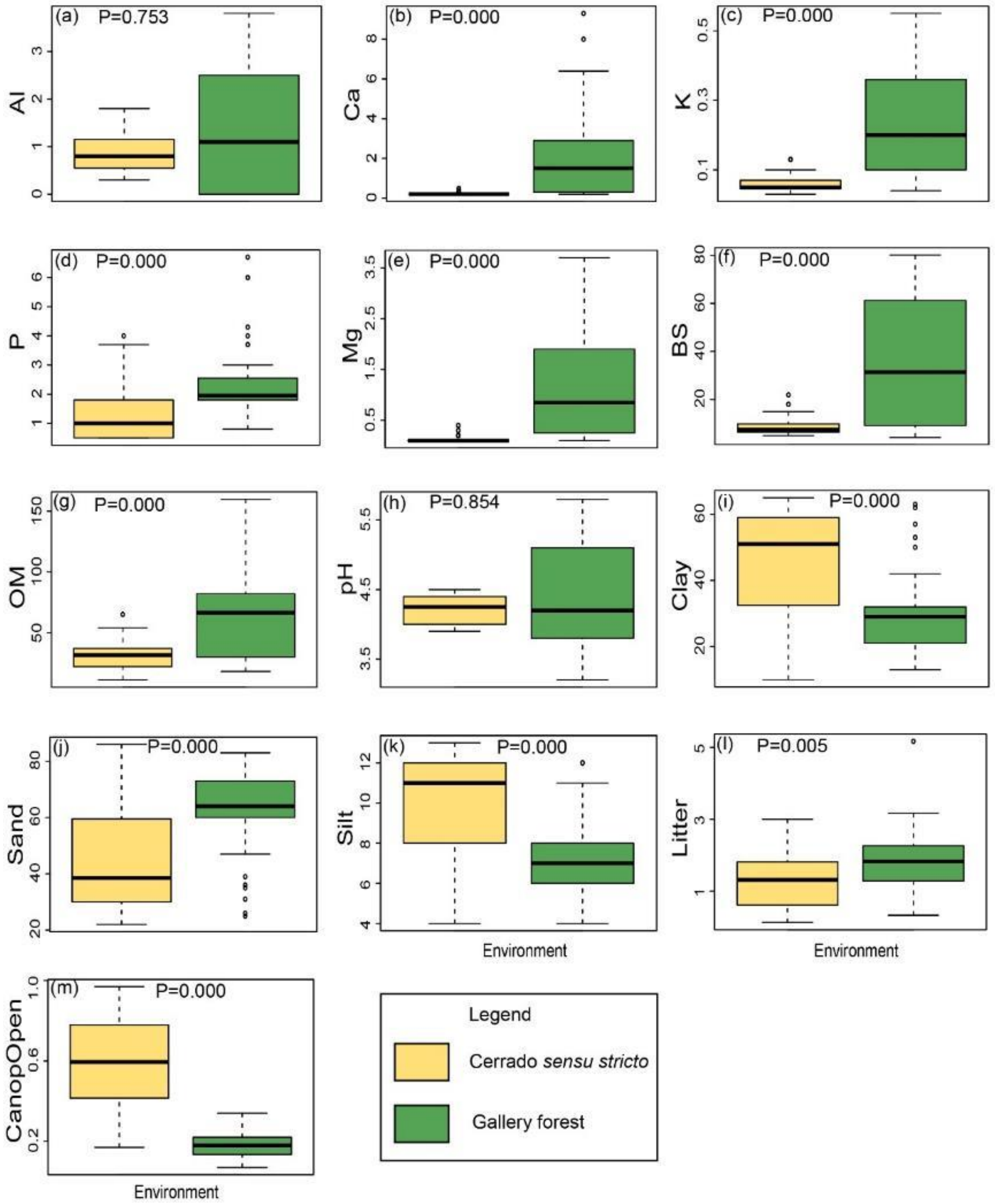

Fig. 3 Box plots of soil physicochemical properties, litter, and canopy openness in gallery forest and cerrado *sensu stricto* habitats. Significance values ($P < 0.05$) obtained from a Kruskal-Wallis test. Cerrado *sensu stricto* n = 40, gallery forest n = 40. BS: Base saturation; OM: Organic Matter; CanopOpen: Canopy openness.

The GLM results indicated that aluminum, calcium, potassium, phosphorus, silt, and canopy openness are significant predictors of species cover in cerrado *sensu stricto* and gallery forests (Table 4), accounting for 82% of the variation in species cover (Rsquared=0.82). Principal coordinate analysis separated cerrado and gallery forest sites into distinct groups (Fig. 4), with the gallery forest sites being more like each other than the cerrado sites. (Fig. 4). Canopy openness and silt were positively correlated with cover in cerrado, while aluminum, calcium, potassium, and phosphorus were positively correlated with species cover in the gallery forest (Fig. 4).

Table 4 Generalized Linear Model (GLM) fitted to explain floristic variation in gallery forest and cerrado *sensu stricto* habitats and its relationship with selected environmental variables. Significant differences P < 0.05. CanopOpen: Canopy openness

	Estimate	Std.Error	*t* value	*P*
(Intercept)	2.25E-18	1.44e-02	0	1
Aluminium	9.07E-02	2.22e-02	4.083	**0.000**
Calcium	4.78E-02	2.17e-02	2.204	**0.035**
CanopOpen	-7.48E-02	2.03e-02	-3.687	**0.000**
Potasium	9.51E-02	1.90e-02	4.997	**0.000**
Phosphorus	6.14E-02	2.13e-02	2.887	**0.012**
Silt	-8.81E-02	1.89e-02	-4.654	**0.000**

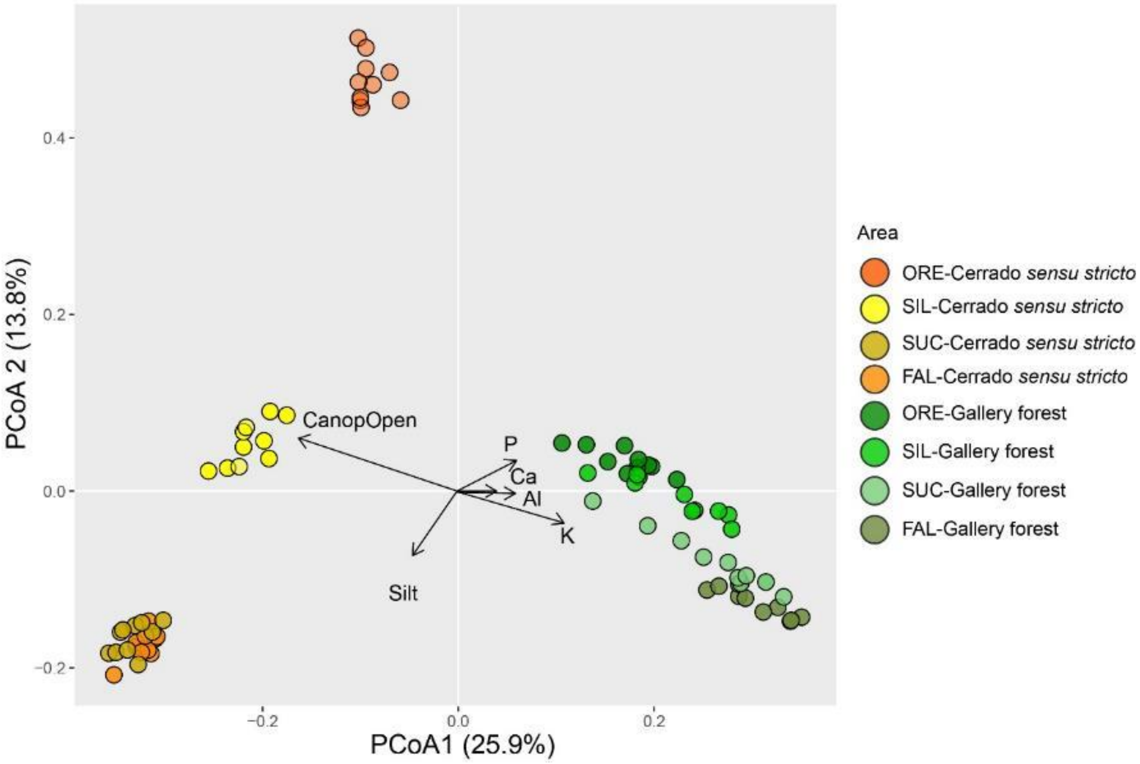

Fig. 4 Principal Coordinate Analysis (PCoA) of the 80 sampled transects from gallery forest and cerrado *sensu stricto* habitats based on species absolute cover and their correlations with variables selected by the model.

DISCUSSION

We observed the evident contrast between gallery forest and cerrado habitats, showcasing a clear distinction in the composition and structure of the herbaceous-shrub layer in these habitats, with varying proportions of life form cover and richness. Some similarities among the most abundant species can be found in other contrasting ecosystems (Singh et al. 2017); for instance, in the tree stratum of gallery forests and cerrado, there is a higher degree of species sharing (Mendonça et al. 2008; Lenza et al. 2015; Flora e Funga do Brasil 2023), albeit fewer species, than observed in the understory. Therefore, the understory appears to be a more distinct layer characterized by an almost complete turnover in species composition.

The contrast in environmental characteristics between forests and open vegetation may favor specific types of life forms over others (Wright et al. 2007), as observed in our study, where graminoid species accounted for more than half of the cover in cerrado (56%), while in gallery forests, shrubs had higher cover (49%). The higher richness and cover of herbaceous-shrub species in cerrado habitats were expected (Mendonça et al. 2008; Flora e Funga do Brasil 2023). Other studies have also shown the richness and abundance of graminoids and subshrubs in cerrado (Sousa et al. 2021). The presence of fire-adapted structures in herbaceous-shrub species of cerrado and the scarcity of water in the soil contribute to their dominance in this vegetation type (Moraes et al. 2016; Pilon et al. 2021). Characteristics such as the presence of the C_4 photosynthetic pathway in graminoid species, which are more common in open cerrado vegetation (Amaral et al. 2021), are advantageous in terms of water use efficiency, especially in habitats with high solar radiation (Edwards et al. 2010), which is the case in Cerrado habitats. In gallery forests, shrubs emerge as the life form with the highest cover and richness, characterized by greater height and branching architecture, facilitating efficient light capture. Most graminoid species in gallery forests exhibit branching structures and prostrate growth, such as stolons (Oliveira et al. 2016; Filgueiras 2021), which also assist in occupying the environment and capturing light. This characteristic contributes to graminoids ranking as the second highest in both cover (23%) and richness (16%) within the studied forests, surpassed only by shrubs.

We found that cerrado sites were more floristically distinct from each other than gallery forest sites. This may have occurred because cerrado occurs in a variety of soil types, including Latosoil, Quartzipsamment, and Litholic Neosols, which influence the composition and structure of the vegetation (Lira-Martins et al. 2022; Viana et al. 2023). Soil type is one of the leading environmental factors responsible for the distribution patterns of herbaceous-shrub species (Amaral et al. 2022). Furthermore, in open Cerrado formations, variations in the frequency of fires can determine differences in the herbaceous-shrub layer (Rodrigues and Fidelis 2022). Therefore, in cerrado, the heterogeneity of edaphic factors and water and fire regimes affect the environment, creating more filters and niches and making the flora of different locations more distinct. Also, historical events of expansion and retraction of tropical forests created refuges of gallery forests that remained connected in Brazil's central region (Oliveira-Filho and Ratter 1995), which may help explain why they exhibit fewer differences in species richness (Fig. 4). Additionally, the milder characteristics of gallery forests, with higher water and nutrient availability (Silva et al. 2008) and fewer fire events (Hoffmann et al. 2012), can create a more homogeneous environment, allowing for greater sharing of species. Other studies have also found similarities in the composition of herbaceous and woody species among gallery forests in the Cerrado (Tavora et al. 2023; Darosci et al. 2021).

The gallery forest's lower canopy openness values were expected since forests exhibit a higher canopy cover of evergreen trees (Ribeiro and Walter 2008), with greater height and larger crown area (Rossatto et al. 2009). The smaller canopy openness allows the formation of microclimatic conditions in the gallery forest understory, which, together with moisture conditions, generates a thermal regime different from Cerrado habitats, affecting litter decomposition and nutrient availability (Gilliam 2007). However, in the understory of gallery forests, shading makes light a primary limiting resource, while nutrient and water availability are limiting resources in savannas (Frost et al. 1986; Hoffmann and Franco 2003). These factors determine the selection of species with different strategies adapted to the characteristics of each vegetation type. For example, graminoid species in the gallery forest understory have leaves with higher specific leaf area and chlorophyll levels, which optimizes light absorption in the shaded understory.

At the same time, graminoid species in cerrado have thicker leaves and higher dry matter content, as well as the C4 photosynthetic pathway, adaptations that assist in water use efficiency (Sage et al. 2012; Amaral et al. 2021). The low levels of species sharing in the understory between the gallery forest and Cerrado habitats result from these filters, favoring species adapted to each of these contrasting conditions.

The gallery forest soils exhibited higher nutrient content, greater base saturation, sand, organic matter, and litter, while Cerrado soils showed higher clay, silt, and canopy openness values. These results are aligned with studies suggesting that the physicochemical properties of gallery forest soils differ from those of cerrado soils, primarily attributed to variations in water regime and topography (Silva Júnior et al. 1996; Haridasan 1998). The location of gallery forests, usually in valley bottoms, also contributes to higher nutrient levels, as water-carried sediments enrich the soil in these areas (Ribeiro and Walter 2008). In the Cerrado biome, at the local scale, soil fertility is the most determining factor for species occurrence in forest formations, while soil texture is more determining for species occurrence in open habitats (Rodrigues et al. 2019). These characteristics can vary over short distances and are strongly linked to species distribution (John et al. 2007). In cerrado habitats, this variation affects species selection and can result in composition variation between different locations, while in gallery forests, which have typically fertile soils (Oliveira-Filho and Ratter 2002), this variation may be less pronounced.

The origins of the Cerrado biome, and of gallery forests specifically, can also explain their environmental and floristic differences. Climatic fluctuations during the Quaternary period had a significant impact on the distribution and evolution of Neotropical formations (Pennington et al. 2004; Leal et al. 2016), where glacial and interglacial periods generated climatic fluctuations that shaped the climate and influenced the occurrence of entire ecosystems. Gallery forests originate from older formations, and evidence such as the presence of species from the Amazon and Atlantic Forest in the Cerrado gallery forests (Prance 1987; Oliveira-Filho and Ratter 1995) indicates that they are remnants of forests that covered the entire Brazilian territory millions of years ago and retracted during interglacial periods (Prance 1987; Sobral-Souza et al. 2015; Bueno et al. 2016). As the climate became drier and colder, coupled with geological processes such as the uplift of the Brazilian Central Plateau (a pivotal factor in shaping the flat and elevated landscape characteristic of the Cerrado), the biome established itself. Its vegetation adapted to the prevailing conditions, expanding over areas once dominated by forests (Cole 1960; Ledru 1993; Silva and Bates 2002). This process may have repeated several times as climatic fluctuations occurred, with forests expanding during warmer and wetter periods and retracting, during drier and colder periods, giving way to the Cerrado (Ledru 1993; Prado and Gibbs 1993; Ledru 1998; Vicentini and Salgado-Labouriau 1996; Werneck 2011; Arruda et al. 2018). These processes selected different plant lineages that evolved alongside each vegetation type (Jacobs et al. 1999).

To our knowledge, no study has yet compared the understory flora of gallery forests and cerrado *sensu stricto*. Limited attention has been directed specifically towards the understory flora of gallery forests (Tavora et al. 2023), which are protected by the Brazilian Native Vegetation Protection Law (Lei 12.651/2012) due to the crucial ecosystem services they provide. Moreover, nonarboreal plants constitute a significant component of biodiversity in tropical forests (Linares-Palomino et al. 2009). Gallery forests are among the formations most affected by land-use change in the Cerrado and face disturbance primarily due to agricultural intensification (Sano et al. 2009). Our study demonstrates that the understory of gallery forests and cerrado exhibits distinct flora and environmental factors. Thus, policies considering their protection and restoration efforts must be distinct. Only in the last two decades has the ground layer of open cerrado formations received attention regarding restoration (Buisson et al. 2019; Buisson et al. 2022; Pilon et al. 2023). However, these studies are lacking in the understory of gallery forests, and there is only little information to guide preservation and restoration strategies for this component.

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Author Contributions

EJA and CBRM shaped the ideas, designed the experimental methodology and collected the data, analyzed the data, and wrote the manuscript.

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Supplementary Material

FIGURES

Fig. S1 Schematic representation of the distribution of transect lines (sampling units) in gallery forests and cerrado *sensu stricto*. Example of the studied site in the Silvânia National Forest, Silvânia, Goiás (SIL)

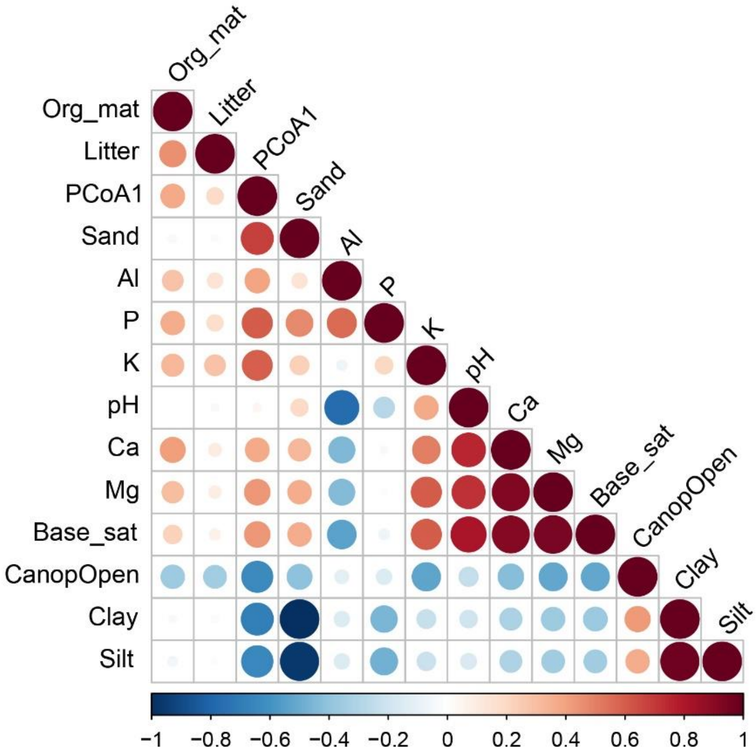

Fig. S2 Pearson correlation among environmental variables sampled in gallery forests and cerrado *sensu stricto* and the PCoA axis. Org_mat: Organic matter; Base_sat: Base saturation; CanopOpen: Canopy openness.

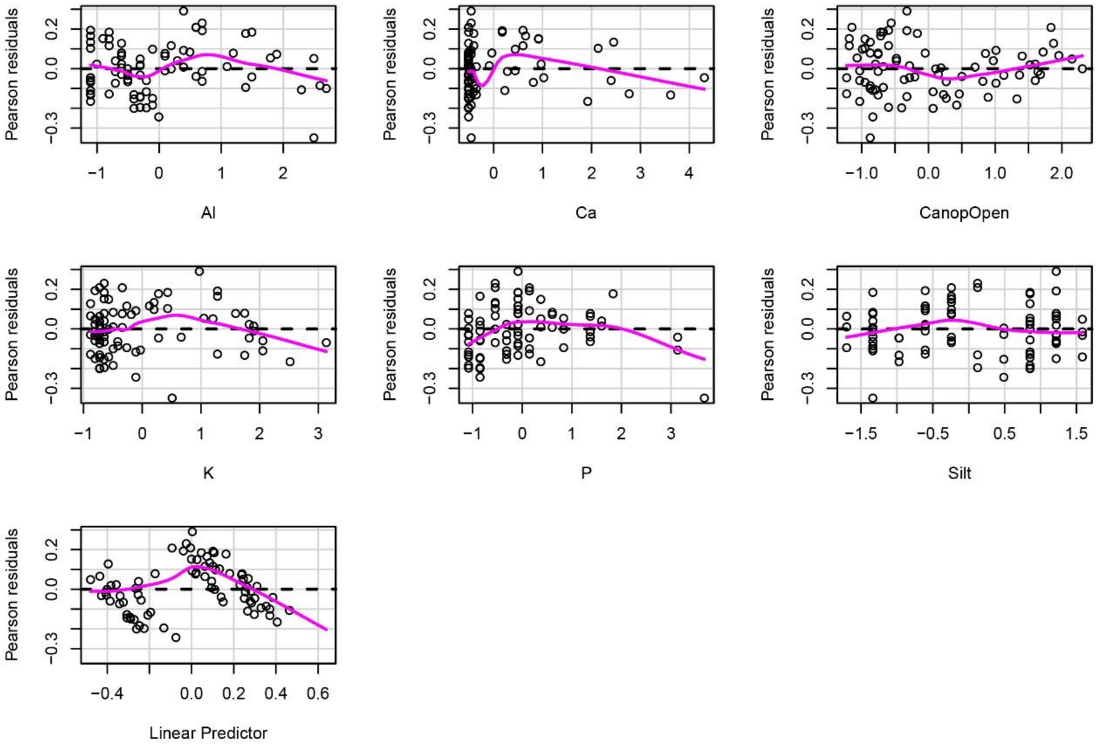

Fig. S3 Residuals of the Generalized Linear Model (GLM) for the selected variables. CanopOpen: Canopy openness.

TABLES

Table S1. Significance values (P<0.05) for Pearson correlation among the sampled environmental variables and the PCoA axis in gallery forests and cerrado *sensu stricto*. Org_mat: Organic matter; Base_sat: Base saturation; CanopOpen: Canopy openness.

	Org_mat	Litter	PCoA1	Sand	Al	P	K	pH	Ca	Mg	Base_sat	CanopOpen	Clay	Silt
Org_mat	0													
Litter	2.50E-05	0												
PCoA1	0.00068	**0.11**	0											
Sand	0.74	0.82	3.60E-12	0										
Al	0.013	0.18	0.00034	0.17	0									
P	0.0012	0.12	4.20E-09	1.30E-05	5.00E-08	0								
K	0.0038	0.012	6.40E-09	0.044	0.57	0.081	0							
pH	0.99	0.77	**0.71**	0.089	1.00E-16	0.013	0.00084	0						
Ca	0.00014	0.36	0.00077	0.0033	2.70E-05	0.78	2.50E-06	9.70E-16	0					
Mg	0.0077	0.41	5.50E-05	0.0012	3.90E-05	0.86	3.00E-09	6.70E-14	1.40E-33	0				
Base_sat	0.047	0.52	7.90E-05	0.00094	2.20E-07	0.54	3.00E-09	2.60E-20	8.50E-32	3.50E-38	0			
CanopOpen	0.001	0.0017	2.30E-10	0.00014	0.29	0.18	3.50E-07	0.032	6.40E-05	7.40E-07	6.70E-07	0		
Clay	0.76	0.81	3.10E-12	1.70E-114	0.17	1.50E-05	0.044	0.082	0.0033	0.0011	0.00086	0.00011	0	
Silt	0.6	0.87	5.10E-11	1.40E-52	0.17	7.80E-06	0.055	0.15	0.0046	0.0021	0.0023	0.001	1.20E-47	0

Table S2. Pearson correlation values (r<0.3) among the sampled environmental variables and the PCoA axis in gallery forests and cerrado *sensu stricto*. Org_mat: Organic matter; Base_sat: Base saturation; CanopOpen: Canopy openness.

	Org_mat	Litter	PCoA1	Sand	Al	P	K	pH	Ca	Mg	Base_sat	CanopOpen	Clay	Silt
Org_mat	1													
Litter	0.45	1												
PCoA1	0.37	**0.18**	1											
Areia	0.038	-0.026	0.68	1										
Al	0.28	0.15	0.39	0.15	1									
P	0.36	0.17	0.6	0.47	0.56	1								
K	0.32	0.28	0.59	0.23	-0.065	0.2	1							
pH	-0.0012	-0.034	**0.042**	0.19	-0.77	-0.28	0.37	1						
Ca	0.41	0.1	0.37	0.32	-0.45	-0.032	0.5	0.75	1					
Mg	0.3	0.092	0.43	0.36	-0.44	-0.02	0.6	0.72	0.92	1				
Base_sat	0.22	0.073	0.43	0.36	-0.54	-0.07	0.6	0.82	0.91	0.94	1			
CanopOpen	-0.36	-0.34	-0.64	-0.41	-0.12	-0.15	-0.53	-0.24	-0.43	-0.52	-0.52	1		
Clay	-0.034	0.027	-0.68	-1	-0.15	-0.46	-0.23	-0.2	-0.32	-0.36	-0.37	0.42	1	
Silt	-0.059	0.019	-0.65	-0.97	-0.15	-0.48	-0.22	-0.16	-0.31	-0.34	-0.34	0.36	0.97	1

Table S3. Variance Inflation Factor (VIF) of the seven variables selected after checking for the presence of collinearity between variables.

Variables	**VIF**
Ca	2.549
Al	2.919
K	1.711
P	2.289
Org_mat	2.248
Silt	2.012
CanopOpen	1.839

Table S4. Moran's test results for spatial autocorrelation in the residuals, after Bonferroni correction for P-values (significance at P=0.025).

Moran I statistic			
dist.class	coef	p.value	n
[1,] 8.008312	-0.01337	0.51526	4920
[2,] 24.02494	-0.00858	0.407913	1400

CAPÍTULO 3. O papel dos filtros ambientais contrastantes da floresta de galeria e da savana na seleção de atributos foliares de espécies herbáceo-arbustivas

RESUMO

Pesquisas que envolvem ecologia funcional de plantas, são motivadas principalmente pelo interesse na compreensão das respostas da comunidade vegetal às mudanças ambientais. Ambientes contrastantes, como savanas e florestas, oferecem cenários propícios para estudar a variação de características das plantas e a influência do ambiente na seleção dessas características. No Cerrado, as florestas de galeria e o cerrado *sensu stricto* podem ocorrer lado a lado e apresentam características ambientais muito distintas que selecionam diferentes tipos de espécies. Nesse trabalho exploramos a variação dos atributos funcionais foliares de espécies herbáceo-arbustivas dos ambientes contrastantes de floresta de galeria e cerrado *sensu stricto* para avaliar se esses ambientes selecionam espécies com diferentes estratégias ecológicas e geram comunidades com estrutura funcional diferentes. Também avaliamos a influência de características edáficas, de disponibilidade de luz e nutrientes na estruturação funcional dessas comunidades. Encontramos que espécies de cerrado *sensu stricto* possuem atributos funcionais foliares mais ligados a estratégias conservativas, enquanto espécies florestais possuem atributos foliares associados a estratégias aquisitivas e que o ambiente de floresta de galeria seleciona espécies com atributos principalmente ligados à competição, portanto gerando uma comunidade funcionalmente mais agrupada, enquanto o cerrado *sensu stricto* apresenta espécies com conjunto de atributos voltados principalmente para adaptação, gerando comunidades funcionalmente mais dispersas. Encontramos também que os ambientes de floresta de galeria e cerrado *sensu stricto* apresentam características edáficas e de disponibilidade de luz distintas que influenciam a seleção de atributos foliares nesses ambientes. Os atributos funcionais das plantas refletem suas estratégias ecológicas, e a compreensão das respostas funcionais ajudam a entender melhor a estrutura e funcionamento das comunidades.

Palavras-chave: Estratégia aquisitiva, estratégia conservativa, convergência funcional, divergência funcional, sub-bosque,

INTRODUÇÃO

Os padrões de diversidade, distribuição e funcionamento de comunidades de plantas têm sido foco de pesquisas há bastante tempo, e um dos campos estudados nesse contexto envolve a ecologia funcional e a capacidade de atributos adaptativos explicarem a ocorrência de espécies de plantas em diferentes habitats (Petchey & Gaston 2006). Esses estudos são impulsionados pela necessidade de compreender como o complexo maquinário ecológico pode responder a mudanças ambientais, e como características adaptativas de plantas que refletem suas estratégias ecológicas podem ajudar a predizer respostas de suas comunidades a mudanças ambientais, e assim influenciar as propriedades do ecossistema (Diaz et al. 2004; Petchey & Gaston 2006). Ambientes contrastantes de savanas e florestas são ideais para estudos de variação de características das plantas, e como os habitats as selecionam (Hoffmann et al., 2005; Maracahipes et al. 2018; Power et al. 2019). O bioma Cerrado, localizado na região central do Brasil é considerado a savana mais diversa do mundo, com um mosaico de paisagens distintas, apresentando desde florestas até savanas e campos (Ribeiro & Walter 2008). A floresta de galeria e o cerrado típico ou cerrado *sensu stricto* podem ocorrer lado a lado, com uma clara distinção na estrutura e composição das espécies (Marimon et al. 2010, Lenza et al. 2015). Esses ambientes são afetados pelas mesmas variáveis em escala regional, como clima e pool regional de espécies, mas apresentam diferenças significativas, principalmente na disponibilidade de recursos como luz, água, nutrientes e interações com o fogo (Hoffmann et al. 2009; Hoffmann et al. 2012).

As florestas de galeria ocorrem em faixas estreitas margeando pequenos cursos d’água, e apresentam cobertura arbórea entre 70 e 95% (Ribeiro & Walter 2008), se estabelecendo em solos férteis (Silva et al. 2008). Suas espécies arbóreas normalmente apresentam características ligadas a estratégias aquisitivas (Hoffmann et al. 2012), voltadas principalmente para a competição por luz, como maior área foliar específica e conteúdo de nutrientes na folha (Ratnam et al. 2011). As espécies permanentes de sub-bosque nas florestas (arbustos, sub-arbustos, e ervas) são as mais afetadas pelo sombreamento, e normalmente são adaptadas à pouca disponibilidade de luz. Ervas graminóides que ocupam florestas por exemplo, apresentam predominantemente via fotossintética C3, com crescimento lateral, folhas pouco lignificadas (Solofondranohatra et al. 2018) e lâminas largas e ovais (Cayssials & Rodríguez 2013) para maior interceptação luminosa. No ambiente de cerrado típico a disponibilidade de luz não é um fator limitante para as plantas do estrato inferior, já que a cobertura de árvores varia de 5 a 20% (Ribeiro & Walter 2008). No entanto, outros fatores como fogo, restrição hídrica durante a seca e baixa fertilidade do solo agem como filtros, selecionando espécies com características adaptativas que permitem sua manutenção no ambiente. Assim, é comum nessas espécies estratégias como, menor investimento em crescimento vertical e área específica foliar, presença de estruturas de armazenamento e rebrota abaixo do solo, e casca do caule espessa (Ratnam et al. 2011; Pilon et al. 2020). Nesses ambientes abertos o estrato inferior é dominado por gramíneas C4 cespitosas, com folhas mais lignificadas (Solofondranohatra et al. 2018), estreitas e filiformes (Cayssials & Rodríguez 2013). Essas características estão ligadas a estratégias conservativas, que permitem que as espécies sobrevivam ao estresse causado pelo fogo, seca e falta de nutrientes. Atributos como síndrome de dispersão também podem variar entre os ambientes florestais e savânicos. No Cerrado, florestas de galeria apresentam maior proporção de espécies dispersas por animais enquanto formações abertas apresentam maior proporção de espécies dispersas pelo vento (Kuhlmann & Ribeiro 2016).

As características funcionais das plantas podem também servir para entender a estrutura funcional da comunidade e discutir quais processos estão atuando na sua estruturação (Fukami et al. 2005; Pavoine & Bonsall 2011). A homogeneidade ou heterogeneidade dessas características pode indicar quais mecanismos ecológicos estão agindo na comunidade. Por exemplo, comunidades com características similares podem ser resultado de filtragem ambiental, onde o ambiente seleciona espécies com atributos semelhantes que permitem se manter e se adaptar as condições abióticas (Fukami et al. 2005; Lemoine et al. 2015). Já comunidades em que os atributos divergem entre as espécies podem indicar uma maior pressão das interações competitivas, onde a limitação de similaridade e a necessidade de explorar outros nichos para evitar a exclusão competitiva gera maior divergência funcional (Weiher et al. 1998; Vamosi et al. 2009). Esses atributos podem ser similares entre espécies próximas filogeneticamente (atributos com sinal filogenético) (Losos 2008), portanto as relações filogenéticas também são importantes na seleção de atributos. A presença de sinal filogenético nos atributos indica que espécies mais próximas são mais parecidas funcionalmente, e que provavelmente os filtros ambientais trabalham gerando comunidades mais próximas funcional e filogeneticamente, enquanto espécies em comunidades onde a competição é o fator mais forte devem ser menos relacionadas filogeneticamente (Webb et al. 2002), apresentando também atributos funcionais mais distintos. Por isso, o uso de medidas de diversidade filogenética comparadas a medidas taxonômicas e funcionais de comunidades podem se complementar, auxiliando na compreensão da estrutura da vegetação e das mudanças ao longo do tempo (Fukami et al. 2005; Larkin et al. 2015).

A variação de atributos de espécies arbóreas entre ambientes savânicos e florestais no Cerrado tem sido explorado em vários trabalhos (e.g. Hoffmann et al. 2003; Hoffmann et al. 2005; Rossatto et al. 2013; Maracahipes et al. 2018). No entanto, como esses ambientes contrastantes afetam as comunidades de plantas herbáceo-arbustivas é uma questão que permanece pouco explorada (Amaral et al. 2021). Nesse trabalho utilizamos atributos funcionais foliares de espécies herbáceo-arbustivas dos ambientes contrastantes de floresta de galeria e cerrado *sensu stricto* para avaliar se esses ambientes selecionam espécies com diferentes estratégias ecológicas e geram comunidades com estrutura funcional diferentes. Sob a hipótese de que: (i) Espécies de savana possuem atributos funcionais mais ligados a estratégias conservativas, enquanto espécies florestais possuem atributos associados a estratégias aquisitivas (Hoffmann & Franco, 2003; Hoffmann et al., 2012; Maracahipes et al. 2018). (ii) O ambiente de floresta seleciona espécies com atributos principalmente ligados à competição, portanto gerando uma comunidade funcionalmente mais agrupadas, enquanto o cerrado apresenta espécies com conjunto de atributos voltados principalmente para adaptação gerando comunidades funcionalmente mais dispersas (Fukami et al. 2005). (iii) Os ambientes contrastantes de floresta de galeria e cerrado *sensu stricto* apresentam características edáficas e de disponibilidade de luz distintas que influenciam a seleção de atributos foliares nesses ambientes.

MATERIAL E MÉTODOS

Áreas de estudo

Este estudo foi conduzido em dois pares adjacentes de floresta de galeria e cerrado *sensu stricto* duas áreas no Distrito Federal, Brasil. A primeira área está localizada na Fazenda Água Limpa (FAL) (15°57'05.0" S, 47°58'04.5"W), dentro da Área de Proteção Ambiental das Bacias dos córregos do Gama e Cabeça de Veado, e a segunda localizada na Fazenda Sucupira (SUC), que engloba o polo científico e tecnológico da Empresa Brasileira de Pesquisa Agropecuária (Embrapa) (Figura 1). O clima da região é do tipo tropical sazonal, Aw de acordo com a classificação de Köppen, sendo caracterizado por duas estações bem definidas, uma quente e chuvosa, que ocorre de outubro a abril, e outra fria e seca de maio a setembro, com pluviosidade média anual de 1.700 mm (INMET 2020).

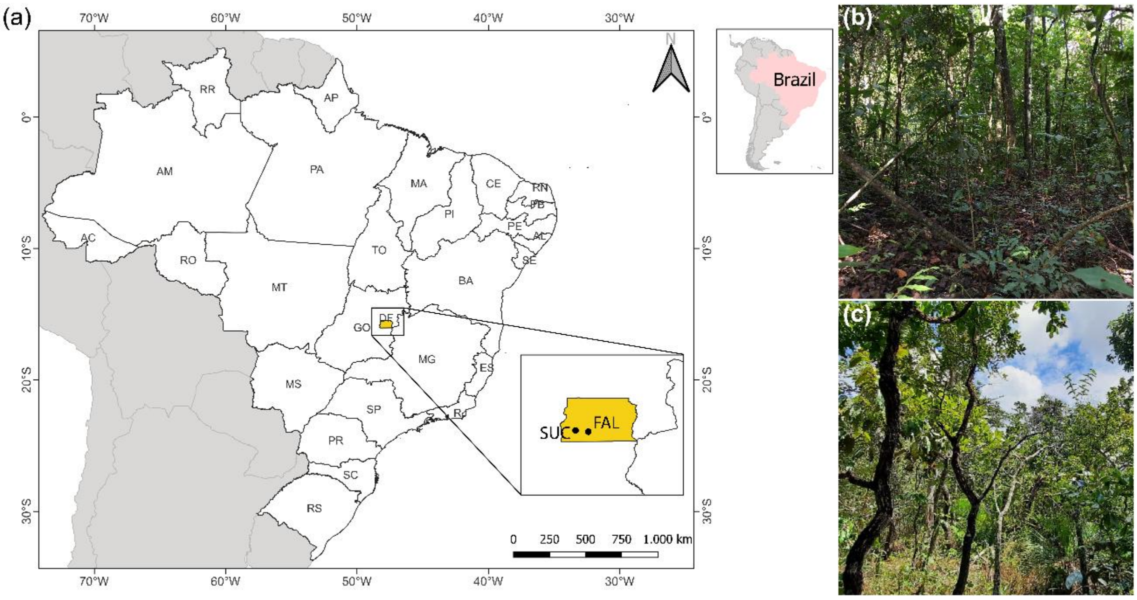

Figura 1. (a) Localidades dos pares adjacentes de floresta de galeria (b) e cerrado *sensu stricto* (c) no Distrito Federal. FAL: Fazenda Água Limpa; SUC: Fazenda Sucupira.

Amostragem da vegetação

Para o levantamento das espécies e determinação de suas coberturas relativas utilizamos o método de inventário por interseção na linha (Canfield 1941 adaptado por Munhoz & Araújo 2011). Em cada área de estudo foram instalados 10 transectos 30 m de comprimento, (10 transectos no cerrado *sensu stricto* e 10 transectos na floresta de galeria adjacente). Os transectos foram distribuídos sistematicamente, em parcelas uniformes de vegetação de floresta de galeria e cerrado *sensu stricto*, sendo a primeira linha sorteada aleatoriamente e as seguintes dispostas a no mínimo 50 m de distância umas das outras. Cada transecto foi considerado como unidade amostral (UA) nesse trabalho, onde uma fita métrica milimetrada foi estendida, colocada a 50 cm do solo, e registrada a projeção horizontal de cada espécie que tocasse ou se aproximasse da linha, tanto abaixo quanto acima (Cummings & Smith 2000). Na floresta de galeria as linhas foram dispostas alternadas entre as duas bordas externas e o centro, de modo a contemplar igualmente o gradiente da vegetação desde as margens do curso d'água até suas bordas com a vegetação aberta adjacente. Ao todo foram amostrados 40 transectos de 30-m, 20 em cada tipo vegetacional.

As amostragens da vegetação foram realizadas na estação chuvosa, entre outubro e março, nos anos de 2019 e 2020. Foram amostrados apenas espécies não arbóreas, incluindo arbustos, subarbustos, ervas e trepadeiras volúveis. As espécies arbóreas, coletadas erroneamente como arbustos por estarem no estágio de plântula, foram retiradas após identificação taxonômica e confirmação da forma de vida consultando o site Flora e Funga do Brasil (2023) (http://floradobrasil.jbrj.gov.br/) e especialistas. Os registros da projeção horizontal de cada espécies foram utilizados para o cálculo da cobertura absoluta e relativa (Kent & Coker 1992). A cobertura absoluta foi calculada pela soma do comprimento total interceptado pela espécie nas 10 unidades amostrais de cada tipo vegetacional por área. A cobertura relativa ou porcentagem de cobertura de cada espécie foi estimada dividindo a cobertura absoluta da espécie no sítio pela soma da cobertura absoluta de todas as espécies nas 10 unidades amostrais multiplicado por 100.

A identificação das espécies foi feita por meio de literaturas específicas, chaves taxonômicas, e por comparação com exemplares identificados por especialistas e depositados no herbário da Universidade de Brasília (UB), ou espécies-tipo disponíveis on-line (e.g. Jstor plant, SpeciesLink Network). Posteriormente, todo o material botânico foi herborizado e depositado no Herbário UB. Adotamos a base de dados do Flora e Funga do Brasil (2023) para uniformizar os nomes na lista de espécies.

Atributos funcionais

A partir do resultado do levantamento de espécie e da tabela de cobertura relativa, selecionamos para a coleta dos atributos foliares as espécies que juntas representavam 80% da cobertura em cada área de estudo. Analisamos área foliar específica (SLA), teor de matéria seca da folha (LDMC) e espessura (Thickness). Para mensuração de todos os atributos foram selecionados cinco indivíduos de cada espécie, distantes no mínimo 10-m entre si. De cada indivíduo foi coletada uma folha totalmente expandida e livre de sinais de predação ou patógenos, totalizando cinco subamostras por espécies. As folhas coletadas em campo foram acondicionadas em sacos plásticos com papel-toalha umedecido, transportados em bolsa térmica com gelo para manter a saturação de água das folhas até o laboratório para as mensurações. Usamos como base para essa etapa o manual de seleção e mensuração de atributos funcionais de Pérez-Harguindeguy et al. (2016).

O SLA é razão entre a área da folha fresca e sua massa seca (área/biomassa) expresso em cm².g-1. Para o cálculo dessa medida a lâmina foliar foi escaneada e digitalizada para obter a medida da área total de um dos lados da folha (cm²), as imagens geradas foram analisadas no programa ImageJ por meio da interface disponível no pacote "LeafArea" disponível em ambiente R. Após o cálculo da área foliar as folhas de cada indivíduo foram transferidas para sacos de papel devidamente etiquetados e levados para estufa por 72h a 60-70°C, em seguida as amostras foram pesadas em balança de precisão (AD200, Marte, Bel 0,001-210g) para obtenção do peso seco.

Para mensuração do LDMC calculou-se a razão da massa seca da folha (g) por sua massa fresca (g), para isso as folhas frescas foram pesadas em balança de precisão (AD200, Marte, Bel 0,001-210g) e posteriormente transferidas para envelopes devidamente etiquetados levados para estufa por 72h a 60-70 °C. Em seguida cada amostra foi pesada novamente para obter o peso seco.

A espessura da folha foi mensurada com o auxílio de um paquímetro digital, evitando-se nervuras para reduzir a variação da amostragem.

Variáveis ambientais

Foram amostradas as seguintes variáveis ambientais: propriedades edáficas texturais (areia, silte e argila) e químicas do solo (Ca^{2+}, Mg^{2+}, K^+, Na^+, Al^{3+}, P^+ e pH), quantidade de matéria orgânica no solo, abertura do dossel e espessura da serapilheira. As amostras de solo (0 a 20 cm) foram coletadas no centro de cada linha de amostragem, totalizando, 10 amostras por site. A textura do solo (conteúdo de areia, silte e argila) foi determinado pelo método densimétrico de Bouyoucos, o pH foi medido utilizando solução 0.01 mol L^{-1} $CaCl_2$ (pH $CaCl_2$), e a porcentagem de matéria orgânica foi determinada utilizando o método Walkley–Black (% C orgânico × 1.724). Os cátions Ca^{2+}, Mg^{2+} e Al^{3+} foram extraídos com solução 1 mol L^{-1} KCl, e K^+, Na^+, e P^+ foram extraídos com solução $Mehlich^{-1}$ (0.0125 mol L^{-1} H_2SO_4 + 0.05 mol L^{-1} HCl). As amostras de solo foram analisadas de acordo com o protocolo da Embrapa (2017).

A abertura de dossel foi calculada a partir de fotografias hemisféricas registradas com câmera fotográfica e lente olho de peixe. As fotografias foram feitas no período da manhã, em dias nublados, no centro de cada unidade amostral, totalizando 10 amostras por site. As imagens foram analisadas utilizando o programa GLA - Gap Light Analyzer, Versão 2.0 (Frazer et al. 1999) que fornece os dados de estrutura do dossel em percentual de abertura. Para medir a espessura da camada de serapilheira, foi utilizado o coletor-medidor Marimon-Hay (Marimon-Junior & Hay, 2008), que coleta a amostra de serapilheira sobre o solo e determina a espessura da camada. As coletas foram realizadas em 3 pontos (5 m, 15 m e 25 m) de cada unidade amostral. Todas as variáveis ambientais foram coletadas no início do período chuvoso, quando a camada de serapilheira ainda não se decompôs e a maioria das espécies arbóreas caducifólias restituíram as folhas perdidas no período seco do ano.

Análises

Para comparar a variação de atributos foliares entre os ambientes de floresta de galeria e cerrado *sensu stricto* utilizamos teste T para amostras com distribuição normal e teste de comparação de médias de Wilcoxon para conjunto de dados que não apresentavam distribuição normal mesmo após as transformações por raiz quadrada e logaritmo. Aplicamos também correção de Holm (Borcard et al. 2011) para levar em conta múltiplas comparações ($P < 0.05$). A normalidade dos dados e a homogeneidade das variâncias foram avaliadas pelo teste de Shapiro-Wilk. Investigamos a estrutura funcional das comunidades de plantas do sub-bosque de floresta de galeria e de cerrado *sensu stricto* a partir dos índices de diversidade funcional (FD), riqueza funcional (FRic), divergência funcional (FDiv), dispersão funcional (FDis) e equabilidade funcional (FEve). Esses índices foram gerados a partir da matriz de atributos funcionais e da matriz de cobertura relativa das espécies selecionadas utilizando a função 'dbFD' no pacote "FD" (Laliberté et al. 2014). Para a comparação dos valores dos índices de diversidade funcional entre os ambientes de floresta de galeria e cerrado também verificamos a normalidade dos dados e a homogeneidade das variâncias por teste de Shapiro-Wilk após transformações por raiz quadrada e logaritmo, aplicando teste T para amostras com distribuição normal e teste de Wilcoxon para dados com distribuição não normal, seguidos por correção de Holm ($P < 0.05$).

Para observar o agrupamento ou dispersão no espaço funcional das comunidades de plantas do sub-bosque entre os ambientes de floresta de galeria e cerrado *sensu stricto* considerando também a cobertura das espécies, utilizamos a média ponderada da comunidade (Community Weighted Mean-CWM) que consiste basicamente na média ponderada de cada atributo, em relação à abundância relativa de cada espécie presente na comunidade (De Bello et al. 2021). Utilizamos o valor médio de cada atributo ponderado pela cobertura relativa para gerar as matrizes usadas na função ‘functcomp’ do pacote “FD” (Laliberté et al. 2014) para cálculo do CWM. Os valores do CWM para cada unidade amostral foram transformados em uma matriz de distância euclidiana, utilizando a função ‘vegdist’ no pacote “vegan” (Oksanen et al. 2022). Utilizamos a matriz de distância criada a partir do CWM para plotar uma PCoA (Principal Component Analysis). Para investigar se houve diferença significativa no espaço funcional entre os grupos formados na PCoA, realizamos uma análise de variância (PERMANOVA) por meio da função ‘adonis2’ no pacote “vegan” (Oksanen et al. 2022), juntamente com um teste de dispersão de homogeneidade através da função ‘betadisper’ no pacote “vegan” (Oksanen et al. 2022).

Utilizamos modelos de regressão para avaliar as relações entre os atributos funcionais e as variáveis ambientais. Analisando as relações dos atributos funcionais (variáveis resposta) com as variáveis ambientais (variáveis preditoras). Essa análise permite incluir os efeitos fixos (variáveis preditoras) e aleatórios (variáveis que afetam as variáveis respostas, mas não nos interessam diretamente) no modelo, permitindo lidar com a falta de independência das observações. Como variáveis resposta utilizamos os valores obtidos de CWM para cada unidade amostral (Ua) condensados nos scores do primeiro eixo da PCoA e calculamos a matriz de correlação com as variáveis ambientais, utilizando a função ‘rquery.cormat’ no pacote ‘corrplot’ (Wei & Simko 2021). A partir dessa matriz excluímos variáveis com baixo valor de correlação estatística (valores de $P<0{,}05$) e biológica (valores de $r<0{,}3$). Depois verificamos a presença de colinearidade entre as variáveis remanescentes com base no Fator de Inflação da Variância – VIF (Quinn & Keough 2002) aplicando limiar de corte de 10 por meio da função ‘vifstep’ no pacote “usdm” (e.g., Borcard et al. 2011). As variáveis remanescentes foram utilizadas no Modelo Linear Generalizado (GLM) baseado na família gaussiana, a qual é indicada para dados contínuos (Zuur et al. 2009). Para selecionar o melhor modelo, utilizamos a função ‘dredge’ do pacote “MuMIn”. Os modelos foram ranqueados pelo Akaike Information Criterion (AICc) e delta < 2. Confirmamos o pressuposto de normalidade dos resíduos por teste de Shapiro. Checamos a autocorrelação espacial nos resíduos utilizando o correlograma de Moran por meio da função ‘correlog’ no pacote “pgirmess”.

Todas as análises foram feitas em ambiente R versão 4.1.3 (R Core Team, 2019).

RESULTADOS

Não houve compartilhamento de espécies entre o sub-bosque de floresta de galeria e cerrado *sensu stricto* considerando as espécies que ocupavam até 80% da cobertura em cada ambiente (Anexo 1). As espécies do sub-bosque de floresta de galeria e cerrado *sensu stricto* se diferenciaram significativamente em todos os atributos foliares analisados (Figura 2). Espécies de cerrado *sensu stricto* apresentaram folhas com maior teor de matéria seca (LDMC), maior espessura das folhas e menor SLA, enquanto espécies de floresta de galeria apresentaram folhas com menor teor de matéria seca, menor espessura e maior SLA (Figura 2).

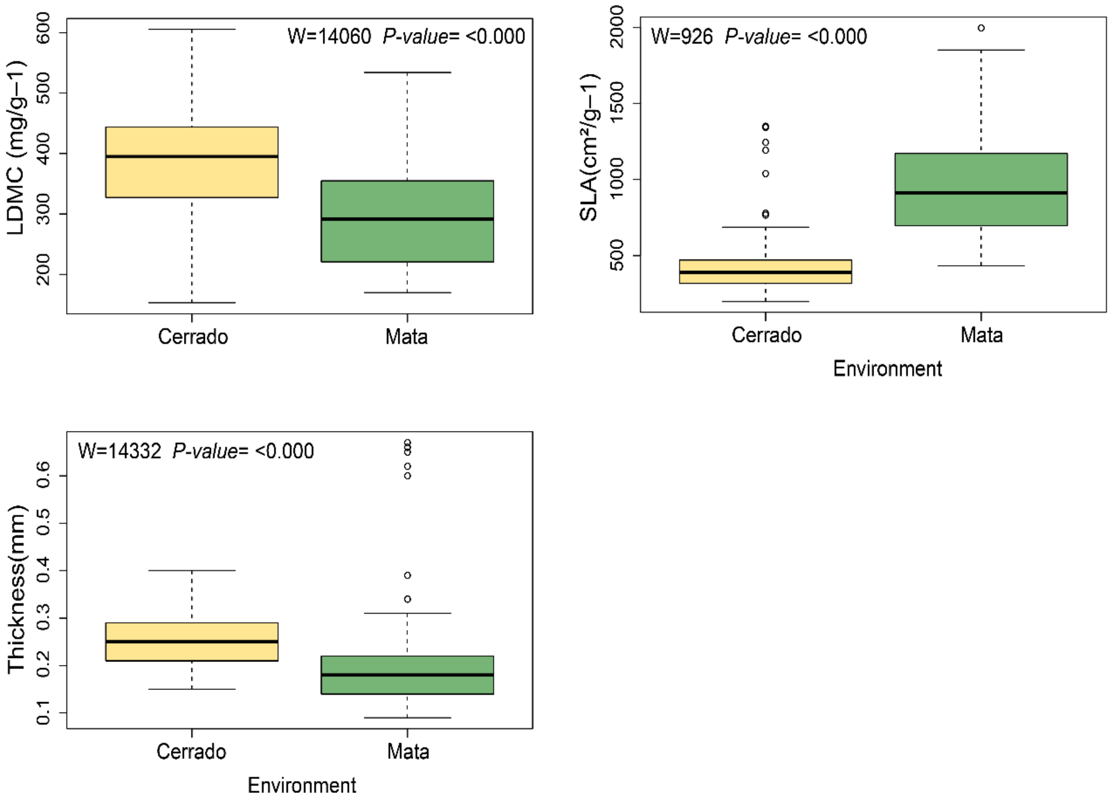

Figura 2. Comparação dos atributos foliares entre os ambientes de floresta de galeria (*n*=22) e cerrado *sensu stricto* (*n*=27). Valor de significância p-value=0.05.

Os índices de diversidade funcional mostraram que os ambientes de floresta de galeria e cerrado *sensu stricto* se diferenciam quanto à diversidade funcional (FD) e riqueza funciona (FRic). As métricas de divergência funcional (FDiv), dispersão funcional (FDis), e equabilidade funcional (FEve) não apresentaram diferença significativa (Figura 3).

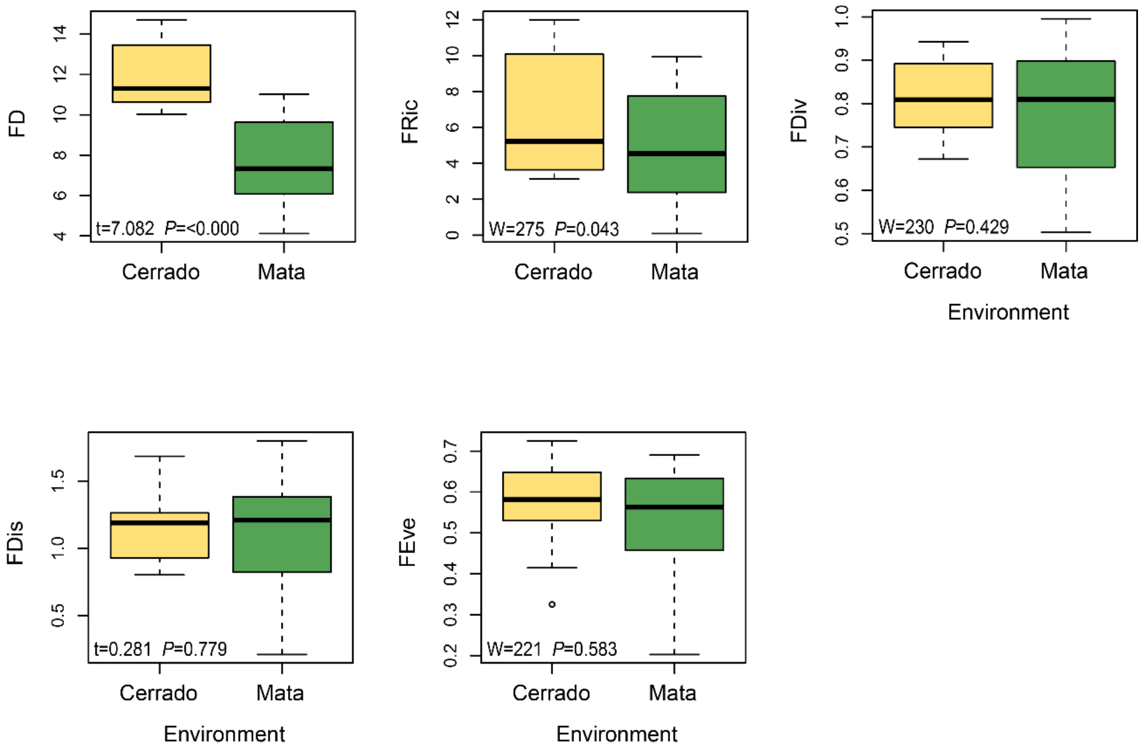

Figura 3. Comparação dos valores dos índices de diversidade funcional entre os ambientes de floresta de galeria (n=20) e cerrado *sensu stricto* (n=20). Valor de significância p-value=0.05.

A PCoA mostra a clara separação do grupo de espécies de floresta de galeria e de cerrado *sensu stricto*, formando grupos com atributos foliares significativamente distintos (R^2 = 0.93, P=0.001) (Figura 4). É possível observar que os valores de atributos foliares das espécies do sub-bosque de floresta de galeria são mais agrupados, enquanto as espécies de cerrado *sensu stricto* apresentam valores mais dispersos.

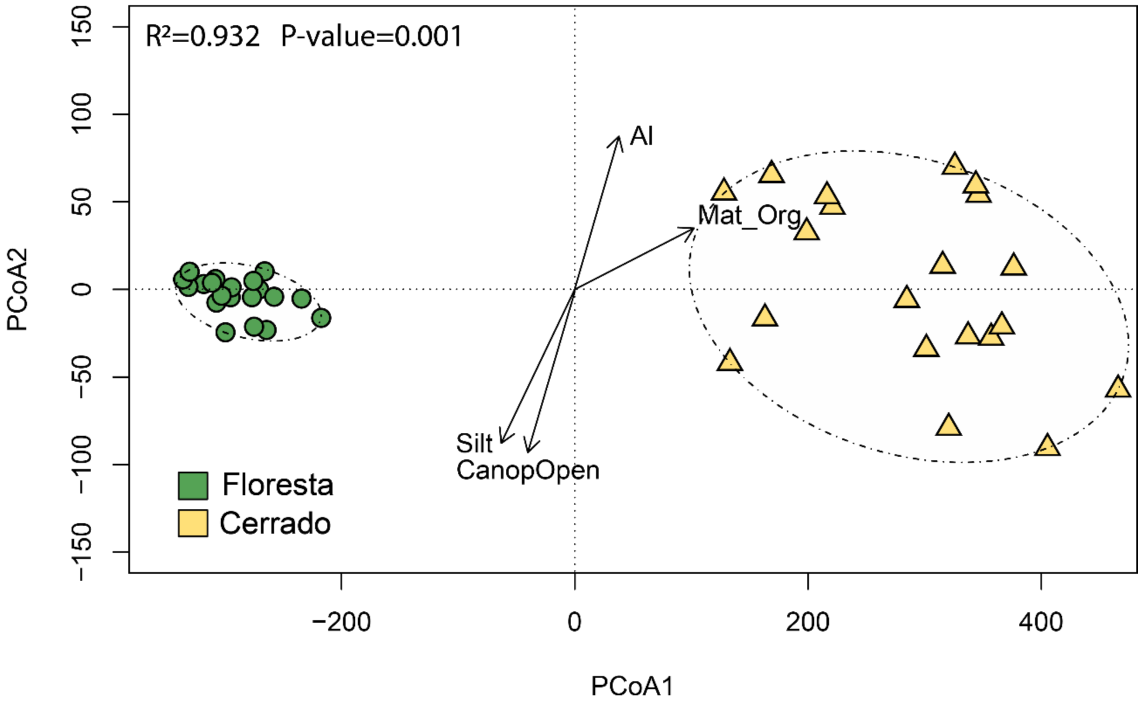

Figura 4. Análise de Coordenadas Principais (PCoA) da composição funcional dos ambientes de floresta de galeria (n=20) e cerrado *sensu stricto* (n=20). As setas representam a correlação das variáveis ambientais selecionadas na GLM com a distribuição funcional das amostras. CanopOpen= Abertura de dossel, Mat_Org= Matéria orgânica.

No primeiro passo para o modelo de regressão, onde eliminamos variáveis com baixo valor de correlação estatística (valores de P<0,05) e biológica (valores de r<0,3), o pH (p= 0.5, r= 0.11) foi eliminado (Anexo 2 e 3). Na análise para verificação de colinearidade entre as variáveis utilizando o Fator de Inflação da Variância – VIF, as variáveis argila, saturação de bases, areia e cálcio foram retiradas por apresentarem colinearidade. As variáveis remanescentes com valor de VIF <5 foram utilizadas no modelo (Anexo 4). O modelo selecionado apresentou normalidade dos resíduos no teste de Shapiro (P=0.811), apresentou r^2=0.902, e AIC=487.75. As variáveis alumínio, matéria orgânica, abertura de dossel e silte foram selecionadas pelo modelo como variáveis importantes para a variação dos atributos foliares das espécies de sub-bosque (tabela 1; Figura 4). A checagem de autocorrelação espacial por meio do correlograma de Moran e não encontrou autocorrelação espacial significativa (Anexo 5).

Tabela 1. Modelo linear generalizado (GLM) ajustado para a variação dos atributos foliares de espécies do sub-bosque em floresta de galeria e cerrado *sensu stricto*, e sua relação com as variáveis ambientais selecionadas. CanopOpen= Abertura de dossel, Mat_Org= Matéria orgânica.

	Estimate	**Std. Error**	**t value**	**P**
(Intercept)	-6.497E-14	15.65	0	1
Al	98.26	22.74	4.321	0.0001
Mat_Org	150.30	19.44	7.735	0.0000
CanopOpen	-84.53	21.05	4.015	0.0009
Silte	-90.96	21.21	-4.288	0.0001

DISCUSSÃO

Nossos resultados mostram que a comunidade de plantas permanentes do estrato inferior de floresta de galeria e de cerrado *sensu stricto* se diferenciam funcionalmente. Espécies de floresta apresentam atributos foliares ligados a estratégias aquisitivas, enquanto as espécies de cerrado *sensu stricto* apresentam ligação com estratégias conservativas. O que vai de encontro com resultados de outros trabalhos que comparam espécies arbóreas de ambientes florestais e savânicos (Hoffmann et al., 2012; Dantas et al., 2013; Maracahipes et al. 2018; Klipel et al 2023). As espécies de floresta de galeria apresentam maior SLA, o que se caracteriza como uma estratégia aquisitiva (Hoffmann et al. 2012; Dantas et al. 2013), pois maiores valores de SLA mostram maior investimento em crescimento e ocupação do espaço, resultado da seleção do ambiente por espécies adaptadas em um melhor aproveitamento da luz disponível no sub-bosque. Ao contrário disso o investimento em espessura e conteúdo de matéria seca na folha nas espécies de cerrado *sensu stricto* mostra o investimento em estratégias conservativas, uma vez que o aumento do tecido paliçádico, que resulta em maior espessura e maior conteúdo de matéria seca, mostra o investimento em estruturas mais resistentes e consequentemente focando em estruturas mais conservativas. O ambiente de cerrado é mais seco, tem menor disponibilidade de nutrientes, passa por eventos de fogo com mais frequência e a pressão por herbivoria é mais forte, portanto, a seleção de espécies de plantas que apresentam características foliares ligados a estratégias conservativas é vantajosa (Perez-Harguindeguy et al. 2016; Maracahipes et al. 2018). Espécies que apresentam folhas com maior espessura e conteúdo de matéria seca tem maior chance de serem selecionadas nesse ambiente pois alocam mais recursos para defesas estruturais contra a herbivoria e patógenos. Esses atributos também permitem um maior controle térmico e hídrico na folha permitindo maior eficiência no uso da água e consequentemente menor perda de água para o ambiente (Liu & Osborne 2015).

As espécies de floresta de galeria apresentam maior similaridade funcional com relação a atributos foliares, enquanto espécies de cerrado são mais distintas. Os índices de Diversidade Funcional (FD) (Petchey & Gaston 2002) e Riqueza Funcional (FRic) (Cornwell et al. 2006) medem a quantidade de espaço funcional preenchido pelas espécies de uma comunidade. Os índices de riqueza funcional geralmente são usados como indicadores do espaço de nicho que é potencialmente usado ou não (Schleuter et al. 2010). Os maiores valores de FD e FRic no ambiente de cerrado mostram que esse ambiente apresenta atributos foliares mais distintos que o ambiente de floresta de galeria o que resulta na ocupação de um maior espaço funcional. Na floresta de galeria o principal filtro limitante é a disponibilidade de luz, assim a competição por luz parece ser forte o suficiente para gerar comunidades com atributos foliares mais agrupadas funcionalmente para competir por esse recurso. No cerrado os vários nichos gerados pelo ambiente mais seco, quente, com menor disponibilidade de nutrientes, maior herbivoria e eventos de fogo, pode permitir que as espécies tenham uma maior variação de atributos foliares para se adaptar aos vários filtros.

As variáveis ambientais selecionadas mostraram que os atributos foliares do sub-bosque de cerrado são mais influenciados por variáveis edáficas relacionadas a menor disponibilidade de nutrientes e matéria orgânica no solo. Enquanto silte e abertura de dossel foram correlacionados com a variação dos atributos de floresta de galeria. Sabemos que o alumínio é um elemento importante no ambiente de cerrado, onde sua concentração é responsável por causar a indisponibilidade de outros nutrientes, como nitrogênio, fósforo, cálcio, magnésio (Haridasan 2008). Essa correlação pode ser responsável pelo maior investimento das espécies de cerrado em folhas mais espessas e lignificadas, pois tem menos chances de perder os nutrientes alocados por predação ou injúrias mecânicas. O menor teor de matéria orgânica se correlacionou com o ambiente de cerrado *sensu stricto*. Nesse ambiente o ciclo de nutrientes é mais lento, por causa das características da menor disponibilidade de água no solo, maior luminosidade e também porque atributos das folhas como o LDMC funcionam como atributos de efeito, pois folhas com maiores valores de LDMC tendem a decompor mais lentamente (Pérez-Harguindeguy et al., 2016).

Os ambientes de floresta de galeria e cerrado *sensu stricto* são contrastantes em muitos aspectos, outros trabalhos já mostraram as suas diferenças ambientais, de diversidade taxonômica, filogenética e funcional, mas poucos focados no sub-bosque desses ambientes (Amaral et al. 2021). Os estudos voltados para o sub-bosque, principalmente de florestas de galeria ainda são escassos (Tavora et al. 2023), e sua inclusão em trabalhos voltados para a diversidade funcional podem ajudar a obter uma visão mais ampla e integrada do ambiente. Estudos considerando outros tipos de atributos em espécies do sub-bosque de floresta de galeria e cerrado também são importantes para melhor entendimento dos processos que afetam essas comunidades. Atributos de estruturas abaixo do solo ou de reprodução, podem ajudar a explicar por exemplo por que espécies como *Ageratum fastigiatum* (Gardner) R.M.King & H.Rob., que ocorre no ambiente de cerrado *sensu stricto* mas apresenta características foliares mais próximas das espécies de floresta de galeria, com valores de SLA mais altos e LDMC mais baixos (Anexo 1), mas mesmo assim apresentam alta cobertura no ambiente aberto de cerrado.

Nossos resultados enfatizam como espécies de floresta de galeria e cerrado se diferenciam funcionalmente, adicionando informações funcionais importantes a um grupo de plantas ainda pouco estudado, o sub-bosque de floresta de galeria. As espécies de cada ambiente têm estratégias distintas. Espécies de floresta de galeria apresentam atributos voltados para estratégias aquisitivas, e adaptadas para a competição por luz, o que gera uma comunidade de plantas mais agrupada funcionalmente. Enquanto no ambiente de cerrado *sensu stricto* as espécies apresentam características foliares que se englobam no estilo de estratégia conservativa, num ambiente onde a alocação de recursos é mais difícil, e existem mais nichos a comunidade de plantas apresenta uma conformação funcional mais dispersa.

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Material suplementar

Anexo 1. Espécies selecionadas (80% da cobertura) em floresta de galeria e cerrado *sensu stricto* e valores médios e desvio padrão de atributos foliares mensurados.

	Atributos foliares		
Cerrado *sensu stricto*	**LDMC (mg g–1)**	**SLA (cm².g–1)**	**Thickness (mm)**
Ageratum fastigiatum	173.15±13.34	1233.81±87.45	0.19±0.007
Axonopus marginatus	298.34±19.89	422.55±69.57	0.16±0.01
Baccharis retusa	318.09±11.85	445.23±22.12	0.29±0.02
Banisteriopsis stellaris	440.47±35.48	435.88±69.26	0.21±0.02
Bauhinia dumosa	498.98±5.12	388.66±13.45	0.23±0.02
Bauhinia holophylla	479.12±28.77	423.57±52.04	0.23±0.02
Campomanesia pubescens	435.25±25.52	361.30±54.77	0.29±0.02
Centrozema bracteosum	299.47±19.22	682.74±83.19	0.25±0.01
Cordiera elliptica	424.12±10.67	321.04±18.45	0.27±0.01
Croton antisyphiliticus	303.90±37.80	454.09±52.18	0.33±0.01
Croton goyazensis	287.61±17.66	598.01±40.84	0.26±0.007
Echinolaena inflexa	381.25±11.58	301.46±19.57	0.18±0.008
Elionurus muticus	382.95±38.47	250.08±53.02	0.23±0.02
Erythroxylum campestre	391.31±10.91	341.26±20.57	0.35±0.02
Esenbeckia pumila	331.33±17.44	434.15±43.04	0.27±0.03
Eugenia chiquitensis	434.80±23.70	417.01±29.03	0.21±0.01
Galactia crassifolia	539.04±44.71	306.32±41.94	0.29±0.03
Miconia fallax	409.86±25.84	263.23±20.15	0.39±0.01
Myrcia linearifolia	506.67±42.26	323.93±32.08	0.25±0.01
Parinari obtusifolia	509.02±14.49	349.65±15.14	0.24±0.02
Paspalum pectinatum	343.20±45.88	519.22±74.62	0.18±0.01
Paspalum trichostomum	347.27±58.96	306.64±76.75	0.25±0.05
Pavonia rosa-campestris	388.05±37.92	355.71±72.59	0.32±0.03
Psidium laruotteanum	420.53±15.61	288.24±30.87	0.34±0.01
Rhynchospora consanguinea	339.95±31.66	322.26±74.20	0.26±0.02
Scleria reticularis	346.58±19.87	572.63±68.04	0.23±0.01
Trachypogon spicatus	378.19±24.58	598.22±17.66	0.15±0.01
Floresta de galeria	**LDMC (mg g–1)**	**SLA (cm².g–1)**	**Thickness (mm)**
Aphelandra longiflora	217.51±15.00	1197.89±35.20	0.21±0.02
Coccocypselum lanceolatum	198.70±8.52	1493.07±143.64	0.23±0.02
Hildaea pallens	159.89±28.54	1050.61±54.15	0.09±0.005
Homolepis glutinosa	379.26±18.45	873.56±46.34	0.14±0.01
Ichnanthus calvescens	197.89±37.52	1323.61±239.37	0.15±0.005
Leandra melastomoides	251.52±25.35	684.18±66.42	0.34±0.03
Miconia nervosa	394.44±14.29	605.88±46.19	0.23±0.01
Palicourea colorata	280.91±43.48	934.36±152.32	0.17±0.01
Palicourea crocea	309.19±23.71	847.82±67.16	0.18±0.01
Palicourea hoffmannseggiana	360.82±46.79	1044.71±127.77	0.14±0.01

Palicourea prunifolia	368.25±7.15	958.52±33.35	0.13±0.01
Palicourea sessilis	299.45±22.85	972.24±56.04	0.14±0.004
Palicourea trichophora	309.31±9.28	1193.08±463.07	0.17±0.01
Panicum sellowii	292.09±29.27	1685.60±224.42	0.10±0.008
Pharus lappulaceus	379.35±29.63	528.08±60.94	0.24±0.02
Piper arboreum	204.91±14.91	762.22±46.63	0.23±0.01
Piper ovatum	256.29±41.77	868.39±294.60	0.22±0.008
Piper tectonifolium	223.61±18.22	822.63±102.10	0.22±0.01
Piper xylosteoides	216.41±18.79	840.99±103.23	0.22±0.005
Psychotria carthagenensis	203.01±15.12	483.57±39.00	0.64±0.02
Rhynchospora exaltata	270.50±19.58	618.47±18.11	0.20±0.03
Scleria bracteata	280.50±15.35	778.47±91.47	0.16±0.01

Anexo 2. Valores de significância ($P<0.05$) para correlação de Pearson das variáveis ambientais amostradas nas florestas de galeria e cerrado *sensu stricto* e o eixo da PCoA.

	Mat_Org	Areia	Al	P	Serrapilheira	PCoA1	K	pH	Ca	Mg	Sat_Bases	CanopOpen	Argila	Silte
Mat_Org	0													
Areia	8.30E-05	0												
Al	0.093	0.00055	0											
P	0.0022	9.60E-05	1.70E-05	0										
Serrapilheira	0.0048	0.002	0.013	1.90E-05	0									
PCoA1	3.50E-07	1.90E-07	4.90E-05	1.80E-06	0.00018	0								
K	0.0019	0.14	0.024	0.0011	0.0036	1.30E-08	0							
pH	0.13	0.45	7.80E-08	0.031	0.27	**0.5**	0.88	0						
Ca	2.60E-06	0.024	0.098	0.98	0.32	0.01	0.27	2.40E-07	0					
Mg	6.30E-07	0.015	0.26	0.63	0.22	0.0015	0.038	3.40E-06	4.10E-21	0				
Sat_Bases	6.60E-06	0.037	0.041	0.89	0.21	0.0038	0.026	1.70E-08	2.20E-19	1.70E-22	0			
CanopOpen	7.20E-06	6.80E-06	1.10E-05	0.00094	0.001	1.20E-09	4.30E-05	0.31	0.16	0.057	0.1	0		
Argila	6.10E-05	2.90E-58	0.00046	8.00E-05	0.0019	1.00E-07	0.12	0.44	0.022	0.013	0.033	5.40E-06	0	
Silte	0.00066	4.20E-28	0.0021	0.00043	0.0038	1.20E-05	0.3	0.49	0.047	0.038	0.076	4.80E-05	1.10E-25	0

Anexo 3. Valores de r (r<0.3) para correlação de Pearson das variáveis ambientais amostradas nas florestas de galeria e cerrado *sensu stricto* e o eixo da PCoA.

	Mat_Org	Areia	Al	P	Serrapilheira	PCoA1	K	pH	Ca	Mg	Sat_Bases	CanopOpen	Argila	Silte
Mat_Org	1													
Areia	0.58	1												
Al	0.27	0.52	1											
P	0.47	0.58	0.62	1										
Serrapilheira	0.44	0.47	0.39	0.62	1									
PCoA1	0.71	0.72	0.6	0.67	0.56	1								
K	0.48	0.24	0.36	0.5	0.45	0.76	1							
pH	0.24	-0.12	-0.73	-0.34	-0.18	**-0.11**	-0.025	1						
Ca	0.67	0.36	-0.27	-0.0044	0.16	0.4	0.18	0.71	1					
Mg	0.7	0.38	-0.18	0.08	0.2	0.49	0.33	0.66	0.95	1				
Sat_Bases	0.65	0.33	-0.32	0.023	0.2	0.45	0.35	0.76	0.94	0.96	1			
CanopOpen	-0.64	-0.65	-0.63	-0.5	-0.5	-0.79	-0.6	0.16	-0.23	-0.3	-0.26	1		
Argila	-0.59	-1	-0.53	-0.58	-0.48	-0.73	-0.25	0.12	-0.36	-0.39	-0.34	0.65	1	
Silte	-0.52	-0.98	-0.47	-0.53	-0.45	-0.63	-0.17	0.11	-0.32	-0.33	-0.28	0.6	0.97	1

Anexo 4. Fator de Inflação da Variância das variáveis selecionadas após checagem de colinearidade entre variáveis.

Variables	VIF
Mg	3.301
Al	2.196
K	2.490
P	2.762
Org_mat	2.504
Silt	2.576
CanopOpen	2.151
Serrapilheira	4.147

Anexo 5. Correlograma de Moran para autocorrelação espacial dos resíduos da GLM.