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ABSTRACT

Most researches in forest communities include the composition and structure of the tree component, due to its economic importance, leaving the understory species to the background. Thus, the aim of this study was to conduct a floristic survey of understory species in the Águas da Prata State Reserve, São Paulo, and compare it with other studies in forests of the same physiognomy. Sampling occurred from December 2007 to May 2008, using the "walking" method. 44 taxa from 23 families were identified. The herbaceous plants were the most representative with 26 species (59%) the shrubs presented 14 species (31.9%) and the lianes, four species (9.1%). Asteraceae (29.54%= 13 spp.), Piperaceae (9.09%= four spp.), Commelinaceae (6.81%= three spp.) and Solanaceae (6.81%= three spp.) were the most representatives families. This survey complements the biodiversity knowledge of the Águas da Prata State Reserve, an important natural remnant.

Keywords: Atlantic Forest, State Reserve, Floristic survey.

RESUMO

A maioria das pesquisas em comunidades florestais contemplam a composição e a estrutura do componente arbóreo, devido sua importância econômica, deixando as espécies do sub-bosque ao segundo plano. Com isso, o objetivo deste estudo foi realizar um levantamento florístico de espécies do sub-bosque na Reserva Estadual de Águas da Prata, São Paulo e compará-la com outros estudos em florestas de mesma fisionomia. As amostragens ocorreram no período de dezembro de 2007 a maio de 2008, utilizando-se o método de "caminhamento". Foram identificados 44 táxons pertencentes a 23 famílias. As plantas herbáceas



foram as mais representativas com 26 espécies (59%), as arbustivas representaram 14 espécies (31,9%) e as lianas quatro espécies (9,1%). A família Asteraceae (29,54%= 13 táxons) foi a mais representativa, seguida de Piperaceae (9,09%= quatro espécies), Commelinaceae (6,81%= três espécies) e Solanaceae (6,81%= três espécies). Os dados obtidos nesse estudo complementam o conhecimento da biodiversidade da Reserva Estadual de Águas da Prata, um importante remanescente natural.

Palavras-chave: Mata Atlântica, Reserva Estadual, Levantamento florístico.

INTRODUCTION

The Atlantic Forest is one of the most diverse ecosystems in Brazil (LIRA et al., 2016) and despite its significant environmental importance, this biome is continually being degraded by various anthropic activities (DANTAS et al., 2017), that through the accelerated process of urban expansion over the natural remnants, cause direct damage causing a drastic loss of biodiversity and placing the biome in a critical situation of alteration of its natural ecosystems (CYSNEIROS et al., 2016; TEIXEIRA et al., 2019) that exhibit only 8.5% of their forest remnants (FUNDAÇÃO SOS MATA ATLÂNTICA, 2014).

The Semideciduous Seasonal Forest, one of the physiognomies of the Atlantic Forest biome, is represented by different physiognomic variations and constituted by arboreal elements (evergreen or deciduous), shrubs, lianas and epiphytes, being in low latitudes related to a climate with two well-defined seasons, one rainy and the other dry, and in high latitudes (greater than 24° S) to a marked thermal variation (IVANAUSKAS, ASSIS, 2012). Such climatic characteristics are identified as determining factors of a strong leaf seasonality of the dominant

arboreal elements in response to the period of water deficit and the drop in temperature in the coldest months (BARBOSA, THOMAS, 2002).

In the state of São Paulo, the forest ecosystems, which at the beginning of their development process covered more than 80% of the surface, have been drastically reduced to less than 5% of their area (CEMA, 1985), with the remaining small extensions of semideciduous seasonal forests corresponding to parks, reserves and residual forests on private properties, which due to easy access and agricultural and real estate pressures suffer continuous and accelerated deforestation (KOTCHETKOFF-HENRIQUES, JOLY, 1994), making its conservation highly dependent on the preservation of these forest fragments dispersed throughout the state (TABANEZ et al., 1997).

Floristic surveys are of great importance for understanding the biodiversity of a particular location, serving as a subsidy to generate information on the ecological attributes of species such as, for example, ecological groups, dispersal syndromes, life forms and phenology (HOSOKAWA et al., 2008), i.e., they constitute the basis of any



study committed to the correct assessment of the value of an ecosystem, about its conservation and with regard to its management (MARANGON et al., 2013). However, normally floristic studies across the planet emphasize the tree component of forest systems, the main holder of forest biomass and with outstanding economic importance (KOZERA, RODRIGUES, 2005), leaving aside the lower forest strata (shrubs, herbs, lianas, others) which are extremely important and can respond to microclimate and edaphic variations in a very expressive way (MÜLLER, WAECHTER, 2001).

Most studies that approach understory species describe them as a secondary and/or complementary item in the characterization of an environment, however, such knowledge is of indispensable importance for understanding the structure of a forest system as a whole, especially in studies of natural regeneration, ecological succession and the dynamics of plant populations, as this stratum is highly sensitive to disturbances (GILLIAM, 2007).

OBJECTIVES

Thus, the present work aimed to carry out a floristic survey of the understory of the Águas da Prata State Reserve, a fragment of Semideciduous Seasonal Forest in the interior of the State of São Paulo, Brazil, and compare it with other studies in different locations with the same phytophysiognomy.

MATERIAL AND METHODS

Study area

The study was conducted in the Águas da Prata State Reserve, which has 48.4 hectares and is located between the geographic coordinates 21°54' to 21°55' S and 46°41' to 46°42' W and at an altitude between 840 and 1060 meters, in the municipality of Águas da Prata, São Paulo (figure 1). The climate in the region is tropical at altitude, characterized by a cold and dry season (April to September) with an average annual temperature of 18 °C and rainfall between 15 and 80 mm/month and another hot and humid season (October to March) with an annual temperature average of 26 °C and rainfall between 100 and 255 mm/month (MIGLIORINI JR et al., 1983).

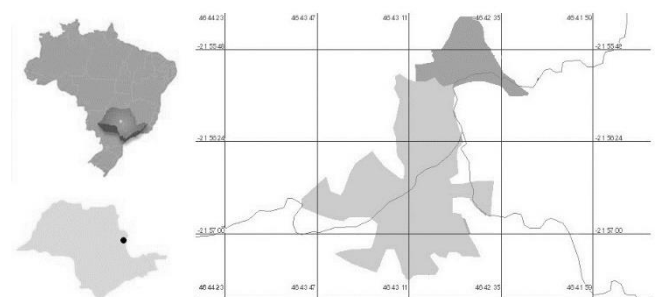


Figure 1. Location of the municipality of Águas da Prata (SP): Urban area (■); State Reserve (■).

Figura 1. Localização do município de Águas da Prata (SP): Área urbana (■); Reserva Estadual (■).

The vegetation cover of the Reserve is composed of Semideciduous Seasonal Forest with vegetation characterized by species typical of dry regions and humid regions, due to the climatic characteristics of the region mentioned above,



where little known plant species are preserved (INSTITUTO FLORESTAL, 2011). From the point of view of the structure of the plant formation, the Reserve has herbaceous, low-shrub, lower and upper tree strata.

Inside the Reserve, there are points where the vegetation is much closed with the presence of parasitic plant species, epiphytes and lichens, in addition to the significant presence of woody species. The Reserve has few scientific papers published, including inventories and other flora studies, the most relevant being the arboreal survey carried out by Toledo-Filho et al. (1993).

Floristic Collection and Analysis

For the floristic survey, the expedited walking method was used, in which trails are opened in the area where the study is to be carried out and basically consists of a concise description of the vegetation of the area to be sampled, listing the species found (FILGUEIRAS et al., 1994).

In this study, the collections were carried out on the Figueira trail that extends for approximately 500 meters and already existed in the place, during the months of December 2007 to May 2008, in random walks with intervals of fifteen days. Only non-arboreal specimens found in a fertile state (presence of flower and/or fruit) were collected. The specimens were identified through consultations with specialists and through comparative morphology in the herbarium of the

Federal University of Lavras (UFLA – Minas Gerais), in addition to the use of specialized bibliography.

To compare the similarity of species abundance between the Águas da Prata State Reserve and other studies also carried out in the Atlantic Forest biome, especially in Semideciduous Seasonal Forests, the Euclidean distance was calculated, where the smaller the value found, the closer are the analyzed areas. These analyzes were performed using the statistical program BioEstat 5.0.

RESULTS AND DISCUSSION

During the study period, 44 fertile species were identified, with 39 genera distributed among 23 families. Among the sampled species, 59% are represented by terrestrial herbs, 20.5% by shrubs, 11.4% by subshrubs and 9.1% by lianas.

Among the 10 most diverse angiosperm families in Brazil, Orquidaceae, Fabaceae, Asteraceae, Piperaceae, Poaceae, Myrtaceae, Melastomataceae, Euphorbiaceae, Rubiaceae and Apocynaceae, respectively (STEHMANN et al., 2009), six were represented in the Águas da Águas State Reserve. Asteraceae qualified as the richest family in the collections with 13 species collected, Piperaceae with four species was the second most registered family and Commelinaceae and Solanaceae had three representatives each (table 1).

The first information about the vegetation of the understory emerged as a



complement to the study of the tree component, but recently in Brazilian forests this portion began to be investigated separately as the main theme in the different biomes (MEIRANETO, MARTINS, 2000; MUNHOZ, FELFILI, 2007;

EUGÊNIO et al., 2011; MIRANDA-SANTOS, MUNHOZ, 2014; AMARAL, 2015; DA CRUZ, CAMPOS, 2015; SILVA, MELO JR, 2016; MELO JR ET AL., 2017; FARIAS, ARAÚJO-MENDES, 2018; ROCHA, COSTA NETO, 2019).

Table 1. List of understory species found in the Águas da Prata State Reserve, São Paulo, with their respective popular name and habits.

Tabela 1. Lista das espécies do sub-bosque encontradas na Reserva Estadual de Águas da Prata, São Paulo, com seus respectivos nomes populares e hábitos.

Family / Specie	Portuguese Popular Name	Habit
Acantaceae		
<i>Anisachantus ramosissimus</i> (Moric.) V.M. Baum	----	Liana
Asclepiadaceae		
<i>Asclepia curassavica</i> L.	Falsa-erva-de-rato; Oficial-de-sala	Terrestrial herb
Asteraceae		
<i>Ageratum conyzoides</i> L.	Mentrasito; Erva-de-São-João	Terrestrial herb
<i>Alomia fastigiata</i> (Gardner) Benth.	Mata-pasto; Melosa	Undershrub
<i>Chaptalia integerrima</i> (Vell.) Bukart.	Língua-de-vaca	Terrestrial herb
<i>Crepis japônica</i> (L.) Benth.	Barba-de-falcão	Terrestrial herb
<i>Eclipta alba</i> (L.) Hassk.	Erva de botão	Terrestrial herb
<i>Elephantopus mollis</i> Kunth.	Erva Grossa	Terrestrial herb
<i>Emilia sonchifolia</i> (L.) DC ex Wigth	Serralha	Terrestrial herb
<i>Galinsoga parviflora</i> Cav.	Picão branco	Terrestrial herb
<i>Galinsoga quadriradiata</i> Ruiz & Pav.	Picão branco	Terrestrial herb
<i>Wulffia stenoglossa</i> (DC.) Huber	Cravo do campo	Shrub
Asteraceae sp. 1	----	Terrestrial herb
Asteraceae sp. 2	----	Terrestrial herb
Asteraceae sp. 3	----	Undershrub
Begoniaceae		
<i>Begônia cucullata</i> Will.	Azedinha do brejo	Terrestrial herb
Bignoniaceae		
<i>Anemopaegma heringerii</i> J.C. Gomes	Pente-de-macaco	Liana
Campalunaceae		
<i>Siphocampylus fimbriatus</i> Regel	Jaratataca	Undershrub
Cyperaceae		
<i>Cyperus rotundus</i> L.	Tiririca	Terrestrial herb



Commelinaceae		
<i>Commelina difusa</i> Burm.f.	Trapoeraba; Marianinha	Terrestrial herb
<i>Commelina erecta</i> L.	Trapoeraba; Erva-de-Santa-Luzia	Terrestrial herb
<i>Tripogandra diurética</i> (Mart.) Handlos.	Trapoeraba-de-cor-rosa	Terrestrial herb
Fabaceae		
<i>Desmodium adscendens</i> (Sw.) DC.	Carrapicho	Terrestrial herb
Lamiaceae		
<i>Hyptis Mutabilis</i> (Rich.) Briq.	Cheirosa	Terrestrial herb
Malphygiaceae		
<i>Banisteriopsis basifixa</i> B. Gates	Vassourinha; Ramo-de-besta	Liana
Malvaceae		
<i>Sida rhombifolia</i> L.	Guanxuma; Mata-pasto	Undershrub
Melatomastaceae		
<i>Huberia ovalifolia</i> DC.	Jacatirão; Mangue-bravo	Shrub
Onagraceae		
<i>Ludwigia elegans</i> (Cambess.)	Crus-de-malta	Terrestrial herb
<i>Onagraceae</i> sp. 1	----	Terrestrial herb
Oxidalaceae		
<i>Oxalis latifolia</i> Kunth.	Trevo; Azedinha	Terrestrial herb
Piperaceae		
<i>Ottonia leptostachya</i> Kunth.	----	Undershrub
<i>Piper aduncum</i> L.	Caapeba; Pimente-de-macaco	Shrub
<i>Piper amalago</i> L.	Jaguarandi; Pariparoba	Shrub
<i>Pothomorphe umbellata</i> L.	Pariparoba	Shrub
Plantaginaceae		
<i>Plantago tomentosa</i> Lam.	Tanchagem	Terrestrial herb
Poaceae		
<i>Setaria geniculata</i> (Lam.) P.Beauv	Capim-rabo-de-raposa	Terrestrial herb
Polygonaceae		
<i>Polygonum acuminatum</i> Kunth.	Capiçoba; Erva-de-bicho	Terrestrial herb
Rubiaceae		
<i>Diodia alata</i> Nees & Mart.	Erva de lagarto	Terrestrial herb
Sapindaceae		
<i>Cardiospermum halicacabum</i> L.	Balãozinho	Liana
Solanaceae		
<i>Solanum aculeatissimum</i> Jacq.	Arrebenta-cavalo	Shrub
<i>Solanum americanum</i> Mill.	Maria-pretinha	Shrub
<i>Solanum erianthum</i> D.Don	Caiçara; Fumo-bravo	Shrub



Verbenaceae
Lippia lupulina Cham.
 Verbenaceae sp. 1

Salva-do-campo

Shrub
 Terrestrial herb

When it comes to the Atlantic Forest, specifically the Semideciduous Seasonal Forest, studies on the flora of the understory are still scarce. Meira-Neto, Martins (2000) found, in a survey carried out in the Forest of Silviculture in Viçosa (Minas Gerais State), the Rubiaceae (n= 16) and Melastomastaceae (n= 8) families as the most abundant and Asteraceae (n= 2) as one of the least abundant. A notable difference when compared to this study, in which Asteraceae (n= 13) was the most abundant and Rubiaceae (n= 1), along with other identified species, were the least abundant, in addition to the fact that the two localities did not present any species in common.

The plant community of the understory of the Águas da Prata State Reserve also showed low floristic similarity with other works in remnants of semi-deciduous seasonal forests, such as, for example, in the municipalities of Ingaí, in Minas Gerais State (BOTREL et al., 2002) and Campinas, in São Paulo State (SANTOS, KINOSHITA, 2003) where no species common to this study were identified, only the genus *Solanum*.

Stranghetti, Ranga (1998), at the Ecological Station of Paulo de Faria (São Paulo State) found in common with this study the species *Asclepia curassavica*, *Oxalis latifolia*, *Piper aduncum*, *Piper amalago* and *Solanum erianthum*, beyond genus

Hyptis sp., *Banisteriopsis* sp., *Sida* sp. and *Cadiospermum* sp. In the municipality of Pedreira (São Paulo State), only the species *Piper amalago* and *Pothomorphe umbellata* and the genus *Solanum* (YAMAMOTO et al., 2005) common to this survey were found.

The result of these comparisons reveals a relatively low number of common species among the different locations, even with the same phytophysiologicals, however it is important to point out that the sample size greatly influences the number of species surveyed. Many studies illustrate that for every tenfold decrease in the sampled area; about 30% of the species of the original community is lost (KAGEYAMA, 1987). In addition, other factors such as climate, differences between altitudes, distances between areas and different types of soil, as well as the different sampling methodologies used by other studies in this comparison, also seem to be acting on this low floristic similarity.

Regarding the number of species, it is noted that this work is more like that found by Yamamoto et al. (2005) (Euclidean distance = 0.2893) and less similar to the study by Meira-Neto, Martins (2000) (Euclidean distance = 2.6384) (table 2).

The Águas da Prata State Reserve shows signs of anthropic and natural alterations that occurred at different times, and for these reasons



the vegetation has become a mosaic of successional situations very characteristic of tropical forests (WHITMORE, 1983; BROWN, 1990).

In addition, the area is on the margins of the

Table 2. Multivariate Euclidean Distance correlation between the Águas da Prata State Reserve and other studies in Semideciduous Seasonal Forests.

Tabela 2. Correlação da Distância Euclidiana multivariada entre a Reserva Estadual de Águas da Prata e outros estudos em Florestas Estacionais Semideciduais.

Semideciduous Seasonal Forests	Águas da Prata State Reserve	Meira-Neto, Martins (2000)	Santos, Kiroshita (2003)	Stranguetti, Ranga (1998)	Yamamoto et al. (2005)
Águas da Prata State Reserve	0	---	---	---	---
Meira-Neto, Martins (2000)	2,6384	0	---	---	---
Santos, Kiroshita (2003)	1,0201	3,6444	0	---	---
Stranguetti, Ranga (1998)	2,3587	0,8289	3,2869	0	---
Yamamoto et al. (2005)	0,2893	2,3491	1,3058	2,087	0

From the floristic survey by the expedited method by walking, it was possible to identify (considering 48.4 ha a small reserve) a great variety of non-tree species of the understory. However, the plant formations inside the Reserve are gradually disappearing, mainly due to the introduction of agricultural crops (e.g. coffee) or through solid waste left by the local population and tourists, who have easy access to its interiors through the trails.

The species richness found in this study constitutes a very valuable natural resource, and, therefore, its conservation is a justifiable measure, not only because it is contained in a State Reserve, but also because of its genetic heritage. However,

Governor Doctor Adhemar Pereira de Barros Highway (SP - 342), probably suffering its influence, mainly due to the edge effect.

the results obtained in this study are partial, and there is a need to continue studies in this area for the cataloging of other species, since, as the reserve showed low similarity with other important areas of semideciduous seasonal forest, rare and even unknown species may occur.

CONCLUSIONS

Floristic inventories are basic and necessary works for understanding the composition of the flora in a particular region and are part of the initial step of local ecosystem knowledge, justifying future studies. In a Conservation Unit, this work becomes even more important, since its results can



be used in the management of the unit and support conservation actions that are essential for the preservation of biodiversity.

In the Águas da Prata State Reserve, work carried out with the plant component is still scarce and, therefore, it is of fundamental importance to better understand the vascular flora of the Reserve, which may serve as a subsidy for future studies.

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