REVISTA FLORESTA Engenharia Florestal
ISSN 1982-4688
Edição 54
Universidade Federal do Paraná
Setor de Ciências Agrárias

PHYTOSOCIOLOGICAL CHARACTERIZATION OF AN URBAN FRAGMENT OF INTERIOR ARAUCARIA FOREST - PARANÁ, BRAZIL

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Received for publication: 23/11/2023 – Accepted for publication: 24/05/2024

Resumo

Caracterização fitossociológica de um fragmento florestal urbano de Mata Atlântica de Interior – Paraná, Brasil. O Parque Natural Municipal Paulo Gorski, situado no Oeste do Paraná, compreende um remanescente urbano de Floresta Ombrófila Mista. Este trabalho teve como objetivo conhecer as espécies arbóreas e realizar a caracterização fitossociológica deste fragmento da Mata Atlântica. Foram realizadas visitas mensais, em dez parcelas de 20 x 5 m, com o intuito de coletar amostras férteis. Foi gerada a curva de rarefação e calculados os parâmetros fitossociológicos, diversidade e distribuição dos indivíduos em classes de diâmetro. Foram amostrados 158 indivíduos arbóreos, distribuídos em 23 famílias e 47 espécies (seis exóticas). Das espécies encontradas, 74,4% apresentam síndrome de dispersão zoocórica, 19,1% anemocórica e 6,5% autocórica. Com relação à categoria sucessional, 63,8% são espécies de sucessão inicial. *Alchornea triplinervia* (Spreng.) Müll.Arg. e *Prunus myrtifolia* (L.) Urb. apresentaram os maiores valores de importância, em razão do elevado número de indivíduos, maiores frequência e área basal. *Araucaria angustifolia* (Bertol.) Kuntz, ameaçada de extinção, também apresentou alto valor de importância. O índice de diversidade de Shannon foi 3,43 e a equabilidade 0,89. Cerca de 70% dos indivíduos se distribuem nas classes de menores diâmetros (< 15 cm), desenhando o J invertido, formato esperado e que indica que este fragmento possui capacidade regenerativa e estrutura de um remanescente florestal conservado, apesar de estar em área urbana e sofrer fortes pressões antrópicas. Pode-se considerar que este fragmento florestal urbano precisa ser preservado, pois reúne espécies arbóreas nativas e ameaçadas da região, funciona como corredor ecológico, mantém funções ecológicas e sociais importantes para a região.

Palavras-chave: Parque Natural Municipal Paulo Gorski, Unidade de Conservação, Fitossociologia, Floresta Ombrófila Mista.

Abstract

The Parque Natural Municipal Paulo Gorski, located in western Paraná, comprises an urban remnant of Mixed Ombrophilous Forest. This study aimed to identify tree species and conduct the phytosociological characterization of this fragment of the Atlantic Forest. Monthly visits were made in ten plots (20 x 5 m) to collect fertile samples. A rarefaction curve was generated, and phytosociological parameters, diversity, and the distribution of individuals in diameter classes were calculated. A total of 158 tree individuals were sampled, distributed across 23 families and 47 species (including six exotic ones). Among the species found, 74.4% exhibited zoochoric dispersion syndrome, 19.1% anemochoric, and 6.5% autocoric. Concerning successional category, 63.8% were early successional species. *Alchornea triplinervia* (Spreng.) Müll.Arg. and *Prunus myrtifolia* (L.) Urb. had the highest importance values due to their high number of individuals, greater frequency, and basal area. *Araucaria angustifolia* (Bertol.) Kuntz, an endangered species, also had a high importance value. The Shannon diversity index was 3.43, and evenness was 0.89. Approximately 70% of the individuals were distributed in smaller diameter classes (< 15 cm), forming an inverted J-shape, an expected pattern indicating a regenerative capacity and structure of preserved forest remnants, despite being in an urban area and facing significant human pressures. This urban forest fragment should be preserved, as it contains native and endangered tree species from the region, serving as an ecological corridor, and maintains important ecological and social functions for the region.

Keywords: Parque Natural Municipal Paulo Gorski, Conservation Unit, Phytosociology, Mixed Ombrophilous Forest.

INTRODUCTION

Urban forest fragments are remnants of natural vegetation surrounded by an urban matrix, and they can host a great diversity of species, serving as an important biodiversity reserve, even for threatened species of high conservation value (MELO *et al.*, 2011; BALD *et al.*, 2021). These areas offer various advantages, which can be ecological, social, aesthetic, and educational. In turn, they provide environmental, sociocultural, and economic benefits, such as ecological processes development, wildlife habitat, microclimate improvement, job creation in monitoring, trail maintenance, city beautification, and enhanced human quality of life (NUCCI, 2001). Employing

these fragments as recreational areas minimizes the impact of certain disturbance factors, such as fires, wood extraction, and cattle intrusion (NUCCI, 2001). However, various other disturbance factors, like excessive trails, litter, biological invasions, among others, degrade these fragments and undermine their ecological potential and the self-sustainability of many species' populations, making these areas face challenging conditions for their perpetuation (MELO *et al.*, 2011). The fragmentation process not only reduces the forested area but also creates an edge effect within the fragments, leading to modified conditions of humidity, temperature, and solar radiation, which compromises ecosystem equilibrium (MURCIA, 1995).

The Parque Natural Municipal Paulo Gorski (PNMPG) establishment took place during the 1970s and 1980s, coinciding with the planning and construction of the reservoir for the lake. This reservoir served the dual purpose of reserving water to support the agricultural growth of the region, while also providing recreational space and sports competitions. Importantly, it was intended to symbolize water preservation for future generations and the city's water supply. Additionally, the park was created to protect the mature Araucaria trees, which were subject to theft in the 1970s (PNMPG, 2022). Today, the park offers the municipality a leisure area featuring walking paths, a children's playground, and the city's first chapel. It also contributes to the city's water supply, as the water surface belongs to the Microbasin of the Cascavel River (PNMPG, 2022).

This study aimed to identify tree species and analyze the phytosociological structure of an urban forest fragment of Interior Atlantic Forest in Paraná, with the objective of evaluating its potential as an ecological corridor between forest remnants in western Paraná.

MATERIAL AND METHODS

Location and characterization of the study area

The Parque Natural Municipal Paulo Gorski (PNMPG) is a Conservation Unit (CU) of Integral Protection. It is located within the urban area of Cascavel, Paraná, at coordinates 24°57'51.61"S and 53°26'14.80"W, with an average altitude of 800 meters (Figure 1) (PNMPG, 2022). The park covers a total area of 842,671.69 square meters with a linear perimeter of 7,563.24 meters, out of which 38,000 square meters constitute the municipal lake. Considering the adjacent and contiguous areas to the park, there is a military area spanning 159.62 hectares, and the Danilo Galafassi Municipal Park (municipal zoo) with 17.91 hectares (PNMPG, 2022). The park's main attraction is the Municipal Lake, which features a walking track of over four kilometers, primarily winding through native woodland, allowing visitors to encounter local wildlife and flora species (PNMPG, 2022)

It is situated on the third plateau of Paraná, within the Paraná Basin III, characterized by basalt rock dikes originating from the basaltic magmatic phase during the Mesozoic era. The predominant soils in the region are Red Latosols and deep Nitosols, known for their good water retention, aeration, and permeability capacity (PNMPG, 2022).

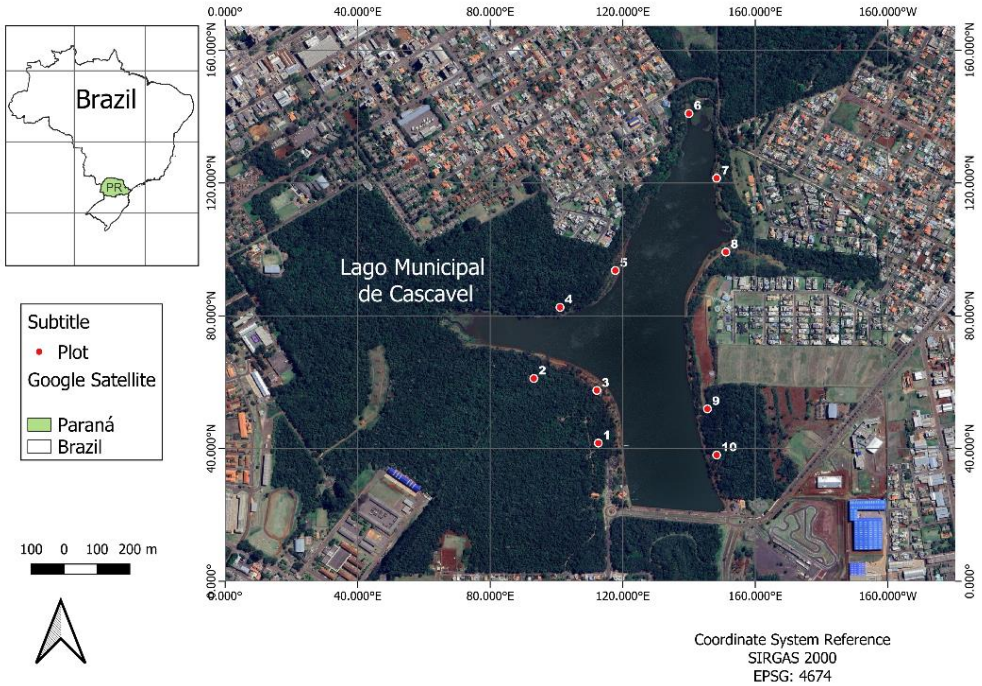

Figure 1. Location of the Parque Natural Municipal Paulo Gorski (PNMPG), Cascavel/PR. Distribution of the plots encircling the PNMPG Lake.

Figura 1. Localização do Parque Natural Municipal Paulo Gorski (PNMPG), Cascavel/PR. Distribuição das dez parcelas contornando o Lago do PNMPG.

The climate is temperate mesothermal and humid, with an average annual temperature of around 21 °C (PNMPG, 2022), and the region is subject to frosts, although not very frequent (PNMPG, 2022). The municipality of Cascavel is located within the phytogeographic domain of the Atlantic Forest, which includes two types of vegetation: Seasonal Semideciduous Forest (FES) and Mixed Ombrophilous Forest (FOM) also known Araucaria Forest. Therefore, the regional vegetation can be classified as an ecotone, characterized as a contact area between these two forest types: MOF and SSF (IBGE, 2012). However, a recent study (SILVA *et al.*, in preparation) classify the PNMPG as a fragment of FOM due to the presence of species typical of this vegetation type, such as *Araucaria angustifolia* (Bertol.) Kuntze, *Ilex paraguayensis* A. St.-Hil., and *Podocarpus lambertii* Klotzsch ex Endl.

Collection and species identification

To assemble the plots, the grassy areas around the lake were disregarded. Beyond this area, the plots were placed 2 meters away from the edge. Furthermore, factors such as accessibility, conservation status, absence of gaps, and representativeness of the vegetation physiognomy were taken into account. Ten plots measuring 20 x 5 meters, with a minimum spacing of 100 meters, were established in these areas, with the marking starting 2 meters from the forest edge to avoid edge effects. The sampling area comprised 0.1 hectares of native forest around the Municipal Lake within the PNMPG.

Within each plot, tree-sized individuals with a circumference at breast height (CBH) equal to or greater than 15 cm were included in the survey. These individuals were sequentially numbered and monitored for 12 months to identify a higher number of fertile species. Species identifications were performed in the field whenever possible. Fertile specimens collected were pressed and dried at a temperature of 70 °C in a forced-air circulation oven for three days, allowing for identification and their inclusion in the Herbarium of the State University of Western Paraná (UNOP), where they were assigned registration numbers (Table 1). The species were identified at the species level through consultation of virtual herbaria and by comparison with exsiccate samples from UNOP or, when necessary, with the assistance of specialists. The classifications according to the successional category and the diaspore dispersal syndrome were checked using specific literature (e.g. LORENZI, 2002; RAMOS *et al.*, 2008).

Species richness and phytosociological analyses

The species listings were produced with botanical families following the current classification system of APG IV (2016), and the authors' names were confirmed using the "*Flora e Funga do Brasil*" website (2023). A rarefaction curve was calculated using the Vegan package in R software version 4.1.2 (R CORE TEAM, 2021) and used to compare species richness (GOTELLI; COLWELL, 2001).

The phytosociological parameters were analyzed using R software version 4.1.2 (R CORE TEAM, 2021), following Mueller-Dombois and Ellenberg (1974): Absolute Dominance and Relative Dominance (ADo, RDo), Absolute Density and Relative Density (AD, RD), Absolute Frequency and Relative Frequency (AF, RF), and Importance Value (IV), which results from the sum of RD + RF + RDo and portrays the ecological significance of the species in the plant community. Floristic diversity was calculated using the Shannon-Wiener index (H') (BROWER; ZAR, 1984) and Pielou's evenness index (J'), according to Magurran (1988). The circumference measurements were converted into diameter measurements to analyze the distribution of individuals among diameter classes, and the class interval was calculated using Sturges' rule, with the first class starting at 4.77 cm, which corresponds to a circumference of 15 cm.

RESULTS

In the ten plots, 158 live trees individual were sampled, representing 23 botanical families and 47 species (Table 1). Lauraceae was the family with higher species richness (6 spp.), followed by Myrtaceae and Fabaceae (5 spp. each). Euphorbiaceae and Rosaceae showed the highest number of individuals throughout the plots, besides the low number of species. Euphorbiaceae was present in 70% of the plots, and Rosaceae in 60%.

Table 1. Tree species and their respective families found in the Parque Natural Municipal Paulo Gorski (PNMPG), Cascavel – PR. DS (dispersal syndrome): Ane = anemochoric, Aut = autocoric, Zoo = zoochoric; SC (successional category): P = pioneer, Es = early secondary, Ls = late secondary, C = climax, and Ex = exotic (LORENZI, 2002; RAMOS *et al.*, 2008); UNOP = Herbarium of the Western Paraná State University.

Tabela 1. Espécies arbóreas em suas diferentes famílias, encontradas no Parque Natural Municipal Paulo Gorski (PNMPG), Cascavel – PR. SD (síndrome de dispersão): Ane = anemocórica, Aut= autocórica, Zoo = zoocórica; CS (categoria sucessional): P= pioneira, Si= secundária inicial, St=secundária tardia, C=clímax e Ex=exótica (LORENZI, 2002; RAMOS *et al.*, 2008); UNOP = Herbário da Universidade Estadual do Oeste do Paraná.

Family	Species	DS	SC	Voucher
Anacardiaceae	*Schinus terebinthifolia* Raddi	Zoo	P	UNOP 11411
Apocynaceae	*Tabernaemontana catharinensis* A.DC.	Zoo	P	UNOP 9346
Aquifoliaceae	*Ilex dumosa* Reissek	Zoo	Es	UNOP 1805
	Ilex paraguariensis A.St.-Hil	Zoo	Es	UNOP 11403
Araucariaceae	*Araucaria angustifolia* (Bertol.) Kuntze	Zoo	P	UNOP 8065
Arecaceae	*Syagrus romanzoffiana* (Cham.) Glassman	Zoo	Es	UNOP 941
Asteraceae	*Moquiniastrum polymorphum* (Less.) G. Sancho	Ane	Es	UNOP 11400
	Piptocarpha angustifolia Dusén ex Malme	Ane	Es	UNOP 9228
Bignoniaceae	*Jacaranda micrantha* Cham.	Ane	Es	UNOP 4586
	Jacaranda mimosifolia D. Don	Ane	Ex	UNOP 11410
	Jacaranda puberula Cham.	Ane	Es	UNOP 6536
Erythroxylaceae	*Erythroxylum deciduum* A.St.-Hil.	Zoo	P	UNOP 4773
Euphorbiaceae	*Alchornea triplinervia* (Spreng.) Müll.Arg.	Zoo	Ls	UNOP 4798
	Sapium glandulosum (L.) Morong	Zoo	P	UNOP 1804
Fabaceae	*Enterolobium contortisiliquum* (Vell.) Morong	Zoo	P/Es	UNOP 487
	Machaerium paraguariense Hassl.	Ane	Es	UNOP 6725
	Machaerium stipitatum Vogel	Ane	Es	UNOP 1868
	Parapiptadenia rigida (Benth.) Brenan	Zoo	Es	UNOP 4880
	Senna macranthera (DC. ex Collad.) H.S.Irwin & Barneby	Aut	P	UNOP 11402
Lamiaceae	*Vitex megapotamica* (Spreng.) Moldenke	Zoo	Es	UNOP 4749
Lauraceae	*Cinnamomum amoenum* (Nees & Mart.) Kosterm.	Zoo	Ls	UNOP 1803
	Ocotea puberula (Rich.) Nees	Zoo	Es	UNOP 1863
	Ocotea pulchella (Nees & Mart.) Mez	Zoo	Es	UNOP 11408
	Ocotea silvestris Vattimo-Gil	Zoo	Ls	UNOP 9819
	Persea americana Mill	Zoo	Ex.	UNOP 1905
	Persea major (Meisn.) L.E.Kopp	Zoo	Ls	UNOP 4799
Lythraceae	*Lagerstroemia indica* L.		Ex.	UNOP 10090
Melastomataceae	*Miconia pusilliflora* (DC.) Naudin	Zoo	P/ Es	UNOP 11404
Meliaceae	*Cabralea canjerana* (Vell.) Mart.	Zoo	Es	UNOP 1140
	Cedrela fissilis Vell.	Ane	P	UNOP 1839
Myrtaceae	*Campomanesia xanthocarpa* (Mart.) O.Berg	Zoo	Es/C	UNOP 5877
	Eugenia involucrata DC.	Zoo	Ls	UNOP 11405
	Plinia peruviana (Poir.) Govaerts	Zoo	Es	UNOP 6891
	Psidium cattleyanum Sabine	Zoo	Es	UNOP 1323
	Siphoneugena reitzii D. Legrand	Zoo	P	UNOP 11305
Primulaceae	*Myrsine umbellata* Mart.	Zoo	Es	UNOP 10731
Rhamnaceae	*Frangula sphaerosperma* (Sw.) Kartesz & Gand	Zoo	Ex.	UNOP 4764
Rosaceae	*Prunus myrtifolia* (L.) Urb.	Zoo	Es	UNOP 11407
	Prunus serrulata Lindl.	Zoo	Ex.	UNOP 1337
Rutaceae	*Citrus aurantiifolia* (Christm.) Swingle	Zoo	Ex.	UNOP 4740
	Zanthoxylum rhoifolium Lam.	Zoo	P	UNOP 1678
Salicaceae	*Banara parviflora* (A. Gray) Benth	Zoo	Es/Ls	UNOP 10537
	Casearia decandra Jacq.	Zoo	Ls	UNOP 11401

	Casearia sylvestris Sw.	Zoo	P	UNOP 1350
Sapindaceae	*Allophylus edulis* (A.St.-Hil. *et al.*) Hieron. ex Niederl.	Zoo	P	UNOP 1649
	Matayba elaeagnoides Radlk.	Zoo	Ls	UNOP 1347
Solanaceae	*Solanum pseudoquina* A.St.-Hil.	Zoo	P	UNOP 8089

When comparing the results of this study with previous work conducted in PNMPG (SILVA, 2016), 12 new records have been identified for this study area. These include: *Banara parviflora*, *Cabralea canjerana*, *Frangula sphaerosperma*, *Jacaranda micranta*, *Jacaranda mimosifolia*, *Machaerium paraguariense*, *Miconia pusilliflora*, *Ocotea silvestri*, *Plinia peruviana*, *Piptocarpha angustifolia*, *Siphoneugena reitzii*, and *Tabernaemontana catharinensis.* Among the 47 species found, 74.4% exhibit zoochoric characteristics, 19.1% are anemochoric, and 6.5% are autocoric. As for the successional category, only 17% of the species are exclusively classified as late secondary, and *Campomanesia xanthocarpa* can be classified as late to climax secondary. Another 2.1% may behave as early to late secondary species. Furthermore, 12.8% of the species are considered exotic to Brazil, namely *Citrus aurantiifolia*, *Frangula sphaerosperma*, *Jacaranda mimosifolia*, *Lagerstroemia indica*, *Persea americana*, and *Prunus serrulata*, all with low representation of individuals (Table 2).

Table 2. List of tree species in terms of Importance Value (IV) in the urban forest fragment. SDS = seed-dispersal syndromes, CS = categories of succession, N = number of individuals, AD = absolute density, ADo = absolute dominance, AF = absolute frequency, RF = relative frequency, and IV = Importance Value.

Tabela 2. Lista de espécies arbóreas em valor de importância (VI) do fragmento florestal urbano. SD = síndrome de dispersão, CS = categoria sucessional, N= número de indivíduos, DA = densidade absoluta, DoA = dominância absoluta, FA = frequência absoluta e FR = Frequência relativa e VI = valor de importância.

Species	**N**	**AD**	**RD**	**ADo**	**RDo**	**AF**	**RF**	**IV**
Alchornea triplinervia	17	170	10.76	10.00	27.27	70	7.78	15.27
Prunus myrtifolia	18	180	11.39	3.40	9.27	60	6.67	9.11
Schinus terebinthifolia	6	60	3.80	4.84	13.20	20	2.22	6.41
Casearia sylvestris	13	130	8.23	1.39	3.78	20	2.22	4.74
Araucaria angustifolia	3	30	1.90	3.18	8.68	20	2.22	4.27
Casearia decandra	8	80	5.06	0.45	1.22	50	5.56	3.95
Ocotea puberula	5	50	3.16	0.80	2.17	40	4.44	3.26
Matayba elaeagnoides	5	50	3.16	0.73	2.00	40	4.44	3.20
Ilex paraguariensis	4	40	2.53	0.94	2.56	30	3.33	2.81
Jacaranda micrantha	4	40	2.53	0.81	2.21	30	3.33	2.69
Solanum pseudoquina	6	60	3.80	0.25	0.67	30	3.33	2.60
Moquiniastrum polymorphum	3	30	1.90	1.27	3.46	20	2.22	2.53
Senna macranthera	4	40	2.53	0.75	2.05	20	2.22	2.27
Allophylus edulis	4	40	2.53	0.26	0.71	30	3.33	2.19
Enterolobium contortisiliquum	1	10	0.63	1.74	4.74	10	1.11	2.16
Cedrela fissilis	2	20	1.27	0.99	2.69	20	2.22	2.06
Syagrus romanzoffiana	2	20	1.27	0.89	2.42	20	2.22	1.97
Cabralea canjerana	5	50	3.16	0.18	0.50	20	2.22	1.96
Erythroxylum deciduum	3	30	1.90	0.20	0.55	30	3.33	1.93
Myrsine umbellata	4	40	2.53	0.33	0.89	20	2.22	1.88
Jacaranda mimosifolia	3	30	1.90	0.78	2.12	10	1.11	1.71
Vitex megapotamica	2	20	1.27	0.16	0.44	20	2.22	1.31
Ocotea pulchella	2	20	1.27	0.17	0.45	20	2.22	1.31
Banara parviflora	4	40	2.53	0.10	0.26	10	1.11	1.30
Cinnamomum amoenum	2	20	1.27	0.13	0.36	20	2.22	1.28
Parapiptadenia rígida	2	20	1.27	0.25	0.69	10	1.11	1.02
Sapium glandulosum	2	20	1.27	0.12	0.32	10	1.11	0.90
Psidium cattleyanum	1	10	0.63	0.35	0.95	10	1.11	0.90
Ocotea silvestres	2	20	1.27	0.09	0.24	10	1.11	0.87
Machaerium stipitatum	2	20	1.27	0.05	0.13	10	1.11	0.84
Persea americana	2	20	1.27	0.06	0.16	10	1.11	0.84
Frangula sphaerosperma	2	20	1.27	0.05	0.13	10	1.11	0.83
Campomanesia xanthocarpa	1	10	0.63	0.19	0.52	10	1.11	0.76
Tabernaemontana catharinensis	1	10	0.63	0.13	0.35	10	1.11	0.70
Lagerstroemia indica	1	10	0.63	0.11	0.30	10	1.11	0.68
Piptocarpha angustifólia	1	10	0.63	0.07	0.20	10	1.11	0.65
Jacaranda puberula	1	10	0.63	0.07	0.20	10	1.11	0.65
Citrus aurantiifolia	1	10	0.63	0.08	0.22	10	1.11	0.65

Zanthoxylum rhoifolium	1	10	0.63	0.08	0.21	10	1.11	0.65
Ilex dumosa	1	10	0.63	0.06	0.18	10	1.11	0.64
Machaerium paraguariense	1	10	0.63	0.05	0.12	10	1.11	0.62
Siphoneugena reitzii	1	10	0.63	0.04	0.11	10	1.11	0.62
Persea major	1	10	0.63	0.02	0.05	10	1.11	0.60
Miconia pusilliflora	1	10	0.63	0.02	0.06	10	1.11	0.60
Eugenia involucrata	1	10	0.63	0.02	0.06	10	1.11	0.60
Plinia peruviana	1	10	0.63	0.03	0.07	10	1.11	0.60
Prunus serrulata	1	10	0.63	0.02	0.07	10	1.11	0.60

The rarefaction curve exhibits a slight inflection point, indicating a tendency toward stability, however, it also shows a minor increase in the number of species as the number of individuals grows (Figure 2). The Shannon diversity index (H') obtained was 3.43 nats.ind, and the Pielou equitability index was 0.89. The average sampled basal area was 36.67 m²/ha. The plots with the highest basal area were Plot 8 with 59.72 m²/ha, Plot 4 with 51.11 m²/ha and Plot 6 with 48.06 m²/ha. The total estimated density for the area was 1580 ind/ha.

The species with the highest Importance Value (IV) were *Alchornea triplinervia* (15.27%), *Prunus myrtifolia* (9.11%), *Schinus terebinthifolia* (6.41%), *Casearia sylvestris* (4.74%), and *Araucaria angustifolia* (4.27%). The highest individual density was recorded for *P. myrtifolia* (180 ind/ha), followed by *A. triplinervia* (170 ind/ha) and *C. sylvestris* (130 ind/ha) (Table 2).

The diameter distribution of this fragment exhibited an inverted J-shape, with the majority of individuals in the first diameter class (50%) (Figure 3). The individuals with the largest diameters at breast height belong to the species *Alchornea triplinervia* (50.29 cm DBH) and *Araucaria angustifolia* (45.84 cm DBH).

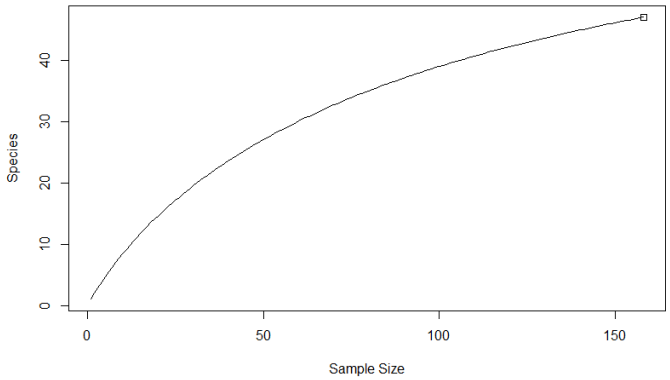

Figure 2. Rarefaction curves for Paulo Gorski Natural Park, illustrating the relationship between the number of tree species and the number of sampled individuals.

Figura 2. Curvas de rarefação para o Parque Natural Paulo Gorski, mostrando a relação entre o número de espécie arbóreas e o número de indivíduos amostrados.

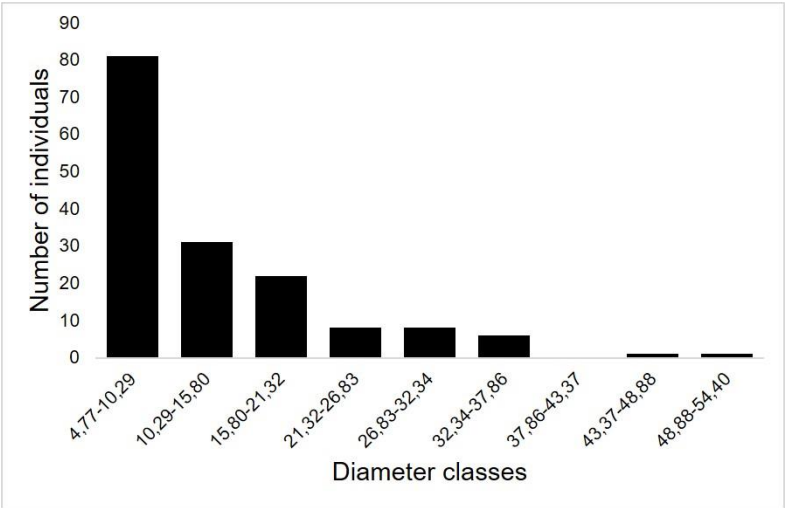

Figure 3. Distribution of diameter classes of tree species in Parque Natural Municipal Paulo Gorski.

Figura 3. Distribuição das classes diamétricas das espécies arbóreas no Parque Natural Paulo Gorski.

DISCUSSION

In this study, Lauraceae, Myrtaceae, and Fabaceae exhibited the highest species richness, aligning with data from other studies conducted in SSF and MOF areas in southern Brazil. These families are among the top ten richest families in terms of species in Brazil (FLORA E FUNGA DO BRASIL, 2023). Lauraceae, in particular, is frequently described as highly abundant in Araucaria Forest, acting as an indicator species associated with this forest type (BORDIN *et al.*, 2019).

Although the stability trend observed in the rarefaction curve is attributed to the environmental heterogeneity, resulting from human influence in the landscape and insufficient sampling (BORDIN *et al.*, 2019), the Shannon diversity index (H' = 3.43) is considered high when compared to values found in other fragments of Seasonal Semideciduous Forest (H' = 2.71 as presented by GRIS *et al.*, 2014; H' = 3.21, BALD *et al.*, 2021) and Mixed Ombrophilous Forest (H' = 2.37, SEGER *et al.*, 2005; H' = 2.79, CORDEIRO; RODRIGUES, 2007; H' = 2.74).

The species diversity is higher when maintained under intermediate levels of disturbance, and these disturbances, occurring in moderate frequency and intensity, can favor greater environmental heterogeneity. This is because pioneer species coexist with more advanced successional stage species that are shade-tolerant, thereby increasing diversity (CONNELL, 1978). This justifies the high diversity index of the study area when compared to areas with less human impact. The creation of canopy gaps and understory openings can lead to an increase in pioneer species (GRIS *et al.*, 2014; CORDEIRO; RODRIGUES, 2007; and SEGER *et al.*, 2005). The presence of pioneer species is crucial for natural regeneration in canopy gaps and the maintenance and dynamics of secondary forests, as their fruits are widely used by wildlife such as bats, primates, and birds (TOSCAN *et al.*, 2017). The evenness (J' = 0.89) found in this study was also considered high when compared to the previously mentioned works (J' = 0.67-0.9). This indicates that individuals are well-distributed among species, with few dominant species and many species with lower abundance (MAGURRAN, 1988).

In this study, the species with the highest Importance Value (IV) was *A. triplinervia*, due to both the number of individuals and their even distribution among the plots, as well as their basal area. This same pattern has been observed in forest fragments located between the cities of Assis Chateaubriand/PR and Toledo/PR, where *A. triplinervia* also ranked second in IV, mainly because of its high density, frequency, and dominance (MORAIS *et al.*, 2023). *Prunus myrtifolia* and *C. sylvestris* also stood out due to their abundant populations, whereas *S. terebinthifolia* and *A. angustifolia* were remarkable for their basal area. Despite *Araucaria angustifolia* being represented by only three individuals, it featured among the five species with the highest IV, mainly because of its substantial basal area.

Seed dispersal by animals represents 75% or more of the tree species in tropical forests, a trend corroborated by the data presented by Toscan *et al.* (2017), which accounted for 75.6% of the species in the region. The prevalence of zoochoric species indicates a high availability of resources for fauna throughout the year, highlighting the conservation of ecological interactions between plants and frugivores. This, in turn, enhances the potential for natural forest regeneration (TOSCAN *et al.*, 2017).

Despite the PNPG being an anthropized and urban area, it only presented 25.5% of pioneer species, a percentage similar to what was observed in the RPPN Fazenda Santa Maria, a rural forest fragment (GRIS *et al.*, 2014). Pioneer species, when combined with early secondary species, accounted for 63.8% of the total. This predominance of early successional species supports the classification of this vegetation as early secondary (PNMPG, 2022).

The distribution of diameter classes in this fragment assumed the typical pattern of an inverted J-curve, which is common in tropical forests, where there is a higher quantity of individuals in smaller size classes that decreases with larger classes (MEYER, 1952). The abundance of smaller trees in the lower diameter classes indicates a balanced distribution, primarily due to the regenerative capacity of plant species. Most of the sampled individuals had a diameter of less than 15 cm, consistent with patterns observed in Atlantic Forest studies (BORDIN *et al.*, 2019), representing young understory individuals and indicating the forest's regenerative capacity. Consequently, there is a lower occurrence of larger trees with greater diameters, which are typically the longer-lived species (CUNHA; SILVA, 2012).

The findings of this study provide insights into the species composition, diversity, and structural attributes of the PNMPG forest fragment. By identifying key species and their ecological roles, this research contributes to a better understanding of the dynamics within this ecotone. The high diversity and evenness indices, along with the notable presence of indicator species, underscore the importance of preserving such areas. These results are useful for other researchers and readers interested in forest ecology, conservation strategies, and the

management of urban ecosystems. The detailed analysis of species distribution, importance values, and regenerative capacities can inform conservation efforts and policy-making, ensuring the protection and sustainable management of these vital habitats.

CONCLUSIONS

- The tree vegetation exhibits a high species diversity, with evenness indicating that individuals are well distributed among the species. There are few dominant species and many with lower abundance. Most species found have a zoochoric dispersal syndrome and belong to the early successional pioneer to secondary categories.
- The five most important species in terms of Importance Value (IV) were *Alchornea triplinervia*, *Prunus myrtifolia*, *Schinus terebinthifolia*, *Casearia sylvestris*, and *Araucaria angustifolia*. *Alchornea triplinervia* and *Prunus myrtifolia* stood out due to their high number of individuals and their even distribution across the plots, as well as their basal area.
- Analysis of the diameter classes suggests that this urban forest fragment has a strong regenerative capacity, with a significant increase in young tree individuals in the lower diameter classes.
- The urban fragment under study holds significant ecological and social functions for the region. Nevertheless, the conservation of the studied area requires proactive management measures, particularly those aimed at enhancing the area with native species. The management of urban forests begins with a comprehensive qualitative and quantitative understanding of their community, as undertaken in this present study.

ACKNOWLEDGMENTS

I would like to express my gratitude to all those who directly or indirectly contributed to the completion of this work, particularly the SEMA for granting the license, my colleagues at the UNOP herbarium for their assistance in field collections and identifications and NAPI-Taxonline and Fundação Araucária by financial support.

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