ANALYSIS OF VASCULAR EPIPHYTIC VEGETATION IN THE STREET TREES OF THE UVARANAS NEIGHBORHOOD, PONTA GROSSA-PR

ANÁLISE DA VEGETAÇÃO EPÍFITA VASCULAR NA ARBORIZAÇÃO VIÁRIA DO BAIRRO UVARANAS, PONTA GROSSA-PR

ANÁLISIS DE LA VEGETACIÓN VASCULAR EPÍFITA EN EL ARBOLADO DE LAS CALLES DEL BARRIO UVARANAS, PONTA GROSSA-PR

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ABSTRACT

Urban afforestation, as one element of the urban landscape, comprises a complex and essential ecosystem that can generate conflicting or beneficial relationships. In neotropical forests, epiphytic flora is an important component in maintaining this ecosystem. Vascular epiphytes are non-parasitic organisms that germinate and live on trees or shrubs without absorbing nutrients from the soil for at least part of their life cycle. Despite their relevance, surveys of epiphytes on urban trees in Brazil are scarce. The Uvaranas neighborhood represents the first Street tree inventory in Ponta Grossa, Paraná State, to include epiphytes as part of the survey. Thus, the objective of this research is to present the results obtained and highlight the relevance of this methodological approach for surveys in your environments. In total, 1185 phorophytes were recorded, on which 1730 epiphytes were observed, distributed across 20 species, with the genera Tillandsia, Microgramma, and Pleopeltis standing out. The frequency of these groups is consistent with other studies conducted in the urban environment of the Atlantic Forest and collaborates with a trend towards homogenization of this vegetation due to the process of anthropization. The use of the application enabled the connection of data on this vegetation integrated with the Urban tree survey of the neighborhood, demonstrating its potential to foster further research on epiphytes in urban forests.

Keywords: Urban Forestation. Vascular Epiphytes. Mixed Ombrophylous Forest. Atlantic Forest. Google My Maps.

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RESUMO

A arborização urbana, como um dos elementos do cenário urbano, compõe um ecossistema complexo e essencial que pode gerar relações conflituosas ou benéficas. Em florestas neotropicais, a flora epifítica é um componente importante para a manutenção desse ecossistema. Epífitas vasculares são organismos não parasitas que germinam e vivem sobre árvores ou arbustos sem absorver nutrientes do solo por, pelo menos, parte do seu ciclo de vida. Apesar de sua relevância, os levantamentos sobre as epífitas presentes em árvores urbanas do Brasil são escassos. O bairro Uvaranas é o primeiro inventário arbóreo das vias públicas de Ponta Grossa-PR, que inclui as epífitas como parte do levantamento. Desta forma, o objetivo desta pesquisa é apresentar os resultados obtidos e apontar a relevância dessa aplicação metodológica em levantamentos no ambiente urbano. Ao todo, foram registrados 1185 forófitos, nos quais foram avistadas 1730 epífitas distribuídas em 20 espécies, das quais os gêneros Tillandsia, Microgramma e Pleopeltis se destacam. A frequência desses grupos está de acordo com outros estudos realizados em ambientes urbanos da Mata Atlântica e corrobora a tendência de homogeneização dessa vegetação decorrente do processo de antropização. O uso do aplicativo Google MyMaps possibilitou a coleta de informações sobre essa vegetação integrada ao levantamento das árvores urbanas do bairro, demonstrando seu potencial para fomentar mais pesquisas sobre epífitas em florestas urbanas.

Palavras-chave: Arborização Viária. Epífitas Vasculares. Floresta Ombrófila Mista. Mata Atlântica. Google My Maps.

RESUMEN

La forestación urbana, como uno de los elementos del paisaje urbano, comprende un ecosistema complejo y esencial que puede generar relaciones conflictivas o beneficiosas. En los bosques neotropicales, la flora epífita es un componente importante para el mantenimiento de este ecosistema. Las epífitas vasculares son organismos no parásitos que germinan y viven en árboles o arbustos sin absorber nutrientes del suelo durante al menos una parte de su ciclo de vida. A pesar de su relevancia, los estudios sobre epífitas presentes en el arbolado urbano en Brasil son escasos. El barrio de Uvaranas es el primer inventario de árboles en vías públicas en Ponta Grossa-PR que incluye epífitas como parte del estudio. Por lo tanto, el objetivo de esta investigación es presentar los resultados obtenidos y señalar la relevancia de esta aplicación metodológica en estudios en el entorno urbano. En total, se registraron 1185 forofitos, de los cuales se observaron 1730 epífitas, distribuidas en 20 especies, entre las que destacan los géneros Tillandsia, Microgramma y Pleopeltis. La frecuencia de estos grupos concuerda con otros estudios realizados en entornos urbanos de la Mata Atlántica y corrobora la tendencia a la homogeneización de esta vegetación como resultado del proceso de antropización. El uso de la aplicación Google My Maps permitió recopilar información sobre esta vegetación, integrándola con el censo del arbolado urbano del barrio, lo que demuestra su potencial para impulsar la investigación sobre epífitas en bosques urbanos.

Palabras clave: Árboles Viales. Epífitas Vasculares. Bosque Mixto Ombrófilo. Mata Atlántica. Google My Maps.

1 INTRODUCTION

The term urban afforestation refers to the vegetation present in urban environments, whether on the sidewalks that accompany the streets, in green areas, in forest remnants or in other spaces. In this way, as one of the elements that make up the urban scenario, this vegetation interacts with the other elements of this environment, participating in conflicting or beneficial relationships (Bastos; Carvalho, 2023).

To promote the maintenance of these biological components, it is necessary to develop urban planning that considers their presence, in order to enhance the benefits offered and minimize the impacts perceived as negative (Tadenuma; Carvalho, 2021; Yugue; Viana, 2022).

In Paraná, in order to assist in this planning, the Public Prosecutor's Office made available a Manual for the Preparation of the Municipal Plan for Urban Afforestation (MP-PR, 2018). The main objective is to subsidize the municipalities of the state in this aspect of urban planning, in addition to highlighting the importance for compliance with the City Statute (Federal Law 10.257/2001), with regard to the right to sustainable cities.

The aforementioned manual presents the term Urban Forests, which defines urban vegetation beyond arboreal individuals (also including shrubs, herbaceous individuals, aquatic plants, among others), without dedicating itself, throughout the document, to plants other than the trees present in these spaces (MP-PR, 2018).

In the Brazilian context, the Atlantic Forest is a biome directly related to urban development. Considered one of the *hotspots* most threatened by anthropogenic action, the biome is characterized by its fragmentation associated with the most populous region of the country, being exploited and deforested intensively since the colonization of the Brazilian territory (Lima, 2025). Within this environment, we find the epiphytic flora, a striking characteristic of humid tropical forests, which can correspond to more than 50% of the vascular vegetation in these ecosystems (Castro et al., 2022; Ariati; Lozano; Kersten, 2025).

Epiphytic plants are those that complete their development on a support plant (phorophyte), without constituting a parasitic relationship and without absorbing nutrients from the soil at least in part of their life cycle, being highly sensitive to anthropogenic disturbances and climate change due to this dependence. This vegetation has a high richness of species that employ different evolutionary strategies, which are fundamental for the preservation of biodiversity in the environments in which they are found (Perini et al., 2025).

Thus, vascular epiphytes perform several important ecosystem functions, such as resource provision, CO_2 conversion through photosynthesis, and are considered bioindicators of disorders. Nevertheless, few surveys have been carried out on them in urban environments in Brazil (Olivo-Neto et al., 2023).

Some tree inventories have already been carried out in the municipality of Ponta Grossa, Paraná, mainly on the sidewalks of public roads in its urban perimeter. However, the presence of epiphytes was addressed for the first time in the survey carried out in the Uvaranas neighborhood, in partnership with the Laboratory of Socio-Environmental Studies (LAESA) of the State University of Ponta Grossa (UEPG) and the City Hall.

The floristic survey of epiphytes involves methodological challenges and significant practical difficulties, which can make the research costly and time-consuming. In this sense, the adoption of different strategies based on the minimum sampling effort can contribute to more efficient research (Lima, 2025).

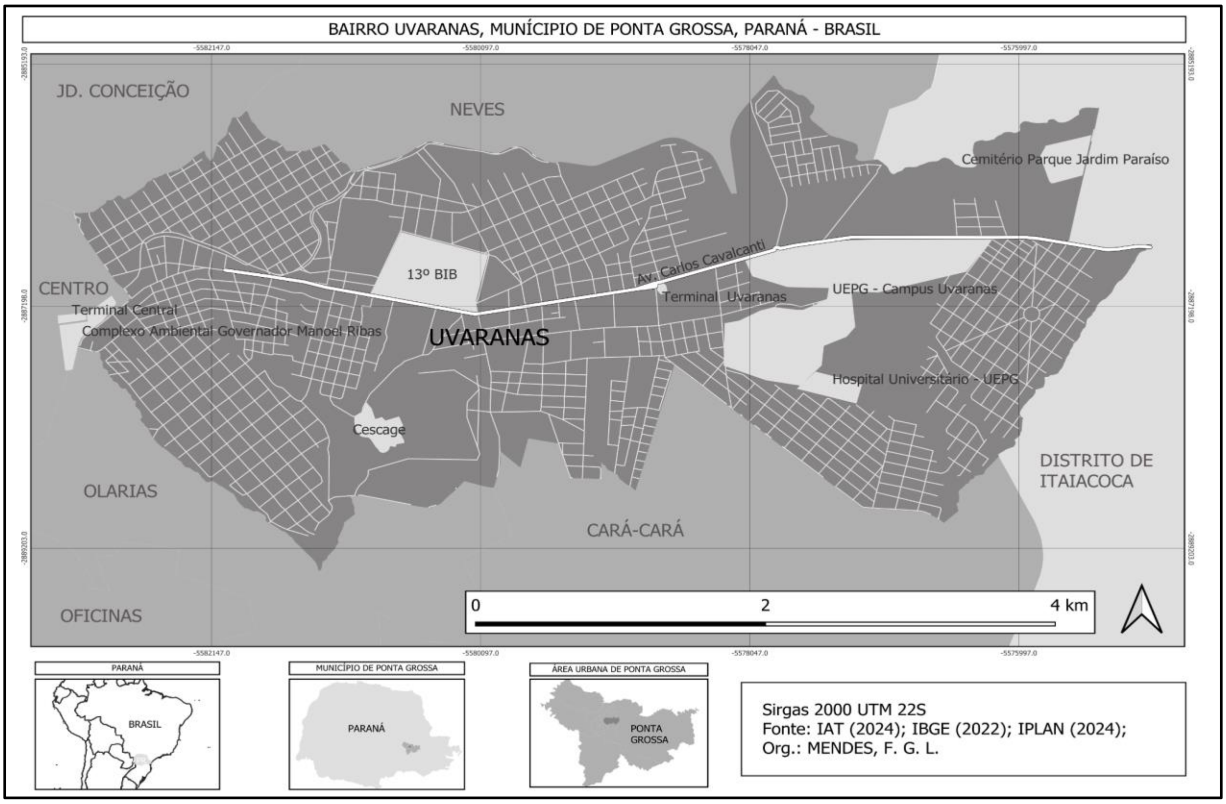
Therefore, the objective of this research is to analyze the results obtained on vascular epiphytes found during the survey of trees on the sidewalks of the Uvaranas neighborhood, in Ponta Grossa-PR, with the intention of demonstrating the relevance of this methodological application for surveys in urban environments influenced by the Vegetal formation of the Mixed Ombrophilous Forest, in the Atlantic Forest biome.

2 METHODOLOGY

For this research, the public roads of the neighborhood of Uvaranas (figure 1), in the municipality of Ponta Grossa, in the State of Paraná, in the southern region of Brazil, were considered as the study area. The city, located on the second plateau of Paraná, has a temperate climate, classified as type Cfb, and its landscape is composed of clean fields and gallery forests or isolated capons of Mixed Ombrophilous Forest, a phytophysiognomy that is part of the Atlantic Forest biome (Ponta Grossa, 2006).

Figure 1

Location of the study area



Source: The authors.

The collection of data on the epiphytes was carried out together with the arboreal inventory of the Uvaranas neighborhood, in which the *Google My Maps* application was used as the main tool for recording the information. For this, a vector layer of points was created, whose attribute table was adapted to receive the questions of the form applied in this survey, which could be answered for each tree represented. The points generated in these layers have georeferenced coordinates and information from the digital form, enabling storage in vector format (shp) or in Excel spreadsheet format (xlsx), facilitating the availability and sharing of the collected data.

To record the sighting of epiphytes in the field, five categories were defined as a response to the item "presence of epiphytes" in the form: 1 - Bromeliads; 2 - Microgram; 3 - Orchids; 4 - Pteridophytes and 5 - Tillandsia. Although the genus Tillandsia is framed in Bromeliaceae and Microgramma, in Samambaias, they were characterized separately, only for practical purposes, due to the representativeness of these genera found in the field. If the epiphyte present does not fit into these categories, the name of the group, such as Araceae or Cactaceae, or its habit in the plant, occasional or vine, for example, was placed.

The analysis of the data collected in the field, in the Excel spreadsheet, was used as a basis to understand the patterns of horizontal distribution in the Uvaranas neighborhood, the possible patterns of interaction between epiphytes and the phorophyte (in relation to the size, species and morphological characteristics of the tree) and its interaction with the characteristics of the environment. In addition, through field analysis and theoretical basis, it was possible to ecologically categorize the species according to Schimper (1888), apud Kersten (2010), regarding nutrition (protoepiphyte, nidiepiphyte, cisternepiphyte and hemiepiphyte) and permanence (holoepiphyte, facultative, primary hemiepiphyte, secondary hemiepiphyte), in relation to substrate, and resistance to water stress (poikilohydric, hygrophytes, mesophytes and xerophytes).

3 THEORETICAL FRAMEWORK

3.1 URBAN AFFORESTATION AND PLANNING

In urban environments, green areas and afforestation are ways to positively impact highly anthropized environments, allowing, through adequate planning, the mitigation of the impacts resulting from urbanization (Yugue; Viana, 2022). Since the publication of the City Statute (Federal Law 10.257/2001), Brazilian municipalities have the obligation to prepare and execute a development plan, also paying attention to the importance of afforestation. In Paraná, this has become even more essential after the publication of the Manual for the preparation of the municipal plan for urban forestation, produced by the State Public Prosecutor's Office (MP-PR, 2018).

According to the aforementioned manual, the municipal plan for urban afforestation comprises different phases: the characterization of the municipality, the diagnosis of afforestation and its planning, which encompasses the implementation and maintenance to be carried out in the following years. The tree inventory is the first moment of the diagnostic phase, in which the technical team must go to the field to collect data on the trees and the environment in which they are found, according to the established research criteria. From the obtaining of this data, it is possible to carry out different analyses as part of the diagnosis of urban vegetation.

In the municipality of Ponta Grossa, the analysis of the spatial distribution of the afforestation of public roads in the urban area was carried out through a digital mapping, based on satellite images. Tadenuma and Carvalho (2021) pointed out that the municipality's public roads have 28925 trees, equivalent to 3.6 trees per 100 meters of radius, a very low afforestation density. Regarding the number of trees per kilometer of road, Ponta Grossa has an average of 22.52 trees/km and fits the Very High level of attention (Iwama, 2014), that is, with a low number of trees per km of road. In addition to this research, the panorama of urban afforestation in the city has some field inventories, carried out in the central area, in the neighborhoods of Olarias, Estrela, Ronda, Órfanas, Nova Russia, Oficinas, Boa Vista and in the city squares (Tadenuma; Carvalho, 2021).

3.2 ATLANTIC FOREST AND VASCULAR EPIPHYTES

The municipality of Ponta Grossa is part of the region of "Campos Gerais do Paraná", a phytogeoFigureic zone characterized by fields with gallery forests or isolated capons of Mixed Ombrophilous Forest, a phytophysiognomy that is part of the Atlantic Forest biome. Thus, many of the native species of this biome were found during these surveys.

The Atlantic Forest is an extremely fragmented Brazilian biome due to the colonizing occupation that has taken place since the arrival of Europeans in Brazilian territory. During this period, the forest had an estimated area of 1.5 million square kilometers, of which 92.19% have been reduced since then. Although it is the biome most affected so far by the anthropization process, the Atlantic Forest continues to be home to more than 20 thousand species that resist in the remaining tiny 102,000 km² (Lima, 2025).

The preservation and recovery of this and other biomes are of great relevance and should occur mainly in conservation units, with the aim of preserving their natural characteristics from direct anthropic action. However, Alvim, Furtado and Menini Neto (2020) suggest that, although urban environments have a high degree of anthropic impact, green areas and urban afforestation can act as conservation areas for native vegetation, and can act as an ecological corridor for some species.

In addition to being highly fractionated, the Atlantic Forest has few large fragments, consisting mainly of sloping terrain. Even so, the biome is considered one of the 36 biodiversity hotspots in the world, which is mainly due to its complexity (Lima, 2025). Like other Neotropical forests, it has different niches and small ecosystems, among which the upper layer of the forest stands out. Called a canopy, it is formed by the set of foliage, branches, branches, trunks and the space that surrounds them, as well as the associated fauna and flora, which gives it great ecological importance for the entire biome (Kersten, 2010). During the last 40 years, different researchers have focused on this area of research, bringing to light relevant scientific knowledge, while keeping it a little-explored environment.

In this context, trees and shrubs can serve as a support (phorophyte) for epiphytic plants, constituting a commensal relationship in which it is possible to observe the colonization of different spaces by these individuals (Francisco, 2017). The stratiFigureic complexity of the vertical distribution of epiphytic communities can vary in size, and may be affected by the microclimate of different regions of the phorophyte (stem, inner canopy, and outer canopy).

The epiphytic flora is considered a striking characteristic of neotropical forests (Madison, 1977) and corresponds to about 10% of the vascular vegetation (Kersten, 2010), and can occupy the entire trunk. Francisco (2017) points out that the interactions between epiphytic individuals and their phorophytes can be considered complex ecological networks, which makes it possible to analyze structural patterns of the epiphytic community. In a neotropical forest, the dispersion, colonization and consequent germination of epiphytes on phorophytes can occur due to several factors, such as the adherence of the phorophyte bark, the available surface area and the microclimate.

Epiphytes perform several ecosystem functions, such as nutrient cycling, water and moisture containment, substrate transformation, and the provision of refuge for fauna, related to evolutionary strategies that include the development of specialized structures and mutualistic interactions with microorganisms. In addition, the dependence on the structure offered by phorophytes makes them sensitive to climatic and anthropogenic changes, constituting an important bioindicator of environmental impacts (Lima, 2025).

Even with all these benefits, epiphytes were considered by few floristic surveys carried out in urban environments in our country (Ritter et al., 2014), a situation pointed out by authors such as Alvim, Furtado and Menini Neto (2020) as an act of negligence and lack of interest on the part of public agencies in relation to this type of vegetation. Another factor pointed out by Lima (2025), as responsible for the low number of studies with epiphytes, is the methodological challenges and practical difficulties of collection, observation or measurement in the field, which can become costly and time-consuming. In this sense, the adoption of different strategies based on the minimum sampling effort can contribute to more efficient research.

Despite the various studies carried out in Ponta Grossa, the inventory of trees on public roads, initiated by the neighborhood of Uvaranas, was the first to consider the presence of epiphytes, an observation that made it possible to analyze this vegetation in the study area.

3.3 *GOOGLE MY MAPS* AS A SEARCH TOOL

Carried out through a partnership between the Laboratory of Socio-Environmental Studies (LAESA) of UEPG and the Department of the Environment of the Municipality of Ponta Grossa, the study recorded 3405 tree individuals in the Uvaranas neighborhood, composed of different species that presented a variety of conservation states and interaction with the urban environment, exceeding the estimate of 2893 for the entire neighborhood

(Tadenuma; Carvalho, 2021). Information about these specimens was collected and stored in the *Google My Maps* application through georeferenced points generated in the field.

Mohan et al. (2020) define the *Google My Maps* as a web-based application through which one can create custom maps, add favorite locations, and can be used for easy navigation and other purposes. According to Bechelli (2013), the free application *Google My Maps* It is characterized as a cheap and easy-to-handle alternative, adapting to the needs of municipal governments. In addition to being easily achievable by people with little knowledge in geotechnologies, the maps can be made available on the internet, becoming public domain, allowing access to the information collected by the population (Bechelli, 2013). Through the creation of vector layers, Google My Maps allows you to work with different groupings, in which lines, points, and areas can be included. Using these layers allows you to categorize objects based on different criteria, based on the data available in the attribute table. Layers can be hidden independently, allowing users to view only the data that matters. Finally, the *Google My Maps* it also allows you to view the basemap in different ways, such as satellite map, relief map, political map, or road map (Bechelli, 2013).

The vector layers created in the application can be exported in Keyhole markup language (.kml) files, georeferenced, which can be opened in tools such as Quantum GIS. In addition, the platform allows you to import Excel spreadsheets or even edit directly in it a table of attributes related to the object of study, which gives the researcher or manager the opportunity to use it as a data collection tool for collective use in the field.

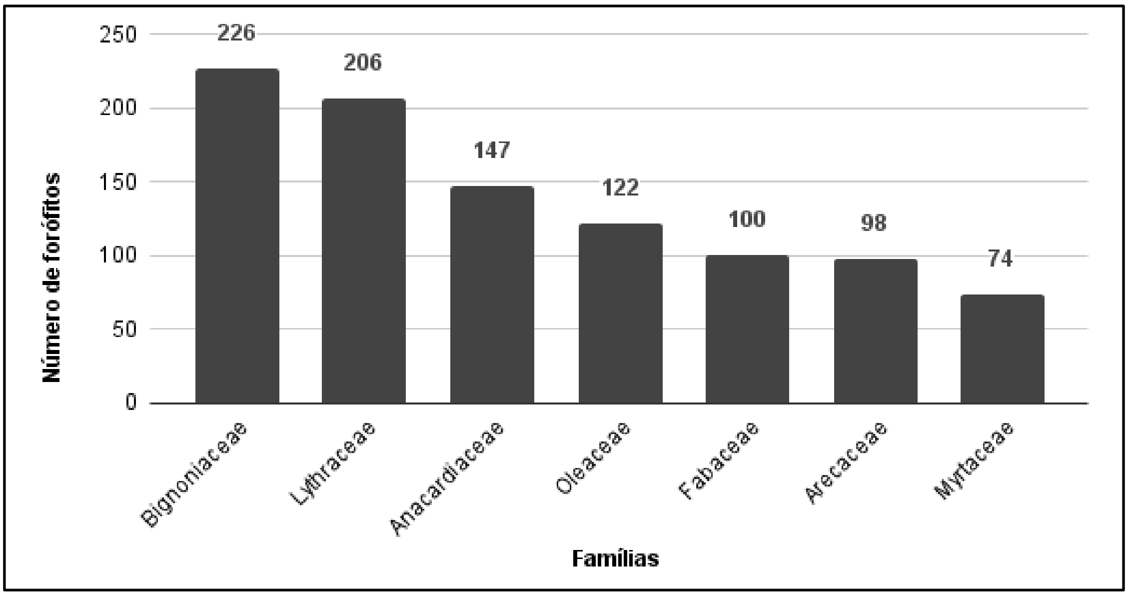
In this way, the research brought an approach that assimilates the survey of epiphytes as part of the form used in the inventory of urban forestation, using the *Google My Maps* as a tool, through which it was possible to carry out several relevant analyses on this vegetation.

4 RESULTS AND DISCUSSION

In the neighborhood of Uvaranas, 34.8% of the trees (1185 individuals) were observed supporting one or more vascular epiphytes. Of these, 19% correspond to the Bignoniaceae family and 17.3% to the Lythraceae family (Figure 2). In all, 1,730 epiphytes were sighted alone or in populations, of which 58.3% belong to the Bromeliaceae family, 25.9% to the Polypodiaceae family, 11.9% to the Orchidaceae family and 1.4% (25) to the Cactaceae and Araceae families in the phorophytes, and another 2.5% of occasional unidentified epiphytes.

Figure 2

Number of phorophytes found in the main families



Source: The authors.

Among the individuals found, 20 different species were identified (Table 1), of which only 3 could not be identified at the species level. Most of the species identified in the most representative families, Bromeliaceae and Polypodiaceae, are native, with the species *Aechmea nudicaulis* (L.) *Griseb*. and *Platycerium bifurcatum* (Cav.) C.Chr., respectively, which have been sighted a few times in the field. In total, 13 species are native to the region where the study area is located, five are exotic and one did not have its origin pointed out, as it was not identified at the species level.

In their work, Parra-Sanchez and Banks-Leite (2020) point to a variation in the richness of species found in fragments of the Atlantic Forest, about 169 species in primary areas, from 29 to 32 species at the edges of fragments, and only 5 species in pasture areas. On the other hand, Ritter et al. (2014) found low species diversity in the urban forest of the municipality of Farol, with only 10 species identified. Thus, the results obtained in the Uvaranas trees, although above the average in relation to other studies, corroborate the low diversity of species in anthropized environments, related to a high degree of biotic homogenization of vascular epiphytes.

Table 1

Species of epiphytes present in the Uvaranas neighborhood

Clade/Family	Species	Origin
Pteridophytes		
Polypodiaceae		
	Microgramma vaccinifolia (Langsd. & Fisch.) COPEL.	N
	Microgramma squamulosa (Kaulf.) de la Sota	N
	Platycerium bifurcatum (Cav.) C.Chr.	E
	Pleopeltis hirsutissima (Raddi) de la Sota	N
	Pleopeltis pleopeltifolia (Raddi) Alston	N
Monocots		
Araceae		
	Monstera sp.	-
	Philodendron barroanum G.S.Bunting*	N
	Thaumatophyllum lundii (Warm.) Sakur., Calazans & Mayo	N
Bromeliaceae		
	Aechmea bromeliifolia (Rudge) Baker	N
	Table 1 – Species of epiphytes present in the Uvaranas neighborhood. (continued)	
	Aechmea nudicaulis (L.) Griseb.**	E
	Neoregelia sp.	N
	Tillandsia recurvata (L.) L.	**N**
	Tillandsia stricta Sol.	N
	Vriesea friburgensis Mez	N
	Wittrockia cyathiformis (Vell.) Rudder	N
Commelinaceae		
	Tradescantia fluminensis Vell.	N
Orchidaceae		
	Dendrobium nobile Lindl.	E
	Oncidium sp.	E
Eudicots		
Cactaceae		
	Epiphyllum phyllanthus (L.) Haw.	N
	Rhipsalis floccosa Sal-Dyck ex Pfeiff.	N
	Selenicereus anthonyanus (Alexander) D.R.Hunt	E

Legend: E = exotic; N = native. *Native to the northern region of Brazil; ** Native to the coast of Paraná.
Source: The authors.

The genus *Tillandsia* showed a high degree of distribution, being present in an equivalent way in the most representative phorophytes. This genus is also the most found in the families Arecaceae, Fabaceae, Lythraceae and Myrtaceae, with an occurrence at least twice as high in these phorophytes, compared to the other groups of epiphytes (Table 2). The family Orchidaceae and the genus *Microgramma* showed a similar pattern of occurrence in individuals of the families Anacardiaceae, Bignoniaceae and Oleaceae. Ferns of the genus *Pleopeltis* were more frequent in the family Bignoniaceae and in the phorophytes of the species *Schinus molle L.*, where they were sighted more than twice as in the other phorophytes. Finally, other species of the Bromeliaceae family were found mainly in the phorophytes of the Bignoniaceae family, with little occurrence in the other groups of great relevance. The higher incidence of epiphytes of different species in phorophytes with porosity or roughness in the bark is pointed out in other studies, such as those by Castro et al. (2022), who state that there is a relationship between colonization by epiphytic species in individuals with characteristic bark, large size, or with many branches, as these structures provide them with support.

Table 2

Relationship between the most observed groups of phorophytes and the main groups of epiphytes

Family/ Group	Species	AIR	BR	TL	CC	OR	MC	SM
Anacardiaceae								
	Schinus molle L.	1	3	62	-	43	49	66
	Schinus terebinthifolia Raddi	1	2	26	-	10	11	14
Arecaceae		-	3	53	-	4	10	20
Bignoniaceae		4	27	186	-	43	49	66
Fabaceae		2	3	65	-	13	17	12
Lythraceae		-	4	44	-	18	11	12
Myrtaceae		1	1	21	2	7	1	5
Oleaceae								
	Ligustrum lucidum W. T. Aiton	2	1	85	-	23	34	29

Legend: AR = Araceae; BR = Bromeliaceae; TL = *Tillandsia* sp.; CC = Cactaceae; OR = Orchidaceae; MC = Microgramma sp.; SM = ferns.
Source: The authors.

Among the bromeliads, the genus *Tillandsia* has a wide distribution along the phorophyte, which can occur from the lowest parts of the trunk to the crown of the highest branches (Figure 3). Its distribution does not seem to be directly related to other epiphytes, nor to the species of phorophytes, being the only individual present in more than 500 phorophytes, even those with a low incidence of epiphytes. Regarding their nutrition and permanence in the phorophyte, the species *Tillandsia recurvata* (L.) L. and *Tillandsia stricta* Sol. are considered protoepiphytes, because they get water and nutrients from the atmosphere through cells present in the leaves that form their rosette, and holoepiphytes, because they are considered strictly epiphytes. Such characteristics show its resilience to the urban environment and its generalist character, which confers great success as a colonizer, either by vegetative reproduction (formation of clumps) or sexual reproduction (with anemochoric seeds), being one of the most representative groups in research in the urban environment, such as those of Ritter et al. (2014).

Figure 3

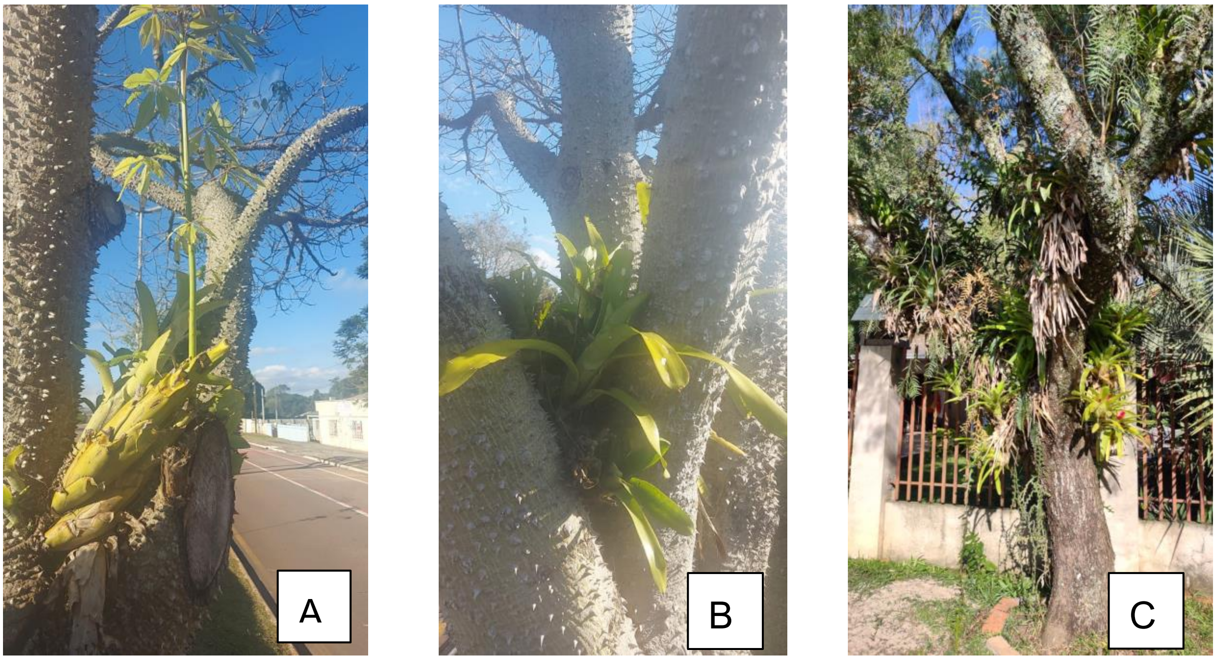
Distribution pattern of Tillandsia spp. in the phorophyte

Legend: A = stem, B = branches and C = lower part of the trunk.
Source: The authors.

On the other hand, larger bromeliads were more often found above the stem, especially on the higher branches exposed to the sun. These species occurred in isolation, with more than one individual only in larger phorophytes, whose structure allows for adequate support to these individuals (Figure 4). Three of the observed large bromeliad species, *Aechmea nudicaulis* (L.) Griseb., *Vriesea friburgensis Mez* and *Wittrockia cyathiformis* (Vell.) Rudder, they are considered holoepiphytes, while the species *Aechmea bromeliifolia* (Rudge) Baker is considered facultative, capable of surviving with terrestrial habits. In the field, individuals of these species and those of the genus *Neoregelia* sp. presented cisterns related to their main type of nutrition. It is important to note that some of these species are not native to the region, being cultivated by the residents, most likely due to their landscape potential.

Figure 4

Arrangement pattern of large bromeliads in the phorophytes

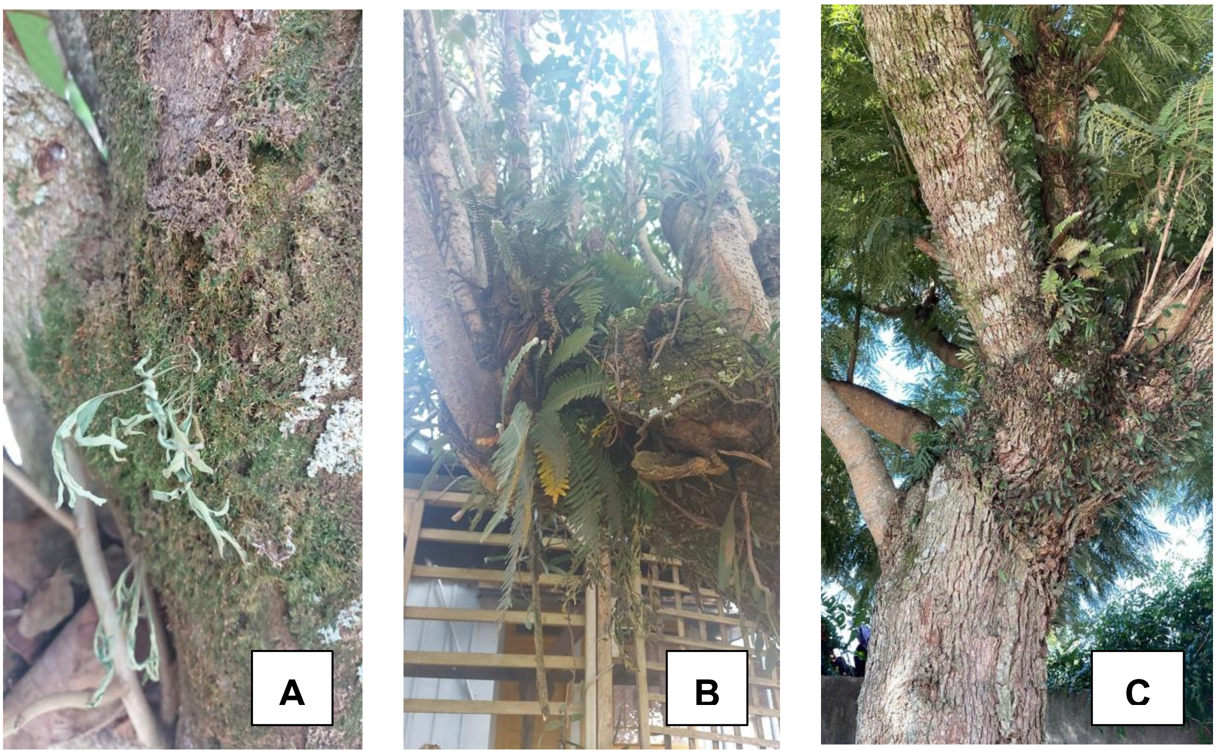


Legend: A = *Aechmea bromeliifolia* on the stem; B = A. nudicaulis on the stem; C = several individuals of the Bromeliaceae family in large phorophytes.
Source: The authors.

The species *Microgramma vaccinifolia* (Langsd. & Fisch.) Copel*. and Microgramma squamulosa* (Kaulf.) de la Sota observed, in turn, tend to occupy mainly the stem and the lower parts of the branches, although they occur on higher branches in some phorophytes. As for its permanence, this group is considered holoepiphyte and can be considered protoepiphyte in terms of its nutrition, as it has adaptations to remove nutrients from organic matter present on the surface of the phorophyte. However, as the individuals of a community occupy the phorophyte, it is possible to observe the accumulation of organic matter between its roots, also classified as nidiepiphytes. Almost half of the sightings of other ferns occur in the presence of *Microgramma* spp. in the phorophyte, the distribution pattern observed varied according to the species. Individuals of *P. hirsutissima* were found near the stem and on the branches of the phorophytes, regularly accompanied by *Microgramma spp.*, bryophytes and lichens, while individuals of *P. pleopeltifolia* were found in different parts of the phorophyte, including the trunk, mainly associated with lichens and bryophytes (Figure 5). The ferns already identified are considered holoepiphytes and obtain water and nutrients from the surface of the phorophyte, which characterizes them as protoepiphytes. In addition to these species, it was possible to observe the presence of a species considered exotic, *Platycerium bifurcatum* (Cav.) C.Chr., whose position in the phorophyte was on the stem, reinforces the idea that these individuals can be cultivated. This species is considered holoepiphytic and its nutrition is mainly protoepiphytic and, in sightings, it has been found only individually.

Figure 5

Distribution of Pleopeltis spp. and its association with other epiphytes



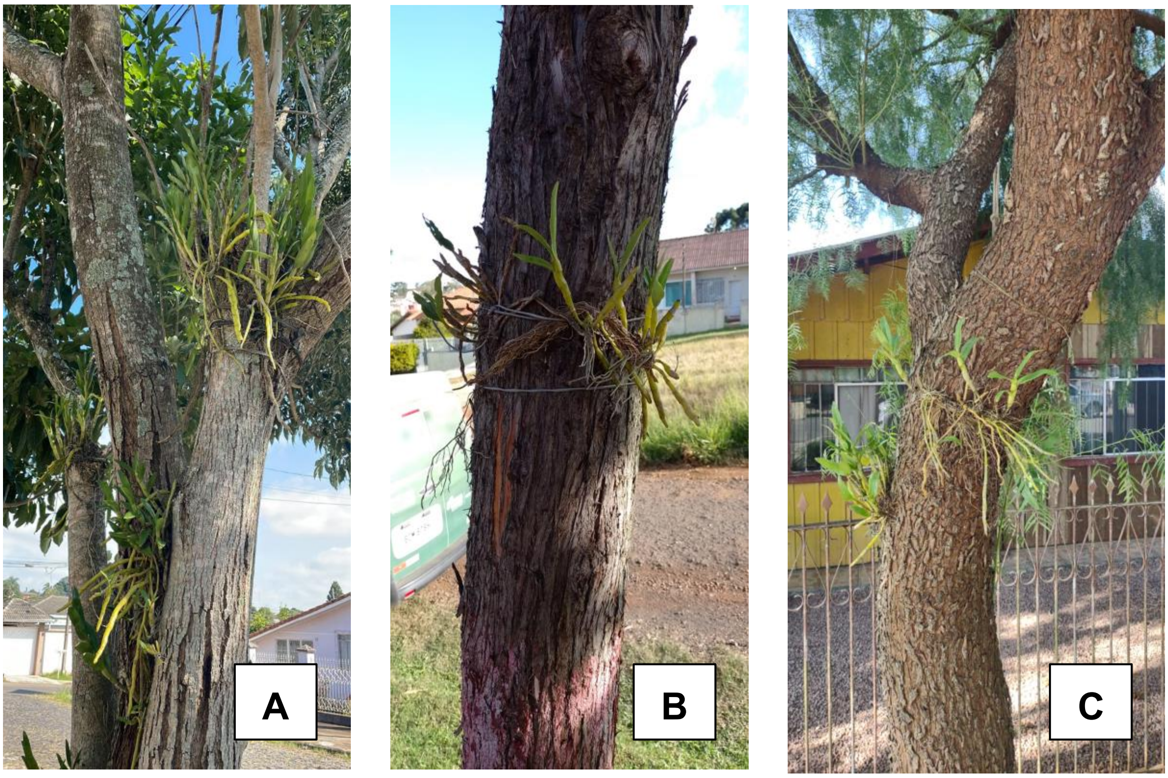
Legend: A and B = association of *Pleopeltis pleopeltifolia* and *P. hirsutissima* with lichens and bryophytes; C = association of *P. hirsutissima* and *Microgramma squamulosa.*
Source: The authors.

The genus Tillandsia, the genera *Pleopeltis* and *Microgramma* were very representative in this and other urban works (Ritter et al., 2014), possibly due to the xerophytic and poikilohydric evolutionary adaptations that these groups present, corroborating what Parra-Sanchez and Banks-Leite (2020) point out about the homogenization of species within the vegetation patches of the Atlantic Forest, due to the edge effect and what Kersten (2010) says Regarding the pressure exerted by anthropogenic disorders that select these characteristics to the detriment of mesophytic adaptations.

Some of the epiphytes found, especially orchids, show signs of being cultivated individuals, that is, that they did not appear in the phorophytes spontaneously, which also occurs with some cacti. In the case of these individuals, the presence of material that attaches them to the phorophytes, such as ropes, wires, or fabrics, is common. These epiphytes are commonly found on the stem or forks of branches, however, they may be in other regions of the tree (Figure 6).

Figure 6

Cultivated orchids fixed in different phorophytes



Legend: A, B and C = Examples of orchids tied to trees, indicating cultivation by residents.
Source: The authors.

This group also seems to have no direct relationship with other groups, being sighted individually in 93 phorophytes. In general, orchids are known for their canopy, a special organ capable of absorbing and storing water and nutrients, and for their association with mycorrhizae, characteristics that define them as protoepiphytes. The only orchid identified at a specific level is considered holoepiphyte. Although authors such as Parra-Sanchez and Banks-Leite (2020) and Kersten (2010) point to the Orchidaceae family as the second most representative in the Atlantic Forest biome, our survey did not obtain the same result, even with the intervention of the population. Ritter et al. (2014), in their study in an urban forest in the city of Farol - PR, obtained the same prevalence result of the Bromeliaceae and Polypodiaceae families, pointing to a trend observed in previous studies in the state of Paraná.

The Araceae (Figure 7) were found mainly on the stem and in regions where the phorophyte was injured. The three species sighted, *Monstera* sp., *Philodendron barroanum* G.S.Bunting and *Thaumatophyllum lundii* (Warm.) Sakur., Calazans & Mayo are considered hemiepiphytes in terms of their diet, absorbing their nutrients from the organic matter present in the trunk of the support tree or in the soil next to it. Individuals of *Monstera* sp. and *Philodendron barroanum* G.S.Bunting can be considered secondary hemiepiphytes, while specimens of *Thaumatophyllum lundii* (Warm.) can be considered primary hemiepiphytes, as they have organs that reach the soil to absorb nutrients.

Figure 7

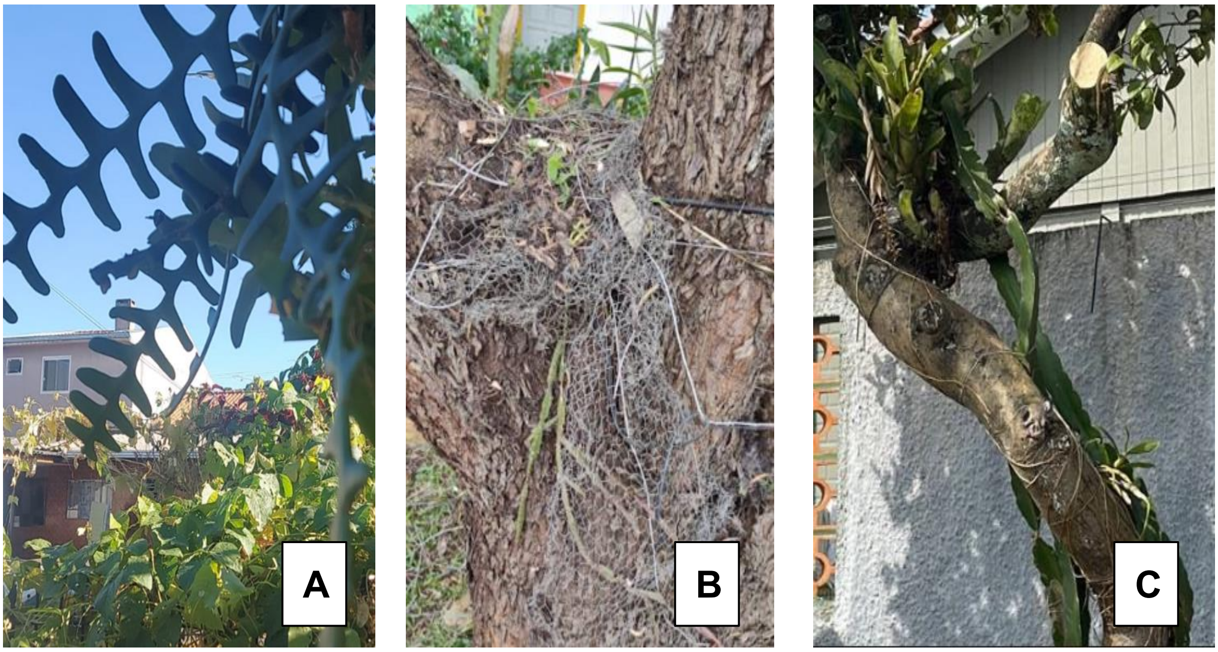
Species of araceae found in the Uvaranas neighborhood

Legend: Org.: A and B = Thaumatophyllum lundii; C = Philodendron barroanum
Source: The authors.

The cacti found (Figure 8) appear to be cultivated and were sighted mainly on the stem of the trees in which they are present or on the ground, supporting themselves along the trunk of the tree. Despite this, of the three species found, only *Selenicereus anthonyanus* (Alexander) D.R.Hunt is not considered native. In the sightings, the species *Epiphyllum phyllanthus* (L.) Haw. and *Rhipsalis floccosa* Sal-Dyck ex Pfeiff. showed clear signs of cultivation by the residents, with the presence of wires and ropes for fixing the phorophyte to the trunk and, in some cases, protective mesh.

Figure 8

Species of Cactaceae found in the Uvaranas neighborhood



Legend: A = Selenicereus anthonyanus; B = *Rhipsalis floccosa*; C = *Epiphyllum phyllanthus.*
Source: The authors.

Finally, accidental individuals are usually found in the trunks of trees, usually in places of great deposition of organic matter. Several terrestrial herbaceous plants and some tree seedlings, including the phorophyte itself, were sighted in spaces with high retention of organic matter on the trunk of the support tree. However, only the species *Tradescantia fluminensis* Vell. was considered, since most observations consist of plants at the beginning of their development, not fitting the concept of accidental epiphytes, which need to complete their life cycle on the support.

Many of the epiphytes sighted have morphological characteristics, considered evolutionary adaptations that allow them to resist the variation of water stress. According to Francisco (2017), plants such as orchids and some bromeliads have a wax coating that reduces water loss through evapotranspiration, in addition, they can have organs and tissues that retain water and nutrients. Also according to the author, Tillandsias are extremely apt to survive temperature variations, being able to resist desiccation for long periods of drought and survive until water is available again. Ferns of the genus *Pleopeltis* also have this poikilohydric characteristic (Figure 9), curling their leaves to preserve themselves in periods of water scarcity, until it is available (Francisco, 2017).

Although long periods of drought are not part of the region's rainfall regime, this relationship may be associated with the urban environment and the effects of anthropization, since it is frequently observed in surveys carried out in urban vegetation and was described by the authors as a homogenizing effect caused by the degree of impact exerted.

Figure 9

Poikilohydric mechanisms of Pleopeltis spp

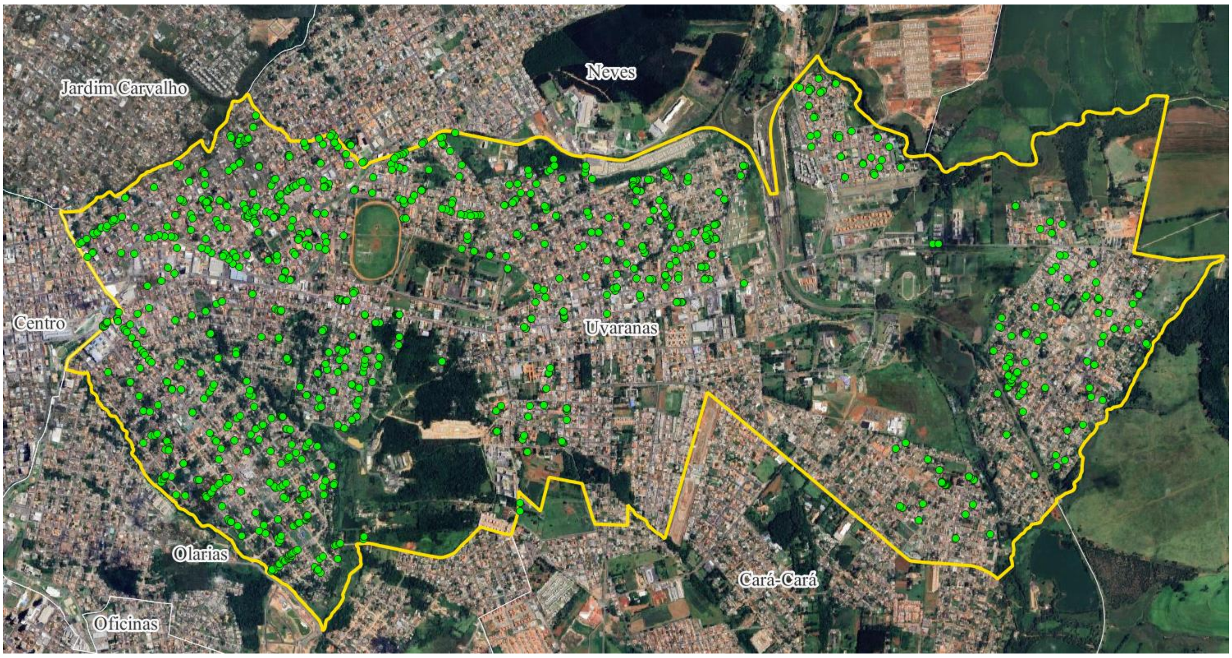
Legend: A = *Pleopeltis hirsutissima* and B = *P. pleopeltifolia* with the leaves curled during the dry period.
Source: The authors.

Fern species reproduce through the dispersion of spores that have water as their main facilitating agent. Among the angiosperms found, the main pollination syndrome was zoophilia, mainly associated with invertebrates. The dispersal method, in turn, was divided into zoochory, for some species of araceae and cacti, and anemochory, for bromeliads and orchids, which may explain their wide horizontal distribution pattern in comparison with the former.

Finally, the pattern of horizontal distribution of epiphytes (Figure 10) was similar in all regions of the neighborhood, with the exception of the roads near the border with the Cará-Cará neighborhood, which showed absence of epiphytic vegetation.

Figure 10

Horizontal distribution of epiphytic vegetation in the Uvaranas neighborhood, Ponta Grossa – PR



The boundary of the neighborhood is demarcated by a yellow line, and the green dots represent the trees that have had one or more epiphytes. The map shows the absence of epiphytes in the region near the border with the Cará-Cará neighborhood.
Source: LAESA.

According to the bill for zoning of land use and occupation present in the master plan of the city of Ponta Grossa (PMPG, 2006), the region is intended for: Single-family housing, horizontal collective housing, vertical collective housing, compatible commerce and services, tolerable commerce and services, small industries and micro industries. Thus, frequent activities in this location, such as the presence of a logging company or construction sites at the time of the survey, may have negatively affected the occurrence of epiphytes. In addition, this region has some of the main accesses to the Cará-Cará neighborhood, where the city's industrial sector is located, which may also have influenced the local vegetation.

5 FINAL CONSIDERATIONS

In general, the results are similar to those described in the literature for urban areas of the Atlantic Forest, highlighting the high incidence of Bromeliaceae (especially of the genus Tillandsia) and Polypodiaceae, in contrast to the low index of Orchidaceae in relation to the expected FOM. The expressive representativeness of the genera *Tillandsia*, *Pleopeltis* and *Microgramma* can be attributed to their xerophytic and poikilohydric adaptations, giving them a selective advantage in disturbed environments, which corroborates biotic homogenization and anthropogenic pressure on mesophytic species, already pointed out in the literature. Nevertheless, a considerable contingent of species that do not fit into these functional groups was recorded.

The variety pattern of the phorophytes of the families Bignoniaceae, Anacardiaceae and Fabaceae reflects the preference for support attributes, such as bark morphology, nutrient retention and branch inclination. The high occurrence of Lythraceae and Oleaceae is due to both their frequency in urban afforestation and the morphological characteristics of the bark and size. The genus Tillandsia stood out for its generalist distribution among the phorophytes, showing resilience to the urban environment and colonizing success. The positive association between Bignoniaceae and Anacardiaceae with the Orchidaceae and Polypodiaceae families is related to the roughness of the bark of these phorophytes, which favors the retention of essential nutrients and the establishment of these epiphytes.

Despite the information observed in the field about the availability of resources and shelters by epiphytes and the positive relationship between the cultivation of certain groups by the population, it is necessary that new studies be carried out to better understand the epiphytic flora in the urban environment, especially regarding the positive and negative impacts on this space and the population's desires in relation to it.

Finally, this research made it possible to verify the potential of the *Google My Maps* application as a tool to record the presence of epiphytes, as a complement in an integrated way to the tree inventory as one of the variables collected in the field. Its intuitive design allows lay people to use this tool, through previous adjustments made by specialized professionals. At the same time, the possibility of importing vector data from the objects added to the layer on the created map, allowing them to be processed in software such as *Quantum GIS*, enables the processing of this data if necessary. Finally, the possibility of exporting these files for editing the data in an Excel table allows the management of the data and the analysis of each variable in a more in-depth way, as was done in this study.

In a historical context in which the relevance of ecosystem services has stood out as a potential mitigator of the impact of anthropogenic actions, better understanding the influence of environmental services and disservices provided by this vegetation can be a way to optimize these processes in urban green spaces, not only for humans, but also for other species. Thus, a more in-depth analysis can be an important resource in decision-making, considering the economic, social and environmental improvement of urban green areas.

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