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TREE SPECIES USED IN URBAN AFFORESTATION OF SANTIAGO NEIGHBORHOOD IN THE CITY OF JI-PARANÁ, RONDÔNIA STATE, BRAZIL

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ABSTRACT

The objectives of this study were to describe the composition and structure of the urban forest and calculate the density of trees per linear meter in Santiago neighborhood, in Ji-Paraná, Rondônia State, and a city in the Brazilian Amazon Biome. We adopted the approach of Linear Meter Density (LMD) registering the diameter at breast height (DBH) and the conflicts with the electric and telecommunication aerial networks of all trees and palm trees in the stretch of the sidewalk studied. Sample sufficiency was verified by using a rarefaction curve with function Chao 1. We also calculated the relative frequency and the relative abundance of sampled species. The urban forest of Santiago neighborhood in Ji-Paraná is characterized by little richness of species, which is compensated by the high density of planted trees (LMD). The vegetation of the neighborhood is composed predominantly by four species: *F. benjamina*, *C. peltophoroides*, *S. malaccense* and *L. tomentosa*. The distribution of trees of *F. benjamina* and *C. peltophoroides* species in terms of DBH suggests the occurrence of fashion trends during the tree planting process. The occurrence of conflicts with the aerial grid, as well as the massive use of exotic species, repeats the pattern of urban afforestation observed in other Brazilian cities.

Key-words: Inventory of species; Exotic species; Brazilian Amazon Forest.

ESPÉCIES EMPREGADAS NA ARBORIZAÇÃO URBANA DO BAIRRO SANTIAGO, JI-PARANÁ/RO

RESUMO

Os objetivos deste estudo foram descrever a composição e a estrutura da arborização pública e calcular a densidade metro linear de árvores no Bairro Santiago em Ji-Paraná/RO, uma cidade no Bioma Amazônico brasileiro. Adotamos a abordagem dada pela Densidade Metro Linear – DML – registrando para todas as árvores e palmeiras, presentes no trecho de passeio público estudado, o diâmetro na altura do peito (DAP) e os conflitos com a rede elétrica e de telecomunicações. A suficiência amostral foi verificada com o uso de uma curva de rarefação com a função Chao 1. Além disso, calculamos a freqüência relativa e a abundância relativa das espécies amostradas. A arborização urbana do Bairro Santiago em Ji-Paraná é caracterizada por uma pequena riqueza de espécies, que é compensada pela grande densidade de árvores plantadas (DML). A vegetação do Bairro é composta predominantemente por quatro espécies: *F. benjamina, C. peltophoroides, S. malaccense* e *L. tomentosa*. As distribuições das árvores de *F. benjamina* e *C. peltophoroides* em função do DAP sugerem a ocorrência de fases de modismo durante o plantio das árvores. O registro de conflitos com a infra-estrutura aérea, bem como uso massivo de espécies exóticas repetem o padrão observado em outras localidades do país.

Palavras-chave: Inventário de espécies; Espécies exóticas; Floresta Amazônica brasileira.

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INTRODUCTION

Urban afforestation or public forests can be defined as the arboreal plant elements planted in cities, or as the planting of shrub-sized trees in squares, parks and sidewalks of public roads (LIMA et al., 1994; SANTOS et al., 2008). Despite the varied definitions, urban afforestation is today one of the most important activities of city management and should be part of plans, designs and urbanistic programs (SANTOS et al., 2008).

Urban trees perform some important functions for urban populations. Urban forests buffers noise, reducing noise pollution; produces shading, cooling the urban surface temperature; and improves air quality by increasing oxygen and humidity levels. Urban afforestation also diminishes the effect of aggressive buildings in urban landscapes. It also protects, identifies and designs the streets and avenues in the city. Although difficult to quantify, there is the psychological aspect, which involves the satisfaction that individuals feel in contact with vegetation and with the environment that it creates (GRAZIANO, 1994; MASCARO et al., 2004).

Furthermore, afforestation in urban squares and parks should receive emphasis in terms of conservation, because it represents refuges for the local fauna and flora (PEREIRA et al., 2005), and, in many cases, it is home to endangered species such as *Araucaria angustifolia* (BRASIL, 2008; OLIVEIRA et al., 2009; ALBERTIN et al., 2011). The unique environmental importance reinforces the well-tutored and diffuse character of urban forests (SILVA, 1997).

Planting trees in cities requires special care, especially because of the decades necessary to attain a set of trees that fulfil the functions listed above. The use of unsuited species in the urban mesh may not provide the expected benefits, as they can conflict with the aerial power grid, public lighting and telecommunication networks, and create obstacles to pedestrians and problems such as clogging gutters and damaging water and sewage systems (MONTEIRO JUNIOR, 2000; MASCARO et al., 2004).

The choice of a species must meet the specific conditions of the area, and it is the City Government’s responsibility to plan and orient the community about which species to be used. For example, species with thorns on the trunk and with active ingredient toxic (allergic) should be avoided and native species to the region, enriching the local flora, should be prioritized (PORTO ALEGRE, 2002; PEREIRA et al., 2005). Thus, plant species should be chosen carefully, taking into account limitations of planting places, the seedling process and care during planting and maintenance. Moreover, policies to support and encourage the implementation and maintenance of trees in cities are needed. The participation and involvement of the population are essential for the green areas and urban afforestation to bring benefits to the city and its residents (PEREIRA et al., 2005; OLIVEIRA et al., 2009).

The objectives of this study were to describe the composition and structure of urban afforestation and calculate the density per linear meter of trees in Santiago neighborhood in the city of Ji-Paraná, Rondônia State, Brazil.

MATERIAL AND METHODS

The city of Ji-Paraná has 107,679 inhabitants and is located in the central region (10°53’07” S – 61°57’06” W) of the state of Rondônia, Brazil, 327 km from the capital city if Porto Velho (IBGE, 2010). It is located in the Western Amazon and the state of Rondônia does not suffer from major influences of the sea or altitude. The predominant climate is tropical wet with an average annual precipitation of 2,250 mm and an annual average air temperature of 23°C. There is a well-defined dry season between June and September, when a moderate water deficit occurs, with precipitation lower than 50 mm/month. The average precipitation for the months of June, July and August is lower than 20 mm/month (SEDAM, 2010).

The study area is located in the neighborhood of Santiago, northwest of the city of Ji-Paraná. The neighborhood is residential and commercial, with two logging firms next to Highway BR 364. Some streets are paved, while others are not and the houses are supplied by water, electricity, telephone lines, and public lighting.

Urban afforestation, consisting of trees distributed linearly along public places, shows a structure considerably distinct from forests. In this context, the usual techniques of sampling vegetation, such as data collection with fixed-size or variable-size parcels (DURIGAN, 2003), do not serve for the study of this component of the urban ecosystem. To overcome this difficulty, we adopted the approach of Linear Meter Density (LMD) (CRISPIN, 2000; ROCHA et al., 2004; SOUZA and CINTRA, 2007). Thus, data collection used 55 lines of 60 m arranged randomly along the sidewalk, totaling 3,300 m in the linear sampling in the neighborhood studied. The LMD of urban afforestation in the neighborhood was calculated by dividing the total number of individuals registered in the sampling interval by total length of sidewalk sampled. All trees and palms inserted within the range of each line were sampled and identified in terms of species and origin using identification guides (LORENZI, 2002ab; 2003)

In August 2010, we recorded for all trees and palm trees the diameter at breast height (DBH, measured at 1.3 m above the ground), as well as conflicts with the infrastructure of electric grid and telecommunication network (LIMA, 1993; SOUZA and CINTRA, 2007).

The sampling sufficiency was verified with the use of a rarefaction curve with the Chao 1 function, in which the estimated richness is equal to the observed richness, added to the square of the number of species represented by only one individual in the samples divided by the double number of species with only two individuals (SANTOS, 2003). The rarefaction curve was calculated using the program *EstimateS*®, version 7.5.2 Windows (COLWELL, 2005).

The relative frequency of the species was calculated dividing the number of rows in which the species was sampled by the total number of sampling lines, multiplied by 100. The relative abundance of the species was calculated dividing the number of individuals of the species by the total number of trees sampled in every line, multiplied by 100 (SOUZA and CINTRA, 2007).

RESULTS AND DISCUSSION

We sampled 421 individuals distributed in 27 species belonging to 16 families in a total length of 3,300 linear meters of sampling (Table 1). The richness of species found in Santiago neighborhood can be considered little compared to species richness reported in other studies in Brazilian cities. For example, 41 species in Nova Brasilia neighborhood in Ji-paraná City (PINTO, 2009); 41 species in Taquara neighborhood in Rio de Janeiro City, Rio de Janeiro State (SOUZA and CINTRA, 2007); 46 species in Rancho Novo neighborhood and 59 species downtown, both in Rio de Janeiro, Rio de Janeiro State (ROCHA et al., 2004). This little species richness cannot be considered an error or even insufficient sampling, because the test of rarefaction of species performed suggests that for the sampling effort used, 31 species were expected to be found, indicating that some rare or little abundant species were probably not sampled (Fig. 1). However, we recorded the most common and abundant species that provide the general aspect of the afforestation in the neighborhood.

The species-area relationship (RODRIGUES and PRIMACK, 2006) can explain the smaller number of species registered in Santiago neighborhood, as long as the area in the neighborhood is close to half of the other neighborhoods used for comparison and, also, that there is no other effect of selection or removal of species. However, no information was found that reports the aforementioned neighborhood. In addition, in commercial neighborhoods, business owners highlight the facade of their stores or businesses, which reduces the number of trees and species. To resolve this issue, a study on the species-area relationship in afforestation is suggested.

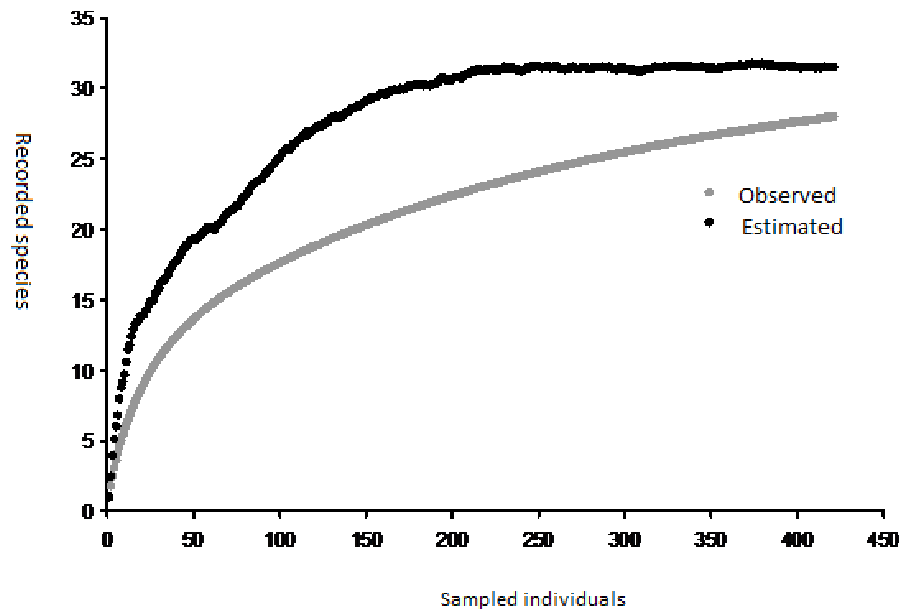
The LMD in Santiago neighborhood was 0.12 trees per linear meter or 1.2 palm tree/every 10 m of sidewalk. This value is much higher than values registered in other works. For example, in Novo Rancho neighborhood, the LMD was 0.035 tree per linear meter and in the Downtown area, it was 0.026 tree per linear meter, both in Nova Iguaçu City, Rio de Janeiro State, Brazil (ROCHA et al., 2004). The LMD in the neighborhood Paulo Frontim was 0.05 tree per linear meter and in the neighborhood Village Santa Cecilia was 0.055 tree per linear meter, both in Volta Redonda City, Rio de Janeiro State, Brazil (CRISPIN, 2000). The LMD in the neighborhood of Taquara, Rio de Janeiro City, Rio de Janeiro State, was 0.05 tree per linear meter (SOUZA and CINTRA, 2007). Therefore, although the Santiago neighborhood showed less species diversity, tree density in the neighborhood is higher than that usually found in other Brazilian cities. This occurs, according to reports, because the residents themselves carry out the planting of trees, who perceive sidewalks as extension of their gardens.

The five most abundant species accounted for 70% of the total number of individuals registered in Santiago neighborhood. Fewer than five trees represented most of the other species. The species *Ficus benjamina* (Figueirinha) accounted for 40% of all the trees that comprise the urban afforestation of Santiago neighborhood (Table 1). The dominance of one species in urban afforestation is not a local phenomenon. There are similar reports for other Brazilian cities, for example, in Piracicaba, São Paulo State, *Caesalpinia peltophoroides* (Sibipiruna) accounted for 52% of the trees in the city (LIMA, 1993) and, in Manaus, Amazonas State, *Licania tomentosa* (Oiti) represents 29% of afforestation (COSTA and HIGUSHI, 1999). This dominance, however, does not disqualify urban afforestation, insofar as its environmental functions as surface shading and evapotranspiration are recognized (MASCARO et al., 2004). However, the literature prescribes that no species should exceed the limit of 10-15% of the total number of trees in urban forests, preventing the dominance of one single species or group of species and spread of pests in urban areas (GREY and DENEKE, 1978 apud MILANO and DALCIN, 2000).

The species with higher relative frequency in the Santiago neighborhood were *F. benjamina* (69.09%), *C. peltophoroides* (38.18%), *Syzygium malaccense* (jambo) (30.90%) and *L. tomentosa* (25.45%) (Table 1). The relative frequency can be understood as an indicator of spatial distribution, meaning that species with greater relative frequency are distributed in a larger area, that is, the species is found in several parts of the neighborhood.

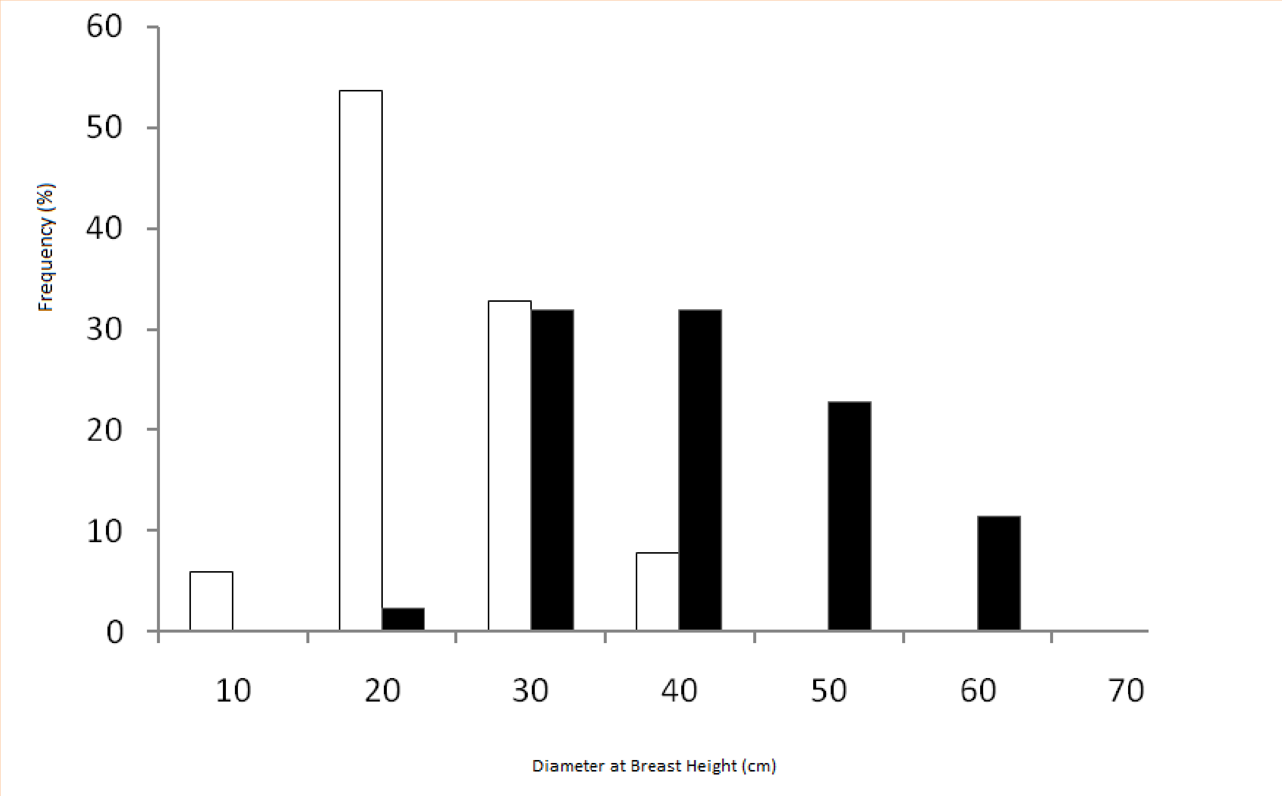
Therefore, the results for relative abundance and frequency of species in urban afforestation of the Santiago neighborhood show that the physiognomy of the vegetation of the neighborhood investigated is composed by only four species: *F. benjamina*, *C. peltophoroides*, *S. malaccense* and *L. tomentosa*.

Figure 1. Rarefaction curve (in black) and accumulation curve (in gray) of tree species in urban forest of Santiago neighborhood, Ji-Paraná City, Rondônia State, Brazil, constructed from 1,000 randomizations in the order of samplings (details in data analyses).



The DBH is usually used as an indirect measurement of the tree age. Authors argue that trees with greater DBH tend to be older (SCHAAF et al., 2006). The population of *F. benjamina* is characterized by DBH classes of 20-30 cm, indicating recent planting. The population of *C. peltophoroides* is characterized DBH classes of 30, 40 and 50 cm, indicating older planting (Fig. 2). These differences, along with the predominance of these species in the afforestation of Santiago neighborhood, may be considered evidence of two phases of fashions in the afforestation of the city. In a certain decade, there was preference for one species to compose the afforestation of the neighborhood to the detriment of other species available (MASCARO et al., 2004). The older phase was marked by massive planting of individuals of *C. peltophoroides* and, recently, the massive planting of trees of *F. benjamina*.

Figure 2. Distribution of trees of *Ficus banjamina* (white bars) and *Caesalpinia peltophoroides* (black bars) according to DBH sampled in inventory of urban trees in Santiago neighborhood, Ji-Paraná City, Rondônia State, Brazil.



Of the 421 trees sampled, roughly 30% showed conflicts with the aerial grid of telecommunications and electric power. Similar results were reported for the cities of Bandeirantes (Paraná State) and Nova Iguaçu (Rio de Janeiro State), in which 31% and 35% of the trees, respectively, presented conflicts with the aerial grid (ROCHA et al., 2004; LIMA et al., 2007). The species *F. benjamina* and *C. peltophoroides*, predominant in the afforestation of Santiago neighborhood, showed most conflicts with the aerial grid. Planning tree planting is the most appropriate action to minimize problems between the infrastructure and the urban afforestation, starting from the choice of suitable species allied to monitoring tree growth (MILANO and DALCIN, 2000).

Only six of the 27 species sampled in Santiago neighborhood are native (Table 1). Native species were considered only those originally form the Brazilian Amazon. Species occurring in Brazil, but in other natural biomes, such as the Pampa or the Atlantic Forest, were considered exotic. Species listed as originating in other countries, even though sub-spontaneous, were also considered exotic. To make this classification, we crossed the information with data provided by Lorenzi 2002, 2003; Forzza et al., 2010.

It is noted that those responsible for the tree planting selected exotic species, both from other countries as well as other Brazilian biomes. According to the inventory reported here, 78% of species used in afforestation are exotic. The predominance of exotic species in urban afforestation is common in Brazilian cities, ranging from 99% of exotic species in Pato Branco City, Paraná State (SILVA et al., 2007) to 53% in Santa Maria City, Rio Grande do Sul State (TEIXEIRA et al., 2009). These results show the little prestige of native tree species with the local population, as well as with municipal managers. It is suggested a greater commitment of the municipal government and the population in general to create an afforestation plan contemplating native species. This shows, in part, a lack of interest of municipal government to offer seedlings of regional flora and to encourage their planting by the population.

Table 1 – Families, species and origin of trees composing the urban afforestation of Santiago neighborhood, Ji-Paraná State, Rondônia State, Brazil. (A%: Relative abundance; F%: Relative frequency). We considered native species those from the Brazilian Amazon, according A= Forzza et al., 2010; B= Lorenzi, 2003; C= Lorenzi 2002.

Family/ Species	Origin	Trees sampled	A%	F%	Sources
ANACARDIACEAE					
Anacardium occidentale L.	Native to Amazon	2	0.47	3.63	A, C
	Occurrence: native; non endemic; North (RR, AP, PA, AM, TO, AC), Northeast (MA, PI, CE, RN, PB, PE, BA, AL, SE), Central-West (MT, GO, DF), Southeast (MG, ES, SP, RJ), South (PR, SC); Amazon, Caatinga, Cerrado, Atlantic Forest, Pampa, Pantanal				
Mangifera indica L.	Exotic	16	3.80	16.36	A, B
	Occurence: sub-spontaneous; non endemic; North (AP, PA, AM), Northeast (MA, PE, BA), Central-West (GO, MS), Southeast (MG, ES, SP, RJ), South (PR, SC); Amazon, Cerrado, Atlantic Forest				
	Native to India				
Schinus molle L.	Exotic to Amazon	2	0.47	3.63	A, C
	Occurrence: native; non endemic; Southeast (SP, RJ), South (PR, SC, RS); Atlantic Forest, Pampa				
ANNONACEAE					
Annona mucosa Jacq.	Native to Amazon	1	0,23	1,81	A, C
	Occurrence: native; non endemic; North (PA, AM, AC), Northeast (BA), Central-West (MT), Southeast (MG, RJ), South (RS); Amazon, Cerrado, Atlantic Forest				
Annona squamosa L.	Exotic to Amazon	1	0,23	1,81	B
	Native to Antilles and Caribbean				
ARECACEAE					
Areca triandra Roxb.	Exotic to Amazon	16	3,80	7,27	B
	Native to India and Malaysia				
Cocos nucifera L.	Exotic to Amazon	3	0,71	3,63	A, C

	Occurrence: sub-spontaneous; non endemic; Northeast (MA, PI, CE, RN, PB, PE, BA, AL, SE), Southeast (ES, SP, RJ); Atlantic Forest				
Mauritia flexuosa L.f.	Native to Amazon	2	0,47	1,81	A, C
	Occurrence: native; non endemic; North (AM, TO, AC, RO), Northeast (MA, PI, CE, BA), Southeast (MG, SP); Amazon, Caatinga, Cerrado				
Roystonea oleracea (Jacq.) O.F. Cook	Exotic to Amazon	25	5,93	12,72	B
	Native to Antilles, Venezuela, Colombia				
BIGNONIACEAE					
Spathodea campanulata P.Beauv.	Exotic to Amazon	3	0,71	3,63	B
	Native to Central Africa				
CAESALPINIACEAE					
Bauhinia variegata L.	Exotic to Amazon	4	0,95	3,63	B
	Native to Asia				
Caesalpinia peltophoroides Benth	Exotic to Amazon	44	10,45	38,18	C
	Occurrence: native; non endemic; Northeast (BA), Central-West (MT, MS), Southeast (RJ, SP); Atlantic Forest, Pantanal				
Cassia fistula L.	Exotic to Amazon	1	0,23	1,81	B
	Native to Asia				
CHRYSOBALANACEAE					
Licania tomentosa (Benth.) Fritsch	Native to Amazon	36	8,55	25,45	A, C
	Occurrence: native; endemic; Northeast (PI, CE, PB, PE, BA), Central-West (MT, DF), Southeast (MG, SP, RJ); Amazon				
COMBRETACEAE					
Terminalia catappa L.	Exotic to Amazon	8	1,90	9,09	B

	Native to Asia				
CUPRESSACEAE					
Thuja occidentalis L.	Exotic to Amazon Native to Canada and USA	5	1,18	7,27	B
LYTHRACEAE					
Physocalymma scaberrimum Pohl	Native to Amazon Occurrence: native; endemic; North (PA, TO, AC), Central-West (MT, GO, DF); Amazon, Cerrado	15	3,56	5,45	A, C
MALVACEAE					
Pachira aquatica Aubl.	Native to Amazon Occurrence: native; non endemic; North (PA, AM, AC); Amazon	18	4,27	14,54	A, C
MELIACEAE					
Melia azedarach L.	Exotic to Amazon Occurrence: sub-spontaneous; non endemic; North (AC), Northeast (PI, CE, BA), Central-West (DF, MS), Southeast (MG, ES, SP, RJ), South (PR, SC); Amazon, Caatinga, Cerrado, Atlantic Forest. Native to India	2	0,47	1,81	A, B
MORACEAE					
Ficus benjamina L.	Exotic to Amazon Native to Asia	168	39,90	69,09	B
Morus alba L.	Exotic to Amazon Native to Asia	2	0,47	3,63	B
MYRTACEAE					
Syzygium cumini (L.) Skeels	Exotic to Amazon Occurrence: sub-spontaneous; non endemic; North (RR, AM), Northeast (PE, BA), Southeast (MG, ES, SP, RJ),	1	0,23	1,81	A, B

	South (PR, SC, RS); Amazon, Cerrado, Atlantic Forest, Pantanal Native to Asia				
Syzygium malaccense (L.) Merr. & Perry	Exotic to Amazon Native to Asia	28	6,65	30,90	B
RUTACEAE					
Citrus X limon (L.) Osbeck	Exotic to Amazon Occurrence: sub-spontaneous; non endemic; Central-West (GO, DF, MS), Southeast (MG, SP), South (PR, SC, RS); Cerrado, Atlantic Forest Native to Asia	1	0,23	1,81	A, B
Murraya paniculata (L.) Jack	Exotic to Amazon Native to Asia	13	3,08	16,36	B
VERBENACEAE					
Duranta erecta L.	Exotic to Amazon Occurrence: native; non endemic; Northeast, Central-West; Atlantic Forest, Cerrado Mexico, Central and South America	3	0,71	3,63	A, B
Non-identified					
Non-identified		1	0,23	1,81	
16 families/27 species		42 árvores 100%			

CONCLUSIONS

The urban afforestation of Santiago neighborhood in Ji-Paraná City is characterized by little species richness, which is offset by the high density of trees (LMD) planted both by the city government and by residents. The vegetation of the neighborhood comprises predominantly four species: *F. benjamina*, *C. peltophoroides*, *S. malaccense* and *L. tomentosa*. The occurrence of trees of *F. benjamina* and *C. peltophoroides* regarding DBH suggests fashion stages during the planting of trees. The conflicts with the aerial grid as well as massive use of exotic species repeat the pattern observed in other Brazilian cities.

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