

POLLINATION SYNDROMES OF THE URBAN FLORA OF SANTO ANTONIO DE PÁDUA MUNICIPALITY, RIO DE JANEIRO STATE, BRAZIL

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ABSTRACT

The current study aimed to describe the pollination syndromes of the tree species occurring in the urban area of Santo Antônio de Pádua, in the northwestern part of Rio de Janeiro state, southern Brazil. This municipality now has less than 4% of its original forest cover, resulting in a heavy decrease in faunal and floral diversity. Reported field observations were made over a one-year period between 2016 and 2017. In the study area, 31 species were identified in 14 families, with Fabaceae (19%) having the largest number of species. Most studied species were exotic (75.6%). The most frequent floral coloration was white (29%), with nectar as the commonest floral reward (47%) followed by nectar/pollen (40%). Melittophilia was the most common pollination syndrome (71%). Keywords: ecology urban, urban flora, floral biology

SÍNDROMES DE POLINIZAÇÃO DA FLORA URBANA DO MUNICÍPIO DE SANTO ANTONIO DE PÁDUA – RJ

RESUMO

O presente trabalho teve como objetivo descrever as síndromes de polinização das espécies arbóreas ocorrentes na área urbana do Município de Santo Antônio de Pádua, localizado no noroeste do estado do Rio de Janeiro. Atualmente este município apresenta menos de 4% de sua cobertura original de mata, o que acaba contribuindo para a diminuição da diversidade de fauna e flora. As observações de campo foram desenvolvidas no período de um ano entre 2016 e 2017. Na área de estudo foram identificadas 31 espécies distribuídas em 14 famílias, sendo Fabaceae (19%) a mais representativa com o maior número de espécies. Foi constatado que a maioria das espécies estudadas era exótica (75,6%). A coloração floral de maior representatividade foi branca (29%) e a principal recompensa floral foi o néctar (47%) seguido do conjunto néctar/pólen (40%). A síndrome de polinização mais comum foi a de melitofilia (71%).

Palavras-chave: Ecologia urbana. arborização urbana, biologia floral.

INTRODUCTION

Given that it brings the natural environment closer to the urban environment, urban floras can be considered an important element in spatial restructuring (BONONI, 2004). The environmental and social benefits of urban vegetation are many, and include: reduction of environmental impacts of urbanization, climate moderation, conservation of energy within houses and buildings, carbon dioxide absorption, improving water quality, control water flow and floods, noise level reduction, shelter and habitat for wildlife (RIBEIRO, 2009).

In addition to the important role of the urban flora in maintaining environmental quality in

cities, it also plays a key role in maintaining the assemblage of natural pollinating agents attracted by these plants. In this context, it is importante to note that pollination is an essential phenomenon for maintaining biodiversity and one that is essential for plant species propagation.

Understanding the process of biotic pollination also involves an understanding of the floral attributes used by the pollinator. These resources need to satisfy at least one of the three main needs of pollinating animals: feeding, breeding or shelter (AGOSTINI et al. 2014). According to Faegri and van der Pijl (1979), all these floral attributes are linked to the various pollination syndromes (that is the set of characteristics of a flower that favors and/or attracts

the visit of a particular pollinating agent), and so constitute an important guide to pollination ecology studies.

Each species or group of plants has specific morphological and physiological characteristics that attract particular types of pollinators. These characteristics have important implications not only for the relationship between the plant and its animal pollinators, but also for the reproduction of the plant species involved. According to Ramirez *et al.* (1990), the different floral types are related to the sensory development of pollinators, especially those concerning the ability to distinguish and memorize particular floral patterns.

The municipality of Santo Antônio de Pádua is located in northwestern Rio de Janeiro state. Its vegetation is composed of semi-humid forests and is part of the Mata Atlântica Biome (IBGE, 1992). However, most of the natural vegetation cover within the municipality has been lost to cattle ranching. More than 90% the original vegetation cover of the municipality has been lost (SOS Mata Atlântica Foundation, 2017), leaving only small fragments of natural forest at various stages of ecological succession, with less than 1% of their original vegetation cover (SILVA *et al.*, 2009).

Afforestation is a very important component of urban ecology. In addition to its aesthetic and landscape function, it provides other innumerable benefits for both human and non-human populations (EMBRAPA 2009). Prominent among these is a capacity to bring humans closer to nature and the decrease of ecological and environmental impacts in the urban environment, so contributing to improvements in quality of life of the resident human population (SANTOS and TEIXEIRA, 2001).

However, urban afforestation must also fulfill the role of harboring and feeding the regional fauna. This is generally achieved by using a broad variety of species, as this positively influences local biodiversity, brings greater stability to food chains and minimizes the chance of pest and diseases vectors buildups. Thus, the urban flora is essential for the maintenance of biodiversity and ecosystem services, such as pollination since, in order for fruits and seeds to be formed plants in urban arborized areas, most plants require animals as pollinators and dispersers of their propagules.

Accordingly, the current study aimed to characterize the pollination syndromes of the urban plant assemblage in the municipality of Santo Antônio de Pádua and answering the following question: Is the urban flora of the region varied

enough to attract a range pollinating animals?

METHODOLOGY

The current study took place between July 2016 and August 2017 in the urban area of the Santo Antônio de Pádua municipality headquarters, in northwestern Rio de Janeiro state. The municipality covers 669 km² and has a mean altitude of 86 meters asl. Regional climate is hot and humid and classified as Aw according to Köppen (1948). The average annual temperature is 22.9°C and average annual rainfall 1234 mm (CLIMARTE- DATA.ORG, 2017).

Only cultivated trees and shrubs in the streets, avenues, alleys, squares and gardens were considered for this study. Monthly, fertile and nonfertile branches of these species were collected for later identification. In addition to the field visits to determine the plant species present, secondary data were also collected from the Municipal Environment Secretariat.

For each collected species the floral attributes such as shape, size, color and floral reward were recorded. To supplement visual observations, photographic records of the cataloged species were made.

Flower morphology was classified according to Faegri and van der Pijl (1979). Additionally, flowers were classified into six color categories: (1) white, (2) red (including orange), (3) greenish (including beige and cream), (4) yellow, (5) lilac (including blue and violet), and (6) pink (including magenta). Five classes of floral resources were considered: (1) pollen, (2) nectar, (3) oils, (4) resin and (5) pollen/nectar (Faegri and Van Der Pijl, 1979).

In order to characterize the pollination syndromes, the species were collected in guilds according to the floral characteristics, in relation to their main pollination vector: Wind (Anemophilia), bees (Melittophilia), wasps (Vespophilia), butterflies and moths (Psychophilia), sphingids (Sphingophilia), flies (Myophilia) and beetles (Cantharophilia), hummingbirds (Ornithophilia) and bats (Chiropterophilia).

RESULTS AND DISCUSSION

Within the study area 31 woody urban plant species were recorded, in 29 genera, from 14 families (Table 1). The city has a great quantity of fruit-bearing trees, such as mangos, Malay apples, mulberries, star fruit, most notably on the margins of the Rio Pomba which cuts through the city.

The commonest families were Fabaceae

(19.4%), Bignoniaceae (12.9%), Myrtaceae (12.9%), Anacardiaceae (9.7%), Lytracae (6.5%), Apocynaceae (6.5%), Malvaceae (6.5%), Moraceae (6.5%). The majority of species were concentrated in eight families, with the remaining six species belonging to one family each. This form of richness by families has also found in other urban flora surveys, where Fabaceae is generally the most species-rich (CARVALHO et al. 2007, LOCASTRO and ANGELIS 2015, MOURA and SANTOS, 2009).

Of the species recorded, 53.3% are foreign

exotic, 33.4% are from the north and northeast of Brazil, and only 13.3% are native to the Atlantic Forest. These data agree with those of Lorenzi (1998), who states that the majority of tree species cultivated in Brazilian cities are exotic. This is in spite of the fact that using native species in urban afforestation may favor climatic and soil adaptability, as well as increasing possibilities of producing healthy flowers and fruits, and as producing food for native animal species, and thus aiding overall native biota conservation.

Table 1. Characteristics of the urban flora of Santo Antônio de Pádua municipality headquarters, Rio de Janeiro State, Brazil.

FAMILY	SPECIES	POPULAR NAME (Brazilian, English)	NATURAL OCCURRENCE
Anacardiaceae	<i>Anacardium occidentale</i> L.	Cajueiro, cashew	Brazil (North/Northeast)
	<i>Mangifera indica</i> L.	Mangueira, mango	India
	<i>Spondias mombin</i> L.	Cajazeiro, sour plum	Brazil (Mata Atlântica)
Apocynaceae	<i>Nerium oleander</i> L.	Espirradeira, oleander	Africa, Asia Minor and Mediterranean
	<i>Plumeria rubra</i> L.	Jasmin manga, plumeria	Tropical America
Arecaceae	<i>Roystonea oleracea</i> Cook.	Palmeira real, royal palm	Caribbean
Bignoniaceae	<i>Spathodea campanulata</i> P.Beauv.	Espátodea, African tulip tree	Africa
	<i>Tabebuia ipe</i> (Mart. ex K. Schum.) Standl.	Ipê-rosa, princess tree	Brazil (Mata Atlântica)
	<i>Handroanthus chrysotricha</i> (Mart. Ex Dc.) Mattos	Ipê-amarelo	Brazil (Mata Atlântica)
	<i>Tecoma stans</i> (L.) Juss. ex Kunth	Epay.ipe Ipê-jardim	Mexico to Peru
		yellow trumpetbush	
Chrysobalanaceae	<i>Licania tomentosa</i> Benth.	Oiti, gopher apple/false zapota	Brazil (North/Northeast)
Combretaceae	<i>Terminalia catappa</i> L.	Amendoeira Indian almond/sea almond	Tropical Asia
	<i>Clitoria fairchildiana</i> Howard	Sombreiro, sombreiro	Brazil (Amazônia)
	<i>Delonix regia</i> (Bojer ex Hook.) Raf.	Flamboyant flamboyant	Madagascar
	<i>Inga edulis</i> Mart.	Ingá, Inga	Brazil (Mata Atlântica)
Fabaceae	<i>Bauhinia variegata</i> L.	Pata de vaca, orchid tree/camels foot tree	Asia
	<i>Caesalpinia leiostachya</i> (Benth.) Hook	Pau-ferro, iron wood	Brazil (Mata Atlântica)
	<i>Albizia lebbek</i> (Benth) Barneby & Grimes	Angico, flea tree	Tropical Asia
	<i>Lagerstroemia indica</i> L.	Extremosa, crepe myrtle	Asia
Lythraceae	<i>Punica granatum</i> L.	Romã, pomegranite	Iran
		Aceroleira, acerola/Barbados cherry	Central America & northern South America
Malpighiaceae	<i>Malpighia emarginata</i> DC	Paineira, kapok tree/silk floss tree	Brazil (Mata Atlântica)
	<i>Ceiba speciosa</i> (St. Hil.) Rav.	Falso cacau	Brazil (North/Northeast)
Malvaceae	<i>Pachira aquatica</i> Aubl.	malabar chestnut	

FAMILY	SPECIES	POPULAR NAME (Brazilian, English)	NATURAL OCCURRENCE
Moraceae	<i>Ficus.sp</i>	Figueira fig	-
	<i>Morus nigra</i> L.	Amoreira, black mulberry	Asia
Myrtaceae	<i>Eugenia uniflora</i> L.	Pitangueira, pitanga/Brazilian cherry	Brazil (Mata Atlântica)
	<i>Psidium guajava</i> L.	Goiabeira guava	Brazil (Mata Atlântica)
	<i>Syzygium cumini</i> (L) Skeels	Jambolão, java plum	Siri Lanka & India
	<i>Syzygium malaccense</i> (L.) Merr.& L.M Perry	Jambo vermelho malay apple, sugar apple	Polynesia
	<i>Ligustrum japonicum</i> Thunb.	Ligustro, Japanese privet	Japan & Korea
Oxilidaceae	<i>Averrhoa carambola</i> L.	Carambola, star fruit	Asia and Indonesia

Seven pollination syndromes were identified for the recorded species (Figure 1). The least common pollination syndrome was anemophilia, found only in *Morus nigra*, while the most common was melittophilia, identified in around 70% of the species recorded. Kinoshita *et al.* (2005), Yamamoto *et al.* (2006) and dos Santos *et al.* (2009) also found that melittophilia is the most common syndrome in natural areas of the Atlantic Forest. Similar proportion have been reported from Cerrado (SILBERBAUER-GOTTSBERGER AND GOTTSBERGER, 1988), Restinga (ORMOND *et al.*, 1993), Caatinga (Leal *et al.* 2006), and Amazon forest (REIS *et al.*, 2012) environments. Thus, it appears that melittophilia is the most common pollination syndrome in practically all natural environments in Brazil.

Ornithophily was present in 9.7% of the recorded species (Figure 1), with the main pollinating species being hummingbirds. Bat-pollinated

plants pollinated constituted 3.2% of recorded species (Figure 1), such species generally have strongly-scented, night-opening flowers (Table 2). Psychophilia occurred in 6.4% of species (Figure 1). In all Brazilian ecosystems the interactions between plants and butterflies and moths is complex.

Considering floral characteristics, plants with white-petaled flowers were most common (29%), followed by pink (26%), greenish (22%), red (10%), and yellow (3%). Accordingly, there was a much higher proportion of species (61%) with pale flowers (including yellow, green and white) than strongly-colored ones (39%: red, pink and lilac). Interestingly, although plant choice must to some extent reflect horticultural contingencies and human preferences, similar proportions have been found in natural regional plant assemblages in Restingas (ORMOND *et al.* 1993), though a predominance of strong colors was recorded in Caatinga by Leal *et al.* (2006).

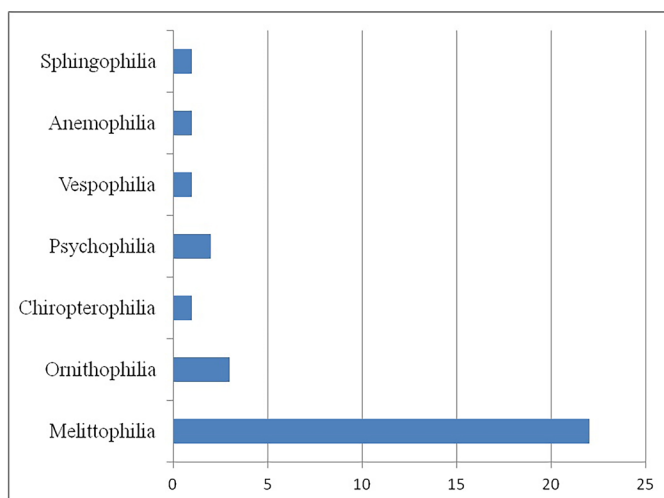


Figure 1- Percentage of pollination syndromes of tree and shrub species recorded in the urban area of Santo Antonio de Pádua municipality headquarters, Rio de Janeiro State, Brazil.

Table 2. Pollination characteristics and syndromes of shrub and tree species in the urban area of Santo Antônio de Pádua municipality, Rio de Janeiro State, Brazil

Species	Anthesis period	Flower color	Floral attract-ant	Floral resource	Pollination syndrome
<i>Albizia lebbbeck.</i> (Benth) Barneby & Grimes	Day	White	Scent	Nectar Pollen	Mellitofilia
<i>Anacardium occidentale</i> L.	Day	Pink	Scent	Nectar Pollen	Mellitophilía
<i>Averrhoa carambola</i> L.	Day	Pink	Color, Scent	Nectar	Mellitophilía
<i>Bauhinia variegata</i> L.	Day	White/Pink	Scent	Nectar	Mellitophilía
<i>Caesalpinia leiostachya</i> (Benth.) Hook	Day	Yellow	Color	Nectar Pollen	Mellitophilía
<i>Ceiba speciosa</i> (St. Hil.) Rav.	Day	Pink	Color	Nectar	Ornitofilia
<i>Clitoria fairchildiana</i> Howard	Day	Liliac	Color	Nectar Pollen	Mellitophilía
<i>Delonix regia</i> (Bojer ex Hook.) Raf.	Day	Red	Color	Nectar Pollen	Ornithophilía
<i>Eugenia uniflora</i> L.	Day	White	Scent	Pollen	Mellitophilía
<i>Ficus</i> .sp	Day	Greenish	Scent	Ovoposition site	Vespophilía
<i>Handroanthus chrysotricha</i> (Mart. Ex Dc.) Mattos	Day	Yellow	Scent	Nectar	Mellitophilía
<i>Inga edulis</i> Mart.	Night	White	Scent	Nectar	Sphingophilía
<i>Lagerstroemia indica</i> L.	Day	Pink	Color	Nectar Pollen	Mellitophilía
<i>Licania tomentosa</i> Benth.	Day	Greenish	Scent	Nectar Pollen	Mellitophilía
<i>Ligustrum japonicum</i> Thunb.	Day	Greenish	Scent	Nectar	Mellitophilía
<i>Malpighia emarginata</i> DC.	Day	Pink	Scent	Nectar Oils	Mellitophilía
<i>Mangifera indica</i> L.	Day	Greenish	Scent	Nectar Pollen	Mellitophilía
<i>Morus nigra</i> L.	Day	Green	-	-	Anemophilía
<i>Nerium oleander</i> L.	Day	Pink	Scent	Nectar	Psychophilía
<i>Pachira aquatica</i> Aubl.	Night	Greenish	Scent	Nectar	Chiropterophilía
<i>Plumeria rubra</i> L.	Day	White	Scent	Nectar	Psychophilía
<i>Psidium guajava</i> L.	Day	White	Scent	Nectar Pollen	Mellitophilía
<i>Punica granatum</i> L.	Day	Red	Scent	Nectar Pollen	Mellitophilía
<i>Roystonea oleracea</i> Cook.	Day	White	Scent	Pollen	Mellitophilía
<i>Spathodea campanulata</i> P.Beauv.	Day	Red	Scent	Nectar	Ornithophilía
<i>Spondias mombin</i> L.	Day	White	Scent	Nectar Pollen	Mellitophilía
<i>Syzygium cumini</i> (L.) Skeels	Day	Greenish	Scent	Nectar Pollen	Mellitophilía
<i>Syzygium malaccense</i> (L.) Merr. & LM Perry	Day	Pink	Color	Nectar	Mellitophilía
<i>Tabebuia ipe</i> (Mart. ex K. Schum.) Standl.	Day	Pink	Color	Nectar	Mellitophilía
<i>Tecoma stans</i> (L.) Juss. ex Kunth	Day	Yellow	Color	Nectar	Mellitophilía
<i>Terminalia catappa</i> L.	Day	White	Scent	Nectar	Mellitophilía

Flower color has a direct relation with the type of vision that visiting animals possess. Varassin and Amaral-Neto (2014) suggest that the visual signals produced by flowers were evolutionarily fundamental for the establishment of such interactions.

Nectar was the most commonly used plant resource (47%), followed by nectar/pollen (40%), pollen grains (7%), oils (3%) and oviposition site (3%). Similar results have been found in other studies of urban plant community resource profiles, including Silberbauer-Gottsberger and Gottsberger (1988), Ramirez et al. (1990), Ormond et al. (1993), Oliveira and Gibbs (2000) and Leal et al. (2006). Floral nectar has an intimate association with the biology of a plant pollinators, since it is a food rich in sugars that provides energy for its activity. Although, many nectar sugar concentrations seem to be adjusted to ensure that pollinators must return fairly soon to the source – thus guaranteeing pollen grains transfer. Accordingly, nectar is a food sought by a wide variety of insects and birds, as well as some mammals (AGOSTINI et al., 2014). Pollen grains, each of which acts as a vehicle for the male gamete, also form part of the diet of several groups of insects, including beetles and bees among others, as well as birds and mammals. The analysis on the chemical constitution of pollen grains show they contain mainly protein, as well as lipids, starches and sugars (AGOSTINI et al., 2014).

FINAL CONSIDERATIONS

The study allowed a quantitative analysis of the composition of the urban flora in the municipality of Santo Antônio de Pádua, and the identification of the most common pollination syndromes. Most of the species present were exotic, and so may be highly beneficial to local wildlife. As already indicated native plants have a high potential and adaptability to be used in the urban arborization, which brings benefits to this fauna.

Melittophilina was the most common pollination syndrome and species producing nectar as a floral resource were also the most common. Finally, a plea is made for the adoption of strong environmental considerations when considering the species composition of urban floral plantings, since, especially in areas where deforestation is extensive, such plants will be responsible for the maintenance and conservation of many of the pollinating animals present in the area. Managed properly urban planting has the potential to significantly attract the local pollinating fauna, especially in areas where much

of its original vegetation is now lost. For urban plantings to have maximum conservation value to the local pollinator assemblage, it is necessary that some measures be taken, such as planting a greater variety of native species and their proper management, as well as studies of which non-native species are most attractive to native pollinators, and planting to guarantee resource availability throughout the year.

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