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FLORISTIC COMPOSITION OF URBAN AFFORESTATION IN SOROCABA, SÃO PAULO STATE, BRAZIL

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ABSTRACT

We carried out a survey of the urban forest in all streets and avenues of Sorocaba City to know the floristic composition, identify the origin of species, and detect possible threatened species. This study was conducted from November 2011 to August 2012. We sampled 51,908 trees that belonged to 203 species, 130 genera, and 47 families. Considering the total of species, 12 of them had some level of damage. Most species (42.36%) and individuals (41.78%) sampled are native species to Brazil. The Shannon Wiener Index (H ') was 3.73, a high value compared to other Brazilian cities. We did not observe the dominance of one or a few species, showing the diversification of tree species in the city. The results show that Sorocaba City has a well-planned and diversified urban afforestation.

Key-words: Urban forestry, Diversity, Urban Management.

COMPOSIÇÃO FLORÍSTICA DA ARBORIZAÇÃO URBANA DE SOROCABA/SP, BRASIL

RESUMO

Foi realizado um censo da arborização urbana em todas as ruas e avenidas do município de Sorocaba, com o objetivo de conhecer a composição florística, identificar a origem das espécies, e detectar possíveis espécies ameaçadas de extinção. Este estudo foi realizado entre novembro de 2011 e agosto de 2012. Foram amostradas 51.908 árvores, 203 espécies, 130 gêneros e 47 famílias. Do total de espécies, 12 apresentaram em algum grau de ameaça à extinção. A maioria dos indivíduos (41,78%) e das espécies (42,36%) são de nativas do Brasil. O índice de Shannon Wiener (H') foi de 3,73, valor alto em comparação com outros municípios brasileiros. Não foi observado dominância de poucas espécies, mostrando a diversificação de espécies na cidade. Considerando estes resultados, pode-se dizer que, de modo geral, a cidade de Sorocaba apresenta uma arborização urbana bem planejada e diversificada.

Palavras-chave: Silvicultura urbana, Diversidade, Gestão urbana.

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INTRODUCTION

The occupation and use of land in Brazilian cities have been historically modifying the landscape. Farms and natural areas at the beginning of colonization were transformed into arid landscapes with highly occupied and paved soils. The first Brazilian cities were formed along the coast and the actions of pioneers lead to the occupation of the interior part of the country. In many cities, the high concentration of population and industrial activities cause serious environmental problems such as soil impermeability and air, water, sound, and visual pollution, in addition to the reduction of vegetation cover (ROCHA et al. 2004).

The Sorocaba region developed based on the metallurgical industry (with the installation of the first gun factory in Araçoiaba Hill) and the construction of Sorocabana Railroad in 1870. This region was originally covered by remnants of the Atlantic Forest and Cerrado Biomes, with the presence of currently threatened species like peroba (*Aspidosperma polyneuron* Müll. Arg.) and pequi (*Caryocar brasiliense* Cambess.), however, the vegetation cover was gradually suppressed by agricultural occupation and activities of ore extraction. Currently the city has high degree of industrialization and urbanization, and the natural elements in the landscape, for the most part, are restricted the avenues, squares and urban parks. The remaining natural forest fragments in the municipality of Sorocaba cover 16% of its total area, and the largest fragments are located in rural areas (MELLO, 2012).

Urban afforestation, in addition to its aesthetic contribution to the landscape, enables the contact of urban residents with nature, despite the high degree of modification of the urban environment. Wooded sites are generally more pleasant to the human senses (ROCHA et al. 2004), and the arboreal elements in the arid landscape of cities break the monotony of the landscape and create unusual beauties, besides attracting wildlife.

In the urban matrix, trees can provide microhabitats for migratory and resident birds, as well as serve as "ecological trampolines" between urban and rural forests and between larger patches of vegetation (SUAREZ-RUBIO and THOMLINSON, 2009). However, to perform these services, urban afforestation should be properly planned in its design, deployment, and management in order to, along with the green areas and protected areas, promote the naturalization of cities (BRIZ and DE FELIPE, 2004; BOADA and SANCHEZ, 2012).

Kramer and Krupek (2012) state that urban afforestation should be a major concern of all municipalities, mainly for development of plans that value the landscape and ecological aspects, therefore, bringing direct benefits to citizens.

To know, analyze, and create a database with remote access to facilitate urban management, we conducted a survey of the urban afforestation in the city of Sorocaba, São Paulo State, Brazil. The study is part of a recent effort of Sorocaba City Hall to adequately tailor the urban environment and provide improved quality of life to its citizens. Thus, this study aimed to know the floristic composition of the streets and avenues of Sorocaba City, identifying the species according to their origin (native, exotic or sub-spontaneous of Brazil), and degree of threat (according to the Red List of the IUCN Species), in order to subsidize the planning and management of afforestation by municipal public managers.

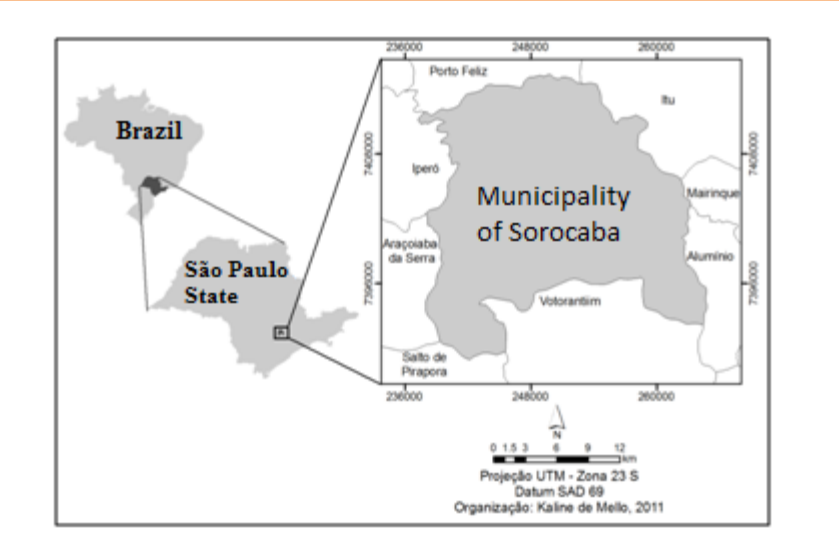
MATERIAL AND METHODS

Study site

The municipality of Sorocaba is located in the southeast region of São Paulo State (23°30'06"S lat; 47°27'29"W long), with average elevation of 601 meters above sea level, 92 Km from São Paulo City, the state capital (Fig. 1). The main highways of the region are Castelo Branco (SP-280) and Raposo Tavares (SP-270). The Municipality cover an approximate area of 450 km^2, being 82.5% in the urban area and 17.5% in the rural area (SOROCABA, 2007), with a population of 598,625 inhabitants and a density of 1,306.55 inhabitants per km^2 (IBGE, 2012). The economic growth and the proximity to São Paulo City led Sorocaba to an intense process of urbanization and industrialization.

The climate of the region is in a strip of transition between Cfa type climate (warm subtropical) and Cwa (warm subtropical, with drier winters), characterized as typically seasonal with markedly dry winters (CEPAGRI, 2012). The remnants of vegetation are part of the Atlantic Forest and Cerrado Biomes, with predominance formation of seasonal semideciduous forest (BRASIL, 2012).

Figure 1: Location Sorocaba municipality, São Paulo State, Brazil. (Source: MELLO, 2012).



Data collection

The data were collected between November 2011 and August 2012 by a team of 26 interns, students of courses of Forestry Engineering and Biology of UFSCar, campus Sorocaba, under the guidance of expert researchers, authors of this work.

The area of the city was divided into 10 regions with approximately the same number of streets and avenues, and at least two interns conducted the survey in each area. We collected qualitative and quantitative data of all tree individuals on streets and avenues, planted in sidewalks and medians. We did not include in this study, individuals on squares and urban parks, nor in the fragments of native vegetation.

We collected botanical material and/or photographic records of the whole individual, details of the branches, bark, flowers, and fruits for subsequent identification.

Data analysis

After the fieldwork completion, we checked the data consistency by verifying the identification of species, the duplication of names, misspellings, among others. The families were named based on the Angiosperm Phylogeny Group III (APG III, 2009; SOUZA and LORENZI, 2012) and spellings of names and synonyms of the species were checked using the list of species in Flora do Brazil (FORZZA et al. 2010) and database of tropical plant of the Missouri Botanical Garden (TROPICOS, 2013). The abbreviations of the names of the authors were uniformed following Authors of Plant Names (Brumitt and Powell, 2004).

The origin (native, exotic or sub-spontaneous) of species were consulted on the list of in Flora do Brazil (FORZZA et al. 2010). In addition, we checked the inclusion of the plants identified the Red List of threatened species of IUCN (2012). From the data collected, we calculated the following parameters: (a) relative density (RD): number of individuals of species/total number of individuals sampled; (b) species diversity of Shannon Wiener Index (H'): $- \sum (n_i/N) \ln(n_i/N)$, where n_i is the number of individuals of a given species and N is total number of individuals sampled.

RESULTS AND DISCUSSION

We surveyed more than 3,100 streets in the municipality of Sorocaba, belonging to 275 neighborhoods, totaling 51,908 individuals, including trees and palm trees. Of this total, 2,171 individuals were identified as seedlings (young individuals, recently planted) and 1,261 could not be identified (Table 1). We identified 203 species with two or more individuals sampled, belonging to 47 families, and 130 genera (Table 1). The Shannon Wiener Index (H') was 3.73.

The families with the highest number of species were Fabaceae (48), Myrtaceae (14), Arecaceae

(14), and Bignoniaceae (14) that, together, accounted for 44.3% of the total species sampled. The species in the family Fabaceae are mostly native with *Poincianella pluviosa* (DC.) L.P. Queiroz (Sibipiruna) as the species with the greatest number of individuals. Among the species of the family Myrtaceae domesticated species predominate (JORGE, 2004; PRANCE and NESBITT, 2005), being native (Jabuticaba, Pitanga), exotic (eucalyptus, Cravo da índia) or sub-spontaneous (Guava). The native species of this family are typical and abundant in the Atlantic Forest Biome. The family Bignoniaceae is represented mostly by ipês (*Tabebuia*), which in general are native species. In the family Arecaceae (palms), only Jerivá and Juçara are native, and the other species are exotic or sub-spontaneous.

Thus, we observe that afforestation of Sorocaba presents families common to other cities in the state, such as Fabaceae, Myrtaceae, and Bignoniaceae (STRANGHETTI and SILVA 2010; SARTORI and BALDERI, 2011) and Brazil, such as Fabaceae and Arecaceae (PARRY et al. 2012).

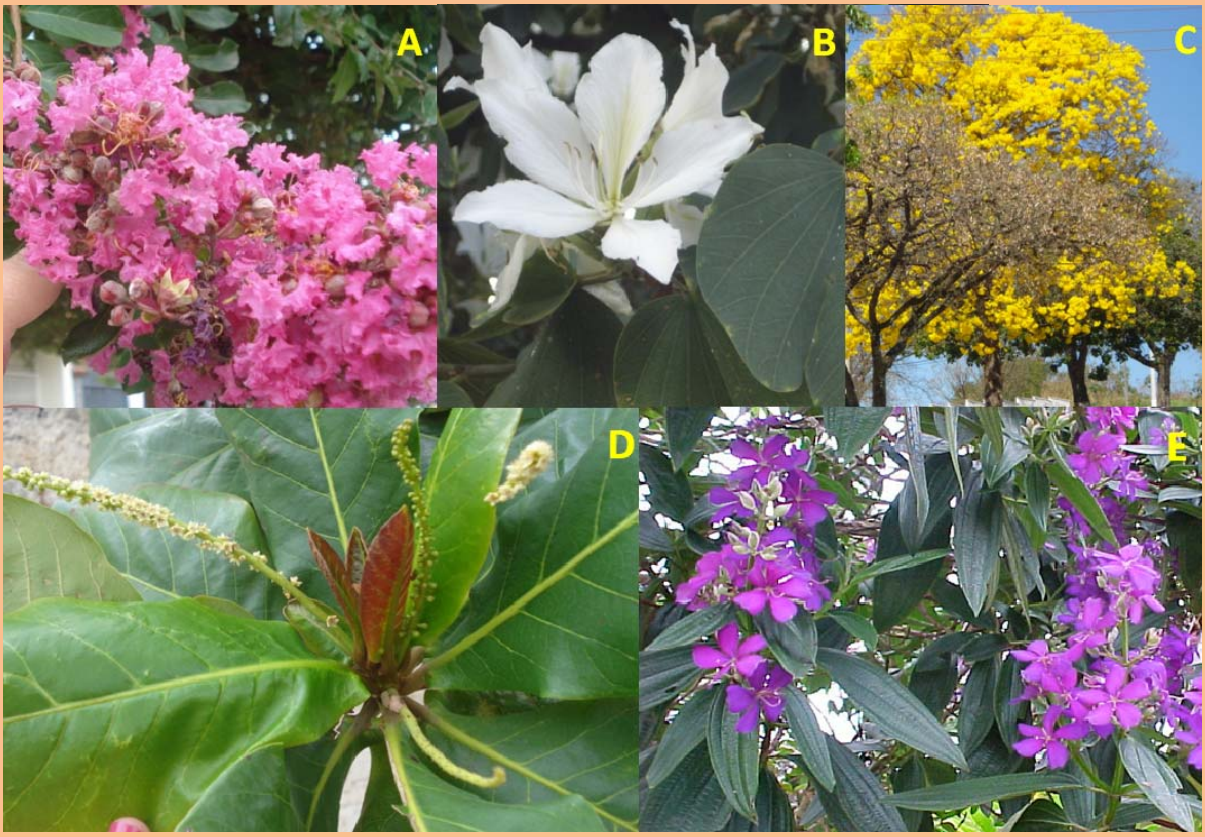
The 20 most common species that represented 71.45% of the total number of individuals sampled were Sibipiruna, False murta, Yellow Ipê, Aroeira salsa, Figueira, Resedá, Chapéu-de-sol, Figo chorão, Quaresmeira, Palmeira jerivá, Pata de vaca, Ipê branco, Ipê, Alfeneiro, Pitanga, Palmeira imperial, Ipê roxo, Tipuana, Flamboyant, Aroeira pimenteira and Oiti (Table 1, Fig. 2). Species such as Falsa murta, Sibipiruna, Figo chorão, Aroeira salsa, Resedá, Alfeneiro and Oiti are also found in other cities in the state with high density, for example Assis (ROSSATO et al., 2008), Cosmópolis (PAIVA et al., 2009), Franca (SILVA et al., 2008), São Carlos (SUCOMINE et al. 2010), Socorro (SARTORI and BALDERI, 2011), and Taubaté (MINHOTO et al., 2009).

Among the species native to Brazil, 12 were placed in some category of threat (IUCN, 2012), which are Araucaria angustifolia (Bertol.) Kuntze (critically threatened); Caesalpinia echinata Lam., Cedrela fissilis Vell. (threatened), Machaerium villosum Vogel (vulnerable); Hymenaea courbaril L., Copaifera langsdorffii Desf., Bauhinia forficata Link, Inga marginata Willd. (little concern); Couroupita guianensis Aubl. (below risk/little concern); Lafoensia pacari A. St.-Hil. (low risk/dependent of conservation); Poincianella pluviosa (DC.) L.P. Queiroz, Myrocarpus frondosus Allemão (lack of information).

Among the exotic and sub-spontaneous species to Brazil, none were included in some category of threat, which are Delonix regia (Bojer ex Hook.) Raf., Callitropsis macrocarpa (Hartw. ex Gordon) D.P. Little, Jacaranda mimosifolia D.Don (vulnerable); Mangifera indica L., Punica granatum L., Erythrina variegata L., Araucaria columnaris Hook., Bismarckia nobilis Hildebr. & H.Wendl. (little concern) and Wodyetia bifurcata A.K. Irvine (low risk/dependent of conservation).

We observe that in most studies conducted in São Paulo State, the sampling was much smaller than that in the present study, which covered the totality of individuals. The richness of species sampled in Sorocaba (203 species) was also higher than that found in several studies in cities from São Paulo that recorded from 40 to 148 species (ROSSATO et al., 2008; PAIVA et al., 2009; SILVA et al., 2008; SUCOMINE et al. 2010; SARTORI and BALDERI, 2011; MINHOTO et al., 2009). Parry et al. (2012) also conducted a survey in the city of Altamira, Pará State, Brazil, sampling 4,294 individuals and 120 species, a much smaller number that that registered in Sorocaba.

Figure 2. A - *Lagerstroemia indica* L., B - *Bauhinia variegata* L., C - *Handroanthus chrysotrichus* (Mart. Ex DC.) Mattos, D - *Terminalia catappa* L., E - *Tibouchina granulosa* (Desr.) Cogn., sampled species in urban forestry of Sorocaba, SP, Brazil.



Photos: Cardoso-Leite, E.2012.

Table 1. Species and families sampled in the survey of urban afforestation in Sorocaba, São Paulo State, Brazil. Orig. = origin, N.ind. = number of sampled individuals, RD = relative density (% of sampled individuals), N = native, E = exotic, SUB = sub-spontaneous, NC = non-classified. Threatened species *.

Species	Family	Popular name	Orig.	N. ind.	RD
Poincianella pluviosa (DC.) L.P. Queiroz *	Fabaceae	Sibipiruna	N	4,050	7.8023
Murraya paniculata (L.) Jack	Rutaceae	Falsa murta	E	3,985	7.6770
Handroanthus chrysotrichus (Mart. Ex DC.) Mattos	Bignoniaceae	Ipê amarelo	N	3,395	6.5404
Schinus molle L.	Anacardiaceae	Aroeira salsa	N	3,324	6.4036
Ficus sp.	Moraceae	Figueira	NC	3,242	6.2457
Lagerstroemia indica L.	Lythraceae	Resedá	E	2,319	4.4675
Terminalia catappa L.	Combretaceae	Chapéu-de-sol	SUB	2,040	3.9300
Ficus benjamina L.	Moraceae	Figo chorão	E	1,846	3.5563

Tibouchina granulosa (Desr.)Cogn.	Melastomataceae	Quaresmeira	N	1,673	3.2230
Syagrus romanzoffiana (Cham.) Glassman	Arecaceae	Palmeira jerivá	N	1,666	3.2095
Bauhinia variegata L.	Fabaceae	Pata de vaca	E	1,593	3.0689
Tabebuia roseoalba (Ridl.)Sandwith	Bignoniaceae	Ipê branco	N	1,363	2.6258
Handroanthus sp.	Bignoniaceae	Ipê	N	1,258	2.4235
Ligustrum lucidum W.T. Aiton	Oleaceae	Alfeneiro	E	1,250	2.4081
Eugenia uniflora L.	Myrtaceae	Pitanga	N	639	1.2310
Roystonea oleracea (Jacq.) O.F. Cook	Arecaceae	Palmeira imperial	E	620	1.1944
Handroanthus impetiginosus (Mart. ex DC.) Mattos	Bignoniaceae	Ipê roxo, Pau d´arco	N	620	1.1944
Tipuana tipu (Benth.) Kuntze	Fabaceae	Tipuana	SUB	574	1.1058
Delonix regia (Bojer ex Hook.)Raf. *	Fabaceae	Flamboyant	E	562	1.0827
Schinus terebinthifolius Raddi	Anacardiaceae	Aroeira pimenteira	N	537	1.0345
Licania tomentosa (Benth.)Fritsch	Chrysobalanaceae	Oiti	N	535	1.0307
Hibiscus tiliaceus Arruda	Malvaceae	Algodoeiro da praia	E	515	0.9921
Citrus sp.	Rutaceae	Limão	NC	509	0.9806
Bauhinia sp.	Fabaceae	Pata de vaca	NC	506	0.9748
Cupressus sp.	Cupressaceae	Cipreste	E	504	0.9709
Mangifera indica L. *	Anacardiaceae	Mangueira	SUB	469	0.9035
Cassia fistula L.	Fabaceae	Chuva de ouro	E	461	0.8881
Handroanthus heptaphyllus (Vell.) Mattos	Bignoniaceae	Ipê rosa, Ipê 7 folhas	N	421	0.8111
Psidium guajava L.	Myrtaceae	Goiabeira	SUB	413	0.7956
Senna multijuga (Rich.) H.S. Irwin & Barneby	Fabaceae	Caquera	N	393	0.7571
Leucaena leucocephala (Lam.) de Wit	Fabaceae	Leucena	SUB	381	0.7340
Caesalpinia pulcherrima (L.) Sw.	Fabaceae	Flamboyant-mirim	SUB	373	0.7186
Eucalyptus sp.	Myrtaceae	Eucaliptus	E	360	0.6935
Tecoma stans (L.) Juss. ex Kunth	Bignoniaceae	Ipe de jardim	E	320	0.6165
Morus nigra L.	Moraceae	Amora	E	315	0.6068
Punica granatum L. *	Lythraceae	Roma	E	229	0.4412
Magnolia champaca (L.) Baill. ex Pierre	Magnoliaceae	Magnolia amarela	E	229	0.4412
Luehea divaricata Mart. & Zucc.	Malvaceae	Açoita cavalo	N	189	0.3641
Malpighia glabra L.	Malpighiaceae	Acerola	E	182	0.3506

Jacaranda mimosifolia D.Don *	Bignoniaceae	Jacarandá mimoso	E	171	0.3294
Malphigia sp.	Malpighiaceae		NC	169	0.3256
Myroxylon peruiferum L.f.	Fabaceae	Cabreúva	N	168	0.3236
Libidibia ferrea (Mart. ex Tul.) L.P. Queiroz	Fabaceae	Pau ferro	N	152	0.2928
Platanus occidentalis L.	Platanaceae	Plátano	E	152	0.2928
Senna sp.	Fabaceae	Sena	NC	142	0.2736
Grevillea robusta A. Cunn. ex R. Br.	Proteaceae	Grevilha	E	131	0.2524
Ceiba speciosa (A. St.-Hil.) Ravenna	Malvaceae	Paineira	N	128	0.2466
Pinus sp.	Pinaceae	Pinheiro	E	125	0.2408
Persea americana Mill.	Lauraceae	Abacateiro	SUB	123	0.2370
Tabebuia heterophylla (DC.)Britton	Bignoniaceae	Ipê de el salvador	E	121	0.2331
Melia azedarach L.	Meliaceae	Santa bárbara	SUB	118	0.2273
Spathodea campanulata P. Beauv.	Bignoniaceae	Espatódea	E	109	0.2100
Eriobotrya japonica (Thunb.) Lindl.	Rosaceae	Nespera	SUB	105	0.2023
Arecaceae (Palmae)	Arecaceae	Palmeira	NC	100	0.1926
Plumeria sp.	Apocynaceae	Jasmim manga	E	93	0.1792
Croton urucurana Baill.	Euphorbiaceae	Sangra d´agua	N	90	0.1734
Pachira aquatica Aubl.	Malvaceae	Castanhola	N	82	0.1580
Nectandra megapotamica (Spreng.) Mez	Lauraceae	Canelinha	N	80	0.1541
Cedrela fissilis Vell. *	Meliaceae	Cedro	N	80	0.1541
Syzygium cumini (L.) Skeels	Myrtaceae	Jambolão	SUB	77	0.1483
Tibouchina mutabilis (Vell.) Cogn.	Melastomataceae	Manacá da serra	N	66	0.1271
Caesalpinia echinata Lam. *	Fabaceae	Pau brasil	N	58	0.1117
Schefflera morototoni (Aubl.) Maguire, Steyerm. & Frodin	Araliaceae	Morototó	N	57	0.1098
Caryota urens L.	Arecaceae	Palmeira-toddy	E	56	0.1079
Peltophorum dubium (Spreng.)Taub	Fabaceae	Sobrasil, faveiro	N	56	0.1079
Callistemon viminalis (Sol. ex Gaertn.) G. Don	Myrtaceae	Escova de garrafa	E	54	0.1040
Grevillea banksii R. Br.	Proteaceae	Grevilha	E	54	0.1040
Malpighia emarginata DC.	Malpighiaceae	Acerola	E	53	0.1021
Thevetia peruviana (Pers.) K.Schum.	Apocynaceae	Chapéu de napoleão	N	52	0.1002
Hovenia dulcis Thunb.	Rhamnaceae	Uva japonesa	SUB	50	0.0963
Mimosa sp.	Fabaceae		NC	47	0.0905

Platanus acerifolia (Aiton) Willd.	Platanaceae	Plátano	E	45	0.0867
Gochnatia polymorpha (Less.)Cabrera	Asteraceae	Cambará	N	43	0.0828
Lagerstroemia speciosa (L.) Pers.	Lythraceae	Resedá gigante	E	43	0.0828
Morus sp.	Moraceae		NC	41	0.0790
Prunus sp.	Rosaceae		NC	38	0.0732
Artocarpus heterophyllus Lam.	Moraceae	Jaqueira	SUB	37	0.0713
Poecilanthe parviflora Benth.	Fabaceae	Coração negro	N	36	0.0694
Nectandra sp.	Lauraceae	Canela	NC	36	0.0694
Caryota mitis Lour.	Arecaceae	Rabo de peixe	E	35	0.0674
Cinnamomum sp.	Lauraceae	Cinamomo	NC	34	0.0655
Plinia cauliflora (Mart.)Kausel	Myrtaceae	Jabuticaba	N	34	0.0655
Spondias purpurea L.	Anacardiaceae	Seriguela	E	29	0.0559
Inga sp.	Fabaceae	Ingá	NC	28	0.0539
Lafoensia sp.	Lythraceae	Dedaleiro	NC	27	0.0520
Acacia podalyriifolia A. Cunn. ex G. Don	Fabaceae	Acácia mimosa	E	25	0.0482
Psidium cattleianum Sabine	Myrtaceae	Aracá	N	25	0.0482
Plumeria rubra L.	Apocynaceae	Jasmim manga	E	23	0.0443
Centrolobium tomentosum Guillem. ex Benth.	Fabaceae	Araribá	N	22	0.0424
Inga vera Willd.	Fabaceae	Ingá banana	N	22	0.0424
Koelreuteria paniculata Laxm.	Sapindaceae	Árvore da china	E	22	0.0424
Annona sp.	Annonaceae		NC	21	0.0405
Cocos nucifera L.	Arecaceae	Coco da Bahia	SUB	20	0.0385
Schizolobium parahyba (Vell.) Blake	Fabaceae	Guapuruvú	N	20	0.0385
Euphorbia cotinifolia L.	Euphorbiaceae	Leiteiro vermelho	N	19	0.0366
Hymenaea courbaril L. *	Fabaceae	Jatobá	N	19	0.0366
Pseudobombax longiflorum (Mart. & Zucc.) A.Robyns	Malvaceae	Embiruçú	N	18	0.0347
Grevillea sp.	Proteaceae	Grevilha	E	17	0.0328
Solanum sp.	Solanaceae		NC	17	0.0328
Cecropia sp.	Urticaceae	Embaúba	NC	16	0.0308
Anacardium occidentale L.	Anacardiaceae	Cajueiro	N	15	0.0289
Cocos sp.	Arecaceae	Coco	SUB	15	0.0289
Erythrina variegata L. *	Fabaceae	Eritrina verde-amarela	E	15	0.0289
Ficus elastica Roxb. ex Hornem.	Moraceae	Falsa seringueira	E	14	0.0270

Eugenia involucrata DC.	Myrtaceae	Cerejeira do mato	N	14	0.0270
Dilodendron bipinnatum Radlk.	Sapindaceae	Maria pobre	N	14	0.0270
Annona squamosa L.	Annonaceae	Fruta do conde	E	13	0.0250
Copaifera langsdorffii Desf. *	Fabaceae	Copaíba	N	13	0.0250
Pterocarpus rohrii Vahl	Fabaceae	Aldrago	N	13	0.0250
Bixa orellana L.	Bixaceae	Urucum	N	12	0.0231
Anadenanthera sp.	Fabaceae	Angico	NC	12	0.0231
Annona mucosa Jacq.	Annonaceae	Ariticum	N	11	0.0212
Cassia sp.	Fabaceae	Cassia	NC	11	0.0212
Dillenia indica L.	Dilleniaceae	Arvore do dinheiro	E	10	0.0193
Muntingia calabura L.	Muntingiaceae	Calabura, tamuã	N	10	0.0193
Ligustrum japonicum Thunb.	Oleaceae	Alfeneiro do Japão	SUB	10	0.0193
Araucaria angustifolia (Bertol.) Kuntze *	Araucariaceae	Pinheiro do paraná	N	9	0.0173
Euterpe edulis Mart.	Arecaceae	Palmito juçara	N	9	0.0173
Syagrus itacambirana Noblick & Lorenzi	Arecaceae	Palmeira	N	9	0.0173
Lithrea molleoides (Vell.)Engl.	Lythraceae	Aroeira brava	N	9	0.0173
Salix babylonica L.	Salicaceae	Salgueiro	E	9	0.0173
Handroanthus serratifolius (A.H.Gentry) S.Grose	Bignoniaceae	Ipê	N	8	0.0154
Albizia niopoides (Spruce ex Benth.) Burkart	Fabaceae	Farinha seca	N	8	0.0154
Erythrina speciosa Andrews	Fabaceae	Eritrina	N	8	0.0154
Averrhoa carambola L.	Oxalidaceae	Carambola	SUB	8	0.0154
Murraya sp.	Rutaceae	Murta	E	8	0.0154
Cordia africana Lam.	Boraginaceae	Cordia africana	E	7	0.0135
Calliandra sp.	Fabaceae		NC	7	0.0135
Campomanesia xanthocarpa (Mart.) O.Berg	Myrtaceae	Guabiroba, sete capotes	N	7	0.0135
Citrus aurantiifolia (Christm.)Swingle	Rutaceae	Laranja	E	7	0.0135
Cestrum sp.	Solanaceae		NC	7	0.0135
Araucaria columnaris Hook. *	Araucariaceae	Pinheiro de natal	E	6	0.0116
Handroanthus ochraceus (Cham.) Mattos	Bignoniaceae	Ipê pardo	N	6	0.0116

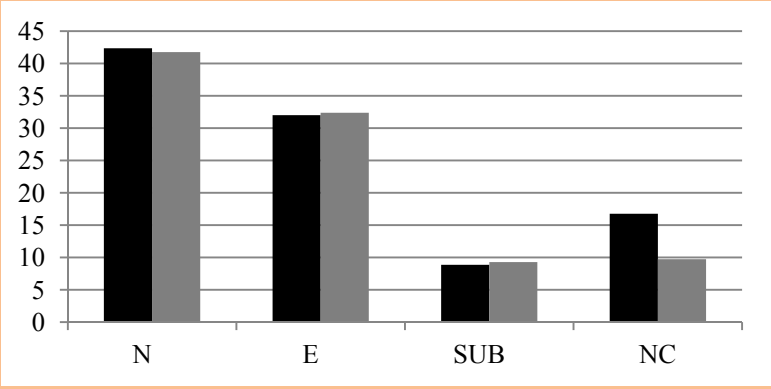
Caryocar brasiliense Cambess.	Caryocaraceae	Pequi	N	6	0.0116
Calliandra tweedii Benth.	Fabaceae	Esponjinha sangue	N	6	0.0116
Malpighiaceae	Malpighiaceae		NC	6	0.0116
Annona coriacea Mart.	Annonaceae	Marolo	N	5	0.0096
Washingtonia robusta H. Wendl.	Arecaceae	Palmeira saia	E	5	0.0096
Cordia sp.	Boraginaceae		NC	5	0.0096
Bauhinia forficata Link *	Fabaceae	Pata de vaca nativa	N	5	0.0096
Luehea grandiflora Mart.	Malvaceae	Açoita cavalo	N	5	0.0096
Theobroma cacao L.	Malvaceae	Cacau	N	5	0.0096
Esenbeckia grandiflora Mart.	Rutaceae	Chupa ferro	N	5	0.0096
Zanthoxylum rhoifolium Lam.	Rutaceae	Mamica de porca	N	5	0.0096
Annona cacans Warm.	Annonaceae	Ariticum cagão	N	4	0.0077
Annona muricata L.	Annonaceae	Graviola	E	4	0.0077
Roystonea regia (Kunth) O.F. Cook	Arecaceae	Palmeira real	E	4	0.0077
Handroanthus umbellatus (Sond.) Mattos	Bignoniaceae	Ipê do brejo	N	4	0.0077
Clusia fluminensis Planch. & Triana	Clusiaceae	Clusia	N	4	0.0077
Diospyros kaki Thunb.	Ebenaceae	Caqui	E	4	0.0077
Albizia lebbeck (L.) Benth.	Fabaceae	Língua de sogra	E	4	0.0077
Albizia polycephala (Benth.) Killip	Fabaceae	Angico da serra	N	4	0.0077
Cassia grandis L.f.	Fabaceae	Cassia rosa	N	4	0.0077
Cassia leptophylla Vogel	Fabaceae	Falso barbatimão	N	4	0.0077
Inga marginata Willd. *	Fabaceae	Ingá mirim	N	4	0.0077
Machaerium hirtum (Vell.)Stellfeld	Fabaceae	Jacarandá bico de pato	N	4	0.0077
Parapiptadenia rigida (Benth.)Brenan	Fabaceae	Angico amarelo	N	4	0.0077
Piptadenia gonoacantha (Mart.) J.F.Macbr.	Fabaceae	Pau jacaré	N	4	0.0077
Lagerstroemia sp.	Lythraceae		NC	4	0.0077
Eugenia sp.	Myrtaceae		NC	4	0.0077
Gallesia integrifolia (Spreng.)Harms	Phytolaccaceae.	Pau d´alho	N	4	0.0077
Salix nigra Marshall	Salicaceae	Salgueiro preto	E	4	0.0077
Labramia bojeri A. DC.	Sapotaceae	Caimito, abricó	E	4	0.0077
Plumeria alba Aubl.	Apocynaceae	Jasmim manga	E	3	0.0058
Bismarckia nobilis Hildebr. & H.Wendl. *	Arecaceae	Palmeira azul	E	3	0.0058
Wodyetia bifurcata A.K. Irvine *	Arecaceae	Palmeira rabo	E	3	0.0058

		de raposa			
Vernonia sp.	Asteraceae		NC	3	0.0058
Adenanthera pavonina L.	Fabaceae	Angico da Ásia	E	3	0.0058
Anadenanthera peregrina (L.) Speg.	Fabaceae	Angico cascuco	N	3	0.0058
Machaerium sp.	Fabaceae		NC	3	0.0058
Machaerium villosum Vogel *	Fabaceae	Jacarandá paulista	N	3	0.0058
Myrocarpus frondosus Allemão *	Fabaceae	Cabreúva	N	3	0.0058
Liquidambar formosana Hance	Hamamelidaceae	Goma doce	E	3	0.0058
Couroupita guianensis Aubl. *	Lecythidaceae	Coitê de macaco	N	3	0.0058
Magnolia grandiflora L.	Magnoliaceae	Magnólia	E	3	0.0058
Callistemon sp.	Myrtaceae		NC	3	0.0058
Pera glabrata (Schott) Poepp. ex Baill.	Peraceae	Tamanqueira	N	3	0.0058
Cerasus vulgaris Mill.	Rosaceae	Pessegueiro do mato	E	3	0.0058
Prunus persica (L.) Stokes	Rosaceae	Pêssego	SUB	3	0.0058
Populus deltoides W. Bartram ex Marshall	Salicaceae	Álamo	E	3	0.0058
Litchi chinensis Sonn.	Sapindaceae	Lichia	E	3	0.0058
Celtis sp.	Solanaceae		NC	3	0.0058
Solandra sp.	Solanaceae		NC	3	0.0058
Cecropia pachystachya Trécul	Urticaceae	Embaúba	N	3	0.0058
Tabernaemontana hystrix Steud.	Apocynaceae	Leiteiro	N	2	0.0039
Archonhtophenix alexandrae (F. Mull.) H.Wendl. & Drude	Arecaceae	Palmeira da rainha	E	2	0.0039
Jacaranda sp.	Bignoniaceae		NC	2	0.0039
Tabebuia insignis (Miq.)Sandwith	Bignoniaceae	Ipê branco do brejo	N	2	0.0039
Callitropsis macrocarpa (Hartw. ex Gordon) D.P. Little *	Cupressaceae	Cipreste	E	2	0.0039
Hura crepitans L.	Euphorbiaceae	Acaçu, acassu	N	2	0.0039
Enterolobium contortisiliquum (Vell.) Morong	Fabaceae	Tamboril	N	2	0.0039
Erythrina sp.	Fabaceae		NC	2	0.0039
Machaerium stipitatum Vogel	Fabaceae	Sapuva	N	2	0.0039
Cinnamomum burmannii (Nees & T. Nees) Blume	Lauraceae	Cinamomo	E	2	0.0039
Persea willdenovii Kosterm.	Lauraceae	Pau andrade	N	2	0.0039
Lafoensia pacari A. St.-Hil. *	Lythraceae	Dedaleiro	N	2	0.0039

Magnolia ovata (A. St.-Hil.) Spreng.	Magnoliaceae	Pinha do brejo	N	2	0.0039
Psidium sp.	Myrtaceae		NC	2	0.0039
Syzygium aromaticum (L.) Merr. & L.M. Perry	Myrtaceae	Cravo da índia	E	2	0.0039
Syzygium sp.	Myrtaceae		NC	2	0.0039
Piper sp.	Piperaceae		NC	2	0.0039
Cerasus avium (L.) Moench	Rosaceae	Pessegueiro do mato	E	2	0.0039
Citrus reticulata Blanco	Rutaceae	Tangerina	SUB	2	0.0039
Other 116 species added (with one individual each)				116	0.2235
Young individuals (seedlings)				2,171	4.1824
Non-identified				1,261	2.4293
TOTAL				**51,908**	

Some authors (SANTAMOUR JUNIOR, 1990; MILANO and DALCIN, 2000) recommend no more than 10-15% of trees of the same species in urban afforestation to prevent the spread of pests and diseases between the plants, in addition to providing a proper afforestation planning. In our study, we did not observe dominance of one or a few species (Table 1) as occurs in most Brazilian cities (STRANGHETTI et. al., 2010; PAIVA, 2009; SUCOMINE et al., 2010; PARRY et al., 2012).

Figure 3: Percentage of individuals (gray), species (black) native (N), exotic (E), sub-spontaneous (SUB), and non-classified (NC), sampled in the survey of urban afforestation of Sorocaba, São Paulo State, Brazil.



In this study, 42.36% of the sampled species are native to Brazil, 32.02% are exotic and 8.87% are sub-spontaneous. (Fig. 3). In relation to the number of individuals, 41.78% are native, 32.37% are exotic and 9.28% are sub-spontaneous. This means that for both species and number of individuals, there was a predominance of native species (Fig. 3), which is unusual in Brazilian cities where exotic

species usually predominate, for example, Taubaté, São Paulo State (MARTINEZ et al., 2009) with 57.5%, and Assis, São Paulo State (ROSSATO et al., 2008) with 61.8%, and Franca, São Paulo State (SILVA et al., 2008) with 68.5%.

For Paiva et. Al. (2009), exotic species should not be excluded from afforestation projects, but it is important to consider that these projects, in addition to fulfilling an aesthetic role, should also fulfill the functional role, promoting environmental services and interactions with the native fauna, which often does not occur with the use of exotic species.

It is desirable to attain a harmonization between the gray urban matrix and the green natural elements of the landscape (BOADA and SANCHEZ, 2012) naturalizing, thus, the cities. The same authors state that one of the indicators that allow to analyze the naturalization of cities is the number of trees per inhabitant, however, there is no optimal number of trees per inhabitant. Sorocaba registered one tree for each 11.3 citizen, or 0.088 tree per human individual. However, this study did not examine squares, urban parks, and remnants of native forest, which would certainly increase the number of trees per inhabitant in the city. The 2010 census of IGBE (IBGE, 2013), which considers afforestation per households, Sorocaba shows 82.2% of wooded homes, second only to cities like São José dos Campos (96.25%), Ribeirão Preto (93.1%), and Campinas (88.4%), in the State of São Paulo, Brazil.

CONCLUSIONS

Considering the number of sampled trees in urban afforestation in the city of Sorocaba, the diversity of species used, the percentage of native species (42.36%), and the existence of endangered species, we conclude that the municipality presents a well-planned urban afforestation. Further studies are needed to assess the distribution of tree planting in different regions of the city to design a future planning to invest in the afforestation of more recently urbanized and less wooded areas.

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