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Exotic species predominates in the urban woody flora of central Chile

Las especies exóticas predominan en la flora leñosa urbana de Chile central

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ABSTRACT

The expansion of cities promotes the replacement of local biotas with exotic species causing a decrease in global diversity. As urbanization continues to expand, efforts directed towards the conservation within urban landscapes could support regional biodiversity conservation. The biogeographic region of central Chile displays a native flora of global importance because of its high endemism. Up to date, studies analysing the composition of the floras within the cities are scarce. The present study aims at characterizing the compositional and distributional patterns of the ornamental flora of five cities of central Chile (La Serena, Valparaíso, Santiago, Rancagua, and Talca). For this purpose, we sampled several streets and squares recording all woody species. The species were then characterized by their biogeographical origin and incidence. It was recorded 302 species of which approx. 86% were exotic and 14% were native, a consistent pattern found in the five cities studied; these results contrast with the European urban flora, where native species can usually overcome 50% of the plant species. Almost half of the exotic species had their origin in Asia (including Australasia, Temperate, and Tropical Asia), Europe, and North America. Consequently, the representation of the regional flora within the urban context is low for central Chile, with the native species registered, accounting for only 0.81% of the total species described for the country. Urban habitats could support regional biodiversity conservation, so a shift towards sustainable urban planning could promote local biological conservation.

Keywords: Native species, plant conservation, urban flora, urban trees.

RESUMEN

La expansión de las ciudades promueve el reemplazo de biotas locales (nativas) por especies exóticas, lo que causa una disminución en la diversidad. A medida que la urbanización continúa, los esfuerzos dirigidos a la conservación dentro de los paisajes urbanos podrían apoyar la conservación de la biodiversidad regional. La región biogeográfica de Chile Central muestra una flora nativa de importancia mundial debido a su alto endemismo. No obstante, hasta la fecha hay pocos estudios que analicen la composición de las floras dentro de las ciudades de esta región. El presente estudio analiza la composición de la flora ornamental para cinco ciudades de Chile central: La Serena, Valparaíso, Santiago, Rancagua y Talca. Para ello realizamos un muestreo de calles y plazas de estas ciudades, registrando especies de plantas leñosas, distinguiendo su origen biogeográfico y su incidencia. Se registraron 302 especies de las cuales aprox. el 86% fueron especies exóticas y el 14% nativas, patrón numéricamente consistente en las cinco ciudades estudiadas. Casi la mitad de las especies exóticas provienen de Asia (incluyendo Australasia y Asia tropical y templada), Norteamérica y Europa. En consecuencia, la representación de la flora regional dentro del contexto urbano es baja para el centro de Chile. Los habitats urbanos podrían apoyar la conservación de la biodiversidad regional, por lo que un cambio hacia una planificación urbana sostenible podría promover la conservación biológica local.

Palabras clave: Árboles urbanos, conservación, especie exótica, especie nativa, flora urbana.

INTRODUCTION

Urbanization represents one of the major processes which have had profound effects on biodiversity and its distribution at a global scale (Aronson 2014). The need to maintain the urban habitat in a homeostatic condition, directly affects the habitat and the conservation of the regional biota (McKinney 2006). Considering that recent sources (ONU 2014) estimate a continuing population growth and urbanization across the globe, the threats to biodiversity are likely to increase. Although cities currently represent about 3% of the world's land usage, their effects on biodiversity extend far beyond their municipal borders (Grimm *et al.* 2008). The regions with the highest percentages of people living in urbanized areas are Europe, Latin America and the Caribbean, and Northern America with 73%, 80% and 82% respectively. Chile is the third most urbanized country (89%) in South America, only preceded by Argentina (92%) and Uruguay (95%) (ONU 2014).

As urbanization continues to expand, with obvious consequences on abundance and species richness, efforts directed towards the conservation within urban landscapes could support regional and global biodiversity conservation, restoration and education as well as improve human well-being (Dearborn & Kark 2010, Faeth *et al*. 2011). The expansion of cities not only alter the habitat of native species but also generates habitat for exotic species that are adapted to urban conditions (McKinney 2006), promoting the replacement of local biotas with cosmopolitan species in a process known as biotic homogenization (McKinney & Lockwood 1999, Sax & Gaines 2003). Furthermore, the introduction of exotic species has the potential to cause biological invasions (Richardson *et al.* 2000), making urban areas pools of potentially spreading taxa. Hence, the balance between native and exotic species could be considered as a first indicator of the effects of urbanization on biodiversity.

So far, relatively few cities have been studied in terms of plant species composition with the majority of them being in Europe (e.g. Grapow *et al.* 1996, 2006, Kent *et al.* 1999, Maurer *et al.* 2000, Leporatti *et al.* 2001, Van der Veken *et al.* 2004, Altay *et al.* 2010, Carretero 2010, Ricotta *et al.* 2010, Milovic & Mitic 2012, Stešević *et al.* 2014). In these analyses, emerges that the native species fraction is commonly higher than the exotic one. Two studies encompassing a total of 117 European and 25 non-European cities have shown that < 50% of the urban flora were native species (Lososova *et al*. 2012, La Sorte *et al*. 2014). Yet, the knowledge about urban biodiversity is considerably inferior in other continents. As for South-America, the attempts to describe urban floras are localized and incipient (Pauchard *et al*. 2006). However, they show a variable representation of native species ranging between 19 and 31%, whereas exotic species ranging between 69 and 81% (see Méndez 2005, Córdova 2013, Moro & Castro 2015). Not surprisingly, given the lack of information, these cities have not been included in such large-scale studies as the aforementioned ones. These floristic studies on South American cities show that the number of exotic species is higher than the number of native species. Nevertheless, a generalization on the base of these results is difficult because the sampling was not systematic, and it would be premature to affirm whether the greater number of exotic species reflects a general trend contrasting the one of European cities.

The biogeographic region of central Chile (30-36º S), displays a native flora of global importance because of its high endemism (45.8% according to Marticorena 1990). The region mainly encompasses the Mediterranean-type climate flora of Chile and comprises 70% of the cities of the country, and 62% of the population (INE 2005). Although the human impact on the vegetation structure of the extra-urban landscape has been investigated (Fuentes *et al.* 1989, Figueroa *et al*. 2011), studies analysing the composition of the floras within the cities are currently scarce. Particularly in central Chile, studies on urban flora have been carried out only in Santiago (Figueroa *et al*. 2016, 2018, Fischer *et al*. 2016, Hernández & Villaseñor 2018), Temuco (Romero-Mieres *et al.* 2009), and Curicó (Lozano-Diéguez & Teillier 2014). Although these studies have analysed different floristic components (i.e. trees, shrubs, and/or herbs; planted or spontaneous species) and habitats (streets, abandoned sites, public and private parks), they have found that exotism (i.e., the proportion of exotic species respect to the total species) ranges between 73 and 92%. Thus, up to date there are no systematic studies that have described and compared the floristic composition of the cities of central Chile and showed how the native flora of the Mediterranean region is represented within them.

The present study investigates the composition of the ornamental flora of five cities of central Chile: La Serena, Valparaíso, Santiago, Rancagua, and Talca. These cities lie on a latitudinal gradient and represent the main urban centres within their respective administrative regions. We realized a systematic sampling of streets and squares aimed at describing and comparing the composition of planted woody species (trees and shrubs). Because of their representation and ornamental importance, we also included palms and bamboos species as well as semi-woody shrubs and succulent. Two main questions leaded our investigation: What is the proportion of native and exotic species in these cities? And does this proportion differs in all the five cities or follows a generalized pattern? Considering the latitudinal disposition of the cities studied, we expect to find a gradient in the representation of native and exotic species associated with environmental conditions observed along the latitude (i.e. temperature and precipitations, see Luebert & Pliscoff 2006). Because the richness of naturalized species increases with the latitude in extra-urban habitats (Fuentes *et al*. 2013), it was hypothesized a similar trend for exotic species

in cities. Additionally, we characterize the composition of the species found in this sampling describing their biogeographical origin, their incidence and their distribution in streets and squares. With this information, we want to draw attention to the scarce representation of the native flora within the cities of central Chile.

METHODS

Study areas

Its was carried out a comprehensive survey of the planted flora of five cities of central Chile: La Serena, Valparaíso, Santiago, Rancagua and Talca (Fig. 1). The area of the cities varies between 46 and 867 km^2 with densities ranging between 2,254 and 6,710 inhabitants × km^{-2} (INE 2005) (Table 1). La Serena and Valparaíso are coastal cities whereas Santiago, Rancagua and Talca are continental cities (Fig. 1). Santiago is the politic and economic capital of Chile, whilst the other cities represent each the main urban centre (from political, administrative, and economic point of view) of the respective administrative regions (Fig. 1). The foundation of all the cities sampled, date back to the colonial time, more than 300 years ago (Table 1).

Sampling

The sampling was carried out between 2012 and 2015. We first generated a specified number of randomly-placed points within the boundaries of each city using ArcGIS (ESRI 2012). Then, the closest street and square to these points were identified using Google Earth. Responding to city size and logistic limitations, the number of points chosen for each city ranged between 64 and 80, except for Santiago whose larger size required a greater sampling effort (Table 1). Sampling along the streets included collecting data from both sidewalks for a length varying between 150 m and 250 m, while the area of the squares ranged between 13 m^2 and 507,000 m^2. For all sampling sites, we recorded the presence of all woody planted species, including both trees and shrubs. Furthermore, its was included palms (Arecaceae), bamboos (genera *Phyllostachys* and *Pseudosasa*), as well as semi-woody plants (genera *Aloysa* and *Hypericum*), cacti (Cactaceae) and succulents (genera *Agave, Aloe*, and *Kalanchoe*).

The classification of individual taxa followed Marticorena & Quezada (1985), Matthei (1995), Rodríguez *et al.* (1983, 2005), Zuloaga *et al.* (2009) and Figueroa *et al.* (2016). Then, nomenclature at species and above species level was updated according to The Plant List (2013). Species were classified as native or exotic to Chile following Marticorena & Quezada (1985), Matthei (1995), Arroyo *et al.* (2000), Zuloaga *et al.* (2009), and Ray *et al.* (2014). Within the native species, we recognized as 'extra-limital native' (see La Sorte *et al.* 2014) those species native to Chile (see Fig. 1) but not to the regions where the cities object of this study are found; nevertheless in this analyses these species were treated as native. As for the exotic species, their original distribution was determined using the World Geographical Scheme for Recording Plant Distributions (WGSRPD) developed by the Taxonomic Database Working Group (TDWG) (Hollis & Brummitt 2001). Most of the species showed a wide geographical distribution combining different regions, which were considered as different categories.

Analyses

Its was calculated the overall representation of exotic and native species (total pool of species) and compared this result with the proportion of exotic and native species found in each city to assess for statistical difference among cities. To statistically assess the significance of the differences, we used the Pearson's chi-squared, where the observed frequencies in each city were compared with the expected frequencies generated from the total pool of species. By similar procedure, its was also compared the origin of the taxa between different habitat types (streets and squares). Furthermore, its was evaluated whether there was an overall significant difference in the origin of the species and whether the origins of the species were the same among cities.

Table 1. The five cities of central Chile object of this study with information about foundation year, area, density and number of plots sampled. / Cinco ciudades estudiadas con información acerca de año de fundación, área, densidad de habitantes y número total de plots empleados en el muestreo.

City	Foundation year	Area (km²)	Density (inhabitants × km^{-2})	Number of plots
Santiago	1541	867	6710	468
Talca	1692	46	4116	78
Valparaíso	1544	47	5567	64
Rancagua	1743	50	4110	80
La Serena	1544	65	2254	80

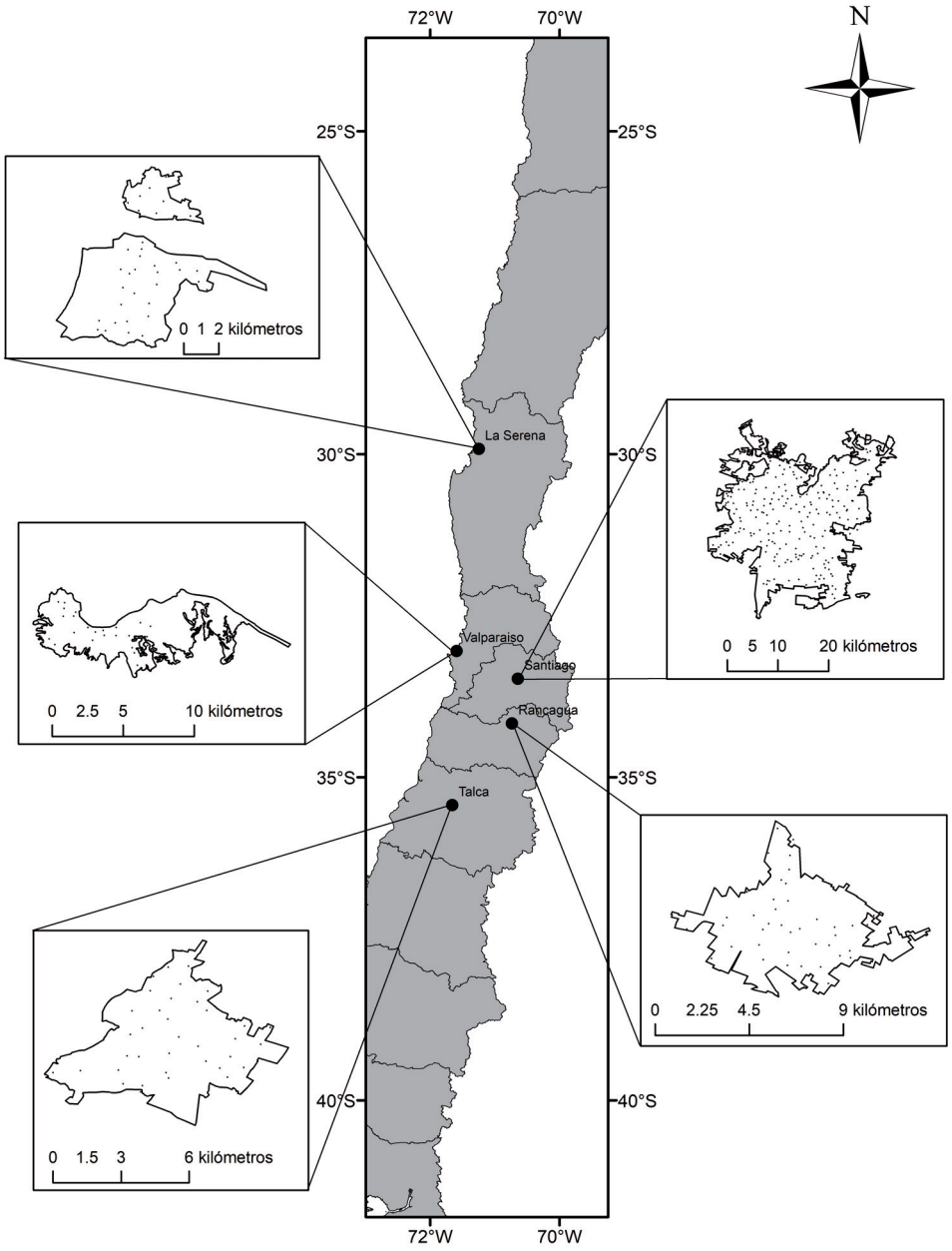

Figure 1. Political map of Chile showing regional division, and close up to the area of central Chile including the cities sampled in this study. / Mapa político de Chile mostrando la división regional administrativa y la ubicación de las cinco ciudades estudiadas.

Additionally, we wanted to assess the incidence of the native and exotic species in the studied cities. We calculated incidence as the number of plots in which the species occurred divided by the total number of plots. This was studied as a function of their biogeographical origin, i.e. native and exotic species. A Kolmogorov-Smirnov test was performed in order to assess the significance of the differences in the incidence between native and exotic species.

RESULTS

A total of 302 species were recorded for the five cities (Annex 1); among these, 275 (91.1%) species were angiosperms and only 27 (8.9%) were gymnosperms (Annex 1). Among the angiosperms, we found 71 families and 177 genera (Annex 1). The most represented families in terms of number of species were Rosaceae (35 species) and Fabaceae (30 species), followed by Malvaceae and

Oleaceae (10 species each). The rest of the families included between 1 and 9 species (Annex 1). At generic level, *Prunus* (12 species) and *Acacia* (9 species) were the most diverse (Annex 1). The rest of the genera were represented by less than 6 species. As for gymnosperms, we recorded 6 families (Annex 1); Cupressaceae (11 species), Pinaceae (9 species) and Araucariaceae (4 species) were the most diverse families (Annex 1). At generic level, 16 genera were recorded among the gymnosperms, and *Cupressus* and *Araucaria* were the most represented, with 4 species each (Annex 1).

Of the 302 species found in this study, its was recorded 42 (13.9%) native and 260 (86.1%) exotic species (Table 2). These frequencies differ of an equitable distribution (50 and 50%; χ^2= 157; f.d.= 1; P < 0.01), and show that each city had a similar proportion of exotic and native species with no significant difference (Table 2). Similar results were obtained when comparing streets and squares: systematically a higher richness of exotic than native plant, following proportions as 88.6% and 11.3% for exotic and native species in streets, and 85.3% and 14.7% for exotic and native species in squares (Table 3).

Table 2. Numbers of exotic and native species found and results from Pearson's chi-squared test comparing the observed frequencies of native and exotic species of the cities to the expected frequencies from the Total pool species. / Número total de especies nativas y exóticas registradas en el muestreo de cinco ciudades y los resultados de la prueba chi-cuadrado de Pearson establecidos al comparar las frecuencias de nativas y exóticas de cada ciudad respecto de la frecuencia esperada a partir del pool de especies totales.

City	Natives	Exotics	Total	χ^2	f.d.	P
La Serena	16	106	122	0.06	1	> 0.05
Valparaíso	9	89	98	1.82	1	> 0.05
Santiago	38	242	280	0.02	1	> 0.05
Rancagua	9	98	107	2.69	1	> 0.05
Talca	15	110	125	0.37	1	> 0.05
Total pool species	42 (13.9%)	260 (86.1%)	302 (100%)			

Table 3. Distribution of the native and exotic species in streets and squares in each of the studied cities and results from Pearson's chi-squared test. This test compares the frequencies observed in each city with the expected one from the total pool of species. / Distribución de especies nativas y exóticas en calles y plazas de las cinco ciudades estudiadas y resultados de la prueba de chicuadrado de Pearson. Esta prueba compara las frecuencias observadas en cada ciudad con la esperada a partir del pool total de especies.

City	Habitat type	Natives	Exotics	χ^2	f.d.	P
La Serena	Street	9	68	0.31	1	> 0.05
	Square	13	89	0.11	1	> 0.05
Valparaíso	Street	1	30	2.95	1	> 0.05
	Square	8	79	1.61	1	> 0.05
Santiago	Street	26	197	0.94	1	> 0.05
	Square	35	201	0.16	1	> 0.05
Rancagua	Street	5	61	2.20	1	> 0.05
	Square	8	83	1.98	1	> 0.05
Talca	Street	7	60	0.66	1	> 0.05
	Square	14	101	0.28	1	> 0.05
Total pool species	Street	27 (11.3%)	211 (88.6%)	1.30	1	
	Square	39 (14.7%)	227 (85.3%)	0.12	1	

Table 4. Species frequency according to their geographical origin (Geographical region) in each studied city. At the bottom of the table are results from Pearson's chi square test; here the observed frequencies were compared with expected frequencies, which were obtained from the total pool species. / Número de especies según su región geográfica de origen (Geographical region), presente en cada ciudad estudiada. En la parte inferior de la tabla se encuentran los resultados de la prueba de chi cuadrado de Pearson; aquí las frecuencias observadas se compararon con las frecuencias esperadas, que se obtuvieron a partir del pool total de especies.

Geographical region	La Serena	Valparaíso	Santiago	Rancagua	Talca	Total
Temperate Asia	20	20	61	30	32	63
North America	11	13	33	16	17	37
Europe, Temperate Asia, Africa	11	13	30	13	12	30
Australasia	20	14	28	9	13	29
South America	9	7	23	5	7	25
Africa	12	3	18	2	4	21
Europe, Temperate Asia	6	7	18	8	11	18
Europe	5	4	8	6	6	11
North America, South America	4	1	8	3	3	8
Temperate Asia, Tropical Asia	3	2	5	2	2	6
Europe, Africa	0	1	3	2	1	3
Temperate Asia, Tropical Asia, Australasia	2	2	2	1	1	2
Tropical Asia, Australasia	1	0	0	0	1	2
Temperate Asia, Africa	0	0	1	0	0	1
Temperate Asia, South America	1	1	1	0	0	1
Tropical Asia	0	0	1	0	0	1
Australasia, Tropical Asia, Africa	1	1	1	1	0	1
Pacific	0	0	1	0	0	1
Total pool species	106	89	242	98	110	260
χ^2	10.1	5.3	0.9	9.3	6.8	
f.d.	7	7	7	7	7	
P	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	

Of the 42 native species, 6 were extra-limital natives: *Araucaria araucana* (Molina) K. Koch, *Tara spinosa* (Molina) Britton & Rose, *Erythrostemon gilliesii* (Hook.) D. Klotzsch, *Cylindropuntia tunicata* (Lehm.) F.M.Knuth, *Hebe salicifolia* G. Forst., and *Schinus areira* L. On the other hand, the 260 exotic species recorded fell in 18 biogeographical categories (Table 4); 39.6% of the exotic species, had their original distribution in different regions of Asia, including Temperate Asia, Tropical Asia and Australasia, with Temperate Asia alone counting for 24.2% (Table 4). North American species added up 14.2%, South America account for 9.6% of the exotic species, while African and European species 8% and 4.2% respectively (Table 4). The rest of the taxa showed original distributions which combines different regions and continents (Table 4). No statistical differences were obtained when comparing the relative proportion of species falling in each category among the five cities (Table 4).

The 302 species recorded, ranged incidence values between 0.001 and 0.430. In 92.1% of the cases (278 species), incidence was < 0.1, while the remaining 24 species showed higher values between 0.1 and 0.430 (Fig. 2). The most frequent exotic species were *Nerium oleander* L., *Melia azedarach* L., *Liquidambar styraciflua* L., *Ligustrum lucidum* W.T. Aiton, *Ligustrum ovalifolium* Hassk., *Prunus cerasifera* Erhr., *Robinia pseudoacacia* L., and *Acer negundo* L., ranging between 53.9 and 85.8%; meanwhile, the most widely distributed native species were *Cestrum parqui* (Lam.) L'Hér., *Cryptocarya alba* (Mol.) Looser, *Acacia caven* (Mol.) Mol., *Maytenus boaria* Mol., *Quillaja*

saponaria Molina, and *Schinus areira* L., ranging between 12.7% and 54.1%. When comparing incidence values between exotic and native species for each city and for all the cities together, no statistical difference were observed (see Fig. 2). Of the 302 species found in our sampling, 41 species (13.6%) were shared by all cities while 119 species (39.4%) were unique to one city. Of the former, 37 were exotic among which the aforementioned *Acer negundo, Robinia pseudoacacia* and *Prunus cerasifera,* and 4 were the native *Quillaja saponaria, Acacia caven, Cryptocarya alba* and *Schinus areira*. These findings show an ornamental trend that results in a few species widely distributed and many species narrowly distributed.

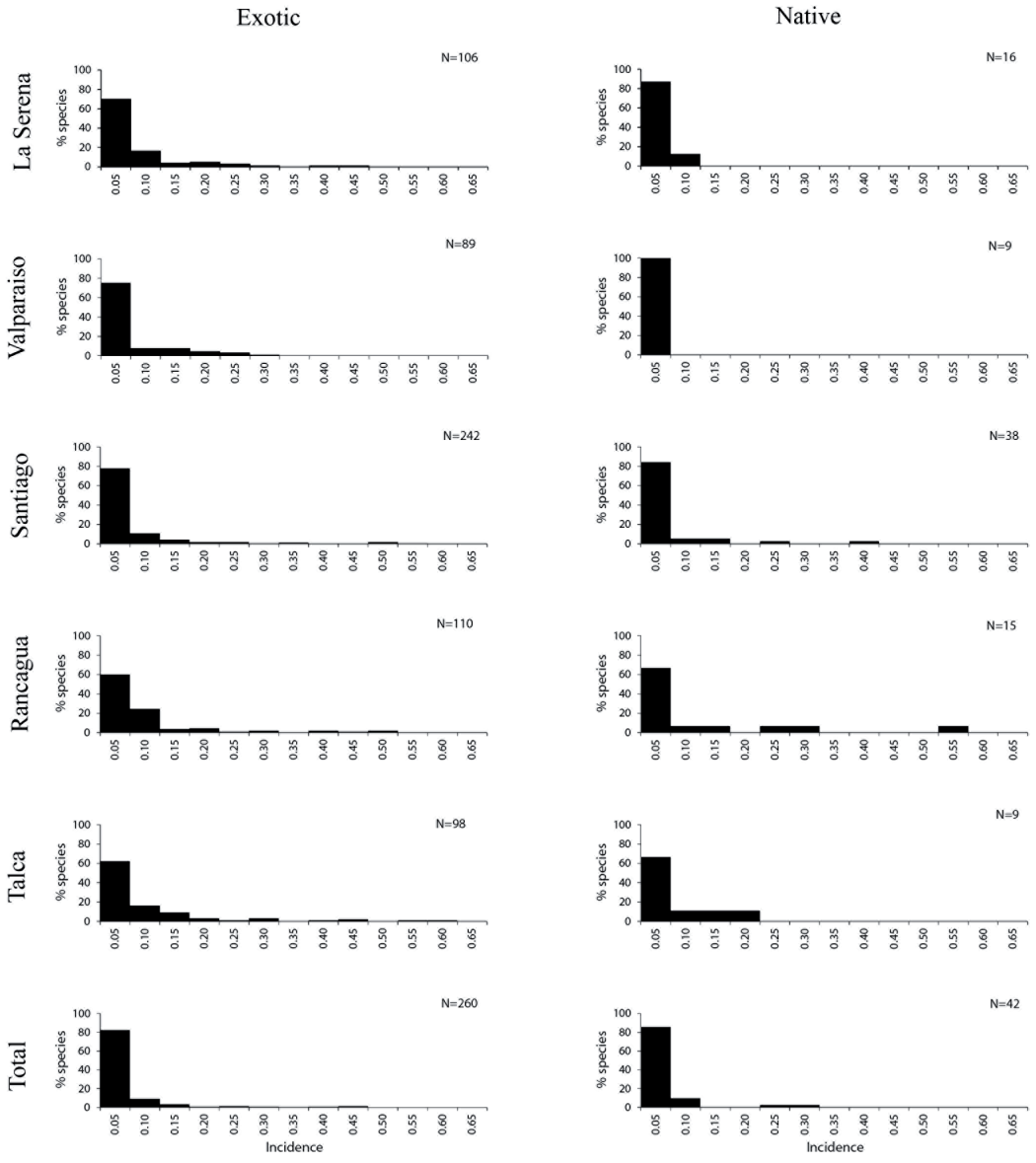

Figure 2. Percentage of native and exotic species plotted against their incidence classes, compared among the five cities and overall. All the cities show a similar pattern of species incidence, with a few taxa well represented across the plots of their boundaries and many taxa present in only a few plots (rare species); comparison were performed by a Kolmogorov-Smirnov test (La Serena D= 0.1, P= 0.925; Valparaíso D= 0.2, P= 0.700; Santiago D= 0.1 P= 0.304; Rancagua D= 0.1, P= 0.294; Talca D= 0.1, P= 0.9; Total D= 0.1, P= 0.171). / Distribución porcentual de la incidencia de especies exóticas y nativas en cinco ciudades estudiadas. Las distribuciones fueron comparadas usando pruebas de Kolmogorov-Smirnov (La Serena D= 0.1, P= 0.925; Valparaíso D= 0.2, P= 0.700; Santiago D= 0.1 P= 0.304; Rancagua D= 0.1, P= 0.294; Talca D= 0.1, P= 0.9; Total D= 0.1, P= 0.171).

DISCUSSION

Previous studies on urban floras have shown that cities may support strikingly high biotic diversity (*e.g*. Godefroid & Koedam 2007) and possibly represent the regional flora to which the cities belong (*e.g*. La Sorte *et al*. 2014). However, our study shows that native species represent approximately 14% of the urban flora, nearly 25% of the Chilean native trees (≈ 120 species; see Rodríguez *et al*. 1983) and only 0.81% of the total species described for Chile (≈ 5,000 species; see Marticorena & Quezada 1985). Thus, the representation of the regional flora within the urban context appears to be low for central Chile. With regards to the exotic flora (which includes naturalized and non-naturalized species), it is difficult to establish quantitative comparisons because the study of their diversity has focused mainly upon the naturalized plants (e.g. Arroyo *et al*. 2000, Figueroa *et al.* 2004, Pauchard *et al*. 2004, Castro *et al*. 2005, Fuentes *et al*. 2008). In a floristic guide, Hoffmann (1998) summarized 94 exotic woody species for the total Chilean cities, of which 98% were found in this study. In a more exhaustive study, Rodríguez *et al*. (2005) recorded 158 exotic species (trees and arborescent species) for Chile, of which 64% were found in this study. These values indicate that within Chilean cities, the exotic trees and arborescent species are more diverse (i.e. greater species richness) and better represented with respect to the total floras (native and exotic sets) than the native ones.

These results are in line with the results of other studies carried out on planted and spontaneous flora of other cities of central Chile. Lozano-Diéguez & Teillier (2014) and Romero-Mieres *et al.* (2009) found that only 8% of the ornamental flora of Curicó and 27% of the ornamental flora of Temuco, respectively, was native. Recently, Hernández & Villaseñor (2018) reported an increase in the representation of native trees within Santiago over the last 12 years. Nevertheless, Figueroa *et al.* (2016) highlighted that the composition of the vascular spontaneous flora of Santiago was represented by 15% of native species and 85% of exotic species. Fischer *et al.* (2016) analysed the composition of spontaneous weeds in grassland and wooded areas of 15 parks of Santiago and found that exotic species contributed for > 90% to the total diversity. Gärtner *et al*. (2015) conducted a study on the ruderal herbs spontaneously growing in public spaces of Santiago and found that 16% of the taxa were native while 84% were exotic; additionally, Figueroa *et al*. (2018) found that 84% of the taxa present in private and public parks in Santiago were exotic species. Interestingly, by using a systematic sampling for the five studied cities we recorded 302 species of which approx. 86% were exotic and 14% were native; these figures were numerically consistent among the five cities studied not showing evidence of a gradient trend as we initially hypothesized by comparison with naturalized plants in extra-urban habitats (Fuentes *et al*. 2013). Additionally, the proportion of native and exotic urban flora encountered in central Chile, differ from the European trend where better representation of the regional flora has been found (Aronson *et al*. 2014, Celesti-Grapow *et al*. 2013, La Sorte *et al*. 2014). The representation of exotic over native species when comparing cities from European and central Chile also extends to the habitats within the cities, particularly between squares and streets (see Lososová *et al*. 2012). In fact, in the analysed cities of Chile, there is a greater representation of exotic species than native ones in both streets and squares whereas native species dominate urban squares and streets in European cities (Lososová *et al*. 2012, 2016). Probably, these differences can be attributed to the use of a greater diversity of native species as ornamentals in European cities (Lososová *et al*. 2012, Kowarik *et al*. 2013), a fact that does not seem to be the case in central Chile (Figueroa *et al*. 2016, 2018).

On the other hand, and despite the efforts to promote a change (e.g. Riedemann & Aldunate 2001, 2003, Riedemann *et al.* 2006, 2008) the scarce number of native species cultivated for ornamental programme purposes, could be related to the lack of knowledge around their possible use as ornamental plants, as well as to the misconception that Chilean native plants grow slowly. The only native species contrasting this general trend were *Schinus areira*, *Quillaja saponaria*, *Maytenus boaria*, *Acacia caven* and *Cryptocarya alba* whose incidence values were the highest among the natives and whose ornamental value, is well known. Given that some species such as *Cryptocarya alba* are considered vulnerable in the Metropolitan Region of the country (Benoit 1989, Riedemann & Aldunate 2001), their use in urban settings could be a valuable mean for conservation. In Chile, the gymnosperms include various conifers among which there are native species of Araucariaceae, Cupressaceae, Podocarpaceae and Ephedraceae. In this study, we only found three species of gymnosperms reported for Chile: the native *Araucaria araucana* and the exotic Pinaceae *Pinus radiata* D. Don and *Pseudotsuga menziesii* (Mirb.) Franco. That means that the 94.1% of the Chilean gymnosperm flora (17 species), according to Marticorena & Rodríguez (1995), would not be represented within the cities of this study. Similarly, this study showed that the representation of the angiosperms was not higher.

With regards to the origin of the ornamental exotic flora, the findings were not consistent with Matthei (1995), Arroyo *et al*. (2000), Figueroa *et al*. (2004), Castro *et al*. (2005), who report that most of the naturalised flora in Chile comes from Mediterranean Eurasia. On the other hand, Lozano-Diéguez & Teillier (2014) and Romero *et al.* (2009) found that 29% and 19% of the ornamental flora of the Chilean cities of Curicó and Temuco respectively, were of Asian origin. The prominent number of exotic species, especially from Asia, can be related with the large number of plants

that European gardeners introduced first to Europe, and then to Chile in the nineteenth century, reflecting the English and French influence over the urban space's ornamentation style in Chile (Lozano-Diéguez & Teillier 2014 and references therein).

Consistent with other studies, the analysis on species incidence has shown a general tendency to use many rare species and a few common species in streets and squares (Lososová *et al*. 2012, Kowarik *et al*. 2013). That is to say, only a minority of the species found were encountered in a consistent number of plots. Examples are *Nerium oleander*, *Melia azedarach*, *Liquidambar styraciflua*, *Ligustrum lucidum*, *Ligustrum ovalifolium*, *Prunus cerasifera*, *Robinia pseudoacacia*, and *Acer negundo*, all exotic to Chile. If making use of many rare species tends to increase diversity, the use of the same species in different cities decreases variability when comparing them.

It shows that exotic species strongly contribute to the homogenization of the floras of the cities studied (Aronson *et al*. 2014, La Sorte *et al*. 2014, Lososová *et al.* 2016). In fact, 90.2% of the species (37 out of 41) shared by all the five cities were exotic; however, the urban homogenization for Chilean cities needs further investigation. The other issue with the predominance of the exotic flora within the urban context, is that much of the species naturalised in Chile such as *Rubus* (Rosaceae), *Rosa rubiginosa* L. (Rosaceae), *Acacia dealbata* Link (Fabaceae) among the others, have turned out to be invasive and have replaced the native flora in many areas (Teillier 2008). Currently, we ignore if the urban populations of these species maintain reproductive relationships with the rural populations.

The use of native flora in cities could benefit in different ways. Not only it can provides support to the regional plant diversity; it can also create stepping stones or corridors for natural populations, as well as provide environmental education and ecosystem services (Dearborn & Kark 2010). Theoretically, species that are well adapted to the local environmental conditions require less intervention for their maintenance (e.g. water requirements), which implicates the possibility of amortising the costs of maintenance. Another aspect, less obvious but realistically important for conservation, is the awareness of the public of native biodiversity. Some studies (Rozzi *et al.* 2003, Ballouard *et al.* 2011) have shown that when people are asked to recall species of their cities, they mostly named exotic ones and they are keener to prioritize virtual exotic iconic biodiversity over local biodiversity. Additionally, it has been pointed out that native plants species may be preferred by native birds, thus a higher representation of native flora it is expected to attract native avifauna to urban areas (Díaz & Armesto 2003, White *et al.* 2005).

Conservation within urban landscapes could support regional and global biodiversity (Dearborn & Kark 2010). Thus, a better monitoring of the urban biota in areas of high regional biodiversity is certainly needed (Aronson 2014). Our study shows that, at least in central Chile, the native flora is poorly represented and scarcely taken into consideration in urban planning ornamentation programmes. Cities are points of entry for numerous ornamental plants that could potentially naturalize, and spread their distribution toward extra-urban habitats, exerting an important impact upon the native biodiversity (Kowarik *et al*. 2013). The massive use of exotic flora in street and squares, especially from Asia, can be linked to historical as well as to socio-cultural drivers. Taking into consideration the importance of these drivers is fundamental to improve the sustainability of our cities and their relationship with the regional environment.

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Annex 1. Woody and arborescent plants from five cities on central Chile. Nomenclature followed to The Plant List (2013), and the taxonomical Information according to APG IV system, origin in Chile (N: native species; E: exotic species). / Plantas leñosas y arborescentes de cinco ciudades del centro de Chile. La nomenclatura siguió a The Plant List (2013), y la información taxonómica según el sistema APG IV; Origen: origen en Chile (N: especies nativas; E: especies exóticas).

Division	Clase	Order	Family	Genus	Species	Author	Origin	Biogeographical distribution
Angiosperms	Eudicots	Dipsacales	Adoxaceae	*Sambucus*	*nigra*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Dipsacales	Adoxaceae	*Viburnum*	*odoratissimum*	Ker. Gawl.	E	Asia temperate, Asia tropical
Angiosperms	Eudicots	Dipsacales	Adoxaceae	*Viburnum*	*opulus*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Dipsacales	Adoxaceae	*Viburnum*	*tinus*	L.	E	Europe
Angiosperms	Eudicots	Dipsacales	Adoxaceae	*Viburnum*	*rotundifolium*	Raf.	E	Asia temperate
Angiosperms	Eudicots	Dipsacales	Adoxaceae	*Viburnum*	*lucidum*	Mill.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Berberidopsidales	Aextoxicaceae	*Aextoxicon*	*punctatum*	Ruiz & Pav.	N	South America
Angiosperms	Eudicots	Saxifragales	Altinginaceae	*Liquidambar*	*styraciflua*	L.	E	North America, South America
Angiosperms	Eudicots	Sapindales	Anacardiaceae	*Lithrea*	*caustica*	Hook. & Arn.	N	South America
Angiosperms	Eudicots	Sapindales	Anacardiaceae	*Schinus*	*areira*	L.	N	South America
Angiosperms	Eudicots	Sapindales	Anacardiaceae	*Schinus*	*polygama*	(Cav.) Cabrera	N	South America
Angiosperms	Eudicots	Sapindales	Anacardiaceae	*Schinus*	*latifolius*	(Gillies ex Lindl.) Engl.	N	South America
Angiosperms	Eudicots	Gentianales	Apocynaceae	*Gomphocarpus*	*fruticosus*	(L.) W.T. Aiton	E	Africa
Angiosperms	Eudicots	Gentianales	Apocynaceae	*Nerium*	*oleander*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Monocots	Alismatales	Araceae	*Philodendron*	*bipinnatifidum*	Schott ex Endl.	E	South America
Angiosperms	Eudicots	Apiales	Araliaceae	*Fatsia*	*japonica*	(Thunb.) Decne. & Planch.	E	Asia temperate
Angiosperms	Eudicots	Apiales	Araliaceae	*Schefflera*	*arboricola*	J.R. Forst. & G. Forst.	E	Asia temperate
Gimnosperms	No clasificada	Coniferales	Araucariaceae	*Araucaria*	*angustifolia*	(Bertol.) Kuntze	E	South America
Gimnosperms	No clasificada	Coniferales	Araucariaceae	*Araucaria*	*araucana*	(Molina) K. Koch	N	South America
Gimnosperms	No clasificada	Coniferales	Araucariaceae	*Araucaria*	*bidwillii*	Hook.	E	Australasia
Gimnosperms	No clasificada	Coniferales	Araucariaceae	*Araucaria*	*heterophylla*	(Salisb.) Franco	E	Australasia
Angiosperms	Monocots	Arecales	Arecaceae	*Brahea*	*armata*	S. Watson	E	North America
Angiosperms	Monocots	Arecales	Arecaceae	*Jubaea*	*chilensis*	(Molina) Baill.	N	South America
Angiosperms	Monocots	Arecales	Arecaceae	*Phoenix*	*canariensis*	Chabaud	E	Africa
Angiosperms	Monocots	Arecales	Arecaceae	*Syagrus*	*romanzoffiana*	(Cham.) Glassman	E	South America
Angiosperms	Monocots	Arecales	Arecaceae	*Trachycarpus*	*fortunei*	(Hook.) H. Wendl.	E	Asia temperate
Angiosperms	Monocots	Arecales	Arecaceae	*Washingtonia*	*filifera*	(Linden ex André) H. Wendl. ex de Bary	E	North America
Angiosperms	Monocots	Arecales	Arecaceae	*Washingtonia*	*robusta*	H. Wendel.	E	North America

Division	Clase	Order	Family	Genus	Species	Author	Origin	Biogeographical distribution
Angiosperms	Monocots	Asparagales	Asparagaceae	*Agave*	*americana*	L.	E	North America
Angiosperms	Monocots	Asparagales	Asparagaceae	*Cordyline*	*stricta*	(Sims) Endl.	E	Australasia
Angiosperms	Monocots	Asparagales	Asparagaceae	*Cordyline*	*australis*	(G. Forst.) Endl.	E	Australasia
Angiosperms	Monocots	Asparagales	Asparagaceae	*Dracaena*	*marginata*	hort.	E	Africa
Angiosperms	Monocots	Asparagales	Asparagaceae	*Yucca*	*aloifolia*	L.	E	North America, South America
Angiosperms	Monocots	Asparagales	Asparagaceae	*Yucca*	*gigantea*	Lem.	E	North America, South America
Angiosperms	Monocots	Asparagales	Asparagaceae	*Yucca*	*gloriosa*	L.	E	North America
Angiosperms	Monocots	Asparagales	Asphodelaceae	*Aloe*	*arborescens*	Mill.	E	Africa
Angiosperms	Eudicots	Asterales	Asteraceae	*Baccharis*	*linearis*	(Ruiz & Pav.) Pers.	N	South America
Angiosperms	Eudicots	Asterales	Asteraceae	*Euryops*	*chrysanthemoides*	(DC.) B. Nord.	E	Africa
Angiosperms	Eudicots	Asterales	Asteraceae	*Euryops*	*pectinatus*	(L.) Cass.	E	Africa
Angiosperms	Eudicots	Asterales	Asteraceae	*Jacobaea*	*maritima*	(L.) Pelser & Meijden	E	Africa
Angiosperms	Eudicots	Asterales	Asteraceae	*Santolina*	*chamaecyparissus*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Asterales	Asteraceae	*Tessaria*	*absinthioides*	(Hook. & Arn.) DC.	N	South America
Angiosperms	Eudicots	Ranunculales	Berberidaceae	*Berberis*	*aquifolium*	Pursh	E	North America
Angiosperms	Eudicots	Ranunculales	Berberidaceae	*Berberis*	*thunbergii*	DC.	E	Asia temperate
Angiosperms	Eudicots	Ranunculales	Berberidaceae	*Nandina*	*domestica*	Thunb.	E	Asia temperate, Asia tropical
Angiosperms	Eudicots	Fagales	Betulaceae	*Betula*	*pendula*	Roth	E	Europe, Asia temperate
Angiosperms	Eudicots	Fagales	Betulaceae	*Corylus*	*avellana*	L.	E	Europe
Angiosperms	Eudicots	Lamiales	Bignoniaceae	*Catalpa*	*bignonioides*	Walter	E	North America
Angiosperms	Eudicots	Lamiales	Bignoniaceae	*Jacaranda*	*mimosifolia*	D. Don	E	South America
Angiosperms	Eudicots	Lamiales	Bignoniaceae	*Tecoma*	*stans*	(L.) Juss. ex Kunth	E	South America
Angiosperms	Eudicots	Buxales	Buxaceae	*Buxus*	*sempervirens*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Caryophyllales	Cactaceae	*Austrocylindropuntia*	*subulata*	(Muehlenpf.) Backeb.	E	South America
Angiosperms	Eudicots	Caryophyllales	Cactaceae	*Brasiliopuntia*	*brasiliensis*	(Willd.) A. Berger	E	South America
Angiosperms	Eudicots	Caryophyllales	Cactaceae	*Cylindropuntia*	*tunicata*	(Lehm.) F.M. Knuth	N	North America, South America
Angiosperms	Eudicots	Caryophyllales	Cactaceae	*Echinopsis*	*pachanoi*	(Britton & Rose) Friedrich & G.D. Rowley	E	South America
Angiosperms	Eudicots	Caryophyllales	Cactaceae	*Nopalea*	*dejecta*	(Salm-Dyck) Salm-Dyck	E	South America
Angiosperms	Eudicots	Caryophyllales	Cactaceae	*Opuntia*	*erinacea*	Engelm. & J.M. Bigelow	E	North America
Angiosperms	Eudicots	Caryophyllales	Cactaceae	*Opuntia*	*ficus-indica*	(L.) Mill.	E	North America
Angiosperms	Eudicots	Caryophyllales	Cactaceae	*Opuntia*	*microdasys*	(Lehm.) Pfeiff.	E	North America

DIVISION	CLASE	ORDER	FAMILY	GENUS	SPECIES	AUTHOR	ORIGIN	BIOGEOGRAPHICAL DISTRIBUTION
Angiosperms	Eudicots	Caryophyllales	Cactaceae	*Opuntia*	*monacantha*	(Willd.) Haw.	E	South America
Angiosperms	Magnoliids	Laurales	Calycanthaceae	*Chimonanthus*	*praecox*	(L.) Link	E	Asia temperate
Angiosperms	Eudicots	Rosales	Cannabaceae	*Celtis*	*australis*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Dipsacales	Caprifoliaceae	*Abelia*	*floribunda*	(M. Martens & Galeotti) Decne.	E	South America
Angiosperms	Eudicots	Dipsacales	Caprifoliaceae	*Abelia*	*triflora*	R.Br. ex Wall.	E	Asia temperate, Asia tropical
Angiosperms	Eudicots	Fagales	Casuarinaceae	*Casuarina*	*cunninghamiana*	Miq.	E	Australasia, Asia tropical, Africa
Angiosperms	Eudicots	Fagales	Casuarinaceae	*Casuarina*	*equisetifolia*	L.	E	Asia tropical, Australasia
Angiosperms	Eudicots	Celastrales	Celastraceae	*Euonymus*	*japonicus*	Thunb.	E	Asia temperate
Angiosperms	Eudicots	Celastrales	Celastraceae	*Maytenus*	*boaria*	Molina	N	South America
Angiosperms	Eudicots	Saxifragales	Crassulaceae	*Aeonium*	*arboreum*	Webb & Berthel.	E	Africa
Angiosperms	Eudicots	Saxifragales	Crassulaceae	*Cotyledon*	*orbiculata*	L.	E	Africa
Angiosperms	Eudicots	Saxifragales	Crassulaceae	*Crassula*	*arborescens*	(Mill.) Willd.	E	Africa
Angiosperms	Eudicots	Saxifragales	Crassulaceae	*Crassula*	*ovata*	(Mill.) Druce	E	Africa
Angiosperms	Eudicots	Saxifragales	Crassulaceae	*Kalanchoe*	*daigremontiana*	Raym.-Hamet & H. Perrier	E	Africa
Gimnosperms	No clasificada	Coniferales	Cupressaceae	*Chamaecyparis*	*lawsoniana*	(A. Murray bis) Parl.	E	North America
Gimnosperms	No clasificada	Coniferales	Cupressaceae	*Cryptomeria*	*japonica*	(Thunb. ex L.f.) D. Don	E	Asia temperate
Gimnosperms	No clasificada	Coniferales	Cupressaceae	*Cupressus*	*arizonica*	Greene	E	North America
Gimnosperms	No clasificada	Coniferales	Cupressaceae	*Cupressus*	*funebris*	Endl.	E	Asia temperate
Gimnosperms	No clasificada	Coniferales	Cupressaceae	*Cupressus*	*macrocarpa*	Hartw.	E	North America
Gimnosperms	No clasificada	Coniferales	Cupressaceae	*Cupressus*	*sempervirens*	L.	E	Europe, Asia temperate
Gimnosperms	No clasificada	Coniferales	Cupressaceae	*Platycladus*	*orientalis*	(L.) Franco	E	Asia temperate
Gimnosperms	No clasificada	Coniferales	Cupressaceae	*Sequoia*	*sempervirens*	(D. Don) Endl.	E	North America
Gimnosperms	No clasificada	Coniferales	Cupressaceae	*Taxodium*	*distichum*	(L.) Rich.	E	North America
Gimnosperms	No clasificada	Coniferales	Cupressaceae	*Thuja*	*occidentalis*	L.	E	North America
Gimnosperms	No clasificada	Coniferales	Cupressaceae	*Thuja*	*plicata*	Donn ex D. Don	E	North America
Gimnosperms	No clasificada	Cycadales	Cycadaceae	*Cycas*	*revoluta*	Thunb.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Elaeagnaceae	*Elaeagnus*	*angustifolia*	L.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Elaeagnaceae	*Elaeagnus*	*pungens*	Thunb.	E	Asia temperate
Angiosperms	Eudicots	Oxalidales	Elaeocarpaceae	*Aristotelia*	*chilensis*	(Molina) Stuntz	N	South America
Angiosperms	Eudicots	Oxalidales	Elaeocarpaceae	*Crinodendron*	*patagua*	Molina	N	South America
Angiosperms	Eudicots	Ericales	Ericaceae	*Arbutus*	*unedo*	L.	E	Europe, Africa

Division	Clase	Order	Family	Genus	Species	Author	Origin	Biogeographical distribution
Angiosperms	Eudicots	Escalloniales	Escalloniaceae	*Escallonia*	*illinita*	C.Presl	N	South America
Angiosperms	Eudicots	Escalloniales	Escalloniaceae	*Escallonia*	*rubra*	(Ruiz & Pav.) Pers.	N	South America
Angiosperms	Eudicots	Malpighiales	Euphorbiaceae	*Colliguaja*	*odorifera*	Molina	N	South America
Angiosperms	Eudicots	Malpighiales	Euphorbiaceae	*Euphorbia*	*pulcherrima*	Willd. ex Klotzsch	E	South America
Angiosperms	Eudicots	Malpighiales	Euphorbiaceae	*Ricinus*	*communis*	L.	E	Africa
Angiosperms	Eudicots	Fabales	Fabaceae	*Acacia*	*caven*	(Molina) Molina	N	South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Acacia*	*dealbata*	Link	E	Australasia
Angiosperms	Eudicots	Fabales	Fabaceae	*Acacia*	*karroo*	Hayne	E	Africa
Angiosperms	Eudicots	Fabales	Fabaceae	*Acacia*	*longifolia*	(Andrews) Willd.	E	Australasia
Angiosperms	Eudicots	Fabales	Fabaceae	*Acacia*	*mearnsii*	De Wild.	E	Australasia
Angiosperms	Eudicots	Fabales	Fabaceae	*Acacia*	*melanoxylon*	R. Br.	E	Australasia
Angiosperms	Eudicots	Fabales	Fabaceae	*Acacia*	*retinodes*	Schltdl.	E	Australasia
Angiosperms	Eudicots	Fabales	Fabaceae	*Acacia*	*saligna*	(Labill.) Wendl.	E	Australasia
Angiosperms	Eudicots	Fabales	Fabaceae	*Acacia*	*visco*	Griseb.	E	South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Albizia*	*julibrissin*	Durazz.	E	Asia temperate
Angiosperms	Eudicots	Fabales	Fabaceae	*Bauhinia*	*forficata*	Link	E	South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Erythrostemon*	*gilliesii*	(Hook.) Klotzsch	N	South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Tara*	*spinosa*	(Molina) Britton & Rose	N	South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Ceratonia*	*siliqua*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Fabales	Fabaceae	*Cercis*	*siliquastrum*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Fabales	Fabaceae	*Erythrina*	*falcata*	Benth.	E	South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Erythrina*	*crista-galli*	L.	E	South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Gleditsia*	*triacanthos*	L.	E	North America, South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Otholobium*	*glandulosum*	(L.) J.W. Grimes	N	South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Parapiptadenia*	*rigida*	(Benth.) Brenan	E	South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Paraserianthes*	*lophantha*	(Willd.) I.C. Nielsen	E	Australasia
Angiosperms	Eudicots	Fabales	Fabaceae	*Parkinsonia*	*aculeata*	L.	E	North America, South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Prosopis*	*chilensis*	(Molina) Stuntz	N	South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Robinia*	*hispida*	L.	E	North America
Angiosperms	Eudicots	Fabales	Fabaceae	*Robinia*	*pseudoacacia*	L.	E	North America
Angiosperms	Eudicots	Fabales	Fabaceae	*Senna*	*candolleana*	(Vogel) H.S. Irwin & Barneby	N	South America

DIVISION	CLASE	ORDER	FAMILY	GENUS	SPECIES	AUTHOR	ORIGIN	BIOGEOGRAPHICAL DISTRIBUTION
Angiosperms	Eudicots	Fabales	Fabaceae	*Sophora*	*cassioides*	(Phil.) Sparre	N	South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Sophora*	*macrocarpa*	Sm.	N	South America
Angiosperms	Eudicots	Fabales	Fabaceae	*Spartium*	*junceum*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Fabales	Fabaceae	*Styphnolobium*	*japonicum*	(L.) Schott	E	Asia temperate
Angiosperms	Eudicots	Fagales	Fagaceae	*Castanea*	*sativa*	Mill.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Fagales	Fagaceae	*Fagus*	*sylvatica*	L.	E	Europe
Angiosperms	Eudicots	Fagales	Fagaceae	*Quercus*	*coccinea*	Münchh.	E	North America
Angiosperms	Eudicots	Fagales	Fagaceae	*Quercus*	*ilex*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Fagales	Fagaceae	*Quercus*	*nigra*	L.	E	North America
Angiosperms	Eudicots	Fagales	Fagaceae	*Quercus*	*robur*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Fagales	Fagaceae	*Quercus*	*suber*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Garryales	Garryaceae	*Aucuba*	*japonica*	Thunb.	E	Asia temperate
Angiosperms	Eudicots	Geraniales	Geraniaceae	*Pelargonium*	*domesticum*	L.H. Bailey	E	Africa
Angiosperms	Eudicots	Geraniales	Geraniaceae	*Pelargonium*	*graveolens*	L'Hér.	E	Africa
Gimnosperms	No clasificada	Ginkgoales	Ginkgoaceae	*Ginkgo*	*biloba*	L.	E	Asia temperate
Angiosperms	Eudicots	Boraginales	Heliotropiaceae	*Heliotropium*	*arborescens*	L.	E	South America
Angiosperms	Eudicots	Cornales	Hydrangeaceae	*Hydrangea*	*macrophylla*	(Thunb.) Ser.	E	Asia temperate, South America
Angiosperms	Eudicots	Cornales	Hydrangeaceae	*Philadelphus*	*coronarius*	L.	E	Europe
Angiosperms	Eudicots	Malpighiales	Hypericaceae	*Hypericum*	*patulum*	Thunb.	E	Asia temperate
Angiosperms	Eudicots	Fagales	Juglandaceae	*Juglans*	*major*	(Torr.) A. Heller	E	North America
Angiosperms	Eudicots	Fagales	Juglandaceae	*Juglans*	*regia*	L.	E	Asia temperate
Angiosperms	Eudicots	Lamiales	Lamiaceae	*Lavandula*	*angustifolia*	Mill.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Lamiales	Lamiaceae	*Rosmarinus*	*officinalis*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Lamiales	Lamiaceae	*Salvia*	*leucantha*	Cav.	E	South America
Angiosperms	Eudicots	Lamiales	Lamiaceae	*Salvia*	*microphylla*	Kunth	E	Africa
Angiosperms	Eudicots	Lamiales	Lamiaceae	*Salvia*	*officinalis*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Lamiales	Lamiaceae	*Teucrium*	*fruticans*	L.	E	Asia temperate, Africa
Angiosperms	Magnoliids	Laurales	Lauraceae	*Beilschmiedia*	*miersii*	(Gay) Kosterm.	N	South America
Angiosperms	Magnoliids	Laurales	Lauraceae	*Cinnamomum*	*camphora*	(L.) J. Presl	E	Asia temperate
Angiosperms	Magnoliids	Laurales	Lauraceae	*Cryptocarya*	*alba*	(Molina) Looser	N	South America
Angiosperms	Magnoliids	Laurales	Lauraceae	*Laurus*	*nobilis*	L.	E	Europe, Asia temperate, Africa

Division	Clase	Order	Family	Genus	Species	Author	Origin	Biogeographical distribution
Angiosperms	Magnoliids	Laurales	Lauraceae	*Persea*	*americana*	Mill.	E	South America
Angiosperms	Eudicots	Myrtales	Lythraceae	*Cuphea*	*hyssopifolia*	Kunth	E	North America, South America
Angiosperms	Eudicots	Myrtales	Lythraceae	*Lagerstroemia*	*indica*	L.	E	Asia temperate
Angiosperms	Eudicots	Myrtales	Lythraceae	*Punica*	*granatum*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Magnoliids	Magnoliales	Magnoliaceae	*Liriodendron*	*tulipifera*	L.	E	North America
Angiosperms	Magnoliids	Magnoliales	Magnoliaceae	*Magnolia*	*grandiflora*	L.	E	North America
Angiosperms	Eudicots	Malvales	Malvaceae	*Anisodontea*	*capensis*	(L.) D.M.Bates	E	Africa
Angiosperms	Eudicots	Malvales	Malvaceae	*Brachychiton*	*acerifolius*	(A. Cunn. ex G. Don) F.Muell.	E	Australasia
Angiosperms	Eudicots	Malvales	Malvaceae	*Brachychiton*	*discolor*	F. Muell.	E	Australasia
Angiosperms	Eudicots	Malvales	Malvaceae	*Brachychiton*	*populneus*	(Schott & Endl.) R.Br.	E	Australasia
Angiosperms	Eudicots	Malvales	Malvaceae	*Hibiscus*	*rosa-sinensis*	L.	E	Asia temperate, Asia tropical
Angiosperms	Eudicots	Malvales	Malvaceae	*Hibiscus*	*syriacus*	L.	E	Asia temperate, Asia tropical
Angiosperms	Eudicots	Malvales	Malvaceae	*Lagunaria*	*patersonia*	(Andrews) G. Don	E	Australasia
Angiosperms	Eudicots	Malvales	Malvaceae	*Sparmannia*	*africana*	L. f.	E	Africa
Angiosperms	Eudicots	Malvales	Malvaceae	*Tilia*	*americana*	L.	E	North America
Angiosperms	Eudicots	Malvales	Malvaceae	*Tilia*	*platyphyllos*	Scop.	E	Europe, Asia temperate
Angiosperms	Eudicots	Sapindales	Meliaceae	*Melia*	*azedarach*	L.	E	Asia temperate, Asia tropical, Australasia
Angiosperms	Magnoliids	Laurales	Monimiaceae	*Peumus*	*boldus*	Molina	N	South America
Angiosperms	Eudicots	Rosales	Moraceae	*Ficus*	*benjamina*	L.	E	Asia temperate, Asia tropical, Australasia
Angiosperms	Eudicots	Rosales	Moraceae	*Ficus*	*carica*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Rosales	Moraceae	*Ficus*	*elastica*	Roxb. ex Hornem.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Moraceae	*Ficus*	*microcarpa*	L.f.	E	Asia tropical, Australasia
Angiosperms	Eudicots	Rosales	Moraceae	*Maclura*	*pomifera*	(Raf.) C.K. Schneid.	E	North America
Angiosperms	Eudicots	Rosales	Moraceae	*Morus*	*alba*	L.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Moraceae	*Morus*	*nigra*	L.	E	Asia temperate
Angiosperms	Eudicots	Myrtales	Myrtaceae	*Eucalyptus*	*camaldulensis*	Dehnh.	E	Australasia
Angiosperms	Eudicots	Myrtales	Myrtaceae	*Eucalyptus*	*globulus*	Labill.	E	Australasia
Angiosperms	Eudicots	Myrtales	Myrtaceae	*Luma*	*apiculata*	(DC.) Burret	N	South America
Angiosperms	Eudicots	Myrtales	Myrtaceae	*Luma*	*chequen*	(Molina) A. Gray	N	South America
Angiosperms	Eudicots	Myrtales	Myrtaceae	*Melaleuca*	*armillaris*	(Sol. ex Gaertn.) Sm.	E	Australasia
Angiosperms	Eudicots	Myrtales	Myrtaceae	*Melaleuca*	*hypericifolia*	Sm.	E	Australasia

DIVISION	CLASE	ORDER	FAMILY	GENUS	SPECIES	AUTHOR	ORIGIN	BIOGEOGRAPHICAL DISTRIBUTION
Angiosperms	Eudicots	Myrtales	Myrtaceae	*Myrceugenia*	*lanceolata*	(Juss. ex J. St.-Hil.) Kausel	N	South America
Angiosperms	Eudicots	Myrtales	Myrtaceae	*Myrtus*	*communis*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Fagales	Nothofagaceae	*Nothofagus*	*alessandrii*	Espinosa	N	South America
Angiosperms	Eudicots	Fagales	Nothofagaceae	*Nothofagus*	*alpina*	(Poepp. & Endl.) Oerst.	N	South America
Angiosperms	Eudicots	Fagales	Nothofagaceae	*Nothofagus*	*obliqua*	(Mirb.) Oerst.	N	South America
Angiosperms	Eudicots	Lamiales	Oleaceae	*Forsythia*	*suspensa*	(Thunb.) Vahl	E	Asia temperate
Angiosperms	Eudicots	Lamiales	Oleaceae	*Fraxinus*	*excelsior*	L.	E	Europe
Angiosperms	Eudicots	Lamiales	Oleaceae	*Fraxinus*	*ornus*	L.	E	Europe, Asia temperate
Angiosperms	Eudicots	Lamiales	Oleaceae	*Fraxinus*	*pennsylvanica*	Marshall	E	North America
Angiosperms	Eudicots	Lamiales	Oleaceae	*Ligustrum*	*japonicum*	Thunb.	E	Asia temperate
Angiosperms	Eudicots	Lamiales	Oleaceae	*Ligustrum*	*lucidum*	W.T. Aiton	E	Asia temperate
Angiosperms	Eudicots	Lamiales	Oleaceae	*Ligustrum*	*ovalifolium*	Hassk.	E	Asia temperate
Angiosperms	Eudicots	Lamiales	Oleaceae	*Ligustrum*	*sinense*	Lour.	E	Asia temperate
Angiosperms	Eudicots	Lamiales	Oleaceae	*Olea*	*europaea*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Lamiales	Oleaceae	*Syringa*	*vulgaris*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Myrtales	Onagraceae	*Fuchsia*	*magellanica*	Lam.	N	South America
Angiosperms	Eudicots	Lamiales	Paulowniaceae	*Paulownia*	*tomentosa*	Steud.	E	Asia temperate
Angiosperms	Eudicots	Caryophyllales	Phytolaccaceae	*Phytolacca*	*dioica*	L.	E	South America
Gimnosperms	No clasificada	Coniferales	Pinaceae	*Abies*	*alba*	Mill.	E	Europe
Gimnosperms	No clasificada	Coniferales	Pinaceae	*Abies*	*procera*	Rehder	E	North America
Gimnosperms	No clasificada	Coniferales	Pinaceae	*Cedrus*	*atlantica*	(Endl.) Manetti ex Carrière	E	Africa
Gimnosperms	No clasificada	Coniferales	Pinaceae	*Cedrus*	*deodara*	(Roxb. ex D. Don.) G. Don	E	Asia temperate
Gimnosperms	No clasificada	Coniferales	Pinaceae	*Cedrus*	*libani*	A. Rich.	E	Asia temperate
Gimnosperms	No clasificada	Coniferales	Pinaceae	*Picea*	*pungens*	Engelm.	E	North America
Gimnosperms	No clasificada	Coniferales	Pinaceae	*Pinus*	*canariensis*	C. Sm.	E	Africa
Gimnosperms	No clasificada	Coniferales	Pinaceae	*Pinus*	*radiata*	D. Don	E	North America
Gimnosperms	No clasificada	Coniferales	Pinaceae	*Pseudotsuga*	*menziesii*	(Mirb.) Franco	E	North America
Angiosperms	Eudicots	Apiales	Pittosporaceae	*Pittosporum*	*tenuifolium*	Banks & Sol. ex Gaertn.	E	Australasia
Angiosperms	Eudicots	Apiales	Pittosporaceae	*Pittosporum*	*tobira*	(Thunb.) W.T. Aiton	E	Asia temperate
Angiosperms	Eudicots	Apiales	Pittosporaceae	*Pittosporum*	*undulatum*	Vent.	E	Australasia
Angiosperms	Eudicots	Lamiales	Plantaginaceae	*Hebe*	*buxifolia*	Cockayne & Allan	E	Australasia

Division	Clase	Order	Family	Genus	Species	Author	Origin	Biogeographical distribution
Angiosperms	Eudicots	Lamiales	Plantaginaceae	*Hebe*	*salicifolia*	G. Forst.	N	South America, Australasia
Angiosperms	Eudicots	Lamiales	Plantaginaceae	*Veronica*	*speciosa*	R. Cunn. ex A. Cunn.	E	Australasia
Angiosperms	Eudicots	Proteales	Platanaceae	*Platanus*	*acerifolia*	(Aiton) Willd.	E	Europe, Asia temperate
Angiosperms	Monocots	Poales	Poaceae	*Phyllostachys*	*aurea*	Carrière ex Rivière & C. Rivière	E	Asia temperate
Angiosperms	Monocots	Poales	Poaceae	*Pseudosasa*	*japonica*	(Steud.) Makino	E	Asia temperate
Angiosperms	Eudicots	Ericales	Polemoniaceae	*Cantua*	*buxifolia*	Juss. ex Lam.	E	South America
Angiosperms	Eudicots	Caryophyllales	Polygonaceae	*Homalocladium*	*platycladum*	(F. Muell.) L.H. Bailey	E	Pacifico
Angiosperms	Eudicots	Proteales	Proteaceae	*Grevillea*	*juniperina*	R.Br.	E	Australasia
Angiosperms	Eudicots	Proteales	Proteaceae	*Grevillea*	*robusta*	A. Cunn. ex R. Br.	E	Australasia
Angiosperms	Eudicots	Fabales	Quillajaceae	*Quillaja*	*saponaria*	Molina	N	South America
Angiosperms	Eudicots	Rosales	Rhamnaceae	*Ceanothus*	*caeruleus*	Lag.	E	North America
Angiosperms	Eudicots	Rosales	Rhamnaceae	*Rhamnus*	*alaternus*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Rosales	Rosaceae	*Chaenomeles*	*japonica*	(Thunb.) Lindl. ex Spach	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Chaenomeles*	*speciosa*	(Sweet) Nakai	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Cotoneaster*	*franchetii*	Bois	E	Asia temperate, Asia tropical
Angiosperms	Eudicots	Rosales	Rosaceae	*Cotoneaster*	*horizontalis*	Decne.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Cotoneaster*	*lacteus*	W. W. Sm.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Cotoneaster*	*pannosus*	Franch.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Cotoneaster*	*salicifolius*	Franch.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Crataegus*	*crus-galli*	L.	E	North America
Angiosperms	Eudicots	Rosales	Rosaceae	*Crataegus*	*monogyna*	Jacq.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Rosales	Rosaceae	*Cydonia*	*oblonga*	Mill.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Eriobotrya*	*japonica*	(Thunb.) Lindl.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Kerria*	*japonica*	(L.) DC.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Malus*	*baccata*	(L.) Borkh.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Malus*	*communis*	Lam.	E	Europe, Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Malus*	*domestica*	Borkh.	E	Europe
Angiosperms	Eudicots	Rosales	Rosaceae	*Malus*	*pumila*	Mill.	E	Europe
Angiosperms	Eudicots	Rosales	Rosaceae	*Photinia*	*serrulata*	Lindl.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Prunus*	*armeniaca*	L.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Prunus*	*avium*	(L.) L.	E	Europe, Africa

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Angiosperms	Eudicots	Rosales	Rosaceae	*Prunus*	*cerasifera*	Ehrh.	E	Europe, Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Prunus*	*cerasus*	L.	E	Europe, Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Prunus*	*domestica*	L.	E	Europe, Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Prunus*	*dulcis*	(Mill.) D.A. Webb	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Prunus*	*ilicifolia*	(Nutt. ex Hook. & Arn.) D. Dietr.	E	North America
Angiosperms	Eudicots	Rosales	Rosaceae	*Prunus*	*laurocerasus*	L.	E	Europe, Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Prunus*	*lusitanica*	L.	E	Europe, Africa
Angiosperms	Eudicots	Rosales	Rosaceae	*Prunus*	*persica*	(L.) Batsch	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Prunus*	*serrulata*	Lindl.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Pyracantha*	*coccinea*	M. Roem.	E	Europe, Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Pyrus*	*communis*	L.	E	Europe, Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Rosa*	*rubiginosa*	L.	E	Europe, Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Rubus*	*ulmifolius*	Schott	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Rosales	Rosaceae	*Spiraea*	*cantoniensis*	Lour.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Spiraea*	*japonica*	L.f.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Rosaceae	*Spiraea*	*thunbergii*	Siebold ex Blume	E	Asia temperate
Angiosperms	Eudicots	Gentianales	Rubiaceae	*Coprosma*	*repens*	A. Rich.	E	Australasia
Angiosperms	Eudicots	Sapindales	Rutaceae	*Citrus*	*limon*	(L.) Osbeck	E	Asia temperate
Angiosperms	Eudicots	Sapindales	Rutaceae	*Citrus*	*reticulata*	Blanco	E	Asia temperate
Angiosperms	Eudicots	Sapindales	Rutaceae	*Citrus*	*sinensis*	(L.) Osbeck	E	Asia temperate
Angiosperms	Eudicots	Sapindales	Rutaceae	*Citrus*	*trifoliata*	L.	E	Asia temperate
Angiosperms	Eudicots	Malpighiales	Salicaceae	*Azara*	*dentata*	Ruiz & Pav.	N	South America
Angiosperms	Eudicots	Malpighiales	Salicaceae	*Azara*	*serrata*	Ruiz & Pav.	N	South America
Angiosperms	Eudicots	Malpighiales	Salicaceae	*Populus*	*alba*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Malpighiales	Salicaceae	*Populus*	*deltoides*	Marshall	E	North America
Angiosperms	Eudicots	Malpighiales	Salicaceae	*Populus*	*nigra*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Malpighiales	Salicaceae	*Populus*	*tremula*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Malpighiales	Salicaceae	*Salix*	*babylonica*	L.	E	Asia temperate
Angiosperms	Eudicots	Malpighiales	Salicaceae	*Salix*	*caprea*	L.	E	Europe, Asia temperate, Africa
Angiosperms	Eudicots	Sapindales	Sapindaceae	*Acer*	*monspessulanum*	L.	E	Europe, Asia temperate
Angiosperms	Eudicots	Sapindales	Sapindaceae	*Acer*	*negundo*	L.	E	North America

Division	Clase	Order	Family	Genus	Species	Author	Origin	Biogeographical distribution
Angiosperms	Eudicots	Sapindales	Sapindaceae	*Acer*	*palmatum*	Thunb.	E	Asia temperate
Angiosperms	Eudicots	Sapindales	Sapindaceae	*Acer*	*pseudoplatanus*	L.	E	Europe, Asia temperate
Angiosperms	Eudicots	Sapindales	Sapindaceae	*Aesculus*	*hippocastanum*	L.	E	Europe
Angiosperms	Eudicots	Sapindales	Sapindaceae	*Dodonaea*	*viscosa*	Jacq.	E	Australasia
Angiosperms	Eudicots	Sapindales	Sapindaceae	*Koelreuteria*	*paniculata*	Laxm.	E	Asia temperate
Angiosperms	Eudicots	Lamiales	Scrophulariaceae	*Buddleja*	*davidii*	Franch.	E	Asia temperate
Angiosperms	Eudicots	Lamiales	Scrophulariaceae	*Buddleja*	*globosa*	Hope	N	South America
Angiosperms	Eudicots	Lamiales	Scrophulariaceae	*Myoporum*	*laetum*	G. Forst.	E	Australasia
Angiosperms	Eudicots	Lamiales	Scrophulariaceae	*Myoporum*	*tenuifolium*	G. Forst.	E	Australasia
Angiosperms	Eudicots	Sapindales	Simaroubaceae	*Ailanthus*	*altissima*	(Mill.) Swingle	E	Asia temperate
Angiosperms	Eudicots	Solanales	Solanaceae	*Brugmansia*	*arborea*	(L.) Steud.	E	South America
Angiosperms	Eudicots	Solanales	Solanaceae	*Cestrum*	*parqui*	(Lam.) L'Hér.	N	South America
Angiosperms	Eudicots	Solanales	Solanaceae	*Iochroma*	*cyaneum*	(Lindl.) G.H.M. Lawr. & J.M. Tucker	E	South America
Angiosperms	Eudicots	Solanales	Solanaceae	*Nicotiana*	*glauca*	Graham	E	South America
Angiosperms	Eudicots	Caryophyllales	Tamaricaceae	*Tamarix*	*ramosissima*	Ledeb	E	Europe, Asia temperate
Gimnosperms	No clasificada	Coniferales	Taxaceae	*Taxus*	*baccata*	L.	E	Europe, Asia temperate
Angiosperms	Eudicots	Ericales	Theaceae	*Camellia*	*japonica*	L.	E	Asia temperate
Angiosperms	Eudicots	Rosales	Ulmaceae	*Ulmus*	*americana*	L.	E	North America
Angiosperms	Eudicots	Rosales	Ulmaceae	*Ulmus*	*laevis*	Pall.	E	Europe
Angiosperms	Eudicots	Rosales	Ulmaceae	*Ulmus*	*minor*	Mill.	E	Europe
Angiosperms	Eudicots	Rosales	Ulmaceae	*Zelkova*	*carpinifolia*	(Pall.) K. Koch	E	Europe, Asia temperate
Angiosperms	Eudicots	Lamiales	Verbenaceae	*Aloysia*	*citriodora*	Palau	N	South America
Angiosperms	Eudicots	Lamiales	Verbenaceae	*Aloysia*	*gratissima*	(Gillies & Hook.) Tronc.	E	North America, South America
Angiosperms	Eudicots	Lamiales	Verbenaceae	*Aloysia*	*looseri*	Moldenke	E	Asia tropical
Angiosperms	Eudicots	Lamiales	Verbenaceae	*Lantana*	*camara*	L.	E	North America, South America
Angiosperms	Magnoliids	Canellales	Winteraceae	*Drimys*	*winteri*	J.R. Forst. & G. Forst.	N	South America

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