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URBAN GREEN AREAS, RECREATIONAL USE AND HEALTH IMPACT OF VICTORY GARDENS (CÓRDOBA – SPAIN)

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Gardens provide from the antiquity a place of easing and leisure for the human being. The development of gardens in cities carries the creation of a green space that serves as support to the oxygenation of the air in these. However, sometimes these parks and gardens can generate health problems in residents due to the presence of species with high level of allergenic pollen. This work presents a study of the allergenicity of the flora of the Victory Gardens of Córdoba (Spain) to observe if this space could be considered as a problem of public health due to its poor air quality. The results obtained in the Victory Gardens suggest that this space presents a moderate allergenic potential and could represent a risk to the citizens, especially in spring, when the most of species are blooming.

Key words: Victory Gardens, Allergenic potential, Ornamental flora, Recreational areas.

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INTRODUCTION

Gardens and parks of the cities are perceived by the inhabitants as beneficial for society due to the numerous contributions of them for the health of the human being: direct contact with nature, habitat of numerous plant and animal species, place of meeting and recreation, etc. (Chiesura et al. 2004). But at the same time, they present some inconveniences to the population due to the increasing incidence of pollen allergy symptoms (Cariñanos et al. 2002, Dopazo et al. 2002, Staffolani et al. 2011).

Recently, an increase of airborne pollen in urban areas has been observed, becoming one of the main public health problems, with incidence figures in the population above 30% (Pawankar et al. 2011). This may have been due to the rapid urbanization in recent years, trying to meet the aesthetic and recreational needs of local residents (United Nations 2007). Among the causes that have increased the allergenic behavior of the ornamental flora are the low biodiversity, the massive use of a few species (Díaz de la Guardia et al., 2006), the incorporation of new species of unknown allergenicity (Trigo et al. 1999) and, above all, the interaction with atmospheric

pollutants present in the urban environment (Beck et al. 2013). To this must be added the incorporation of pollen emissions from forest or extensive crops in the peri-urban environment, i.e. olive pollen in Córdoba (Velasco-Jiménez et al. 2013, Galán et al. 2016).

Respiratory diseases, linked to the presence of pollen in the air, have also been pointed out as some of the problems with greater predictions of increase in the coming decades as a result of climate change (McMichael et al. 2006) and the deterioration of quality of the urban air.

The challenges that cities must do in the face of the expectations of population growth and the effects of climate change further reaffirm their essential role in the context of a sustainable and healthy city. However, it is also necessary to review some of the negative effects associated with this ornamental flora, among them the costs derived from the allergic reactions caused by pollen emissions during flowering.

The ornamental flora has a clear influence on the pollen concentration in the air that affects the population suffering from pollinosis (Cariñanos et al. 2011, Staffolani et al. 2011, Velasco-Jiménez et al. 2014). An analytical study of the presence of potentially allergenic species, their biological characteristics and the factors involved in their activity as sources of pollen emission, would be very useful when creating and designing new gardens or urban parks and a solution to redesign those already existing. On the other hand, not all pollen grains have proteins that cause allergy and, among those pollen grains with allergenic proteins, not all have the same allergy potency (Behrendt & Becker 2001), so it is very convenient to know these characteristics of pollen grains.

This study focused on the Victoria Gardens of the city of Córdoba (Spain) to raise awareness of the allergenic potential of this park and, in this way, contribute to better management of the park, minimizing the impact of plant species on the resident population.

MATERIAL AND METHODS

Study area

Córdoba (37º 50' N, 4º 45'W) is located in Andalusian, south Spain, at 123 m above sea level (Fig.1); it is a medium-sized city with a population of around 325,000 inhabitants (according to the last census of 2016) and a surface of 290.23 km^2. It is characterized by a Mediterranean climate with some continental features, cold, rainy winters and hot, dry summers. The annual average temperature is 18.2ºC, mean annual rainfall is 605 mm. (data from 1981-2010, AEMET – State weather agency).

The Victory Gardens were built in 1776, located initially to the outskirts of the historical center. Nowadays they are completely integrated in the center of the city. These gardens have an area of 52,175 m^2 and present a large part dedicated to vegetation, along with recreational areas for children, in addition to presenting numerous architectural elements of the nineteenth and twentieth centuries, modernist style.

Fig. 1. Map showing the location of Córdoba city.

Airborne pollen

Airborne pollen databases were obtained from sampling station located in the University Campus of Rabanales (Córdoba), which belongs to the Spanish Aerobiology Network (REA). Sampling was performed from 2017, using volumetric suction samplers based on the impact principle, i.e. Hirst-type spore traps (Hirst 1952). The methodology designed by the REA (Galán et al. 2007), in compliance with the minimum requirements set out by the European Aerobiology Society (EAS) (Galán et al. 2014), was used for sampling and for calculating average daily airborne pollen concentration (pollen grains/m^3).

Ornamental flora data

Complete lists of ornamental flora growing in the urban green area were compiled in situ observation.

A series of characteristics have been studied for each species.

- **Pollen allergen potency:** amount of allergen per pollen grain, measured as mass in nanograms or picograms per pollen grain (Galán et al. 2017). It is based on database www.allergome.org.

- **Pollen allergy potency:** is the ability of pollen to cause allergy to a significant part of the population (Galán et al., 2017). For this to occur, the plant must have substances (proteins or glycoproteins) recognized as immunologically harmful to a given individual. The allergy potency values (low = 1, moderate = 2 or high = 3) are based on data provided in reports and by databases (Galán et al. 2007, Trigo et al. 2008, Le Réseau National de Surveillance Aérobiologique -R.N.S.A.).

- **Pollination strategy:** Entomophilous, insect-pollinated species; Anemophilous, wind-pollinated species and Amphiphilous species that may be insect- or wind-pollinated.

- **Principal pollination period:** was established based on pollen calendar for the city of Córdoba, developed using daily mean pollen data for over 10 years (Martínez-Bracero 2015).

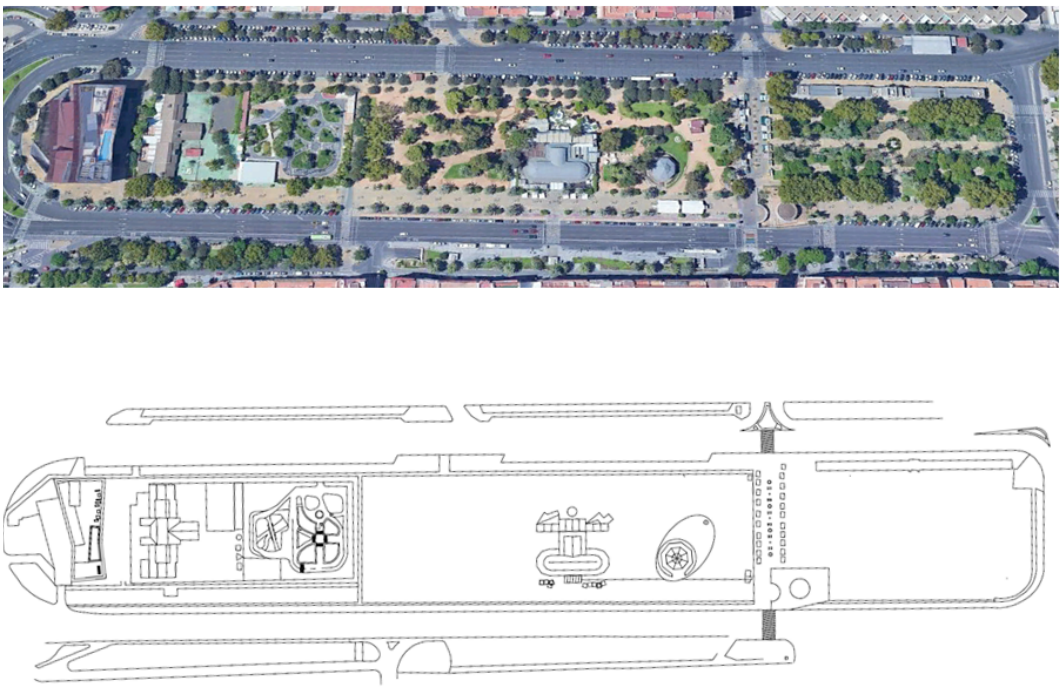

Fig. 2. Aerial photo of the Victory Gardens (Google earth) and architectural plan (own elaboration).

RESULTS

The list of species presents in the Victory Gardens, together with the characteristics of each one has been detailed in Table 1. The analysis of ornamental flora in the study of the Victory Gardens (Córdoba) has been based on a total of 579 individuals belonging to 33 different species. These species are grouped into 22 botanical families: 3 gymnosperms (Cupressaceae, Ginkgoaceae and Pinaceae) and 19 angiosperms.

The families with the highest representation of species were Arecaceae and Fabaceae, both with 4 species. It is followed by the Pinaceae family, with 3 species, and Oleaceae families, with 2 species. The rest of the families have only one species.

The species with the highest number of specimens were *Citrus aurantium*, L. (235), *Celtis australis*, L. (80), *Phoenix canariensis*, Hort. ex Chabaud (45), *Platanus x hispanica*, Mill. ex Munch (44), *Phoenix dactylifera*, L. (40), *Washingtonia filifera*, (Lindl.) H. Wendl. (25), *Casuarina equisetifolia*, L. (18) and *Cercis siliquastrum*, L. (18). Within these species, those with anemophilous pollination are *Celtis australis*, L., *Phoenix dactylifera*, L., *Platanus x hispánica*, Mill. ex Münchh. and *Phoenix canariensis*, Hort. ex Chabaud.

There is a predominance of species from Mediterranean origin, such as *Arbutus unedo* L., *Celtis australis* L., *Chamaerops humillis* L., *Ceratonia siliqua* L., *Cupressus sempervirens* L., *Laurus nobilis* L., *Olea europaea* L., *Pinus pinea* L., or *Quercus ilex* L. They are followed by species from Asian origin, such as *Pittosporum tobira* (Thunb.) W.T.Aiton., *Ginkgo biloba* L. or *Sophora japonica* L., and European, as *Cercis siliquastrum* L. and *Populus nigra* L. Some species from American and Australian origin, such as *Yucca* spp. or *Casuarina equisetifolia* L. have been observed (Fig. 3).

Fig.4 shows the number of individuals wich used each polination strategy. The biggest number was found for the specimens that use entomophilous pollination, followed very closely by the anemophilous ones.

Approximately, the 74% of the individuals found in the gardens have presented some pollen

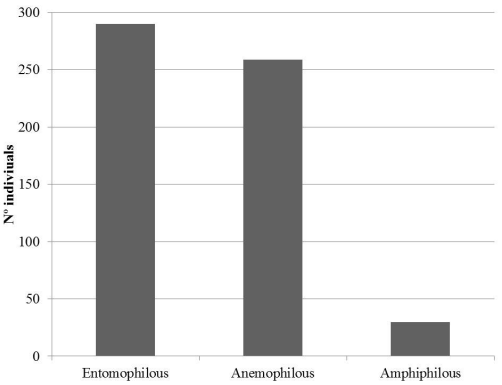

Fig. 4. Pollination strategy for ornamental flora in the studied gardens.

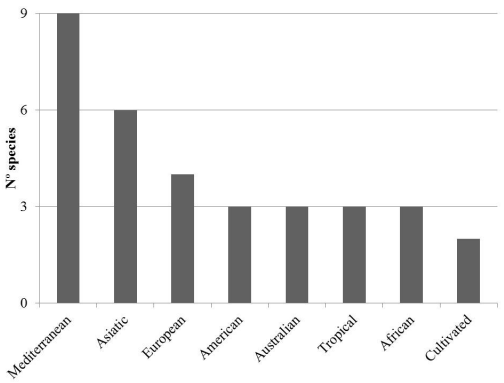

Fig. 3. Origin for ornamental flora in the studied gardens.

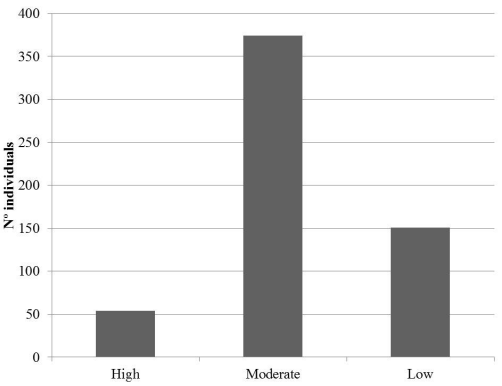

Fig. 5. Potencial allergenicity for ornamental flora in the studied gardens.

Table 1. List of species in the Victory Gardens

Nº	Species	Family	Nº individuals
1	*Aesculus hippocastanum* L.	Hyppocastanaceae	1
2	*Araucaria excelsa* (Salisb.) Franco.	Araucariaceae	2
3	*Arbutus unedo* L.	Ericaceae	1
4	*Brachychiton populneus* Schott & Endl.	Salicaceae	8
5	*Casuarina equisetifolia* L.	Casuarinaceae	18
6	*Cedrus atlantica* (Endl.) Manetti ex Carrière.	Pinaceae	4
7	*Cedrus deodara* L.	Pinaceae	1
8	*Celtis australis* L.	Ulmaceae	80
9	*Ceratonia siliqua* L.	Fabaceae	1
10	*Cercis siliquastrum* L.	Fabaceae	18
11	*Chamaerops humilis* L.	Arecaceae	4
12	*Citrus aurantium* L.	Rutaceae	235
13	*Cupressus sempervirens* L.	Cupressaceae	8
14	*Ginkgo biloba* L.	Ginkgoaceae	3
15	*Jacaranda mimosifolia* D.Don.	Bignoniaceae	4
16	*Laurus nobilis* L.	Lauraceae	1
17	*Ligustrum lucidum* L.	Oleaceae	1
18	*Magnolia grandiflora* L.	Magnoliaceae	3
19	*Olea europea* L.	Oleaceae	1
20	*Philadelphus coronarius* L.	Saxifragaceae	3
21	*Phoenix canariensis* Hort. ex Chabaud.	Arecaceae	45
22	*Phoenix dactylifera* L.	Arecaceae	40
23	*Pinus pinea* L.	Pinaceae	2
24	*Pittosporum tobira* W.T. Aiton	Pittosporaceae	4
25	*Platanus x hispanica* Mill. ex Münchh.	Platanaceae	44
26	*Populus nigra* L.	Salicaceae	5
27	*Prunus cerasífera* Ehrh.	Rosaceae	1
28	*Punica granatu,* L.	Punicaceae	2
29	*Quercus ilex* L.	Fagaceae	3
30	*Robinia pseudoacacia* L.	Fabaceae	3
31	*Sophora japonica* L.	Fabaceae	2
32	*Washingtonia filifera* (Lindl.) H.Wendl.	Arecaceae	25
33	*Yucca sp.*	Agavaceae	6
		Total individuals	**579**

allergen potency. Regarding the pollen allergy potency of ornamental flora in these gardens, the majority of individuals have moderate allergenicity (64.6%). Even, about 50 specimens with high allergenicity have been observed (Fig. 5). Of these last species, those that present a greater number of described allergens are *Olea europaea* L., *Cupressus sempervirens* L. and *Platanus x hispánica* Mill. Ex Münchh.

Pollen concentrations of the principal pollen types observed in the gardens during 2017 have been represented in Fig. 6. During winter, the most important pollen type is *Cupressus*; in spring *Platanus* and Pinaceae; Arecaceae pollen type is present during all the time; finally, *Casuarina* pollen type appears in autumn.

The great majority of the individuals found in the park have a principal pollination period of more than 3 weeks and more than 250 specimens have a period exceeding 6 weeks (Fig. 7).

DISCUSSION

The study of the ornamental flora carried out in the Victory Gardens (Córdoba) has shown the variability of species used, both taxonomic groups and diverse origins, which contributes to enrich the urban landscape of the city.

The majority of the species used in these gardens are from Mediterranean origin. These species have recently been incorporated, trying to present the residents of the city with the great richness of our natural flora, as well as considering their low allergy potency. The remarkable presence of Asian, American and Australian species, common to other parks in Spain (Velasco-Jiménez et al. 2014, Cariñanos et al. 2016), is due to the numerous cultural exchanges that have been done since the Renaissance. On the other hand, Córdoba is characterized by a climate with a certain degree of continentally, with frequent

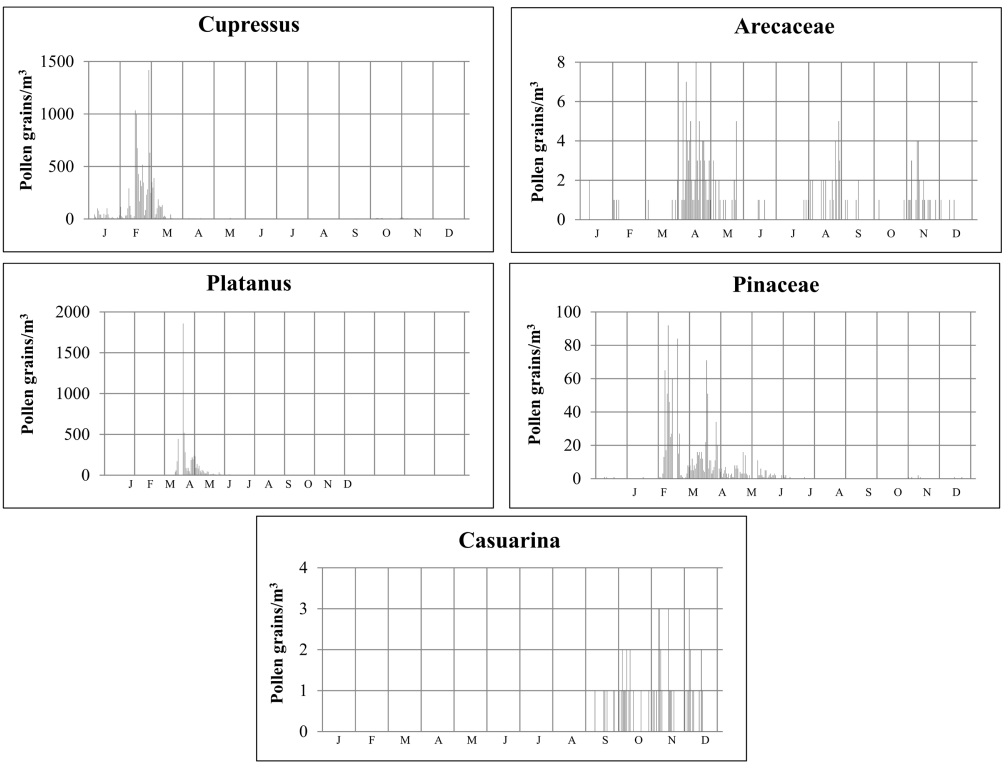

Fig. 6. Daily pollen concentrations of the principal pollen types in the city of Córdoba during 2017, related to ornamental flora in the Gardens of Victory.

nights of frost in winter, which could explain the greater representation of species from European origin and a lower percentage of tropical species than coastal cities, such as the case of Málaga (Velasco et al. 2014).

Half of the individuals found in the gardens present an anemophilous or amphiphilous pollination strategy. Although this strategy is not always related with pollen allergen potency (for example *Pinus* sp. or *Quercus* sp.), it often coincides with species that are allergenic (*Cupressus* sp., *Platanus x hispánica* Mill. Ex Münchh, *Phoenix* sp., *Casuarina equisetifolia* L. and other)

Another studied parameter was the duration of the main pollination period, considering the study of Martínez-Bracero et al. (2015). Most species of Victoria Gardens bloom in spring, which makes it the most adverse time for allergic people who often cross these gardens or spend time in them. Nevertheless some species bloom during winter (cypress) and other in autumn (Australian pine). *Platanus x hispanica* Mill. Ex Münchh. and *Casuarina equisetifolia* L., have been the species that have mostly contributed to the allergenicity of the park, both due to its high pollen allergen potency and the high number of individuals employed. However, the species *Citrus aurantium* L., despite having many individuals, has entomophilic pollination and therefore, its contribution to the allergenicity is lower.

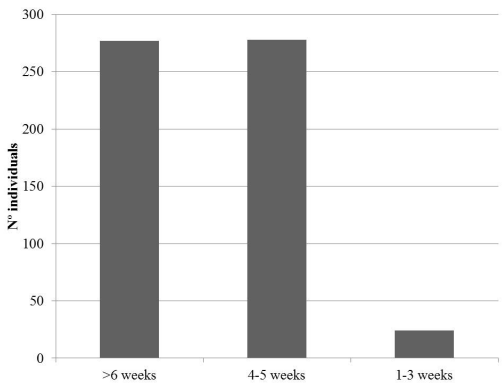

Fig. 7. Principal pollination pediod for ornamental flora in the studied gardens.

The massive use of individuals of the same species is causing a significant increase in pollen concentrations in the air (Alcázar et al. 2011). Some of these species, in many cases allochthonous, present high pollen allergy potency (Alcázar et al., 2004; Velasco-Jiménez et al. 2014), despite which they are widely used as ornamental plants in Spanish cities, mainly due to its resistance to urban pollution (Bytnerowicz et al. 2007).

The use of *Cupressus* species is very common in Spanish parks (Cariñanos et al. 2016), despite it having high pollen allergen potency (Guerra et al. 1996), and being the main cause of winter pollinosis (D'Amato & Licciardi. 1994). Fortunately in our case, the impact is low because few individual has been found in the studied garden. A similar case has been found with specimens of Oleaceae family, with only two individuals in the garden. On the other hand, it is worth highlighting in this study the use of species with low pollen allergen potency based on literature, such as *Cercis siliquastrum* L., *Magnolia grandiflora* L. and *Prunus cerassifera* L., among others.

In green spaces, in addition to the species that make up the park, it is also important its distribution on the surface and the environment in which this space is located. The gardens of this study are located in the urban center, with elevated buildings, so it should be considered that pollen emissions in the park itself can remain for a long time in the local environment due to the difficulties for dispersion (Cariñanos et al. 2001 and 2008). In addition, the gardens are located near to important traffic routes, so that an interaction between biological material and other pollutants could occur, with even more damaging effects on health. Likewise, it should be necessary to consider the presence of other biological emissions in the atmosphere of the park, both from nearby foci as well as from others located at a distance, which can be transferred with the air currents (Oteros et al. 2015).

CONCLUSION

The results obtained in the Victory Gardens suggest that this space presents moderate allergy potency and could represent a risk to the citizens, especially in spring, when the most of species are blooming.

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REFERENCES

Alcázar P., Cariñaos P., de Castro C., Guerra F., Moreno C., Domínguez E. et al. 2004. Airbone plane-tree (*Platanus hispanica*) pollen distribution in the city of Córdoba. South-western Spain. and possible implications on pollen allergy. *Journal of Investigational Allergology and Clinical Immunology*. 14(3). 238-243.

Alcázar P., García-Mozo H., Trigo M.M., Ruiz L., González-Minero F.J., Hidalgo P et al 2011. Platanus pollen season in Andalusia (Southern Spain): trends and modeling. *Journal of Environmental Monitoring*. 13. 2502-2510.

Beck I., Jochner S., Gilles S. et al. 2013. High environmental ozone levels lead to enhanced allergenicity of birch pollen. *PLosONE*; 8:e80147.

Behrendt. H., Becker W.M. 2001. Localization. release and bioavailability of pollen allergens: the influence of environmental factors. *Current opinion in immunology*. 13(6). 709-715.

Bytnerowicz A., Omasa K., Paoletti. E. 2007. Integrated effects of air pollution and climate change on forests: a northern hemisphere perspective. *Environmental Pollution*. 147(3). 438-445.

Cariñanos P., Casares-Porcel M., de la Guardia C., Aira M.J., Boi. M., Cardador C., et al. 2016. Salud Ambiental de los parques españoles: Aproximación al potencial alergénico de espacios verdes urbanos. *Revista de Salud Ambiental*. 16(1). 33-42.

Cariñanos P., Galán C., Alcázar P., Domínguez E. 2008. Classification. analysis and interaction of solid airbone particles in urban environments. In A. G. Kungolos. C. A. Brebbia. & M. Zamorano (Eds.). *Environmental Toxicology II* (317-325).

Cariñanos P., Prieto J.C., Galán C., Domínguez E. 2001. Solid suspended particles affecting the quality of air in urban environments. *Bull. Environ. Contam. Toxicol*; 67:385-91.

Cariñanos P., Sánchez-Mesa J.A., Prieto J.C., López A., Guerra F., Moreno C. et al. 2002. Pollen allergy related to the area of residences in the city of Córdoba. southwest Spain. *Journal of Environmental Monitoring*. 4:734–738.

Cariñaos P. & Casares M. 2011: Urban Green zones and related pollen allergy: A review. Guidelines for designing spaces of low allergy impact. *Landscape and Urban Planning*. 101. 205-214.

Chiesura A. 2004. The role of urban parks for the sustainable city. *Landscape and Urban Planning*. 68:129-138.

D'Amato G. & Liccardi G. 1994. Pollen related allergy in the European Mediterránean area. *Clinical and Experimental Allergy*. 24:210-219.

Díaz de la Guardia C. Alba F. De Linares C. et ál. 2006. Aerobiological and allergenic analysis of Cupressaceae pollen in Granada (Southern- Spain). *J. Invest. Allergol. Clin. Immunol*; 16:24-33.

Dopazo A., Aira M.J., Armise´n M., Vidal. C. 2002. Relationship of clinical and aerobiological pollen data in the north-west of Spain. *Allergologie et Immunopathologie*. 30(2). 74–78.

Galán C, Smith M, Thibaudon M, Frenguelli G, Oteros J, Gehrig R & EAS QC Working Group. (2014). Pollen monitoring: minimum requirements and reproducibility of analysis. *Aerobiologia*, 30(4), 385-395.

Galán C., Alcázar P., Oteros J., García-Mozo H., Aira M. J., Belmonte J., ... & Pérez-Badía R. 2016. Airborne pollen trends in the Iberian Peninsula. *Science of the Total Environment*, 550, 53-59.

Galán C., Ariatti A., Bonini M., Clot B., Crouzy B., Dahl, A. & Levetin E. 2017. Recommended terminology for aerobiological studies. Aerobiologia, 33(3), 293-295.

Galán C., Cariñanos P., Alcázar P., Domínguez E. 2007. *Quality and management manual of the Spanish aerobiology network*. Servicio de Publicaciones de la Universidad de Córdoba. Spain.

Guerra F., Daza J.C., Miguel M., Moreno C., Galán C., Domínguez-Vilches E., Sanchez-Guijo P. 1996. Sensitivity to Cupressus. allergenic significance in Córdoba (Spain). *Journal of Investigational Allergology & Clinical Immunology*. VI(2):117-120.

Hirst, J. 1952. An automatic volumetric spore trap. *Annals of applied Biology*, 39(2), 257-265.

Martínez-Bracero M., Alcázar P., de la Guardia C. González-Minero F.J., Ruiz L., Pérez M. T., Galán C. 2015. Pollen calendars: a guide to common airborne pollen in Andalusia. *Aerobiologia*, 31(4), 549-557.

McMichael A.J., Woodruff R.E., Hales S. 2006. Climate change and human health: Present and future risks. *Lancet*. 367: 859-869.

Oteros J., García-Mozo H., Alcázar P., et ál. 2015. A new method for determining the sources of airborne particles. *J. Environ. Manage*. 155:212-8.

Pawankar R., Canonica G.W., Holgat S.T., Lockey R.F. 2011. *World Allergy Organization (WAO) white book on allergy*. Wisconsin: World Allergy Organisation.

Staffolani L., Velasco-Jiménez M.J., Galán C., Hruska K. 2011. Allergenicity of the ornamental urban flora: ecological and aerobiological analyses in Córdoba (Spain) and Ascoli Piceno (Italy). *Aerobiologia*. 27. 239–246.

Trigo M.M., Jato V., Fernández D., Galán C. 2008. *Atlas aeropalinológico de España*. Secretariado de Publicaciones. Universidad de León.

Trigo M.M., Recio M., Toro F.J. et al.1999. Annual variations of airborne Casuarina pollen in the Iberian Peninsula. *Polen*. 10:67-73.

United Nations. World urbanization prospects: The 2007 revision. Executive summary. New York: United Nations. Dep. Econ. Social Affairs. 2008.

Velasco-Jiménez M. J., Alcázar P., Domínguez-Vilches E., Galán C. 2013. Comparative study of airborne pollen counts located

in different areas of the city of Córdoba (south-western Spain). *Aerobiologia*, 29(1), 113-120.

Velasco-Jiménez M.J., Alcázar P., Valle A., Trigo M.M., Minero F., Domínguez E., Galán C. 2014. Aerobiological and ecological study of the potentially allergenic ornamental plants in south Spain. *Aerobiologia*. 30(1). 91-101.

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