

Short Communication

The impact of the botanical gardens on the aeroplankton of the city of Cagliari, Italy

Mauro Ballero^{1*}, Giovanni Piu² & Alberto Ariu¹

¹*Dipartimento di Scienze Botaniche dell'Università di Cagliari, Cagliari, Italy;* ²*Ospedale G. Brotzu, Cagliari*
(*author for correspondence, e-mail: ballero@unica.it; fax: +39 070 6753535)

(Received 25 September 1999; accepted in final form 28 December 1999)

Key words: air biological sampling, Botanical Gardens, Cagliari, exotic pollens

Abstract

In this study the authors analyse the incidence in the airborne pollen from exotic plants that grow in the Botanical Gardens of the University of Cagliari. It was possible to collect the pollen grains of 52 of the species cultivated in the Botanical Gardens, most of which belong to the *Leguminosae*, the *Moraceae* and the *Myrtaceae*. *Casuarina stricta* Aiton of Australian origin shows the highest concentration with 137 grains per cubic metre of air.

1. Introduction

The study of allergies to pollen has received considerable attention in the past years thanks to more careful and detailed environmental analyses carried out in collaboration between medical specialists and botanists, also in the City of Cagliari (Sardinia, Italy), where constant allergological and aeropalynological observations have been carried out for over twenty years. As a result, important information on airborne pollen could be used by allergologists to introduce new therapeutic protocols.

In this study, the authors analyse the incidence in the airborne pollen from the exotic vegetation growing in the Botanical Gardens of the University of Cagliari resulting from research carried out as part of a study on air plankton of the city produced by autochthonous flora (Ballero and Ariu, 1997).

The Botanical Gardens were founded by Patrizio Gennari in 1866. They extend for about 300 metres, over an area of 5 hectares. They are located in the Palabanda Valley, at 70 metres above sea level and at a distance from the sea of about 1,000 metres; latitude 39° 12' N, longitude 9° 12' E. The founder's ideal of acclimatising botanical species of tropical or sub-tropical origin in this area was fulfilled in the very middle of the city centre. Thanks to the dry thermo-

Mediterranean type of climate it has been possible to establish plant species from several temperate and sub-tropical regions such as Australia, South Africa, America and the Middle East.

In the Botanical Gardens there are 400 trees, shrubs and lianas growing in the open ground, represented by about 1,200 specimens of different ages, sizes and structures; 600 potted species; and 1,000 succulent plant species, partly growing in glasshouses and partly in the open ground (Mossa and Del Prete, 1992).

2. Materials and methods

Airborne pollen samples were taken with a Burkard volume weekly sampler, placed next to the Botanical Gardens in the city at a height of about 20 metres above ground level, and at a distance of over 400 metres from the Gardens, in other words outside the perimeter of the area where most of the released grains are deposited (Hirst and Hurst, 1967; Michel et al., 1979).

The airborne pollen was compared with a specific pollen collection containing pollen grains gathered from the exotic species growing in the Botanical Gardens.

Table 1. After the Linnaean binomial this list shows the family, country of origin, flowering time (in Roman numerals), average number of pollen grains (per day per cubic metre of air) detected during flowering time of the exotic plants in the Botanical Garden and pollen percentages over totals for the same period.

Acacia cavenia Bert.	Leguminosae	Argentina, Chile	III–IV	15	2
Acacia pendula A. Cunn.	Leguminosae	Australia	III–IV	14	2
Acokanthera oppositifolia (Lam.) Codd.	Apocynaceae	Southern Africa	IV–VI	15	4
Adhatoda vasica Nees.	Acanthaceae	Tropical Asia	III–V	17	2
Brachychiton acerifolius Cunn.	Sterculiaceae	Australia	V–VI	16	7
Berberis vulgaris L.	Berberidaceae	China	IV–V	17	6
Buddleja davidii Franch.	Buddlejaceae	China	I–IV	13	1
Buddleja madagascariensis Lam.	Buddlejaceae	Madagascar	I–IV	10	1
Caesalpinia tinctoria Domb.	Leguminosae	S. America, S. Africa	II–IV	18	2
Callistemon citrinus (Curtis) Skeels	Myrtaceae	Australia	II–V	16	1
Carissa edulis Vahl	Apocynaceae	Tropical Africa	V–VII	10	4
Casimiroa edulis La Llave	Rutaceae	Central America	IV–V	10	3
Cassia corymbosa Lam.	Leguminosae	Mexico	VI–IX	11	10
Cassine crocea (Thunb.) Kuntze	Celastraceae	Southern Africa	V–VI	11	5
Casuarina stricta Aiton	Casuarinaceae	Australia	XII–III	137	12
Catalpa bugnonioides Walt.	Bignoniaceae	North America	V–VI	13	6
Catha edulis Forsk.	Celastraceae	Africa, Arabia	IV–V	10	3
Chorisia speciosa St. Hil.	Bombaceae	Brasil, Argentina	VII–VIII	21	66
Cinnamomum camphora Nees. & Eberm.	Lauraceae	China, Japan	IV–V	14	5
Duranta plumieri Jacq.	Verbenaceae	Tropical America	VI–VIII	14	18
Erythrina corallodendron L.	Leguminosae	South America	V–VI	12	5
Feijoa sellowiana Berg.	Myrtaceae	Brasil	V–VI	11	5
Ficus sp.p. L.	Moraceae	Tropical Asia	II–X	22	1
Gossypium arboreum L.	Malvaceae	America, Asia	VI–VIII	10	13
Grewia occidentalis L.	Tiliaceae	South Africa	IV–VI	10	3
Gymnosporia montana Benth.	Celastraceae	Tropics	V–VI	11	5
Jacaranda mimosifolia G. Don	Bignoniaceae	Brasil	V–VII	24	10
Kalanchoe beharensis Drake de Castillo	Crassulaceae	Madagascar	II–III	14	1
Lagunaria patersonii G. Don	Malvaceae	Australia	VII–VIII	41	56
Maclura pomifera (Rafin.) Schneid.	Moraceae	Central America	V–X	24	8
Mahonia japonica Thunb.	Berberidaceae	China, Japan	III–IV	10	1
Medicago arborea L.	Leguminosae	North Africa, Asia	IV–VI	10	3
Melaleuca dendron L.	Myrtaceae	America	V–VII	27	11
Melaleuca hypericifolia Smith	Myrtaceae	Australia	V–VI	23	10
Melia azederach L.	Meliaceae	India, Himalaya	III–V	31	4
Montanoa bipinnatifida C. Koch	Compositae	Mexico	XII–II	11	2
Phymosia umbellata Desv.	Malvaceae	Northern America	IV–V	14	5
Podocarpus neriifolia G. Don	Podocarpaceae	Himalaya	III–V	15	2
Polygala myrtifolia L.	Polygalaceae	South Africa	III–V	23	3
Prosopis nandubey Lorentz	Leguminosae	Argentina	V–VI	13	6
Psidium guajava Raddi	Myrtaceae	Tropical America	IV–V	13	4
Rhus laevigata L.	Anacardiaceae	North America	III–IV	38	4
Raphiolepis indica Lindl.	Rosaceae	China	III–IV	10	1
Schinus dependens Orteg.	Anacardiaceae	South America	III–VII	47	5
Schinus latifolius Engl.	Anacardiaceae	South America	III–VII	51	5
Schotia afra (L.) Thunb.	Leguminosae	South Africa	VI–VII	21	31
Sparmannia africana L.	Tiliaceae	South Africa	X–V	19	1
Sterculia diversifolia G. Don	Sterculiaceae	Australia	V–VI	22	10
Taxodium distichum (L.) Rich.	Taxodiaceae	North America	II–IV	43	4
Thalia dealbata Fras.	Marantaceae	Carolina	VI–IX	10	9
Thuja orientalis L.	Cupressaceae	Japan, Persia	II–IV	51	4
Zelkova crenata Spach	Ulmaceae	Caucasus, Crimea	III–IV	38	5

Table 1 shows a list of all the exotic species flowering in the Botanical Gardens and whose pollen grains have been found in the atmosphere in concentrations of over 10 grains per cubic metre of air. Besides the specific name, we report here the family, country of origin, flowering time (in Roman numerals), and the average number of pollen grains per day per cubic metre of air sampled in the 1996–1998 three-year period.

3. Results

From an analysis of Table 1, we can extrapolate a few indications of an aerobiological and phenological nature.

First of all the fact that pollen grains attributed to 28 families, 48 genera and 52 species among those growing in the Botanical Gardens have been captured and determined in the atmosphere.

The most represented families in this sampling were the *Leguminosae*, the *Moraceae* and the *Myrtaceae*, respectively with 8, 7 and 5 species, followed by the *Anacardiaceae*, the *Celastraceae* and the *Malvaceae* with 3 species each. In 2 families we number 6 species: i.e. the *Apocynaceae*, the *Berberidaceae*, the *Bignoniaceae*, the *Buddlejaceae*, the *Sterculiaceae* and the *Tiliaceae*. Finally in 16 families we number as many as one species, including the *Bombaceae*, the *Casuarinaceae*, the *Cupressaceae*, the *Taxodiaceae* and the *Ulmaceae*.

It also emerges from Table 1 that *Casuarina stricta* Aiton, of Australian origin, shows the highest concentration, with 137 pollen grains per cubic metre of air, followed by *Schinus latifolius* Engl., from South America, and *Thuja orientalis* L., from Japan and Persia, both with 51 pollen grains, *Schinus dependes* Orteg. (South America) and *Taxodium distichum* (L.) Rich. (North America) respectively with 47 and 43 pollen grains, *Lagunaria patersonii* G. Don (Australia) with 41 pollen grains and finally *Rhus laevigata* L. (North America) and *Zelkova crenata* Spach (Caucasus, Crimea) with 38 pollen grains. The pollens of *Ficus bellengeri* C. Moore, *Ficus elastica* Roxb., *Ficus magnolioides* Borzi, *Ficus religiosa* L., *Ficus retusa* L. and *Ficus rubiginosa* Desf., were all present in the Botanical Gardens and all come under the name of *Ficus* sp. pl., with 22 pollen grains per cubic metre of air. The remaining species present pollen values greater than 10 pollen grains per cubic metre of air, and as many as 18 out of the 52 registered exotic

Table 2. Pollen totals observed in the 1996–1998 two-year period.

Months	pollen total	exotic sp. totals
January	908	61
February	13837	89
March	17734	178
April	3452	222
May	5424	199
June	1400	138
July	608	104
August	369	47
September	1052	10
October	675	5
November	533	2
December	444	54

species, corresponding to 32%, reach values higher than the threshold dose, i.e. the dose above which pollen grains may generally trigger an allergic reaction, and quantified as 20–22 grains per cubic metre of air (Kumer et al., 1978).

Table 2 shows a comparison for the 1996–1998 three-year period between pollen totals and pollen attributed to exotic species alone. The comparison shows an appreciable presence of pollens attributed to exotic species especially in July, with more than 17% of the total concentration, in August with 12.7%, and in December with 12.1%.

As far as regards phenology (Figure 1), it has been observed that most plants flower in the period between March and June. In May as many as 31 non autochthonous taxa out of the 52 registered species, corresponding to 54%, are in flower, while the remaining exotic species flower in the September-January period. It is clearly seen therefore that airborne pollen grains are prevalently distributed in the first semester, that is in a relatively short time period of 140–170 days.

A further observation shows that the presence in the atmosphere of pollens of prevalently arboreal species capable of forming pollen in considerable concentrations, even in the autumn-winter period. This fact is not adequately taken into consideration by allergologists, since such species are usually widespread locally and only known as ornamental plants. A case in point is *Casuarina stricta* Aiton. This plant has only recently been included in routine allergological analyses, though its high con-

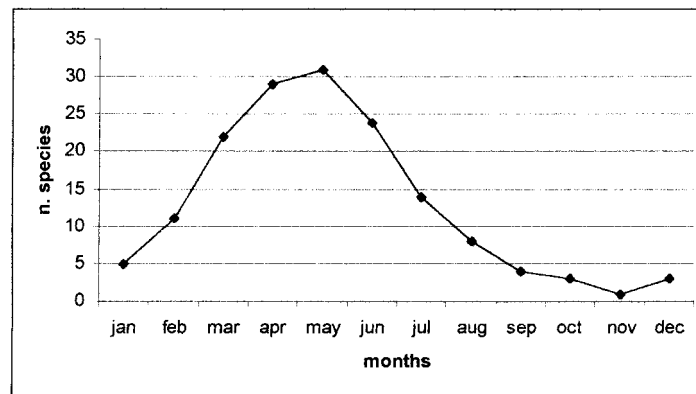


Figure 1. Number of exotic species that blossom in the Botanical Gardens over the year.

centrations of pollen grains (up to 137 daily grains per cubic metre of air) are capable of inducing considerable immuno-allergic manifestations, prevalently oculo-nasal, in the autumn-winter period (Ballero, 1987).

During our survey in fact, pollen grains from four species were captured rather frequently, and not only in the Botanical Gardens of the city of Cagliari, but also in other green areas of the city, since these species are now used extensively to adorn many squares and avenues in the city. The species are prevalently *Buddleja davidii* Franch., *Buddleja madagascariensis* Lam., *Sparmannia africana* L. and *Taxodium distichum* (L.) Rich.. A brief description of their pollen follows to facilitate their recognition in the pollen aerosol. *Buddleja madagascariensis* Lam. is a shrub from Madagascar, blossoms from January to April. Its grains are 3(-4)-colporate, spheroidal prolate (polar axis 12-15 micron). Sexine about as thick as nexine, reticulate, or provided with a more or less obscure pattern.

Buddleja davidii Franch. is a shrub from China. It blossoms from January to April. Its grains are 4-colporate (or 4-ruporate), spheroidal prolate. Sexine about as thick as nexine, reticulate, or provided with a more or less obscure pattern. Size 20 x 14 micron.

Sparmannia africana L. from South Africa is an arborescent plant with magnificent ornamental characteristics. It blossoms from October to May. Its grains are 3-colporate (-brevicolpate), prolate spheroidal (52 x 46 micron). Sexine reticulate. Its pattern is more or less intermediate between those in *Grewia* and *Nettoa*.

Taxodium distichum (L.) Rich. A gymnosperm from North America where it grows spontaneously in swamps, marshes and submerged land or in the

presence of very high humidity. The plant blossoms from February to April. Its grains are more or less spheroidal, and similar to those of *Juniperus*. They are provided with a single germ pore, consisting of a conical papilla similar to that of *Cryptomeria*, but much less prominent and not bent at the top. Size 28-35 micron.

4. Conclusions

We may conclude that most pollen released by the exotic species that grow in the Botanical Gardens of Cagliari tend to spread very easily in the city aeroplankton reaching appreciable concentrations. These particles are therefore to be considered potential allergen carriers, even though so far they have not been adequately considered in epidemiological studies. In fact, in absence of more specific evidence, the airborne pollen component that could not be readily determined, has been and still is indiscriminately included, whatever its nature, in one generic category, without any further investigation, and notwithstanding the increasing use of exotic taxa in the city. These species could be responsible for many of the immuno-allergic manifestations of unknown etiology and would certainly dispel a few current doubts. This statement is supported and confirmed by the data in Table 2, where it is seen that the pollen concentrations ascribable to the exotic species in July represent a significant percentage of the total airborne pollen, as also in August and December, when the most classical sources of pollen sensitisation (the *Poaceae*, the *Urticaceae*, the *Oleaceae* and the *Compositae*, etc.) are almost entirely silent.

References

- Ballero M.: 1987, Airborne pollens analysis in Cagliari (South Sardinia): observations on *Ailanthus altissima*, *Casuarina equisetifolia* and *Schinus molle*. *Centro* **4**, 22–27.
- Ballero M. and Ariu A.: 1997, Relazioni tra flora nitrofila e ruderale e concentrazioni aeropolliniche nell'area urbana di Cagliari. *Rendiconti Facoltà Scienze dell'Università degli Studi di Cagliari* **67**, 39–46.
- Hirst J.M. and Hurst G.W.: 1967, Long-distance spore transport, in P.H. Gregory and J.L. Monteith (eds), *Airborne Microbes*. Symp. Soc. Gen. Microbiol., Cambridge University Press, 385 pp.
- Kumer E., Mandrioli P. and Tampieri F.: 1978, A comparison between the concentration of airborne pollen and the clinical symptomatology in allergic subject under treatment with hypsensitizing agents. *Proc. Int. Congr. Aerobiology*.
- Michel F.B., Seignalet Ch. and Cour P.: 1979, Contribution palynologique, allergologique, météorologique et climatologique de l'Etude des flut polliniques entre la Scandinavie et l'Afrique du Nord. Premiers résultats. "Les Pollinoses", Ed. Fisons, 159 pp.
- Mossa L. and Del Prete C.: 1992, L'Orto Botanico dell'Università di Cagliari. In: F.M. Raimondo (eds), *Orti Botanici, Giardini Alpini, Arboreti Italiani*. Edizioni Grifo, Palermo, pp. 51–61.

