

# Airborne plane-tree (*Platanus hispanica*) pollen distribution in the city of Córdoba, South-western Spain, and possible implications on pollen allergy

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## Summary

Plane-trees are widely grown in Spain as ornamentals. This taxon releases large amounts of pollen into the air and this pollen type seems to have proved implications on pollinosis. The aim of this study was to analyse airborne *Platanus* pollen content in the air of Córdoba (South-western Spain) over the last 10 years, and its distribution in different areas of the city, as well as to consider possible implications regarding pollen allergies. Results revealed that *Platanus* pollen concentrations have been at their highest over the last 5 years. Within the city, the lowest pollen concentrations were in Northern areas of the city. Nevertheless, concentrations high enough to be of risk are reached over the whole city. All the patients studied presented symptoms during the *Platanus* pollen season. We can therefore conclude that plane pollen presents a risk for the whole city although symptoms are more intense and persistent in districts with a higher number of plane-trees. *Platanus* allergy is a particular problem for city-dwellers, where these trees are commonly used as ornamentals.

**Key words:** plane-tree pollen, *Platanus* pollinosis, pollen spatial variability, urban aerobiology, urban pollinosis.

## Introduction

Plane trees are widely grown for shade in the cities' streets and gardens. In the city of Córdoba (South-western Spain), this species is the most frequently planted. It is an anemophilous tree with many anthers per inflorescence, each anther producing large amounts of pollen [1].

Research has shown that *Platanus* pollen is a major contributor to pollinosis symptoms during March and April [2-7]. A high prevalence of positive skin prick tests has been recorded for *Platanus hybrida* in Madrid: 52%-56% [3, 7].

Despite the abundance of airborne plane-tree pollen and its proven implication in pollinosis, few studies have actually addressed the implications of this airborne pollen content [8-11]. The aim of this study was, firstly, to determine the dynamics of plane-tree pollen in the air of the city of Córdoba over the last 10 years (1992-2001), studying possible year-to-year fluctuations in pollen season characteristics. Secondly, a clinical study was undertaken to determine the relationship between airborne *Platanus* pollen and the incidence of pollinosis. Finally, airborne pollen content was studied in different areas of the city (North, Centre, South and West) to

ascertain the spatial distribution of *Platanus* pollen and the possible implications with respect to pollen allergies, and thus, to clarify whether, during the pollen season, *Platanus* presents a general risk in the city as a whole, or simply a local risk in areas abounding in plane trees.

## Material and Methods

The study was carried out in the city of Córdoba (37°50'N, 4°45'W) in Andalusia, South-western Spain, at 123m above sea level. The city has around 310,000 inhabitants.

The climate of Córdoba is Mediterranean, with cold rainy winters and very hot, dry summers. Below-zero temperatures occur in winter and 40°C or more in summer. Although rainfall occurs on relatively few days, it can be torrential in nature; total annual rainfall is around 600 mm, although periods of drought are not rare. The natural flora is typical of the Mediterranean, and agriculture is mainly based on olive trees, cereals and sunflowers.

The main problems of pollinosis in Córdoba stem from grasses and olive trees but nowadays the pollen of some ornamental species such as Cypress, privet, poplar, elm and plane-trees is emerging as a cause of allergy problems. Some of these trees are being massively used as ornamentals in the city.

According to official data from the City Council Parks and Gardens Department, by 1998 over 5000 plane-trees had been planted as ornamentals in the city of Córdoba. Since then, almost 2000 more have been newly-planted in residential areas in the West of the city.

The aerobiological study was performed at two levels: by using a permanent sampler covering the whole city area, and by using portable samplers to determine spatial variability within the city. Airborne pollen samples from the last 10 years (1992-2001) were obtained with a permanent Hirst-type volumetric sampler, working continuously in the Western part of the city, in an open area at 15m above ground level. At this location, general information about the airborne pollen spectrum of the city can be obtained. Additionally, over 2000 and 2001, local measurements were taken with portable Lanzoni VPPS 1000 samplers, having no wind vane, in the Northern, Southern and Central parts of the city. Samples were obtained by placing the portable sampler on private buildings in each area, at about 15m above ground level with no surrounding obstacles to free airflow. The samplers worked simultaneously for 12 hours each day, from 8.00 a.m. to 8.00 p.m. Samples were taken on non-rainy days during the main pollen season, which in the year 2000 was from February 24th to April 12th, but which in 2001 was later (March 19th to April 5th) due to rain.

Meteorological data (precipitation and temperature) were supplied by the National Institute of Meteorology.

To determine the influence of plane-tree pollen on

pollinosis incidence in the area, data from two different sources were used. Firstly, the contributions to a survey installed during 2001 on the web site of the Spanish Aerobiology Network; the survey was answered by 251 allergy patients. Secondly, clinical data supplied by the Allergy Unit of the Reina Sofia Hospital (Córdoba) were used to determine whether pollen counts were of clinical significance in IgE sensitized patients. Nineteen patients from the Córdoba province attending this unit, all showing seasonal symptoms, were selected for more detailed study during 2000. They all had positive skin prick tests (SPT) (>3mm diameter) with *Platanus* extract (20 mcg/ml protein, LETI, Spain) and specific IgE to *Platanus* (Pharmacia CAP system, Sweden). IgE levels >0.35 KU/L were considered positive. Each patient kept symptom-score diaries before, during, and after the *Platanus* pollination season. Ocular symptoms of redness and itching, nasal symptoms of sneezing, itching, congestion and rhinorrhoea, and bronchial symptoms of wheezing, tightness, coughing and shortness of breath were scored by all 19 patients on a daily basis using a scale from 0 to 3 (0: absence of symptoms, 1: mild symptoms, 2: moderate symptoms, and 3: severe symptoms).

Statistical analysis was performed with the SPSS programme to determine the correlation between *Platanus* pollen counts and patients' symptom scores (Spearman correlation). Probability ( $p$ ) < 0.05 has been considered statistically significant.

## Results

*Platanus* pollen accounts for a large proportion of the total pollen spectrum recorded in the atmosphere of Córdoba. For instance, in the year 2000 it made up 21% of the annual total pollen recorded and 62% of the total pollen recorded during March. Since 1997, pollen concentrations have been much higher, probably due to the increase in the number of plane trees planted in the city, although some differences between years could also be due to pruning differences and meteorological factors (Table 1). In addition, 1996 saw the end of a five-year drought; concentrations of most pollen types have recovered since then. It should be noted, however, that in the case of the plane-tree, drought was a less decisive factor because some trees grow in gardens which are artificially watered.

The *Platanus* pollen season was defined following García Mozo et al. [12]. In Córdoba, the main pollen season over the last 10 years has consisted of an average of 36 days. Another characteristic of the *Platanus* pollen season is that pollen appears abruptly in the air. The peak pollen concentration is usually reached within a week (Table 1). The average starting date for the pollen season over the last 10 years was March 6th and the average end date April 11th. The average day for the peak of the season was March 18th.

The internet survey was answered by 251 patients suffering from pollinosis from all over Spain, of which

Table 1. Characteristics of *Platanus* pollen season for the last ten years (1992-2001)

Year	Total	MPS	Peak day	Mean	N>50 (days)	N>200 (days)	Days before peak day
1992	678	09/3-01/4 (24)	215 (15/3)	32	3	1	6
1993	3757	10/3-14/4 (36)	609 (21/3)	104	13	9	11
1994	2436	08/3-03/4 (27)	555 (15/3)	94	11	3	7
1995	1744	07/3-10/4 (35)	177 (22/3)	50	17	0	15
1996	2608	21/3-18/4 (29)	711 (29/3)	90	14	2	8
1997	10634	25/2-16/4 (51)	1481 (06/3)	213	25	15	9
1998	8263	28/2-06/4 (38)	1297 (18/3)	217	23	17	18
1999	10934	05/3-20/4 (47)	2690 (22/3)	233	21	12	17
2000	9528	27/2-09/4 (43)	1769 (10/3)	22	19	9	12
2001	5428	08/3-15/4 (39)	1519 (18/3)	139	11	7	10

MPS: Mean pollen season

60 complained of plane tree pollinosis. This means that 24% of all patients with pollinosis had symptoms related to *Platanus* pollen. In Córdoba, the percentage of patients with *Platanus* pollinosis was 62% (15 cases of *Platanus* pollinosis from a total of 24 contributions). Most of the patients had symptoms at pollen concentrations of 51-200 pollen grains/m<sup>3</sup>. Therefore risk concentrations (N>50) were reached during less than a month (Table 1). The Coordination Centre of the Spanish Aerobiology Network (REA) requested that patients contributed their experiences by phone. Most of the patients reported that symptoms usually began a few days after pollen concentrations had reached 50 grains/m<sup>3</sup>.

The official data supplied by the Córdoba City Council Parks and Gardens Department indicates that the Northern part of the city has the lowest number of plane trees, amounting to less than 1000. Moreover, it is an open area where airborne pollen is easily dispersed. On the other hand, in the central area, which is densely built-up, the plane-trees are concentrated in several streets and gardens, making the free flow of air difficult.

With regard to the local measurements taken with the portable samplers, the year 2000 afforded 26 days of sampling, starting at the end of February after a month without rain. However, in 2001 there was rain during February, and the first fortnight of March was very wet (260 mm), so that local sampling was delayed compared to 2000 and did not start until March 19th after the rain ceased. As a result, in 2001 there were only 12 days of sampling. Data from the Western part of the city were obtained with the permanent Hirst Spore-trap but only data taken between 8.00 a.m. and 8.00 p.m. were used in order to establish comparisons with the data from local measurements obtained with portables. Results of local measurements indicated that lower pollen concentrations were obtained in the Northern part of

the city (4241 grains in year 2000; 664 grains in year 2001), where plane-trees are less common. These trees came into bloom first in the Southern and Central parts of the city and several days later in the Northern and Western areas.

Higher pollen concentrations were obtained in the South (year 2000: 48957 grains; year 2001: 14963) and Centre of the city (year 2000: 8016 grains; year 2001: 16335 grains). The pollen content in the Western part of the city varied considerably between years (2000: 11479 grains; 2001: 2406 grains). This was probably due to pruning and cutting differences from one year to another. Moreover the pollen recorded in this area could be higher, as the permanent sampler is provided with a wind vane so that the orifice is always oriented windwards. In the Central and Southern parts of the city more than half of the sampling days had risk pollen concentrations (N>50).

Looking at the clinical results, reaction to *Platanus* pollen have been studied since 1996 in the Allergy Unit of the Reina Sofia Hospital, in Córdoba. Sensitivity to *Platanus* pollen was found in 88 patients with pollinosis out of 529 attending the unit. This suggests a 17% sensitivity to *Platanus*.

The tests from the Allergy Unit showed that the 19 patients studied during year 2000 had positive SPT and specific IgE to *Platanus*. The characteristics of the patients are detailed in Table 2.

All 19 patients presented symptoms during the *Platanus* pollen season (end of February, March and first part of April) from 0 to 3 (Figure 1). Data from the permanent sampler was chosen because the sampler was working 24 hours a day throughout the year, rainy days included. Most patients presented symptoms when pollen concentrations were high, but symptoms did not disappear immediately if pollen concentrations fell.

Table 2. Characteristics of the studied patients

Sex	Age	Patient Envir.	Season sympt.	Family atopy	Years Sympt	Total IgE	Clinical sympt.	Others
F	35	Urban	Spring	+	20	191	RCE,A,U	P
M	37	Urban	Spring	+	6	152	RCE	P,O,G,C,A,H,PL
F	16	Rural	Spring	+	12	128	RCAE	P,O,G,C,A,H,PL,M
F	20	Rural	Spring	+	18	45.2	RCAE	O,G,H,PL,AL
M	12	Urban	Spring	+	3	237	RCE,A,U	O,C, Dried fruits
F	31	Urban	Spring	+	5	297	RCAE	O,G
F	32	Rural	Spring	+	5	204	RCAE	O,G,C,PL,DP,DF
M	26	Urban	Spring	+	4	518	RCAE	O,C,A,H,PL
M	40	Urban	Spring	+	6-7	67.7	RCE	Monoespecific
F	19	Urban	Spring	+	5	80.9	RCE,A,U	O,G,H
F	57	Urban	Spring	+	3	49.6	RCAE	Monoespecific
F	22	Urban	Spring	+	10	112	RCAE	DP,DF
M	32	Urban	Spring	-	10	499	RCAE	O,G,C,A,H,PI,M
M	32	Urban	Spring	+	2	322	RCAE	O,G,H, PI
F	35	Urban	Spring	+	7	205	RCAE	O,G
M	25	Urban	Spring	-	4	225	RCAE	P,O,G,C,PL,M,Cat
F	20	Rural	Spring	+	9	980	RCAE	P,O,G,C,A,H,PL,M
M	28	Urban	Spring	+	20	778	RCE	DP,DF,O,G,C
F	15	Rural	Spring	+	1	778	RCAE	O,C,A,H,PI,P,M,As

Sex: F(Female), M(Male); Clinical symptoms: RCE (rhinoconjunctivitis), RCAE (rhinoconjunctivitis and asthma), A (angioedema), U (urticaria); Others: P: Parietaria, O: Olea, G: Gramineae, C: Chenopodiaceae, A: Artemisia, H: Helianthus, P1: Plantago, M: Mercurialis, Al: Alternaria, DP: Dermatophagoides pteronyssinus, DF: Dermatophagoides farinae, As: Aspergillus.

Turning to the statistical analysis, there was significant correlation (Spearman correlation) between *Platanus* pollen counts and symptoms in 11 cases, when pollen data from the permanent sampler was used (Table 3). Analyses were also carried out with the pollen counts obtained from the portable samplers, and there was

correlation between pollen counts and symptoms in only 6 cases out of the 19 in each location. Nevertheless, in several patients the best results (higher correlation coefficients) were obtained with the data from the North (Patients 3, 7, 10 and 12), Centre (Patients 6, 9 and 16) or South (Patients 8 and 11) (Table 3).

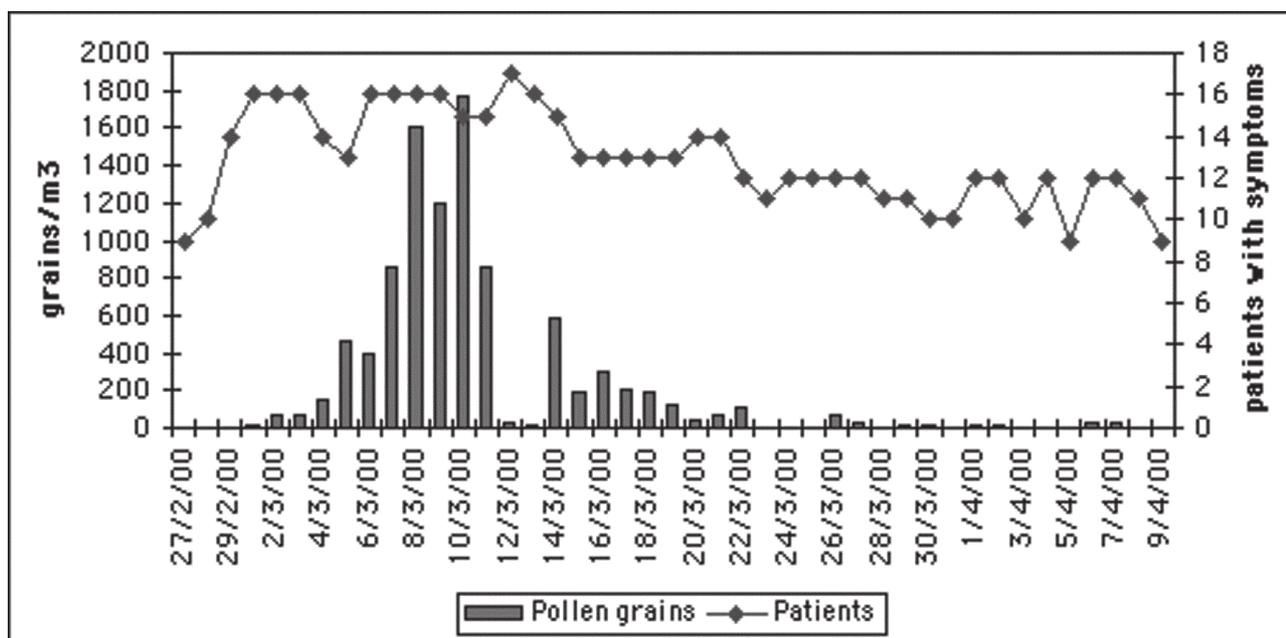


Figure 1. Daily number of patients presenting symptoms and daily plane-tree pollen concentrations during year 2000

Table 3. Correlation between the patients' symptom scores and *Platanus* pollen counts from permanent (PE) and portable samplers (PO) in each location.

Patients	West (PE)	North (PO)	Centre (PO)	South (PO)
1	0.36*	0.223	-0.255	0.053
2	-0.012	0.084	-0.139	-0.152
3	0.359*	0.599**	0.329	0.486*
4	-0.129	0.116	-0.344	-0.275
5	0.003	0.148	0.053	-0.061
6	0.205	0.089	0.500*	0.339
7	0.466**	0.712**	0.187	0.380
8	0.380	0.429	0.455*	0.482*
9	0.332*	0.333	0.517*	0.412
10	0.358*	0.508*	0.257	0.154
11	0.434**	0.499	0.582*	0.694**
12	0.516**	0.648**	0.441*	0.616**
13	0.563**	0.380	0.122	0.451*
14	0.091	-0.111	-0.148	-0.332
15	0.313*	0.428	0.022	0.405
16	0.439**	0.476*	0.664**	0.493*
17	0.162			
18	0.111	0.240	0.002	-0.037
19	0.090	0.173	-0.079	-0.016

\* Correlation signification at the 0.5 level (2-tailed)

\*\* Correlation signification at the 0.1 level (2-tailed)

Patient 17 presented with no variation in his symptoms throughout the period sampled with the portables.

## Discussion

*Platanus* pollen appears to be the most common taxon in the air of Córdoba during March. Additionally, over the last five years, plane-tree pollen concentrations have been increasing due to more frequent planting. Moreover, pruning – which could reduce the number of inflorescences, and thus pollen emission – is less drastic, since individual trees are older and bigger, making pruning less necessary. This tendency for *Platanus* pollen to rise was also found in Madrid [7]. The high pollen concentrations recorded in the atmosphere of Córdoba resulted in a high incidence of sensitivity to *Platanus* pollen among Córdoba's pollinosis patients. Although the *Platanus* pollen season is very short in comparison to other pollen seasons, an advantage for plane-pollen allergy sufferers, symptoms persist for a longer period, even when the pollen season is over.

This is a very common and widespread urban tree; airborne pollen concentrations and therefore the severity of the symptoms depend on the abundance of these trees as ornamentals. Madrid, Barcelona and Córdoba are the cities with the highest *Platanus* pollen counts in Spain [11]. In these cities, plane-trees have been used to a great extent as ornamental trees in parks and along streets. However, in cities with few plane-trees, concentrations of this pollen type in the air are lower, e.g. in Málaga, where plane-tree pollen accounts for only 5% of total

pollen recorded and only 8% of SPT from 200 patients of rhinoconjunctivitis and/or asthma are positive to plane pollen [5].

As to the clinical data, most patients showed polysensitization and only two displayed monosensitizations, which coincides with the findings of Subiza et al. [7]. The majority of patients with *Platanus* pollen allergy symptoms were also sensitive to Poaceae and Olea, the two pollen types with the highest incidence in Córdoba. Patients presented symptoms almost immediately after the *Platanus* pollen season began, as this pollen type appears abruptly in high concentrations in the air. However, when the pollen count decreases for a short time, such as, for instance, on a rainy day, symptoms do not disappear, and when the pollen season ends, symptoms also remain for several days. This could be due to the presence of a *Platanus* pollen allergenic aerosol fraction (<5 micrometres) as reported by Varela et al. [3]

Statistical tests showed that symptoms in the 19 patients with *Platanus* pollinosis correlated more closely (i.e. for 11 patients) with the data from the permanent sampler than from the portables. This permanent sampler, working 24 hours a day and placed in an open area at a height of 15 metres, gives a general idea of the pollen content in the air of the city and the surrounding few kilometres. Nevertheless, only in 11 cases was there a significant correlation between symptoms and pollen

counts, probably due to the fact that some patients came to the Hospital from villages many kilometres far from the city. The pollen counts obtained with the portable samplers gave better correlation coefficients with some patients, presumably because a patient would get a higher result with the portable located nearest to his district. Thus, portable samplers are more useful in obtaining a more precise result of the plane-tree pollen content in the air for a particular neighbourhood, and to measure the influence on pollinosis symptoms in patients living in this area. It must be taken into account that each patient graded the intensity of his symptoms, daily, during the whole 24 hours and, in the case of the permanent sampler, it worked the whole day. The portable samplers, on the other hand, worked only from 8 a.m. to 8 p.m. Similarly, on rainy days, samples were only available from the permanent sampler, since the portables are made of wood and therefore cannot be used. In the four sampled areas, concentrations high enough to produce symptoms in the sensitive patients were measured and so it can be assumed that pollen grains from plane-trees are a risk for the whole city of Córdoba, although symptoms are more intense and persistent in districts with a high number of plane-trees such as the Central and Southern areas.

As regards symptoms, there was a high incidence of asthma as compared with other studies, while results for angioedema and urticaria were similar to those reported in other studies [13]. All patients suffered symptoms during spring. Most patients with *Platanus* pollinosis live in an urban environment as this particular allergy is especially troublesome to people living in cities where these ornamental trees are widely used. The positive SPT, specific IgE and the occurrence of symptoms during the *Platanus* pollen season point to the clinical importance of this pollen type in the city of Córdoba. Taking into account the high pollen concentrations of this type in the air of Córdoba during March, the massive use of plane-trees in the city and the correlation between pollen concentrations and symptoms, the authors would advise against the monospecific use of plane-trees as ornamentals in gardens and streets of the city and encourage the use of other species instead.

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