

Aerobiological behaviour of *Platanus* L. pollen in Catalonia (North-East Spain)

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Abstract

The aim of this paper is to characterise the airborne behaviour of an allergenic and abundant pollen type, *Platanus*, in seven sites of the Aerobiological Network of Catalonia (Xarxa Aerobiològica de Catalunya, XAC). In Catalonia, the most extended *Platanus* species is *Platanus* × *hybrida* Brot., widely planted in forestry and as ornamental tree in streets and gardens. Naturalised specimens can also be found along river banks. The pollen records analysed are from different periods comprised between 1994 and 2000 in Barcelona, Bellaterra, Cambrils, Girona, Lleida, Manresa and Tarragona. All data were obtained using seven-day volumetric spore Hirst traps. *Platanus* pollination is concentrated in a few weeks, between March and April. *Platanus* pollen is present in all the atmospheric pollen spectra for the sites mentioned above. In Barcelona, *Platanus* pollen attained the highest concentrations, with an extreme annual index (sum of the mean daily concentrations) of 25790 in 1997, and a maximum daily concentration of 2567 P/m³ on 15th March 2000. The lowest annual index (647) corresponds to Cambrils, 2000, and the lowest maximum daily concentration (74 P/m³) was registered on 7th April 1996, in Manresa. The interannual variation of *Platanus* pollen values can be explained not only by meteorological parameters and the endogenous factors of the tree, but also by human activity such as elimination, pruning and watering.

Introduction

The genus *Platanus* L. comprises six species (Mabberley, 1987). In Catalonia, the most common species (Bolòs and Vigo, 1989) is *Platanus* × *hybrida* Brot. (= *P. acerifolia* (Aiton) Willd., = *P. cuneata* Willd., = *P. hispanica* Miller ex Münchh., = *P. occidentalis* × *orientalis*), flowering between April and June, and growing from 0 to 1500 m in altitude. Also present, but rare, are *P. orientalis* L. and *P. occidentalis* L.

Platanus is mainly found in cities, planted as ornamental tree, because of its quick growth and resistance to air pollution, however, it is also found as a forestry tree. It is not rare to find naturalised specimens near streams and river banks, particularly in wet regions. Its use as a roadside tree is decreasing.

Many authors have considered that *Platanus* pollen has a moderate allergenic power (Lewis et al., 1983; Belmonte, 1988; Hernández de Rojas et al., 1991). Recent studies (Subiza et al., 1994; Varela et al., 1997) concluded that, in Madrid, *Platanus* pollen is an important cause of pollinosis. Yman (1982) points out that there is cross-reaction between *Platanus* × *hybrida*, *P. orientalis* and *P. occidentalis* pollen.

Materials and methods

The study was carried out in seven localities in the North-Eastern part of the Iberian Peninsula (Figure 1 and Table 1), where Hirst (1952) seven-day spore traps have been working for different years between 1994 and 2000, at an approximate height of 20–25 m

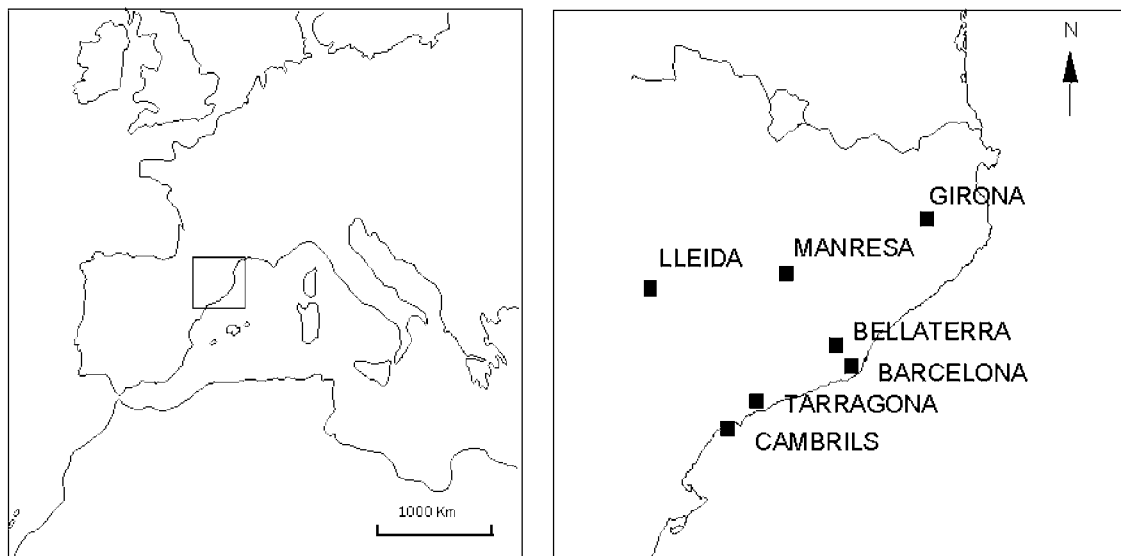


Figure 1. The aerobiological network of Catalonia (Xarxa Aerobiològica de Catalunya, XAC): station location.

Table 1. Aerobiological sampling stations and main geographical and climatic characteristics.

Sampling stations and study period	Geographical characteristics		Climatic characteristics		
	Altitude (m. a.s.l.)	Geographical coordinates	Mean annual temperature (°C)	Annual Rainfall (mm)	Phytoclimates (Allue, 1990)
Barcelona (1994–2000)	12	41°24' N, 02°11' E	16.4	593	Fresh-Tethyc-semiarid
Bellaterra (1994–2000)	190	41°33' N, 02°07' E	15.2	594	Fresh-Continental Oriental-semihumid
Cambrils (2000)	24	41°04' N, 01°03' E	15.7	514	Fresh-Tethyc-semiarid
Girona (1996–2000)	70	41°59' N, 02°60' E	15.0	740	Fresh-Continental Oriental-semihumid
Lleida (1996–2000)	221	41°37' N, 00°37' E	15.1	385	Fresh-Transitional-semiarid
Manresa (1996–2000)	238	41°43' N, 01°50' E	13.6	619	Fresh-Continental Oriental-semihumid
Tarragona (1996–2000)	20	41°07' N, 01°15' E	15.8	478	Fresh-Tethyc-semiarid

above ground level. From a climatic point of view, the localities studied are rather similar. Girona, Manresa and Bellaterra are more humid and fresh, whereas Barcelona, Tarragona and Cambrils are hotter. Lleida has a more extreme climate, which is always dry with cold winters and hot summers.

The counting method followed is the proposed by Domínguez et al. (1991) for the Spanish Aerobiology Network (Red Española de Aerobiología, REA). The raw data obtained were first converted into mean daily pollen concentrations (P/m^3). Gaps in the series shorter than 9 data have been filled by linear interpolation, longer gaps remain. Mean daily pollen concentrations have been averaged to obtain mean weekly pollen concentrations. The convention that the first week of the year is that containing the first

Thursday has been followed to establish week numbering.

Results and discussion

From the different annual series of mean weekly data for station, the mean, median and maximum concentration series were calculated for each sampling site. These three series are presented in Figure 2 (period from 8th to 21st weeks) and Figure 3. Figure 2 shows that *Platanus* pollination takes place suddenly, usually achieving very high concentrations at all the studied sites, especially in Barcelona. The phenomenon of refloitation is very noticeable in late summer-autumn in this site (Figure 3).

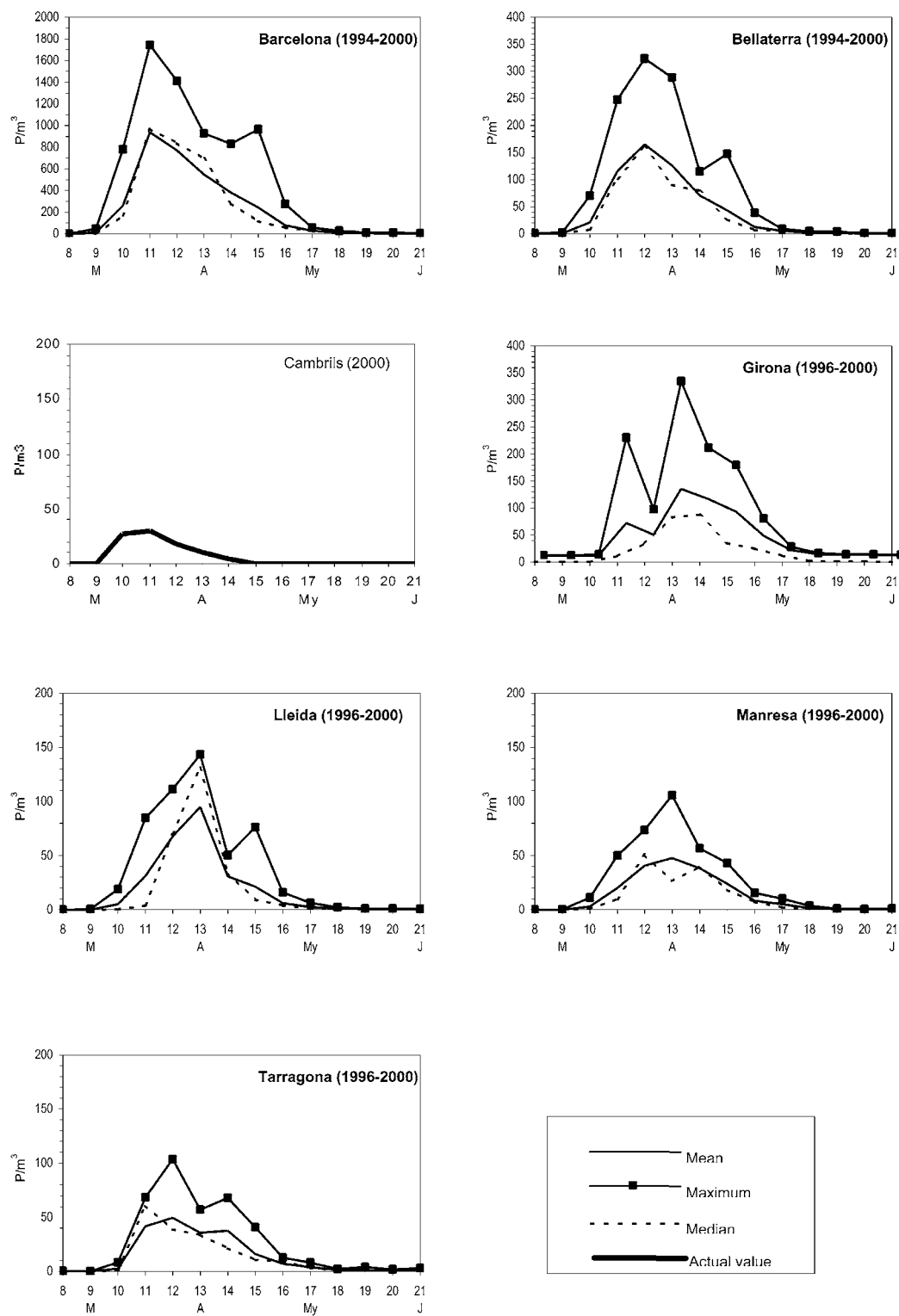


Figure 2. Graphical synthesis of *Platanus* pollen dynamics at the XAC sites, between weeks number 8 to 21.

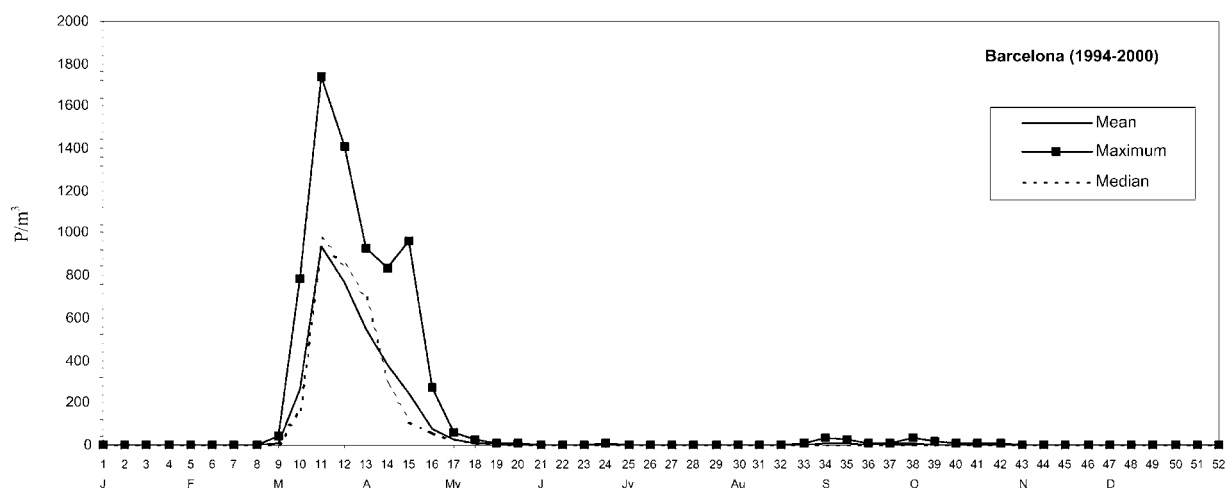


Figure 3. Graphical synthesis of the annual dynamics of *Platanus* pollen at Barcelona.

As can be seen in Figure 2, the series of weekly concentrations given by the mean and median do not differ considerably, for the period covered in this study. The mean is most used within the literature to represent annual dynamics but, when analysing series that have several yearly periods, we consider the median more appropriate, as it is a real value. The curve given by the maximum concentrations registered during the study period shows that there are cases where actual concentrations are at least twice mean and median values. These episodes have to be taken into account when referring to data from allergenic pollen types.

In Table 2, we present some parameters, which can be used to evaluate the presence and abundance of *Platanus* pollen at an annual, daily and weekly level. The annual summary includes the annual index, calculated as the sum of the mean daily concentrations, and the percentage of *Platanus* pollen, relative to the total amount of pollen recorded throughout the year. As expected, Barcelona, which is the biggest city included in the XAC, and which has an important number of plane trees planted, is the site with the highest annual index (25790), whereas Cambrils, a medium sized urban nucleus, is the site with the lowest (647). In Barcelona, *Platanus* pollen represents on average 46.3% (39.3–52.5) of the total annual pollen. In the other localities, this value is much lower, ranging between 4.4% (1.8–7.0, Manresa) and 10.8% (7.9–12.6, Bellaterra).

The daily summary in Table 2 shows the maximum mean daily concentration for the year, the percentage

of pollen recorded in this maximum with respect to the annual *Platanus* index and the date of the maximum. In localities with the highest annual index (Barcelona and Bellaterra), the maximum mean daily *Platanus* pollen concentration of a yearly series contains a lower percentage (7–10%) of the annual pollen than in the other localities (9–26%). The daily maximum occurs, in 71% of cases, in March, and, for the rest, in April. Girona and Manresa are the sites with the lowest probability of finding the maximum in March (80% and 60% of cases in April, respectively).

The weekly summaries of Table 2 also provide information about the maximum mean weekly concentration, the percentage of pollen recorded in this week with respect to the annual index (in this case, the sum of mean weekly concentrations), and the number of the week in which the maximum was reached.

When looking at the mean weekly concentrations, we see that the weekly maximum contains between 25 and 66% of the yearly pollen, the lowest percentages being reached at localities with the highest annual indexes. In 28.6% of cases, the maximum occurs in week 12, this percentage increasing to 71.4% when considering weeks 11 to 13. Only in Tarragona and Girona do weekly maxima occur later (weeks number 14 and 15, respectively).

The annual indexes and maximum daily concentrations obtained for Barcelona are comparable to those published for Madrid by Díaz de la Guardia et al. (1999) and are higher than values cited by Subiza et al. (1994) for the same city. The differences in the pollen concentrations registered by the two traps in

Table 2. Parameters for evaluating the presence and abundance of *Platanus* pollen in the XAC stations.

Sampling stations and years	Annual summary		Daily summary			Weekly summary		
	Annual index	Percentage relative to total pollen	Daily maximum P/m3	Percentage of the maximum relative to annual index	Date of the maximum month/day	Weekly maximum P/m3	Percentage of the maximum relative to annual index	Week no. of the maximum week
Barcelona								
1994	18456	49.6	1620	9	M11	969	37	11
1995	23435	52.5	1543	7	M19	840	25	12
1996	20597	39.3	1622	8	A9	965	33	15
1997	25790	39.7	2052	8	M12	1533	42	11
1998	25621	45.8	2022	8	M20	1410	39	12
1999	24426	48.9	2557	10	M21	1281	37	11
2000	25093	48.2	2567	10	M15	1770	49	11
Average	23345	46.3	—	—	—	—	—	—
Bellaterra								
1994	3020	10.7	277	9	M20	156	36	12
1995	3697	12.4	263	7	M20	161	30	12
1996	2954	7.9	278	9	A7	147	35	15
1997	4599	9.0	396	9	M15	247	38	11
1998	4896	11.8	459	9	M20	323	46	12
1999	4524	12.6	358	8	M31	288	45	13
2000	4179	11.4	426	10	M24	224	38	11
Average	3981	10.8	—	—	—	—	—	—
Cambrils								
2000	647	3.1	92	14	M10	31	34	10
Girona								
1996	1773	2.5	244	14	A13	167	66	15
1997	3851	6.1	440	11	M15	218	40	11
1998	1788	3.4	167	9	A3	116	45	14
1999	4828	8.4	612	13	A4	322	47	13
2000	1919	3.8	317	17	A12	138	50	15
Average	2832	4.8	—	—	—	—	—	—
Lleida								
1996	2071	7.1	235	11	M26	143	48	13
1997	1873	5.9	275	15	M18	111	42	12
1998	1952	5.3	286	15	M29	143	51	13
1999	1388	7.0	357	26	M31	131	66	13
2000	1459	6.3	144	10	M22	69	33	12
Average	1749	6.3	—	—	—	—	—	—
Manresa								
1996	697	1.8	74	11	A7	38	38	15
1997	1371	2.6	139	10	M16	74	38	12
1998	1672	4.3	120	7	M22	80	33	13
1999	1334	6.3	166	12	A3	106	55	13
2000	1637	7.0	122	7	A8	46	20	14
Average	1342	4.4	—	—	—	—	—	—
Tarragona								
1996	1192	3.1	130	11	A2	63	37	14
1997	1691	4.6	200	12	M18	103	43	12
1998	1462	4.5	230	16	M24	68	33	14
1999	1350	4.4	164	12	M19	70	36	12
2000	1342	6.8	144	11	M15	83	43	11
Average	1407	4.7	—	—	—	—	—	—

M = March; A = April

Table 3. Parameters for evaluating *Platanus* main pollen season (MPS) in the XAC stations.

Aerobiological station and sampling year	Beginning date of the MPS (week no., date)	Ending date of the MPS (week no., date)	No. of days until the MPS beginning date (from 1 January)	No. of days until the MPS ending date (from 1 January)	Duration of the MPS (days)	Mean pollen concentration during MPS P/m ³
Barcelona						
1994	10, M8	13, A1	66	90	24	710
1995	11, M12	16, A19	70	108	38	564
1996	13, M27	16, A20	86	110	24	787
1997	10, M7	14, A8	65	97	32	743
1998	11, M13	15, A13	71	102	31	763
1999	11, M17	16, A18	75	107	32	703
2000	10, M11	15, A14	70	104	34	683
Average	11, M14	15, A13	72	103	31	708
Bellaterra						
1994	10, M11	14, A8	69	97	28	100
1995	11, M15	16, A17	73	106	33	101
1996	13, M27	16, A20	86	110	24	114
1997	10, M7	14, A7	65	96	31	138
1998	11, M16	14, A7	74	96	22	207
1999	11, M18	15, A12	76	101	25	167
2000	11, M13	15, A13	72	103	31	122
Average	11, M16	15, A12	74	101	28	136
Cambrils						
2000	10, M7	14, A4	66	94	28	22
Girona						
1996	13, M30	17, A25	89	115	26	63
1997	11, M12	15, A10	70	99	29	122
1998	12, M25	17, A25	84	114	31	55
1999	12, M24	16, A18	82	107	25	175
2000	14, A5	17, A25	95	115	20	88
Average	12, M25	16, A20	84	110	26	101
Lleida						
1996	13, M26	16, A17	85	107	22	88
1997	10, M11	14, A8	69	97	28	62
1998	12, M24	15, A10	82	99	17	77
1999	12, M24	15, A10	82	99	17	75
2000	10, M11	15, A13	70	103	33	42
Average	11, M16	15, A12	78	101	23	69
Manresa						
1996	13, M30	19, My 13	89	133	44	14
1997	10, M9	15, A12	67	101	34	37
1998	11, M18	17, A24	76	113	37	43
1999	12, M21	16, A18	79	107	28	43
2000	11, M12	17, A24	71	114	43	36
Average	11, M18	17, A24	76	114	37	35
Tarragona						
1996	13, M26	20, My19	85	139	54	20
1997	11, M12	15, A15	70	101	34	46
1998	11, M15	16, A17	73	113	33	41
1999	11, M17	15, A13	75	107	27	47
2000	11, M12	16, A22	71	114	41	30
Average	11, M17	17, A25	75	115	38	37

M = March; A = April; My = May

Table 4. Summary statistics for *Platanus*.

Site	Statistics	1994	1995	1996	1997	1998	1999	2000
Barcelona	No. days	188	205	146	221	235	227	225
	Mean	54.93	64.21	56.28	70.66	70.19	66.92	68.56
	Std. deviation	208.32	202.14	215.17	268.60	258.09	273.15	286.96
	CV	3.79	3.15	3.82	3.80	3.68	4.08	4.19
	Daily maximum	1619.8	1542.8	1621.9	2052.4	2022.3	2557.1	2566.9
Bellaterra	No. days	100	133	77	87	105	101	117
	Mean	8.27	10.50	8.39	12.60	13.42	12.39	11.42
	Std. deviation	32.90	33.59	34.33	48.36	60.20	48.96	48.87
	CV	3.98	3.20	4.09	3.84	4.49	3.95	4.28
	Daily maximum	276.5	263.2	277.9	395.5	458.5	358.44	25.6
Cambrils	No. days							43
	Mean							6.50
	Std. deviation							14.85
	CV							2.29
	Daily maximum							92.4
Girona	No. days			52	95	75	93	90
	Mean			5.72	10.85	5.21	13.68	5.68
	Std. deviation			27.86	45.98	21.04	63.00	29.57
	CV			4.87	4.24	4.04	4.61	5.21
	Daily maximum			244.3	440.3	166.6	611.8	317.1
Lleida	No. days			83	66	70	71	66
	Mean			5.82	5.37	5.35	3.80	3.99
	Std. deviation			25.73	23.72	27.64	25.72	16.55
	CV			4.42	4.42	5.17	6.76	4.15
	Daily maximum			235.2	275.1	285.6	357.0	144.2
Manresa	No. days			73	74	69	67	70
	Mean			2.15	3.76	4.58	3.66	4.47
	Std. deviation			8.86	14.79	17.24	16.87	14.81
	CV			4.12	3.94	3.76	4.61	3.31
	Daily maximum			74.2	139.3	119.7	165.9	121.8
Tarragona	No. days			90	88	80	71	70
	Mean			3.54	4.63	4.01	3.70	3.67
	Std. deviation			14.74	21.21	18.17	16.67	15.06
	CV			4.17	4.58	4.54	4.51	4.11
	Daily maximum			129.5	200.2	230.3	163.8	143.5

Madrid are possibly due to their location. *Platanus* pollen appears to be hindered by the sheltering effects of adjacent buildings, giving rise to considerable local variation in the counts (Emberlin et al., 1990) and does not seem to be easily transported by the wind (Belmonte and Roure, 1991). These arguments also explain the low values obtained in Girona, where *Platanus* is abundant in its parks and streets and in orchards near the city (Belmonte, 1988).

González and Candau (1997) reported a certain biannual rhythm in the *Platanus* pollen yearly sum in

Sevilla. Although annual indexes for Girona seem to be alternatively high and low, we conclude, as did Díaz de la Guardia et al. (1999), that there is no alternating pattern in terms of annual pollen production.

Pollen levels in Barcelona during the refloatation period attain values (the highest being 123.9 P/m³ on 24th August 1995) of the same order as usual concentrations during the pollination period in sites with low levels (Cambrils, Manresa, Tarragona).

Table 3 contains information about the Main Pollen Season (MPS) calculated following Nilsson

and Persson (1981). It includes the beginning and ending date, the number of days passed until the beginning date as well as the number of days until the ending date, the duration and the mean pollen concentration during the MPS.

MPS always began in March, except in Girona, 2000 (April), and lasted from between 17 (Lleida, 1998, 1999) to 54 days (Tarragona, 1996), usually being between 23 and 38 days. The other values lead us to observations rather similar to those obtained from Table 2. In the present case, furthermore, 10% of the pollen discarded in Barcelona to establish the MPS accounts for 2334.5 (1845.6–2579.0), fairly close to most annual indexes from the rest of the localities studied. Therefore, even if we agree that MPS provides arguments with which to comment on and discuss the data, we think that, as indicated for Cupressaceae (Belmonte et al., 1999) and for *Olea* (Belmonte et al., 2000), it is not useful for *Platanus*.

Table 4 illustrates the relationship between the mean and other statistics. The stability of the coefficient of variation CV, which is the ratio of the mean divided by the standard deviation, shows that they are roughly proportional. Nevertheless, these coefficients have been found to be more stable for other pollen types such as Urticaceae (Belmonte and Canela, submitted to Aerobiologia). The mean is also roughly proportional to the maximum. The least square estimate for the ratio of the maximum divided by the annual index is 8.70%, with $R^2 = 0.972$.

Interannual variation in *Platanus* pollen counts should obviously have a meteorological explanation, which we intend to analyse in the near future; however, even being cautious, it can be said that human activity such as the introduction or elimination of plants, pruning, and watering, considerably affect pollen production. The research is now oriented to modelling airborne *Platanus* pollen as a time series, as in Belmonte and Canela (submitted to Aerobiologia).

Conclusions

There is no part of Catalonia free from *Platanus* pollen. The presence of this pollen type in the air depends on the presence of ornamental plants, orchards or naturalised trees near the aerobiological station. Among the localities studied, Cambrils, Manresa, Tarragona and Lleida produced the lowest levels. Progressively higher levels of *Platanus* pollen have been found in Girona, Bellaterra and Barcelona.

Platanus pollen is present in the atmosphere during March and April. Reflotation episodes occur from September to November, and are noticeable in Barcelona.

As expected in plants frequently planted for ornamental purposes or in forestry, humans are a cause of variation in the pollen levels, together with meteorological parameters.

The use of plants capable of causing allergenic problems near human settlements is not recommended.

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