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AEROPALYNOLOGICAL STUDY OF THE GENUS *PLATANUS* L. IN THE IBERIAN PENINSULA

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SUMMARY**:** A study was made of the aerobiological behaviour of pollen from P*latanus hispanica* Miller ex Münchh, a tree that is used for ornamental purposes throughout the Iberian Peninsula. Sampling was performed using Hirst-type volumetric spore-traps installed in 14 cities with different climatic and biogeographical characteristics affecting the start and development of this taxa pollen season. The number of years studied differed according to the cities studied; the longest period was from 1992 to 1998 and the shortest from 1996 to 1998, and the average of the years studied is shown in the accompanying graphs. The main pollen season is established to 98%, and interannual and mean pollen season (MPS) variations between stations were analyzed. The results show that during the years studied there were notable differences in the start, severity and end of the MPS; Barcelona is the city that always presented the longest MPS, whereas the result for the other cities were similar. The two stations with the highest *Platanus*-pollen counts are Barcelona and Madrid, while Malaga and Vigo are the cities in which the lowest counts were recorded. Maximum daily counts were recorded during the second fortnight of March, except in León, where this occurred in April or, exceptionally, in May.
KEY WORDS**:** Aeropalynology, pollen, *Platanus hispanica* Miller ex Münchh, Iberian Peninsula.

RESUMEN**:** En este trabajo se presenta un estudio sobre el comportamiento aerobiológico del polen procedente de *Platanus hispanica* Miller ex Münchh, árbol muy utilizado como ornamental en toda la Península Ibérica . El muestreo se ha realizado mediante captadores

volumétricos tipo Hirst, instalados en 14 ciudades españolas con características climáticas y biogeográficas diferentes que van a influir de una manera importante en el inicio y desarrollo de la estación polínica de este taxon. El número de años analizados varía según las ciudades, el período más amplio se extiende desde 1992 a 1998 y el más corto desde 1996 a 1998, representándose en los gráficos el promedio de los años estudiados. Se establece el período de polinización principal al 98%, analizándose las variaciones interanuales y del MPS en las distintas estaciones de control. Los resultados indican que en la serie de años muestreados existen notables diferencias en el inicio, severidad y final del MPS; Barcelona es la ciudad que presenta siempre un período de polinización más largo mientras que en el resto de las ciudades es muy semejante. Las dos estaciones que logran los niveles de polen más elevados son Barcelona y Madrid, por el contrario Malaga y Vigo son las que registran menos granos de polen de *Platanus* L. Las máximas concentraciones diarias se producen en la segunda quincena de Marzo excepto en León que se detecta en Abril o excepcionalmente en Mayo.
PALABRAS CLAVE: Aeropalinología, polen, *Platanus hispanica* Miller ex Münchh, Península Ibérica.

INTRODUCTION

The genus *Platanus* L. is represented in the Iberian Peninsula by a number of species that have subsequently been hybridized. They are used ornamentally in many city parks, squares, boulevards and streets. The most commonly grown species is *P. hispanica* Miller ex Münchh (= *P. hybrida* Brot.), which is believed to be the result of hybridization between *P. orientalis* L. and *P. occidentalis* L. These heavily-branched deciduous trees have palmate leaves with 3–7 lobes and spherical unisexual inflorescences in groups of 2–7 on long peduncles. According to ROCHA AFONSO (1990) *P. orientalis* L. is also sometimes grown. The plane (*P. hispanica*) is an anemophilous tree that is highly significant from an aerobiological standpoint. According to TORMO MOLINA *et al.* (1996), this tree produces 31744–55272 pollen grains per anther, with 277–365 anthers per inflorescence. Given this production rate, high airborne levels of this type of pollen are recorded in most of the cities studied here, and numerous studies have focused both on pollen calendars involving this taxon as one of the most prevalent common types and on the effect of temperature and rainfall on the start of the pollen season and total annual counts (CEPEDA & CANDAU, 1990; GONZÁLEZ MINERO & CANDAU, 1997; ALBA & DÍAZ DE LA GUARDIA,1998).

Many authors have addressed the possible allergenic effects of *Platanus* pollen on the human population, although all of them agree that it is only moderately allergenic (SOLOMON, 1984; BOUSQUET *et al*., 1984; ERIKSSON *et al.*, 1987; D'AMATO & SPIEKSMA, 1991; NEGRINI, 1992; GARCÍA GONZÁLEZ, 1994; SUBIZA *et al.*, 1994). For these reasons, together with the growing interest in the pollen of ornamental plants (GONZÁLEZ MINERO *et al.*, 1997; GARCÍA GONZÁLEZ *et al.*, 1997), the aeropalynological behaviour of *Platanus* pollen in different Spanish cities is analyzed in this paper, focusing particularly on the differences that affect the main pollen season (MPS), its start, severity and duration, and the maximum levels recorded.

MATERIAL AND METHODS

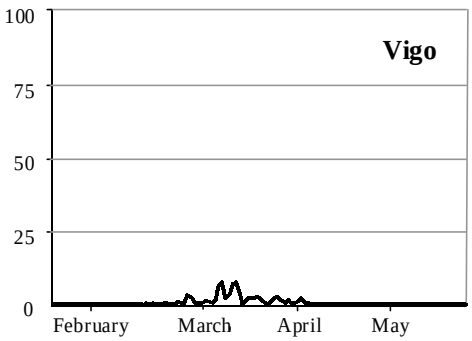
The study was carried out in the cities of Córdoba, Málaga, Estepona, Granada, Jaén, Madrid, Santiago de Compostela, Vigo, Ou-

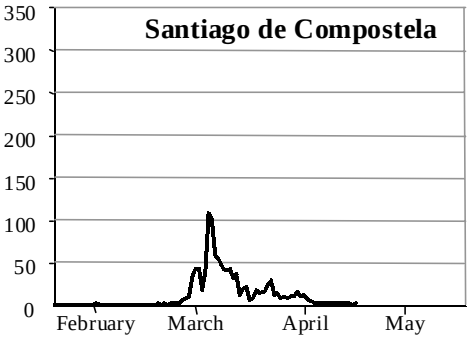
rense, León, Barcelona, Tarragona, Girona and Lleida; these cities are located chorologically in different regions and biogeographical provinces of the Euro–Siberian region, where the cities of Santiago de Compostela and Vigo are located in eucolline and thermocolline bioclimatic belts, respectively, of the Cantabro–Atlantic province; and in the Mediterranean chorological region, the remainder of the sampling stations (Ourense and León in the Carpetan–Iberiano–Leonese province; Madrid in the Castillian–Maestrazgo–Manchego province; Barcelona, Tarragona, Girona and Lleida in the Catalan–Valencian–Provenzal province; and Malaga, Estepona, Córdoba, Granada and Jaén in the Baetic province) which are situated between the thermo- and meso-Mediterranean climatic belts, with the exception of León, which reaches the lower supra-Mediterranean belt (RIVAS MARTÍNEZ, 1987). At all these stations, Burkard or Lanzoni volumetric spore traps (HIRST, 1952) were installed in the city centers at an approximate height of 20–25 meters above ground level. The preparation and analysis of the daily samples was performed in accordance with the methodology proposed by DOMÍNGUEZ *et al.* (1991), using silicone as the adhesive material and glycerogelatine-basic fuchsin as the mounting medium. Daily data are expressed as pollen grains/m^3 of air. The duration of aerobiological sampling varied between cities, Córdoba, Granada and Málaga have the longest pollen series (1992–1998), followed by Santiago de Compostela and Ourense (1993–1998) and Madrid, León and Barcelona (1994–1998) with a lower number of sampling years at the other stations.

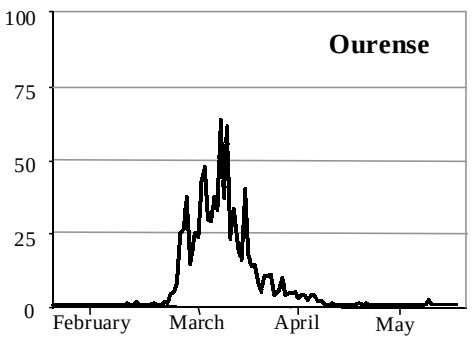
MPS was established to 98%, using (except in Barcelona) the methodology proposed by NILSSON & PERSSON (1981); this is the most suitable procedure for a taxon with such a short pollen season. The characteristic MPS data for each of the stations was used to draw up the tables showing the start and end date, the maximum count and the date on which it was recorded, the mean count during the MPS and the number of days upon which the count exceeded 50 grains/m^3. The tables also include annual absolute total values for *Platanus* pollen for each of the cities. Graphs have also been plotted to show the annual total for each year of the study, together with the mean daily count for all the years analyzed at each station.

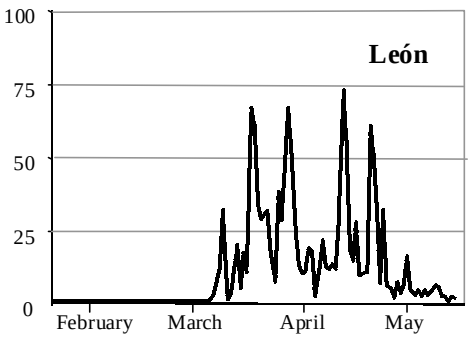
RESULTS

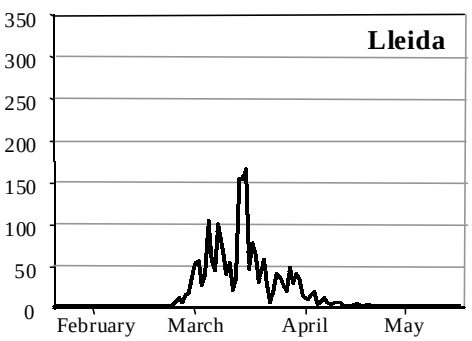
The results show that in most of the cities the MPS of *Platanus* takes place in March and April (Fig. 1). However, in the coastal areas of Málaga and Vigo the pollen season starts in late February and may exceptionally last until May in cities such as León, where the temperatures in early spring are relatively low, and may even last into the summer, as occurs in Barcelona (Tab. 1). The day of the maximum count was usually detected in March, particularly during the second fortnight, and was occasionally recorded in early April. Exceptionally, the peak day in León fell in May in 1998. Barcelona and Madrid presented the highest daily maximums, with 4936 grains/m^3 in Madrid in 1998. The highest mean concentrations during the MPS were also recorded in Madrid, with values of 377–896 grains/m^3, followed by Barcelona, with mean values of over 200 grains/m^3. Moreover, these two locations present an MPS of over 20 days, with values of over 50 grains/m^3. In the other cities (except for certain years in Cordoba and Granada) seasonal means of under 100 grains/m^3 were recorded, with 0–20 days on which the pollen count was higher than 50 grains/m^3 (Tab. 1).

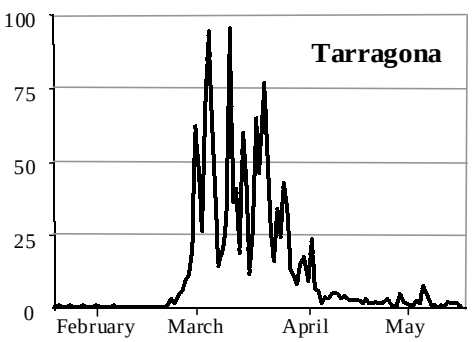

Vigo
100
75
50
25
0
February
March
April
May

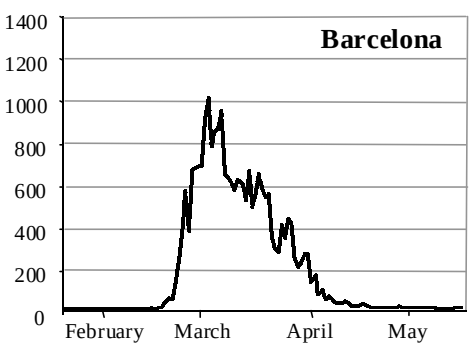

Santiago de Compostela
350
300
250
200
150
100
50
0
February
March
April
May

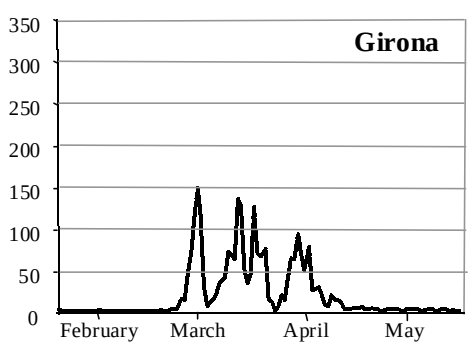

Ourense
100
75
50
25
0
February
March
April
May


León
100
75
50
25
0
February
March
April
May


Lleida
350
300
250
200
150
100
50
0
February
March
April
May


Tarragona
100
75
50
25
0
February
March
April
May


Barcelona
1400
1200
1000
800
600
400
200
0
February
March
April
May


Girona
350
300
250
200
150
100
50
0
February
March
April
May

Based on average seasonal daily variations at the different control stations (Fig. 1), three groups were determined: (a) Madrid and Barcelona, with seasonal levels of over 1000 grains/m^3; (b) Córdoba, Granada, Santiago de Compostela, Lleida and Girona, with seasonal averages of over 100 grains/m^3; and (c) cities such as Vigo, Orense, León, Tarragona, Jaén, Estepona and Málaga, with seasonal variations of under 100 grains/m^3.

DISCUSSION

The aerobiological analysis of *Platanus* pollen carried out in the Iberian Peninsula

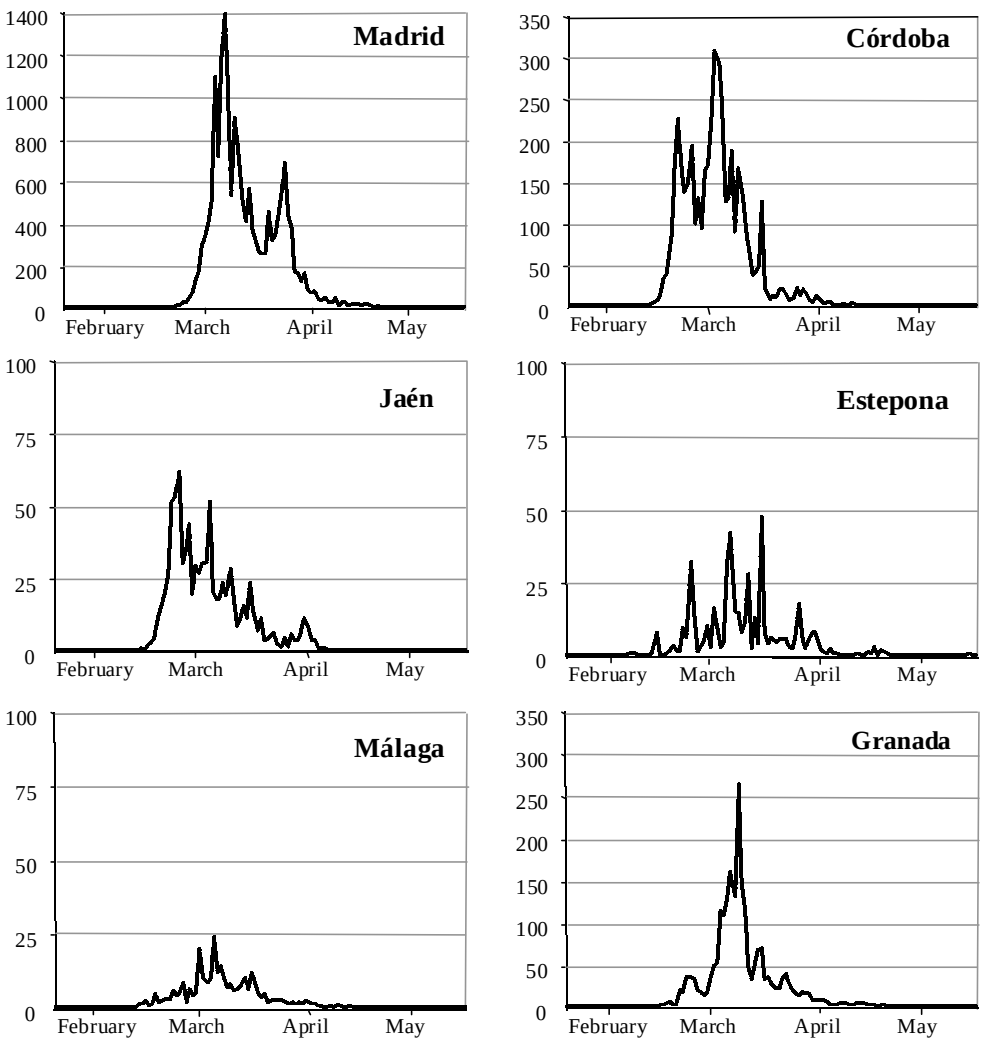


FIGURA 1. Evolution of the average daily *Platanus*-pollen count; representation of the average (pollen grains/m^3) over the years studied for each of the sampling stations.

confirmed that this type of pollen reaches high concentrations in most of the cities studied. However, the total annual values present major quantitative differences, not only between stations, but also over the different sampling years. Examination of the evolution of the total annual counts (Tab. 1) revealed that the highest annual figures usually occurred in Barcelona (25785 grains in 1997) and Madrid (28196 grains in 1998), since these are major metropolitan centers in which this taxon has traditionally been used as an ornamental plant in parks and boulevards. Málaga and Vigo were invariably the stations where the lowest pollen counts were detected, with the highest annual value in both being recorded in 1997 (496 grains in Málaga and 873 grains in Vigo). These values indicate that it is less commonly used in these cities, where other ornamental taxa are used instead. The other cities presented significant variations, with years in which the pollen count was high and others in which it was extremely low, such as Córdoba, where only 818 grains were obtained in 1992 as against 10378 grains in 1997.

The interannual fluctuations observed at a single control station in the series of years studied may be attributed, on the one hand, to meteorological factors, since, as BELMONTE *et al.* (1990) and GONZÁLEZ MINERO & CANDAU (1997) have pointed out, the pollen production of *P. hispanica* depends directly on the total rainfall during the months before the pollen season, and, on the other, to the severe pruning that these trees often undergo, which dramatically reduces the number of inflorescences and thus the amount of pollen that is dispersed. This effect can be seen in the city of Granada, where, unlike in other stations, maximum counts were recorded in 1992 and 1993, with much lower figures in subsequent years. Our results differ from those obtained by GONZÁLEZ MINERO & CANDAU (1997); here, no alternating pattern was observed in terms of annual pollen production such as that reported for Seville at any of the control stations. However, in some cities there was a gradual increase (Madrid, Barcelona and Jaén) or reduction (Granada) in the total annual counts over the study period. Nor was there any concordance in terms of the year in which the maximum total counts were recorded; whilst in Granada this occurred in 1993, in Estepona and Ourense it was in 1995, in León and Lleida in 1996, in Córdoba, Málaga, Vigo, Santiago de Compostela, Tarragona, Girona and Barcelona in 1997, and in Jaén and Madrid in 1998.

With the exception of Barcelona, the MPS in all the cities was very short compared to that of other types of pollen: usually only 20–35 days (although exceptionally it may last over 40 days). The duration of the MPS depends on meteorological variables during flowering and pollination; as reported by ANDERSEN (1991), falling temperatures in March in some years lead to a longer, less intense pollination period. Furthermore, GONZÁLEZ MINERO & CANDAU (1997) reported a link between the duration of the MPS and the temperature and rainfall i.e. once the MPS has begun, high temperatures and a lack of rainfall tend to shorten its duration, whereas if temperatures are low and rainfall occurs, the MPS is lengthened. This phenomenon would seem to be the case in Barcelona, where the spring months are generally wet with mild temperatures (BELMONTE *et al.* 1998), giving rise to the longest MPS of all the stations studied.

Insofar as the start date of the MPS is concerned, no major differences were

PLATANUS						
Sites	**Year**	**Total**	**MPS 98%**	**Peak day**	**Mean**	**N>50**
Vigo	1995	371	9/3-14/4 (37 days)	36 (22-26/3)	10	0
	1996	415	17/3-16/4 (31 days)	43 (24/3)	13	0
	1997	873	28/2-4/4 (36 days)	70 (7/3)	24	7
	1998	584	22/2-1/4 (39 days)	161 (3/3)	14	2
Santiago de Compostela	1993	188	7/3-2/4 (27 days)	21 (24/3)	3	0
	1994	350	21/3-23/4 (34 days)	93 (29/3)	10	1
	1995	911	21/3-16/4 (27 days)	164 (5/4)	33	6
	1996	198	2/4-16/4 (15 days)	47 (12/4)	12	0
	1997	2445	10/3-3/4 (25 days)	478 (18/3)	96	11
	1998	1779	10/3-1/4 (23 days)	272 (20/3)	76	10
Ourense	1993	475	13/3-18/4 (37 days)	70 (27/3)	12	1
	1994	930	10/3-9/4 (31 days)	103 (21/3)	29	7
	1995	1181	15/3-19/4 (36 days)	246 (23/3)	32	8
	1996	515	26/3-24/4 (30 days)	128 (29/3)	17	1
	1997	815	8/3-3/4 (27 days)	190 (13/3)	30	6
	1998	995	6/3-1/4 (27 days)	183 (18/3)	35	8
León	1994	97	12/4-4/5 (23 days)	29 (22/4)	4	0
	1995	1307	6/4-20/4 (15 days)	291 (11/4)	85	9
	1996	2527	19/4-29/5 (41 days)	358 (26/4)	60	13
	1997	2287	20/3-27/4 (39 days)	330 (31/3)	57	14
	1998	340	03/4-26/5 (53 days)	117 (9/5)	6	2
Lleida	1996	2056	25/3-26/4 (33 days)	235 (26/3)	61	14
	1997	1779	9/3-15/4 (38 days)	275 (18/3)	45	11
	1998	1942	18/3-25/4 (39 days)	286 (29/3)	49	11
Tarragona	1996	1192	23/3-2/5 (41 days)	130 (2/4)	26	9
	1997	1691	9/3-29/4 (52 days)	200 (18/3)	31	10
	1998	1462	11/3-19/4 (40 days)	230 (24/3)	35	9
Barcelona	1994	18201	6/3-23/4 (49 days)	1620 (11/3)	336	27
	1995	23435	8/3-26/8 (172 days)	1543 (19/3)	134	43
	1996	20589	24/3-18/5 (56 days)	1622 (9/4)	362	23
	1997	25785	4/3-11/6 (100 days)	2052 (12/3)	254	39
	1998	25621	10/3-27/6 (110 days)	2022 (20/3)	229	39
Girona	1996	2634	28/3-25/4 (29 days)	244 (12/4)	88	19
	1997	3809	9/3-25/4 (48 days)	440 (14/3)	78	19
	1998	1584	25/3-30/4 (37 days)	167 (3/4)	41	11
Madrid	1993	11593	28/3-22/4 (26 days)	2364 (8/4)	437	22
	1994	13109	15/3-9/4 (26 days)	2013 (25/3)	493	22
	1995	15715	20/3-17/4 (29 days)	1952 (26/3)	533	26
	1996	12608	29/3-30/4 (33 days)	1553 (2/4)	377	25
	1997	21684	9/3-5/4 (28 days)	2920 (18/3)	759	26
	1998	28196	16/3-15/4 (31 days)	4936 (21/3)	896	26
Córdoba	1992	818	11/3-14/4 (35 days)	215 (15/3)	19	3
	1993	3684	15/3-01/4 (18 days)	609 (21/3)	205	13
	1994	2409	9/3-28/3 (20 days)	555 (15/3)	120	11
	1995	1714	10/3-7/4 (29 days)	177 (22/3)	59	17
	1996	2571	23/3-17/4 (26 days)	711 (29/3)	99	14
	1997	10378	2/3-27/3 (26 days)	1481 (6/3)	399	24
	1998	8301	5/3-27/3 (23 days)	1297 (17/3)	354	23
Jaén	1996	404	26/3-16/4 (22 days)	65 (29/3)	17	1
	1997	1054	1/3-18/3 (18 days)	133 (9/3)	57	6
	1998	1070	6/3-29/3 (24 days)	103 (18/3)	44	9
Estepona	1995	1166	3/3-17/4 (46 days)	120 (21/3)	25	6
	1996	104	21/3-20/4 (31 days)	34 (29/3)	2	0
	1997	135	2/3-4/4 (34 days)	11(8/3)	3	0
Málaga	1992	198	11/3-12/4 (33 days)	59 (14/3)	6	1
	1993	277	10/3-8/4 (30 days)	43 (21/3)	9	0
	1994	159	26/2-31/3 (34 days)	18 (19/3)	4	0
	1995	284	26/2-18/4 (52 days)	53 (19/3)	5	1
	1996	279	17/3-18/4 (33 days)	59 (29/3)	8	1
	1997	496	24/2-29/3 (34 days)	49 (19/3)	14	0
	1998	271	8/3-9/4 (33 days)	21 (31/3)	8	0
Granada	1992	4287	16/3-26/4 (42 days)	726 (22/3)	100	17
	1993	4472	16/3-8/4 (24 days)	970 (23/3)	183	16
	1994	1249	11/3-10/4 (31 days)	117 (24/3)	39	10
	1995	1231	12/3-14/4 (34 days)	135 (26/3)	35	10
	1996	1251	27/3-21/4 (26 days)	183 (5/4)	47	8
	1997	1515	2/3-29/3 (28 days)	218 (8/3)	53	9
	1998	1055	7/3-30/3 (24 days)	169 (22/3)	43	8

TABLE 1. Total annual *Platanus*-pollen count and characteristics of the MPS for each of the sampling stations by year.

observed between different years in the same city; between 1996, when the latest pollination was recorded, and 1997, when it was earliest, the greatest difference (in León) was only 30 days, and in Vigo it was only 17 days. Certain meteorological factors, particularly temperature, caused a delay in the start of the MPS in certain cities such as Leon (where the mean annual temperature is 10ºC), with long, cold winters (FERNÁNDEZ-GONZÁLEZ *et al.*, 1998). This could mean that maximum daily concentrations are not recorded until April. The flowering of *Platanus* therefore depends both on endogenous factors corresponding to the tree and on pre-seasonal meteorological factors. Several authors have highlighted the importance of temperature on the start of pollination. Thus, ALBA & DÍAZ DE LA GUARDIA (1998) stated that the start of the MPS for *Platanus* may be related to the accumulated pre–seasonal temperatures from January onwards, which normally range between 428 and 607 ºC, considering 8.4 ºC to be the mean daily temperature that triggered flowering. Other authors (such as GONZÁLEZ MINERO & CANDAU, 1997) report that the start of the MPS is affected by the mean temperature in February.

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