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The pollen spectrum of trees and shrubs in SW Spain (1987–1996)

FRANCISCO JOSE GONZALEZ MINERO, PILAR CANDAU, JULIA MORALES and CARMEN TOMAS

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A Cour trap was used to sample the air of Seville of continuously from 1987 to 1996. The most important climatological feature recorded during that period was the drought that began in 1990 and which was at its most severe in the first half of 1995.

The behaviour of a total of 20 pollen types was studied: those exceeding 0.01% of the total pollen collected during the ten-year period. These were *Quercus*, *Olea*, Cupressaceae, *Platanus*, Myrtaceae, Pinaceae, Palmae, Moraceae, *Fraxinus*, Ericaceae, *Citrus*, *Pistacia*, *Acer*, *Casuarina*, Salicaceae, *Ulmus*, *Alnus*, *Castanea*, Cistaceae, and *Viburnum*.

The following aspects are described and analysed: the spectrum of tree and shrub types identified in the air, and their possible significance for allergies; the relationship between the woody vegetation of the region and the composition of the pollen spectrum in quantitative terms; and the possible effect of the drought on annual variations total pollen concentrations. A detailed study of olive pollen, aimed at finding applications in allergy and agriculture is also given. In particular, the possibility of forecasting both the date of olive pollination from observations of preceding mean temperatures, and the size of the crop from palynological and agronomical data.

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This work presents the spectrum of tree and shrub pollen identified in the air of Seville, SW Spain (37° 23'N, 5° 58'W.), after ten consecutive years of aeropalynologically monitoring the city's atmosphere. It studies the vegetation (mainly anemophilous) represented in the pollen composition of the air, the effect of climatology on airborne pollen concentrations, and the applications of aeropalynology in allergy and agriculture.

The results can be considered a model of the aeropalynology of southern Spain in particular and of the western European Mediterranean area in general. They add to those of previous studies on the aerobiology of the region (Candau & González Minero 1992, González Romano et al. 1992, Tomás et al. 1997). At the same time, this work forms part of the pollen studies carried out at other sites in the Mediterranean basin (Mincigrucci et al. 1985, Bousquet et al. 1984, Keynan et al. 1991, Bickaci et al. 1996, Waisel et al. 1997).

A climatological characteristic of the region is the irregularity in annual total precipitation: abundantly rainy years alternate with dry periods. This is exemplified by the six drought periods between 1922 and 1996, when the annual total rainfall during two or more consecutive years did not exceed 600 mm (1934–35, 1949–50, 1956–57, 1973–75, 1980–82, and 1990–95; Data supplied by the Tablada Observatory, Seville, of the National Meteorological Institute).

The tree and shrub vegetation potentially contributing to the pollen content of the air of the city is described below.

There is a considerable ornamental flora, which is distributed through 1,374,644 m² of public green areas, comprising two large parks and 18 smaller gardens (not counting those plants bordering the streets and in the numerous private gardens). The total census reveals more than 800 different species included in 47 botanical families. The best-represented families are Pinaceae, Cupressaceae, Moraceae, Ulmaceae, Salicaceae, Platanaceae, Leguminosae, and Palmae. Species of American and Asian origin predominate, possible because of the important historical role of the city as the Spanish centre of commerce with the Indies (Andrés Camacho 1991).

In the immediate surrounds of the city the arboreal vegetation consists mainly of forests of holm oak (*Quercus ilex* ssp. *rotundifolia*) and cork oak (*Quercus suber*), olive groves (*Olea europaea*), and plantations of pine (mainly *Pinus pinea* and *P. pinaster*), eucalyptus (*Eucalyptus globulus*, *E. camaldulensis*, *E. rostrata*), and chestnut (*Castanea sativa*) (Fig. 1, Plan Forestal Andaluz, 1990). This present-day composition is the result of changes in the natural environment that have been accelerating in the last hundred years. The original *Quercus* forests have been replaced by more profitable agricultural land (Poaceae and olive) or afforested (chestnut at altitudes above 800 metres), or have often been abandoned, giving way to an invasive scrubland: Cistaceae, Labiatae, Leguminosae, and Rhamnaceae in the case of *Quercus ilex*; and Ericaceae in the case of *Quercus suber* (Fig. 1). At the end of the last century, there was a massive plantation of olive in certain areas, so that this species from being marginal and restricted in presence came to occupy

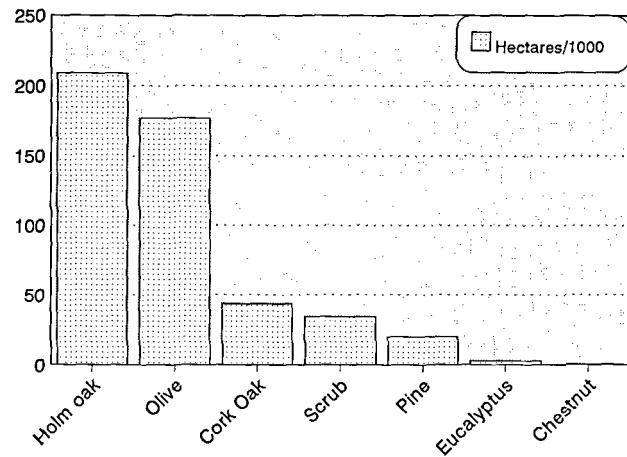


Fig. 1. Area coverage of the most important arboreal species in the province of Seville.

large areas of the Guadalquivir valley. Today, olive groves occupy some 174,000 hectares, that is, 8.14% of the Spanish olive growing area and 2.14% of the world's (Peralta Prieto 1994). The olive is one of the region's main economic resources, in terms of both the work generated in its picking and in the subsequent production and marketing of the oil. The increasing worldwide demand for olive oil (Bonazzi 1997) favours the current expansion of olive groves in the region. In response to the needs of the paper and timber industry in the 1940s, massive reforestation of the abandoned areas then dominated by degraded scrubland began. The trees planted were of rapid growth, competitive, and adapted to drought: *Eucalyptus* and *Pinus pinaster*. Recently, the *Quercus* forests have begun to be recovered, with the incentive of state grants. In many places, these forests are well preserved, since either they have been converted into oak-savannahs for use as pastures, or they have been used for hunting. Finally, there is also riverside woodland (*Alnus glutinosa*, *Corylus avellana*, Ulmaceae, *Fraxinus excelsior*, Salicaceae). Such areas, characterized by the fertility of their soils, have been subjected to continuous deterioration through being replaced by agricultural lands, with their partial or total desiccation during the summer in years of drought.

MATERIALS AND METHODS

Airborne pollen was monitored with a Cour trap (Cour 1974) installed on the roof of the School of Pharmacy, Seville University, at a height of 15 metres above the ground. The trap consists of two vertical filters supported on a rod 3 metres in length. It is protected from the rain and is continuously faced into the wind by the action of an incorporated vane. The device uses no electrical power: particles in the air become impinged on the filters.

The filter comprises five sterile gauzes overlain to form of a net and fitted into a plastic frame, giving a surface area of 400 cm². The filters are normally exposed for a week, although they can be changed two or three times weekly if, for example, the aim is to make crop prediction studies (González Minero & Candau 1995a).

At least two days are required to complete the chemical treatment of the filters and the microscope analysis of the preparations. This has already been described in varying degrees of detail in previous publications (Cambon 1981, Rajeriarison 1984, Richard 1985,

Belmonte 1988, Durand & Comtois 1989, González Romano et al. 1992, González Minero et al. 1993, Tomás et al. 1997). The procedure can be summarized in five stages:

- The gauze is dissolved and the sand and organic particles retained with the pollen are removed. This is achieved with successive treatments of sulphuric acid, 70% hydrofluoric acid, and hydrochloric acid.
- The resulting pollen is acetolyzed and coloured with basic fuchsin.
- The volume of pollen collected is quantified. This is done by adding a known volume of glycerine and sampling the resulting volume (pollen + glycerine) with a micropipette.
- A large portion of the total pollen released will be examined, and for this purpose, the microscope preparations are prepared with 50 µl of the above volume.
- Both the amount and diversity of the pollen collected on the filter are determined. The wind speed is known from the totalizing anemometer situated beside the sampler, so that the pollen count from the analysis can be expressed as grains/m³ of air.

Tomás et al. (1997) demonstrated the relationship between the Cour method and that of Hirst, and established the coefficients for converting Cour weekly pollen concentrations into Hirst weekly pollen concentrations for 16 pollen types.

The trap operated continuously for 10 consecutive years (1987–1996). Samples were taken each Monday. The microscope identification of the pollen types was based on the work of Valdés et al. (1987a).

The meteorological data (annual and weekly mean temperature, annual total precipitation and wind direction) were obtained from information supplied by the station of the National Meteorological Institute in María Luisa Park (Tablada Observatory), 1 km from the pollen trap.

The analyses are based on those tree and shrub pollen types which exceeded 0.01% of the total pollen collected over the ten year period. The list of specimens included (See p. 116) shows the most important taxa studied, according to Valdés et al. (1987b). The concept of the main pollination period (MPP) was used. This is described by Pathirane (1975) as that period of the year when between 5 and 95% of the total pollen collected by the end of the year is captured.

RESULTS AND DISCUSSION

Fig. 2 shows the pollen calendar for tree and shrub types identified in the air of Seville, listed by starting date of the main pollination period (Table I). This shows that pollen appears in the air mostly between February and May, and is scarcest between June and January. In January, small concentrations were recorded for *Alnus* (2.5 grains/m³), Cupressaceae (30 grains/m³), and *Fraxinus* (2 grains/m³). February saw the maximum concentrations of Cupressaceae, especially in dry winters, such as in week seven of 1992, when the highest weekly concentrations found for any pollen type (3104 grains/m³) were recorded (Table I). This characteristic makes the pollen of Cupressaceae a potential inducer of winter pollinosis (Dhivert et al. 1979, Panzani et al. 1991).

In February, small amounts (fewer than 10 grains/m³) of *Ulmus* and Salicaceae were also collected, and types such as *Acer*, Moraceae, *Viburnum*, and Ericaceae appeared in the air. Palmae and *Citrus* appeared at the beginning of March, when *Platanus* pollen also made a sudden appearance (in a few days its presence went from zero to amounts that could be higher than 1200 grains/m³, depending on the year) and then diminished (Table I). The work of Subiza et al. (1994) reports an increase in pollinosis caused by *Platanus* pollen in Madrid, indicating that this plant should be taken into

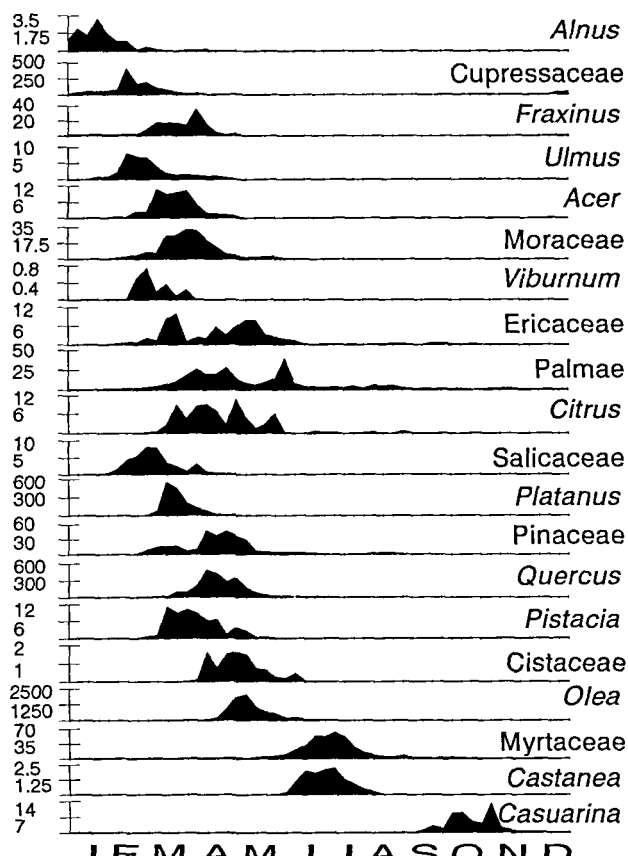


Fig. 2. Spectrum of tree and shrub pollen types identified in the air of Seville during the period 1987–1996. Note the differences in scale (grains/m³) indicated together with the name of each pollen type.

account when considering allergies. In the second fortnight of March, Pinaceae, *Pistacia* and *Quercus* types appeared in the air. April saw the maximum peaks of *Quercus* (>1400 grains/m³), *Fraxinus* (40 grains/m³), Cistaceae (2.5 grains/m³), and Pinaceae (70 grains/m³), and the main pollination period of *Olea europaea* began. In May, airborne concentrations of most of the types reported in the preceding months fell, the main pollination period of Myrtaceae began, and the maximum concentrations of *Olea europaea* pollen were recorded (up to more than 1000 grains/m³, depending on the year, Table I). The latter and the pollen of Poaceae jointly cause the most serious allergy problems in the region (González Romano et al. 1992).

Fortunately for allergy sufferers, the high concentrations of olive pollen last only a short time, as reported some years ago for Jerusalem by Tas and Feibrum (1962). At the beginning of June, the highest concentrations of Palmae were recorded (40 grains/m³), and small amounts of *Castanea sativa* pollen (2.5 grains/m³) appeared in the air, coming from the chestnut plantations in the north of the province. Since these are more than 100 km from the sampling point, pollen transport is at the regional scale.

This hypothesis is confirmed by the fact that in eight of the ten years of study, the incidence of northern winds (NNE + WNW) during the weeks of chestnut pollen collection exceeded 40%. A similar finding has been reported in

the neighbouring locality of Huelva (González Minero & Candau 1995b). At the beginning of July, the highest concentrations of Myrtaceae were recorded (60 grains/m³). The last type to appear in the spectrum was *Casuarina*, flowering in autumn and present in the air in amounts lower than 10 grains/m³. At the end of the year, pollen of the autumn-flowering Cupressaceae (*Juniperus oxycedrus*) again appeared in the air.

Table II details the starting dates of the main pollination period of olive in the years 1987–1996. These dates differ by a maximum of 30 days (day 96 in 1990 and day 126 in 1991). This variation can be related to the mean temperatures of the months (February and March) preceding the appearance of airborne olive pollen, since it was observed that the lowest mean temperature was for the latest period (11.8°C and day 126, in 1991), and vice versa (15.52°C and day 96, in 1990). This relationship of temperature/starting date of main pollination period is given by the following equation $D = 216.55 - 7.89 \times T$ ($r = 0.878$; $r^2 = 0.771$; $p = 0.0008$), where D is the date of the start of the main pollination period, expressed as number of days from 1 January, and T is the mean of the mean temperatures of February and March. This direct negative relationship between the two parameters can be used to forecast the start of olive pollination, which is of great value in agriculture (it offers the chance to use retarding agents to delay flowering when frosts are expected), and in the field of allergies (allergic attacks caused by pollen can be forestalled). Similar relationships between preceding temperatures and starting date of olive pollination have been shown in Italy by Frenguelli et al. (1989). They are based on the tree accumulating daily temperature above a certain threshold, following its emergence from the period of dormancy at the end of January, this temperature is a direct, positive stimulus for the development of the floral buds (Rallo 1994).

The pollen types can be grouped into three artificial classes on the duration of the main pollination period (Table I).

The shortest periods, less than 9 weeks, are for those types with one or a few species that flower at the same time (*Acer*, *Alnus*, *Castanea*, *Casuarina*, Moraceae, *Olea*, *Pistacia*, *Platanus*, and *Ulmus*), or those with entomophilous or mixed pollination. These latter are not abundant in the spectrum, and appear only on those days when their flowering is at its height (Cistaceae, Salicaceae, and *Viburnum*).

Types with intermediate periods (>9–14 weeks), among which are Cupressaceae, *Citrus*, *Fraxinus*, Pinaceae, and *Quercus*, are characterized by including numerous species (Table I) with a flowering consisting of successive steps during several months of the year (Valdés et al. 1987b).

In third place are those types with a main pollination period longer than 14 weeks. This class comprises Myrtaceae (*Eucalyptus* species flower mainly in June and July, with a continual, not very vigorous flowering during the rest of the year), Ericaceae and Palmae (with numerous representatives having flowering periods spread through the year).

Table I also shows the percentages of representation of arboreal types in the pollen spectrum. These make up 76.6% of the total pollen collected. The five most abundant types in the air of Seville were (in decreasing order): *Quercus* (29.52%), *Olea* (13.96%), Cupressaceae (11.39%), *Platanus*

Table I. Summary of the different aeropalynological parameters of the Seville tree and shrub pollen spectrum.

Starting date MPP – start of the main pollination period (first day of the week in which the MPP began);
 Length MPP – duration of the main pollination period;
 Maximum concentration – weekly concentration measured during the sampling period.
 The first three parameters are mean values calculated from observations carried out between 1987 and 1996.

Taxa	Starting date MPP (from 1st January)	Length MPP (Weeks)	% with respect to total pollen	Maximum concentration	
				Grains/m ³	Week & Year
<i>Acer</i>	19 Feb (50)	6.6	0.39	45	10, 1994
<i>Alnus</i>	3, 3 Jan (3)	8	0.09	23	4, 1992
<i>Castanea</i>	12 Jun (163)	5.2	0.09	10	28, 1991
<i>Casuarina</i>	30 Sep (273)	7.2	0.37	100	49, 1988
Cistaceae	6 Apr (96)	4.9	0.07	5.60	21, 1993
<i>Citrus</i>	9 Mar (68)	9.9	0.53	31.33	18, 1993
Cupressaceae	30 Dec (364)	11	11.19	3104	7, 1992
Ericaceae	23 Feb (54)	19	0.53	42	20, 1993
<i>Fraxinus</i>	5 Feb (36)	10.4	1.08	126	14, 1988
Moraceae	20 Feb (51)	8.1	1.39	82.66	13, 1993
Myrtaceae	2 May (122)	17.1	2.94	145.18	28, 1991
<i>Olea</i>	18 Apr (108)	6.1	13.96	1014	18, 1989
Palmae	6 Mar (65)	27.9	2.24	144	17, 1988
<i>Distacia</i>	19 Mar (78)	7.1	0.45	31	14, 1995
Pinaceae	13 Mar (72)	13.6	2.40	218	15, 1988
<i>Platanus</i>	11 Mar (70)	2.71	8.79	1216	11, 1992
<i>Quercus</i>	16 Mar (75)	11.1	29.52	2113	18, 1991
Salicaceae	10 Feb (41)	4.4	0.28	53	9, 1992
<i>Ulmus</i>	15 Feb (46)	7.4	0.27	31	7, 1989
<i>Viburnum</i>	20 Feb (51)	4	0.01	2.6	20, 1988
Total			76.60		

Table II. Data related to olive aeropalynology.

Mean Temp. – mean of the mean temperatures preceding the presence of airborne olive pollen;
 Starting date – start day of main pollination period (first day of the week in which the MPP began);
 Pollen (MPP) – total amount of olive pollen collected during the main pollination period;
 Production – olive production in the province of Seville.

Year	Mean Temp. Feb–Mar (°C)	Starting date MPP (from 1st January)	Pollen (MPP) (grains/m ³)	Production (kg/ha)
1987	13.11	107	1975	1605
1988	13.88	100	1244	967
1989	14.23	105	1533	1475
1990	15.52	96	1287	1280
1991	11.80	126	4091	1866
1992	13.54	112	2033	1167
1993	12.99	116	970	1050
1994	14.30	104	1007	1209
1995	14.25	101	1017	1178
1996	13.99	113	1496	1365

(8.79%), and Myrtaceae (2.94%). These results broadly reflect the regional vegetation, except for the shrubs (Cistaceae, Ericaceae, Labiatae), which have only a minor presence in the spectrum because of their basically entomophilous nature (Fig. 1). Pinaceae are scarcely present, despite the family's high representation in the region and its very easily wind-dispersed pollen (with floatation vesicles). The contradiction may lie in the fact that this pollen type is dispersed less effectively in urban areas than are other anemophilous types, since its large size causes it to be filtered out by buildings and other urban barriers (Candau & González Minero 1992). Other significant characteristics of

the pollen spectrum of the tree and shrub types of Seville are the abundance of *Quercus* pollen (almost 30% of the total pollen) and the considerable presence of *Platanus* pollen (the fourth highest). In terms of Spanish localities, the percentage of *Quercus* pollen found in Seville is exceeded only by that in Cáceres (Table III). This suggests that the province of Seville constitutes one of the largest areas of Mediterranean forest in Spain. The profusion of *Platanus hispanica* in the ornamental flora of the city – it is a tree of rapid growth, it withstands pruning and is resistant to pollution, it refreshes the surroundings on hot days, and gives shade from the spring and summer sun – is seen in the

Table III. Percentages of *Quercus* pollen recorded in the pollen spectra of other Spanish cities.

Site	% <i>Quercus</i>	Reference
Zaragoza	6.70	Belmonte et al. (1995a)
Mallorca	4.00	Belmonte et al. (1995b)
Albacete	10.00	Belmonte et al. (1995c)
Barcelona	9.40	Belmonte et al. (1995d)
Girona	17.70	Belmonte et al. (1995d)
Cáceres	32.80	Belmonte et al. (1995e)
Vigo	11.50	Belmonte et al. (1995f)
Huelva	14.75	González Minero & Candau (1995a)

abundance of its pollen. The same characteristics make *Platanus* a very popular tree in other Spanish cities, such as Madrid and Barcelona, where pollen percentages similar to those of Seville have been reported (Sáenz Laín & Gutiérrez Bustillo 1983, Roses-Codinachs et al. 1992).

Table IV shows the interannual variation of annual total concentrations of the pollen types studied. In 1995, there was a general decrease in tree pollen (only one quarter of the maximum collected, in 1991), and small amounts of annual pollen were collected for *Quercus* and Cupressaceae (the lowest of the ten years), and *Platanus* and *Olea* (among the lowest of the ten years). A possible cause of this phenomenon is the intensification of the drought in early 1995. The lack of rain in those months added to the effect of the three preceding years, when the annual total rainfall did not exceed 400 mm. The drought ended with abundant rainfall between November 1995 and February 1996. Roure & Belmonte (1988) have suggested a negative relationship between water deficit and pollen production in trees.

Another notable aspect from Table IV is the biennial alternation (between 1987 and 1992) in olive pollen production and emission. This pattern was interrupted in the period 1993–95, but seems to have become re-established in 1996

(Fig. 3). The interruption of 1993 was possibly a result of the adverse climatological conditions already mentioned, which almost certainly had a negative effect on the plant, breaking down its well known resistance to stress (Zohari & Hopf 1988). Such alternation has been shown before by various authors (Macchia et al. 1991, Domínguez Vilches et al. 1993), and is the product of the plant's particularly long biological cycle: once flowering and pollination have occurred (April and June), the fruit is formed and will remain on the tree for a number of months before being collected (between September and January of the following year). During the period when the fruit remains on the tree, gibberellins are accumulated in the seed endosperm. These plant hormones inhibit (in November) flowering, which does

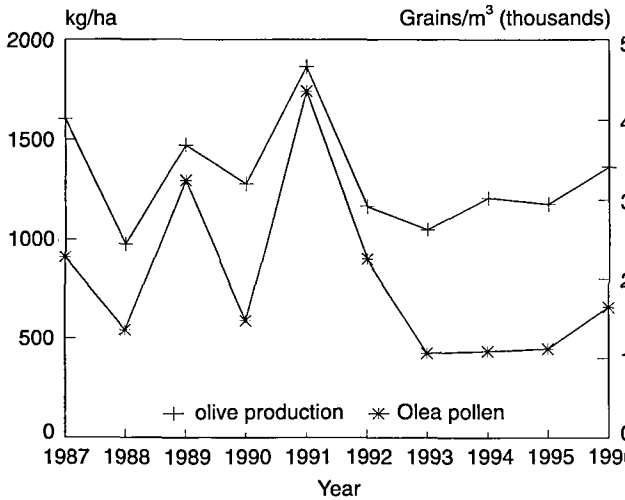


Fig. 3. Interannual variation of olive production in the province of Seville (kg/ha, axis Y₁) and of olive pollen (grains/m³, axis Y₂) collected during the main pollination periods.

Table IV. Interannual variation in the annual total concentration (expressed in grains/m³) of the pollen types studied.

Taxa	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
<i>Acer</i>	43.7	50.5	42.1	40	17.3	40.3	89.7	99.5	70.9	55.6
<i>Alnus</i>	10.3	4.9	28.8	10.8	14.7	35.5	4.1	10.2	5.3	1.2
<i>Castanea</i>	9.6	6.6	5.5	5.5	33.7	17.2	19.8	5.3	15.4	6.7
<i>Casuarina</i>	37.6	182.9	50.9	18.9	48.7	5.5	51.2	38.2	27.9	59.9
Cistaceae	4.9	2.7	6.9	3.6	12.7	5.7	18.8	10.4	5.5	10.4
<i>Citrus</i>	220.1	65.7	78.7	17.1	40.5	18	220.1	5.5	1.1	82.7
Cupressaceae	829.8	511.4	1551.9	425.3	2893.1	5869	1582.6	1047.9	396.4	822.2
Ericaceae	76.1	20.5	122.7	11.9	90.9	45.8	208.8	105.3	19.2	47.7
<i>Fraxinus</i>	12.4	296.2	520.7	155.3	59.8	103.9	178.3	140.7	37.6	30.1
Moraceae	107.8	243.6	304.5	272.7	142.2	62.3	359	253.9	64.2	167.8
Myrtaceae	441	592	480	100	494.8	203.7	639	669.6	337.7	228.1
<i>Olea</i>	2277	1354	3244	1471	4361	2251	1064	1089	1119	1646
Palmae	315.1	1189.9	583.2	358.7	128.9	64.99	71.55	36.92	256.0	178.4
<i>Pistacia</i>	56.3	28.6	87.1	29.8	126.9	27.2	28.1	67.6	73.4	116
Pinaceae	185	636	624.2	141.4	291.5	503	403.2	190.3	256	178
<i>Platanus</i>	1599	11163	1575	820	1043	2120	811	1122	953	1308
<i>Quercus</i>	1574	1419	2518	2380	7642	3902	1617	3296	464	4965
Salicaceae	4.8	20	8.8	48.8	70.1	105.7	49.5	62.4	1.3	22.5
<i>Ulmus</i>	45.4	37.1	82.3	14.1	35.8	93.4	33.8	21.2	10.3	4.13
<i>Viburnum</i>	3.42	3.23	4.55	1.12	0.98	2.12	111	0.73	0.21	1.25
Total	7853	7781	11920	6326	17549	15476	7451	8273	4115	9932

not then occur until the following spring (Rallo 1994). It is known that high pollination implies a great production of fruits (González Minero & Candau 1995a), and consequently a large amount of seeds and gibberellins. A high pollination will thus be followed by a reduction in both flowering and pollination the following year. The variation in annual amounts of olive pollen (calculated for the main pollination period) has been related (Fig. 3) to the production of olives (expressed in kg/ha) in the province of Seville. The production figures (Table II) were supplied by the Department of Agriculture of the regional government of Andalusia (CAP J. Anadalućia 1988–1995). The relationship is given by the following equation: $P = 924.95 + 0.235 \times OP$ ($r = 0.814$; $r^2 = 0.633$; $p = 0.0041$), where P is the olive production in the province, expressed in Kg./Ha., and OP is the amount of olive pollen collected during the main pollination period. This equation, calculated retrospectively, enables the olive crop to be forecast several months in advance, concretely at the end of June, when pollination has finished. Crop forecasting based on airborne pollen counts has been carried out in hazelnut (Lletjos et al. 1993), citrus fruits (Cour & Villemur 1985), and grapes (Cour & Van Campo 1980, González Minero & Candau 1995b).

CONCLUSIONS

The results set out here are a good indication of the behaviour of tree and shrub pollen captured in the air of Seville through the year, and over the years. This assertion is based on the reasonably long period (10 years) of observations, which moreover included a period of drought – a frequent feature of the Mediterranean climate. With regard to allergy prevention, high concentrations of allergenic types are recorded at three moments in the year: February (Cupressaceae), March (*Platanus*), and May (*Olea*).

The composition of the Seville pollen spectrum tree and shrub reflects the natural vegetation surrounding the city (*Quercus* forests), agricultural lands (*Olea europaea*), reforestation with alien species (*Eucalyptus*), and the ornamental flora of the city itself (Cupressaceae and *Platanus*).

The variation in annual total concentration over the years shows how a period of drought can affect the airborne pollen composition, causing a decrease in the amount of *Quercus* and Cupressaceae pollen, and the interruption of the biennial rhythm of pollen production in the olive.

Finally, a detailed study of the aeropalynology of types having important socio-economic implications in the region (such as the olive), in which palynological, meteorological, and agronomical data are contrasted, offers the possibility of forecasting when pollen will start to be present in the air (which is very important in the field of allergies) and the size of the crop (which is very important for agriculture).

LIST OF SPECIMENS INCLUDED

<i>Acer</i>	<i>Acer negundo</i> , <i>A. pseudoplatanus</i>
<i>Alnus</i>	<i>Alnus glutinosa</i>
<i>Castanea</i>	<i>Castanea sativa</i>
<i>Casuarina</i>	<i>Casuarina cunninghamiana</i> , <i>C. stricta</i>
Cistaceae	<i>Cistus ladanifer</i> , <i>C. salvifolius</i> , <i>C. populifolius</i>
<i>Citrus</i>	<i>Citrus aurantium</i> , <i>C. bergamia</i> , <i>C. deliciosa</i> , <i>C. limon</i> , <i>C. myrtifolia</i> , <i>C. sinensis</i>

Cupressaceae	<i>Cupressus sempervirens</i> , <i>C. arizonica</i> , <i>C. macrocarpa</i> , <i>Thuja plicata</i> , <i>Chamaecyparis lawsoniana</i> , <i>Juniperus oxycedrus</i> ,
Ericaceae	<i>Erica ciliaris</i> , <i>E. arborea</i> , <i>E. scoparia</i> , <i>E. umbellata</i> , <i>Arbutus unedo</i> , <i>Calluna vulgaris</i>
<i>Fraxinus</i>	<i>Fraxinus angustifolia</i> , <i>F. excelsior</i> , <i>F. ornus</i>
Moraceae	<i>Morus nigra</i> , <i>M. alba</i> , <i>Broussonetia papyrifera</i>
Myrtaceae	<i>Eucalyptus globulus</i> , <i>E. camaldulensis</i> , <i>E. rostrata</i> , <i>Myrtus communis</i>
<i>Olea</i>	<i>Olea europaea</i>
Palmae	<i>Phoenix</i> sp., <i>Washingtonia</i> sp., <i>Trachycarpus fortunei</i>
Pinaceae	<i>Pinus pinea</i> , <i>P. pinaster</i> , <i>P. halepensis</i> , <i>P. canariensis</i> , <i>Cedrus deodara</i>
<i>Pistacia</i>	<i>Pistacia lentiscus</i> , <i>P. terebinthus</i>
<i>Platanus</i>	<i>Platanus hispanica</i>
<i>Quercus</i>	<i>Quercus ilex</i> , <i>Q. suber</i> , <i>Q. coccifera</i> , <i>Q. faginea</i> , <i>Q. pyrenaica</i> , <i>Q. canariensis</i>
Salicaceae	<i>Salix</i> sp., <i>Populus</i> sp.
<i>Ulmus</i>	<i>Ulmus minor</i> , <i>U. glabra</i>
<i>Viburnum</i>	<i>Viburnum tinus</i> , <i>V. opulus</i>

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