

Aerobiological monitoring of Cupressaceae pollen in Santiago de Compostela (NW Iberian Peninsula) over six years

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Abstract

This study analyzes the pollen representation of Cupressaceae in the atmosphere of Santiago de Compostela (NW Iberian Peninsula) during the years 1993–1998. The samples were collected with a Hirst volumetric spore trap, situated at a height of 27 m above ground level on a building situated in the south of the city. Cupressaceae pollen is present in the atmosphere practically all year round, although it is predominant in the winter period along with *Alnus* and *Pinus*, standing out due to its marked allergenic nature. During the period under study 5,128 grains were recorded, which represented 5% of the total pollen identified. The principal pollination period for this pollen type in each sampling year and its intra-diurnal variation were calculated. The correlation between the pollen content of each year and the main meteorological parameters is likewise presented.

1. Introduction

Cupressaceae pollen has been cited by different authors as an important allergen in the Mediterranean region (Caiiaffa et al., 1998; Cimignoli et al., 1992; D'Amato and Licardi, 1994; Nardi et al., 1996). However, different aerobiological studies show that its presence is also very considerable outside that area (Galán et al., 1998; Hirotaka et al., 1996; Levetin, 1998; Naito et al., 1998) since different species of this family are frequently used for ornamental purposes in parks and gardens in many cities.

The Cupressaceae family includes around 20 genera with more than 100 species of widely distributed evergreen trees and bushes. Taxaceae and Taxodiaceae species, which are similar from a pollen morphology point of view, have also been included in the Cupressaceae pollen type. The level of allergenicity of the different species largely depends on the quantity of allergen or allergens that the pollen releases 5–10 minutes after coming into contact with the respiratory tract. There are Cupressaceae species

with a poor allergenic capacity, but cases have been reported of cross reactivity with some Pinaceae (Pettyjohn et al., 1997) and Taxodiaceae species (Crosta et al., 1996).

This study analyzes this pollen type representation in the atmosphere of Santiago de Compostela (Galicia, Spain) during a six-year period (1993–1998) in order to ascertain its oscillations throughout the year and determine its principal pollination period. In the same way, attempts have been made to ascertain the relationship between pollen concentration and meteorological parameters (precipitation, average, maximum and minimum temperatures, wind) in order to carry out future predictive studies of the onset and severity of the pollen season.

2. Methodology

Santiago de Compostela (Figure 1) is situated in the northwestern corner of the Iberian Peninsula (coordinates 42° 53' N and 8° 32' W). Biogeographi-

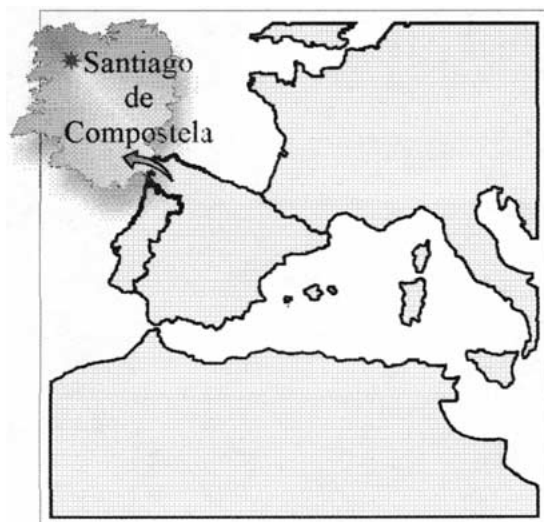


Figure 1. Map of the geographical situation.

cally, it is located within the Atlantic Province of the Euro-Siberian Region (Izco, 1987), with a maritime-temperate climate of high humidity. According to Carballeira et al. (1983), it has an average temperature of 12.9°C and an annual precipitation in the order of 1,288 mm, mainly concentrated in the winter months.

Near the sampling point there are large areas of non-autochthonous forest of *Eucalyptus globulus* Labill., *Pinus radiata* D. Don and *Pinus pinaster* Aiton (Izco, 1987). The Cupressaceae, Taxaceae and Taxodiaceae families form part of the city's ornamental flora.

Atmospheric pollen was obtained weekly using a Hirst volumetric spore trap, Lanzoni VPPS-2000 model (Hirst, 1952), located in the south campus of the University of Santiago de Compostela at a height of 27 m above ground level. The samples were collected on a Melinex tape cut into seven segments corresponding to the days of the week. Each of them were placed on a microscope slide and fixed with a solution of glycerinated gelatin impregnated with a fuchsin solution. Subsequently, the pollen count was carried out on four longitudinal traverses, with the aid of a light microscope using a magnification of 40x. The final concentrations were expressed as number of pollen grains/m³ of air (Domínguez et al., 1991).

Routine pollen counts using an optical microscope do not usually differentiate between the pollen morphology of some species of Cupressaceae, Taxaceae and some Taxodiaceae species (*Taxodium*, *Cryptomeria*) due to the similarity of their dimensions

and morphology (Bortenschlager, 1990; Caramiello et al., 1991). Therefore, the "Cupressaceae" pollen type used in this study includes different species close to the trap. Some of the species belonging to the Cupressaceae found in nearby gardens are: *Calocedrus decurrens* (Torr.) Flor., *Chamaecyparis lawsoniana* (Murray) Parl., *Chamaecyparis obtusa* (Sieb. and Zucc.) Endl., *Chamaecyparis pisifera* (Sieb. and Zucc.) Endl., *Cupressus glabra* Sudw., *Cupressus lusitanica* Mill., *Cupressus macrocarpa* Hart. ex Gordon, *Cupressus sempervirens* L., *Juniperus chinensis* L., *Juniperus communis* L., *Juniperus oxicedrus* L., *Juniperus squamata* Buch. Ham. ex Lamb., *Juniperus virginiana* L., *Thuja occidentalis* L., *Thuja orientalis* L., *Thuja plicata* D. Don, *Thujopsis dolabrata* (L. fill.) Sieb. and Zucc. Taxaceae is represented by only one species, *Taxus baccata* L., while Taxodiaceae is represented by *Cryptomeria japonica* D. Don, *Sequoia sempervirens* (D. Don) Endl. and *Taxodium distichum* (L.) Richard.

The meteorological data were provided by the University of Santiago's Astronomical Observatory, situated near the sampling point. The Spearman's test was applied, using the *Statistica* computer programme, in order to determine the correlation between meteorological factors and Cupressaceae pollen type concentrations. Despite the high number of species included in the Cupressaceae type, it was deemed appropriate to calculate the principal pollination period (PPP) since it is a pollen type with a high incidence in winter allergies. The period between September and the following August was taken as the annual cycle although its pollination does not correspond to specific years, if the data are analyzed according to the method of Nilsson and Persson (1981). The method of Galán et al. (1991) was used in the intra-diurnal analysis, selecting the dry days surpassing or equalling the average value of Cupressaceae pollen concentrations during the principal pollination period. The data are presented as the percentage of pollen recorded in each hour of the day.

3. Results

Figure 2 shows the variation of total annual Cupressaceae pollen during the years under study. 1997 is seen to be the year in which the maximum value of 1,397 pollen grains was recorded, followed by 1998 with 1,269 grains. On the other hand, the minimum was recorded during 1996 with only 169 grains. The

percentage of Cupressaceae pollen with regard to the annual total oscillated between 3% in 1994 and 7% in 1998. The Cupressaceae pollen type's principal pollination period mainly covers the months of December to the following May, with the highest values occurring in January, February and March. Figure 3 shows the average monthly value of the six years from December to May.

The days on which the highest average values were attained during the pollination period (Table 1) lie within the first three months of the year, with a peak value of 118 grains/m³ on January 12th, 1997. In 1996 the concentrations were abnormally low, like the general behaviour of all the taxa.

Figure 4 represents the variation of Cupressaceae pollen concentration between January and April, considering for each day the average value of the concentrations registered during the six-year period studied. In this figure two important peaks can be noticed on January 12th and February 10th, during which the average atmospheric pollen concentrations of Cupressaceae of 30 grains/m³ and 33 grains/m³ were recorded respectively. In January this value coincided with the date on which the 1997 daily maximum was recorded (January 12th: 118 grains/m³). In February it coincided with the date of the maximum daily value of 1998 (73 grains/m³) and, likewise, with the maximum daily of that month in 1997 (85 grains/m³), contributing preferentially to the obtention of a very high average value for the six-year period. In March there is a secondary peak whose value is lower than the previous one (18 grains/m³), coinciding with the date of the maximum of this month in 1995 (March 25th: 69 grains/m³). The representation of the five day running mean, shows a peak in the first fortnight of January, another larger one in the first fortnight of February and a third one at the end of March, in which the highest average daily values of the entire Cupressaceae pollination period were recorded.

Figure 5 shows the intra-diurnal variation of Cupressaceae during the period 1993–1998. The greatest concentration of pollen is recorded in the main hours of midday (between 11 am and 3 pm), with the highest values at 11 am and 1 pm. These concentrations decrease as the day goes on, with the lowest values at dusk and during the night.

Spearman's test was applied in order to establish the weight of linear relation between the concentration of Cupressaceae pollen and meteorological parameters studied, since the pollen concentrations do not follow a normal distribution model. Such a correlation was

established for the six years as a whole as well as for each independent year, taking the days of the PPP (Table 2). In analyzing the variation year by year, precipitation and humidity maintain a negative correlation that fluctuates between 99% and 90% depending on the year. In the same way, the number of hours of sunshine maintains a positive correlation in all cases, except for the period 1996–97 in which this parameter has no significance. The correlations with maximum, minimum and average temperatures were calculated with daily values and accumulated values of two days; a better correlation was obtained with the presence of Cupressaceae by considering the accumulated values, especially in the case of maximum temperature; the minimum temperature generally has no significance, while the average temperature attains significant values of 99% in the periods 1994–95 and 1997–98.

In order to determine the wind direction that most influenced the presence of Cupressaceae pollen in the atmosphere, an analysis was done on the number of hours in which each one of the four directions (first quadrant: NE direction, second: SE, third: SW and fourth: NW) was dominant. The correlation between the Cupressaceae pollen concentration and the NE direction has turned out to be positive and with a high level of significance for the six years as a whole as well as for each individual period. On the contrary, the SW winds correlate in a negative way in all cases. So, SW winds are those that least favour the presence of Cupressaceae in the air.

In the overall study of the six years with the meteorological parameters, precipitation and humidity have a negative correlation with the pollen concentration, with a significance value of 99%. The maximum and average accumulated temperatures positively influence the amount of Cupressaceae pollen, while with the minimum accumulated temperatures the correlation is not significant. Finally, the wind factor was 99% positively significant in the NE and SE directions, while the SW direction was 99% negatively significant in all cases.

4. Discussion

Cupressaceae pollen was present in the atmosphere, to a greater or lesser degree, during the entire period under study (January 1993 to December 1998), except for four months (August and November 1996 and July and September 1998), representing on average 5%

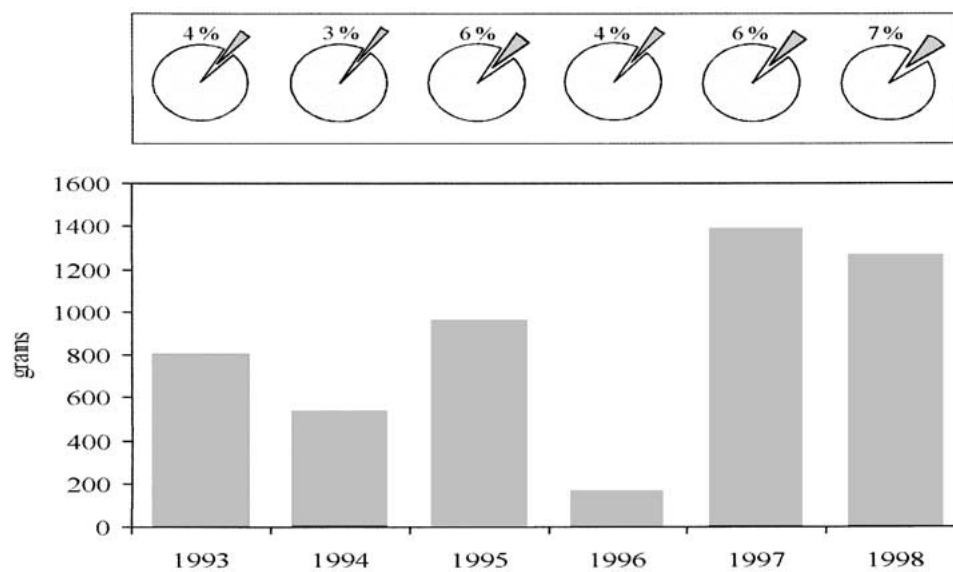


Figure 2. Annual variation of Cupressaceae pollen and representation in relation to total pollen.

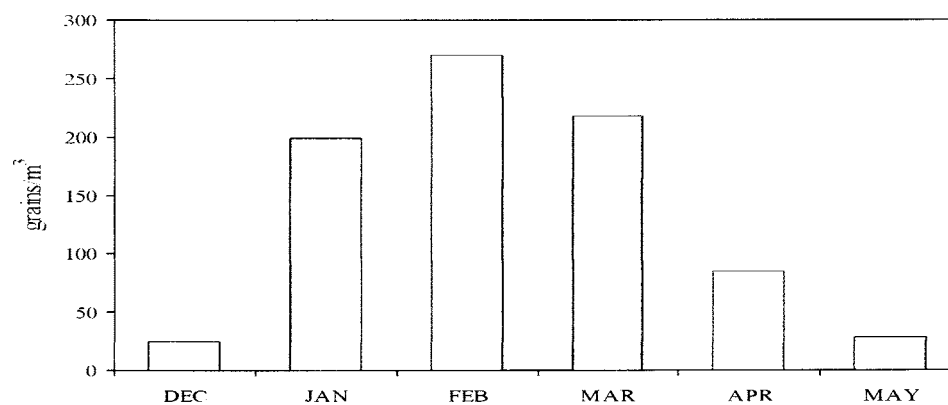


Figure 3. Average monthly values of Cupressaceae pollen during pollination period.

Table 1. Maximum values of Cupressaceae pollen attained during period under study

	1993		1994		1995		1996		1997		1998	
	Day	Valour	Day	Valour	Day	Valour	Day	Valour	Day	Valour	Day	Valour
December	14	5	2	8	7	1	25	2	17	3	15	8
January	26	33	28	37	12	38	25	2	12	118	10	69
February	16	41	13	13	6	37	18	6	10	85	10	73
March	24	40	5	42	25	69	11	7	27	52	20	50
April	7	19	13	10	1	55	29	4	4	19	25	5
May	5	3	3	2	4	9	1	1	1	6	7	8

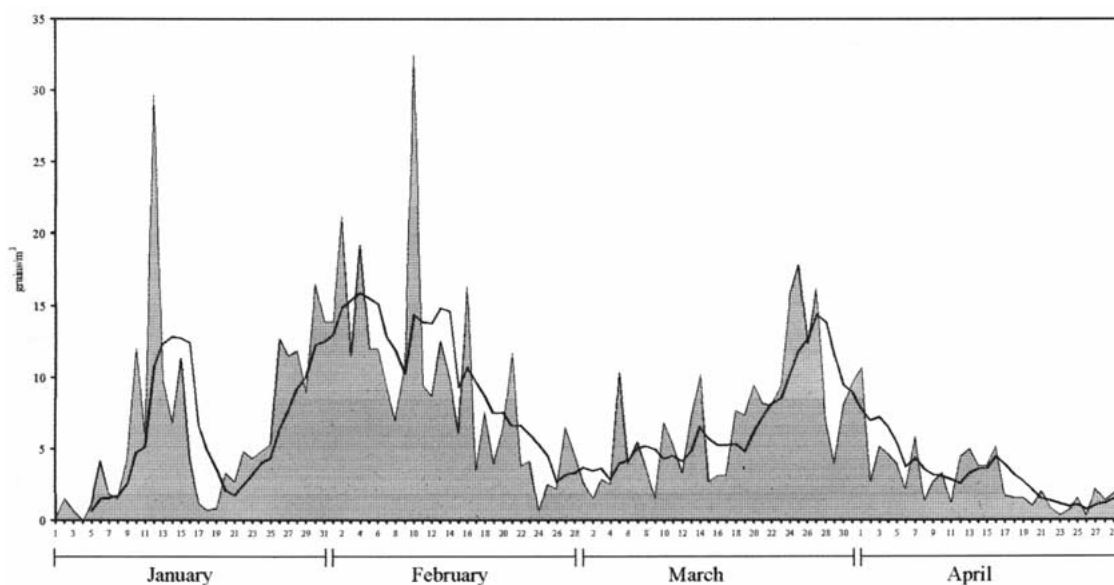


Figure 4. Daily variations of Cupressaceae and representation of running average.

PERIOD 93-98

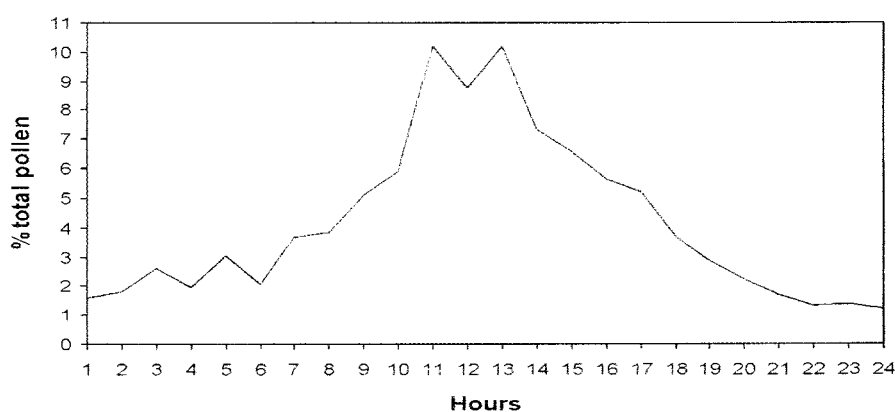


Figure 5. Intra-diurnal variation of Cupressaceae pollen.

of the total pollen count. This value is one of the highest recorded in the stations of the NW Iberian Peninsula (Fernández et al., 1998; Iglesias et al., 1998; Rodríguez et al., 1998), with the only exception of Ponferrada (León), which attained 38% in 1997 (Valencia et al., 1998). Along with *Alnus* and *Pinus* they are the most allergenic pollen type of the winter period. Their maximum levels are mainly recorded from December to April, reaching peaks between January and March, depending on the year. In accordance with studies carried out in other national and

European areas (Caramiello et al., 1991; Cimignoli et al., 1992; Galán et al., 1998; Luca et al., 1997; Romano et al., 1994), their presence during the rest of the year is much lower than that of these months.

The total pollen count of each year shows an important dependence on the meteorological parameters analyzed in this study. The maximum and average temperatures favoured the presence of Cupressaceae pollen in the air, while precipitation and humidity had a negative correlation. Small differences were observed in the single analysis of each

Table 2. Correlations between total Cupressaceae pollen during principal pollination period and meteorological parameters

	PERIOD					
	1993–94	1994–95	1995–96	1996–97	1997–98	1993/98
Precipitation	–0.441***	–0.366***	–0.173**	–0.201*	–0.643***	–0.398***
Humidity	–0.360***	–0.535***	–0.227***	–0.213**	–0.635***	–0.451***
Sun	+0.311***	+0.492***	+0.145**	+0.138	+0.390***	+0.325***
Temperatures						
Maximum	+0.292***	+0.581***	+0.162	+0.122	+0.630***	+0.403***
Minimum	–0.059	+0.306***	+0.010	–0.007	+0.181*	+0.054
Average	+0.167**	+0.555***	+0.083	+0.096	+0.549***	+0.324***
Two-day accumulated temperatures						
Maximum	+0.330***	+0.608***	+0.203***	+0.237**	+0.624***	+0.426***
Minimum	–0.066	+0.374***	–0.047	–0.030	+0.102	+0.040
Average	+0.177**	+0.583***	+0.077	+0.154	+0.491***	+0.330***
Wind run						
NE direction	+0.427***	+0.402***	+0.227***	+0.185*	+0.482***	+0.356***
SE direction	+0.239***	+0.123	+0.040	+0.082	+0.560***	+0.239***
SW direction	–0.297***	–0.365***	–0.161**	–0.359***	–0.552***	–0.285***
NW direction	+0.053	–0.203**	+0.008	–0.044	–0.386***	–0.046
Calm	+0.174**	–0.133	+0.092	–0.043	+0.407***	+0.139***

* 90%

** 95%

*** 99%

annual period; thus, during the periods 1993–94 and 1995–96 the smallest quantities of Cupressaceae pollen were found, due to the fact that precipitation was recorded almost constantly during the months of pollination, resulting in a continuous washing of the atmosphere; in other years intermittent precipitation occurred during those months, with higher levels being maintained in the air. Wind direction also played an important role in the presence of Cupressaceae pollen in the air, since in the days with the highest pollen levels the wind direction was always NE, with lower counts corresponding to those days on which the SW wind was more influential.

The onset of the pollination period is fairly variable in the case of winter-flowering species (Levetin, 1998), especially if it is taken into account the fact that the Cupressaceae family includes numerous species whose pollination periods overlap each other time-wise. Following Levetin's methodology, it was also observed that the years in which the onset of the pollination period was anticipated (December 13th for the period 1993–94 and December 25th for 1995–96) coincided with those in which a smaller pollen count was obtained. In the rest of the years of the

study period the onset did not take place until January (oscillating between the 7th and 12th) and the pollen concentrations were higher.

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