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CONCENTRACIONES DE POLEN DE CUPRESÁCEAS EN LA ATMÓSFERA DE VALENCIA (ESTE DE ESPAÑA) Y SU RELACIÓN CON LOS PARÁMETROS METEOROLÓGICOS

Cupressaceae pollen in the atmosphere of Valencia (East of Spain), and relationships with meteorological parameters

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RESUMEN: Este trabajo presenta la concentración polínica de Cupressaceae en Valencia (Este de España). El periodo principal de polinización, de los cuatro periodos anuales estudiados, ha sido definido de acuerdo con la fenología y se ha analizado estadísticamente la relación existente entre las concentraciones polínicas y los principales parámetros meteorológicos, obteniendo que los parámetros relacionados con la temperatura son los que se encuentran más correlacionados, mientras que los parámetros relacionados con el viento muestran peores correlaciones necesitando por tanto un estudio más detallado.

PALABRAS CLAVE: aerobiología, polen, Cupressaceae, Valencia.

SUMMARY: This paper presents data of airborne pollen concentration of Cupressaceae, in Valencia (East of Spain). According with the phenology we have defined the main pollen season of the four studied annual periods and we have analysed, statistically, the relationship between the pollen concentrations and the main meteorological parameters obtaining that temperature parameters are the more correlated while wind parameters have poor correlation results needing a more detailed study.

KEY WORDS: aerobiology, pollen, Cupressaceae, Valencia, Spain.

INTRODUCTION

Despite spring is the period of the year with the biggest pollinic concentrations, Cupressaceae pollen is responsible for the fact that the months of autumn and winter also display high levels too.

This pollen type includes species of three botanical families: Cupressaceae, which gives the name to the pollinic type, Taxaceae and Taxodiaceae. This taxonomical heterogeneity is caused by the similarity of the pollen which cannot be differentiated under optical microscopy (BORTENSCHLANGER, 1990), therefore it is not possible to detect the partial contribution of each species (HIDALGO *et al.*, 1999). However, knowing both the distribution and density of the populations of the species in the area of study and their capacity of pollinic production allows identifying the ones that mainly contribute to the whole pollen collected (HIDALGO *et al.*, 1999).

These three families are represented in different degree in the area of study. Cupressaceae is the most abundant taxon between autochthonous and allochthonous flora. Among the autochthonous taxa genus *Juniperus* is the most abundant, being part of the vegetation of the forest and the scrubland. On the other hand, among the alocton taxa, the genus *Cupressus* stands out with the species *Cupressus arizonica* E. L. Greene, *C. semprevirens* L. y *C. macrocarpa* Hartweg which are extensively used in gardening. Due to the urban situation of the trap, ornamental species are the most abundant and therefore, contribute in a large extent to total pollen amount. Taxaceae and Taxodiaceae families are less represented in this area, and their pollen production is lower than the groups described above, contributing in a small amount to the total pollen count (CARAMIELLO *et al.*, 1991).

This pollen is the only one with a high incidence in winter time, being its pollinosis the most important in this part of the year and thus clinically characterized (PANZANI *et al.*, 1991) and widely described both in the Mediterranean area (D'AMATO & LICARDI, 1994; LACOVACCI *et al.*, 1998) and Spain (GUERRA *et al.*, 1996; SUBIZA *et al.*, 1998; SUBIZA, 2001).

The aim of this work is to define the behaviour of this pollen type in Valencia's atmosphere as well as its variation in relation to the main meteorological parameters.

MATERIAL AND METHODS

Valencia is located in the middle east of the Iberian Peninsula (Fig. 1) and has a typical Mediterranean climate with a long dry period of four to five months. Mean annual temperature is 17 ºC, with small thermal fluctuations all through the year. Mean temperature ranges between 11.5 ºC in the coldest month (January) and 24.9 ºC in the warmest one (August). Annual average rainfall is 465 mm and usually occurs in autumn and spring.

Sampling was carried out during four years (September 1998 to August 2002), using a volumetric trap (HIRST, 1952), a Burkard seven-day-recording volumetric spore-trap sampler. It was located on the roof of the Faculty of Biology, at approximately 20 m above ground level and one kilometre from the city of Valencia. For pollen count the method recommended by the Red Española de Aerobiología was followed (DOMÍNGUEZ *et al.*, 1991). Data used correspond to the mean daily values expressed as number of pollen grains per cubic meter of air (p/m^3).

The annual periods were defined according to the Cupressaceae flowering phenology, therefore the starting point of the year was September and the end was August. Such definition has been used in similar works (DÍAZ DE LA GUARDIA *et al.*, 1998; AIRA *et al.*, 2001; GUTIÉRREZ *et al.*, 2001). Annual data was only used for the calculation of the percentage of Cupressaceae in relation with the rest of the pollen types recorded.

Main Pollen Season (MPS) was determined according to NILSSON & PERSSON (1981). Starting at the day in which the sum of the daily means reaches 5% of the annual amount, and ending when this sum reaches 95%. For its graphical representation five-day running means were used.

Spearman's correlation of the daily values was used to establish the relationship between pollen count and main meteorological parameters: mean maximum and minimum temperatures, rainfall relative humidity, sunshine, wind speed, wind direction and frequency of calms. These data were provided by the Centro Meteorológico Territorial de Valencia and were recorded at the meteorological station of Manises

FIGURE 1. Map showing the location of trapping site.

located at approximately 10 kilometre of the monitoring point.

To avoid the annual variations and according to MOSEHOLM *et al.* (1987), pollen data were standardized before the statistical analysis.

Due to the big amount of peaks produced by the different species included in this pollen type (Fig. 2) the habitual differentiation between pre-peak and post-peak period was not established and the correlation analysis was carried out for all the MPS.

To complement the statistical signification, the confidence intervals were calculated with significant correlation coefficient.

RESULTS

The annual sum average of Cupressaceae pollen concentration was approximately 1,000 p/m^3, being the most important pollinic type in amount (Table I).

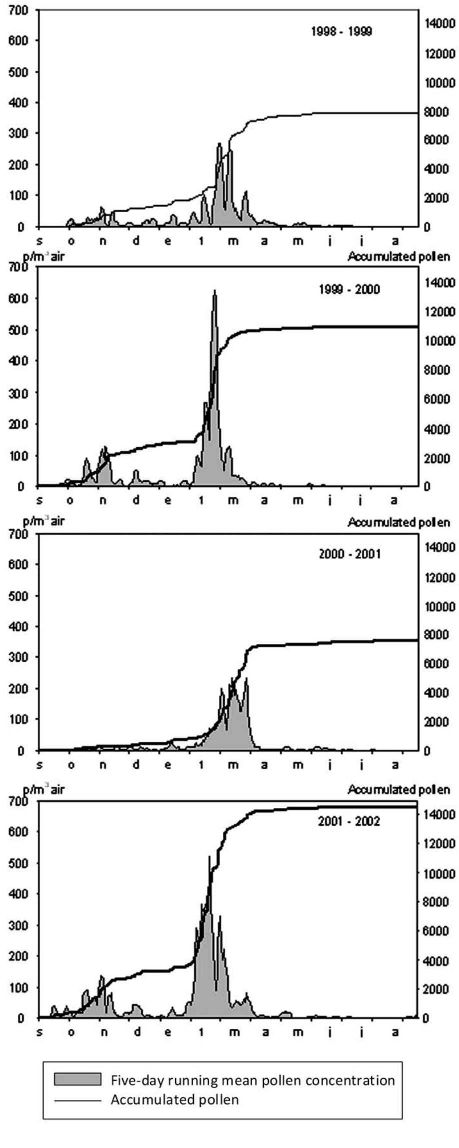

FIGURE. 2. Annual variation in five-day running means (1998-2002) and accumulated Cupresaceae pollen.

The maximum annual sum was registered in 01-02, with a total amount of 14,583 p/m^3 whereas the minimum annual quantities, 7,503 p/m^3, were recorded in 00-01 (Table II).

The date of the highest value (pollinic peak), ranged between the second half of February and beginning of March. Higher values for total amount were recorded when the pollinic peak was observed early in the year, 1,027 and 985 p/m^3, in 2000 and 2002 respectively, while lower values, 619 and 363 p/m^3, were identified when such pollinic peak appeared later in the year, 1999 and 2001 respectively (Table II).

Cupressaceae pollen was detected in Valencia's atmosphere all through the year. In agreement with the results of other spanish pollen monitoring stations (BELMONTE *et al.*, 1999), autumn and winter were the seasons in which maximum concentrations were recorded (Fig. 2), being October and November usually the months with the highest values (Table III), except for 2000, when important rainfall occurred at the moment of flowering. In winter time, February and March were the months with the highest annual concentrations (Table III). The lowest values were recorded in summer, being August the month with the minimum values, practically null.

MPS (Table IV) usually started in late October, with the exception of 2000 when rainfall delayed it until late November. The end of the season always took place at late March-early April. The length of the MPS differed little from one year to another, ranging between 162 days in 98-99 and 123 in 00-01. Despite not being the longer MPS, and

	1999	2000	2001	2002
Percentage	23%	32%	32%	39%

TABLE I. Cupressaceae percentage from total annual pollen.

Period	Total	Maximum	Date
98-99	7,794	619	03/03/1999
99-00	10,843	1027	16/02/2000
00-01	7,503	363	03/03/2001
01-02	14,583	985	10/02/2002

TABLE II. Total and maximum pollen values (p/m^3 air) and date of the highest value.

	Period			
Months	98-99	99-00	00-01	01-02
September	32	155	11	402
October	588	1,085	203	1,501
November	592	1,084	165	922
December	295	553	110	408
January	613	422	390	1,533
February	2,806	6,368	2,144	8,131
March	2,441	994	4,116	1,269
April	260	98	147	258
May	118	56	119	56
June	48	26	78	39
July	0	2	18	2
August	0	1	2	62

TABLE III. Monthly values (p/m^3 air) during the annual periods.

coinciding with the total annual values, the MPS of 99-00 and 01-02 had the highest records.

Correlation analysis (Table V) showed that temperature parameters invariably presented a positive correlation, usually

MPS	Total	Start date	End date	Lengh
98-99	7.052	24/10/1998	03/04/1999	162
99-00	9.849	18/10/1999	09/03/2000	144
00-01	6.753	29/11/2000	29/03/2001	123
01-02	13.303	15/10/2001	20/03/2002	157

TABLE IV. Data for airborne Cupressaceae pollen during the MPS.

	98-99	99-00	00-01	01-02
Mean temperature	+0.561**	+0.696**	+0.356**	+0,534**
Maximum temperature	+0.569**	+0.755**	+0.410**	+0,581**
Minimum temperature	+0.375**	+0.530**	+0.225*	+0,252**
Insolation	+0.304**	+0.331**	+0.223*	+0,511**
Rainfall	-0.136 N.S.	-0.273**	-0.134 N.S.	-0,400**
Relative humidity	-0.377**	-0.374**	-0.123 N.S.	-0,340**
Wind speed	+0.425**	+0.258**	+0.184*	+0,066 N.S.
1st quadrant	-0.047 N.S.	-0.033 N.S.	+0.084 N.S.	-0,120 N.S.
2nd quadrant	-0.095 N.S.	+0.164*	-0.017 N.S.	+0,218**
3rd quadrant	+0.343**	+0.250**	-0.062 N.S.	+0,178*
4th quadrant	-0.329**	-0.354**	-0.053 N.S.	-0,120 N.S.
Calm	-0.170*	-0.70 N.S.	-0.150 N.S.	+0,090 N.S.

TABLE V. Spearman correlation coefficients between daily average pollen concentrations and meteorological parameters during MPS. (**) $p < 0.01$, (*) $p < 0.05$ and (N.S.) p not significant.

with moderate values and with a high level of significance. Among those parameters, maximum temperature presented the highest coefficient values. Mean temperature greatly related with the previous parameter also presented high significantly positive correlations, while minimum temperature and sunshine showed lower correlation coefficients but with a high significance level, except in 00-01.

Rainfall and relative humidity coefficients were not always significant; however, when they were they had a high level, 99%, and a moderate value.

Regarding to wind parameters heterogeneous results were found, wind speed presented significant coefficients, 99%, with positive sign, but only with moderate value in 98-99, whereas in 99-00, the coefficient value was low despite having a good signification level, and in 00-01 the correlation coefficient was very low, in fact the lower limit of confidence was practically 0. Finally, in 01-02, there was not any correlation between wind speed and pollen concentrations. The wind from the third and fourth quadrant, south-west and north-west, showed moderated-low correlations during 98-99 and 99-00 with a significance level of 99%, having positive sign the former years and negative sing the later ones. No significative results were found related to calms.

DISCUSSION AND CONCLUSIONS

Cupressaceae pollen was the most abundant one in the monitoring station presenting a stable seasonal behaviour, with two stages of maximum presence, autumn and winter.

Total annual concentrations show different behaviour according to either a phenological or a natural year grouping. In the first case an annual alteration on concentrations can be observed as noted in other studies from the south of Italy (CAIAFFA *et al.*, 1993). Nevertheless, more data is needed in order to reach more reliable conclusions. On the other hand if such grouping is made considering natural years, the result is an increasing trend since 1999 until 2002, standing out the high increase observed in 2002 in which the total annual amount came up to a maximum of 14,583 p/m^3. This phenomenon occurred simultaneously with a great urban development of the area of study consequent with an ornamental utilization of this species.

In general terms February was the month with the maximum concentrations, except for 2001, in which, rainfall occurred in February slow down the pollination process; therefore the highest values occurred in March.

Starting and ending dates of the MPS have been enough homogeneous, and when it moved away from those dates the cause has been identified. In 00-01 period, the starting date took place later owing to rainfall occurred in the autumnal species pollinitiation moment. On the other hand, in 99-01 period an earlier end of the season occurred, because of an augment in the February temperatures, which reached a monthly average of 14 ºC against the sixty year average of 11 ºC.

Agree with previous Spanish studies (GALÁN *et al.*, 1998; CARIÑANOS *et al.*, 2000; AIRA *et al.*, 2001), best correlations coefficients have been found with thermal parameters, rainfall and relative humidity.

Despite negative effect of rainfall on atmospheric pollen concentrations is an easy deducible fact, widely documented, we have not found significant correlation all the years. The cause lies in the need to occur simultaneously pollen atmospheric presence and rainfall. For this we consider that against to rainfall, relative humidity is a more effective parameter and a clear proof of this are the good correlation coefficients obtained.

Wind correlations seem to indicate a positive variation in relation to third quadrant and negative with fourth quadrant. However the results are not much conclusive. We think that a detailed work including the phenology and the geographical distribution of the different species, could improve those results.

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