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ANNUAL VARIATIONS OF *CASTANEA* AIRBORNE POLLEN AT THIRTEEN SPANISH SITES

Iglesias, I.[1]; Jato, V.[1]; Aira, M.J.[2]; Sbai, L.[3]; Valencia, R.[4]; Recio, M.[5]; Sabariego, S.[6]; Cervigón, P.[7] & Cariñanos, P.[8]

[1] Departamento de Biología Vegetal y Ciencias del Suelo, Universidad de Vigo, Facultad de Ciencias, Campus Universitario As Lagoas, 32004-Ourense, Spain.
[2] Departamento de Biología Vegetal, Universidad de Santiago de Compostela; Facultad de Farmacia, 15706-Santiago de Compostela, Spain.
[3] Unidad de Botánica, Facultad de Ciencias, Universidad Autonoma de Barcelona, 08193-Bellaterra, Barcelona, Spain.
[4] Departamento de Biología Vegetal, Campus de Vegazana, Universidad de León, 24071-León, Spain.
[5] Departamento de Biología Vegetal, Facultad de Ciencias, Universidad de Málaga, 29080-Málaga, Spain.
[6] Departamento de Biología Vegetal, Facultad de Ciencias, Universidad de Granada, 18071-Granada, Spain.
[7] Departamento de Biología Vegetal II, Facultad de Farmacia, Universidad Complutense de Madrid, Plaza de Ramón y Cajal s/n., 28040-Madrid, Spain.
[8] Departamento de Biología Vegetal, Campus de Rabanales, Universidad de Córdoba, 14071-Córdoba, Spain.

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SUMMARY: This study analyses *Castanea* pollen concentrations at thirteen stations in different parts of Spain. Hirst-type spore-traps were used in all cases, and for different numbers of years. In general, the stations in the North of Spain collect greater overall quantities of this type of pollen. The main pollination period lasts from June to July, but may occur earlier in southeastern stations, even as early as April. At sites with higher pollen counts (Ourense, Vigo, Santiago de Compostela and Girona), a correlation analysis was made with temperature and rainfall by applying Spearman's non-parametric correlation test. The results obtained suggest positive and negative relationships with temperature and rainfall, respectively. Thus, the highest concentrations for this pollen type were obtained on days with higher temperatures and no rainfall.
KEY WORDS: *Castanea*, Chestnut, Spain, Aerobiology.

RESUMEN: En el presente trabajo se analizan los datos para el polen de *Castanea* recogidos en trece estaciones repartidas por todo el territorio peninsular. En todas ellas se han utilizado captadores tipo Hirst, que se han mantenido en funcionamiento durante un número variable de años. En general, las estaciones situadas en el norte de la península recogen cantidades totales mayores de polen perteneciente a este tipo polínico. El período de polinización principal se extiende a los meses de junio y julio, aunque en las estaciones situadas más al sur de la península éste comienza con anterioridad, incluso en el mes de abril. En las localidades en las que se recogen mayor cantidad de polen de este tipo polínico, Ourense, Vigo, Santiago de Compostela y Girona, se realiza un análisis de correlación con la temperatura y la precipitación. Para ello se ha utilizado el coeficiente de correlación no paramétrico de Spearman. Los resultados que se han obtenido sugieren una relación positiva con la temperatura y negativa con la precipitación, por lo que días con temperaturas más elevadas y ausencia de precipitaciones cabe esperar concentraciones más elevadas para este tipo polínico.
PALABRAS CLAVE: *Castanea*, Castaño, España, Aerobiología.

INTRODUCTION

The *Castanea* pollen type includes only one genus with two species, *Castanea sativa* Miller, with wide representation, and *Castanea crenata* Siebold Zucc. introduced and cultivated for its resistance to *Phytophtora* infection. These are great character trees. Their bark cracks lengthways in ripe types. Male flowers form catkins, 13-30 cm in length and 5-7 mm in diameter, which are green when ripe and yellow during the flowering period. The fruit is a dark brown and contains a shiny nut 2.5-4 cm.

In terms of morphology, these pollen are small grains, P 14-15 / E 9-11 µm, with three ectoapertures (colpus) and three endoapertures (pore) located in the equator. The exine is thin, approximately 1-2 µm thick, and the surface is rugulate. It has been classified as an allergen by MONSERRAT (1953), SAENZ (1978), HALSE (1984) and DOMINGUEZ *et al.* (1984). Allergenic diseases induced by *Castanea* pollen have been reported by various authors (LAURENT *et al.*, 1993, CARAMIELLO & GALLESIO, 1987 and ICKOVIC & THIBAUDON, 1991).

In terms of ideal weather conditions, the chestnut is not a very demanding tree and can survive in mild maritime weather conditions, both Briton type and Pyrenaic type, as well as in Mediterranean or continental conditions. The most adverse growth conditions are cold weather and drought. In bioclimatological terms, the chestnuts are found at altitude below 1200 m, and grow well in wet, moist and moist Mediterranean conditions. The frost-free period must be less than 300 days a year. This tree can therefore be found on plains, hills and middle mountains, close to supra-Mediterranean and sub-Atlantic areas. In more Mediterranean locations, it is perfectly adapted to shady areas, protected from dry summer weather. In areas with a greater Atlantic influence, it prefers northern slopes.

The chestnut is not a lime species, although it can grow on poor ground. Ideally, this should be fertile, light, deep, well-drained soil, with low active limestone content, rich in K and with a reduced acid pH (BOURGEOIS, 1992), common characteristics which predominate in siliceous areas with granite or derivative sands from the destruction of schists or gneiss.

In Spain, chestnut can be found in Galicia, on the Cantabrian coast, in high and milder valleys in Galician, Asturian and Cantabrian mountain ranges and in the Western Pyrenees to the Mediterranean coast, where it forms small groups on the Penibaetic mountains in Málaga and Granada. In western Spain, the chestnut can be found in many places between La Coruña and Huelva, thanks to the mild zones influenced by the Atlantic Ocean. In central Spain, the chestnut appears in Cáceres, Salamanca and Avila, up to the Sierra of Gredos (VIETIEZ, 1996). The study area is very extensive, with climatological and phytogeographical differences between the north and south of the Iberian Peninsula. The individual characteristics of different cities have been studied by BELMONTE *et al.* (1995), CABEZUDO (1995), FERNÁNDEZ & VALENCIA (1995), IGLESIAS *et al.* (1995) and GUTIE-RREZ & NAVARRO (1998).

MATERIALS AND METHODS

The results from thirteen locations were analyzed; nine of these were in the North of Spain (Galicia, Cataluña, Castilla-León and Madrid) and the other four in Andalucia.

In order to determine the main pollination

period, the curve for the accumulated period was obtained, and the inflexion points of each curve taken as the start and end of said period. (PATHIRANE, 1975).

The dates for each sample point were determined for the different groups belonging to the REA (Spanish Aerobiology Network). The same method was applied for all groups and samples taken over seven days using a Hirst-type spore trap. The preparation and handling of samples was the same for all groups, in accordance with the instructions provided by DOMÍNGUEZ *et al.* (1991).

RESULTS AND DISCUSSION

Prior to examining the values for each of the thirteen locations, the northern cities (Ourense, Santiago de Compostela, Vigo and Girona) were known to have the greatest concentrations of this pollen. Table 1 shows that in 1993 Ourense presented the highest *Castanea* pollen count (1392 grains/m^3) of all the cities and years studied. In Santiago de Compostela, total counts were higher than 1000 grains/m^3 in 1993, 1997 and 1998. This was also the case in Girona in 1996. Counts for central Spain (León or Madrid) were lower –only 300 grains/m^3 in 1996– in 1998.

In northeastern Spain, values ranged between 254 grains/m^3 in 1994 and 104 grains/m^3 in Barcelona. High concentrations were recorded in Lleida, with only two sampling years.

In the other cities, counts were much lower, with few counts over 100 grains/m^3; this was the case in Granada in 1993 and 1994, and in Málaga in 1996 and 1997. Another striking result was the total pollen count in Estepona in 1997, which reached 536 grains/m^3.

Locations	1992	1993	1994	1995	1996	1997	1998	mean
Ourense	417	1392	982	897	1040	672	590	855
Santiago		1031	986	595	255	1017	1041	821
Vigo				580	870	586	823	715
Girona					1002	411	599	671
Estepona				193	195	536		308
Tarragona					466	146	154	255
León			81	90	322	203	224	184
Barcelona			254	159	204	104	193	183
Madrid			95	79	147	110	331	152
Lleida					150		106	128
Málaga	33	65	92	89	161	142	59	92
Granada	56	120	181	36	31	22	31	68
Córdoba		6	6	8	80	32	19	31

TABLE 1. Total pollen counts at the different locations during the study period. The last column shows the mean count for each location. In each case, the number of years is different.

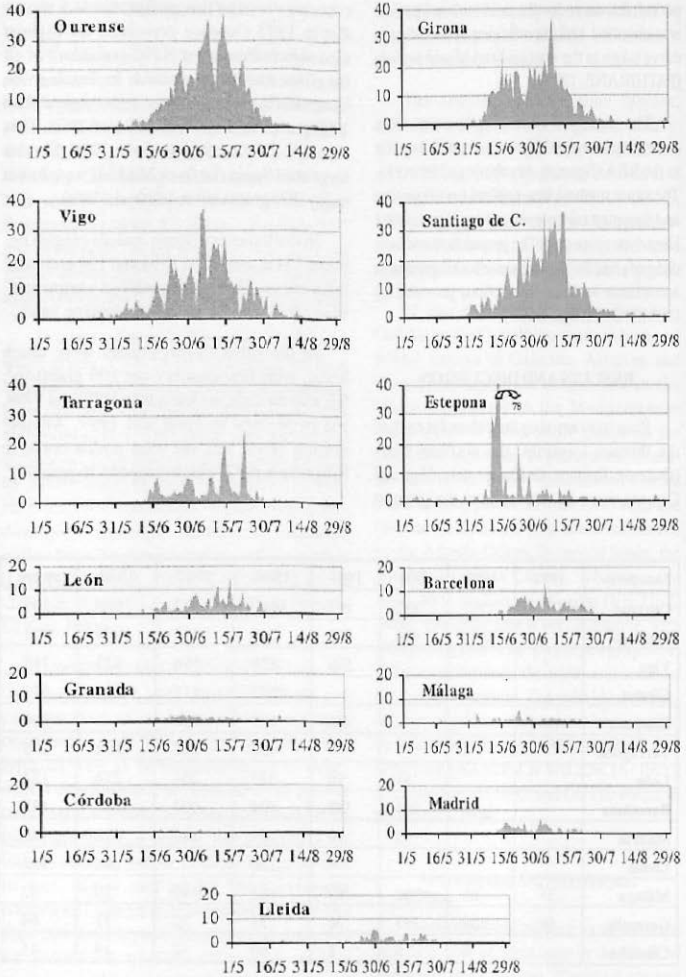

FIGURE 1. Mean period obtained during the year studied. the dates are represented in the horizontal axis, and the daily average pollen concentration (pollen grains/m³) in the vertical axis.

Sites	Years	MPP	Max	Dates
Ourense	1992	20-6/26-7	71	14-7
	1993	20-6/04-8	78	08-7
	1994	18-6/21-7	77	13-7
	1995	14-6/25-7	71	25-6
	1996	23-6/28-7	67	13-7
	1997	07-6/21-7	86	04-7
	1998	25-6/03-8	55	10-7
Vigo	1995	05-6/14-7	50	22-6
	1996	22-6/31-7	71	11-7
	1997	03-6/19-7	102	06-7
	1998	15-6/15-8	77	14-7
Santiago	1993	23-6/26-7	123	13-7
	1994	21-6/23-7	130	05-7
	1995	15-6/26-7	77	23-6
	1996	23-6/27-7	16	14-7
	1997	06-6/15-7	70	17-6
	1998	14-6/01-8	81	04-7
Girona	1996	11-6/28-7	74	08-7
	1997	02-6/07-7	37	06-7
	1998	09-6/22-7	48	08-7
Lleida	1996	23-6/28-7	11	13-7
	1998	21-6/28-7	15	30-6
Tarragona	1996	14-6/24-7	68	21-7
	1997	12-6/16-7	25	09-7
	1998	26-6/30-7	20	01-7
Barcelona	1994	19-6/12-8	52	05-7
	1995	23-6/27-7	20	24-6
	1996	25-6/25-7	15	20-7
	1997	11-6/28-7	10	15-6
	1998	22-6/27-7	20	29-6
León	1994	28-6/12-7	20	02-7
	1995	13-6/20-7	12	16-7
	1996	25-6/22-7	39	20-7
	1997	14-6/17-7	22	20-6
	1998	28-6/29-7	29	16-7
Madrid	1993	10-7/27-7	08	20-7
	1994	12-6/15-7	08	12-7
	1995	12-6/04-7	12	19-6
	1996	19-6/25-7	21	01-7
	1997	12-6/04-7	17	15-6
	1998	01-6/30-6	31	05-6
Granada	1992	25-6/25-7	10	03-7
	1993	12-6/06-8	11	26-6
	1994	15-6/04-8	19	29-6
	1995	14-6/19-7	03	21-6
	1996	23-6/17-8	03	30-6
	1997	10-6/23-7	05	25-6
	1998	11-7/06-8	05	04-8
Córdoba	1996	02-5/11-7	05	15-6
	1997	13-6/01-7	04	18-6
	1998	26-4/09-8	03	19-5
Málaga	1992	07-6/11-7	05	22-6
	1993	04-6/02-8	03	22-6
	1994	01-6/04-7	19	25-6
	1995	26-5/18-7	08	12-6
	1996	09-5/24-7	08	17-5
	1997	21-4/16-7	21	04-6
	1998	28-4/20-7	04	04-7
Estepona	1995	07-5/06-7	66	13-6
	1996	16-5/24-7	51	22-6
	1997	07-6/26-6	233	13-6

TABLE 2. Main values for the main pollen season at the thirteen locations studied. Maximum values are mean daily values.

The highest values, as well as the highest overall values, often corresponded to the Northwest, as shown in Figure 1 and Table 2. Thus, the highest values were recorded in Santiago de Compostela, with 130 grains/m^3 in 1994, in Vigo with 102 grains/m^3 in 1997 or in Ourense, where the highest average pollen count, as will be seen later, was only 86 grains/m^3 in the same year.

In the Northeast, values were lower; 76 grains/m^3 in Girona in 1996, 68 grains/m^3 in Tarragona in 1996, and only 52 grains/m^3 in 1994 in Barcelona. In central Spain, the most significant results were recorded in Leon, with 39 grains/m^3 in 1996, and in Madrid, with 31 grains/m^3 in 1998. In the South, no more than 19 grains/m^3 were recorded in any year in Granada, Córdoba and Málaga. Significantly, the highest count in Andalusia was recorded in Estepona in 1997 with 233 grains/m^3, the highest of the study period. Although this was only one value, higher values are recorded in this town than in the rest of Andalucia.

The period of highest pollen concentration in southern Spain tended to occur earlier than in the northern sampling points. Thus, in places like Estepona or Málaga, these higher values were obtained half-way through June or even in May, whereas in the North, these values were not recorded until the first half of July.

In terms of the sites with the highest annual average counts for different years, Ourense presented the highest average with 855 gp/m^3, followed by Santiago de Compostela, (827 grains/m^3), Vigo and Girona (700 grains/m^3), Estepona and Tarragona (300 and 200 grains/m^3), León, Barcelona, Madrid, Lleida and Málaga (100 grains/m^3) and finally Granada and Cordoba less than100 grains/m^3.

As regards the respective counts at sites where the interannual average is over 500 grains/m^3, a correlation, using the "Statistica" statistic package, was made with the average temperature and rainfall during the main pollination period.

Since the data distribution was not normal, Spearman's non-parametric correlation coefficient was determined. The results show

Locations	Ourense		Santiago		Vigo		Girona	
Years	Avg. T°	Rainfall	Avg. T°	Rainfall	Avg. T°	Rainfall	Avg. T°	Rainfall
1992	**0.496****	**-0.443****						
1993	0.120	**-0.564****	-0.133	-0.144				
1994	**0.335***	-0.305	**0.436****	**-0.448****				
1995	**0.372****	-0.185	0.000	0.289	0.116	-0.138		
1996	0.119	**-0.375***	**0.448****	**-0.535****	**0.621****	**-0.619****	**-0.392****	-0.073
1997	-0.095	-0.267	**0.419****	-0.217	**0.552****	**-0.429****	**0.574****	**-0.432****
1998	**0.347***	**-0.361***	**0.937****	-0.260	**0.279***	**-0.472****	0.159	-0.202
Total	**0.308****	**-0.287****	**0.270****	**-0.155***	**0.407****	**-0.419****	0.149	**-0.281****

TABLE 3. Spearman's Correlation coefficients for the locations in which the total t. Castanea pollen count is higher. (* $p<0.05$, ** $p<0.01$).

the existence of a positive and, in most cases, 99% significant correlation with average temperature, albeit negative with rainfall, such as analyzing the years one by one, as considering all of them together. The results of this correlation test are shown in Table 3.

CONCLUSIONS

In general terms, the interannual behavior of overall pollen counts in the different years and sites studied was similar.

The annual pollen index and the maximum value were always higher in northern locations.

The behavior of the beginning of the main pollen season is different to that of the annual pollen count. In some southern cities such as in Málaga or Córdoba, pollination starts much sooner, even as early as April. In the north, pollination is similar to that of summer trees, since more pollen and peak pollen counts are obtained in June and July.

In general terms, it may be concluded that temperature plays an important role in pollination and, therefore, on the airborne concentration of this pollen type. In this connection, the correlation coefficient provides significant positive values in several cases and at numerous sites.

In contrast, rainfall seems to have a different effect. The value of the correlation coefficient was negative in almost all cases.

Thus, hot summers would appear to foster the presence of this pollen type in the atmosphere, whereas rainfall washes out airborne pollen, prompting a decrease in pollen concentration.

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REFERENCES

BELMONTE, J.; ROURE, J.M.; BOTEY, J. & CADAHÍA, A. (1995) Aerobiologia de Catalunya. Pont de Suert, Girona, Bellaterra, Barcelona, Tarragona, Roquetes (Tortosa) and Lleida. **Bol. Red Esp. Aerobiol.** 1:87-102.

BOURGEOIS, C. (1992). **Le chatinier: un arbre, un bois.** IDF, Paris.

CABEZUDO, B. (1995) . Aerobiología de Andalucía. Vegetación. **Bol. Red Esp. Aerobiol.** 1:13-14.

CARAMIELLO, R. & GALLESIO, M.T. (1987). **Il castagnio: specie di interesse allergologico.** Riassuti 18° Cogresso della Società Italiana di Allergologia ed Immunologia Clinica. pp. 28. Firence.

DOMÍNGUEZ, E.; UBERA, J.L. & GALÁN, C. (1984). **Polen Alergógeno de Córdoba.** Publicaciones del Monte de Piedad y Caja de Ahorros Córdoba, Córdoba.

DOMÍNGUEZ, E.; GALÁN, C.; VILLAMANDOS, F. & INFANTE, F. (1991). **Handling and evaluation of the data from aerobiological sampling. REA Monogr.** 1:1-18.

FERNÁNDEZ, D. & VALENCIA, M.R. (1995). Red Española de Aerobiología. Estación de la Universidad de León. **Bol. Red Esp. Aerobiol.** 1:81-85.

GUTIERREZ, M. & NAVARRO P. (1998). Aerobiología en Madrid: Estación Ciudad Universitaria (1995-1996). **Bol. Red Esp. Aerobiol.** 3:85-88.

ICKOVICH, M.R. & THINBAUDON, M. (1991). Allergenic significance of Fagaceae pollen. In: G. D'AMATO, F.TH. SPIEKSMA & S. BONINI (eds). **Allerllenic pollen and pollinosis in Europe,** pp. 98-108. Blackwell Sci. Pub., Oxford.

IGLESIAS, I.; JATO, V. & IZCO, J. (1995). Acropalinología en Galicia. **Bol. Red Esp. Aerobiol.** 1:109-115.

LAURENT, J.; LAFAY, M.; LATTANZI, B.; LEGALL, C. & SAUVAGET, J. (1993). Evidens for Chesnut pollinosis in Paris. **Clin. Exp. Allergy** 23:39-43.

MONTSERRAT, P. (1953). La polinosis en Canarias. **Museo Canario** 45(48):65-129.

PATHIRANE, L. (1975). Graphical determination of the main pollen season. **Pollen et Spores** 17(4):609-610.

SÁENZ, C. (1978). **Polen y esporas. Introducción a la Palinología y vocabulario palinológico**. Blume, Madrid.

VIEITEZ CORTIZO, E.; VIEITEZ MADRIÑÁN, M.L. & VIEITEZ MADRIÑÁN, F.J. (1996). **El Castaño**. Edilesa, León.