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Short Communication

Airborne pollen records and status of the anemophilous flora in arid areas of the Iberian Peninsula

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ABSTRACT

This paper reports on the relationship between the airborne pollen spectrum and the status of anemophilous flora in the south-eastern Iberian Peninsula. Variations in pollen counts with respect to data for a previous sampling period were also examined. The key finding was that the spectrum contained pollen from the most characteristic local species, such as xerophytes adapted to arid conditions, ruderal and nitrophilous species, sclerophyllous Mediterranean pine and holm-oak forest and vegetation in dry watercourses. The main variations with respect to earlier data were attributable to changes in land use, with increasing production of certain crops and a growing trend towards ecological agriculture, the introduction of allochthonous species and the recovery of local flora in dry watercourses.

The flora of any given territory is largely the result of the substrate on which it grows and of local bioclimatic conditions. The unique characteristics of the south-eastern Iberian Peninsula have prompted such a wide variety of endemic flower species (Sagredo, 1987), that the area has been recognised as a Centre of Plant Diversity in the Mediterranean (Médail and Quézel, 1997; Molero-Mesa, 1994; Peñas et al., 2005; Pick up et al., 1995).

The major contributory factors are an annual rainfall of barely 400 mm, and often considerably less, and a summer drought period lasting over two months. These conditions commonly give rise to xerophytic plants, adapted to long periods of drought and able to withstand over 3000 h of sunlight per year (Allue-Andrade, 1990; Capel-Molina, 1981). The specific substrate composition of local soils is also of interest, in that it has led to the development of a number of plants displaying a strong preference for the abundant limestones and dolomites (Mota et al., 1993, 2004, 2008).

The analysis of airborne pollen released during the pollination period provides substantial information on local plant status (Alba et al., 2008; Trigo et al., 2006). Long-term data sets, where available, enable the researcher to chart the dynamics, behaviour and response of various species to changing – and at times restrictive – climate situations (Cariñanos et al., 2004; Frenguelli, 2002; Frenguelli et al., 2004; Fuad-Hassan et al., 2008). Studies show that the pollen spectrum in the south-eastern Iberian Peninsula includes pollen grains from natural vegetation, ruderal and nitrophilous species, crops and ornamentals; xerophytic plants adapted to salty soils and soil water deficit are major contributors to the spectrum (Alba et al., 2008; Cariñanos et al., 1998, 2000, 2004; Moreno-Grau et al., 2000; Sabariego et al., 2000).

This study sought to chart 1) the relationship between airborne pollen counts and the status of the anemophilous flora in an arid environment, and 2) variations in the pollen spectrum by comparing recent records with data recorded some years earlier. The effects of human activity (i.e. changes in land use, ecological production and introduction of allochthonous species), and the influence of rainfall patterns and temperature, were also examined.

The study was carried out at Chirivel (37°30′N, 2°11′W, 1114 m a.s.l.), a small rural village located on the sunny slopes of the Sierra de Maria in the north of Almeria province, south-eastern Iberian Peninsula. The area lies within the Western-Mediterranean region, biogeographical sector Guadiciano-Bacense, chorological province Murciano-Almeriense (Rivas-Martínez et al., 2002). The climate may be defined as arid or semi-arid, depending on the bioclimate index used, with a Precipitation/Temperature (P/T) ratio of <2 for more than nine months a year, a dry season lasting over two months (Allue-Andrade, 1990), and over 3000 h of sunlight per year (Capel-Molina, 1981). Although the annual rainfall index is about

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400 mm, over recent years annual rainfall values have ranged around 200–250 mm or even lower. By contrast, torrential rains (over 100 mm in less than 24 h) have become more frequent (AEMET, Western Andalusian Office). Mean temperatures remain in the range 12.5–13 °C, with marked oscillations between very cold winters – subzero temperatures and frequent frosts – and mild summers.

In terms of potential vegetation, the area is characterised by the Mesomediterranean series of Oak (*Bupleurum rigidi–Quercetum rotundifolia*), with *Quercus rotundifolia and Quercus coccifera* as characteristics species, sharing area with communities of *Pinus* and *Juniperus* (Valle, 2003). Mediterranean maquis and mountainous shrub vegetation mainly comprises species belonging to the families Asteraceae, Amaranthaceae, Lamiaceae, Cistaceae and Fabaceae.

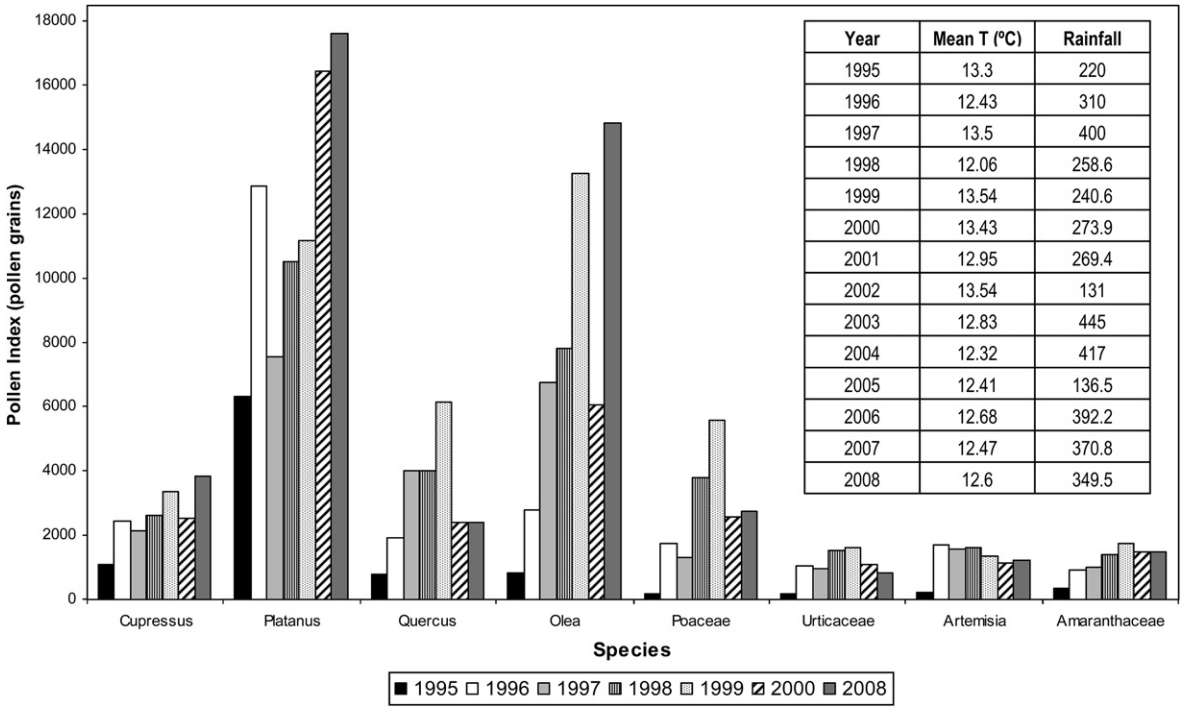
To determine airborne pollen content, a Hirst-type volumetric sampler (Hirst, 1952), reinstalled at the Chirivel Town Hall, ran constantly from January to December 2008. The installation conditions and sampling method were exactly as used in a previous study covering the period 1995–2000 (Cariñanos et al., 2004), in order to ensure data comparability. Sampling was performed following the procedures recommended by the Spanish Aerobiology Network in its Quality and Management Manual (Galán et al., 2007), which consists in drawing air at a rate of 10 l/min, and trapping the pollen grains on a Melinex tape coated with silicon fluid as adhesive. Microscopic analysis enabled pollen counts (expressed as grains/m^3 of air) and differentiation of pollen types from a range of mostly-anemophilous plant species.

Given the well-documented relationship between weather parameters and pollen production in plant species, data on average temperatures (maximum and minimum) and rainfall, and pollen data for the eight most common pollen types, were statistically analysed (Spearman's non-parametric test) in order to ascertain the response of each taxon to given conditions.

The results showed that the airborne pollen spectrum for Chirivel in 2008 comprised 44 pollen types, 22 from tree species and the other 22 from shrubs/herbaceous species (Appendix 1). Six of the 44 species were not detected during the previous sampling period: *Aesculus, Cedrus, Cistus, Eleagnus*, Myrtaceae and *Typha*, and a further 10 were detected only sporadically. The annual Pollen Index, defined as the daily sum of pollen grains collected during one year, was 52,428 grains; tree species accounted for 83.3% of the total and shrubs/herbaceous species for 16.65%. Maximum monthly airborne pollen counts were recorded from late winter to the end of summer, the peak counts being observed in April (17,388), due to the full flowering of *Platanus* and the start of the *Olea* flowering season. By contrast, minimum values were recorded in December (159 pollen grains, mostly from *Artemisia* and – to a lesser extent – from Cupressaceae and Urticaceae). It should be noted that the Annual Pollen Index in 2008 was the highest of the available data series 1995–2008; it was similar to that of 1999, and well above those recorded in the drought years 1995 and 1996.

The longest pollen season was recorded for Amaranthaceae, a merger of Chenopodiaceae and Amaranthaceae based on molecular systematics (Angiosperm Phylogeny Group, 2003), whose pollen was present in the air for more than 200 days in 2008; slight shorter seasons were recorded for Urticaceae and *Artemisia* (Appendix 1).

Pollen Indices for the 8 main taxa (4 tree: *Cupressus, Platanus, Quercus* and *Olea*, and 4 shrubs/herbaceous: Poaceae, Urticaceae, *Artemisia* and Amaranthaceae) are shown in Fig. 1, together with temperature and rainfall values for the series 1995–2008. For three of the taxa, *Cupressus, Platanus* and *Olea*, 2008 indices were the highest of the series. Also remarkable was the heterogeneous distribution of the Pollen Index, with increasing trends for *Platanus* and *Cupressus*, alternating peaks and troughs for *Quercus* and Poaceae, and very little difference between maximum and minimum Pollen Indices for *Artemisia* and Amaranthaceae. Analysis of average temperature and rainfall values over the same period showed that temperatures remained close to the mean value of 13 °C for the area as a whole over the last 25 years (Capel-Molina,



Year	Mean T (°C)	Rainfall
1995	13.3	220
1996	12.43	310
1997	13.5	400
1998	12.06	258.6
1999	13.54	240.6
2000	13.43	273.9
2001	12.95	269.4
2002	13.54	131
2003	12.83	445
2004	12.32	417
2005	12.41	136.5
2006	12.68	392.2
2007	12.47	370.8
2008	12.6	349.5

Fig. 1. Pollen Index in pollen grains for the main pollen taxa: *Cupressus, Platanus, Quercus, Olea,* Poaceae, Urticacaceaea, *Artemisia* y Amaranthaceae detected in the atmosphere of Chirivel during the period 1995–2000 and 2008. In table: Meteorological parameters (Average temperatures and Annual rainfall) recorded in Chirivel during the period 1995–2008.