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Annual, daily and diurnal variations of Urticaceae airborne pollen in Málaga (Spain)

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Abstract

In the Mediterranean area, Urticaceae pollen, together with the pollen of olive and grasses, are the aeroallergens with the highest incidence in the population. From October 1991 to September 1993, with the aid of a Burkard spore-trap, we carried out a study on the Urticaceae pollen content in the atmosphere of Málaga, a seaside resort situated in the Costa del Sol (southern Spain). In Málaga, the Urticaceae pollen season is very long and their pollen grains are detected throughout the year. However, peaks were recorded in March and April and the variables most influencing concentration were maximum air temperature, sunshine hours and relative humidity. Diurnal patterns show that peaks occur generally from 10:00 h to 16:00 h when the temperature reaches its highest values.

Keywords: Aerobiology; Pollen; Urticaceae; *Parietaria*; Southern Spain; Málaga

1. Introduction

Málaga is located in southern Spain (latitude 36°47′ N; longitude 4°19′ W). It has a Mediterranean climate, characterized by a mean temperature of 12°C in the coldest month (January) and 25°C in the hottest month (August). The annual rainfall is about 450 mm with two rainy periods, one in spring and the other in autumn.

In this Mediterranean area, Urticaceae pollen, together with the pollen of olive and grasses, are the aeroallergens with the highest incidence in the population. In fact, *Parietaria* is the most important allergenic plant in some of the regions bordering the Mediterranean Sea (Bousquet et al., 1986; D'Amato et al., 1991, 1992). In Málaga, the species belonging to this taxon are: *Parietaria judaica* L., *Parietaria mauritanica* Durieu in Duchartre, *Urtica urens* L. and *Urtica membranacea* Poiret in Lam. They are ruderal weeds, very common on ancient walls and other nitrificate places. Despite the fact that *Parietaria* and *U. dioica* have triporate pollen grains and *U. membranacea* smaller polipantoporate pollen grains, both pollen types have been studied together.

2. Materials and methods

The sampling was carried out from October 1991 to September 1993 using a Burkard spore-trap, located on the roof of the Faculty of Medicine building of Málaga University, about 15 m above ground level. The site is located 1 km west of the town center, in an open space, without any surrounding buildings.

The pollen data, expressed as grains per cubic metre of air per day, were obtained by counting hourly, four horizontal sweeps on the slide with a × 40 objective (0.45 mm field) (Domínguez Vilches et al., 1991). In Fig. 1a, the weekly average (4 periods per month) are represented.

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The main pollen season for each year has been defined using the methodology of Pathirane (1975) and the model of Mullenders et al. (1972). These authors use the cumulative percentages beginning at the moment considered as the start of the pollination period. For this model, the weekly cumulative percentage has been used.

The diurnal variation patterns have been calculated considering only dry days with no rainfall, when the number of pollen grains were equal to or more than twice the daily average; 95% of the annual count was taken from the days in which the cumulative sum reached 2.5% of the seasonal total. For the diurnal temperature curve, the same days were taken into consideration.

The correlations between pollen concentrations and meteorological variables were obtained with the Pearson's product-moment correlations, using the daily average values. These data were first transformed into their logarithmic values to get normal models. Daily meteorological data were provided by the Málaga Airport station through the Regional Meteorological Institute of Málaga. This station is located 5 km west of the sampling site, and the selected variables were: mean, minimum and maximum air temperature; sunshine hours; relative humidity; mean wind velocity and wind direction, the latter expressed as frequency percentages.

3. Results

The Urticaceae pollen season in Málaga (Fig. 1a) is very long, and this pollen type is present in the air throughout the year. The annual patterns show that the peaks were obtained in March and April while the lowest concentrations were recorded during August, September and October, rising again in early November with the first rainfall.

The cumulative percentage curves were very similar during the 1991–1992 and 1992–1993 periods. The main pollen season occurred from the third week of January to the last week of June, lasting 128 days, when 85% of total annual pollen was collected (Fig. 2).

The correlations between pollen concentrations and temperature, relative humidity, sunshine and wind velocity show that the most influential variables were maximum temperature, especially during March and April, followed by sunshine, mean temperature and relative humidity (Table 1).

In the diurnal graph (Fig. 3a), very similar trends were obtained during 1992 and 1993. This graph was plotted with two-hourly counts and shows that the highest Urticaceae pollen concentrations were recorded between 10:00 and 16:00 h (35.56% of the daily total pollen in 1992 and 42.48% in 1993), reaching a peak around midday (12:00–14:00 h).

4. Discussion

The Urticaceae pollination period found in Málaga is similar to that of other Mediterranean cities such as Barcelona, Palma de Mallorca (Belmonte and Roure, 1991; Mañas et al., 1990), Naples (D'Amato et al., 1983, 1991, 1992) or Tesalónica (Gioulekas et al., 1991), where the main pollen season occurs from the end of winter to early spring with maximum peaks in March and April, and a secondary peak at the end of May or early June, due to the last spring rainfall.

The correlations obtained pinpoint the maximum temperature and sunshine as the most influential variables in the flowering of these species (Table 1), especially during March and April when the concentration of atmospheric pollen is the highest. The same variables are not correlated after April, probably due to drought stress. However, peaks seem to be determined by rainfall levels, rainy periods followed by prolonged sunshine intervals being the main reason for the increase of pollen concentrations in the atmosphere. 1992 and 1993 were very similar in temperature (Fig. 1b) and sunshine hour patterns but not in rainfall frequencies, especially in March, with more rain in 1993. This high level of rain favoured a higher peak in April of the same year. This observation agrees with the data obtained by D'Amato et al. (1983) and by Fornaciari et al. (1992) for Naples and Perugia, respectively, where the highest peaks of Urticaceae pollen concentration were related to the rainfall observed during the previous period.

For relative humidity, the correlation analysis showed negative coefficient values, but these values are significant only in February 1993. This lack of significant correlation is probably due to the fact that, in Málaga, relative humidity is generally high. In addition we have observed that rainfall negatively affects the pollen concentration collected by the sampler, however this phenomenon is temporary (Fig. 1a,c).

The correlation coefficients do not show clear trends with mean wind velocity (Table 1). At first, we could have expected that an increase in wind velocity would facilitate the atmospheric pollen dispersal, but it seems possible that our results were also influenced by wind direction. In Málaga the prevailing winds blow from south-east (SE) and north-west (NW); calm periods account for about 6% of the annual total (García de Pedraza and García Vega, 1991). When a NW wind blows, it carries a lot of pollen from the inland areas, with a SE wind, coming from the sea, it partially clears the atmosphere, distorting the results. So, as can be seen from Table 1, when we obtain significant correlation coefficients with SE and NW wind direction, they show a negative sign for SE wind and a positive sign for NW wind.

The diurnal rhythm of Urticaceae pollen in Málaga (Fig. 3a) shows a similar trend to that obtained in

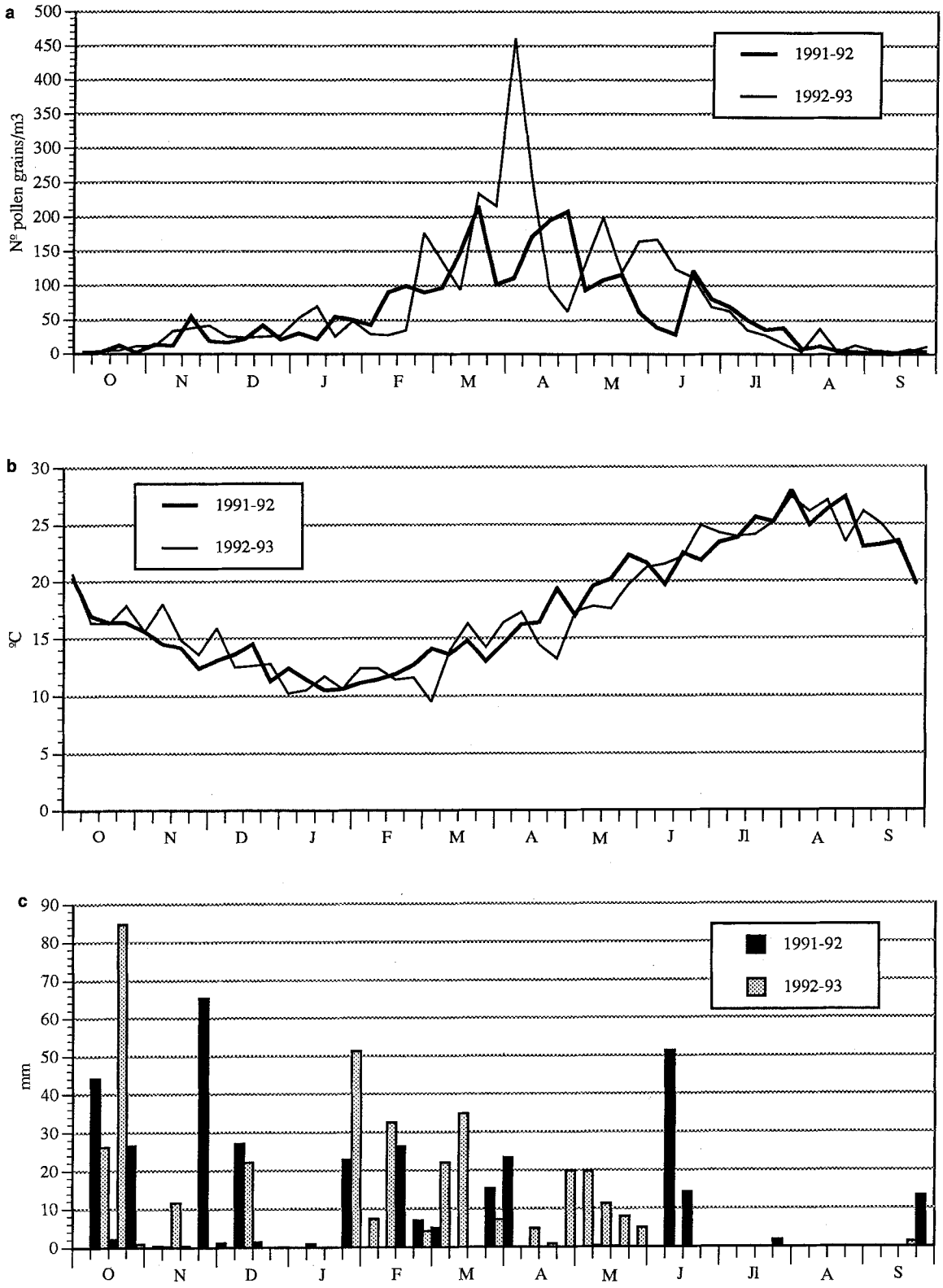

Fig. 1. (a) Seasonal variation in Urticaceae pollen counts 1991–1993, weekly mean values. (b) Weekly mean temperature, 1991–1993. (c) Weekly rainfall, 1991–1993.

Córdoba by Galán et al. (1991) where the highest concentration was also detected between 10:00 and 16:00 h, although the peak recorded by these authors was higher. Similar research on diurnal variations of

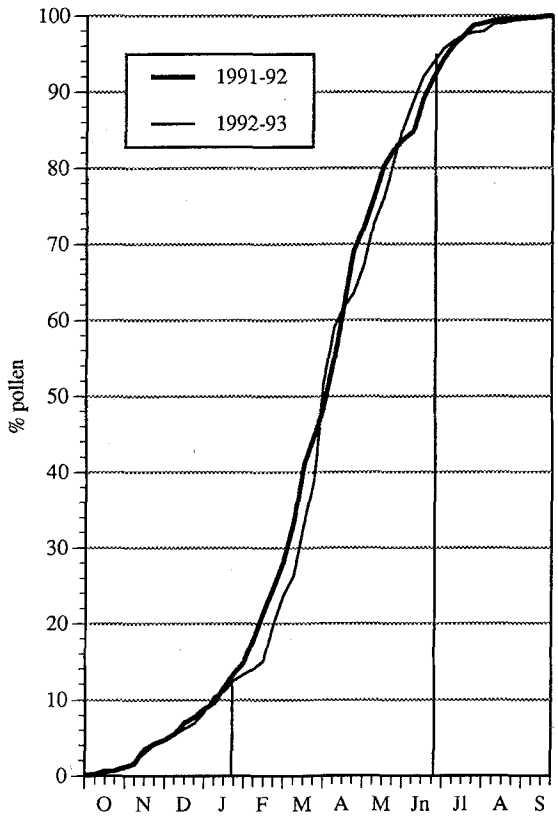

Fig. 2. The main pollen season of Urticaceae in Málaga.

Urticaceae was carried out by Frenguelli et al. (1986) in Perugia (Italy) and, though based on only a few days, similar results were obtained.

On the other hand, still in Perugia, Fornaciari et al. (1992) observed during 1989, that the maximum peaks of Urticaceae pollen take place in the hours with the highest temperature, whereas Emberlin and Norris-Hill (1991) and Corden and Millington (1991) recorded peak concentrations in the early evening in studies carried out in London and Derby, respectively. The cause for such late peaks is likely to lie in the colder climate.

In Málaga (Fig. 3a–c), the maximum Urticaceae pollen concentration coincides with the highest increase of temperature, around midday. High temperature produces anther dehiscence and consequently pollen emission in the atmosphere, which is detected by the sampler with a c.2-h gap.

5. Conclusions

In Málaga, the Urticaceae pollen season is very long, and this pollen type can be detected throughout the year. The highest concentrations occur during March and April and 85% of total pollen is collected from the third week of January to the last week of June. The variables influencing highest Urticaceae pollen concentrations are maximum air temperature and sunshine hours. The height of the peaks seem to be determined by rainfall levels, rainy periods followed by prolonged sunshine intervals being the main cause of the pollen concentration increase in the atmosphere. The highest concentration occurs between 10:00 and 16:00 h, reaching a maximum around midday (12:00–14:00 h) when the increase of temperature is highest.

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Table 1
Pearson's correlation coefficients (r) between daily average pollen concentration (logarithmic values) and meteorological parameters

	February		March		April		May	
	1992	1993	1992	1993	1992	1993	1992	1993
Mean temperature	0.109	0.052	0.182	0.463*	0.351	0.486*	−0.253	−0.022
Minimum temperature	−0.154	0.048	−0.293	0.239	0.167	0.350	−0.288	−0.027
Maximum temperature	0.492*	0.033	0.428*	0.636***	0.442*	0.504*	−0.214	−0.012
Sunshine	0.449*	−0.196	0.466*	0.328	0.543***	0.421	0.047	−0.128
Relative humidity	−0.214	−0.563*	0.100	−0.100	−0.100	−0.130	0.291	0.397
Wind velocity	0.075	0.410	−0.110	0.387	−0.260	0.413	−0.499***	−0.278
% Wind NE	−0.478*	−0.057	0.153	−0.009	−0.221	0.008	0.140	0.171
% Wind SE	−0.414*	−0.215	0.033	−0.438*	0.091	0.071	0.352	0.030
% Wind NW	0.403*	0.160	−0.136	0.409*	0.128	0.536**	−0.322	0.229
% Wind SW	0.163	−0.285	0.130	0.112	−0.277	−0.603**	−0.109	0.157
% Calm weather	0.409*	0.236	0.089	0.013	−0.014	−0.492**	0.051	0.191

*$P \leq 0.05$.
**$P \leq 0.01$.
***$P \leq 0.001$.

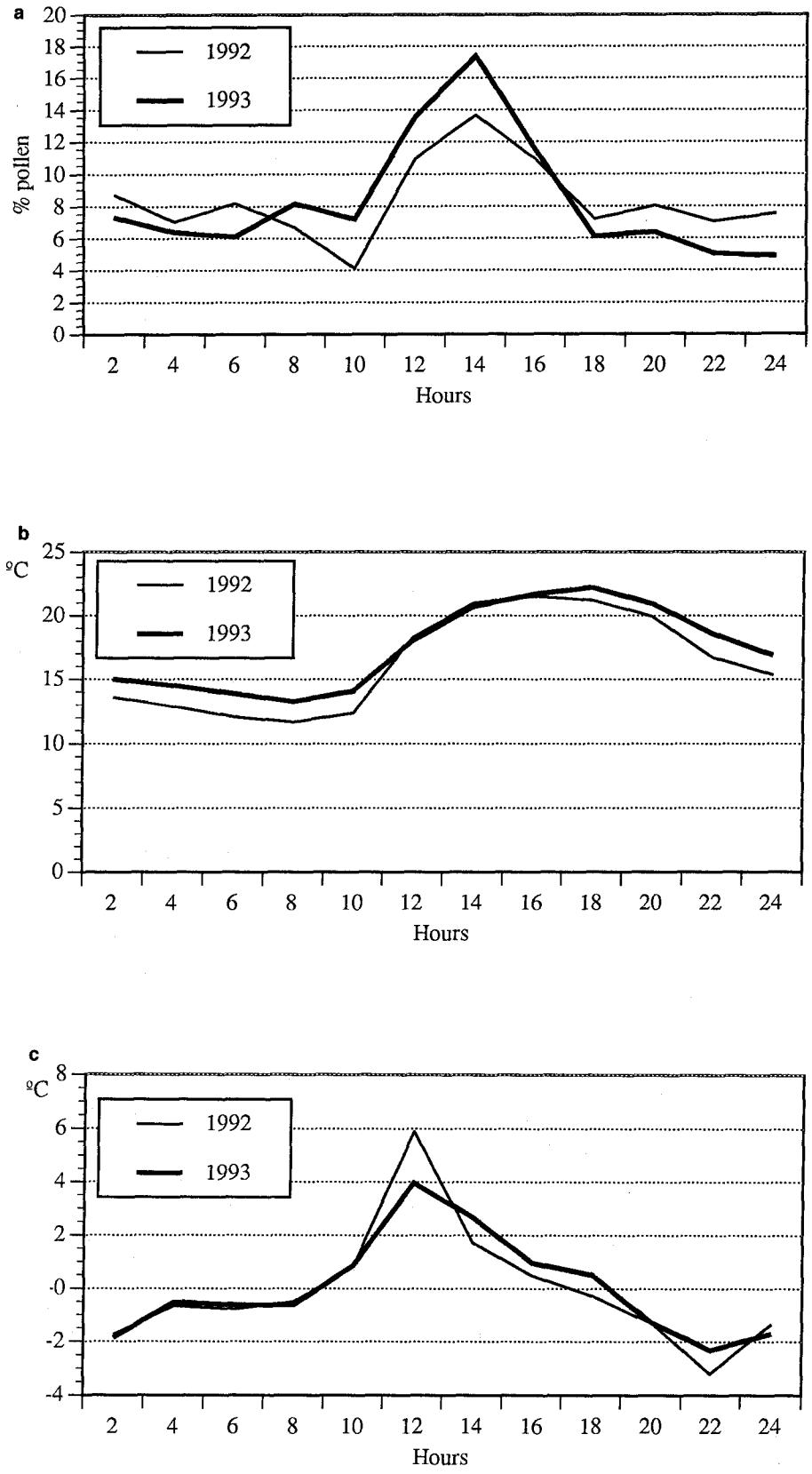

Fig. 3. (a) Percentage pattern of daily pollen concentration over 2-h periods from January to June, dry days only. (b) Diurnal trend of daily mean temperature. (c) Diurnal trend of increasing and decreasing temperature.

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