

Vertical variation in Urticaceae airborne pollen concentration

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Received 15 November 1996; received in revised form 25 June 1997; accepted 12 March 1998

Abstract

The pollen contents at different heights (1.5 and 15 m) of species of the Urticaceae family have been studied by sampling with Hirst type volumetric samplers. In order to achieve this, the two pollen types belonging to this family have been treated separately, *Urtica urens*-*Parietaria* sp. on the one hand and *Urtica membranacea* on the other, the latter having a smaller pollen grain. The results show that meteorological factors are bound to influence the behaviour of both these types of pollen in relation to height. With damp weather the pollen contents vary very slightly at different heights while when the weather is dry and calm, differences in pollen content at different heights become more significant. Nevertheless, when the atmosphere is stratified, the behaviour of each pollen type is different. The results show that, for most of the months considered, there is a higher pollen content of *U. membranacea* at upper heights, while *U. urens*-*Parietaria* sp. has higher levels of pollen content at a lower height. High temperatures, absence of rain and calm weather conditions favour the presence of convective phenomena which in turn create a favourable atmosphere for the vertical transportation of the small pollen grains of *U. membranacea*, which are better represented in the samplers placed at 15 m. © 1998 Elsevier Science Ireland Ltd. All rights reserved.

Keywords: Airborne; Urticaceae pollen; Vertical variation

1. Introduction

The influence of height placement of the volumetric samplers in relation to their efficiency in capture and as indicators of the factors which affect the dispersion of the pollen has been the object of recent studies. In these studies it has been concluded that the pollen concentration diminishes with height for well-represented taxa in the zone of study, as Rantio-Lehtimäki et al. (1991) and Galán et al. (1995) comment, provided that the sampling is done in an open space. On the other hand, Bryant et al. (1989) and Malik et al. (1990), in their height comparison studies in London and Delhi respectively, conclude that pollen concentrations are inferior at a lower height when the study is performed in very populated zones because of the negative effect of buildings on the air flow.

In a previous study performed by us in the city of Córdoba (Alcázar, 1995), a greater pollen content was observed at a lower height for herbaceous species, except for the Urticaceae family, which showed a greater pollen concentration in the sampler placed at 15 m height than in the one placed at 1.5 m.

This distinct behaviour focused our attention on this family to try to find a possible explanation for the rise in pollen concentration with height.

In a previous paper (Galán et al., 1995), it was noted that the explosive liberation mechanism of the pollen grains of some of the species of the Urticaceae family and their small size might be the cause of higher pollen contents at greater heights, showing a different behaviour from the rest of the studied taxa. Nevertheless, it was concluded that the cause of such a phenomenon was probably only the size of the pollen grain, given that it was proved that the differences with height were

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Table 1
Statistical analysis between roof and human height Urticaceae pollen counts

	Mean (15 m)	Mean (1.5 m)	Mean difference	Freedom degree	<i>t</i> -value	2-Tail probability
Paired samples <i>t</i>-test						
<i>Urtica membranacea</i>	0.533	0.394	0.139	181	2.70	0.008
<i>Urtica urens-Parietaria</i> sp.	0.809	0.911	-0.101	181	-2.02	0.044
	1.5 m < 15 m	1.5 m > 15 m	1.5 m = 15 m	Total	Z-value	2-Tail probability
Wilcoxon test						
<i>Urtica membranacea</i>	62	32	88	182	-2.35	0.019
<i>Urtica urens-Parietaria</i> sp.	55	76	51	182	-2.72	0.007

only significant from January to June, and not during November and December, months in which the pollen contents primarily pertain to the *Parietaria* genus (Alcázar, 1995). It was not thought that the explosive liberation mechanism of these plants was the cause of the phenomenon, considering that a different behaviour had been detected according to the time of year.

This later flowering of the *Parietaria* genus is also mentioned by other authors such as Corden and Millington (1991) in Derby, although the flowering periods do not coincide exactly with those in the Mediterranean region.

Thus, the aim of this study has been to verify the influence of size in the differences of pollen concentration of the Urticaceae family in relation to height during the period from January to June, which is the period of the year in which significant differences in relation to height have been found. In order to achieve this, the two most clearly identifiable pollen types of this family have been considered: *Urtica urens-Parietaria* sp. with a 3-zonoporate pollen between 14 and 20 μm in size; and *Urtica membranacea* with a 6–8 pantoporate pollen of a smaller size, between 9 and 12 μm (Diez, 1987).

2. Materials and methods

The sampling has been performed in an open location at the Faculty of Science of Córdoba, in the west-southwest outskirts of the city.

The climate of the city is Mediterranean, specifically subcontinental semihumid. Winters are short and temperate-cold, and summers are long, dry and hot. The percentage of calm weather in the city is quite high, exceeding 30% almost every month.

Two Hirst type samplers (Burkard Manufacturing) have been used for this analysis, one placed at 1.5 m above the ground and the other at 15 m on the roof, both placed leeward on the Eastern part of the Faculty of Science in Córdoba.

The methodology followed for the preparation and

recording of the sampling has been as proposed by the Spanish Aerobiological Network (REA), with four continual horizontal traverses, the results being multiplied by a factor in order to express the number of pollen grains per cubic metre of air (Domínguez et al., 1992).

The study was performed from January to June 1992 because, as was previously mentioned, prior studies (Alcázar, 1995) carried out during these months highlighted significant differences in pollen concentrations of the Urticaceae family with height.

For each pollen type (*U. membranacea* and *U. urens-Parietaria* sp.) comparison of means has been performed by parametric analyses (Student *t*-test) from the results obtained at different heights, for which the data have been standardized according to the formula $\ln(\text{grains}/\text{m}^3 + 1)$. The data have also been subjected to a non-parametric analysis (Wilcoxon test) to verify if there were any differences between the two pollen types studied in relation to height, not only in their mean but throughout the entire distribution.

3. Results

The results show a greater concentration of *U. urens-Parietaria* sp. pollen type at 1.5 m height with a total for the period studied of 374 grains while at 15 m the total was 301 grains. In the case of the pollen grains of *U. membranacea* pollen type, of smaller size, the situation is just the opposite, as the total concentration at 1.5 m was of 153 grains while at 15 m it was 207 grains.

In relation to the statistical analyses applied to the concentrations obtained at different heights for each pollen type, the Student *t*-test demonstrates that the differences in the mean with height are significant for both pollen types as the probability is inferior to 0.05. This result also shows that for the *U. membranacea* type the mean is significantly higher at 15 m, while that for the *U. urens-Parietaria* sp. is higher at 1.5 m (Table 1).

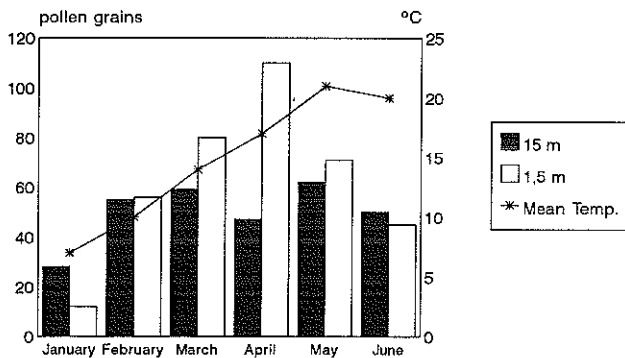
The Wilcoxon test, which compares not only the mean but also whether there are any differences

throughout the entire period studied, shows that there are differences in relation to height as once again the probability is inferior to 0.05. In this case it shows that for the *U. membranacea* pollen type the days with higher pollen contents at 15 m height are more frequent, while on the other hand, for the type *U. urens-Parietaria* sp., days with greater concentration at 1.5 m height predominate (Table 1).

In Fig. 1 the monthly total obtained during the entire period of the study is shown, from January to June, for each height and each pollen type. Once again there is usually a higher pollen count at 1.5 m for *U. urens-Parietaria* sp. and a higher count at 15 m for *U. membranacea*.

In order to analyze the behaviour of each pollen type in relation to height in different climactic conditions, the weekly total of the pollen counts has also been calculated for the period from January to June, and the weeks in which the highest concentrations occurred were chosen. The pollen levels registered during these weeks at different heights are represented in Fig. 2

Urtica urens-Parietaria sp.



Urtica membranacea

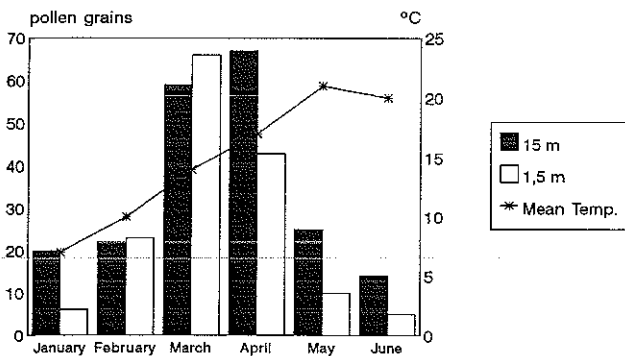
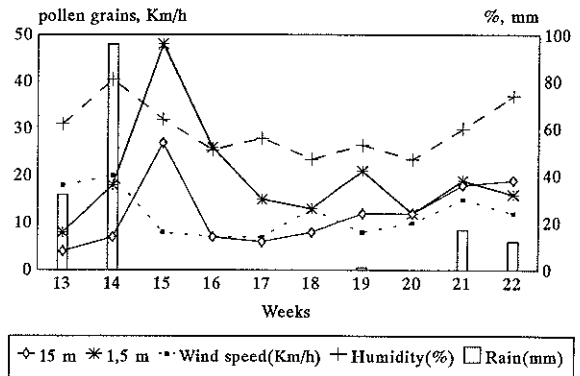


Fig. 1. Monthly pollen concentration for each pollen type for the two sampling heights studied together with mean temperature.

Urtica urens-Parietaria



Urtica membranacea

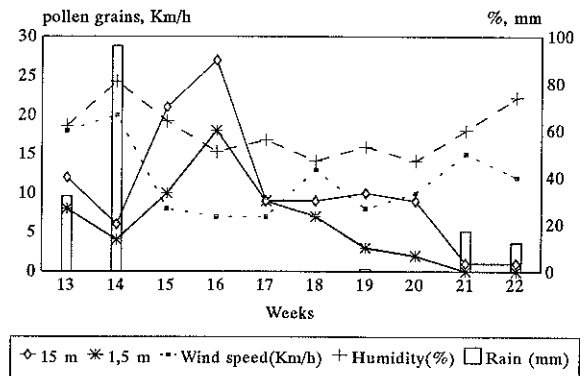


Fig. 2. Weeks of maximum pollen concentration for roof and human heights together with wind speed, humidity and rain.

together with precipitation, humidity and wind velocity. In general, for both pollen types, the differences in concentration with height diminish on rainy, wet and windy days, while in periods with rising temperature, lower precipitation, lower wind speed and calm weather, there is a clear atmospheric stratification which provokes greater differences in pollen concentrations between the two samplers used in the study. In these weather conditions, the pollen concentrations are higher in the sampler placed at 15 m in the case of *Urtica membranacea* and they are lower in the case of *Urtica urens-Parietaria* sp.

4. Discussion

From these results we may infer that rainy and humid conditions, and a rise in wind speed provoke, in both pollen types, a decreasing difference in pollen concentration in relation to height of the samplers,

probably due to a greater mixing of airborne pollen; while in higher temperature conditions, with lack of precipitation and predominance of calms, there is a greater stratification of the atmosphere. Nevertheless, while in the case of the *Urtica urens*-*Parietaria* sp. pollen type a greater number of pollen grains is detected in the sampler placed at 1.5 m, coinciding with similar observations made by other authors in the case of herbaceous plants near the sample site (Rantio-Lehtimäki et al., 1991; Galán et al., 1995), in the case of the *Urtica membranacea* type, greater concentrations are detected with the sampler placed at 15 m above ground.

According to the results obtained it may seem logical to conclude that the size of the pollen grains in the case of *U. membranacea* is a factor that significantly determines its concentration in relation to height, provided that there are calm conditions and frequent convective phenomena. Considering that this species blooms only in the Mediterranean region, it is logical that, although it is a herbaceous plant, our results do not coincide with those obtained by Rantio-Lehtimäki et al. (1991) for the entire Urticaceae family in Finland.

This conclusion is supported by the fact that weather conditions which favour a greater concentration of this pollen at upper heights are high temperatures, more hours of sunlight, absence of precipitation, low humidity and wind speed, conditions which favour convection phenomena (Figs. 1 and 2) with rising air drafts carrying small size pollen to considerable height, keeping it suspended for a longer time and preventing it from being deposited swiftly.

Therefore, although as Mandrioli (1987) explains, pollen grains are too large in general to be affected by thermal convection phenomena, *U. membranacea*

due to its extremely small size could indeed be influenced.

Acknowledgements

The authors are grateful to the DGICYT for financial support granted through Project PB-92-0814-C04-01.

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