Original Article

Differences in the spatial distribution of airborne pollen concentrations at different urban locations within a city

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Summary. *Background:* The objective of the present work was to compare pollen counts at three different urban locations within a city to each other and to the counts from a fixed trap. This information could be useful to delimit zones in the urbanized part of the city according to the risk of allergic affections.
Methods: Aerobiological sampling using portable traps was carried out at three points in urban zones of the city of Badajoz (SW Spain) over one year at the same time as continuous sampling using a fixed trap at a point in the non-urban outskirts of the city. The sources of airborne pollen were studied by counting the trees in the streets and squares of the selected zones. A statistical analysis was performed of the differences between the portable and fixed traps and of the temporal and spatial variation in the city as a function of the distribution of the most important pollen sources.
Results: Forty-eight pollen types were identified with the fixed trap, and 28 with the portable traps. The grass, olive, and oak pollens come from almost exclusively external sources, there being no spatial differences in their concentrations in the city. Cypress pollen concentrations were much higher at the urban locations than at the fixed trap site. Plane tree pollen levels could be locally very high, reflecting the proximity of the source. Except for ornamental plants, pollen levels were lower at the urban locations than at the site on the outskirts of the city.
Conclusions: 1) Using portable traps at different urban zones in a city could provide information about the spatial variation of atmospheric pollen levels. 2) A knowledge of the often widely variable distribution of ornamental plants with potentially allergenic pollen could be useful in indicating city zones with a greater or lesser incidence of potential pollinosis.

Key words: aerobiology, air sampling, allergens, outdoor, pollen, portable traps.

Resumen. El objetivo del presente estudio fue comparar los recuentos de polen en tres puntos urbanos distintos de una ciudad entre ellos y respecto a los recuentos de un captador de polen fijo. Esta información podría ser útil para delimitar zonas en la parte urbanizada de la ciudad según el riesgo de afecciones alérgicas.
Métodos: Se realizó un muestreo aerobiológico con captadores de polen portátiles en tres puntos de zonas urbanas de la ciudad de Badajoz (sudoeste de España) durante un año, al mismo tiempo que se llevó a cabo un muestreo continuo con un captador de polen fijo en un punto no urbano de las afueras de la ciudad. Se estudiaron las fuentes de polen en el aire contando los árboles en las calles y en las plazas de las zonas seleccionadas. Se realizó un análisis estadístico de las diferencias entre los captadores de polen fijos y los portátiles, y de la variación espacial y temporal en la ciudad en función de la distribución de las fuentes de polen más importantes.
Resultados: Se identificaron cuarenta y ocho tipos de polen con el captador fijo, y 28 con captadores portátiles. Los pólenes de roble, olivo y gramíneas provienen casi exclusivamente de fuentes externas, y casi no existen diferencias espaciales en sus concentraciones en la ciudad. Las concentraciones de polen de ciprés fueron mucho mayores en

los puntos urbanos que en el lugar del captador fijo. Los niveles de polen del plátano podrían ser localmente muy elevados, lo que refleja la proximidad de la fuente. Excepto en el caso de las plantas ornamentales, los niveles de polen fueron menores en los puntos urbanos que en los alrededores de la ciudad.
Conclusiones: 1) El uso de captadores de polen portátiles en diferentes zonas urbanas de una ciudad podría proporcionar información sobre la variación espacial de los niveles de polen atmosférico. 2) Podría ser útil conocer la distribución a menudo muy variable de plantas ornamentales con polen potencialmente alergénico para indicar las zonas de la ciudad de mayor o menor incidencia de polinosis potencial.

Palabras clave: Aerobiología, muestreo del aire, alérgenos, exterior, polen, captadores de polen portátiles.

Introduction

Volumetric aerobiological sampling is usually done with fixed traps operating all year round. Where to locate the trap has to be a compromise between its effectiveness, the availability of suitable sites, and the ease of maintenance. The results are extrapolated to cover some tens of kilometres, although such important factors as the height of the trap and the effects of buildings and topography on the circulation of air masses have to be taken into account.

The main purpose of an aerobiological study in any given city is to determine which pollens represent a risk to patients with allergies. Because the counting process is so laborious, there is usually no more than a single fixed trap. One might question, however, the validity of extrapolating the counts recorded at a single site to the entire urban area, especially since the trap is often located on the outskirts of the city.

The objective of the present work was to use portable traps to monitor pollen counts at different urban locations within a given city over an entire year in order to compare them with each other and with the counts from a fixed trap. The causes of any differences would be analyzed in terms of the distribution of the sources of pollen, fundamentally of ornamental plants and urban weeds. Finally, the aim was to delimit zones in the urbanized part of the city according to the risk of allergic affections because of the distribution and abundance of pollen sources. It is well known that people living in an area with high atmospheric concentration of a given pollen have a higher risk of developing allergic sensitization to that pollen. In addition, people already sensitized might experience exacerbation of allergic respiratory symptoms if they enter the area with high concentrations of that pollen. Thus the results could be used in town planning if the distribution of the sources of potentially allergenic particles is to be taken into account [1], particularly since it is documented that there is an increased incidence of allergies to pollen in urban zones [2]. There are hardly any studies of this type reported in the literature. Particularly noteworthy is the contribution of Cariñanos et al [3] for the city of Córdoba, which showed that there were spatial differences in pollen concentrations within the urban area and that there was a greater presence of patients who were allergic to ornamental plant pollens.

Material and Methods

Badajoz, on the River Guadiana near the Spanish-Portuguese border, is a city of 138,415 inhabitants. Since March 1993 there has been continuous aerobiological monitoring with a Burkard volumetric trap [4] located on the outskirts of the city [5].

Sampling in the urban zones of the city was performed with two portable volumetric traps (Burkard trademark) from 7 March 2003 until 26 February 2004, i.e., practically a complete year. Samples were collected on a total of 27 days at a rate of approximately once a month from August to December (7 sampling days) and approximately once every ten days from January to July (20 sampling days), months which include the principal pollination period. The fixed trap was located on the flat roof of a two-storey building at a height of about 6 m above ground level including the platform which raises it, and situates the inlet of the trap at 1.6 m above the roof level. Although there may exist differences when height is important [6-8], no differences are detected at ground level and at a height of 1.5 m [9].

Within the urban zone of the city, three sampling points were selected to represent the three principal built-up areas of the city. They were all open public plazas with varying degrees of city gardening. Sampling point 1 is the oldest zone of the three, with examples of *Platanus hispanica* and *Phoenix dactylifera*. Sampling point 2 has *Eucalyptus camaldulensis* and *Citrus aurantium*. Sampling point 3 is the most modern zone of the three, with examples of *Celtis australis*, *Cupressus sempervirens*, *Cupressus arizonica*, and *Prunus cerasiferai*. No sampling point was selected in the oldest, historical part of the city, as its population density is very low, and there are very few city garden areas.

The traps were placed at ground level, with the inlet at a height of 10 cm. Two traps were used simultaneously except in 5 cases (13/5, 20/5, 27/5, 10/6, 22/7), resulting in a total of 147 samples. The sampling time was in all cases close to solar noon on cloudless and relatively windless days. The sampling time was 10 minutes at each site, and the time lapse between the different sampling points on the same day was 10-15 minutes. The fixed trap was operating continuously, except in the period 1-11 January 2004.

The sources of airborne pollen were studied by counting the trees in the streets and squares of the selected zones, and plotting them on a map of the city. The area of the city selected is that with the greatest concentration of population. Peripheral zones, with mostly single-family dwellings, were not included. The census of the trees

Table 1. Number of days of appearance of pollen and concentration in grains/m³.

	Annual fixed trap		Sampling fixed trap		Portable traps P1	P2	P3	P1	P2	P3
	days	grains/m³	days	grains/m³	days	days	days	grains/m³	grains/m³	grains/m³
Alnus	28	0.4	2	0.6	0	0	1	0.0	0.0	0.2
Amaranthaceae-Chenopodiaceae	162	2.1	9	1.5	1	2	4	0.4	0.7	1.1
Anthemideae	69	0.5	7	0.8	1	2	0	0.2	0.6	0.0
Apiaceae	42	0.2	3	0.4	1	1	0	0.2	0.2	0.0
Arecaceae	60	0.5	3	0.7	3	2	2	2.0	0.9	0.6
Brassicaceae	44	0.2	6	0.4	1	0	2	0.2	0.0	0.9
Castanea	39	0.4	2	1.1	0	0	1	0.0	0.0	0.6
Celtis	0	0.0	0	0.0	1	1	2	0.2	0.2	1.1
Cupressaceae	137	9.0	7	7.7	6	7	5	11.9	18.0	22.0
Cyperaceae	19	0.1	1	0.0	6	4	1	3.9	1.7	0.4
Echium	56	0.7	6	0.6	3	1	1	1.5	0.2	0.4
Eucalyptus	149	10.3	12	4.3	0	4	2	0.0	11.9	0.6
Juglans	15	0.1	2	0.1	0	1	1	0.0	0.2	0.2
Juncus	8	0.0	1	0.0	0	1	2	0.0	0.4	0.7
Lactuceae	68	0.8	9	1.2	2	1	2	1.1	0.4	0.6
Mercurialis	42	0.2	5	0.4	0	1	0	0.0	0.2	0.0
Morus	51	1.7	7	4.6	1	0	1	0.2	0.2	0.2
Olea	139	16.2	13	17.8	7	5	7	12.2	9.8	17.4
Pinaceae	97	1.1	12	4.3	9	11	11	5.2	5.0	10.0
Plantago	148	5.2	14	8.6	7	11	12	9.4	8.1	13.7
Platanus	35	1.6	6	1.9	5	5	5	70.2	11.1	21.1
Poaceae	267	47.4	23	93,9	13	14	14	43.3	29.8	35.7
Populus	20	0.5	3	0.2	0	1	0	0.0	0.2	0.0
Quercus	261	30.6	23	40.3	12	12	13	29.3	26.9	29.8
Rumex	132	3.9	17	7.1	9	11	11	5.6	7.0	8.1
Ulmus	37	0.8	5	1.6	1	0	1	0.2	0.0	0.2
Urticaria membranacea	100	2.8	14	8.7	4	7	3	3.0	2.2	1.7
Urticaceae p.p.	228	5.5	19	5.8	3	8	8	1.3	3.5	4.4
Unidentified	250	1.5	15	2.2	19	16	14	8.1	5.4	6.3
TOTAL	357	149.2	26	222.0	27	27	27	209.3	144.3	177.2

excluded species of which there were only isolated examples, very young individuals, and those within places of restricted access.

The non-parametric Friedman test for several related samples was used to analyse the differences between the portable trap and the fixed trap data, comparing results for the same day or for the same pollen types. The comparisons with the fixed trap data were made using both the mean of all the days of the sampling period and only the days of portable trap sampling, considering the number of days of appearance of each pollen type, and the concentration (grains/m³) as a daily mean or only at solar noon.

Results

During the sampling period, 48 pollen types were identified with the fixed trap and 28 with the portable traps (22, 24, and 25 at sampling points 1, 2, and 3, respectively). Table 1 lists all the pollen types found on the portable traps, with the number of days on which each appeared, and the mean concentration in grains/m³.

The highest mean concentrations corresponded to the grasses, except for sampling point 1 where plane tree pollen clearly predominated. Next in importance in all cases were the *Quercus* species, followed by olive pollen except at sampling point 2 where the *Cupressaceae*, *Eucalyptus*, and *Platanus* pollen types were more common than olive. These three types followed olive in importance at the other sampling points. With respect to the number of days of appearance, the *Poaceae* and *Quercus* pollen types were the most frequent, followed by *Pinaceae*, *Plantago*, and *Rumex*. Although the latter types were present for a longer period, their concentrations did not surpass those of the aforementioned *Cupressaceae*, *Eucalyptus*, and *Platanus* types, which have a shorter and more intense pollination.

Table 2 lists the concentrations in grains/m³ of the *Poaceae*, *Quercus*, *Cupressaceae*, *Olea*, and *Platanus* pollen types, giving the mean daily and solar noon data for the fixed trap, and the portable trap data for each urban sampling point.

The Friedman test was applied to the data of Table 1 in order to compare the portable trap results with those of the fixed trap (for the sampling days only) as a function

Table 2. Concentrations in grains/m³ of the principal pollen types for the days of sampling.

	Poaceae					Quercus					Cupressaceae					Olea					Platanus				
date	F	F12	P1	P2	P3	F	F12	P1	P2	P3	F	F12	P1	P2	P3	F	F12	P1	P2	P3	F	F12	P1	P2	P3
7-3	4	0	0	5	0	0	0	0	5	0	33	86	0	20	0	0	0	0	0	0	0	0	0	0	0
14-3	9	0	5	20	20	9	0	0	5	10	22	144	10	0	0	0	0	0	0	0	11	29	40	20	20
18-3	1	0	0	0	0	5	0	15	0	0	0	0	15	0	5	0	0	0	0	0	2	0	305	195	30
28-3	1	0	0	0	0	50	86	20	5	40	0	0	0	0	0	0	58	0	0	0	19	58	590	45	5
2-4	11	86	30	15	20	203	720	140	130	255	0	0	0	5	0	1	86	0	0	0	10	86	575	35	490
9-4	2	0	0	0	0	295	230	285	325	235	0	0	0	0	0	0	0	0	0	0	6	0	380	5	25
24-4	11	0	0	0	10	44	86	25	25	25	0	0	0	0	5	1	0	5	0	0	1	0	0	0	0
29-4	11	0	0	5	25	23	29	10	25	10	0	0	0	0	0	4	29	0	0	0	0	0	0	0	0
6-5	39	58	45	0	15	78	86	85	25	65	0	0	0	0	0	1	0	5	0	5	0	0	0	0	0
13-5	559	317	310	280	240	208	144	130	140	60	0	0	0	0	0	184	173	130	170	280	0	0	0	0	0
20-5	1348	749	420	250	350	66	29	20	30	30	0	0	0	0	0	160	202	130	70	110	0	0	0	0	0
27-5	197	173	260	90	150	23	58	30	0	20	0	0	0	0	0	73	58	20	10	40	0	0	0	0	0
3-6	52	0	25	25	20	9	0	5	5	5	1	0	0	0	0	5	29	30	5	5	0	0	0	0	0
10-6	67	29	10	0	20	6	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0
17-6	69	202	35	55	75	6	29	0	5	5	0	0	0	5	0	10	29	0	10	25	0	0	0	0	0
2-7	27	0	15	0	0	2	0	0	0	5	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
22-7	17	0	0	10	0	6	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
2-9	0	0	5	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24-9	6	0	0	5	5	9	0	0	0	5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
1-10	1	0	0	25	0	1	0	0	0	0	0	0	15	10	0	0	0	0	0	0	0	0	0	0	0
1-11	0	0	0	0	0	1	0	20	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19-12	0	0	0	0	0	1	0	0	0	0	0	29	0	0	5	0	0	0	0	0	0	0	0	0	0
5-1			0	5	0			0	0	0			0	0	0			0	0	5			0	0	0
19-1	4	0	0	0	0	2	0	0	0	0	7	0	0	5	0	0	0	0	0	0	0	0	5	0	0
3-2	6	86	0	15	10	0	0	0	0	0	77	58	145	400	530	0	0	0	0	0	0	0	0	0	0
13-2	5	29	5	0	5	1	0	0	0	0	50	86	70	25	35	0	0	0	0	0	0	0	0	0	0
26-2	5	0	5	0	0	1	0	0	0	0	11	0	65	15	15	0	0	10	0	0	0	0	0	0	0

(F): daily means with the fixed trap; (F12): levels at solar noon with the fixed trap; (P1, P2, P3): levels for the three sampling points with the portable traps.

of the pollen spectra. There were significant differences with respect to the number of days (chi-squared 31.333, sig. 0.000) and the concentrations (chi-squared 8.517, sig. 0.036). In the comparisons of the portable trap results only, there were significant differences with respect to the concentrations (chi-squared 5.056, sig. 0.080), but not with respect to the number of days of appearance of the pollen types (chi-squared 2.191 sig. 0.334).

The same test was applied to the data of Table 2 to compare the five pollen types between the sampling sites. For the grasses, there were no differences between the three urban zone sampling points (chi-squared 0.250, sig. 0.882) nor when the fixed trap data corresponding to solar noon was included (chi-squared 1.1139, sig. 0.768), but there were differences between the urban sampling points and the daily fixed trap data (chi-squared 15.044, sig. 0.002). The same was the case with *Quercus* pollen: there were no differences between the portable traps (chi-squared 1.000, sig. 0.607) nor when the solar noon fixed trap data were added (chi-squared 1.776, sig. 0.620), but there were differences when the daily fixed trap data were used (chi-squared 22.725, sig. 0.000). In *Cupressaceae*, there were no significant differences in any of the three cases: portable trap data only (chi-squared 0.200, sig. 0.905), portable and solar noon fixed trap data (chi-squared 0.245 sig. 0.970), or portable and daily fixed trap data (chi-squared 0.202, sig. 0.997). In *Olea*, there were significant differences between the three urban zone sampling points (chi-squared 4.903, sig. 0.086), which were even more marked when the solar noon fixed trap data (chi-squared 9.483, sig. 0.024) and the daily fixed

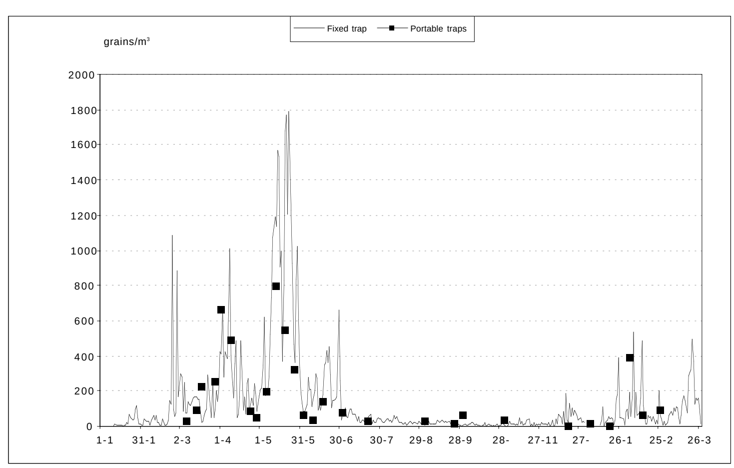

Figure 1. Distribution of the daily pollen concentration determined with the fixed trap and the mean of the portable traps on the days of sampling.

Figure 2. Distribution of species of *Platanus* in the urban zone of the city of Badajoz (SW Spain).

trap data (chi-squared 13.343, sig. 0.004) were included. The case of the *Platanus* type was similar, with the differences between the traps being even greater – the portable trap data only (chi-squared 9.818, sig. 0.007), portable plus solar noon fixed trap data (chi-squared 11.836, sig. 0.008), and greatest with the inclusion of the daily fixed trap data (chi-squared 26.763, sig. 0.000).

The census of the ornamental trees in the study area gave 53 species and 7538 individuals. The commonest were the plane trees (929 *Platanus hispanica*, 519 *P. orientalis*; Fig. 2), followed by nettle-trees (876 *Celtis australis*), chinaberry (517 *Melia azedarach*), glossy privet (410 *Ligustrum lucidum*), palms (309 *Phoenix dactylifera*, 292 *Phoenix canariensis*, 258 *Washingtonia filifera*), Japanese cherry (338 *Prunus cerasifera* var. *pisardii*), cypress (161 *Cupressus sempervirens*, 103 *Platycladus orientalis*, 75 *Cupressus arizonica*, 18 *Cupressus macrocarpa*, 27 *x Cupressocyparis leylandii*, 8 *Calocedrus decurrens*; Fig. 3), and finally olive (91 *Olea europaea*; Fig. 4).

These trees are very unevenly distributed in the city. Their density increases progressively with advancing urbanization. While plane trees (Figure 2) are most abundant in the most recently built-up zones, there is a major concentration at sampling point 1, and they are located farther away from sampling points 2 and 3. The cypresses (Figure 3) are somewhat more abundant in the older zones of the city, being little used in the newly built-up zones except for the hybrid *x Cupressocyparis leylandii*. The olives have a scattered distribution (Figure 4), and there were no individuals near the urban zone sampling points.

Discussion

The difference in the number of pollen types identified by the fixed trap (48) and the portable traps (28) was clearly due to the sample sizes, since the types not detected in the portable traps were usually those of more sporadic appearance. The differences in pollen concentrations reflected the local variations.

Pollen grasses were always top-ranked in concentration. Their presence in the urban zone of the city was fundamentally due to external sources. The apparent 20% reduction in pollen count recorded at the urban sites relative to the fixed trap at the same time of day was not statistically significant. The statistically significant differences between the portable

Figure 3. Distribution of species of *Cupressaceae* in the urban zone of the city of Badajoz (SW Spain).

Figure 4. Distribution of olive trees in the urban zone of the city of Badajoz (SW Spain).

trap data and the daily means of the fixed trap data was probably because the time of day of the portable trap sampling did not correspond to the peak concentration of grass pollens, although it has to be noted that there is no homogeneity in the hourly distribution pattern of this pollen, since many differently behaving species are involved [10-14].

The case was similar for the pollen grains of the *Quercus* species –fundamentally *Q. rotundifolia*, and to a lesser extent *Q. suber* and *Q. coccinea*– but the reduction of the concentration towards the interior of the urban zone of the city was more notable, although this difference is due essentially to a single day, 2 April 2003. This pollen type practically all comes from outside the urban zone of the city. Consequently, the three urban sampling points present concentrations of this pollen that are statistically similar. The differences observed on comparing the urban zone results with the daily means from the fixed trap could be due to the hourly distribution pattern. The literature indicates, however, that there is no well-defined pattern for this pollen type, and that the great abundance on certain days [11,15,16] together with major interannual differences [17] may make it difficult to determine a standard hourly distribution pattern.

With respect to the *Cupressaceae*, the counts with the portable traps were greater than those with the fixed trap at the same time of day. The differences were especially marked at sampling point 3, which was close to sources of this pollen type, in particular, to several individuals of *Cupressus arizonica*. These apparent differences, however, were found not to be statistically significant, even when the comparison was with the mean daily fixed trap data. Cypresses are planted as ornamentals throughout the urban zones, being more frequent towards the oldest part of the city. It should also be noted that there are sources of this pollen type not very far from the fixed trap, and that the peak in the release of this pollen occurs at around solar noon [5,16].

A significantly smaller quantity of olive pollen grains were detected in the urban traps than in the fixed trap. There are few olive trees in the city, and none near the sampling points. The statistically significant differences between the three sampling points could reflect relative differences in proximity to the sources, but it is also important to note that the cause of the greater presence at sampling point 3 could be because olive pollen from outside the city can reach this location more easily.

The *Platanus* pollen type had a representation of only 1.1% in the fixed trap, while it was second in importance in the portable traps (19.3%). This is fundamentally because the sources were much closer to the portable traps, especially at sampling point 1. The notable differences between the three sampling points reflect a greater or lesser abundance of these commonly used ornamental trees. The slight phenological difference between the two species involved, with *P. hispanica* being somewhat earlier than *P. orientalis*, could explain the difference in the peak that appears at sampling point 3 relative to the other two.

With respect to the mean concentrations on the sampling days, the overall urban zone levels measured with the portable traps were approximately 20% lower than those measured with the fixed trap on the outskirts of the city. By pollen type, this reduction was observed for *Poaceae*, *Quercus*, and *Olea*, but was reversed for *Cupressaceae* and *Platanus*. Most pollen grains of the former group –*Poaceae*, *Quercus*, and *Olea*– come from outside the urban zone of the city, while the sources of the *Cupressaceae* and *Platanus* pollen are almost exclusively within the urban zones themselves.

The observed differences between the three urban sampling points could be due on the one hand to the proximity and abundance of the sources of the pollen, and on the other to the presence of buildings hindering the circulation of air masses which transport the pollen grains. With respect to total counts, the central-most sampling point attained the highest level. This was due, however, to the great abundance of plane tree pollen. It was also the location where most grass pollen grains were collected, although the differences for this pollen type between the three urban sampling points were not statistically significant. The counts at sampling point 2 reflected the lower presence of ornamental trees in its area of influence, with the exception of *Eucalyptus* pollen during the pollination period of nearby trees of this genus. Sampling point 3 is the least central of the three, and is also that with the greatest proportion of parks and city garden areas. This was reflected in its having the highest counts of pollen grains corresponding to species typical of the surroundings of a city, such as the *Quercus*, *Olea*, *Plantago*, *Rumex*, and *Pinaceae* pollen types.

Conclusions

Aerobiological samples taken at a particular time in a given place provide an estimate of atmospheric pollen levels. Since turbulence phenomena cause spatial and temporal variations in the concentrations, a more precise estimate is given by continuous sampling. With a generally fixed location, however, no information is provided about the spatial variation. This information can be obtained using portable traps at different points, although temporal variations will not be recorded unless the sampling is carried out continuously.

The degree to which an urban area possesses public gardens and parks, and whether the location in the city is more central or more peripheral, will significantly influence not only the quantity of airborne pollen grains but also the spectrum of pollen types over the course of the year. If to this one adds the dependence on the time of day, it is clear that one must consider many different situations. A knowledge of the hourly distribution patterns and of the spatial distribution of the pollen sources may help to establish not only the times of the day and of the year with the greatest incidence of allergenic pollen, but also which places represent a greater threat for patients with pollinosis.

The urban zone of a city reduces by some 20% the concentrations of pollen grains whose sources lie outside the city. However, ornamental plants raise the total pollen levels, so that if the fixed trap is located on the outskirts of the city the observations will not accurately reflect the state of the atmosphere that a patient with allergy to pollen will have to face.

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