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Aeropalynologic analysis of La Plata City (Argentina) during a 3-year period

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Abstract

A continuous aeropalynologic survey of the atmosphere of La Plata was carried out between July 1998 and June 2001 in order to study flowering development from winter to summer using a Lanzoni volumetric spore trap. The total pollen spectrum was represented by 79 pollen types. Between 10 and 12 pollen types showed a relative concentration of more than 1% of the annual total. Airborne pollen was mainly represented by *Platanus, Fraxinus*, Cupressaceae, Poaceae, Urticaceae, Cyperaceae, Myrtaceae, *Celtis, Casuarina* and *Morus* during the 3-year period. *Acer* and *Ambrosia* pollen types were only dominant in the first 2 years. Maximum absolute concentrations were recorded in the the July 1998–June 1999 period, and the minimum concentrations were recorded in the July 2000–June 2001 period. The contribution of the arboreal pollen grains was higher than 68% relative to the annual total for each year. Two periods of maximum pollen emissions were found for each year: pollen from aboreal taxa predominated from July to October, and pollen from herbaceous taxa predominated from November to March. There was very little pollen in the atmosphere between April and June. The maximum arboreal and herbaceous pollen emissions were recorded during hours of daylight: at 10:00 and 14:00 hours.

1. Introduction

The pollen record in the atmosphere provides an indirect inventory of the compositional structure of a vegetal community. Multiple biological and environmental factors influence this record, ranging from the taxon genesis to pollen dispersion and, consequently, the degree of representativeness in the atmosphere.

In Argentina, aeropalynological studies in which the Hirst-type volumetric sampler has been used are a recent development. Two locations in which such studies have been carried out are Buenos Aires (Nitiu et al., 1997, 2003) and Mar del Plata (Bianchi, 1994; Latorre, 1997, 1999; Latorre and Perez, 1997; Latorre and Bianchi, 1998; Perez and Paez, 1998; Gasmann et al., 2002). Since 1998, aeropalynologic samplings applying Hirst-type volumetric methodologyhave been conducted in the city of La Plata, and the results of these investigations have been published (Nitiu and Romero, 2001, 2002; Nitiu and Mallo, 2002; Nitiu, 2003, 2004).

This article presents the results of a 3-year-long qualitative-quantitative study of airborne pollen that was carried out on the atmosphere of the city of La Plata. The objective of the investigation was to analyse the hourly presence and distribution of pollen and to identify the pollen types that are abundantly represented in the atmosphere.

2. Materials and methods

2.1. *Location of the study*

The city of La Plata (34°55′ S and 57°17′ W) is located in the northeastern part of Buenos Aires Province, Argentina, and is the second-largest urban center in the country, surpassed only by

Buenos Aires. The urban pollen sources are mainly cultivated trees used for ornamental purposes and naturally occurring herbs. Trees are present along streets and avenues and in numerous parks and gardens in the surroundings of the city. Herbaceous taxa are mainly found in the park areas.

The climate, according to the Thornthwaite classification (Burgos and Vidal, 1951), is mesothermal, sub-humid/humid with marked seasonality. The mean annual temperature is 16.5 °C, with temperatures that range from −2 to 38.2 °C in June and January, respectively. The mean annual precipitation is 1132.9 mm, and the dominant winds are from NE to SE.

2.2. *Sampling pollen*

Aeropalynologic monitoring was carried out using a Hirst-type spore trap (Lanzoni VPPS model 2000; Lanzoni, Bologna, Italy) (Hirst, 1952) that was placed near the geographical center of the city at a height of 15 m. The area is completely urbanised with buildings several meters in height mixed with low buildings and abundant vegetation.

The annual flowering period was taken to be from July to June in order to include the flowering season from winter to summer.

2.3. *Pollen counts*

The trapped pollen grains were analysed by light microscopy at a magnification of ×200. The daily pollen count was analysed every 6 hours: 02:00, 08:00, 14:00 and 20:00 hours. A pollen count at 1000 hours was also included as it was considered to be an important time of the day with respect to possible pollen emission.

The identification of pollen grains was based on available literature (Heusser, 1971; Bassett et al., 1978; Moore et al., 1991) and was carried out at different levels: family, genera or species. Data were expressed either as number of pollen grains per cubic meter of air or as percentages of total pollen counted.

3. Results

The total pollen concentration recorded in the period July 1998 to June 1999 was 181,144 pollen grains; in July 1999 to June 2000, 142,500 pollen grains; in July 2000 to June 2001, 106,060 pollen grains. Seventy-nine different pollen types were determined at the family, genus or species level during the 3-year study period (Table 1).

During July 1998–June 1999 and July 1999–June 2000, 12 pollen types were present in the atmosphere in the highest concentrations, with each type contributing more than 1% to the annual total. These were: *Platanus, Fraxinus*, Cupressaceae, Poaceae, Urticaceae, Myrtaceae, Cyperaceae, *Acer*, *Ambrosia, Celtis*, *Casuarina* and *Morus* (Figure 1). During July 2000–June 2001, ten pollen types were the most prevalent in the atmosphere: *Platanus, Fraxinus*, Cupressaceae, Poaceae, Urticaceae, Cyperaceae, Myrtaceae, *Celtis*, *Casuarina* and *Morus*.

The contribution of these groups of pollen types represents 95.2% (July 1998–June 1999), 94.5% (July 1999–June 2000) and 92.3% (July 2000–June 2001) of the total pollen concentrations in the air for each of the study periods; this translates into 171,050 pollen grains, 134,698 pollen grains and 97,857 pollen grains, respectively. The remaining 4.8, 5.4 and 7.7% for each year was contributed by other pollen types for which the pollen concentration represented less than 1% of the annual concentration of pollen. These included: *Quercus, Populus, Salix, Castanea, Schinus, Artemisia* and *Ulmus*.

3.1. *Arboreal pollen and non-arboreal pollen relation*

The pollen spectrum of La Plata city showed two periods of maximum pollen emission in each of the years studied.

Arboreal pollen types: Aborealpollen types consist of pollen from arboreal taxa (AP). These were present in the atmosphere from mid-winter (July) to mid-spring (October) of each year. Of the total pollen present in each year at maximum pollen emission, these pollen types represented 69.2% during July 1998–June 1999, 74.8% in July 1999–June 2000 and 68.9% during July 2000–June 2001 (Figure 2). The greatest pollen contributor to the total pollen concentration during the 3-year study period was *Platanus*, with 56,648 pollen grains, 51,648 pollen grains and

Table 1. Pollen types present in the air during the 3-year study period

Pollen types	AP/NAP[a]
Three-year study period	
Acer negundo	A
Alternanthera sp.	N
Ambrosia tenuifolia	N
Alnus acuminata	A
Artemisia verlotorum	N
Aster sp.	N
Asteraceae	N
Casuarina cunninghamiana	A
Castanea sativa	A
Celtis spinosa	A
Cheno-Amaranthaceae	N
Cupressus sp.	A
Cyperaceae	N
Echium plantagineum	N
Ephedra sp.	A
Fraxinus pennsylvanica	A
F. excelsior	A
Juglans australis	A
Juncus sp.	A
Ligustrum lucidum	A
Phoenix	A
Morus alba	A
Myrtaceae	A
Nothofagus dombey	A
Persea americana	A
Pinus sp.	A
Plantago tomentosa	N
Platanus acerifolia	A
Poaceae	N
Populus deltoides	A
Quercus robur	A
Q. ilex.	A
Ricinus communis	A
Rumex sp.	N
Salix humboldtiana	A
Schinus sp.	A
Taraxacum officinale	N
Typha sp.	N
Tilia moltkei	A
Umbelliferae	N
Ulmus pumila	A
U. procera	A
Urticaceae	N
Two-year study period	
Betula pendula	A
Caryophyleaceae	N
Cedrus sp.	A
Euphorbiaceae	N
Gallium sp.	N
Liquidambar styraciflua	A
Lotus sp.	N
Mimosa sp.	A
Rapanea sp.	A
Strelitzia sp.	A
One-year study period	
Adesmia sp.	A
Aesculus hippocastanum	A
Amaranthus sp.	N
Calliandra tweedi	A
Chrysanthemun sp.	N
Corilus sp.	A
Corrigiola sp.	N
Fagus sp.	A
Geraniaceae	N
Jacaranda mimosifolia	A
Medicago	N
Miriophylum sp.	N
Papaver sp.	A
Prunus sp.	A
Ranunculaceae	N
Ranunculus sp.	N
Rosaceae	A
Solidago sp.	N
T. Brassica sp.	N
T. Crataegus sp.	A
T. Cruciata sp.	N
T. Humulus sp.	A
T. Larix sp.	A
Xanthium sp.	N

[a]NAP: pollen non-arboreal; AP: pollen arboreal.

27,428 pollen grains, respectively. The accumulated percentage curve for the arboreal group revealed that the highest total number of pollen grains occurred in September in all 3 years: 78,909 pollen grains, 74,014 pollen grains and 46,623 pollen grains, respectively. The aboral pollen count in September represented 63.6, 70.1 and 68.9% of the total arboreal pollen, respectively, and 43.5, 51.9 and 43.9% of the total pollen concentration for each year, respectively (Figure 3).

Non-arboreal pollen: Non-arboreal pollen types consist of pollen from herbaceous taxa (NAP). These were present in the atmosphere from mid-spring (October) to the end of summer (March) (Figure 4). The NAP types that made the greatest

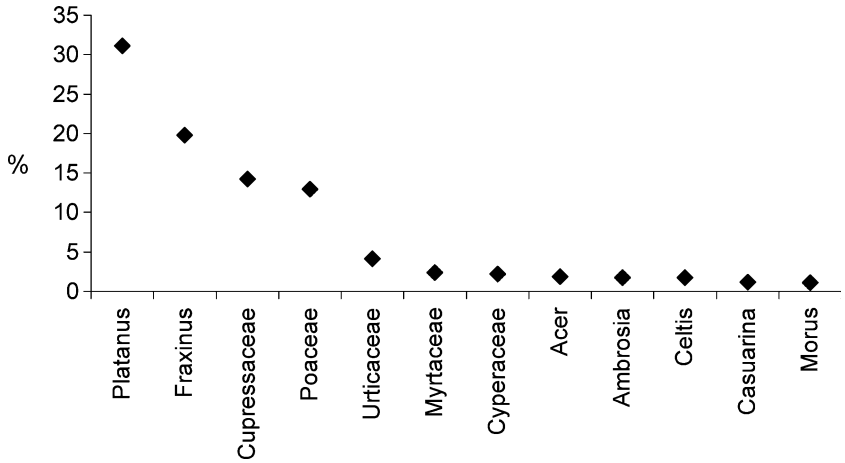

Figure 1. Pollen types present at the highest concentrations in the atmosphere during July 1998–June 2001 (annual pollen concentration of each type was more than 1% of annual total).

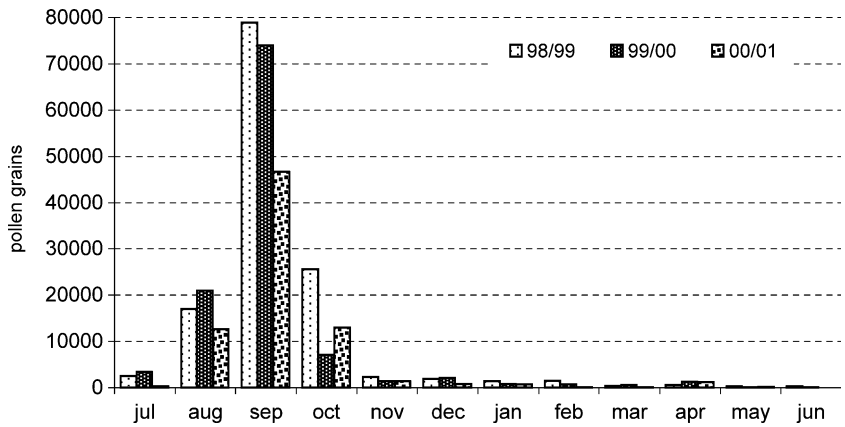

Figure 2. Monthly concentrations of pollen types from arboreal taxa during the 3-year study period.

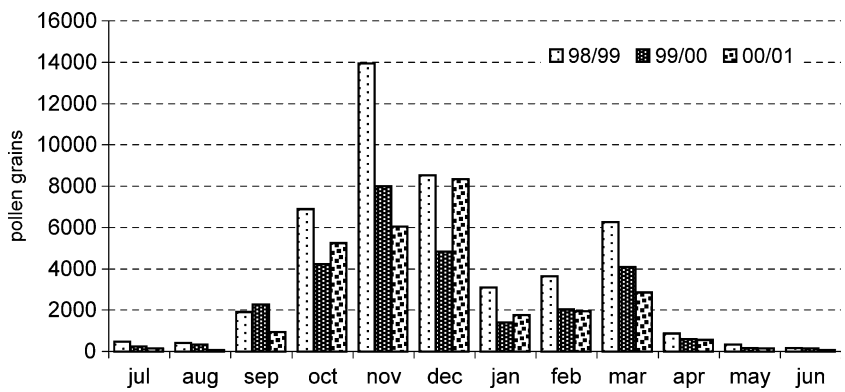

Figure 3. Accumulated percentage of arboreal pollen types in the air during the 3-year study period.

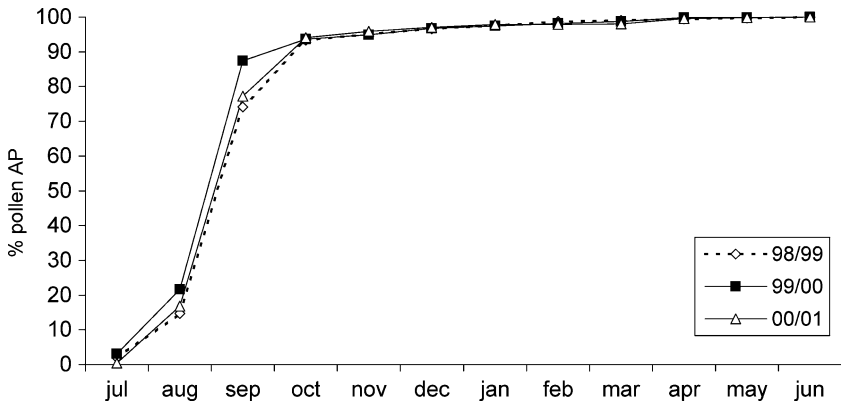

Figure 4. Monthly concentrations of pollen types from herbaceous taxa during the 3-year study period.

contribution to the atmosphere, in decreasing order of contribution, were: Poaceae, Urticaceae, Cyperaceae, Cheno-Amaranthaceae, *Ambrosia* and *Artemisia*. Poaceae made the largest contribution to the total pollen concentration during July 1998–June 1999, July 1999–June 2000 and July 2000–June 2001, with 25,859, 14,271 and 15,333 pollen grains, respectively. The highest pollen concentration during July 1998–June 1999 and July 1999–June 2000 was in November, with 13,942 and 8010.5 pollen grains, respectively; during July 2000–June 2001, this was December, with 8340 pollen grains. These concentrations represented 29.9, 39.4 and 29.6% of the total herbaceous pollen, and 7.7, 5.6 and 7.8% of the total pollen (AP and NAP). The accumulated percentage curve for the herbaceous group revealed that 70% of the total NAP occurred in December for all 3 years, while more than 95% of the total NAP pollen occurred in March (Figure 5).

The lowest pollen concentrations were recorded at the beginning of the autumn (April) and the beginning of the winter (June): 1.43, 1.70 and 2.12% of the total pollen for each year (July 1998–June 1999, July 1999–June 2000, July 2000–June 2001). The pollen types present in this period were: *Casuarina*, Poaceae, Myrtaceae, Cheno-Amaranthaceae, and Cupressaceae. The *Casuarina* pollen type was the only arboreal taxa that showed a maximum concentration in February during the 1998–1999 study period and in April during the 1999/2000 and 2000/2001 study periods.

3.2. *Intradiurnal variation of AP and NAP*

The daily arboreal emission pattern (AP) (Figure 6) was consistent during the 3-year study period, with a minimum concentration of airborne pollen being recorded during the hours of the night, at 02:00 hours. The concentration of pollen during the night (02:00 hours) was only 10% of that recorded during daylight hours. During the mid-morning measurement, at 00:10 hours, the emission was 29, 28.7 and 29.5% for July 1998–June 1999, July 1999–June

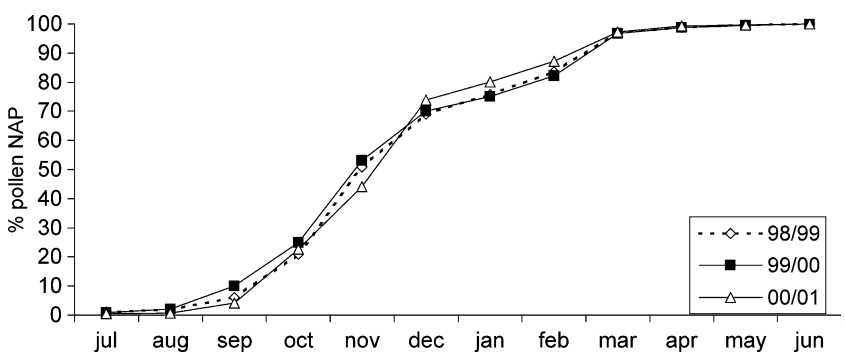

Figure 5. Accumulated percentage of herbaceous pollen grains during the 3-year study period.

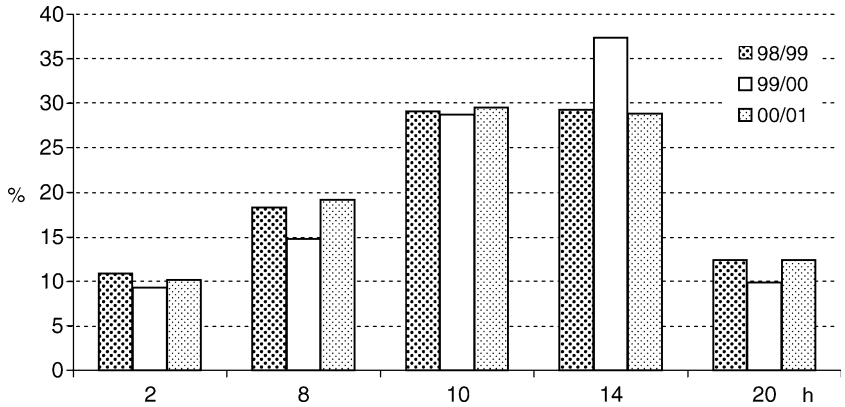

Figure 6. Intradiurnal arboreal pollen distribution during the hours analysed.

2000 and July 2000–June 2001, respectively. The last value represents the maximum emission hourly record during 2000–2001. At 00:14 hours the emission was 29.3, 37.4 and 28.8% for each of the study years; inthis case, the first two values show the maximum emissions for the 1998–1999 and 1999–2000 years, respectively.

The daily herbaceous pollen emission pattern (NAP) (Figure 7) also showed minimum values of pollen emission at 02:00 hours during all of the study years, with the amount of pollen emitted during the night (00:02 hours) only 11.9, 11.8 and 13.6% of that during the day for July 1998–June 1999, July 1999–June 2000 and July 2000–June 2001, respectively. At 10:00 hours, there was an increment in NAP emission; this was notable for the 1998/1999 period with a 27.5% pollen emission and was the time of maximum pollen emission for this period. In 1999–2000 and 2000–2001 the corresponding values were 25.6 and 23.7%. At approximately 0014 hours, pollen emissions were 26.6% (1998/1999) and 29.5 and 26.2% (1999/2000 and 2000/2001, respectively). These two latter values were the respective maximum values for the period.

3.3. *Intradiurnal variations of pollen types*

An intradiurnal variation in AP types in the atmosphere was found. At different times during the day the following pollen types were at a maximum: Cupressaceae and Cyperaceae (10:00 hours) or *Platanus, Fraxinus*, *Acer*, *Celtis* and *Quercus* (00:14 hours) (Figure 8).

Casuarina and *Morus* pollen types reached their maximum concentrations during the midday (10:00–14:00 hours). Other pollen types, such as Myrtaceae, were present in the atmosphere during the whole day and did not shown a defined concentration curve.

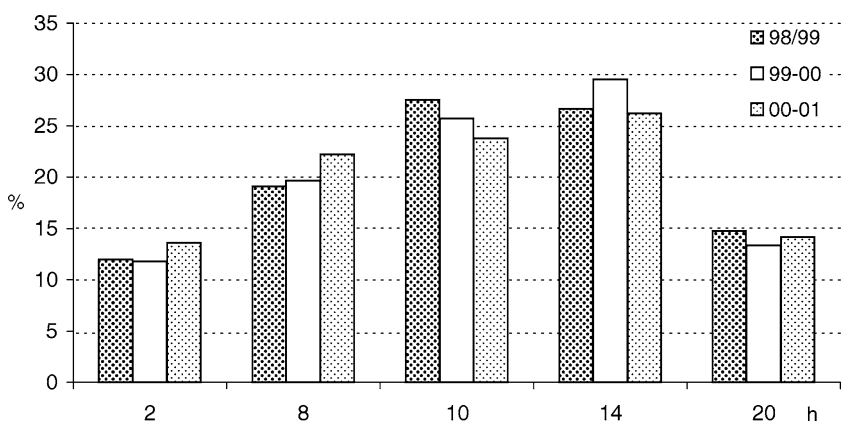

Figure 7. Intradiurnal herbaceous pollen distribution during the hours analysed.

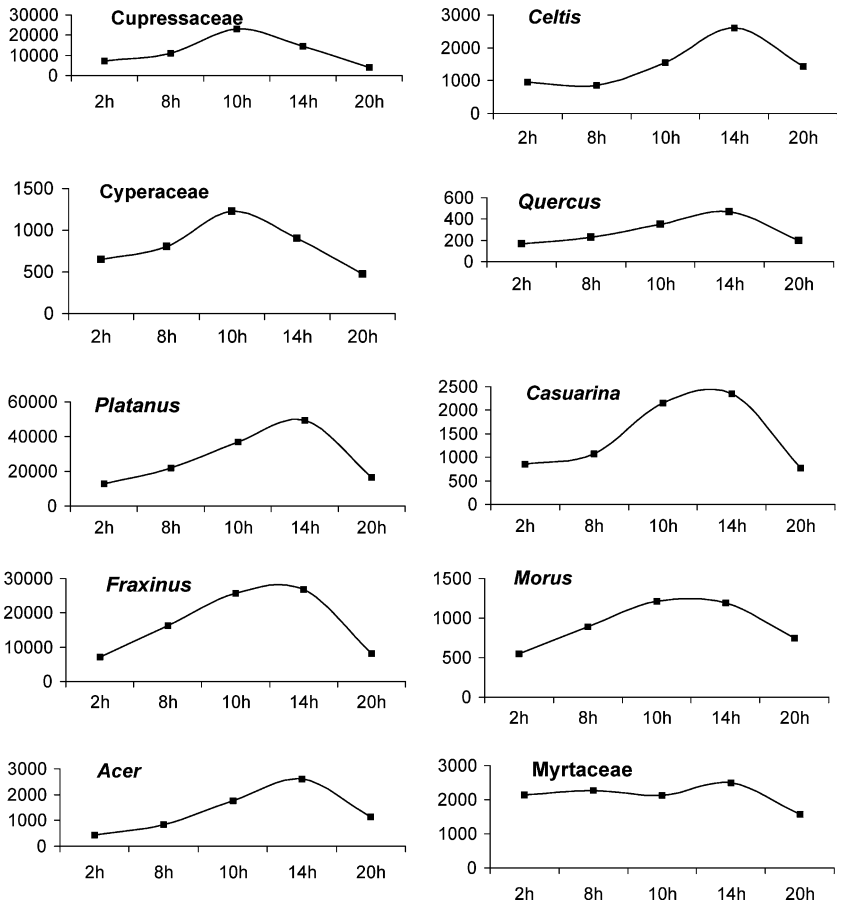

Figure 8. Intradiurnal distribution for the most frequent arboreal pollen types.

4. Conclusion

The analysis of pollen present in the atmosphere of La Plata City revealed a high level of diversity due to the floristic complexity of the urban vegetation. Plants, mainly exotic, with anemophilous pollination were the best represented. The total pollen spectra of the 3-year study period show variations in the total airborne pollen. These values were proportional to the contribution from arboreal and herbaceous plant types for each year.

There was a restricted number of dominant pollen types in the atmosphere, most of which were produced by arboreal taxa.

The highest level of pollen emission during the 3-year study period was recorded during July 1998–June 1999; the lowest absolute concentration of pollen was recorded during July 2000–June 2001.

In each year, two marked pollen seasons were observed. One was characterised by arboreal pollen. This season lasts from July to October, which coincides with the low temperatures that occur in late winter–early spring. This period showed the climatic seasonality of the area, which was mirrored in the vegetable phenology and reproduction. The maximum concentration of airborne pollen was recorded in September for all 3 years. This is the month in which most of anemophilous arboreal taxa are in one of the flowering phenophases. September also had the highest concentration compared to the total pollen concentration – higher than the annual percentage of 44%. The highest arboreal contribution to airborne pollen was also in September – 62% compared to the total monthly amount, probably due to *Platanus* pollen.

The other season was characterized by herbaceous taxa, mainly grasses, which prevail from November to March and coincide with the highest temperatures of the year. A maximum concentration of these taxa was recorded in November during 1998–1999 and 1999–2000 and in December during 2000–2001. The very low number of grains observed was noticeable from autumn to early winter, with a minimum percentage occurring in June, which showed the absence of,or only the presence of a very few, species in one of the floration stages.

The accumulated airborne pollen percentage followed a sigmoid pattern with a positive correlation with time; the shape of the curve was similar during each of the study periods. This was observed for both the arboreal-shrub-like taxa and the herbaceous taxa.

Among those taxa studied, three types of intradiurnal concentration curves or rate of daily pollen concentrations were distinguished: those whose peak of emission was represented at a certain hour of the day, those whose maximum concentration was found during a short period of time of the day and those whose presence in the atmosphere was constant during the whole day.

Intradiurnal pollen concentration showed a daily circadian pattern in the atmosphere for every taxa analysed, which would be the result of various interacting factors. The most probable main factors are meteorological and environmental conditions, the distance from the pollen-emitting source to the captor and the number of species which contribute to this pollen type.

Daily pollen concentrations followed the trend of high concentrations during daylight hours and low concentrations at night. The minimum concentration of arboreal and herbaceous pollen in the atmosphere occurred at 02:00 hours, with a slight increase at about 08:00 hours (with the first hours of daylight). The maximum concentration was reached at both 10:00 hours and, most often at 14:00 hours. At about 02:00 hours a new decrease was observed in the number of pollen grains present in the atmosphere.

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