



Intradiurnal fluctuation of pollen in La Plata, Argentina. Part I, herbaceous pollen types

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Abstract

A pollen analysis was carried out on six herbaceous pollen types whose annual concentration represents a percentage higher than 0.3% in the atmosphere of the city of La Plata, Argentina, from July 1998 to June 2001. They are: *Ambrosia*, Cyperaceae, Chenopodiaceae-Amaranthaceae, *Plantago*, Poaceae and Urticaceae. Hourly patterns of the pollen types analysed with the intradiurnal daily index (IDI) could be grouped into three categories account the percentage that represent of pollen concentration registered during five hourly periods of the day. Group I includes pollen types that show a sharp peak in abundance just one at hour of the day. Group II is formed by pollen types that show high concentrations in more than one hourly band during the daylight. Group III is characterized by the pollen types that show lower concentrations over a broad hourly band during the day.

1. Introduction

The quantitative relationship between the number of pollen grains of a taxon deposited on the sediment and the number of individuals of the taxon in the vegetation of the sampling site is influenced by the abundance of the taxon in the vegetation and by various interacting factors. Genetic, physiologic, and phenological to ecological, meteorological and climatic factors control the flowering and the pollen production of each individual.

In numerous investigations (Käpylä, 1981, 1984; O'Rourke, 1986, 1989; Golberg et al., 1988; Perez et al., 2003), it has been recorded that the relationship between the rise in temperature and the decrease of relative humidity during the same period of time is a favourable condition for the presence and persistence of pollen grains in the atmosphere. Evidences show that the wind speed and direction affect the concentration during daylight hours, when instability and convective movements prevail (Perez et al., 2001).

The degree of pollen production during the period of emission to the atmosphere, the number of days

the pollen is present in the air, the day of maximum pollen emission as well as the intra-diurnal variation of pollen concentration can be obtained from continuous aeropalynologic annual samplings. These data allow a comparison of different pollen types during their period of pollination and they are very important to other areas of scientific and health interest.

The purpose of this paper is to analyse the intradiurnal presence of pollen grains of herbaceous pollen types present in the atmosphere whose annual concentration represents a percentage exceeding 0.30% of the pollen rain between July 1998–June 2001. They are: *Ambrosia*, Cyperaceae, Chenopodiaceae-Amaranthaceae, *Plantago*, Poaceae and Urticaceae.

2. Material and methods

Samples were taken with a Lanzoni VPPS 2000 Hirst trap (1952) located 15 m above the ground level, on a terrace of a building in the center of the city of La Plata, Argentina (34°55' S, 57°17' W). The area is characterised by residential buildings and few green spaces.

The climate is characterised as subhumid-humid, mesothermal (Burgos and Vidal, 1951). The climatic values for the period 1991–2000 registered an annual mean temperature of 23.25 °C, annual mean precipitation of 93.30 mm. Predominant winds blow from E and N sectors with average intensities of 9.8 km/h.

Daily patterns of pollen concentration were obtained calculating the average concentration for every each hour counted (2 h, 8 h, 10 h, 14 h and 20 h) in transverse lines, perpendicular to the axis of the sample. Results were expressed either as number of pollen grains per cubic meter of air or as percentages of total pollen counted during an hour.

In order to determine the Maximum Pollination Period (MPP) the criterion quoted by Emberlin and Norris-Hill (1991) was followed. The beginning of the period of maximum pollen production is considered from the first day on which an accumulated pollen concentration represented a percentage higher than 5% and the end of the period would correspond to the day in which the accumulated pollen concentration represented a percentage of 95% of the total pollen.

All days were considered of periods in the diurnal analysis, including rainy days.

The Intra-diurnal Daily Index (IDI) adopting the method explained in Trigo et al. (1997), which considers the maximum and minimum hourly value in a certain time interval in relation to the total value of the analysed hours. The range of values of this index is between 0 and 1 depending on the distribution of the pollen concentration during the day. Values close to 1 indicate that the pollen emission was remarkably higher at an hour or hourly band than the others.

The meteorological data were provided by the Seismology Department and Meteorological Information of the College of Astronomic and Geophysics Sciences of the National University of La Plata, Argentina.

3. Results

The greatest proportion of pollen capture in the atmosphere was of Poaceae with concentration values that represent from 10% to 14.46% of the total pollen count, and with values that represent from 49.5% to 54% of the non-arboreal pollen count. The pollen types spectra with low percentage was *Plantago* with concentration values that represent from 0.32% to 0.61% of the total pollen count, and with values that represent from 1.57% to 2.49% of the non-arboreal

pollen count. The other pollen types analysed are listed in Table 1.

3.1 Daily pollen spectra

Ambrosia is represented by three species *A. tenuifolia*, *A. elatior* and *A. scabra* which are very common in uncultivated lands. It presents a stable pattern of pollination during the three years with a gradual increase from 2 h in favour of the hours of greater insolation. Its maximum emission to atmosphere is found at 14 h with a pollen contribution that represents 36.7%, 28.7% and 30.1% of the total counts and decreases in the evening at 20 h with a pollen contribution that represents 14.67% (Figure 1). The pollen grains are in the atmosphere from the middle of Summer to the middle of Autumn 90, 101 and 137 days, and their maximum concentration is found in February and March. Its maximum pollen contribution to the atmosphere is found on 29/2/99, 8/3/00 and 11/3/01 (Table 2). The IDI value varies between 0.26, 0.17 and 0.90 and its variation coefficient is 90.68% (Table 3).

The Cyperaceae are represented by species of the *Carex*, *Androtrichum*, *Cyperus*, *Scirpus*, *Fimbristylis*, *Eleocharis*, *Rhynchospora* y *Bulbostylis* genera. They are mainly found in uncultivated lands and green spaces. This family is observed in the sampling almost all year long since it shows coexistence and succession of flowering times of the various taxa that it represents. The maximum peak of pollination is found in the morning at 10 h in the three years with a pollen contribution that represents 33.8%, 27.9% and 28.6% of the total counts. Their pollen emission to the atmosphere is from the end of Winter to the middle of Autumn (Table 2) 194, 102 and 148 days. They show a maximum daily concentration on 15/10/98, 1/9/99 and 31/10/00 (Figure 1). The IDI value varies between 0.23 and 0.16 between the years and the variation coefficient is 24.17% (Table 3).

The group formed by Chenopodiaceae-Amaranthaceae is mainly represented by species of the *Chenopodium* y *Amaranthus* genus, although it is also represented by the *Salicornia*, *Holmbergia* and *Iresine* genera among others. The maximum pollen concentration value was found in the morning at 10 h during 1998 representing 33.2% and 1999 with 38%, except for 2000 when it was observed the midday at 14 h representing 36% of the total counts (Figure 2). It is found in the atmosphere during Spring and all the Summer 216, 167 and 194 days (Table 2). Its greatest concentration is seen in the months of October and

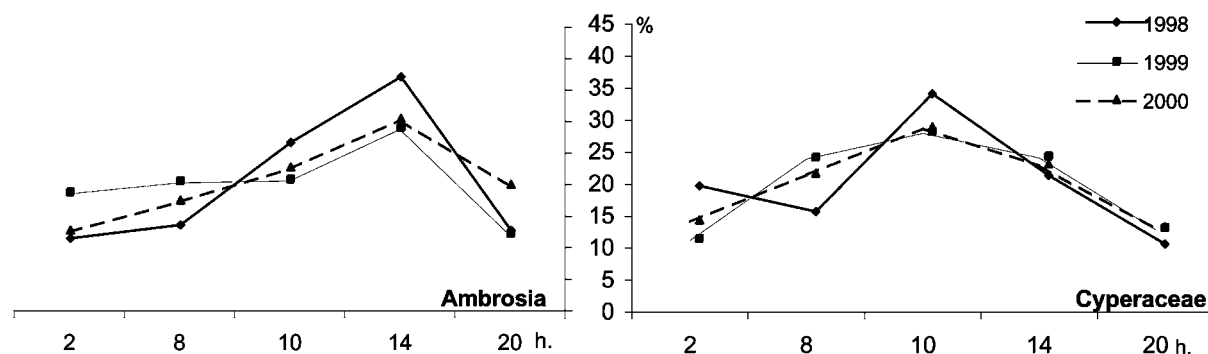


Figure 1. Daily pollen patterns of *Ambrosia* and *Cyperaceae* represented as percentage of the total pollen sum for each taxon in the period 1998–2001.

Table 1. Percentage of each taxa regarding the total pollen (PT) and non-arboreal pollen (NAP) for 1998–2001.

	Periods	<i>Ambrosia</i>	<i>Cyperaceae</i>	<i>Cheno-Amar.</i>	<i>Plantago</i>	<i>Poaceae</i>	<i>Urticaceae</i>
PT	98–99	1.84	3.26	0.66	0.61	14.28	3.74
	99–00	1.66	1.87	0.82	0.32	10.01	3.86
	00–01	1.4	3	0.53	0.49	14.46	4.93
NAP	98–99	6.99	12.37	2.49	2.49	54.14	14.14
	99–00	8.2	9.25	4.07	1.57	49.49	19.05
	00–01	5.22	11.17	1.97	1.83	53.81	18.35

Table 2. Characterization of pollen types during 1998–2001. Day of beginning and end of the period of maximum pollination (MPP) and day of maximum concentration in the atmosphere.

Pollen types	1998–1999			1999–2000			2000–2001		
	Initiation MPP	End MPP	Maximum day	Initiation MPP	End MPP	Maximum day	Initiation MPP	End MPP	Maximum day
<i>Ambrosia</i>	26–1	11–6	8–3	5–2	16–5	29–2	15–1	15–4	11–3
<i>Cyperaceae</i>	26–9	8–5	15–10	1–9	11–12	1–9	11–10	7–3	31–10
<i>Plantago</i>	10–10	8–3	7–1	13–10	18–3	17–12	6–10	17–3	21–10
<i>Chenop.-Amar.</i>	25–9	29–4	11–3	17–10	1–4	10–3	8–10	26–4	18–3
<i>Poaceae</i>	5–11	24–6	4–12	26–10	22–4	20–11	24–10	21–6	3–12
<i>Urticaceae</i>	26–7	27–6	1–10	12–8	29–6	21–9	16–9	27–6	6–10

April in the various uncultivated lands of the city. The maximum pollen emission was observed between 11/3/99, 10/3/00 and 18/3/01. The IDI value varies 0.23 and 0.29, its variation coefficient being 11.89% (Table 3).

Plantago is represented by the species *P. berroi*, *P. penantha*, *P. brasiliensis*, *P. tomentos* and *P. australis* in the green spaces of the city. The maximum concentration was recorded at midday at 14 h during 1998 with 32.5% and 2000 with 29.7% except for 1999 that was recorded in the morning at 10 h with

40.4% of the total counts (Figure 2). It is present from the beginning of Spring to the end of Summer, between 149 and 157 days. Its greatest pollen record is found from October to December. The maximum daily concentration was found on 7/1/99, 17/12/99 and 21/10/00 (Table 1). The IDI value varies between 0.02, 0.32 and 0.20 with a variation coefficient of 83.88% (Table 2).

The *Poaceae* are a family with 105 species quoted for the area (Cabrera and Zardini, 1993). Some of the main genus are *Guadua*, *Leersia*, *Poa*, *Festuca*, *Alopecurus*.

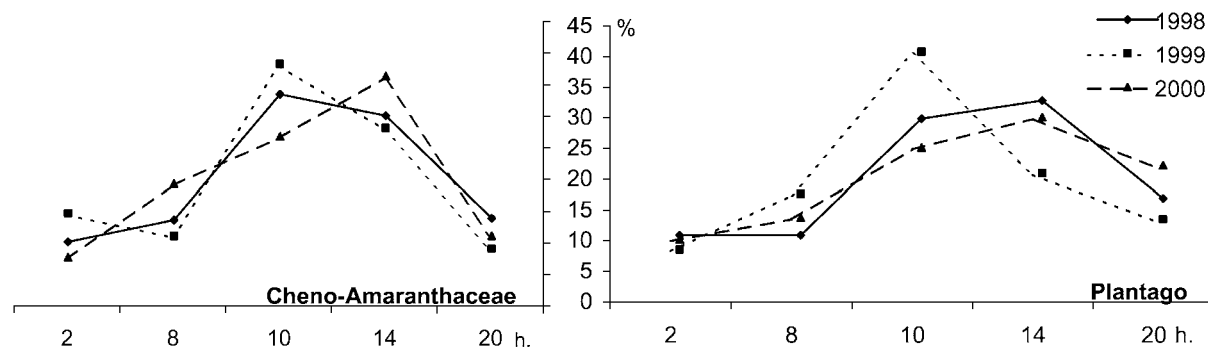


Figure 2. Daily pollen pattern of Chenopodiaceae-Amaranthaceae and *Plantago* represented as percentage of the total pollen sum for each taxon in the period 1998–2001.

Table 3. Annual intradiurnal daily index and variation coefficient obtained during the sampling for the different pollen types.

	1998	1999	2000	mean	cv (%)
<i>Ambrosia</i>	0.26	0.17	0.90	0.44	90.68
Cyperaceae	0.23	0.16	0.16	0.18	24.17
<i>Plantago</i>	0.02	0.32	0.20	0.18	83.88
Chenop.- Amaranthaceae	0.23	0.29	0.29	0.27	11.89
Poaceae	0.10	0.17	0.14	0.14	24.44
Urticaceae	0.10	0.07	0.08	0.08	17.07

curus, *Stipa*, etc. The pollen concentration increases slightly during the hours of greatest insolation in the three years compared to the hours of the night, the averages vary between 12.7% at 2 h., 20.6% at 8 h., 23.6% at 10 h., 24% at 14 h. and 14.6% at 20 h of the total counts (Figure 3). The maximum concentration in the atmosphere is recorded between the months of November and June, during Spring and the end of Autumn. The duration of the season in the atmosphere was 231, 179 and 241 and the maximum pollen emission was recorded on 4/12/98, 20/11/99 and 3/12/00 (Table 2). It shows an intradiurnal pattern with very low values of IDI between 0.10 and 0.17 with a variation coefficient of 24.44% (Table 3).

The Urticaceae are represented by species of the *Urtica*, *Parietaria* and *Bohemeria* genera in any green area of the city. The record of pollen emission is similar to the analysed hours, 16.1% at 2 h, 21.2% at 8 h, 22.7% at 10 h, 22.1% at 14 h and 17.6% at 20 h of the total counts (Figure 3). The greatest pollen concentrations are observed in the months of September and October, although pollen are found in the air during 336, 322 and 284 days. On 1/10/98,

21/9/99 and 6/10/00 the maximum pollen concentration in the atmosphere is found (Table 2). The IDI value is 0.10, 0.07 and 0.08, which is the lowest among the analysed pollen types and the variation coefficient is 17.07% (Table 3).

3.2 Meteorological variables

The meteorological parameters have a diurnal cycle with maximum values of temperature and wind speed, and minimum values of relative humidity between 10 h and 14 h. The highest mean temperature in the period 1998–1999 reached 19.2 °C at 14 h and the lowest relative humidity 61.3% at the same hour. Wind speed showed the highest value at 14 h with 11.8 km/h.

During 1999–2000 the temperature reached a maximum value of 19.7 °C at 14 h. The lowest relative humidity was 64.2 °C and the highest wind speed of 11.8 km/h at the same hour.

During 2000–2001 the temperature reached a maximum value of 20.4 °C at 14 h. The lowest relative humidity was 73.5 °C and the highest wind speed of 11.1 km/h at the same hour.

Daily temperature and wind speed patterns showed differences not significant during periods 1998–2001, except for relative humidity that showed highest values in 2000/01 that the previous periods.

The winds were registered from all directions, but NE, SE and NW remain the more frequent sectors. It was registered a gradual increase in frequencies of winds from N and SE between 10 h and 14 h.

4. Discussion

From the analysis of IDI, three groups of pollination rhythms have been recognized. Group I includes

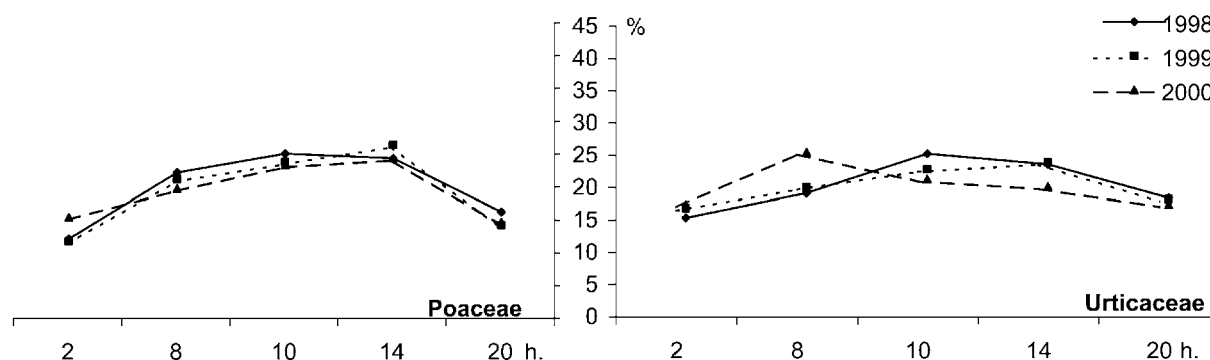


Figure 3. Pattern of intradiurnal variation of Poaceae and Urticaceae represented as percentage of the total pollen sum for each taxon in the period 1998–2001.

all those pollen types that represent the peak of pollen concentration at a given hour of the day, they are, *Ambrosia* and Cyperaceae. Group II includes all those pollen types with peak pollen concentration lasting several hours, they are, Chenopodiaceae-Amaranthaceae and *Plantago*. Group III includes those pollen types whose pollen contribution to the atmosphere is distributed in a roadly during the day, they are Poaceae and Urticaceae.

Among these selected pollen types it is observed that their maximum pollination periods coexist mainly between the beginning of Spring and the end of Summer. This is when the maximum concentrations and diversity of herbaceous species are seen in the atmosphere (Nitíu and Romero, 2002a, b).

Quantitative composition of the daily NAP spectrum did not show important changes during the years analysed.

When analyzing the hourly behaviour of these large taxonomic groups, it should be taken into account that each taxon represents a group of types with their corresponding species, which have not been considered individually for this paper. Each of them has a particular rhythm of pollen emission. This is important since the behaviour of each of the species is overlapped by the general behaviour of the taxa, which may be representative or not for all the cases involved.

The days with maximum pollen emission between the different years varied with a day of difference as in the case of Poaceae in 1998 and 2000 and Chenopodiaceae-Amaranthaceae in 1998 and 2000 and more than two months as in the case of *Plantago* in 1998 and 2000 and Cyperaceae in 1999 and 2000. In spite of that, there is not a record of a year whose behaviour pattern is remarkably different from the other two, and a slight tendency of a early beginning in the year 2000 is

observed, which would be due to favourable meteorological conditions before and during the pollination period for these pollen types.

For the city of La Plata, during 1998 to 2001, the maximum values of intradiurnal index for each taxon were in general greater in Group II, accumulating 65% of the total daily concentration in the hourly band between 10 h and 14 h. In the second place, there is Group I which accumulates between 30% and 35% of the total daily concentration at a certain hour. The reason for this is that the representatives of Group I did not show hourly peaks of pollen concentration which are very significant compared to the other hours and on the other hand the pollen types that represent Group II showed them in an important proportion.

The behaviour of Group III as regards the hourly period of presence in the atmosphere shows that, in general the maximum concentrations of pollen grains are recorded in the hours close to midday when the meteorological conditions of temperature and humidity would be more favourable for the release and dispersion of pollen grains (Galán et al., 1991; Perez et al., 2001), although there are some pollen types whose intradiurnal behaviour would seem not to adjust strictly to it, like Urticaceae and Poaceae in this diurnal analysis.

In the city of La Plata, there are previous few studies on the diurnal dynamics and relate to some airborne pollen during the same periods (Nitíu, 2003; Nitíu and Mallo, 2002). The trend showed a daily oscillation with high concentrations during daylight hours and low concentrations in the night, when meteorological conditions are more stable. Daily curves for some of these pollen types were analysed by Perez et al. (2001) in city of Mar del Plata (Argentina), Kápylä M. (1981) in the city of Jyväskylä and

Turku (Finland), Galán et al. (1991) in the city of Cordoba (Spain) and by Trigo et al. (1997) in the city of Malaga (Spain). We observed in some cases the same daily distributions of pollen concentration than those for La Plata, in spite of the difference of latitudes and climates between the various samplings. Each pollen pattern observed is influenced by local processes operating through the urban microclimate. It should be pointed out that the airborne pollen trap in the city of La Plata is located 15 m above the ground level in a central urban area with high buildings takes place a deep change in trigger termic, mechanical turbulence, in wind speed direction and in the increase of wind speed.

Even if they sometimes show a certain tendency from the intradiurnal distribution indexes recorded for the selected herbaceous pollen types group it can be inferred that: the hourly distribution records of concentration are inherent to each taxon, whose specific patterns may differ annually within the same city and therefore with other cities.

The intradiurnal index will be applied in the future to other pollen types records of the city of La Plata.

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