

First volumetric airborne pollen sampling in Montevideo City, Uruguay

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Abstract

A volumetric aeropalynological sampling was carried out for the first time in Montevideo, Uruguay, from October 2000 to September 2001, using a Rotorod sampler Model 40. During the year 76 pollen types were identified. Airborne pollen was recorded over the year but a maximum pollen period was observed from August to April. For the rest of the months, pollen concentration was below 1% of the total annual pollen (TP). The pollen spectrum was characterized by the dominance of herbaceous pollen (NAP), which represented 68% of the TP and dominates the spectrum from November to March. Poaceae was the most frequent and abundant pollen type accounting for 45% of TP. The pollen spectrum reflected the floristic diversity of the city and most of the sources of airborne pollen are present in local and regional flora. Fourteen pollen types reach more than 1% of the TP and most of them are cited as allergenic pollen in other regions. These results may prove important for future medical research.

Abbreviations: NAP – herbaceous pollen; AP – arboreal and shrub pollen; TP – total annual pollen

1. Introduction

The present study constitutes the first attempt to record airborne pollen grains in a qualitative and quantitative way in Montevideo, Uruguay. The aims were to identify the airborne pollen content during a year and to recognize the most important pollen periods.

In this South-American region, airborne pollen sampling has been performed in several cities in Argentina (Bianchi, 1992; Latorre and Pérez, 1997; Murray et al., 2002; Nitiu et al., 2003) and some cities of Brazil (Barth, 1978; Lorscheitter et al., 1986). However, in Uruguay the only antecedents are the works performed by Vaz Ferreira (1946) in which pollen grains, fungi spores, plant hairs and little animals were recorded, and Tejera and Beri (2003) that presented a preliminary volumetric analysis of a 6-month pollen record in Montevideo. No quantitative data are available

from the study of Vaz Ferreira (1946) and therefore it is difficult to compare the present results with this. Nevertheless he identified an earlier pollen period, due to the flowering of exotic trees, from winter to spring. In addition, a high grass pollen period from October to May with high pollen counts from November to early January was recorded. Moreover, Amaranthaceae-Chenopodiaceae and Astereae were registered from November to May.

2. Materials and methods

Montevideo (34°56'S–56°09'W) is the capital and the most populated city of Uruguay, with about 1.5 million inhabitants and is located on the Río de la Plata estuarine coast (Figure 1). The climate is temperate–subtropical humid, with rainfalls all through the year (1098 mm), mean annual temperature of 16.5 °C (Figure 2a, b) and relative

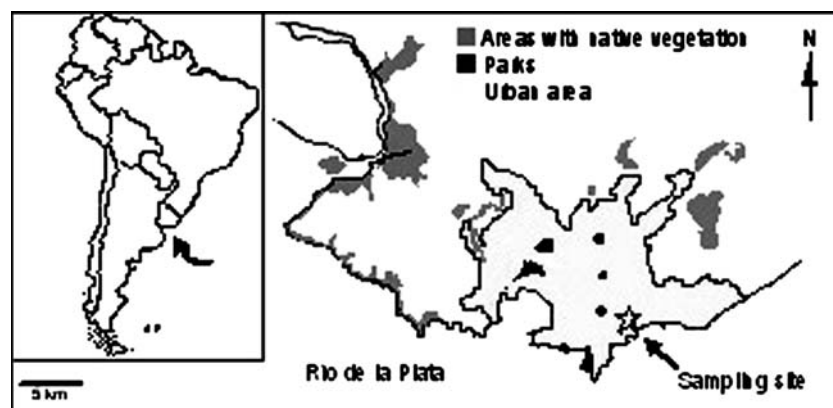


Figure 1. Sampling site and parks in Montevideo city.

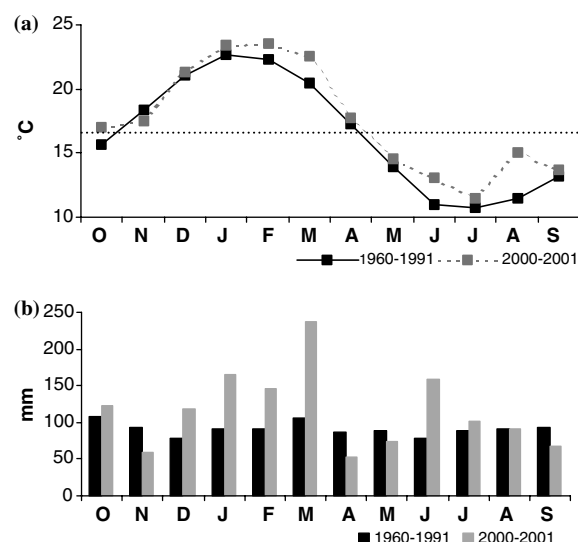


Figure 2. (a) Monthly mean temperature, (1960–1991, 2000–2001); (b) Monthly Precipitation, (1960–1991, 2000–2001).

humidity of 75%. The precipitations are basically controlled by the interaction of the South Atlantic and Pacific Anticyclone. Mean monthly wind velocity is up to 5.7 m s^{-1} all months of the year. Meteorological data corresponding to the historical period 1961–1991 and to the sampling period were supplied by Dirección Nacional de Meteorología and correspond to the nearest meteorological station $34^{\circ}50'S$, $56^{\circ}00'W$, located at Carrasco International Airport, approximately 6 km from the trap location.

Phytogeographically, the region belongs to the Pampa Province, Uruguayense District Cabrera and Willink (1973). Grassland is the dominant vegetation in Uruguay, but shrub and tree vegeta-

tion formations are also present. Near Montevideo city there are native shrub and tree vegetation areas. The main species in those areas are *Acacia caven*, *Iodina rhombifolia*, *Myrsine laetevirens*, *Scutia buxifolia*, *Schinus longifolius*, *Celtis spinosa*, *Sapium glandulosum* and *Berberis laurina*. Other species are also present such as *Arecastrum romanzoffianum*, *Blepharocalyx salicifolius*, *Cephalanthus glabratus*, *Daphnopsis racemosa*, *Phytolacca dioica*, *Salix humboldtiana*, *Sapium glandulosum*.

The urban flora is mainly composed of exotic trees and shrub species that are cultivated for ornamental purposes in streets, avenues, parks and cemeteries over the entire city. The most abundant tree and shrub species in open areas of the city are: *Melia azederach*, *Fraxinus* spp., *Eucalyptus* sp., *Platanus* spp., *Tipuana tipu*, *Salix* sp., *Acer negundo*, *Pinus* sp., *Nerium oleander*, *Ulmus* spp., *Jacaranda ovalifolia*, *Cupressus* spp., *Schinus molle*, *Acacia* spp. and *Ligustrum* sp. They account for 78% of the total trees and shrubs in open areas of Montevideo Pizzorno (1999). Herbaceous vegetation occurs spontaneously in open areas or it is cultivated in parks and private gardens. The most important herbaceous pollen sources belong to the families Poaceae, Asteraceae, Apiaceae, Amaranthaceae and Chenopodiaceae.

The aeropalynological sampling was carried out daily during 1 year, from October 2000 to September 2001, using a Rotorod sampler Model 40 (Sampling Technologies Inc.). One week (8–14 April) was lost due to a failure of the electrical supply. The sampler was installed on the roof of the Centro de Investigaciones Nucleares de la Facultad de Ciencias at ca. 12 m above floor level, in an open area.

Daily data were obtained according the standard method (Brown et al., 1993). The sampler was programmed at 10% of the cycle, the rods whirled for 1 min in every 10 and the rest of the time remain folded and static. Samples were mounted on a specially designed polystyrene microscope slide provided with transversal grooves and were stained with Calberla's solution. The rows were scanned horizontally and all the pollen grains contained in them were counted and analyzed under $400 \times$ magnification, using a Photomicroscope Olympus BH. Pollen was identified with the aid of the reference palynological collection of the Palynology laboratory (Palynología-Facultad de Ciencias) and specific bibliography (Basset et al., 1978; Markgraf and D'Antoni, 1978; Lewis et al., 1983).

The pollen data were converted into concentration values, using the following expression:

$$\text{grains m}^{-3} = N/V$$

where V is the volume of air sampled = (rod exposed area) $\times$ (head diameter) $\times \pi \times 2400$ rpm $\times$ time exposed; N = number of pollen grains.

We especially selected those types that account at least 1% of TP and are presented according their annual incidence. The allergenic potential of important types is indicated according to Vaz Ferreira (1946), Lorscheitter et al. (1986), Lewis et al. (1983) and D'Amato et al. (1991a), Carignano et al. (1998).

To analyze the correlation between pollen data and meteorological variables the Spearman Rank correlation coefficient was used. The variables selected were daily and monthly: total pollen (August–April period), arboreal and shrub pollen (August–October period) and herbaceous pollen (November–April period); mean daily and monthly temperature, total daily and monthly precipitation and mean daily and monthly wind velocity. The analysis was done using Statistica 5.5 (Stat Soft, Inc.).

3. Results

Seventy-six pollen types were identified during the year (Table 1) and account for a total pollen concentration (TP) of $10,497 \text{ grains m}^{-3}$. Pollen was recorded over the whole year but a major pollen concentration period could be established from

Table 1. Pollen types registered in Montevideo (October 2000–September 2001)

Aceraceae	Lauraceae
<i>Acer</i>	Loranthaceae
Amaranthaceae–Chenopodiaceae	Malvaceae
Anacardiaceae	Monocotiledonea
<i>Schinus</i>	Moraceae
Apiaceae	Myoporaceae
Aquifoliaceae	<i>Myoporum laetum</i>
<i>Ilex</i>	Myrsinaceae
<i>Asteraceae</i>	<i>Myrsine</i>
Astereae	Myrtaceae
Cardueae	Oleaceae
<i>Ambrosia</i>	<i>Fraxinus</i>
other Heliantheae	<i>Ligustrum</i>
<i>Artemisia</i> type	<i>Olea europaea</i>
other Anthemideae	Oxalidaceae
<i>Cichorium</i> type	<i>Oxalis</i>
<i>Taraxacum</i>	Palmae
<i>Xanthium</i>	Phytolaccaceae
Balsaminaceae	<i>Phytolacca dioica</i>
<i>Impatiens</i>	Pinaceae
Betulaceae	<i>Pinus</i>
<i>Alnus</i>	<i>Tsuga</i>
Boraginaceae	Plantaginaceae
<i>Echium platagineum</i>	<i>Plantago</i>
Brassicaceae	Platanaceae
Calyceraceae	<i>Platanus</i>
<i>Acicarpa</i>	Poaceae
Caprifoliaceae	Polygonaceae
<i>Sambucus</i>	<i>Polygonum</i> type
Casuarinaceae	<i>Rumex</i>
<i>Casuarina</i>	Potamogetonaceae
Combretaceae	<i>Potamogeton</i>
<i>Terminalia</i>	Ranunculaceae
Cupressaceae	Rosaceae
Cyperaceae	<i>Prunus</i>
Ephedraceae	Rutaceae
<i>Ephedra</i>	<i>Citrus</i>
Ericaceae	Salicaceae
Euphorbiaceae	<i>Populus</i>
<i>Ricinus communis</i>	<i>Salix</i>
Fabaceae	Santalaceae
<i>Erythrina</i>	Acanthosyris
Fabaceae type	Sapindaceae
<i>Lotus</i>	<i>Allophylus</i>
<i>Mimosa</i>	<i>Dodonaea viscosa</i>
<i>Spartium</i>	Scrophulariaceae
Fagaceae	<i>Gerardia</i>
<i>Castanea</i>	Simaroubaceae
<i>Nothofagus</i>	<i>Ailanthus altissima</i>
<i>Quercus</i>	Typhaceae
Hamamelidaceae	<i>Typha</i>
<i>Liquidambar</i>	Ulmaceae

Table 1. (Continued)

Juglandaceae	<i>Celtis</i>
<i>Carya</i>	<i>Ulmus</i>
<i>Juglans</i>	Urticaceae
Lamiaceae	Verbenaceae

August to April (Figure 3), as this period represented the 98.05% of TP. The highest monthly pollen concentration was observed in December (26.6% TP) followed by November (17.9% TP) and September (15.5% TP) (Figure 3). Monthly pollen concentration was lower than 10% during the other months and from May to July was below 1% TP (Figures 3, 4). The richness varied along the year with a similar tendency to pollen concentration (Figure 4), the maximum number of pollen types was registered in October (47 types) and the minimum was recorded in June (14 types). Two main airborne pollen periods and a third period of very low pollen concentration were identified in this study (Figures 3, 4). The first period, mainly

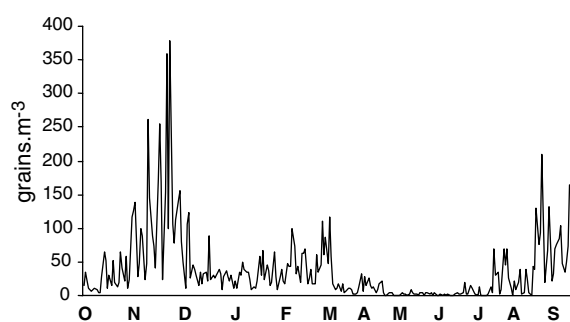


Figure 3. Daily total pollen concentration.

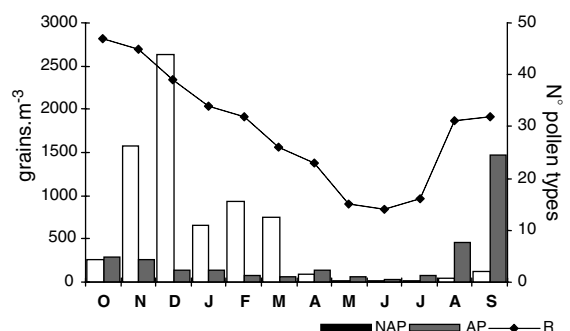


Figure 4. Total monthly non-arboreal (NAP) and arboreal pollen (AP) concentration and pollen richness (R) as number of pollen types.

from August to October, accounted for 30% of the TP. A second period occurred from November to April and accounted for 68% of TP. Included in this period, a period of highest pollen concentration can be distinguished from November to December, represented essentially by Poaceae (Figure 5a). It is followed by a period of minor pollen concentration from January to March, mainly for pollen types belonging to Asteraceae family and in April mainly *Casuarina* and *Myrsine* (Figure 5a, b).

From May to July the lowest pollen concentrations were recorded and the monthly pollen concentrations were below 1% TP.

NAP was correlated positively with mean monthly temperatures (Spearman $R = 0.78$, $p = 0.002$), whereas AP was negatively correlated (Spearman $R = -0.93$, $p = 0.0002$). Precipitation showed low negative correlation with all pollen variables, TP (Spearman $R = -0.23$, $p < 0.01$), AP (Spearman $R = -0.24$, $p < 0.01$) and NAP (Spearman $R = -0.32$, $p < 0.01$). No more meteorological variables were significantly correlated with pollen data.

Fourteen types recorded concentrations of up to 1% of TP and accounted for 85.9% of TP (Table 2, Figure 5a, b). Types representing arboreal pollen were registered from autumn and dominate the pollen spectrum during winter and the start of spring (Figure 4). Cupressaceae was registered mainly from July to October (Figure 5a) and was responsible for the increment on pollen concentration recorded in August (Figure 3). The most abundant genera belonging to this family in Montevideo is *Cupressus* (Pizzorno, 1999) but *Juniperus*, *Libocedrus*, *Chamaecyparis* and *Thuja* are also present (Lombardo 1979; Pizzorno 1999). Cupressaceae accounted for more than 50% of monthly pollen concentration during July and August; during the first month they co-dominated the pollen spectrum together with *Fraxinus* (Figure 5b). *Fraxinus* presented a bimodal pollen curve, the first period with higher pollen concentrations in July and the second one in September (Figure 5b). *Fraxinus americana* and *F. lanceolata* are common near the sampling station and constitute the most abundant anemophilus tree of the city (Pizzorno, 1999).

During September, *Platanus* (Figure 5a) was recorded in relatively high concentrations and accounted for 56% of the pollen concentration of

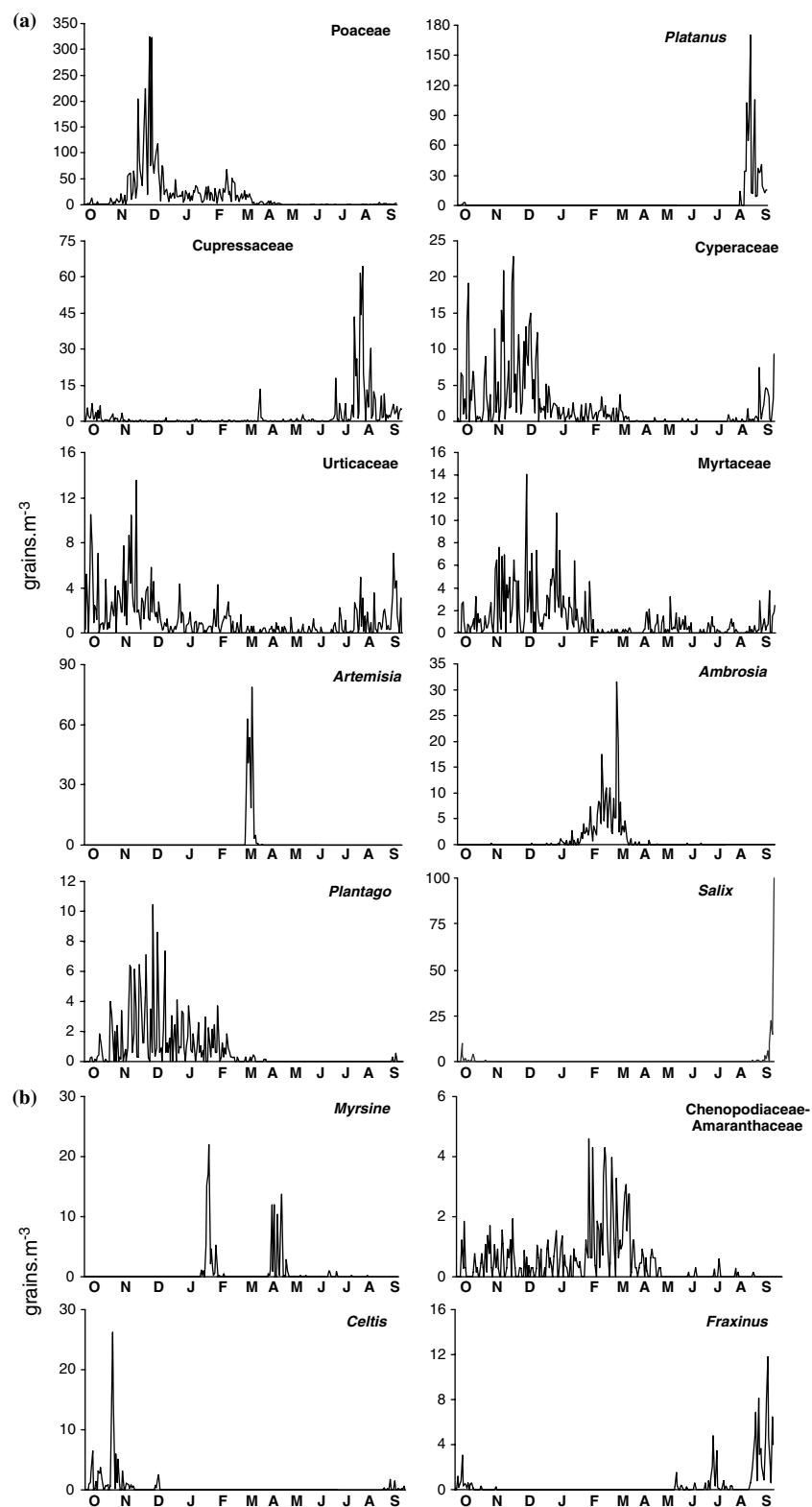


Figure 5. (a) Daily pollen concentrations. Note the different scales. (b) Daily pollen concentrations. Note the different scales.

Table 2. Dominant pollen types; annual incidence (% of TP); month of highest incidence and allergenic potential

	Annual incidence	Highest incidence		Allergenic potential
		Month	Amount (%)	
Poaceae	45.7	December	79	+
<i>Platanus</i>	8.9	September	56	+
Cupressaceae	6	August	73	+
Cyperaceae	5.1	October	16	+
Urticaceae	3.2	October	11	+
Myrtaceae	3.1	May	23	+
<i>Artemisia</i> type	3	March	38	+
<i>Ambrosia</i>	2.4	February	14	+
<i>Plantago</i>	1.9	January	4	+
<i>Salix</i>	1.8	September	10	+
<i>Myrsine</i>	1.4	April	27	no data
Chenopodiaceae–Amaranthaceae	1.2	February	4	+
<i>Celtis</i>	1.1	October	14	+
<i>Fraxinus</i>	1	July	15	+

this month. *Platanus acerifolia*, *P. occidentalis* are the pollen sources of this pollen type in the study area (Lombardo, 1979; Pizzorno, 1999) and are the second more abundant anemophilous tree in the city (Pizzorno, 1999).

Salix showed a short pollen period in which it reaches high pollen concentrations, from late September to early October (Figure 5a). At least five species could contribute to this pollen type: *Salix caprea*, *S. babylonica*, *S. fragilis*, *S. humboldtiana* and *S. alba* (Lombardo, 1979).

Celtis was recorded exclusively from September to December and accounted for higher concentration during October (Figure 5b), when it co-dominates the pollen spectrum with Poaceae, Cupressaceae, Cyperaceae, Urticaceae, *Populus* and *Acer*. Only 3 species are present in Montevideo: *Celtis australis*, *C. occidentalis* and *C. tala* (Lombardo, 1979) and they are not common in public spaces of the city, but are usually found in some parks and native areas in the city's periphery.

A strong increase in TP occurred in November due to a strong increase of Poaceae that dominated the pollen spectrum until February (Figure 5a), accounting more than 50% of total monthly pollen in those months. Although Poaceae was registered all year, their highest pollen concentration occurred in November–December and minor concentrations were recorded from January to

April. Many species belonging to this family are present in the studied area. This type was the most frequent and abundant airborne pollen, representing 45.7% of the TP.

Cyperaceae and Urticaceae were recorded mainly during August to March and sporadically with low concentration from April to July (Figure 5a). Many species belonging to Cyperaceae are present in Montevideo. Urticaceae is represented in this city by *Parietaria*, *Urtica* and *Bohemeria* (Lombardo, 1982); nevertheless *Parietaria* is the most abundant genera and could be the most important pollen source for this pollen type.

Myrtaceae is another type recorded all through the year but their highest pollen concentration occurred during spring and early summer (Figure 5a). Although other genera belonging to this family present the same pollen morphology, the most abundant genera cultivated in the city is *Eucalyptus* (Pizzorno, 1999).

Ambrosia and *Artemisia* were found in relatively high concentration from January to March and exclusively in March, respectively (Figure 5a). According to Lombardo (1983), the only species present in Montevideo is *Artemisia verlotorum* and it could be the main pollen source. However, the presence of another species cannot be discounted. *Ambrosia artemisifolia* and *A. tenuifolia* are cited as the more important species of the city (Lombardo, 1983) and are relatively common, especially bordering avenues and roads and could be considered the most relevant pollen sources for this type.

Plantago was recorded from September to March, mainly from November to February (Figure 5a). Many species are present in Montevideo and are responsible for this pollination pattern.

Chenopodiaceae–Amaranthaceae is another pollen type with a long pollen period in which it was recorded in relatively low pollen concentration. Their highest values were recorded in February and March (Figure 5b).

Myrsine (Figure 5b) was recorded in two periods separated by a null pollen record, from late January to early February and from mid-April to early May.

4. Discussion and conclusions

Despite the fact that airborne pollen was recorded during the whole year, a period of major concen-

trations was observed from August to April. It could be explained because this corresponds to the flowering period of the majority of the species (Lombardo, 1979; 1982; 1983; 1984). The presence of two periods of pollen dominance, one of arboreal and shrub pollen (AP) and other of herbaceous pollen (NAP) is a characteristic of cities with temperate climates. Comparing the pollen spectrum of Montevideo with those of other cities of the region showed some similarities with Buenos Aires, Mar del Plata and Bahía Blanca (Latorre and Pérez, 1997; Murray et al., 2002; Nitiu et al., 2003). The same dominance period of herbaceous pollen (November–March) as also the presence of a period of very low pollen concentration were recorded in Buenos Aires (Nitiu et al., 2003). However this period, called the residual period in Buenos Aires, was registered 1 month later in Montevideo. Also the arboreal pollen dominance period was registered 1 month later than in Buenos Aires but finished in the same month (October). The lowest concentration period was recorded in exactly the same months as in Bahía Blanca (Murray et al., 2002) also during the coldest months but the temperatures were below 12 °C only in June and July in Montevideo. The dominance of Poaceae, as the most abundant pollen type, was also registered in Mar del Plata; while AP dominated the pollen spectrum of that city (Latorre and Pérez, 1997).

The maximum pollen richness observed in October was related with the overlapping of the end pollination periods of many arboreal and the start pollination periods of non-arboreal species.

Most of the dominant pollen types identified in this study (Table 2), except *Myrsine*, are encountered as important pollen in other cities of the region (Lorscheitter et al., 1986; Latorre and Pérez, 1997; Murray et al., 2002; Nitiu et al., 2003) as well as in other regions of the World. *Ambrosia*, *Artemisia*, *Chenopodiaceae-Amaranthaceae*, *Cupressaceae*, *Plantago*, *Poaceae*, and *Urticaceae* appear also as important pollen types in Europe (Spiekma, 1991).

These similarities are explained by the fact that more or less the same exotic tree species are cultivated for ornamental purposes in most of the cities of the Western hemisphere, by climatic similarities in regions with temperate climates and by floral similarities in cities of the region.

In spite of that, the pollen spectrum of Montevideo presents characteristics that are specific for the region, with pollen types representing native taxa. Clear examples are *Myrsine* and *Celtis*. In addition, pollen types as *Allophylus*, *Acanthosyris*, *Phytolacca dioica*, *Sambucus*, *Erythrina*, recorded in lower concentrations, represent native sources near the city, however others have exotic sources too, for example, *Salix*. This could possibly be used as a biogeographical marker; nevertheless specific analysis on this topic must be carried out to confirm such a possibility.

Myrsine is an interesting pollen type, because it is represented, exclusively by native species in Montevideo. Although no phenological study was conducted, these two peaks could be related to the flowering period of two different species: *Myrsine laetevirens* and *M. coriaceae* (E. Marchesi, personal communication) and one of them is located around 200 km East of the sampling point. Although their pollen morphology (small, psilate, exine $\sim 1.5 \mu\text{m}$) could favour their transport and it is not cited as part of Montevideo flora, their presence in private gardens or peripheral areas can not be discounted.

Most of the pollen types identified during this study have their pollen source in the city. However, the record of *Nothofagus* ($5.2 \text{ grains m}^{-3}$), which is not present in the regional vegetation, indicates an extra regional contribution. This type has been registered in other cities of the region such as Mar del Plata, where an origin in the sub-Antarctic forest more than 2000 km away was indicated (Latorre and Bianchi, 1997). Maybe another pollen types could come from extra regional flora but the presence of their source also in the vegetation of the city does not allow us to make this differentiation.

Poaceae was the most important pollen type recorded in this study. This high representation in the pollen spectrum can be explained partially due to local factors because it is dominant in the local vegetation and the consecutive flowering patterns of different grass species are responsible for this long pollination period. Nevertheless, this family is also dominant in the regional and extraregional vegetation, and this characteristic was also recorded in other cities of the region, as Mar del Plata (Latorre and Pérez, 1997). This is congruent with the dominance of this family in geographic areas with temperate climates (Barber, 2003).

According to the pollen concentrations accounted and their allergenic potential cited for Montevideo (Vaz Ferreira, 1946), other cities of the region (Lorscheitter et al., 1986); Carignano et al., 1998) and other regions of the world (Lewis et al., 1983, D'Amato et al., 1991a), some pollen types recorded during this study could be involved in allergenic pollinosis. However, the lack of medical data concerning pollinosis does not allow one to solidly hypothesise that this pollen type can cause allergenic responses in sensitive persons in Montevideo, but this should be considered in future medical works. These pollen types are: Poaceae, *Ambrosia*, *Artemisia*, and *Salix*. They accounted for pollen concentrations considerably higher than for herbs (>20 grains m^{-3}) and trees (>90 grains m^{-3}).

Several facts suggest that Poaceae could be involved in allergic pollen reactions in Montevideo: the higher concentrations recorded (high and very high for grasses); their abundance in the vegetation; the high allergenic potential of some genera (Barber, 2003) present in our flora (Lombardo, 1984).

Other dominant pollen types recorded in this study and cited as allergenic (Table 2) do not account for high concentrations; however, they could be involved in the allergenic process. For example, *Parietaria*, which did not account for high concentrations (<20 grains m^{-3}), is considered one of the most important allergenic pollens in Mediterranean areas (D'Amato et al., 1991b), responsible for allergenic reactions even in relatively low concentrations.

Obviously, the fact that airborne pollen has only been studied for one year implies that the results are provisional but they could serve as an approximation, particularly in the absence of any previous study with this characteristic.

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References

- Barber D.: 2003, Mesa Redonda Polinosis I, Gramíneas: alérgenos y reactividad cruzada. *Alergología e Inmunología Clínica* **18** (3), 12–16.
- Barth O.M.: 1978, A estação polínica nas proximidades do Rio de Janeiro. *Revista Brasileira de Botânica* **1**, 113–138.
- Bassett I.J., Crompton C.W. and Parmelee J.A.: 1978, *An Atlas of Airborne Pollen Grains and Common Fungus Spores of Canada*, Canada. Department of Agriculture: Canada, Ottawa.
- Bianchi M.M.: 1992, Calendario polínico de la ciudad de Mar del Plata (Agosto 1987–Agosto 1989). *Archivos Argentinos de Alergia e Inmunología Clínica* **23**, 73–86.
- Brown T., Frenz D.A. and Wimpsett T.L.: 1993, *Operating Instructions for the Rotorod Sampler*. Sampling Technologies, Inc., Minnetonka.
- Cabrera A.L. and Willink A.: 1973, *Biogeografía de América Latina*, Secretaría de la, OEA, Washington D.C.
- Carignano C., Iaquinandí A., Aramayo E., Valle A., Andrada A. and Lamberto S.: 1998, Polinosis en la región de Bahía Blanca. *Archivos Argentinos de Alergia e Inmunología Clínica* **29** (3), 21–28.
- D'Amato G., Spieksma F.Th.M. and Bonini S.: 1991a, *Allergic Pollen and Pollinosis in Europe*. Blackwell Scientific Publications: Great Britain.
- D'Amato G., Ruffilli A. and Ortolani C.: 1991b, Allergic significance of *Parietaria* (Pellitory-of-the-wall) pollen, in G. D'Amato, F.Th. Speksma and S. Bonini (eds.), *Allergic Pollen and Pollinosis in Europe*. Blackwell Scientific Publications: Great Britain, pp. 113–118.
- Latorre F. and Bianchi M.M.: 1997, Relación entre aeropolen y vegetación arbórea en Mar del Plata (Argentina). *Polen* **8**, 43–49.
- Latorre F. and Pérez C.: 1997, One year of airborne pollen sampling in Mar del Plata (Argentina). *Grana* **36**, 49–53.
- Lewis W.H., Vinay P. and Zenger V.E.: 1983, *Airborne and Allergic Pollen in North America*. The Johns Hopkins University Press, Baltimore.
- Lombardo A.: 1979, *Los árboles cultivados en los paseos públicos*. Intendencia Municipal de Montevideo, Montevideo.
- Lombardo A.: 1982, *Flora Montevicensis. Tomo I*. Intendencia Municipal de Montevideo, Montevideo.
- Lombardo A.: 1983, *Flora Montevicensis. Tomo II. Gamopétalas*. Intendencia Municipal de Montevideo, Montevideo.
- Lombardo A.: 1984, *Flora Montevicensis. Tomo III. Monocotiledoneas*. Intendencia Municipal de Montevideo, Montevideo.
- Lorscheitter M.L., Machado F. and De Oliveira F.: 1986, Conteúdo polínico atmosférico na cidade Caxias do Sul, Rio Grande do Sul (Brasil), e sua correlação alérgica. *Geociências* **17**, 131–140.
- Markgraf V. and D'Antoni H.L.: 1978, *Pollen flora of Argentina. Modern Spore and pollen Types of Pteridophyta, Gymnospermae and Angiospermae*. The University Press, Tucson.
- Murray M.G., Sonaglioni M.G. and Villamil C.B.: 2002, Annual variation of airborne pollen in the city of Bahía Blanca, Argentina. *Grana* **41**, 183–189.
- Nitiu D.S., Mallo A.C. and Romero E.J.: 2003, Quantitative aeropalynology in the atmosphere of Buenos Aires city, Argentina. *Aerobiología* **19**, 1–10.
- Pizzorno D.: 1999, *Informe del relevamiento vegetal de los espacios públicos*. Intendencia Municipal de Montevideo, Montevideo, Uruguay.
- Spieksma F.Th.M.: 1991, Regional European pollen calendars, in G. D'Amato, F.Th. Speksma and S. Bonini (eds.),

- Allergenic Pollen and Pollinosis in Europe*. Blackwell Scientific Publications, Great Britain, pp. 49–65.
- Tejera L. and Beri A.: 2003, Estudio aeropalinológico de la ciudad de Montevideo, R.O. del Uruguay. Análisis preliminar. *Polen* **12**, 107–115.
- Vaz Ferreira R.: 1946, Los agentes de la polinosis. In: B. Varela, R. Recarte and A. Graña (eds.), *Alergia en la práctica clínica*. Espasa-Calpe-Argentina-S.A, Buenos Aires, pp. 314–348.