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Quantitative aeropalynology in the atmosphere of Buenos Aires city, Argentina

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Abstract

For the first time, a volumetric study of Buenos Aires city atmosphere was conducted using a Lanzoni collector from March 1997 through March 1998. Fifty-four pollen types were recorded of which 13 had a relative concentration of more than 1% of the yearly total. The lowest concentration of pollen grains was recorded in June, when *Urtica* spp., *Morus* spp., and Myrtaceae were low. On the other hand, the highest concentration of pollen grains was reached in September, with an increase in *Fraxinus* spp. The aeropalynological record may be divided into three periods: *AP Dominant from July to October, *NAP Dominant from November to March, and *Residual Period from April to June with low pollen concentrations. The greatest number of species was recorded in November, when 32 types were present, and the lowest number of species in June, when only 13 pollen types were recorded. In June, the pollen concentration was not dominated by any species whereas in September 85% of the pollen was derived from one species of *Fraxinus.* Earlier studies on the aeropalynology of Buenos Aires City were performed using Tauber and Rotorod samplers. They were comparable to this study, especially since the pollen peak was reached in September, although the main pollen producing species were different.

1. Introduction

Aerobiology is an interdisciplinary science that studies the origin, transport, and impact of airborne biological particles. Aeropalynology, a branch of aerobiology, specialises in pollen grains and all factors related to their release, dispersion and presence in the atmosphere.

These aeropalinology studies allow the characterization of the pollen content of the atmosphere, which provides a valuable contribution to basic biology (biogeography, ecology, environment); as well as to allergies treatment and prevention caused by pollen ("pollinosis") (Romero and Nitiu, 1996).

The first study on atmospheric pollen in Buenos Aires city is from the year 1940. A more recent study was made between July 1989 and June 1992 in Almagro, Ciudad Universitaria and Costanera Sur neighborhoods (Romero et al., 1992; Majas et al., 1992; Majas and Romero, 1992), with a Tauber gravitational collector taking monthly samples. The results of this investigation established three (3) aeropalynologic seasons for Buenos Aires city: one season with predominance of tree and shrub pollen between July and October; one season with predominance of herbaceous pollen between November and April; and one residual season with very low pollen concentrations between May and June.

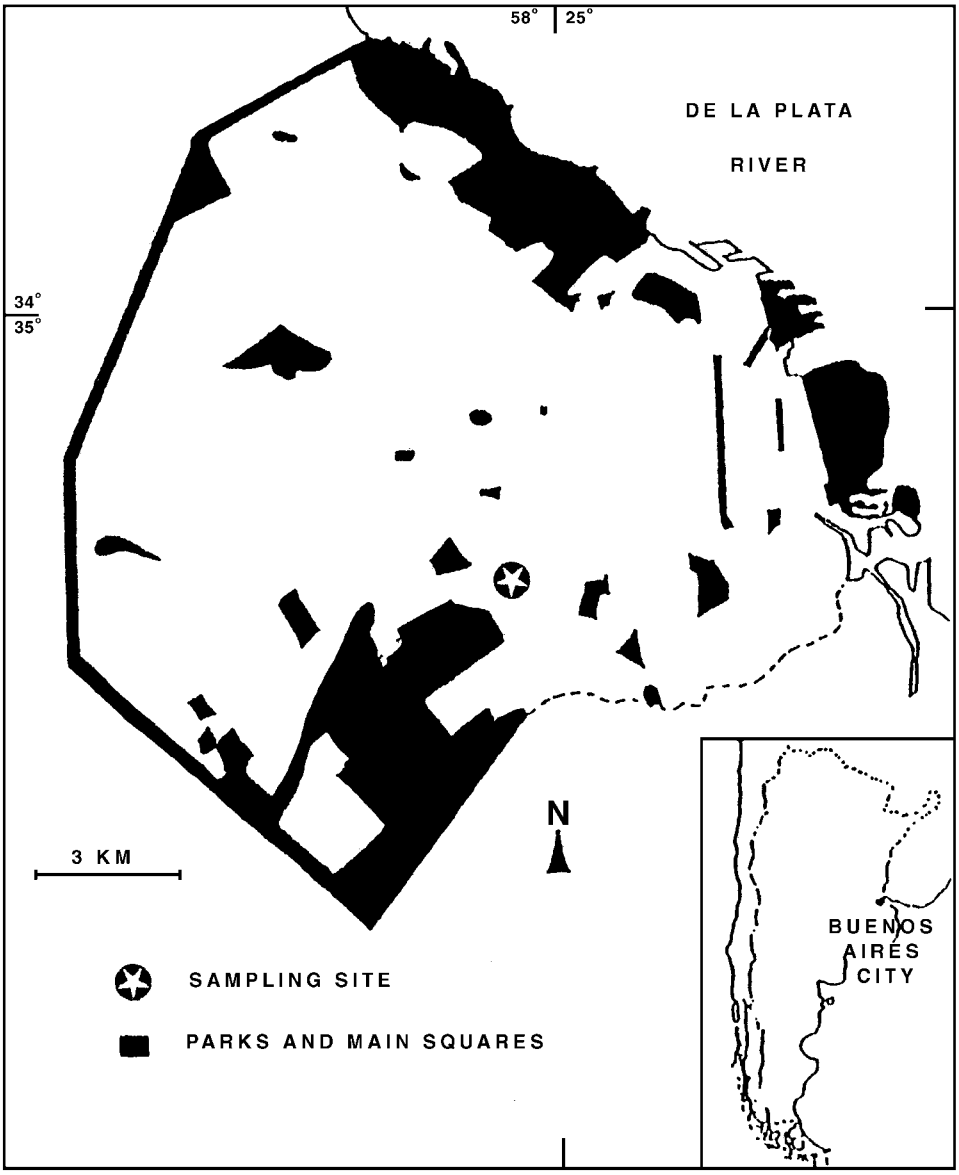

Figure 1. Sampling site and main vegetation sources of Buenos Aires city.

In a second study, daily volumetric monitoring of the atmospheric pollen of Buenos Aires city was carried out in Villa Urquiza neighborhood during 1993–1994 with a Rotorod volumetric sampler (Noetinger and Romero, 1997; Noetinger, 1993; Noetinger et al., 1994). The results obtained revealed: a) the start and finish of the high, medium and low concentration periods for total atmospheric pollen; b) the low number of taxa that produce high and medium pollen concentrations; c) the restriction of the September peak to its maximum values between 11 and 18 September; d) the beginning of the predominant period of herbaceous pollen from 21 October.

This investigation analysed the aeropalynological content of the atmosphere of Buenos Aires city during 1997–1998, in the Caballito district using a Lanzoni volumetric sampler (Figure 1).

The interest of this study is centered on the identification of the most representative pollen types; the evaluation of the relation between tree, shrub and herbaceous pollen concentration; the analysis of the

diversity and richness of the pollen types and comparison with previous years.

2. Materials and methods

Buenos Aires city (58°25′ long W, 34°35′ lat S), capital of Argentina, extends along the Rio de la Plata river coast at sea level. Its area is about 200 km^2 with a population of 7.000.000 inhabitants including suburban areas.

The climate of the region is humid with sharply defined seasons. Rain is frequent throughout the year with peaks at the beginning of Spring (September–October) and Autumn (March–April). The average winter and summer temperatures are 10 °C and 23 °C, respectively and the dominant winds from NE and SW.

The urban vegetation is predominantly trees and shrubs planted in parks, squares, gardens and city streets like *Fraxinus spp., Acer spp., Platanus spp., Cupressus spp., Morus spp., Myrtaceae, Celtis spp., Pinus spp.* and *Casuarina spp.*

Native vegetation is restricted to patches located in the NE and E of the city, and in the coast border, represented by the subclimatic marginal forest and the Talar (Cabrera, 1976). The principal sources of herbaceous pollen are mostly adventitious species in city parks and gardens like *Plantago spp.,* Cyperaceae, Urticaceae, *Ambrosia spp.* and Cheno-Amaranthaceae.

The daily census of Buenos Aires city atmosphere was made during the period March 1997–March 1998 (52 weeks) in a sampler station located in the Caballito district (center west of Buenos Aires city).

In deciding the location of the sampler, the vegetation of the surrounding streets and parks, and the direction of the dominant winds were taken into account to choose a site being most representative of the city.

A Lanzoni (VPPS, 2000) continuous, volumetric sampler was installed on a roof 10 meters above ground level.

Four-hourly traverses of the slide were analysed, representing 2 a.m., 8 a.m., 2 p.m. and 8 p.m., every day, with a magnification of 200x in a light microscope. The concentration of pollen by time and volume was calculated using the O'Rourke model (1990). The quantities counted in those bands were added and averaged to obtain the number of grains per m^3, per day by species. NAP (non arboreal pollen) and AP (arboreal pollen) were calculated as well.

Pollen grains determination was made at family, genus or species level according to the pollen morphology by comparison with the reference palynological collection of the Palinology Unit of the Facultad de Ciencias Naturales y Museo (FCNYM) of La Plata University, Palinology and Paleobotany Laboratory of the Facultad de Ciencias Exactas y Naturales (FCEYN) of Buenos Aires University, and specific bibliographical consultation (Erdtman, 1943; Moore and Webb, 1978; Heusser, 1971).

The pollen grains determined belong to different pollen types, which arrive in Buenos Aires city from local, regional and extraregional sources, the former being the most important (Majas et al., 1992; Romero et al., 1992; Noetinger, 1993; Noetinger, 1994). However, we did not analyse fungal spores in this paper.

3. Results and discussion

Fifty-four pollen types were determined at family, genus or species level (Table 1). They constitute the Annual Pollen Calendar of Buenos Aires city (Figure 2). The yearly sum of the pollen grains of a given species counted every day gives the total number of pollen grains of that species. The sum of that number for every species gives the total number of total grains, which was 18,832.9.

Fifteen taxa have at least in one month more than 5% of the total number of pollen grains. Table 2 is a summary with information on the pollen, including AP and NAP taxa, highest incidence, month of maximum incidence, allergenic potential (Latorre, 1997; Dominguez Vilches, 1984; Bianchi, 1994).

The month with the lowest pollen total was June with 429.2. Maximum peaks of average concentration were recorded on 17 June and 25 June with 9.25 gr/m^3. The pollen types that made the greatest contribution were: *Urtica* spp., *Morus* spp. and Mirtaceae. The minimum amountswere produced during the two first days of the month when no pollen grains were recorded (Figure 3).

The month with the highest pollen total was September with 35,608.8. Maximum peak of daily concentration was on 23th September with 367.75 gr/m^3, the minimum one was recorded by 3rd September with 7 gr/m^3. The greatest pollen contribution to the total pollen was made by *Fraxinus* spp. (Figure 4).

Table 1. Pollen types monitored in the atmosphere of Buenos Aires city, March '97–March '98

Pollen types identified	
Amaranthaceae	Juglandaceae
Alternanthera sp.	*Juglans sp.*
Anacardiaceae	Lauraceae
Schinus sp.	*Laurus nobilis*
Apiaceae	*Persea sp.*
Asteraceae	Meliaceae
Ambrosia sp.	*Melia azedrach*
Artemisia sp.	Monocotiledoneae
Taraxacum officinale	Moraceae
Tipo Mutisia sp.	*Morus sp.*
Xantium sp.	Myrtaceae
Equinada	*Eucalyptus sp.*
Fenestrada	Oleaceae
Betulaceae	*Fraxinus sp.*
Alnus sp.	*Ligustrum sp.*
Betula sp.	*Olea sp.*
Bignoniaceae	Pinaceae
Jacaranda mimosifolia	*Pinus sp.*
Bombacaceae	Phytolacaceae
Chorisia speciosa	*Phytolaca dioica*
Boraginaceae	Plantaginaceae
Echium plantagineum	*Plantago sp.*
Cannabinaceae	Platanaceae
Casuarinaceae	*Platanus acerifolia*
Casuarina cunnighamiana	Poaceae
Cupressaceae	Polygonaceae
Cupressus sp.	*Rumex sp.*
Cyperaceae	Salicaceae
Cheno-Amaranthaceae	*Populus sp.*
Ephedraceae	*Salix sp.*
Ephedra sp.	Simaroubaceae
Euphorbiaceae	*Ailanthus alttisima*
Ricinus comunnis	Thypaceae
Fabaceae	*Typha sp.*
Mimosoideae	Ulmaceae
Mimosa sp.	*Celtis sp.*
Papilionoideae	*Ulmus sp.*
Adesmia sp.	Urticaceae
Tipuana sp.	Urtica dioica
Fagaceae	Vitaceae
Castanea sativa	*Vitis vinifera*
Nothofagus sp.	

3.1 *Most important pollen types*

Of the 54 pollen types, 13 exceeded 1% of the total relative concentration (Figure 5): *Fraxinus*, Poaceae, *Cupressus, Ambrosia*, Urticaceae, *Artemisia*, Myrtaceae, *Casuarina*, Asteraceae, Cyperaceae, *Celtis,* Cheno-Amaranthaceae, and *Morus.*

3.2 *Related arboreal pollen (AP) and non arboreal (NAP)*

The pollen spectrum of Buenos Aires city could be divided into three main periods as follows: (Figure 6).

*AP predominance: this period goes from July to October. The first important peak was recorded on 22 July and corresponds to *Cupressus* spp.; AP predominance continued until 18 October when a marked reduction was recorded in *Fraxinus* spp., *Celtis* spp., and *Cupressus* spp. concentrations. The maximum concentration occurred in September where AP reached 91% of total pollen. *Fraxinus* spp. was predominant.

*NAP predominance: this period goes from November to March. It started on 16 November with the contributions of *Plantago* spp., *Cyperaceae* spp., and especially Poaceae and extended until 24th March when a marked decrease in Poaceae, Cheno-Amaranthaceae, *Artemisia* spp., and *Ambrosia* spp. concentration was recorded. Maximum concentration was in November with 92% of the total pollen count.

*Residual season: April, May and June, months in which the pollen concentration is low.

As observed by Latorre F. and Perez C. (1997), the high concentrations of NAP take place with high temperatures, from November-March (+ correlation); and a high concentration of AP in the low temperature period July–October (– correlation).

3.3 *Pollen richness*

Pollen richness gives an idea of the number of pollen types present in the atmosphere during the year. November presents a maximum of 32 pollen types represented in greater proportion by herbaceous pollen, whereas the minimum is in May with 13 pollen types of which six are herbaceous and the others arboreal (Figure 7).

3.4 *Pollen diversity*

Pollen diversity index (H') was computed using the Shannon and Weaver formula for each month, including all pollen types analyzed (Odum, 1984).

The (H') shows the distribution of the pollen concentrations for the different pollen types. A high value of (H') shows the greatest balance in the distribution of the concentrations in each pollen type; low values of (H') shows that few species contain the greater quantities of pollen grains. A sharp drop in (H') values shows a notable increase in pollen

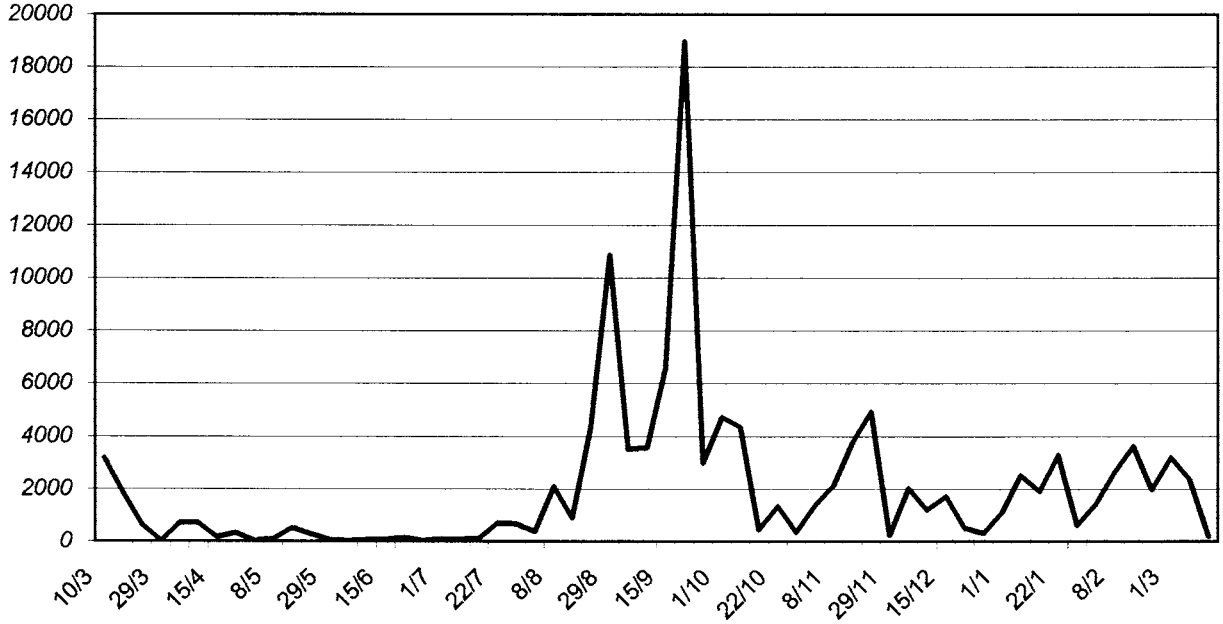

Figure 2. Pollen calendar of Buenos Aires city. Weekly pollen totals.

Table 2. Dominant and arboreal-shrubby pollen types; identified genus; maximum relative incidence; month of highest incidence; allergenic potential

Pollen type		*Genus*	*Amount of highest incidence*	*Month of highest incidence*	*Allergenic potential*
NAP	Apiaceae		7%	January	yes
	Asteraceae		18%	March 97	yes
		Ambrosia	39%	February	yes
		Artemisia	39%	March 98	yes
	Boraginaceae	*Echium*	6%	January	no
	Cheno-amar		12%	March	yes
	Cyperaceae		5%	November	no
	Poaceae		62%	November	yes
	Urticaceae	*Urtica*	25%	September	yes
AP	Anacardiaceae	*Schinus*	5%	November	yes
	Casuarinaceae	*Casuarina*	29%	February	yes
	Cupressaceae	*Cupressus*	62%	August	yes
	Moraceae	*Morus*	13%	June	no
	Myrtaceae		13%	November	
	Oleaceae	*Fraxinus*	85%	September	yes
	Ulmaceae	*Celtis*	10%	October	yes

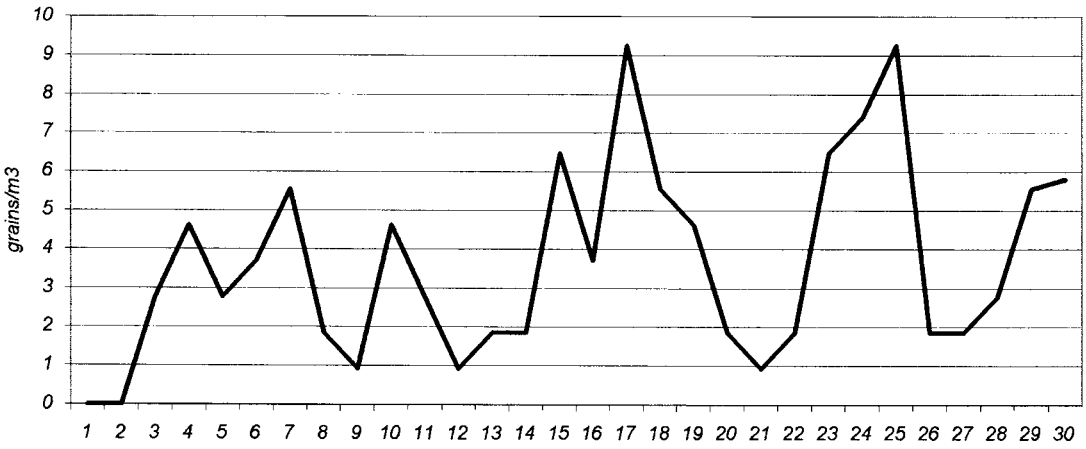

Figure 3. Daily pollen concentration of June 1998.

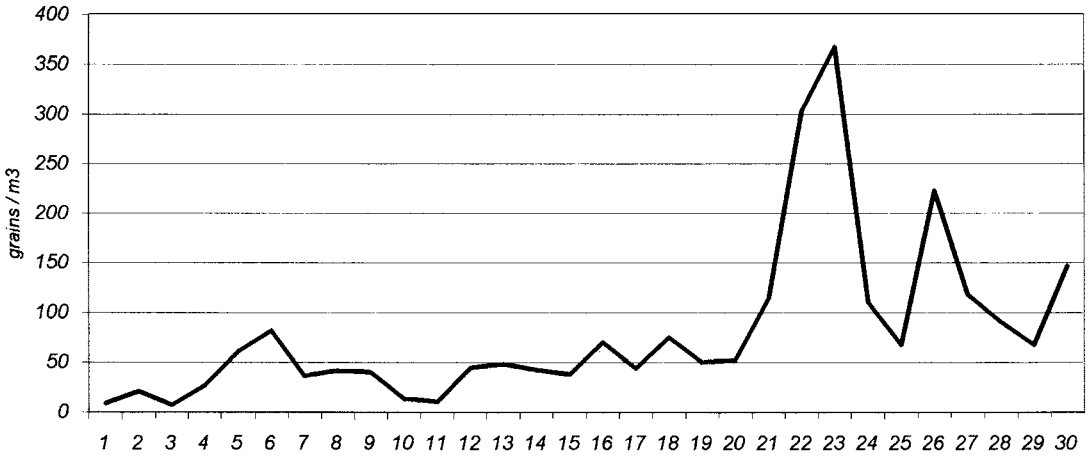

Figure 4. Daily pollen concentration of September 1998.

grain concentrations belonging to few pollen types (Figure 8).

In this study the maximum value of (H') was found in June, with a value of 3.43. This is due to the fact that during that month, total pollen concentration and specific richness are impoverished. However, the balance in the distribution of the pollen types reaches its maximum value.

The minimum value of (H') 0.96 is given in September and is related to the maximum concentration of *Fraxinus* spp. representing 82.5% of total pollen sampled in this period.

Fraxinus spp. stands out from the rest by its high representation in a short period. The first important peak appeared in the fourth week of August with 5313.2 gr/m^{3}on the 29th and reached its maximum concentration on the 23rd September with 4932.1 gr/m^3 and in the week from 21st to 27th of September a total of 12838.7 gr/m^3; reaching a total pollen concentration for this month of 35608.8 gr/m^3. From the second week of October there was sharp decrease until the minimum in the third week of December with 37 gr/m^3 (Figure 5).

3.5 *Comparison with previous data*

Comparison with previous aeropalynological sampling in Buenos Aires city shows that there is a coincidence of the maximum concentration in September, but differences in the taxa that contribute to the peak.

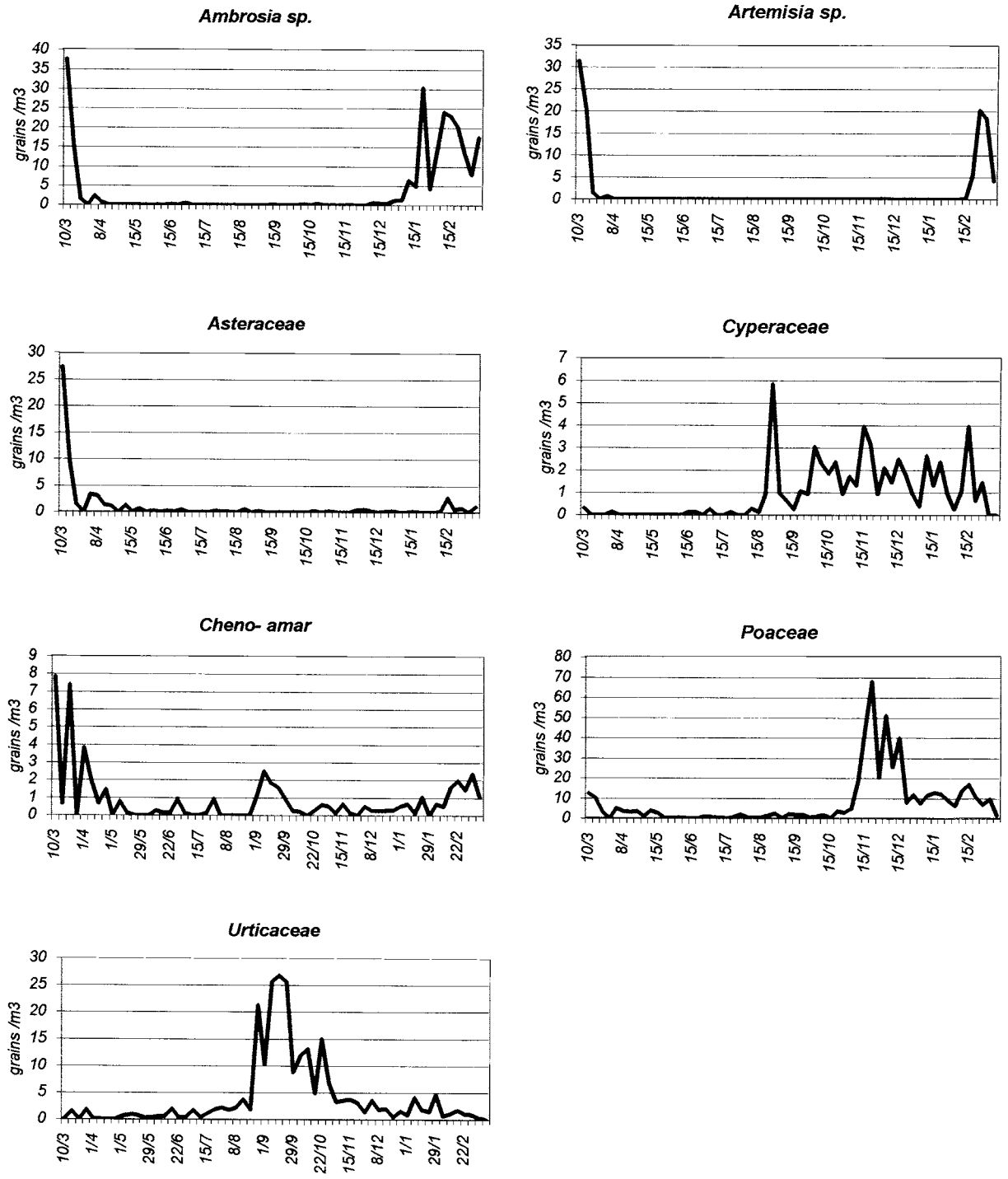

Figure 5a. Pollen concentration of the dominant species of NAP. Weekly averages.

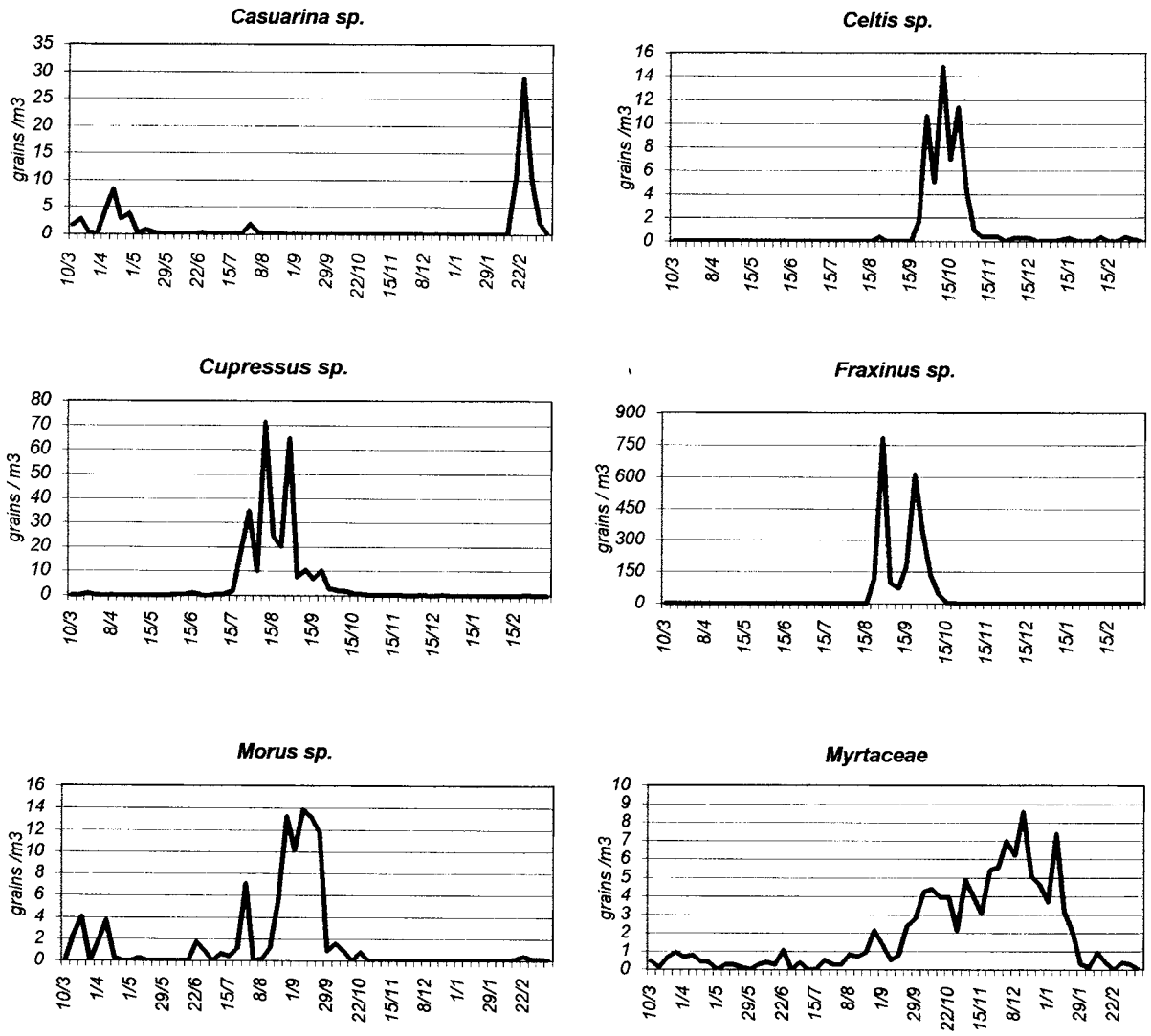

Figure 5b. Pollen concentration of the dominant species of AP. Weekly averages.

In the previous studies, the main pollen recorded was *Platanus* spp.; in this one, the difference is probably due to the composition of the urban vegetation in the sampling area, *Fraxinus* spp. is the predominantly arboreal pollen tree.

In addition, six of the most representative pollen types are still present, *Cupressus* spp., *Morus* spp., Urticaceae, Poaceae, and Myrtaceae. The month when they are recorded in the pollen sampling is also the same.

This study was in agreement with that of Noetinger et al. (1997) who observed three aeropalinology seasons for Buenos Aires city: one season with predominance of trees and shrubs between July and October 1997; one season with predominance of herbaceous from November 1997 to March 1998, and one residual season between April and June 1997.

4. Conclusions

Admittedly, a year of studies is not sufficient to analyse long trends of daily and seasonal variations of airborne pollen, and anthesis is affected by meteorological conditions each year. Consequently, the area is being monitored to obtain more information on floral phenology of the main species and the factors affecting seasonal pollen emission, to improve our knowledge.

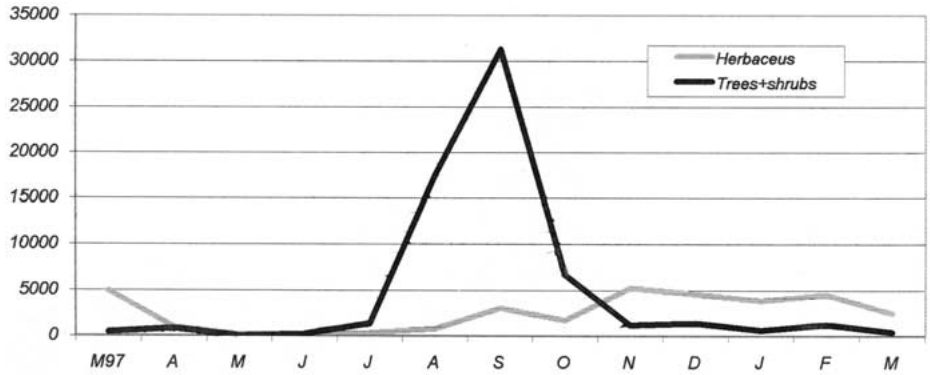

Figure 6. Annual totals in relation to AP/NAP.

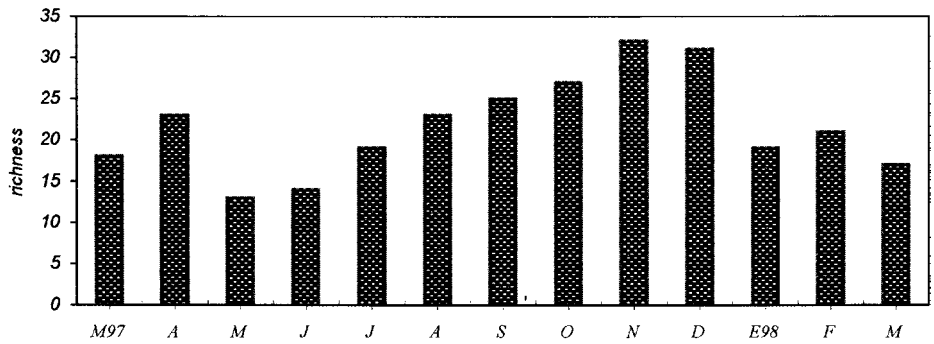

Figure 7. Pollen types recorded during the sampling period.

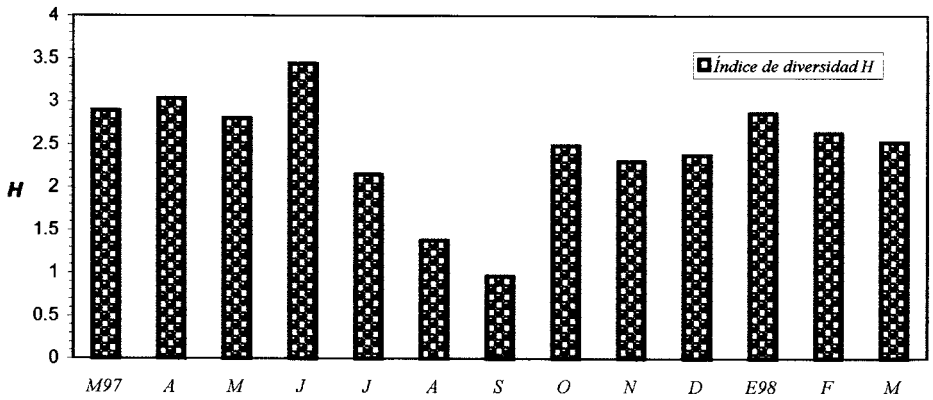

Figure 8. Pollen diversity of the sampling period. H: Pollen diversity index.

However, the methodology employed gave results fairly comparable with those of previous years and yielded the following information: (a) The total pollen concentration recorded during the sampling period, which was 118832.9 (b) The counts include 54 different pollen types present in the atmosphere. (c) There is a predominant period of AP pollen from July to October, after that there is a replacement of pollen types to NAP that are extended until the end of March, (d) The diversity shows that it is inversely proportional to pollen concentration per taxa, and the influence of those pollen types that have a short cycle with high productivity, like *Fraxinus* spp.

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