AIRBORNE POLLEN GRAINS COLLECTED IN AN URBAN AREA: MERCED, MEXICO CITY

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ABSTRACT
During an aeropalynological study carried out in Merced, Mexico City from October to April (dry season), pollen index of 62,097 grains was obtained using a volumetric sampler (Burkard). A total of 24 taxa were recorded, including 14 arboreal pollen types and 10 herbaceous taxa. Nonetheless, only five of the most abundant and allergenic pollen types were analyzed: Cupressaceae, *Fraxinus, Liquidambar, Pinus* and *Quercus*. *Fraxinus* was the most important taxon, comprising 38% of the pollen total, followed by Cupressaceae, with 17%; both taxa significantly increased during the dry cool season (November-January). Concentrations of other pollen types were not representative of the seven months analyzed.

Keywords: Mexico City, pollen, allergies, airborne pollen, aeropalynology.

POLEN COLECTADO EN LA ATMÓSFERA DE UN ÁREA URBANA: MERCED, CIUDAD DE MÉXICO

RESUMEN
Este documento reporta los resultados de un estudio aeropalinológico llevado a cabo en la Merced, Ciudad de México durante siete meses, utilizando el método volumétrico (Burkard). Se colectaron 62,097 granos, en todo el periodo. Se registraron un total de 24 taxa, 14 tipos polínicos arbóreos y 10 herbáceos. No obstante, en este estudio sólo se analizaron las concentraciones de los cinco tipos polínicos de mayor importancia alergénica (Cupressaceae, *Fraxinus, Liquidambar, Pinus* y *Quercus*). *Fraxinus* fue el taxón más abundante, representando 38% del total de polen, seguido por Cupressaceae con 17%. Estos dos taxa presentaron un aumento significativo en sus concentraciones en secas frías. Las concentraciones de los otros tipos polínicos no fueron representativas en estos meses de muestreo.

Palabras Clave: Ciudad de México, polen, alergias, polen aéreo, aeropalinología.

INTRODUCTION

Airborne biological particles include bacteria, viruses, pollen grains, fungal spores, algae, small seeds, insect larvae and protozoa of 0.5-100 µm [1]. Among them, pollen grains have been widely studied due to the fact that they may cause allergic illness such as asthma and hay fever [2, 3]. Some studies have shown an increase of pollinosis diseases within large urban areas [4, 5]. Therefore, to facilitate the diagnosis and treatments of allergic disease, it is important to carry out aeropalynological studies within highly populated urban areas. Aeropalynological studies determine heterogeneity of pollen concentration, as well as diurnal and seasonal variation in the atmosphere associated with meteorological factors [6, 7, 8].

Mexico City is one of the largest urban areas in the world, with 8.8 million inhabitants [9]. This City is located at an altitude of 2240m a.s.l. The nearly flat basin covers 5000 km^2 of the Mexican Plateau [10] (Figure 1), with 30 000 hectares of natural ecosystems in a temperate, rainy climate. Nevertheless, a high proportion of plants that inhabit Mexico City have been introduced [11].

Previous studies carried out in Mexico City recorded the highest pollen concentrations from October to April. During that period, the most abundant taxa were

Asteraceae, *Casuarina*, *Cupressus*, *Fraxinus*, *Liquidambar*, *Quercus*, *Pinus* and Poaceae, representing about 90% of the total pollen count [12, 13, 14] . These plants form characteristic synantrophic communities that are spread throughout the City. Moreover, there were found relationships between pollen concentration and meteorological parameters.

The aim of this research was to determine the daily variations of five airborne pollen types that were found in the atmosphere of one monitoring station located in the Historical Center of Mexico City.

MATERIALS AND METHODS

The sampling site was placed in eastern downtown Mexico City, also known as the "Historic Center", in the Merced locality (Figure 1). This area has low plant biodiversity, with synantrophic plant communities. Green space represents only 15% of the total area, 77% of which is occupied by grasses and shrubs growing in parks and private gardens. The urbanization index (built-up area/total area) of the town is UI=0.85 [9]. The mean annual temperature is 16°C, and mean annual accumulated precipitation is 600 mm.

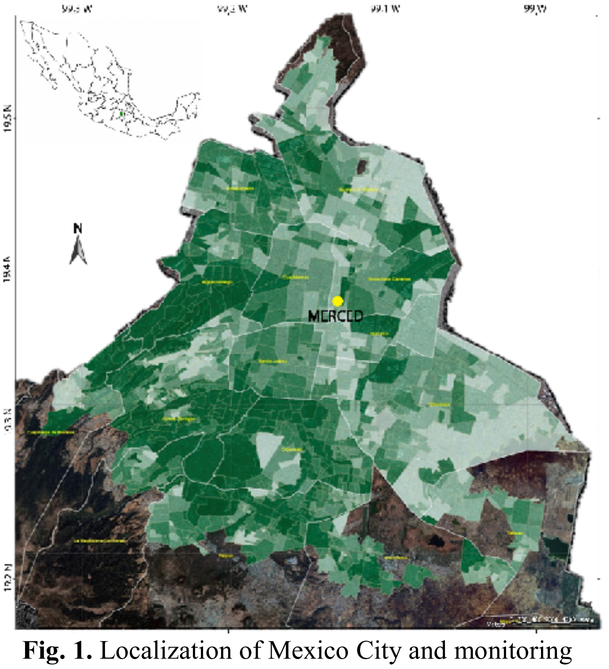

Fig. 1. Localization of Mexico City and monitoring station in Merced. Dark green denotes the least urbanized areas, while the most urbanized areas are in light green.

Continuous monitoring was performed using a spore trap on the roof of the "Dr. Luis E. Ruiz" Health Center at a height of four meters, from October 2012 to April 2013. The flow rate of sampling was ten liters of air per minute, which represents the average of human respiratory flow. To collect daily airborne pollen, a trapping surface of Melinex film coated with petrolatum and hexane solution was mounted on the drum rotating inside the sampler at a speed of 2 mm/h. The drum was changed weekly, and the exposed tape was carefully cut into seven segments that correspond to every day in order to carry out daily pollen counts. Each 24 h slide was analyzed every 2 h under a Ziess, Axio Lab.A1 microscope with an X100 objective, using four longitudinal traverse methods according to the Spanish aerobiological network, REA [15]. The pollen was expressed in pollen grains/m^3. For analyses with the scanning electron microscope (SEM), acetolyzed pollen grains were first washed and dehydrated through an ethanol series, and critical point dried through carbon dioxide using a critical point drier (Samdri-790; Tousimis Research, Rockville, MD). Dried samples were mounted on aluminum stubs using carbon conductive tabs and sputter coated with gold by using a ion sputter JEOL JFC-1100 for 5 min at 20 lA°; and after the pollen grains were covered with carbon in a vacuum evaporator JEOL JEE-4x. They were examined in a JEOL JSM-6300 scanning electron microscope (SEM) using an operating voltage of 15 kV and a working distance of 15 mm. The investigation was carried out at the Electron Microscopy Laboratory of the Instituto de Geología, Universidad Nacional Autónoma de México.

The pollen count was plotted in the Tilia program version 1.7.16.

RESULTS AND DISCUSSION

In the present study, 48 slides from October to April (2012-2013) were examined. A total of 62,097 pollen grains were determined, belonging to 24 taxa; of which 14 pollen types were from trees and 10 from weeds. A significant percentage of pollen in the Mexico City atmosphere belongs to arboreal taxa (Table 1).

In this research, we only focus on five arboreal pollen types, considered the most important allergenic taxa [16]: 1) Cupressaceae/Taxodiaceae: inaperturate pollen grain, tectate, supramicroverrugate Diameter = 25-35 µm. (Fig. 3); 2) *Fraxinus*: tetrabrevicolpate pollen grain, subtectate, reticulate, homobrocate Equatorial axis: 25-30 µm (Fig. 2); 3) *Liquidambar*: periporate pollen grain, tectate, foveolate, verrucate pore membranes, Diameter = 45-40 µm. (Fig. 3); 4) *Pinus:* monosulcate pollen grain, dissacate, tectate, verrugate-rugulate, main body = 45-55 µm sacci = 10-15 µm. (Fig. 6); and 5) *Quercus*: Tricolporate, tricolporoidate pollen grain, tectate, supraverrugate, Equatorial axis = 24-35 µm. (Fig. 5).

Table 1. Relative abundance of airborne pollen types found in Mexico City.

TAXA	AMOUNT	%
Cupresaceae/Taxodiaceae	10752	17.31
Fraxinus uhdei	23888	38.47
Liquidambar sp.	105	0.17
Pinus spp.	4896	7.89
Quercus spp.	1585	2.56
Total arboreal	57588	92.74
Total herbaceous	4326	6.9
Others	183	0.3
Pollen index	62097	100

Cupressaceae/Taxodiaceae (Fig. 3) represents 17% of the total pollen count with 10,752 pollen grains (Table 1). It was present throughout the entire sampling period, and daily concentrations showed a double-peak pattern with almost similar intensities in January and March, while the lowest occurrence took place in October and November (Fig. 4).

The most abundant pollen type was *Fraxinus* (Fig. 2), with 38% of the total pollen count (Table 1). A significantly increased concentration was registered at the end of November, reaching the highest concentration in December (218 pg/m^3). In contrast, the lowest concentrations were documented in October and November (Fig. 4).

Liquidambar pollen grains (Fig. 3) were scarcely found during the sampling period. The concentrations of this taxon increase only in March. Previous studies [12, 13, 14] had also reported maximum concentrations of this pollen type from March to April (Fig. 4).

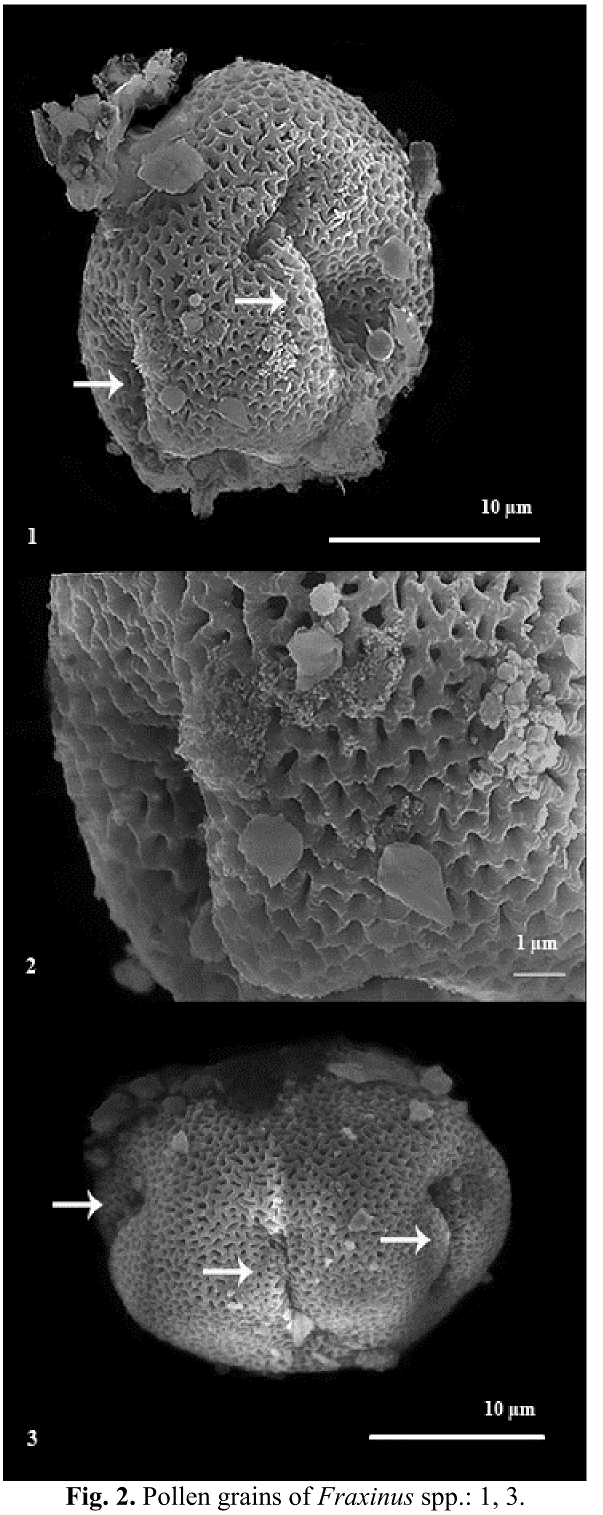

Fig. 2. Pollen grains of *Fraxinus* spp.: 1, 3. Subequatorial view showing brevicolpus; 2. Reticulate and homobrocate exine ornamentation.

There were 4,896 pollen grains of *Pinus* (Fig. 6), representing 8% of the total pollen count (Table 1). The concentrations of *Pinus* reached a maximum value in February, reaching 127 pg/m^3 (Fig. 4).

Quercus (Fig. 5) represents only 3% of the total pollen count, with just 1,585 pollen grains registered from February to April. The concentration peak of this pollen type occurred during the first week of April (Fig. 4).

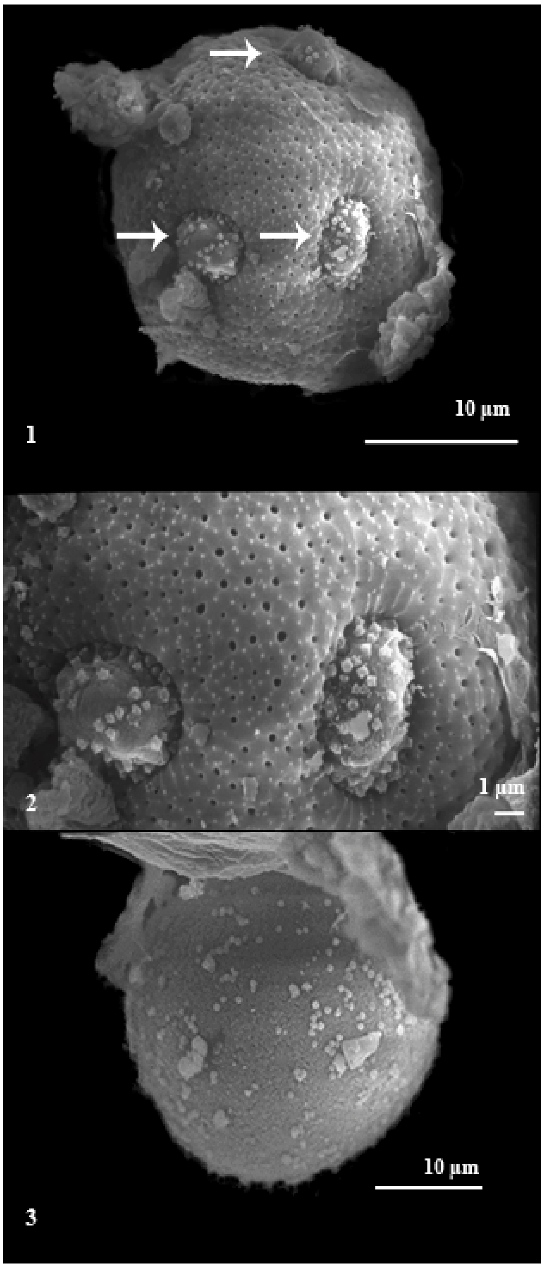

Fig. 3. 1 and 2. *Liquidamar* sp. pollen grain. 1. This view shows pore apertures; 2. Foveolate and supramicroequinate exine and verrucate pore; 3. Cupressaceae inaperturate pollen grain showing heterogeneous verrugate ornamentation.

Monthly concentration of Cupressaceae/Taxodiaceae, *Fraxinus, Pinus* and *Quercus* showed variations. This can mainly be explained by the blooming period of each taxon. These arboreal taxa are specific to the urban environment [17, 18], and the highest *Fraxinus* and Cupressaceae/Taxodiaceae pollen concentrations may be attributable to plant availability surrounding the monitoring site.

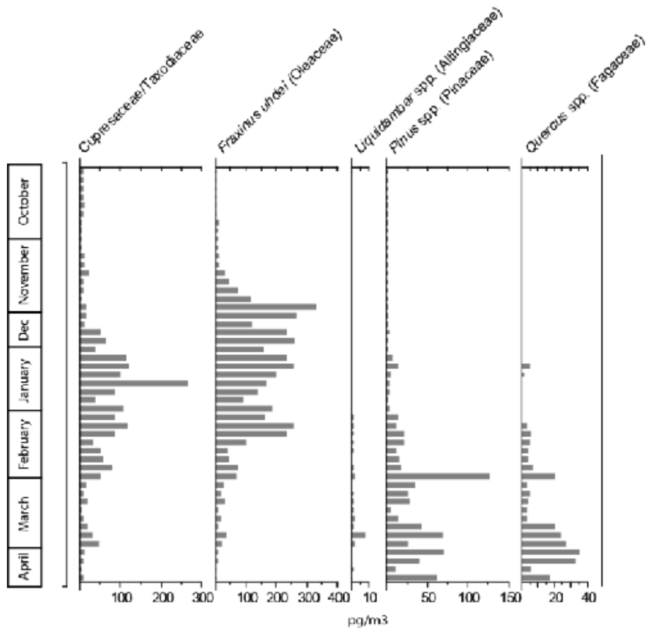

Fig. 4. Concentrations of five airborne pollen types (48 samples) at the Merced sampling station, Mexico City.

CONCLUSIONS

The results show that the presence or absence of atmospheric pollen grains is directly related to the flowering phenology of each taxon. However, the spatial and daily variation is also affected by meteorological factors, such as precipitation, wind strength and convection currents; for instance, the bonding of pollen to surfaces is affected by temperature and moisture [7]. In the same way, it has been shown that pollen counts reveal significant positive correlation with the daily maximum temperature, while there is negative correlation with precipitation [19]. Wind direction and speed influence horizontal particle dispersion and affect the daily distribution of pollen concentration [20].

Pollen grains from Cupressaceae [21], *Quercus* [22], *Fraxinus* [23], *Liquidambar* [24] and *Pinus* [25] trigger allergic respiratory diseases such as asthma and allergic rhinitis. Therefore, the results obtained from this study may be helpful in medical diagnosis and treatments for patients that suffer from pollen allergies.

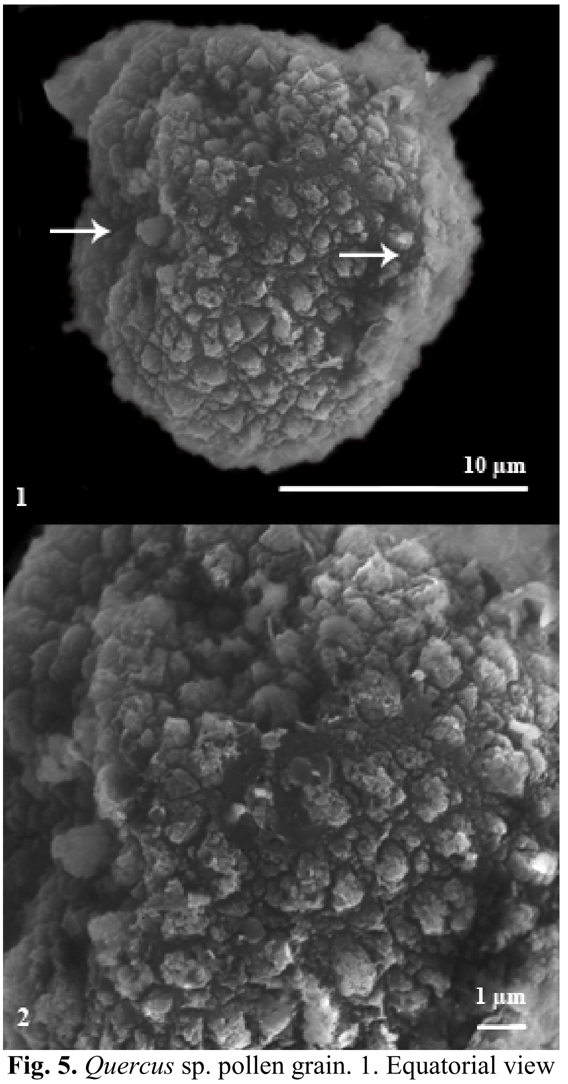

Fig. 5. *Quercus* sp. pollen grain. 1. Equatorial view showing colpus; 2. Verrucate exine ornamentation.

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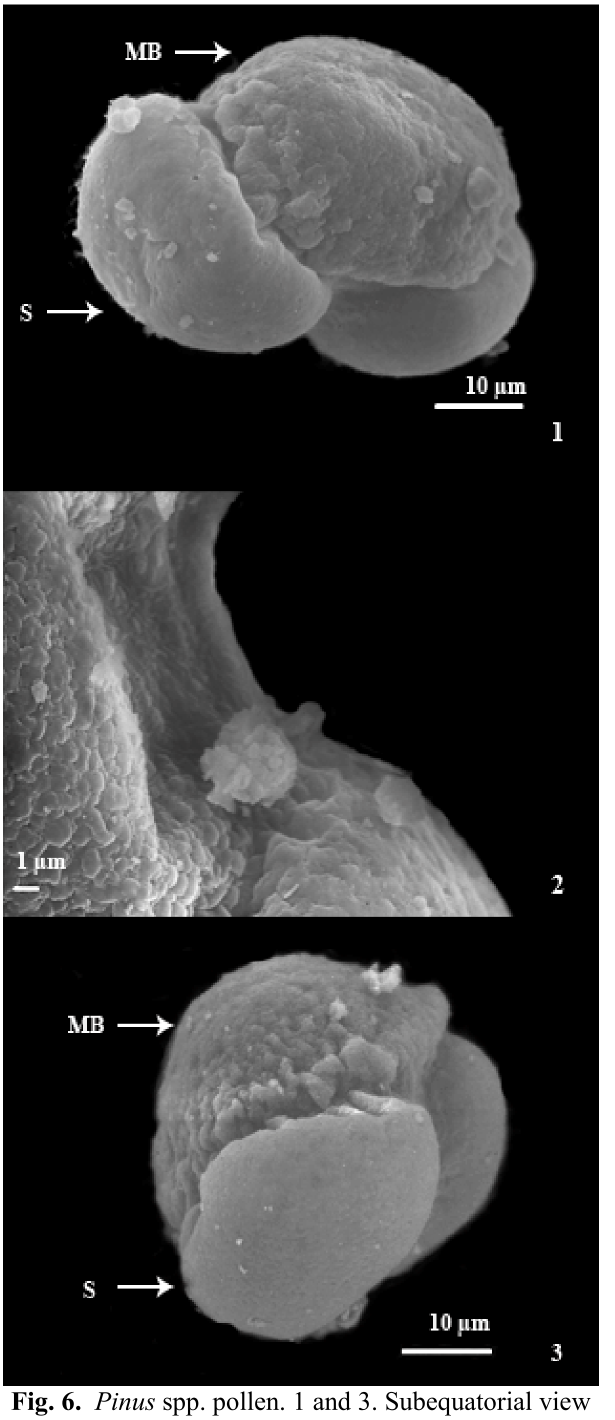

Fig. 6. *Pinus* spp. pollen. 1 and 3. Subequatorial view showing the main body (MB) and sacci (S); 2. Verrucate-rugulate exine ornamentation.

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