PREDOMINANT AIRBORNE POLLEN IN A DISTRICT OF BEIRUT, LEBANON FOR THE PERIOD EXTENDING FROM MARCH 2004 TO AUGUST 2004

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ABSTRACT

Pollen grains rank high among causative agents of hay fever, allergic rhinitis, allegro-conjunctivitis, and asthma. Data on aerial pollen types, concentrations and patterns in Lebanon is lacking. Hence, we undertook the pioneering task of identifying and enumerating atmospheric pollen types in Beirut, the Lebanese capital, for the period extending from March 2004 to August 2004. Our aim was to shed some light on the prevalent sorts of airborne pollen in the city for subsequent studies attempting to assess associations between pollen types and allergic disease varieties. For this purpose, a VPPS 2000 Sampler (Lanzoni, Bologna, Italy) was employed.

The daily average number of pollen detected for the span of the study was 41.32 pollen grains/m^3 of air. The ten most commonly encountered pollen types were Cupressus, Pinus, Quercus, Parietaria, Fraxinus, Urtica, Buxus, Brassica, Syringa, and Chenopodium. Levels of the majority of pollen types peaked in April; however, March had the highest daily average record mostly enforced by immense bouts of Cupressus pollen.

A pollen-monitoring network is in demand in Lebanon. Identification of airborne pollens in Lebanon would allow allergists to include them in a panel of potential allergens used in tests aimed at determining causative allergens in their patients.

Keywords: allergy, asthma, Beirut, pollen, rhinitis, volumetric sampler

INTRODUCTION

Beirut, the governorate district of Lebanon, is the hot-hub capital with an estimated area of 20 Km^2 and a population averaging 1 million. The climate in Beirut is sunny with infrequent rainfall from May through October. Temperatures rarely exceed 32°C in the

summer. Winters are mild with temperatures infrequently dropping below 4°C. Annual rainfall peaks during the December through March period and averages 90 cm. On the other hand, the fall and spring seasons are rather short (Country profile, 2005).

The flora of the country is relatively acquainted with in the literature; however, no formal studies have pursued enumerating or identifying airborne pollen types. Pollen grains, along with dust, moulds, dander and weeds rank high among causative or triggering agents of allergic rhinitis and asthma. Data on the prevalence of allergic diseases in Beirut is scarce with most studies focusing on young children, a risk group in which asthma causes substantial morbidity (Asher *et al*., 1995). Nevertheless, asthmatic problems rank as the third most common reason for reporting to primary health care centers in the country (Adib *et al*., 1995). The prevalence rates of allergic rhinitis and atopic eczema are estimated to be 25.5% and 11%, respectively, among Lebanese 13-to-14 year-old children (Ramadan *et al*., 1999). One of us (AMA) reported on causative allergens in patients clinically diagnosed with rhinitis and/or asthma (Abdelnoor *et al*., 2002, 2004; Ramadan *et al*., 1998). Causative allergens were not identified in 58% of the asthmatics and 34% of the rhinitis patients. A commercially available enzyme immunoassay was used in these studies and it was thought that the panel of potential causative allergens included was incomplete, especially with respect to pollens.

Hence, the pioneering task of identifying and enumerating atmospheric pollen types in Beirut, the Lebanese capital, is undertaken for the period extending from March 2004 to August 2004. The aim was not to establish pollen count and identification centers in different districts of Lebanon. Rather, it was hoped that the results of this study would encourage the authorities, in particular the weather bureau, to do so. Knowledge of airborne pollens in Lebanon would be beneficial to both the allergists and their patients.

MATERIALS AND METHODS

For the purpose of assessing airborne pollen prevalence, a VPPS 2000 Sampler (Lanzoni, Bologna, Italy), supplied by Essex Chemie AG, was used.

The volumetric trap sampler was instated at a height of 15 m atop a building in an area in Beirut where no obstructive structures hindered the airflow. The sampler was mounted on aluminum props at a height of 1 m above the roof surface. The location of installment allowed for the capture of pollen grains prevalent in the greater Beirut area and its suburbs.

A seven-day cycle drum with a 168-hour strip coated with silicon adhesive was used to capture pollen grains. Strips were freshly coated with silicon, mounted on sampler drums and exposed within the sampler for a period of one week; henceforth, strips were changed once per week. Strips were processed immediately after exposure by being cut into 48 mm segments, each representing a period of 24 hours. Strip segments were mounted on microscopic slides, stained with gelatin-fuchsin and covered with cover glasses.

Pollen grains were counted and identified under a 40X magnification in 12 longitudinal traverse lines along every strip segment. Raw counts were converted to daily average aerial pollen concentrations per m^3 of air assuming a manufacturer-asserted sampler air intake of 0.01 m^3 per minute and a microscopic field of 0.45 nm.

RESULTS AND DISCUSSION

The average number of pollen per day detected in air samples from Beirut, Lebanon for the period extending from March 2004 to August 2004 was 41.32 pollen grains/m^3. The highest count was recorded in March with a daily average count for the month of 122.86 pollen grains/m^3. The daily average counts for the six-months span of the study are portrayed in Figure 1. The highest recorded count on a single day fell in March with a count of 361.8 pollen grains/m^3.

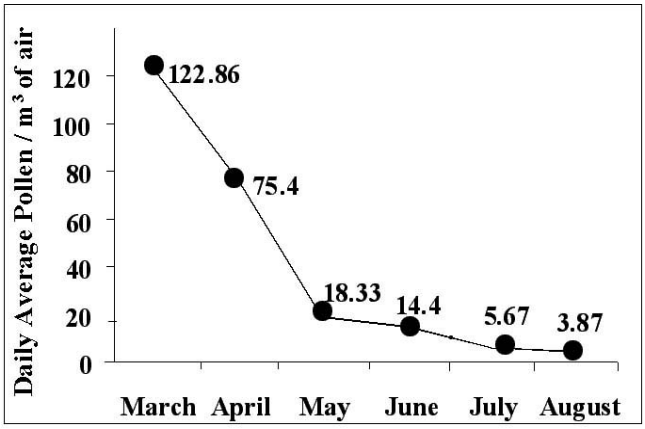

Figure 1. Variations in daily average pollen counts for the six-months period of air sampling in Beirut, Lebanon.

The ten most commonly encountered pollen types during the 184 days of the study were *Cupressus*, *Pinus*, *Quercus*, *Parietaria*, *Fraxinus*, *Urtica*, *Buxus*, *Brassica*, *Syringa*, and *Chenopodium*. These types along with their respective daily average concentrations for the entire period of the study are depicted in Figure 2.

In total, one hundred and twenty pollen varieties were detected during the pollen-monitoring period. Excluding the ten most frequent sorts, all other pollen types had daily average concentrations of less than 1 pollen grain/m^3 for the duration of the study.

The predominant genre of pollen, *Cupressus*, was noted to peak in March with a daily average count of 101.5 pollen grains/m^3. Counts of this pollen type sharply declined in April (5.4 pollen grains/m^3) and then gradually decreased from May (1.37 pollen grains/m^3) through August (0.27 pollen grains/m^3). After average levels of 2.4 pollen grains/m^3 in March, *Pinus* pollen displayed a peak in detection during April with daily average counts of 13 pollen grains/m^3. However, this pollen type was not abstinent from detection during any of the six months that this study spanned; levels depressed in May (1.32 pollen grains/m^3), slowly rose back in June (3.02 pollen grains/m^3) but plummeted again in July (0.22 pollen grains/m^3). Record lows of *Pinus* were during August (0.06 pollen grains/m^3). *Quercus* types

also peaked in April with daily average counts of 10.24 pollen grains/m^3; however, levels slowly decreased then disappeared during the seasonal shift to summer. *Parietaria* pollen also peaked in levels during April with daily average counts of 4.2 pollen grains/m^3 and nearly disappeared in August (0.22 pollen grains/m^3). Nevertheless, *Parietaria* maintained steady levels during March, May, June, and July (1.32 – 1.92 pollen grains/m^3). Like *Quercus*, the *Fraxinus* type of pollen peaked in April with daily average counts of 4.6 pollen grains/m^3. *Fraxinus* levels progressively dwindled and disappeared with the advent of summer. *Urtica*, on the other hand, peaked in March with 3.12 pollen grains/m^3 per day for that month; levels of this pollen variety were also pertinent in April with daily average counts that were only slightly depressed in comparison to those of March. The *Urtica* daily average levels during April approximated 2.68 pollen grains/m^3. *Buxus*, *Brassica* and *Syringa* revealed a peak in April with respective daily average counts of 3.08, 4.24, and 4.68 pollen grains/m^3. Levels of these pollen types were modest in May (averaging 1 pollen grains/m^3) and were barely detectable during the warm months of June, July and August. The tenth most detectable pollen type was *Chenopodium*. This variety peaked in March with daily average counts of 1.84 grains/m^3; levels sharply decreased in April (0.68 pollen grains/m^3) and were not detectable in May. However, as the weather altered to warmth, *Chenopodium* levels gradually increased rendering this sort of pollen to be the most frequently detected type during August with daily average counts of 1.3 pollen grains/m^3.

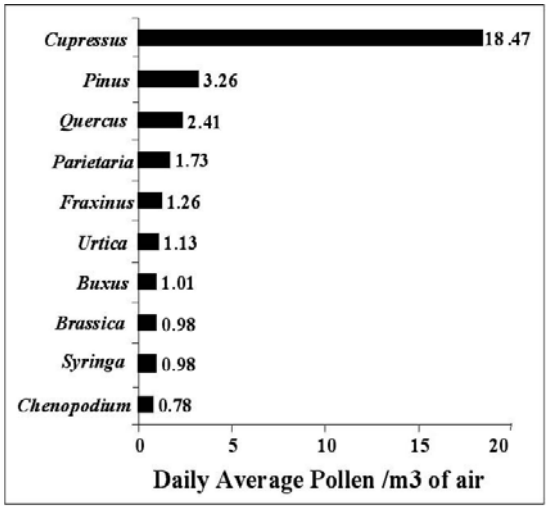

Figure 2. Predominant pollen types detected during the six-months period of air sampling in Beirut, Lebanon.

Regarding prominent monthly varieties, the ten most common types of pollen grains for the month of March were *Cupressus*, *Urtica*, *Pinus*, *Buxus*, *Parietaria*, *Chenopodium*, *Fraxinus*, *Ulmus*, and *Citrus* with respective daily average counts of 101.50, 3.02, 2.32, 2.09, 1.86, 1.78, 1.32, 1.32, and 1.24 pollen grains/m^3. Commonly encountered types during April were *Pinus*, *Quercus*, *Cupressus*, *Syringa*, *Fraxinus*, *Brassica*, *Parietaria*, *Buxus*, *Artemisia*, and *Platanus* with respective daily average counts of 13, 10.24, 5.4, 4.68, 4.6, 4.24, 4.2, 3.08,

3.08 and 3 pollen grains/m^3. In May, the most common types were *Quercus*, *Fraxinus*, *Cupressus*, *Pinus*, *Parietaria*, *Syringa*, *Brassica*, *Artemisia*, *Buxus*, and *Maclura* with respective daily average counts of 3.27, 1.57, 1.37, 1.28, 1.28, 1.08, 1.05, 0.89, 0.83, and 0.75 pollen grains/m^3. The most prevalent pollen sorts in June were *Pinus*, *Parietaria*, *Cupressus*, *Quercus*, *Ginkgo*, *Maclura*, *Brassica*, *Centaurea*, *Artemisia*, and *Eucalyptus* with respective daily average counts of 3.02, 1.56, 1.14, 0.72, 0.56, 0.54, 0.5, 0.44, 0.42, and 0.38 pollen grains/m^3. In July, the ten most prominent types were *Parietaria*, *Chenopodium*, *Ulmus*, *Centaurea*, *Urtica*, *Pinus*, *Celtis*, *Anthriscus*, *Plantago* and *Maclura* with respective daily average counts of 1.35, 0.58, 0.29, 0.23, 0.23, 0.21, 0.21, 0.19, 0.19 and 0.17 pollen grains/m^3. Prevalent pollen levels detected in August were *Chenopodium*, *Maclura*, *Tilia*, *Cupressus*, *Ranunculus*, *Parietaria*, *Eucalyptus*, *Avena*, *Aster*, and *Urtica* with respective daily average counts of 1.25, 0.85, 0.32, 0.27, 0.25, 0.21, 0.17, 0.09, 0.09, and 0.058 pollen grains/m^3 for that particular month.

Although the Cedar tree is the Lebanese national emblem, its growth is almost exclusive to particular areas remote to Beirut. According to some sources, much more common in the country is the Umbrella, or Stone, Pine tree, *Pinus pinea*. *Pinus pinea* grows below 1200 meters and forms the dense forests in the lower mountains around Beirut (Abou-Haidar, 1996). However, indicating that the Umbrella Pine tree is the most common one in the country is based on personal remark with no formal figures statistically attesting to the observation. Our data merely reflects that pollen of the *Cupressus* type were the most frequently detected in aerobiological samples; this does not necessarily imply that trees of the Cypress family are more common in Beirut. Regular pollination levels particular to each species, wind conditions and climate specificities ought to be taken into account before extrapolating tree-type prevalences.

Cupressus trees, whose pollen counts were predominant in our samples, are indigenous to warm temperate climates and are abundant around the Mediterranean basin, in North America and Asia (Ducrey *et al*., 1999). Pollinosis due to cypress pollen types has been documented to increase in recent years in Asian as well as in Mediterranean populations (Charpin, 2000; Sposata *et al*., 2001; Papa *et al*., 2001; Arianio *et al*., 1999; Inouye & Sakagushi, 1990). With no previous studies examining relationships between *Cupressus* pollen and allergic or asthmatic reactions in Lebanon, the profusion of this pollen variety in air samples from Beirut, as indicated by our study, delineates a need to investigate such associations particularly in the grand Beirut area where cypress trees are abundant. Worth mentioning, however, is that cypress trees are very numerous among the arboreal flora on the campus of the American University of Beirut in the vicinity of the building atop which the aerobiological sampler employed in this study was installed; hence, the abundance of this pollen variety in our samples may be explicable.

Pinus pollen was the second most prevalent type in our specimens. Pinaceae pollen are not considered to be highly allergenic (Rawat *et al*., 2000); nevertheless, some reports suggest that sensitization to these pollen types is an extant issue (Newmark & Itkin, 1967; Harris & German, 1985; Fountain & Cornford, 1991). The steady detection of *Cupressus* and *Pinus* pollen throughout the six months of our investigation should be kept in perspective when speculating the impact of their roles in sensitized individuals.

Quercus, another pollen type indicted of being a potential allergen (Singh & Kumar, 2003; Lin *et al*., 2002) was also major in our samples. However, far more important was the

occurrence of the infamous *Parietaria* in prominent amounts. *Parietaria* pollen, particularly that of *Parietaria judaica*, is the foremost pertinent cause of allergy in the Mediterranean basin, with a triggering-factor prevalence of 60 to 80% in Italy and Greece and 25 to 40% in Spain and southern France among allergic patients. With strong allergenic properties and lofty pollen- release peaks (Cvitanovic, 1999; Asturias *et al*., 2003)) *Parietaria* is not a type to be reckoned with. In the Mediterranean climate of mild winters and dry summers it has a long pollination period lasting primarily from March through July and in lesser daily amounts from August through October (D'Amato & Lobefalo, 1989). Our pollen monitoring showed a peak of this pollen type in April; nevertheless, it was present in quite significant aerial concentrations during the six months of the study.

Fraxinus - or ash tree - pollen was another frequently detected type in our specimens. Some reports (Gilardi *et al*., 1994; Guerra *et al*., 1995) depict high sensitization rates to this pollen sort among patient groups; however, whether serum reactivity in these patients is due to *Fraxinus*-specific allergens or to cross-sensitization to other allergic pollen, particularly to olive tree pollen, *Olea*, has not been deciphered yet (Hemmer *et al*., 2000). Other pollen types with pertinent allergenicity were also frequently detected in our samples; these included *Urtica* (Bousquet *et al*., 1986), *Brassica* (Singh & Kumar, 2003) and *Chenopodium* (Galan *et al*., 1989).

In addition, among the ten most commonly detected pollen types were *Syringa* and *Buxus*; however, an allergenic attribute of these varieties, if existent, is not described in the literature.

To the best of knowledge this is the first report on airborne pollen identification and counts in a district of Beirut, Lebanon. The aim of this study was not to establish pollen monitoring centers in Lebanon. Rather, it was anticipated that the results would encourage the authorities to establish an airborne pollen monitoring system in Lebanon whereby results are broadcast with the weather reports. Such information would allow allergists to include the identified airborne pollens in their panel of potential allergens used in tests that identify causative allergens in their patients.

In a brief overview, as the temperate climate in Beirut shifted from spring to summer the seasonal variation was expectedly depicted as a decrease in daily pollen counts. Levels of the majority of pollen types peaked in April; however, March had the highest daily average record mostly enforced by immense bouts of *Cupressus* pollen. With a notable rise in air-pollution in Beirut (Hashisho & El-Fadel, 2004), an increase in evidence linking pollution and vehicle exhaust to pollen-induced allergy (Singh & Kumar, 2003) and a marked frequency of asthma and respiratory diseases in the country, a pollen-monitoring network is in demand in Lebanon. Such a network would abet establishing pollination calendars that can highly aid allergy or asthma patients and physicians in determining correlations between particular aerial pollen concentrations and seasonal allergic symptoms. In a previous study (Ramadan *et al*., 1998) undertaken in Lebanon, only three pollen types of the one hundred and twenty sorts we detected in our census were considered as possible triggering factors of allergic diseases. These namely were those of Bermuda grass, Parietaria and olive trees. Hence, further studies investigating the frequency of sensitization to major pollen types and their relationships to allergy-mediated diseases in inhabitants of Beirut and in the Lebanese population at large ought to be initiated and conducted.

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Figure 1. Variations in daily average pollen counts for the six-months period of air sampling in Beirut, Lebanon.

Figure 2. Predominant pollen types detected during the six-months period of air sampling in Beirut, Lebanon.