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AERIAL POLLEN DIVERSITY OF TWO BIO-GEOGRAPHICAL ZONES OF WEST BENGAL AND THEIR CLINICAL SIGNIFICANCE IN ALLERGIC DISEASES

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ABSTRACT

Abstract: *The present study has been carried out to assess the allergenicity of dominant pollen types from the atmosphere of two bio-geographical zones of West Bengal. During the study period (2014-2015), 64 different kinds of pollens belonging to 38 families were recorded from Santiniketan while, 56 pollen types were recorded belonging to 36 families. Total number of pollen grains trapped during two year's study in Santiniketan was much higher than that of Chandannagar which reflects the rich pollen diversity of Santiniketan area due to its luxuriant vegetational patterns. In the present survey, grass pollen (Poaceae) was found to be most dominant (6.64% and 9.01%) in both the sites. Antigenic extract of 21 pollen types were selected for skin prick tests (SPT). The allergenic pollens selected for the present study belong to families: Apocynaceae, Arecaceae, Bignoniaceae, Brassicaceae, Caesalpiniaceae, Cycadaceae(gymnosperm), Dipterocarpaceae, Fabaceae, Lythraceae, Meliaceae, Myrtaceae, Phyllanthaceae, Poaceae, and Solanaceae. Out of 1687 patients, 70.92 % subjects showed +1 skin sensitivity in SPT grade towards one and more than one antigenic extract. Saccharum spontaenum, Alstonia scholaris and Cassia sophera were clinically found to be most sensitive among these pollens.*

KEY WORDS

Pollen diversity, Chandannagar, Santiniketan, allergenicity, skin prick tests, allergenic pollens.

INTRODUCTION

The contribution of airborne pollen grains to respiratory allergies has increased around the world over recent times. Now-a-days, pollen-related allergic diseases are an alarming health problem in Indian scenario (Bhattacharya et al. 2006; Mandal et al. 2009; Sharma et al. 2009). Allergic symptoms like rhinitis or bronchial asthma are very much related to the timing, composition and abundance of bio-aerosols which include invisible biomass of particulate matter of plant and animal origin. Thus, information on prevalence of airborne pollen grains may serve as guide for allergologist and clinicians to accurately manage allergic diseases. Atmospheric pollen spectra have been monitored in different sites in India (Kasliwal et al. 1959; Dua and Shivpuri 1962; Chanda 1973; Chanda and Mondal 1980; Singh et al. 1987; Gupta and Chanda 1989; Banik and Chanda 1990; Singh et al. 1992; Boral and Bhattacharya1999; Anonymous 2000; Chakraborty et al. 2003; Boral et al. 2004; Chauhan and Goyal 2006; Sharma et al 2009; Wani et al 2010; Ghosal et al 2015; Chaturvedi, 1993; Singh and Babu, 1982; Singh, 1996; Jain and Gupta, 1999) and also from the other countries (Stam & Timmermans 1989; Cosentino et al. 1995; Bunnag et al. 1997; Wong et al. 2004; Wan-Ishlah and Gendeh 2005; D'Amato et al. 2007; Erbas 2007). The pollen count can be an important tool in the management of individuals with seasonal allergies.

Since it is important to make pollen calendars of a particular ecozone which will be useful in the

prevention and diagnosis of allergic diseases caused by pollen and to detect the timing and severity of the pollen season. Pollen calendars in a given location are of particular interest since they provide readily accessible visual information on the various airborne pollen types occurring in the course of the year (Recio et al. 1998, Belmonte and Roure 2002).

Aeropalynological surveys conducted in different parts of our country have shown local climate plays a vital role in plant phenology, especially on reproductive phenology. Moreover, meteorological factors like temperature, precipitation, humidity and wind affect atmospheric pollen dispersion and loads (Puc and Puc 2004). Thus, sensitive patients generally get recurrence of symptoms during those particular seasons and places. The sources and nature of pollen thus vary in different parts of the country. In each geographic area, there is a succession of different flowering species throughout the year. Therefore, it is exigent to collect information on pollen of different eco zones for management of allergic ailments of local population.

Thus, in the present study efforts have been made to conduct an aeropalynological survey of two distinct geographic zone of West Bengal, namely Santiniketan and Chandannagar with an object to identify the different airborne pollen types having allergic significance. Santiniketan is a semi-urban township of Birbhum district which represent a lateritic zone and Chandannagar is an urban city situated at the river bank of Ganga.

MATERIALS AND METHODS

Study area:

We have chosen two distinct sampling locations namely Santiniketan (site I) and Chandannagar (site II) which are geographically far apart from each other with different soil composition and different climatic conditions. Site I is Santiniketan, a semi-rural establishment based on Visva-Bharati, a central university on the outskirts of the Bolpur town having luxuriant vegetation. The site II is a sub-urban industrial township, located on the bank of Ganga river in a densely populated area with poor vegetation cover, formerly a French colony (20 sq. km) of Hooghly district.

The site I is located at 160 km north-west of Kolkata (23.68°N 87.68°E) and has an average elevation of 56 m. As it is a lateritic zone, the summer temperature is moderately high, less humid and the winter temperature becomes much lower. The site II situated about 35 km far to the north of Kolkata (22° 52' 9" N and 88° 22' 37" E) with average elevation of 10 metres.

Aerobiological monitoring:

Monitoring of airborne pollen flora was done with the help of "Burkard portable volumetric sampler" (suction rate = 10L/min) for two consecutive years (January 2014 to December 2015) at two different places (Gurupally and Shyambati) in site I and three different sites (Bagbazar, Palpara and Mankundu) in site II. Air sampling was done at three different time intervals: morning (09:30hr-10:30hr), afternoon (12:30hr-13:30hr) and evening (19:30hr-20:30hr) at weekly intervals.

The hourly counts were then averaged to obtain the mean concentration which in turn gave the monthly concentration. The exposed slides were mounted, scanned thoroughly, counted and converted into number of pollen per m^3 following the guidelines of the British Aerobiology Federation (1995). Possible plant sources of airborne pollen were identified by conducting monthly vegetation surveys and field collections. Both entomophilous and anemophilous plants were recorded and observed their flowering times. The identification of air borne pollen was done mainly with the help of prepared reference slides by our laboratory and also by consulting published literatures (Erdtman 1969; Huang 1972; Gupta et al. 1985; Nayar 1990; Banik et al. 1986; Bhattacharya et al. 2006).

Meteorological Data:

The detailed meteorological data such as maximum and minimum temperature (°C), rainfall (mm), wind speed (km/h), relative humidity (%) were collected weekly both from the Sriniketan Meteorological station, situated about 3 km away from the sampling site I and the Chandannagar Meteorological Station, situated about 5 km away from the sampling site II.

Statistical Analysis:

The relationship between the meteorological parameters and weekly pollen concentration was calculated using the Pearson nonparametric correlation coefficient (Andersen, 1980; Bricchi et al. 1992; Subiza et al. 1992). Statistical analysis was undertaken with R studio where values of $P < 0.05$ were considered to be statistically significant.

Antigen procurement:

A total of 21 pollen types prevalent in the atmosphere of both the sites were selected for skin prick tests (SPTs). The SPTs were done at Mediland Diagnostic Institute, Kolkata with the Kind help of physicians. Pollen extracts were prepared from bulk uncontaminated pollen grains following the method of Shivpuri (1962) and Sheldon *et al.* (1967). 50 % glycerinated phosphate buffer (1:10) and histamine dichloride (1 mg/ml) were mixed with sterilized antigenic extracts for pollen allergy diagnosis. SPTs were performed according to Boral et al. (2004). According to the International guidelines (Dreborg & Fraw 1993), positivity was defined as mean wheal diameter ≥3 mm compared with negative control. The reaction was graded from +1 to +3 level according to Stytis *et al*. (1982). None of the patients were receiving immunotherapy during SPT. The study was approved by the Ethics Committee of the Mediland Diagnostics Institute and prior consents were obtained from the patients before SPT and sera collection.

RESULTS AND DISCUSSION

A total of 64 pollen types were identified which belonging to 37 families of angiosperms, 1 Gymnosperm from Santiniketan (site I) while 56 pollen types were identified which belonging to 35 families of angiosperms and 1 Gymnosperm from Chandannagar (site II) during the entire study period though a few pollen types remained unidentified (Table 1 and 2).

During our observation, the maximum monthly mean concentration of aero pollen was observed in April (13408 /m^3) accounting 17.02% of total pollen load in 2 successive years, followed by May (11104 /m^3), March (10240 /m^3) and June (8288/m^3) in both the years in the atmosphere of Santiniketan i.e. site I (Fig 1). Grasses contributed maximum pollen grains (6.64%), followed by *Solanum* sp. (5.41%), *Cassia* sp. (4.55%) while, minimum number of pollens was contributed by *Brownea coccinea* (0.69%) (Table 1). The pollen grains of *Acacia auriculiformis*, *Cyperaceae*, *Cycas sp.*, *Lagerstromia* sp., Asteraceae, *Eucalyptus sp*, *Spathodea campanulata, Phoenix sylvestris, Trema orientalis, Phyllanthus emblica* and *Peltophorum petrocarpum, Parthenium hysterophorus* showed the remarkable percentage of pollen contribution in both of the years.

In Chandannagar (site II), the maximum monthly mean concentration was also observed in April (9988/m^3) accounting 16.08% of total pollen load in two successive years, followed by March (8736/m^3), May (8288/m^3) and February (6976/m^3) in both the years (Fig 2). Grasses contributed maximum pollen grains (9.01%), followed by *Acacia* sp. (4.28%), while minimum number of pollen was contributed by *Zizyphus* sp. (0.57%) (Table 2). The pollen grains of Cyperaceae, *Cassia sp.*, *Solanum* sp., *Catharanthus roseus, Ricinus communis,* Asteraceae, *Cycas* sp., *Lagerstromia* sp., *Spathodea campanulata*, and *Parthenium hysterophorus* showed the moderate percentage in both the years in the atmosphere of Chandannagar.

Mainly two pollen seasons were recognized from the monthly pollen diversity: one from mid-February to May and other from mid-September to end-November (Fig 1 and 2). The first pollen season was loaded with tree and shrub pollen, while grasses and weeds showed fairly good occurrence in air in the second pollen season. The predominant pollen types in the first season belong to *Acacia auriculiformis, Areca catechu, Casuarina equiseitifolia, Cocos nucifera, Cassia* sp., *Solanum* sp., *Catharanthus roseus*, Asteraceae, *Parthenium hysterophorus, Borassus flabellifer, Cycas* sp., *Lagerstroemia* sp., *Spathodea campanulata, Carica papaya* etc. The second season was loaded with pollen of Cheno-Amaranthaceae, Cyperaceae and grasses (poaceae) in both the eco zones.

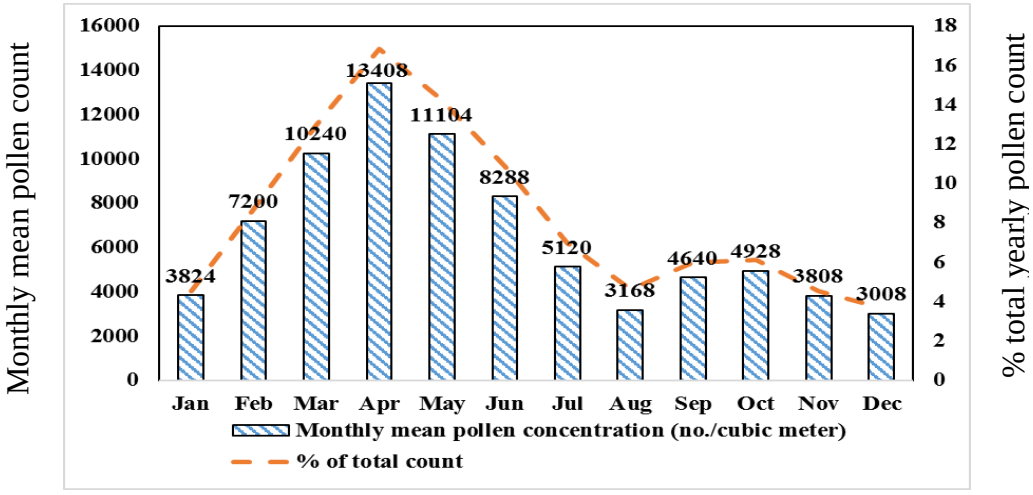

Fig 1: Seasonal variation of the monthly mean pollen concentration (pollen grains/m³) recorded in the air of Santiniketan (2014-2015).

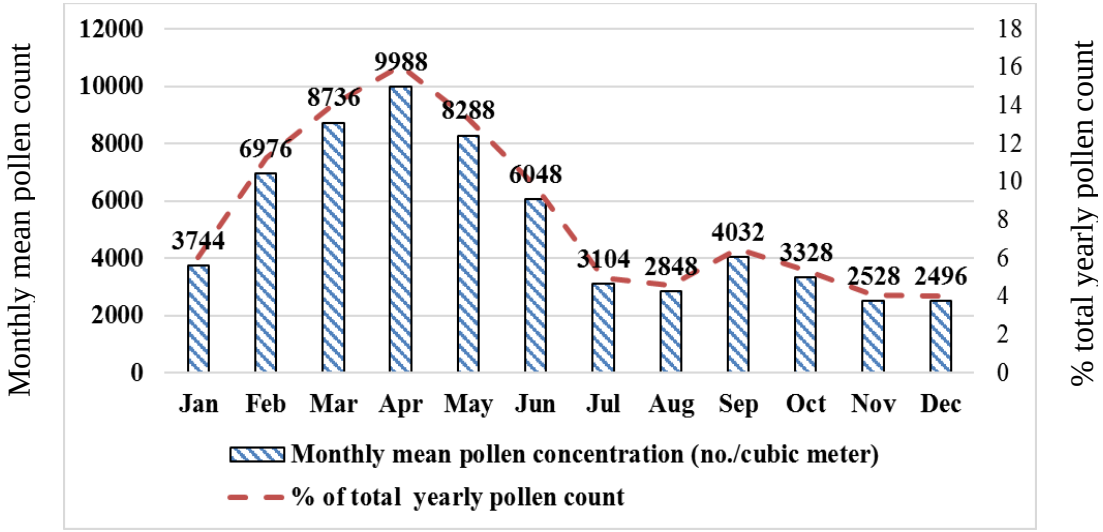

Fig 2: Seasonal variation of the monthly mean pollen concentration (pollen grains/m³) recorded in the air of Chandannagar (2014-2015).

Statistical analysis

Meteorological factors like temperature, rainfall, relative humidity and wind speed are responsible for fluctuations in pollen concentration Andersen et al.1980; Bricchi et al. 1992; Galan et al. 2000. The effects of four such most influencing meteorological factors on prevalance of pollen counts in the air of Santiniketan and Chandannagar have been considered to analysis their influence on pollen dispersal. To get the correlation between total weekly pollen count and the meteorological parameters, Pearson product-moment correlation was computed and p-values were considered to judge their significance

In the present study, pollen dispersal was influenced by meteorological factors where weekly total pollen count was positively skewed and kurtotic indicating a non-normal distribution. In the both sites, weekly total pollen count was correlated positively and significantly with maximum temperature and wind speed and negatively correlated with relative humidity and rainfall (Table 3).

The statistically significant r values, for site I, for PC and maximum temperature was 0.21 and PC; while for PC and wind speed was 0.24 with the given probability values p <0.001 for all the mentioned variables (Table 3), while minimum temperature was not found to be

statistically significant. However, our results show that relative humidity (RH) and rainfall is negatively correlated with the pollen count (r value= -0.58 and -0.37 respectively) with the p value <0.001; thus, less pollen grains were trapped during heavy rainfall.

The statistically significant r values, for site II, for pollen count and maximum temperature was 0.45 and minimum temperature was 0.41; while for PC and wind speed was 0.54 with the given probability values p <0.001 for all the mentioned variables (Table 3). However, our results show that only rainfall is negatively correlated with the pollen count (r value= -0.40) with the p value <0.001, but RH was not found to be significantly correlated; thus pollen catch was low to due to wash out of pollen grains from atmosphere by rainy shower. It is evidenced that temperature is the factor that exerts the greatest influence on the release of pollen grains in the atmosphere (Puc 2002; Vega-Maray *et al*.2010). The pollen grains were found to be correlated positively with temperature, thus our finding supports the view that moderately high temperature with low relative humidity accelerates the pollen dispersal.

Variations in daily pollen loads may be attributable to meteorological factors, species diversity, long distance pollen transport and pollen refloating (Andersen 1980; Bhattacharya and Dutta 1992). High temperature promotes an increase in pollen concentration, while a rise in relative humidity and rainfall cause a decrease in pollen concentration. The anemophilous pollen usually outnumbered and dominated over the entomophilous pollen. This could be attributed to the wind currents which are the carrier of pollen from one plant to another.

Clinical investigation of allergenic significance of pollen

Out of 1687 patients, 70.92 % subjects showed +1 skin sensitivity towards one and more than one antigenic extract. The percent of patients showing markedly positive (+2) skin reactions to one or various pollen antigens was 57.25 % while 28.3% high skin reactivity (≥3+) was shown towards one or more antigenic extracts.

Saccharum spontaenum, Alstonia scholaris and *Cassia sophera* were clinically found to be most sensitive (58.91%, 54.30% and 54.30 respectively) followed by *Azadirachta indica* (53.58%), *Borassus flabellifer* (52.88%), *Cassia nodosa* (52.41%), *Cycas circinalis* (52.31%), *Eucalyptus citriodora* (51.92%), *Syzigium cumini* (48.91%), *Shorea robusta* (48.20%), *Cassia siamea* (46.15%), *Peltophorum pterocarpum* (46.15%) etc (Table 4). Comparatively less potent types were *Phyllanthus emblica* (34.45%), *Coccos nucifera* (34.25%), *Spathodea campanulata* (33.02%) *etc* while moderate skin sensitivity was shown by *Lagerstromia speciosa* (44.85%), *Acacia auriculiformis* (42.30%), *Delonix regia* (42.20%). But, it was noticable that *Saccharum spontaenum* showed the most sesitization for 3+ or more SPT level (23.64%) while *Peltophorum pterocarpum* have shown the least. Moderate 3+ SPT potency was shown by *Borassus flabellifer* (14.42%), *Cycas circinalis* (13.16%), *Shorea robusta* (12.23%), *Coccos nucifera* (10.03%), *Syzigium cumini* (9.78%), *Alstonia scholaris* (9.27%) and *Azadirachta indica* (9.16%) (Table 4).

CONCLUSION

The study of bio-monitoring revealed a wide range of pollen spectra in two successive years in the atmosphere of both Santiniketan an rural area with luxurient vegetation and Chandannagar, an industrial suburban city with humid tropical vegetation. The two-year comparative investigation of airborne pollen spectra of two sites provides data to establish the pollen calendars in these two eco-geographically distinct zones of West Bengal for the first time. Though the natural vegetation of both the sites have been reduced due to urbunization, the wild and ornamental trees still grow arround and contributed a fair amount of tree pollen load. Documentation of airborne pollen in these two eco-geographical zones of West Bengal may help in understanding the flowering behaviour of local vegetation also. The mode of environmental transmission of pollen can influence the level and incidence of exposure to pollen allergens by sensitized individuals of local inhabitants (Smart et al. 1979; Solomon 1984; Mandal *et al*. 2006; Taketomi *et al.* 2006; Piotrowska-Weryszko and Weryszko-Chmielewska 2014; *Ščevková* et al. 2015).

Total number of pollen grains trapped in two years' study in Santiniketan was 1,57,472 pollen/ cubic meter of air, which reflects the rich pollen diversity of this rural area while in Chandannagar, it was 1,24,232 pollen/ cubic meter of air. Our results showed that 64 taxa belonging to 38 families were observed in the atmosphere of the Santiniketan while in Chandannagar, 56 taxa belonging to 36 families were recorded. These

results demonstrated that Santiniketan is rich in vegetation comprising mostly of ornamental tree and herbaceous plants. In addition, vast green land, gardens surrounded by agricultural fields also reflected in its aero-pollen diversity whereas Chandannagar is comparatively less in **rich** vegetation due to its fast-growing urbanization and industrial growth. The pollen spectrum includes several ornamental plants (*Bauhinia, Cycas, Areca catechu, Thevetia* etc.), plants of agricultural value (*Brassica* sp.*, Oryza sativa, Saccharum officinarum, Solanum,* Asteraceae etc.) and avenue trees (*Acacia auriculiformis, Albizia lebbeck, Alstonia scholaris, Delonix regia, Lagerstromia* sp.*, Peltophorum pterocarpum, Spathodea campanulata* etc.). Grasses are the common ground vegetation of the both study sites thus alone dominated the airborn pollen assemblage in both the sites. Peak pollen season was observed in pre-monsoon time, from March to June, in Santiniketan and from Febuary to May in Chandannagar (Fig 1). In the pollen peak season, the frequency of pollen count showed an increase between Feburary to May in Chandannagar while it from March to June in Santiniketan (Fig 2). Pollen counts decreased during June to September due to heavy rainfall. Meteorological conditions are known to govern the quality and quantity of pollen spectra (Carin˜anos 2004). Temparature, wind speed and rain fall were key factors for fluctuation of pollen dispersal. The maximum number of pollen grains were recorded during pre-monsoon season due to the fact that the increasing temparature during this period is favourable for many plants to flower in this region. The warm and the dry season may stimulate dehiscence of anthers and release pollen to the air (Solomon 1997). The results in Chandannagar, are similar to those presented by Ghosal et al. (2015) which showed a positive correlation with thermal parameters and negative correlation with rainfall.

In the present survey, grass pollen (Poaceae) was found to be most dominant with (6.64% and 9.01%) in both the sites. The pollen grains of Cyperaceae, *Cycas* sp., *Acacia auriculiformis*, *Lagerstroemia* sp., Asteraceae, *Eucalyptus* sp., *Spathodea campanulata, Phoenix sylvestris, Trema orientalis, Phyllanthus emblica* and *Parthenium hysterophorus* showed the remarkable percentage of pollen contribution in both of the years, in Santiniketan. The pollen grains of *Cassia sp.*, *Acacia auriculiformis*, *Ricinus communis, Solanum sisymbriifolium*, Asteraceae, *Catharanthus roseus, Cycas* sp.*, Lagerstromia* sp., *Spathodea campanulata*, *Trema orientalis* and *Parthenium hysterophorus* pollen showed the moderate percentage of occurrence in both the years in the air of Chandannagar. Some predominant airborne pollen types recorded in the present study were reported to be allergenic by many researchers (Singh and Babu 1982; Banik and Chanda 1992; Chowdhury 1998; Chakraborty 1998; Chakraborty *et al*. 2003; Boral et al. 2004; Ghosh *et al*. 2007). Out of 1687 patients tested for SPT with 21 pollen antigens, 70.92 % subjects showed +1 skin sensitivity, while 57.25 % atopic patients showed 2+ and 28.3% showed 3+ or more skin sensitization towards one or more antigenic extracts. Pollen of *Saccharum spontaenum* (Poaceae) was clinically most potent (54.30%) showing positive in (23.64%) for 3+ or more SPT sesitization level, while *Peltophorum pterocarpum* showed the least. It seems that grass pollen is the most important allergenic pollen in the regions under examination. Moderate SPTs (3+) sensitization was shown by many other pollen types like *Borassus flabellifer* (14.42%), *Cycas circinalis* (13.16%), *Shorea robusta* (12.23%), *Coccos nucifera* (10.03%), *Syzigium cumini* (9.78%), *Alstonia scholaris* (9.27%) and *Azadirachta indica* (9.16%).

The present study the airborne pollen spectra varies from place to place in terms of qualitative and qualitative assemblages of pollen due to variation of geology, vegetations and other climatic factors. The role of the different pollen allergens varies with environment conditions, such as climatic factors, pollution and degree of exposure. The knowledge on diurnal, seasonal and annual variations in airborne pollen in any geographical area is essential for effective diagnosis and treatment of pollen allergy. Because of alteration in the climatic conditions, observation on diurnal and seasonal dominance becomes very important (D'Amato et al. 2002). Therefore, a continuous monitoring of aerial pollen diversity is important.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

Table 1: **Average total pollen load (No. of pollen/m³ of air) and yearly average percentage contribution of different pollen types in the air of Santiniketan (Site I)**

Types of pollen	Yearly % of contribution	Types of pollen	Yearly % of contribution
Acacia sp.	4.06	*Euphorbia* sp.	0.77
Acanthaceae	1.54	Fabaceae	1.30
Ailanthus sp.	0.93	Liliaceae	1.14
Albizia lebbeck	1.22	*Lantana camara*	2.11
Alstonia scholaris	1.02	*Lagerstroemia* sp.	2.64
Apiaceae	1.46	Lamiaceae	1.50
Areca catechu	1.50	*Leucas* sp.	0.53
Argemone Mexicana	1.02	*Madhuca indica*	1.06
Asteraceae	3.82	Malvaceae	1.87
Azadirachta indica	0.98	*Mangifera indica*	0.89
Barringtonia racemosa	0.77	*Mimosa pudica*	1.34
Bauhinia sp.	0.93	*Murraya paniculata*	1.06
Bombax ceiba	0.93	*Nyctanthes arbor-tristis*	0.81
Borassus flabellifer	1.26	*Parthenium hysterophorus*	1.99
Brassica sp.	1.18	*Peltophorum pterocarpum*	1.59
Brownea coccinea	0.69	*Phoenix sylvestris*	1.71
Caesalpinia pulcherrima	1.38	*Phyllanthus emblica*	1.34
Callistemon sp.	1.22	Poaceae	6.64
Carica papaya	1.63	*Psidium guajava*	1.30
Cassia sp.	4.55	*Ricinus communis*	1.42
Catharanthus roseus	1.46	*Shorea robusta*	0.61
Casuarina equiseitifolia	1.06	*Solanum* sp.	5.41
Cheno-Amaranthaceae	1.63	*Spathodea campanulata*	2.44
Clerodendrum sp.	0.49	*Syzygium* sp.	1.02
Cocos nucifera	1.63	*Tabebuia* sp.	0.33
Convolvulaceae	0.89	*Tectona grandis*	0.65
Croton bonplandianum	1.67	*Tinospora cordifolia*	0.65
Cycas sp.	3.05	*Trema orientalis*	1.34
Cyperaceae	3.01	Verbenaceae	0.81
Dalbergia sisoo	0.89	*Xanthium strumarium*	1.14
Delonix regia	1.06	*Zizyphus sp.*	0.49
Eucalyptus sp.	2.07	Unidentified	1.10

Table 2: Average total pollen load (No. of pollen/m³ of air) and yearly average percentage contribution of different pollens types in the air of Chandannagar (Site II)

Types of pollen	Yearly % of contribution	Types of pollen	Yearly % of contribution
Acacia sp.	4.28	Fabaceae	1.70
Acanthaceae	1.44	Liliaceae	1.39
Albizia lebbeck	0.77	*Lantana camara*	2.27
Alstonia scholaris	1.71	*Lagerstroemia* sp.	2.64
Apiaceae	1.70	Lamiaceae	1.49
Areca catechu	1.18	*Leucas* sp.	0.58
Argemone mexicana	0.88	Malvaceae	2.16
Asteraceae	3.97	*Mangifera indica*	1.24
Azadirachta indica	0.77	*Mimosa pudica*	1.34
Barleria sp.	0.72	*Murraya paniculata*	1.29
Bauhinia sp.	0.67	*Parthenium hysterophorus*	2.47
Bombax ceiba	0.98	*Peltophorum petrocarpum*	1.80
Brassica sp.	1.29	*Phyllanthus emblica*	2.01
Caesalpinia pulcherrima	1.60	Poaceae	9.01
Callistemon sp.	0.93	*Psidium guajava*	1.55
Carica papaya	1.34	*Ricinus communis*	1.80
Cassia sp.	3.97	*Shorea robusta*	0.67
Catharanthus roseus	3.04	*Solanum* sp.	3.73
Casuarina equiseitifolia	1.29	*Spathodea campanulata*	2.39
Cheno-Amaranthaceae	1.80	*Syzigium*sp.	0.88
Clerodendrum viscosum	0.93	*Tectona grandis*	0.72
Coccos nucifera	1.65	*Tinospora cordifolia*	0.82
Convolvulaceae	0.82	*Trema orientalis*	1.65
Croton bonplandianum	1.44	*Typha*sp.	1.03
Cycas sp.	2.11	Verbenaceae	1.29
Cyperaceae	3.91	*Xanthium strumarium*	1.44
Delonix regia	1.08	*Zizyphus* sp.	0.57
Eucalyptus sp.	1.65	Unidentified	0.82
Euphorbia sp.	1.34		

Table 3: Study on the correlation between total pollen count and meteorological parameters by Pearson nonparametric correlation coefficient (Santiniketan and Chandannagar).

	Max. temp	Min. temp.	RH	Rain fall	Wind speed
Pollen (Site I)	**0.21(<0.001)****	0.06(0.69)	**-0.58(<0.001)****	**-0.37(<0.001)****	**0.24(<0.001)****
Pollen (Site II)	**0.45(<0.001)****	**0.41(<0.001) ****	0.07(0.87)	**-0.40(<0.001)****	**0.54(<0.001)****

Significant values in bold; Level of significance *0.05, **0.001

Table 4: Results of skin tests (SPT) with various pollen antigens

Pollen antigenic extracts	Number of patients tested	1+	2+	≥3+	Sensitization Frequency (%)	% Pollen Frequency in air Site I	Site II	Sensitization Frequency (%) ≥3+
Acacia auriculiformis	182	46	19	12	42.30	4.06	4.28	6.59
Alstonia scholaris	151	44	24	14	54.30	1.02	1.71	9.27
Azadirachta indica	502	131	92	46	53.58	0.98	0.77	9.16
Borassus flabellifer	104	11	29	15	52.88	1.26	-	14.42
Cassia occidentalis	112	22	14	10	41.07			8.92
Cassia fistula	259	21	54	16	35.13	4.55	3.97	6.17
Cassia sophera	267	71	62	12	54.30	Counted with		4.49
Cassia siamea	390	79	66	35	46.15	*Cassia* pollen		8.97
Cassia nodosa	145	32	33	11	52.41			7.58
Coccos nucifera	508	58	65	51	34.25	1.63	1.65	10.03
Cycas circinalis	281	51	59	37	52.31	3.05	2.11	13.16
Eucalyptus citriodora	312	82	56	24	51.92	2.07	1.34	7.69
Delonix regia	616	112	101	47	42.20	1.06	1.08	7.62
Lagerstromia speciosa	272	41	59	22	44.85	2.64	2.64	8.08
Peltophorum pterocarpum	247	61	42	11	46.11	1.59	1.80	4.45
Phyllanthus emblica	296	55	29	18	34.45	1.34	2.01	6.08
Saccharum spontaenum	516	96	86	122	58.91	Counted with poaceae pollen 6.64	9.01	23.64
Shorea robusta	139	29	21	17	48.20	0.61	0.67	12.23
Spathodea campanulata	218	41	12	19	33.02	2.44	2.39	8.71
Solanum symbriifolium	282	39	22	22	29.43	Counted with *Solanum* pollen 5.41	3.73	7.80
Syzigium cumini	92	25	11	9	48.91	1.04	0.88	9.78

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