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Airborne pollen sampling of Govindpur, a river bank city in Allahabad, India

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Abstract
Aerobiological studies when confined to pollen and spores and associated plant materials (Palynomixtum) are known by the term Aeropalynology. Aeropalynological survey of an area gives an idea of qualitative and quantitative existence of airborne pollen grains in that locality. This data is useful in allergy testing. With this objective a new site of Govindpur (Allahabad, U.P.) has been explored. A total of 73 pollen types have been identified from this area with dominance of 11 types. These include *Holoptelea integrifolia* (60.30%), Poaceae (9.31%), *Parthenium hysterophorus* (3.19%), *Typha angustifolia* (3.12%), Amaranthaceae /Chenopodiaceae (2.51%), *Azadirachta indica* (2.45%), *Madhuca longifolia* (1.93%), *Croton bonplandianum* (1.91%), *Ricinus communis* (1.64%), *Brassica campestris* (1.12%) and other Asteraceae (1.64%).

Keywords: pollen, Govindpur, qualitative, quantitative, allergic diseases

Introduction
In the recent past aerobiological studies have received much attention due to their wide application in allergy, forestry, agriculture and horticulture. Aeropalynology, a branch of aerobiology, specializes in the study of pollen content of the atmosphere including their release, transportation or dispersal and deposition. Aeropalynological studies are of paramount importance in the diagnosis and management of allergic diseases caused by pollen grains apart from their significance in biogeography, ecology and environment. [1, 2, 3, 4, 5].
Composition of airborne pollen is characteristic for each biogeographical zone. Thus information of the pollen types and their pollen season is of great interest to clinicians and allergy patient as a means of establishing a chronological correlation between the air pollen concentration and hay-fever and asthma symptoms [6].
In Allahabad earlier aeropalynological surveys were conducted during 1973-79 [7] and 1990-92. [8, 9, 10]. Thus the present work was undertaken after a gap of ten years to reinvestigate the aeropalynoflora in order to update the airborne pollen calendar of Allahabad.

Materials and Methods
Monitoring of airborne pollen grains was carried out using vertical cylinder spore trap installed at a height of 11 meters. Daily exposure of vertical glass rods of 0.5mm diameter covered with glycerine jelly coated cellophane tapes was made for a period of one year from October 2006 to September 2007. The exposed tapes were mounted in safranin glycerine jelly on a slide under a coverslip of 20mm area. Entire area of the coverslip was scanned thoroughly in several vertical sweeps in order to ensure the counting of each pollen grain. Pollen counts estimated in 3.24cm^2 area were then converted to per sq. cm. Fortnightly field surveys were conducted in the area around the sampling site to prepare a flowering calendar and to collect the polleniferous material. Identification of airborne pollen grains was done with the help of reference slides prepared from authentically identified ground plants and from published literature [11, 12, 13, 14].
The sampling site is located in the Govindpur locality of Allahabad. On its North flows the River Ganga at about 500 meters distance while on the other sides it is surrounded by residential and market area. There are several avenue trees growing around the sampling site along with the patches of grasses. Across the River Ganga is the neglected wasteland with several trees, weeds and grasses growing profusely.

Results and Discussion
During one year study period 2995.68 pollen grains/cm^2 were trapped from the air. Out of these 95.66% of the pollen grains could be identified and assigned to 73 taxa (Table 1). Out of these 11 types recorded total pollen counts greater than 1 % (annual pollen catch more than 30 pollen grains/cm^2). *Holoptelea integrifolia* was the most abundant type contributing 60.30% to the total annual catch. Next dominant types were those of Poaceae (9.31%), *Parthenium hysterophorus* (3.19%), *Typha angustifolia* (3.12%), Amaranthaceae/Chenopodiaceae (2.51%), *Azadirachta indica* (2.45%), *Madhuca longifolia* (1.93%), *Croton bonplandianum* (1.91%), *Ricinus communis* (1.64%), *Brassica campestris* (1.12%) and other Asteraceae (1.64%). The above types constituted 89.12% of the pollen spectrum. Remaining 62 types formed 6.54% while 4.34% remained unidentified (Fig. 1). Among the above types pollen grains of *Madhuca longifolia* recorded their presence in the air for shorter period of two months while those of *Azadirachta indica* and *Holoptelea integrifolia* for four months. Those of *Brassica campestris*, *Ricinus communis* and *Typha angustifolia* were recorded from the atmosphere for five to six months, those of *Croton bonplandianum* for nine months while pollen grains of Amaranthaceae / Chenopodiaceae, other Asteraceae, *Parthenium hysterophorus*, and Poaceae were found present in

the air almost throughout the year (eleven to twelve months, Fig. 2, 3).

Variations in the pollen counts and pollen types have been observed during different months of the year (Figs. 4 and 5). Highest counts were registered in the month of March (1664.20 pollen grains/cm^2) followed by April (582.72 pollen grains/cm^2) while the month of November and December recorded the lowest pollen counts (28 pollen grains/cm^2, Fig. 4). The richness in diversity was maximum in the month of March (34 pollen morphotypes) followed by April (30 pollen types) and minimum in the month of August (9 pollen types) (Fig. 5).

Table 1: Monthly incidence of pollen grains (per cm²) in Govindpur locality (Site III) of Allahabad during 2006-07.

S. No	Pollen Types	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total	Per cm^2
1.	*Acacia nilotica*	1			1						3	2		7	2.16
2	*Adhatoda vasica*							2						2	0.62
3.	*Aegle marmelos*								16	10	1			27	8.33
4.	*Ailanthus excelsa*					8	9	8	2					27	8.33
5.	*Alnus* sp.						11							11	3.4
6.	Amaranthaceae/ Chenopodiaceae	21	1	4	5	38	113	44	8	1	1	1	7	244	75.31
7.	Apiaceae					18	9		1					28	8.64
8.	*Artemisia* sp.	11	3										2	16	4.94
9.	Other Asteraceae	9	2	2	3	1	15	31	7	3	4	22	8	107	33.02
10.	*Azadirachta indica*						21	185	30	2				238	73.46
11.	*Bombax ceiba*						1							1	0.31
12.	*Bougainvillea* sp.			1	1									2	0.62
13.	*Brassica campestris*		2	8	41	55	3							109	33.64
14.	*Cajanus cajan*			1	1	1	1							4	1.23
15.	*Callistemon citrinus*	1	1				17			1				20	6.17
16.	*Cannabis sativa*	1	2		2	2	3	16	10	1			1	38	11.73
17.	*Caryota urens*						4	1						5	1.54
18.	*Cassia fistula*								2				2	4	1.23
19.	*Cassia nodosa*		1											1	0.31
20.	*Cassia siamea*				1			2	1					4	1.23
21.	*Toona ciliata*						8	12						20	6.17
22.	*Celosia cristata*	4			3	11	6	4	2					30	9.26
23.	*Casuarina equisetifolia*				1									1	0.31
24.	*Chrysanthemum* sp.				1									1	0.31
25.	*Convolvulus* sp.	1												1	0.31
26.	*Coronopus didymus*				1	1	2							4	1.23
27.	*Croton bonplandianum*	1	2				17	16	40	3	36	69	1	185	57.10
28.	Cyperaceae	2	2			3	7	3		1	1	10	11	40	12.35
29.	*Emblica officinalis*						12		5					17	5.25
30.	*Eucalyptus citriodora*					1								1	0.31
31.	*Euphorbia geniculata*				2									2	0.62
32.	*Euphorbia pulcherrima*				2									2	0.62
33.	*Feronia limonia*						7	6	1					14	4.32
34.	*Hibiscus rosa-sinensis*	20												20	6.17
35.	*Holoptelea integrifolia*					376	4706	766					2	5850	1805.56
36.	*Iberis amara*			1			2							3	0.93
37.	*Impatiens balsamina*	1	1											2	0.62
38.	*Ipomoea* sp.						1							1	0.31
39.	*Justicia simplex*			1										1	0.31
40.	*Lagerstroemia indica*	2												2	0.62
41.	*Leucaena glauca*						1	4						5	1.54
42.	*Madhuca longifolia*							186		1				187	57.72
43.	*Mangifera indica*						2							2	0.62
44.	Other Monocots	10	1			9	16	14	7	2		4	5	68	20.99
45.	*Morus alba*	1									1			2	0.62
46.	*Murraya koenigii*						1							1	0.31
47.	*Nyctanthes arbor-tristis*		1											1	0.31
48.	*Nymphaea* sp.							18	4					22	6.79
49.	*Ocimum sanctum*					1								1	0.31

50.	*Parthenium hysterophorus*	20		30	6	2	35	1	46	28	6	98	38	310	95.68
51.	*Peltophorum roxburghii*	8	6						4					18	5.56
52.	*Pithecellobium dulce*							3						3	0.93
53.	*Pinus roxburghii*						2	10	4	2				18	5.56
54.	Poaceae	291	34	16	17	20	152	193	40	15	9	28	89	904	279
55.	*Polyalthia longifolia*							3						3	0.93
56.	*Pongamia pinnata*					1								1	0.31
57.	*Prosopis juliflora*					3	19	18	2					42	12.96
58.	*Psidium guajava*	1	1	2	1									5	1.54
59.	*Putranjiva roxburghii*						4	29						33	10.19
60.	*Ricinus communis*		9	14	32	41	54	9						159	49.07
61.	*Rorippa dubia*							2						2	0.62
62.	*Roystonia regia*	1												1	0.31
63.	*Rumex dentatus*					1	19	1						21	6.48
64.	*Santalum album*	1												1	0.31
65.	*Spergula fallax*						1							1	0.31
66.	*Tamarindus indica*									1				1	0.31
67.	*Thespesia* sp.												1	1	0.31
68.	*Thuja occidentalis*						3							3	0.93
69.	*Tinospora cordifolia*										24		9	33	10.19
70.	*Typha angustata*							207	83	1	1	3	8	303	93.52
71.	*Vernonia cinerea*						2							2	0.62
72.	*Xanthium strumarium*	19						4	11	2			2	38	11.73
73.	*Ziziphus jujuba*			1										1	0.31
	Unidentified	48	21	10	12	30	106	90	41	19	10	6	28	421	129.63
	Total (per 3.24 cm^2)	475	90	91	133	623	5392	1888	367	93	97	243	214	9706	2995.68
	Total (Per cm^2)	146.60	27.78	28.09	41.05	192.28	1664.2	582.72	113.27	28.70	29.94	75.0	66.05	2995.68	

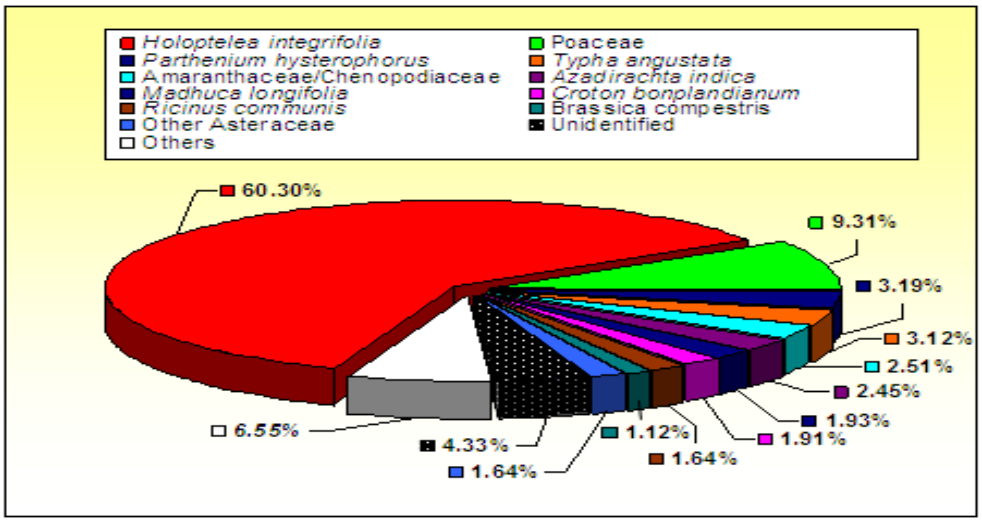
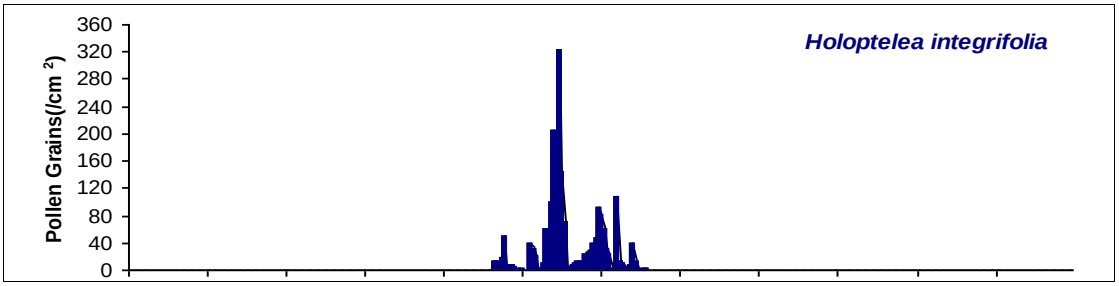


Fig 1: Pollen Spectrum at Govindpur site during 2006-07.



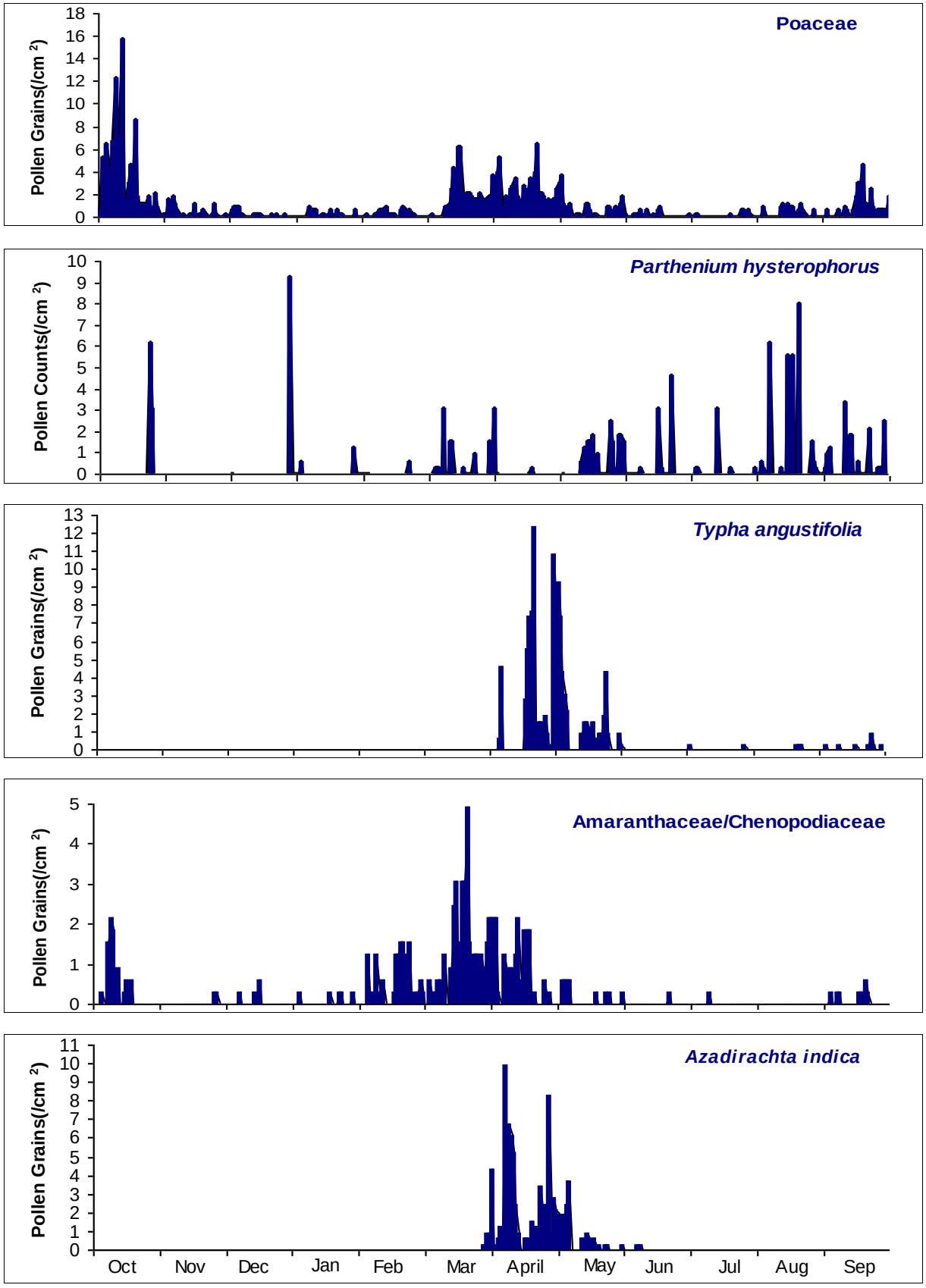


Fig 2: Daily variations in pollen counts of dominant types in the atmosphere of Allahabad during 2005-06.

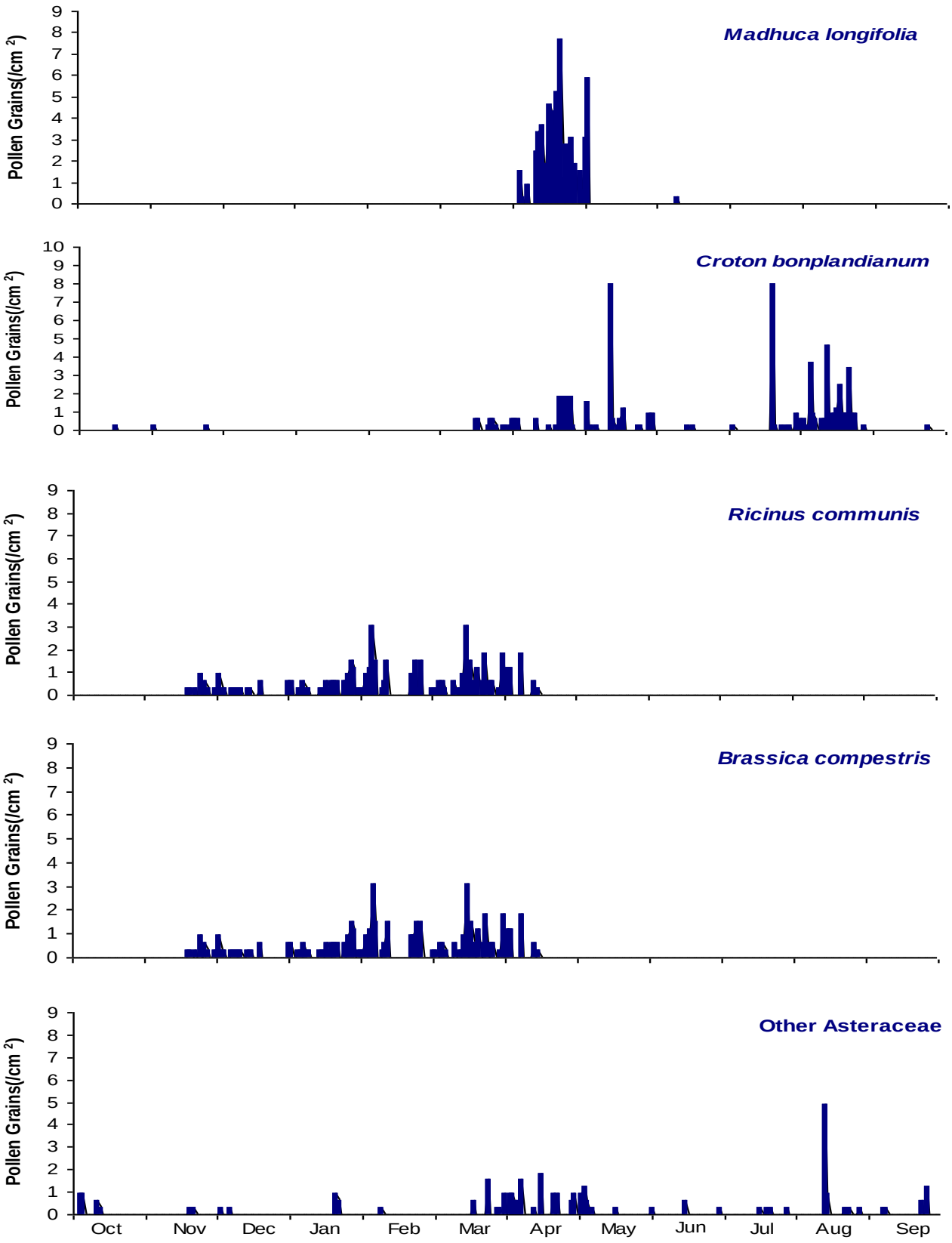


Fig 3: daily variations in pollen counts of dominant types in the atmosphere of Allahabad during 2005-06.

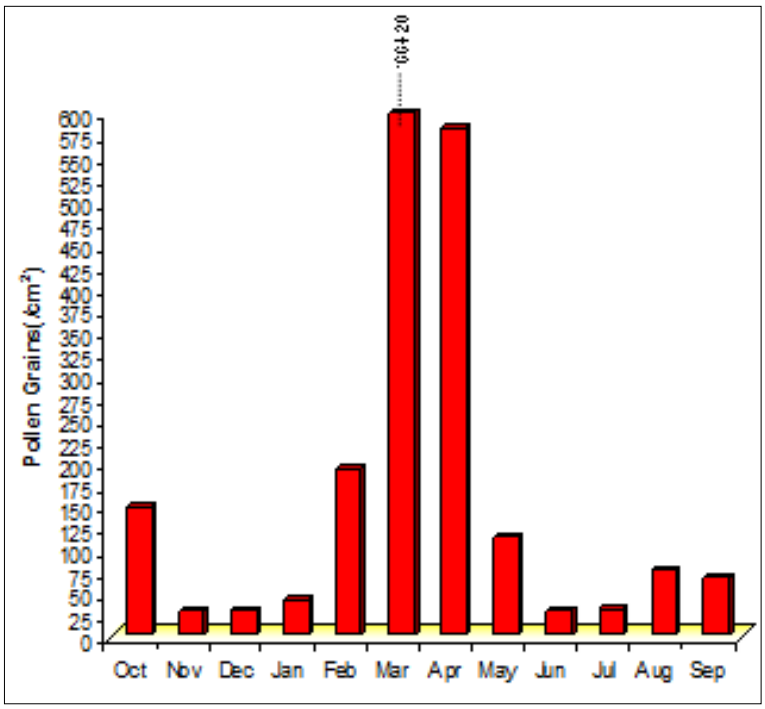


Fig 4: Monthly quantitative variations in pollen counts of Govindpur locality of Allahabad during 2006-07.

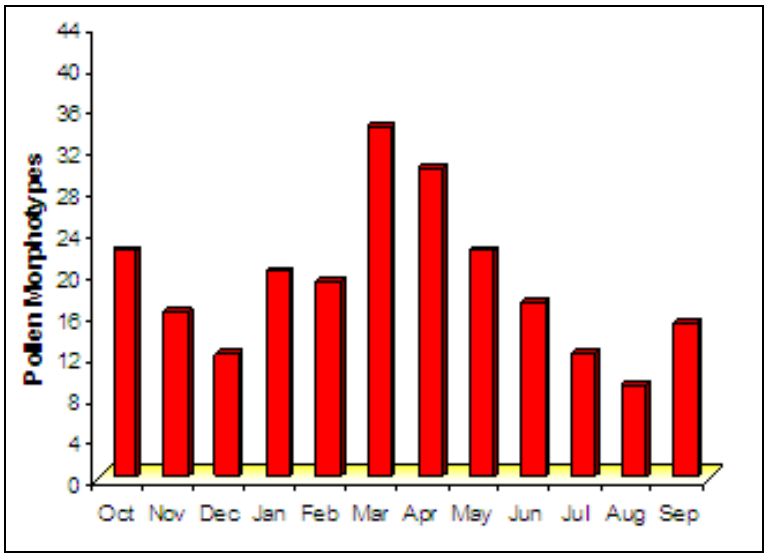


Fig 5: Monthly qualitative variations of pollen types in Govindpur locality of Allahabad during 2006-07.

Based on the monthly concentration of airborne pollen grains two well defined high pollen concentration periods were identified which alternate with two low pollen periods. February to May was the principal pollen period recording 85.21% of the annual catch dominated by the pollen grains of trees. Maximum numbers of pollen types (51 pollen morphotypes) were also recorded during this period. Trees are considered to be the chief source of pollen because of their common incidence, and high pollen production.[15,16] In the present study about 79.31% of the pollen catch of February to April originated from arboreal taxa (25 types) which coincide with their flowering periods. Among them *Holoptelea integrifolia*, *Azadirachta indica* and *Madhuca longifolia* were the dominant types. *Holoptelea integrifolia* alone constituted 70.71% of the pollen catch of February to May with peak in March followed by *Azadirachta indica* and *Madhuca longifolia* with peak in April. *Ailanthus excelsa*, *Callistemon citrinus*, *Prosopis juliflora*, *Putranjiva roxburghii* and *Toona ciliata* were the other tree taxa recording pollen in good numbers during this period. Pollen grains of Poaceae were also represented in dominant numbers in air during this period contributing 4.90% to the total pollen catch of February to May recording the minor peak in April. While other herbs (20 types) contributed 11.16% to the pollen catch of February to May. Among them *Typha angustifolia* and Amaranthaceae/Chenopodiaceae were found in dominating numbers recording their peak in April and March respectively. Among other herbs pollen grains of *Brassica campestris*,

Cannabis sativa, Celosia cristata, Croton bonplandianum, Nymphaea sp., *Parthenium hysterophorus, Rumex dentatus* and those belonging to other Asteraceae and Umbelliferae recorded their presence in good numbers during February to May. Only 1.40% of the pollen catch during this period was contributed by shrubs (five types). Among them pollen grains of *Ricinus communis* were present in dominating numbers during this period with peak occurrence in March while rest of the four types showed sporadic occurrence.

After May there is a fall in the pollen counts in the air which can be correlated with the end of pollination period of several arboreal plants which produced and released high amounts of pollen grains into the atmosphere. Similar observations were also made by Bicakci and Akyalcin (2000) [17].

The second high pollen frequency period was August to October with 9.60% of the total annual pollen catch (Fig. 4). The chief pollen contributor during this period was Poaceae which alone constituted 43.78% of the pollen catch of August to October recording the major peak in October. Herbaceous taxa (belonging to 11 types) constituted 38.20% of the pollen catch of August to October. Abundant types during this period were pollen grains of Amaranthaceae/Chenopodiaceae, other Asteraceae, *Croton bonplandianum*, Cyperaceae, *Parthenium hysterophorus* and *Xanthium strumarium*. Among five shrubs which formed 5.04% component of August to October *Artemisia* sp., *Hibiscus rosa-sinensis* and *Tinospora cordifolia* recorded their presence in significant numbers. Although in stray numbers pollen grains of some arboreal taxa (10 types) were also recovered during this period contributing 2.15% of the pollen catch of August to October.

The two low pollen frequency periods of June to July and November to January registered 1.96% and 3.24% of the annual pollen catch respectively. During June to July pollen grains of *Croton bonplandianum, Parthenium hysterophorus* and Poaceae were well represented while during November to January pollen grains of *Brassica campestris, Parthenium hysterophorus*, Poaceae and *Ricinus communis* were found in good numbers.

The annual pollen count on the basis of habit of plants showed tree pollen to be the most dominant type in the pollen spectrum (68.48%) followed by other herbs (15.30%), grasses (9.31%) and shrubs (2.57%). Dominance of arboreal taxa in the atmosphere has also been reported in previous surveys conducted at Allahabad [7, 10] and at other places [18, 19, 20, 21, 22, 23, 16, 3].

With regard to mode of pollination pollen grains belonging to anemophilous plants (78.57%) were found to dominate the atmosphere followed by those of entomophilous (10.35%) and amphiphilous (6.74%) types. Similar observations have also been made by other workers [24, 25, 18, 20, 26].

Conclusion

The present study carried out in the Govindpur locality showed *Holoptelea* and Poaceae as the two dominant types contributing 69.61% to the total annual pollen catch. It may be mentioned here that Govindpur locality recorded higher concentration of pollen grains belonging to weeds as compared to the other localities investigated in previous surveys of Allahabad. Pollen calendar shows concentration of eleven types and their period of occurrence during different months of the year which can serve as a ready guide in the selection of pollen allergens in allergy testing.

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