J. Indian bot. Soc Vol. 86 (3 & 4) 2007 : 172-177

AEROPALYNOLOGICAL SURVEY OF BANDA, UTTAR PRADESH

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The paper deals with aeropalynological data collected during January to December, 2001 by using modified Durham's air sampler. The air samples of three distant sites and at 15 feet and 45 feet heights altogether revealed a total of 78 pollen types. Of these, 31 pollen types are well known allergens responsible for nasobronchial allergy in human beings. The identified pollens belong to 38 angiospermic families (33 dicots and 5 monocots). The pollen incidence at 15 feet and 45 feet height revealed a ratio of 4 : 1. The Sorensen's Index of Similarity shows highest similarity between pollen flora of Site I and Site II. The pollen diversity was maximum (49 types) during winter and minimum (31 types) during monsoon. December showed highest pollen count (1013) whereas July the least (179).

Key words : Airborne, pollen grains, allergy

Aeropalynology is an interdisciplinary branch of aerobiology which deals with the release of poilen grains and microspores from the plant, mode of dispersal through air, impaction, sedimentation and their role in pollination and in the causation of nasobronchial and dermal allergy in human beings. The concentration and composition of the aerial pollen flora varies from region to region depending upon the density and diversity of the vegetation, geographic location and climatic conditions. A number of scientists surveyed airborne pollen flora from different parts of the world including India in relations to diagnosis and treatment of pollinosis, asthma and airborne contact dermatitis (Lewis, 1984; Mittal *et al.*, 1978; Agnihotri and Singh, 1971; Singh and Singh, 1994). The aeropalynological surveys in Uttar Pradesh were mainly confined in the metrocities viz. Allahabad (Nautiyal amd Midha, 1984; Sahney *et al.*, 1995), Agra (Singh and Chauhan, 1999), Kanpur (Shukla and Mishra, 1978; Gupta *et al.*, 1984), Lucknow (Chaturvedi *et al.*, 1988; Khandelwal and Vishnu Mittre, 1975; Khandelwal, 2002), Meerut (Gaur, 1978; Singh *et al.*, 1996) and Varanasi (Jha *et al.*, 1975). The present study is an attempt to explore aerial pollen diversity of Banda city which is a small district place of the Bundelkhand region located between 24°-59' North and 80° – 07' East.

MATERIALS AND METHODS

Aeropalynological survey was conducted during January to December, 2001 at three different sites, viz., Site I – Indra Nagar, Site II – Navab Tank, Site III– Bambeshvar Baba of Banda city. In each site, the Durham's air samplers were placed at two heights, viz., 4.57m (15 feet) and 13.72m (45 feet). The sites of air sampling were situated at one kilometer away from each other. The vaseline coated slides were exposed at 45° at 10.30 h continuously for a period of three days. After every 72 h, the slides were replaced by fresh ones. After mounting with glycerin jelly, an area of 18 x 18 mm of each slide was scanned under 450x magnification. The trapped pollen grains were identified with the help of literature (Erdtman, 1952; Nair, 1970) and by comparing with standard pollen slides which were prepared according to the method prescribed by Erdtman (1957). The morphologically similar pollen grains were distinguished on the basis of flowering period and availability of the plants in the region.

RESULTS AND DISCUSSION

A total of 720 air samples (60 samples per month) from three different sites were collected and analyzed during the period from January to December, 2001. A total of 78 types of pollen grains

Table-1: Aggregate count of pollens trapped on gravity slides exposed at three different sites and two heights in Banda city

S.No.	Plant / pollen type and family	Plant's habit & mode of pollination	Pollen count												% out of grand total*
			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	
1	*Abutilon indicum*, Malvaceae	S, A	10	–	–	–	–	–	–	–	–	–	22	32	64	1.1
2	*Acacia nilotica**, Mimosaceae	T, Am	–	–	–	–	–	–	32	38	54	45	–	–	169	2.8
3	*Achyranthes aspera**, Amaranthaceae	H, Am	3	25	–	–	–	–	–	–	–	–	23	30	81	1.4
4	*Ageratum conyzoides**, Asteraceae	H, E	4	6	4	–	–	–	–	–	–	4	2	3	23	0.4
5	*Ailanthus excelsa**, Simaroubaceae	H, Am	–	25	31	–	–	–	–	–	–	–	–	–	56	0.9
6	*Alternanthera pungens**, Poaceae	H, Am	5	–	–	–	–	–	–	7	–	27	26	31	96	1.6
7	*Amaranthus**/*Chenopodium**, Amaranthaceae/ Chenopodiaceae	H, Am	55	–	–	–	–	–	–	–	4	15	48	47	169	2.8
8	*Anagallis arvensis*, Primulaceae	H, E	2	2	–	–	–	–	–	–	–	–	2	3	9	0.2
9	*Argemone maxicana**, Papaveraceae	S, A	–	–	11	28	37	26	–	–	–	–	–	–	102	1.7
10	*Asparagus racemosus**, Liliaceae	S, A	–	–	–	–	–	–	–	–	–	4	6	3	13	0.2
11	*Azadirachta indica**, Meliaceae	T, Am	–	–	–	23	34	–	–	–	–	–	–	–	57	1.0
12	*Barleria cristata*, Acanthaceae	H, E	3	5	–	–	–	–	–	–	–	–	6	4	18	0.3
13	*Bauhinia variegata**, Caesalpiniaceae	T, Am	5	–	–	–	–	–	–	–	–	–	36	35	76	1.3
14	*Boerhavia diffusa**, Nyctaginaceae	H, Am	28	7	17	15	20	26	11	27	20	23	32	36	262	4.4
15	*Brassica campestris**, Brassicaceae	H, Am	–	–	20	15	–	–	–	–	–	–	–	–	35	0.6
16	*Butea monosperma*, Papilionaceae	T, E	–	–	38	52	–	–	–	–	–	–	–	–	90	1.5
17	*Callistemon lanceolatus**, Myrtaceae	T, E	–	–	–	–	–	–	–	–	–	–	14	23	37	0.6
18	*Carica papaya**, Caricaceae	S, E	2	2	2	3	3	3	3	2	3	4	3	4	34	0.6
19	*Cassia sophera*, Caesalpiniaceae	S, Am	24	11	35	31	58	28	15	26	–	–	–	24	252	4.2
20	*Cassia fistula**, Caesalpiniaceae	T, A	–	–	–	–	16	29	2	–	–	–	27	22	96	1.6
21	*Chrozophora prostrata*, Euphorbiaceae	H, Am	–	–	–	–	10	11	8	–	–	–	–	–	29	0.5
22	*Clerodendrum inerme*, Verbenaceae	S, E	7	–	–	–	–	–	–	–	12	35	34	47	135	2.3
23	*Cleome viscosa**, Cleomaceae	H, Am	–	–	–	–	–	–	–	4	5	6	–	–	15	0.3
24	*Commelina benghalensis*, Commelinaceae	H, Am	–	–	–	–	–	–	–	13	16	25	–	–	54	0.9
25	*Convolvulus arvensis*, Convolvulaceae	H, Am	21	8	25	20	26	–	–	–	–	–	22	24	146	2.5
26	*Convolvulus tricolor*, Convolvulaceae	H, Am	–	–	2	16	18	–	–	–	–	–	–	–	36	0.6
27	*Croton oblongifolius*, Euphorbiaceae	H, Am	–	20	39	–	–	–	–	–	–	–	–	–	59	1.0
28	*Cyperus triceps**, Cyperaceae	H, A	–	–	–	–	–	–	–	–	–	21	29	30	80	1.3
29	*Dalbergia sissoo**, Papilionaceae	T, E	–	–	–	45	18	22	–	–	–	–	–	–	85	1.4
30	*Delphinium ajacis*, Ranunculaceae	H, E	–	4	16	–	–	–	–	–	–	–	–	–	20	0.3
31	*Delonix regia**, Caesalpiniaceae	T, E	–	–	–	47	38	31	–	–	–	–	–	–	116	2.0
32	*Datura metel**, Solanaceae	H, E	20	–	–	–	–	–	–	12	8	–	17	29	86	1.5
33	*Eclipta prostrata*, Asteraceae	H, Am	–	31	–	–	–	–	3	13	–	–	–	–	47	0.8
34	*Erigeron conadensis*, Asteraceae	H, Am	–	–	–	–	–	32	4	–	–	–	–	–	36	0.6
35	*Eucalyptus globulus**, Myrtaceae	T, Am	–	6	6	44	–	–	–	–	–	5	18	34	113	1.9
36	*Euphorbia microphylla*, Euphorbiaceae	H, Am	21	15	27	18	25	13	10	17	26	21	35	27	255	4.3
37	*Evolvulus alsinoides*, Convolvulaceae	H, Am	–	–	–	–	–	–	0	7	17	23	33	26	106	1.8
38	*Fumaria indica*, Fumariaceae	S, Am	8	11	20	–	–	–	–	–	–	–	8	14	61	1.0
39	*Gomphrena celosioides*, Amaranthaceae	H, A	–	–	–	–	–	27	13	12	18	–	–	–	70	1.2
40	*Gossypium hirsutum*, Malvaceae	S, E	–	–	–	–	–	–	–	–	–	27	35	26	88	1.5
41	*Hyptis suaveolens*, Labiatae	H, Am	34	–	–	–	–	–	–	–	–	–	21	27	82	1.4
42	*Iberis amara*, Brassicaceae	H, Am	–	–	7	19	19	–	–	–	–	–	–	–	45	0.8
43	*Indigofera linifolia*, Papilionaceae	H, Am	–	–	–	–	–	–	–	2	18	25	18	22	85	1.4
44	*Ipomoea reptans*, Convolvulaceae	H, E	32	–	–	–	–	–	–	–	–	–	16	27	75	1.3
45	*Ipomoea fistulosa*, Convolvulaceae	S, E	34	–	–	–	–	–	–	–	–	–	23	19	76	1.3
46	*Justicia betonica*, Acanthaceae	S, E	–	–	5	31	30	–	–	–	–	–	–	–	66	1.1
47	*Launaea aspleniifolia*, Asteraceae	H, Am	–	–	23	27	–	–	–	–	–	–	–	–	50	0.8
48	*Ludwigia perennis*, Onagraceae	H, Am	–	–	–	–	–	11	13	10	–	–	–	–	34	0.6
49	*Mimosa pudica*, Mimosaceae	H, Am	–	–	–	–	–	–	–	–	6	20	–	–	26	0.4
50	*Nyctanthus arbor-tristis*, Nyctanthaceae	T, E	–	–	–	–	–	–	–	–	16	25	–	–	41	0.7
51	*Ocimum canum*, Labiatae	H, Am	–	–	–	–	–	–	–	2	23	31	31	33	120	2.0
52	*Oxalis corniculata*, Oxalidaceae	H, Am	11	18	42	–	–	–	–	–	–	–	9	25	105	1.8
53	*Parthenium hysterophorus**, Asteraceae	H, Am	–	15	–	–	–	–	6	17	16	24	18	18	114	1.9
54	*Peristrophe bicalyculata*, Acanthaceae	H, E	21	–	–	–	–	–	–	–	–	–	9	18	48	0.8
55	*Polygonum glabrum**, Polygonaceae	H, Am	8	10	15	–	–	–	–	–	–	14	19	33	99	1.7
56	*Pongamia pinnata**, Papilionaceae	T, Am	–	–	–	–	18	–	–	–	–	–	–	–	18	0.3
57	*Psidium guajava*, Myrtaceae	T, Am	–	–	–	–	–	–	–	–	–	24	–	–	24	0.4
58	*Putranjiva roxburghii*, Euphorbiaceae	T, A	–	–	–	40	31	–	–	–	–	–	–	–	71	1.2
59	*Ricinus communis**, Euphorbiaceae	T,Am	–	19	17	–	–	–	–	–	–	–	–	–	36	0.6
60	*Rungia pectinata*, Acanthaceae	H, Am	–	–	–	–	–	–	–	–	–	8	30	38	76	1.3
61	*Scoparia dulcis*, Scrophulariaceae	H, Am	–	–	–	–	–	–	–	–	–	6	30	35	71	1.2

Table-1 (Contd....)

S.No.	Plant / pollen type and family	Plant's habit & mode of pollination	Pollen count												% out of grand total*
			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	
62	*Sida spinosa*, Malvaceae	H, Am	–	–	–	–	–	–	–	–	–	34	38	32	104	1.8
63	*Sida rhombifolia*, Malvaceae	H, Am	–	–	–	–	–	–	–	–	10	25	21	30	86	1.4
64	*Sesamum indicum*, Pedaliaceace	H, Am	–	–	–	–	–	–	–	4	9	17	–	–	30	0.5
65	*Sonchus oleraceus*, Asteraceae	H, Am	–	–	5	18	32	–	–	–	–	–	–	–	55	0.9
66	*Syzygium cumini**, Myrtaceae	T, Am	–	–	–	–	27	14	–	–	–	–	–	–	41	0.7
67	*Tectona grandis*, Verbinaceae	T, Am	–	–	–	–	–	–	–	18	26	–	–	–	44	0.7
68	*Tephrosia purpurea*, Papilionaceae	H, Am	–	–	–	–	–	–	–	–	–	22	22	–	44	0.7
69	*Thevetia peruviana*, Apocynaceae	S, E	4	2	6	6	7	5	4	6	4	4	7	8	63	1.1
70	*Tridax procumbens**, Asteraceae	H, E	3	2	4	9	9	5	6	5	5	6	6	7	67	1.1
71	*Triticum aestivum**, Poaceae	H, A	10	10	15	–	–	–	–	–	–	–	–	14	49	0.8
72	*Triumfetta rhomboidea*, Tiliaceae	H, Am	23	–	–	–	–	–	–	–	–	–	7	14	44	0.7
73	*Typha angustata*, Typhaceae	S, A	5	–	–	–	–	–	–	–	–	–	6	7	18	0.3
74	*Vernonia cinerea**, Asteraceae	H, Am	31	30	34	35	33	24	39	35	35	38	34	31	399	6.7
75	*Zinnia elegens*, Asteraceae	H, E	–	–	–	–	–	–	–	–	3	2	7	–	12	0.2
76	*Zea mays**, Poaceae	S, A	–	–	–	–	–	–	–	–	6	18	18	20	62	1.0
77	*Zizyphus mauritiana*, Rhamnaceae	T, E	–	–	–	–	–	50	9	–	–	–	–	–	59	1.0
78	Unidentified		17	3	2	2	2	2	1	–	4	–	3	1	37	0.6
	Total		**451**	**287**	**468**	**544**	**511**	**359**	**179**	**277**	**364**	**628**	**871**	**1013**	***5952**	**100**

*Pollens having allergenic potential as reported by Shivpuri and Dua (1963), Shivpuri and Singh (1971) and Prasad and Pramila (1998).
A = Anemophilous, E = Entomophilous, Am = Amphiphilous

Table-2: Monthly count of aerial pollens of different plant groups

Plant's group	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	%out of total*
Herb	335	233	337	220	229	175	113	187	239	437	611	694	3800	63.8
Shrub	94	26	68	71	98	86	31	34	25	92	162	204	991	16.6
Tree	5	25	61	251	182	96	34	56	96	99	95	114	1114	18.7
Unidentified	17	3	2	2	2	2	1	-	4	-	3	1	37	0.6
Total	**451**	**287**	**468**	**544**	**511**	**359**	**179**	**277**	**364**	**628**	**871**	**1013**	***5952**	**99.7**

were identified, of which 31 pollen types are well known human allergens (Table 1). It was found that highest number of pollens (3800) was contributed by 49 herbaceous species followed by 17 tree species (1114) and 12 shrub species (991) (Table 2). Thus, pollen contribution of woody plants (shrubs and trees) and herbaceous species was 35.3% and 63.8% respectively. These results are slightly different from those reported by Singh *et al.* (1999) from Agra (57 % woody and 43 % herbaceous). The identified pollen grains belonged to 38 angiospermic families, of which 33 families belong to dicotyledons and 5 to monocotyledons (Table 3). Amongst 78 pollen types, 73 types belonged to dicotyledons and 5 types to monocotyledons. The dicot plants contributed maximum number of pollen grains (5543 & 93.1%) as compared to monocots (372 & 6.3%). An annual count of 37 pollen grains remained unidentified. The yearly pollen contribution of different families ranged from 9 pollen grains of Primulaceae (0.2 %) to 803 pollen grains of Asteraceae (13.5.%). Primulaceae comprised 1 pollen type and Asteraceae the 9 types, of which *Parthenium hysterophorous* made highest pollen contribution (1.9%) (Table 3).

The annual count of pollens flora of the different sites varied considerably. Maximum number of pollen grains (2625) was sampled from Site II (Nawab tank) which is outskirt of the Banda city surrounded by luxuriant vegetation and agricultural crops. Site I comprised 1494 pollens and Site III 1833 pollens depending upon the density of the surrounding vegetation (Table 4). The pollen flora also varied according to the height of air sampling. The annual pollen incidence at 15 feet and 45 feet height was 4765 and 1187 pollen grains respectively

Table-3: Annual count of atmospheric pollens belonging to different plant families

Sr. No.	Family	Pollen Count	Pollen Percentage
A	**DICOTS**		
1	Asteraceae	803	13.5
2	Caesalpiniaceae	540	9.1
3	Euphorbiaceae	450	7.6
4	Convolvulaceae	439	7.4
5	Malvaceae	342	5.7
6	Papilionaceae	322	5.4
7	Amaranthaceae/ Chenopodiaceae	320	5.4
8	Nyctaginaceae	262	4.4
9	Myrtaceae	215	3.6
10	Acanthaceae	208	3.5
11	Labiatae	202	3.4
12	Mimosaceae	195	3.3
13	Verbenaceae	179	3.0
14	Oxalidaceae	105	1.8
15	Papaveraceae	102	1.7
16	Polygonaceae	99	1.7
17	Solonaceae	86	1.4
18	Brassicaceae	80	1.3
19	Scrophulariaceae	71	1.2
20	Apocyanaceae	63	1.1
21	Fumariaceae	61	1.0
22	Rhamnaceae	59	1.0
23	Meliaceae	57	0.9
24	Simaroubaceae	56	0.9
25	Tiliaceae	44	0.7
26	Nyctanthaceae	41	0.7
27	Caricaceae	34	0.6
28	Onagraceae	34	0.6
29	Pedaliaceae	30	0.5
30	Ranunculaceae	20	0.3
31	Cleomaceae	15	0.3
32	Primulaceae	9	0.2
	Total (A)	**5543**	**93.1**
B	**MONOCOTS**		
33	Poaceae	207	3.5
34	Cyperaceae	80	1.3
35	Commelinaceae	18	3.5
36	Typhaceae	13	1.3
37	Liliaceae		0.9
	Total (B)	**372**	**6.3**
C	**UNIDENTIFIED**	37	0.2

which revealed a ratio of 4 : 1. This is statistically significant different at a = 0.05, based on the principle that airspora concentration decreases with increasing height. The Sorensen's (1948) index of similarity and dissimilarity calculated for the

Table-4: Site and height wise monthly pollen count of three different sites in Banda

Month	Height	Site I	Site II	Site III	Total
January	I	20	36	18	74
	II	106	141	130	377
February	I	20	40	10	70
	II	64	82	71	217
March	I	37	42	14	93
	II	111	162	102	375
April	I	41	76	54	171
	II	97	151	125	373
May	I	39	76	50	165
	II	81	136	129	346
June	I	28	39	36	103
	II	62	105	89	256
July	I	14	13	18	45
	II	39	53	42	134
August	I	21	35	16	71
	II	42	95	68	205
September	I	8	40	23	72
	II	49	129	115	293
October	I	21	56	17	94
	II	94	231	209	534
November	I	34	61	10	105
	II	196	348	222	766
December	I	29	80	15	124
	II	241	398	250	889
Total	I	312	594	281	1187
	II	1182	2031	1552	4765
Grand Total		**1494**	**2625**	**1833**	**5952**

I = 45 feet (13.72m) height; II = 15 feet (4.57 m) height

assessment of diversity in the composition of pollen flora of different sites revealed highest degree of similarity, i.e., 97.2 % between the samples of Site I (Indra Nagar) and Site II (Navab tank) and minimum i.e. 65.1 % between the Site I (Indra Nagar) and Site III : Bambeshvar Baba (Table 5).

The composition of pollen flora in different seasons varied considerably. Data revealed two periods of pollen maxima viz., October to November and March to April and one period i.e. July to August as pollen minima. Singh *et al.* (1996) from Meerut reported February to April as pollen maxima period whereas Singh and Chauhan (1999) from Agra reported October to November and February to April

Table-5: Index of similarity and dissimilarity in the composition of airborne pollen flora of different sites

Between sites	Pollen types			% of similarity index S=2C/(A+B) x 100	Dissimilarity index (%) D = 100-S (%)
	Site (A)	Site (B)	Site (C)		
Site I (A) & II (B)	72	76	72	97.2	2.8
Site I (A) & III (B)	72	63	44	65.1	3.5
Site II (A) & III (B)	76	63	58	72.6	2.7

Table-6: Index of similarity and dissimilarity in the composition of airborne pollen flora of different seasons.

Between sites	Pollen types			% of similarity index S=2C/(A+B) x 100	Dissimilarity index (%) D = 100-S(%)
	Site (A)	Site (B)	Site (C)		
Winter (A) & Summer (B)	50	34	21	50.0	50.0
Winter (A) & Monsoon (B)	50	35	18	42.4	57.6
Winter (A) & Post monsoon (B)	50	44	33	70.2	29.8
Summer (A) & Monsoon (B)	34	35	13	37.7	62.3
Summer (A) & Post monsoon (B)	34	44	9	23.1	77.0
Monsoon (A) & Post monsoon (B)	35	44	23	58.2	41.8

as pollen maxima period. Later report is almost similar to the present findings. There is a little shifting of pollen maxima and minima periods depending upon flowering periods of the local vegetation.

An analysis of seasonal variation in the incidence of pollen types indicates that 19 types of pollens occurred in any one of the five seasons, 38 types in any two seasons and 14 types in any three seasons. The 6 pollen types viz. *Boerhavia diffusa, Carica papaya, Euphorbia microphylla, Thevetia peruviana, Tridax procumbens* and *Vernonia cinerea* occurred in all the five seasons. The similarity and dissimilarity index of composition of the atmospheric pollen flora in different seasons shows highest similarity (70.2%) between winter and post-monsoon and the lowest (23.1%) between summer and post-monsoon (Table 6). This is because of the reason that the onset of flowering of the local vegetation occurred in the post-monsoon and the blooming continued up to the winter. On the contrary, flowering flora of summer was quite different from that of post-monsoon except of a few species which flower in both the seasons.

Authors are thankful to Dr. G.P. Agarwal, Emeritus Professor, Department of Biological Sciences, Rani Durgavati University, Jabalpur for his valuable suggestions and inspirations, to the Head, Department of Biological Sciences, R.D. University, Jabalpur (M.P.) and to the Principal, P.G. College, Atarra (U.P.) for providing laboratory facilities.

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