

Aeropalynological Survey of Meerut: Airborne Pollen Diversity and Seasonal Distribution

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Abstract: *Aerobiological studies provide valuable information on the diversity, composition, and seasonal distribution of airborne biological particles, particularly pollen grains and fungal spores. The present study investigated the occurrence and diversity of airborne pollen and associated biological particles in the atmosphere of Meerut, Uttar Pradesh, India, during two consecutive years, 2000 and 2001. Atmospheric samples were collected using an aeroscope installed on the terrace of a house at a height of 6 m above ground level. Microscope slides coated with safranin-stained glycerin jelly were exposed to the atmosphere and replaced at 24-hour intervals. Reference pollen slides prepared from locally growing plants were used to assist pollen identification. The study recorded 39 pollen types, comprising 37 angiosperm types and two gymnosperm types. Members of the families Asteraceae and Poaceae were the dominant pollen contributors during both years. In 2001, Asteraceae accounted for 35.48% of the recorded pollen, followed by Poaceae at 23.74%. The monthly distribution showed marked seasonal variation, with the highest monthly pollen count recorded in October (13.40%) and the lowest in December (2.05%) during 2001. Differences in the occurrence and abundance of pollen types were also observed across the study period. Other biological materials, including fungal spores, fungal hyphae, trichomes, algal filaments, and insect fragments, were also reported in the atmospheric samples. These historical observations provide a record of airborne pollen diversity and seasonal occurrence in Meerut during 2000–2001 and may serve as baseline information for comparison with future aerobiological investigations.*

Keywords: Aerobiology, Aeropalynology, Airborne pollen, Pollen diversity, Seasonal distribution, Air-spora, Meerut, Historical data

I. INTRODUCTION

It is well established that the air surrounding us contains an invisible biomass of particulate matter derived from plant and animal sources. The study of these airborne biological materials falls within the scope of aerobiology. Such materials include pollen grains, fungal spores, fungal hyphae, algal filaments, epidermal peels, xylem and phloem elements, insects, insect fragments, eggs, and other biological particles. Among these components, fungal spores and pollen grains are important components of airborne biological material (Gregory, 1961; Singh & Mathur, 2012). Gregory (1952) used the term aerospora in reference to pollen grains and fungal spores suspended in the air.

Palynology is the branch of science concerned with the study of pollen grains and spores and their applications. Hyde and Williams (1943) helped establish the terminology and scope of pollen research through their early work on atmospheric pollen. The term is derived from the Greek word palynō, meaning to scatter, referring to the dispersal of pollen grains and spores, which are often transported by wind. In its simplest definition, palynology is the study of pollen grains and spores, which represent the reproductive units of plants.

Aeropalynological studies are based on several principles, particularly in relation to pollen allergy and its implications for human health (Singh & Kumar, 2003; Singh & Mathur, 2012). These principles include the following:

1. **Pollen dispersal:** Pollen grains are dispersed through different agents, including air currents (anemophily), water (hydrophily), and insects (entomophily).

2. **Pollen productivity:** Pollen production varies among anemophilous, entomophilous, and hydrophilous plants. In general, anemophilous plants produce and release larger quantities of pollen into the atmosphere than plants pollinated by insects or water.
3. **Resistance of the pollen wall:** The outer wall of a pollen grain, known as the exine, contains sporopollenin, a highly resistant organic material that protects the pollen grain from degradation and contributes to its long-term preservation.
4. **Pollen identification:** The exine exhibits distinctive morphological characteristics that are useful in identifying and distinguishing pollen grains and, where possible, determining their parent plant taxa.

The application of palynology is largely facilitated by the distinctive morphological features of the pollen exine. These features are valuable in taxonomic and phylogenetic investigations, as well as in the analysis of pollen grains in a dispersed state. Accordingly, the study of the external morphological characteristics of mature pollen grains forms an important aspect of palynology.

Palynological research can be broadly divided into basic and applied branches. Basic palynology deals with pollen morphology, the physical and chemical properties of the sporoderm, and the relationships between palynology, cytology, and taxonomy. Applied palynology includes several specialized fields, such as geopalynology, which deals with fossil pollen and spores; iatropalynology, which concerns the medical aspects of pollen and spores; melissopalynology, which involves the study of pollen in honey; and aeropalynology, which focuses on pollen grains present in atmospheric air.

The applied study of aerospores is also important in understanding allergic disorders in humans, which may be caused by airborne moulds, pollen grains, and other biological particles. Furthermore, aeropalynological investigations help identify and document the plants growing in a particular geographical area. Owing to its applications in medicine and environmental research, aeropalynology is important for documenting regional pollen composition and seasonal patterns (Singh & Kumar, 2003; Singh & Mathur, 2012).

The main objective of the present study was to investigate the composition, diversity, and occurrence of airborne biological particles (aerospora) in the atmosphere of Meerut, Uttar Pradesh, India, during 2000 and 2001.

II. MATERIALS AND METHODS

For the aerospora study, microscopic slides measuring 75 mm × 25 mm were prepared by applying a thin layer of molten, safranin-stained glycerin jelly. The coated area measured approximately 24 mm × 60 mm, corresponding to the size of the coverslip. The prepared slides were exposed to the atmosphere and replaced at regular intervals of 24 hours. This procedure was carried out over two consecutive years, 2000 and 2001.

An aeroscope was installed on the terrace of a house in Meerut district at a height of 6 metres above ground level. The instrument was used to trap airborne pollen grains, fungal spores, and other associated biological materials.

For the identification of pollen grains, reference slides were prepared from pollen collected from plants growing in the surrounding area. These reference slides were prepared without acetolysis (unacetolysed) and were used for comparison with the pollen grains collected from the atmosphere.

Incidence of Pollens Meerut

Table 1: Incidence of Pollens Meerut During 2000

SN o.	TAXA	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%	Month of Occurrence	Peak Month
1.	Amaranthus sp. (Amaranthaceae)	26	28	44	72	13	-	3	7	11	14	56	10	102	0.83	1-5, 8-12	4

2.	Apocynaceae	-	-	7	10	5	5	7	11	14	3	10	-	42	0.34	3-6, 8-10	10
3.	Arecaceae	-	-	7	10	4	3	-	2	3	10	-	-	42	0.34	3-6, 8-10	4, 10
4.	Asteraceae	21	36	456	319	387	518	623	569	456	565	375	92	4417	36.02	1-12	7
5.	Azadirachta indica (Meliaceae)	-	-	-	28	17	11	-	-	-	-	-	-	56	0.46	4-6	4
6.	Betulaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.	Brassicaceae	16	21	16	7	3	-	-	6	16	53	46	23	207	1.69	1-5, 8-12	10
8.	Caesalpiniaceae	-	20	16	3	7	-	-	21	4	8	12	28	119	0.97	2-5, 8-12	12
9.	Cannabis sativa (Cannabinaceae)	28	17	40	89	78	12	52	21	10	26	15	40	428	3.49	1-12	4
10.	Chenopodium sp. (Chenopodiaceae)	9	17	28	60	16	15	7	-	-	26	12	9	199	1.62	1-7, 10-12	4
11.	Convolvulaceae	-	3	4	-	-	8	11	31	8	15	6	-	86	0.70	2-3, 6-11	8
12.	Coriandrum sativum (Apiaceae)	5	7	-	-	-	-	-	1	7	28	11	20	79	0.64	1-2, 8-12	10
13.	Caricaceae	-	-	-	-	-	-	-	-	16	30	2	1	49	0.40	8-12	10
14.	Casuarina sp (Casuarinaceae)	7	-	-	-	-	-	-	-	-	20	12	4	43	0.35	1, 10-12	10
15.	Cuscuta sp (Cuscutaceae)	2	8	14	5	-	-	-	-	-	-	-	3	32	0.26	1-4, 12	3
16.	Cyperaceae	3	7	25	29	3	-	-	3	24	10	20	7	139	1.13	1-5, 7-12	4
17.	Euphorbiaceae	21	12	44	78	37	29	64	49	28	3	5	2	372	3.04	1-12	4
18.	Fabaceae	11	5	21	12	-	-	-	20	8	3	41	3	124	1.01	1-4, 8-12	11
19.	Grevillea robusta (Proteaceae)	-	-	7	12	10	4	-	-	-	-	3	33	33	0.27	3-6	4

20.	Holoptelea integrifolia (Urticaceae)	8	7	41	12	-	-	-	-	3	5	-	-	76	0.6 2	1-4, 9, 10	3
21.	Lamiaceae	-	-	-	-	13	-	-	-	-	-	-	-	13	0.1 1	5	5
22.	Liliaceae	11	12	3	10	-	-	-	10	9	-	-	13	62	0.5 1	1, 4, 7-8	9
23.	Malvaceae	17	10	28	38	15	17	47	11	19	12	3	23 0	230	1.8 8	1-12	7
24.	Mangifera indica (Anacardiaceae)	33	51	16	8	7	-	-	-	-	-	-	11 5	115	0.9 4	2-6	3
25.	Morus alba (Moraceae)	6	3	18	21	16	6	-	-	-	-	1	71	71	0.5 8	1-6, 12	4
26.	Mimosaceae	-	6	10	8	-	-	-	-	-	-	-	24	24	0.2 0	2-4	3
27.	Myrtaceae	15	32	74	96	49	12	10	2	5	62	59	10	426	3.4 7	1-12	4
28.	Nyctaginaceae	3	10	13	36	38	3	-	6	11	7	6	2	135	1.1 0	1-5, 7-12	5
29.	Papaveraceae	-	5	4	10	12	1	7	-	-	3	2	-	44	0.3 6	2-6, 10-11	5
30.	Poaceae	17 3	21 6	42 1	19 6	13 9	13 9	15 4	37 3	28 9	59 7	66 4	41	340 2	27. 74	1-12	11
31.	Polygonaceae	7	8	-	10	3	-	-	-	-	17	31	-	76	0.6 2	1-2, 4-5, 10-11	11
32.	Rosaceae	-	8	21	42	3	-	-	-	14	17	28	7	140	1.1 4	2-5, 8-11	4
33.	Rutaceae	-	2	42	50	2	-	-	-	-	-	-	10 7	107	0.8 7	2-5, 9	4
34.	Solanaceae	-	-	17	24	3	2	11	10	12	-	-	-	79	0.6 4	3-9	4

Table 2: Incidence of Pollens Meerut During 2001

S.No	TAXA	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Total	%	Month of Occurrence	Peak Month
1.	Amaranthus sp. (Amaranthaceae)	1 6	3 4	54	49	15	-	-	-	5	12	9	7	201	1.5 5	1-5	3
2.	Apocynaceae	-	-	-	8	3	5	3	17	15	7	-	-	55	0.4 1	4-6, 8-10	8

3.	Arecaceae	-	-	-	14	1	3	4	6	4	7	-	-	39	0.3 0	4-10	4
4.	Asteraceae	1 6	5 7	46 8	51 8	46 3	51 5	52 8	74 8	38 9	57 3	26 4	39	457 8	35. 48	1-12	8
5.	Azadirachta indica (Meliaceae)	-	-	5	35	33	7	-	-	-	-	-	-	80	0.6 2	3-6	4
6.	Betulaceae	-	-	-	-	-	-	-	-	6	5	11	-	22	0.1 7	8-9, 10	10
7.	Brassicaceae	5	4 2	18	4	1	-	-	-	7	68	35	11	191	1.4 8	1-5, 9- 12	10
8.	Caesalpiniaceae	-	2 7	63	8	5	-	-	14	20	9	73	30	249	1.9 2	2-5, 8- 12	11
9.	Cannabis sativa (Cannabinaceae)	1 2	1 0	98	13 0	11 8	23	48	14	12	31	33	22	551	4.2 7	1-12	4
10.	Chenopodium sp. (Chenopodiaceae)	7	3 0	31	43	3	11	-	2	4	23	36	12	202	1.5 6	1-6, 8- 12	4
11.	Convolvulaceae	1	5	-	7	-	3	5	26	17	11	14	-	89	0.6 8	1, 2, 4, 6-11	8
12.	Coriandrum sativum (Apiaceae)	3	4	-	-	-	-	-	2	11	25	12	13	70	0.5 4	1, 2, 8- 12	10
13.	Caricaceae	-	-	-	-	-	-	-	-	-	3	11	6	20	0.1 5	10-12	11
14.	Casurina sp. (Casurinaceae)	3	1	-	-	-	-	-	-	16	3	8	3	34	.26	1-2	9
15.	Cuscuta sp. (Cuscutaceae)	2	6	4	7	-	-	17	15	17	72	38	47	160	1.2 4	1-6, 9- 12	4
16.	Cyperaceae	3	2 1	18	64	51	17	7	6	6	4	41 8	3. 24	1- 12	11		
17.	Euphorbiaceae	1 2	4 3	52	69	51	17	72	38	47	7	6	21	99	0.7 7	1-4, 8- 12	11
18.	Fabaceae	1 0	7	4	14	25	-	-	14	7	6	21	16	69	0.5 3	3-5	5
19.	Grevillea robusta	-	-	21	23	25	-	-	-	-	-	-	-	69	0.5 3	1-4, 9, 10	3

	(Proteaceae)																
20.	Holoptelea integrifolia (Urticaceae)	12	23	28	67	15	2	-	-	-	7	-	3	157	1.22	1-6, 9, 12	4
21.	Lamiaceae	-	-	-	32	-	42	-	-	-	-	-	-	74	0.57	4, 6	6
22.	Liliaceae	13	26	-	13	-	-	3	6	-	2	-	-	63	0.49	1, 2, 4, 7, 8, 10	8, 10
23.	Malvaceae	13	28	46	64	57	28	37	7	22	25	2	10	339	2.63	1-12	10
24.	Mangifera indica (Anacardiaceae)	-	18	42	22	7	5	-	-	-	-	-	-	94	0.73	2-6	3
25.	Morus alba (Moraceae)	2	12	36	18	2	12	-	-	-	-	3	-	85	0.66	1-6, 11	5
26.	Mimosaceae	1	-	21	15	28	-	-	4	15	-	-	15	99	0.77	1, 3-5, 8, 9, 12	5
27.	Myrtaceae	26	25	91	111	76	25	12	13	7	75	70	12	543	4.21	2-5, 8-12	5
28.	Nyctaginaceae	-	13	18	25	44	-	-	5	13	11	7	11	147	1.14	2-5, 8-12	11
29.	Papaveraceae	-	-	1	-	31	2	26	-	-	-	1	-	61	0.47	3, 5-7, 10	7
30.	Poaceae	260	316	123	103	216	178	138	156	463	738	336	36	3063	23.74	1-12	10
31.	Polygonaceae	5	-	-	15	-	-	-	-	-	5	26	-	51	0.40	1, 4, 10, 11	11
32.	Rosaceae	-	7	31	36	-	14	-	-	12	51	10	6	167	1.29	2-4, 8, 9-10	9
33.	Rutaceae	-	2	42	50	2	-	-	-	-	-	-	107	107	0.87	2-5, 9	4
33.	Rutaceae	-	2	42	50	2	-	-	-	-	-	-	107	107	0.87	2-5, 9	4
34.	Solanaceae	-	26	30	11	8	5	12	32	7	7	-	3	141	1.09	2-10, 12	8

35.	Tribulus sp. (Zygophyllaceae)	2	-	6	-	3	-	-	-	10	-	4	-	25	0.19	1, 3, 5, 9, 11	9
36.	Typhaceae	-	-	2	3	14	-	-	-	-	7	9	4	39	0.31	3-5, 10-12	5
37.	Verbenaceae	-	-	24	8	-	-	7	4	12	14	23	5	97	0.75	3-4, 7-12	3
38.	Gymnosperms Cupressaceae	41	29	13	5	-	-	40	10	7	9	4	-	158	1.22	1-4, 7-11	1
39.	Pinaceae	15	13	22	5	18	4	-	7	-	3	-	-	87	0.67	1-6, 8, 10	3
Unidentified		2	7	8	11	12	9	10	13	6	7	9	5	99	0.77	1-12	8
Total		483	845	1441	1560	1324	883	942	1185	1233	1712	1026	269	12903			
%		3.7	6.4	11.1	12.09	10.26	6.84	7.22	9.08	9.51	13.40	7.88	2.05				
Number of Taxa		24	26	30	32	27	19	13	24	27	28	24	21				

III. RESULT AND DISCUSSION

The aerobiological study of Meerut revealed the presence of various biotic and abiotic components in the atmosphere. The biotic components included pollen grains, fungal spores, trichomes, fungal hyphae, algal filaments, and insects or their parts. Among these components, pollen grains constituted a major component of the airborne biological particles. A total of 39 types (37 were angiosperm types and two were gymnosperm types), of pollen grains were identified, although some pollen grains remained unidentified. The observed diversity of pollen types indicated considerable variation in the composition and abundance of airborne pollen throughout the study period. The presence of other biological materials, including fungal spores, trichomes, fungal hyphae, algal filaments, and insect fragments, further demonstrated the diversity of biological particles present in the atmosphere of Meerut.

A total of thirty-nine types of pollen have been identified as a result of an extensive two-year study of the aerospora of Meerut (from January 2000 to December 2001). Of these, thirty-seven belong to angiospermic families and two belong to gymnospermic families.

In the year 2000, the contribution of pollen grains to the total aerospora was 36.88%. The dominant pollen types belonged to the family Asteraceae, contributing 36.02%. This was followed by Poaceae with 25.34%.

Pollens of some other families found round the year were:

Cannabaceae	3.49%
Myrtaceae	3.47%
Euphorbiaceae	3.04%
Malvaceae	1.88%

Along with these, Amaranthaceae and Brassicaceae were two other families. Although these were not present throughout the year, they nevertheless constituted a major part of the aerospora, with 1.82% and 1.69%, respectively.

Pollen grains of Cyperaceae, Cupressaceae, Verbenaceae, Rosaceae, Fabaceae, Nyctaginaceae, Cyperaceae and Caesalpiniaceae were observed more than eight months, while pollen grains of Caricaceae, Lamiaceae, Proteaceae, Cuscutaceae, Betulaceae were observed only in 3-4 months. During this year minimum pollens were contributed by Typhaceae with 0.11%. This was followed by Mimosaceae (0.20%) and Tribulus pollens (0.21%).

In the year 2000 maximum number of pollens were observed in the month of October (13.38%) followed by March (12.68%), April (11.18%) and in November (11.13%). While minimum pollens were found in the month of December (2.72%) followed by January (3.4%) and February (4.35%). Maximum pollen types were observed in months of March and April. In both months thirty two types of Pollen were observed. This was followed by February and May in which, twenty seven types of Pollen were observed. While minimum pollens type observed in month of July (fourteen types) followed by June with eighteen types. In 2001 total thirty nine types of pollens were identified. Out of which thirty seven types belonged to Angiosperms and two belonged to Gymnosperms. The contribution of pollen grains to the total aerospora was 39.78%. The dominant pollen type was Asteraceae contributes 35.48%. This was followed by Poaceae with 27.74%. Pollens of some other families occur round the year having good percentage these are :

Euphorbiaceae - 3.26%

Malvaceae - 2.63%

Cannabaceae - 4.27%

Myrtaceae - 4.20%

Along with this pollens of Amaranthaceae and Brassicaceae were not present round the year but constitute main part of aerospora with 1.56% and 1.48% respectively. Pollen grains of Cyperaceae, Chenopodiaceae, Verbinaceae, Solanaceae, Convolvulaceae and Cupressaceae were present more than eight months, while pollens of Caricaceae, Proteaceae, Betulaceae were observed only in 3-4 months.

In this year minimum pollens were contributed by Caricaceae with 16%. This was followed by Betulaceae 17% and Typhaceae 19%.

In 2001 maximum pollens were observed in the month of October (13.40%) which was followed by April (12.09%) and March (11.16%), while minimum pollens occur in month of December (2.05%) followed by January (3.73%) and February (6.49%). Maximum pollen types were observed in month of April in which thirty two types of pollen observed. This was followed by March and October in which twenty nine types of taxa were present, while minimum taxa noted in July in which only thirteen types of pollen were observed, which was followed by June with nineteen types of pollens.

Historical aerobiological data are valuable for understanding the composition, seasonal distribution, and atmospheric occurrence of airborne pollen grains and fungal spores. Although the present study is based on observations recorded during 2000–2001, these data remain scientifically relevant because they provide a record of the aerobiological conditions of the study area during that period. Earlier studies have demonstrated the importance of documenting seasonal variations in airborne pollen and fungal spores. Gregory (1961) provided a fundamental account of atmospheric microorganisms and the dispersal of biological particles through the air. Similarly, Satpute et al. (1983) investigated seasonal variations in atmospheric pollen and fungal spores in Shillong, India, while Singh et al. (1987) documented daily and seasonal variations in airborne pollen and fungal spores at Dehradun over two consecutive years. These studies demonstrate the value of systematic aerobiological observations for characterizing regional air-spore patterns. The preservation and publication of historical datasets can contribute to the scientific literature by documenting previously observed pollen and spore types, identifying their seasonal occurrence, and providing baseline

information for comparison with future investigations. Such records may also support subsequent studies of environmental change, plant phenology, and airborne biological particles. Therefore, the present study is important as a historical record of the aeropollen and air-spore composition of the study area during 2000–2001, particularly where comparable observations from the same location are limited.

Historical aerobiological data are valuable for understanding the composition, seasonal distribution, and atmospheric occurrence of airborne pollen grains and fungal spores. Earlier studies in India have documented regional differences in airborne pollen diversity and seasonal peaks, including Shillong, Dehradun, Delhi, and Allahabad (Satpute et al., 1983; Singh et al., 1987; Singh et al., 2003; Sahney & Chaurasia, 2008). These studies support the value of systematic, location-specific observations, while also showing that pollen spectra and peak seasons vary between locations and sampling periods. The present dataset therefore provides a historical record of pollen occurrence in Meerut during 2000–2001. It should be treated as baseline information for future comparisons rather than direct evidence of environmental change, which would require comparable later observations and validated methods.

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