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Aerobiological Diversity and Seasonal Dynamics of Airborne Pollen in Meerut: Influence of Plant Habit and Meteorological Factors

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Abstract: *Airborne pollen is a major component of atmospheric bioaerosols and is important for understanding plant phenology, ecosystem health, and human allergy risk. The present study examines the seasonal distribution of airborne pollen grains in Meerut, Uttar Pradesh, India, using continuous aerobiological observations recorded during 2000 and 2001.Sampling was conducted using an aeroscope installed on the terrace of a residential building approximately 6 m above ground level. Microscope slides measuring 75 × 25 mm were coated with safranin-stained glycerin jelly and exposed to the atmosphere at 24-hour intervals. Pollen identification was performed by comparing airborne specimens with reference slides prepared from pollen collected from surrounding vegetation. A total of 12,264 pollen grains were recorded in 2000 and 12,903 in 2001. October was the month with the highest pollen count in both years (1,641 grains in 2000 and 1,712 grains in 2001), followed by March and April. December recorded the lowest counts (334 in 2000 and 269 in 2001). Herbs were the predominant plant-habit category, contributing 82.05% in 2000 and 78.80% in 2001. Asteraceae was the dominant family (36.02% in 2000 and 35.84% in 2001), followed by Poaceae (23.73%). Thirty-nine pollen types were identified, including 37 angiosperms and 2 gymnosperms, with maximum diversity in March-April (32 types). Meteorological data from CPRI, Modipuram, Meerut showed that July had the maximum rainfall (272 mm in 2000), followed by August and February. Low pollen counts in rainy months were due to washing effect of rain and less flowering. Low temperature in December-January provided unfavourable conditions for flowering. Maximum pollens were recorded in March-April and October-November when temperature ranged between 10°C to 30°C and humidity between 50 to 70%. This provides a valuable historical baseline for future aerobiological monitoring and allergen forecasting.*

Keywords: Aerobiology, airborne pollen, seasonal distribution, plant habit, meteorological factors, pollen calendar, Meerut

I. INTRODUCTION

The atmosphere contains a diverse assemblage of biological particles originating from plants, fungi, and other organisms. These particles, collectively studied within aerobiology, include pollen grains, fungal spores, and various biological fragments. Their release, transport, and deposition depend on the characteristics of the source organisms and the meteorological conditions. Airborne pollen is particularly useful for understanding flowering phenology, vegetation composition, and seasonal changes. Previous investigations in India have demonstrated considerable regional and seasonal variation. Satpute et al. (1983) in Shillong reported distinct pollen peak periods. Singh et al. (1987) investigated airborne pollen at Dehradun over two years and identified two principal pollen periods, February-April and August-October.

II. OBJECTIVES

1. To describe monthly and annual distribution during 2000 and 2001
2. To examine relative contribution of herbs, shrubs, and trees

3. To summarize dominant and less frequent pollen families
4. To examine seasonal patterns alongside meteorological factors
5. To establish a historical reference

III. REVIEW OF LITERATURE

Shaheen (1992) conducted aeromycological investigations in the Amman area of Jordan from May 1987 to May 1988 using a volumetric spore trap. The study recorded 14 families and 38 genera of airborne fungi. Kothari et al. (1993) investigated the relationship between airborne *Alternaria* spores and bronchial asthma, highlighting the clinical relevance of monitoring airborne biological particles. Sathees, Rao, and Nair (1993) studied atmospheric pollen at Kodaikanal during 1987–1988 using an aeroscope and identified 52 pollen types.

Kalkar and Patil (1994) investigated airborne bioparticles at Nagpur during 1986–1987 and recognized 67 types, including 39 fungal spores, 21 pollen types, and seven other biological particles. Poaceae, Amaranthaceae, Chenopodiaceae, *Parthenium*, and *Cassia* were among the prominent components. Comtois (1994) examined airborne pollen dispersal on Mount Sutton, Canada, contributing to the understanding of pollen transport under different environmental conditions. Singh, Gangal, and Singh (1994) studied airborne fungi in a Delhi hospital from May 1989 to April 1991 and reported peak concentrations during June–September.

Ong et al. (1995) developed a pollen calendar for Melbourne, documenting pollen from 22 families and reporting the relative contributions of trees, grasses, and weeds. Guardia et al. (1995) investigated annual and daily concentrations of Gramineae pollen in Granada, Spain, over four consecutive years using a Burkard spore trap. Their work highlighted the importance of long-term monitoring for understanding pollen seasonality and daily fluctuations. González-Minero et al. (1998) studied airborne grass pollen in southern Spain over ten years (1987–1996), providing information on interannual variations in grass pollen occurrence. Chakraborty et al. (1999) conducted a two-year airborne pollen survey in Greater Calcutta from July 1994 to June 1996, contributing to the knowledge of regional pollen diversity and seasonal occurrence.

Chanda et al. (2000) investigated pollen morphology and its applications in palynological research, building on Professor Gunnar Erdtman's contributions. Erdtman's foundational work on pollen morphology, taxonomy, and ecology established important principles for pollen identification and classification. His book *Handbook of Palynology* (1969) remains a useful reference for understanding pollen structure and its taxonomic significance.

Subsequent research has emphasized the influence of meteorological conditions on airborne pollen concentrations and pollen-season timing. Jones and Harrison (2004) reviewed how meteorological factors affect atmospheric bioaerosol concentrations and discussed how environmental conditions influence the release and dispersal of biological particles. Schramm et al. (2021) systematically reviewed evidence concerning temperature, precipitation, airborne pollen concentrations, and pollen-season timing. Their findings indicated that warmer conditions are generally associated with earlier and longer pollen seasons, while the effects of precipitation vary according to pollen type and seasonal conditions.

Bastl et al. (2018) reviewed approaches to defining pollen seasons and highlighted the importance of consistent criteria when comparing pollen observations. Such methodological considerations are relevant to studies examining monthly pollen counts, seasonal distribution, and flowering phenology.

The literature reviewed above demonstrates the importance of aerobiological monitoring for documenting airborne pollen diversity, seasonal occurrence, and environmental influences. However, pollen distribution varies with geographical location, vegetation composition, flowering periods, and meteorological conditions. Therefore, the present investigation of Meerut during 2000–2001 provides a regional account of airborne pollen incidence and its monthly distribution. By examining pollen records alongside flowering periods, reported pollination modes, pollen morphology, and meteorological observations, the study can contribute to a more integrated understanding of airborne pollen patterns in the region.

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IV. 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.

Meterological data was collected from CPRI(Central Potato Research Institute), Modipuram,Meerut.

V. OBSERVATION

The meteorological data recorded during 2000 and 2001 revealed considerable monthly variations in temperature, relative humidity, and rainfall in Meerut. In 2000, the average temperature was highest in May (32.85°C), followed by June (31.75°C), whereas the lowest average temperature was recorded in January (13.75°C). In 2001, the highest reported average temperature was in July (31.30°C); however, some monthly average temperature values require verification against the corresponding maximum and minimum temperatures. Relative humidity generally increased during the monsoon months, particularly in July and August 2000, when average humidity reached 79.40% and 77.15%, respectively. Rainfall was highest in July 2000 (272.0 mm), followed by August (190.5 mm), indicating a strong monsoon influence. The pollen incidence data showed that herbs constituted the dominant habit group in both years, contributing 82.05% of the annual pollen count in 2000 and 78.80% in 2001. Shrubs and trees contributed smaller proportions overall. In 2000, the monthly pollen count was highest in October (1,641) and lowest in December (334), whereas in 2001, the highest monthly count was recorded in October (1,712) and the lowest in December (269). These observations indicate seasonal variation in airborne pollen abundance, with herbs making the largest contribution to the recorded pollen assemblage. The monthly patterns may reflect differences in flowering phenology and seasonal environmental conditions.

TABLE : METEOROLOGICAL DATA : TEMPERATURE, RELATIVE HUMIDITY AND RAINFALL FOR THE YEAR 2000

SNo.	Month	Maximum	Minimum	Average (Temperature)	Maximum	Minimum	Average (Humdity)	Rain Fall in MM
1.	JANUARY	19.8	7.7	13.75	84.7	52.6	68.65	76.6
2.	FEBRUARY	22.9	8.7	15.80	87.0	50.5	68.75	108.8
3.	MARCH	30.0	13.4	21.70	84.9	33.4	59.15	12.2
4.	APRIL	39.4	21.4	30.40	64.4	29.6	47.00	1.0
5.	MAY	38.2	27.5	32.85	68.7	41.5	55.10	Nil
6.	JUNE	37.9	25.6	31.75	83.7	52.1	67.90	25.0
7.	JULY	33.0	25.8	29.40	91.9	66.9	79.40	272.0
8.	AUGUST	31.6	24.8	28.20	89.5	64.8	77.15	190.5

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9.	SEPTEMBER	32.2	23.1	27.65	86.9	65.2	76.05	66.5
10.	OCTOBER	34.5	18.1	26.3	92.7	61.1	76.90	10.6
11.	NOVEMBER	29.6	11.5	20.55	87.1	51.1	69.30	Nil
12.	DECEMBER	23.7	6.1	14.9	95.8	42.2	69.00	0.51

TABLE 2 : METEOROLOGICAL DATA : TEMPERATURE, RELATIVE HUMIDITY AND RAINFALL FOR YEAR 2001

SNo.	Month	Maximum	Minimum	Average (Temperature)	Maximum	Minimum	Average (Humdity)	Rain Fall in MM
1.	JANUARY	19.9	16.5	18.2	90	61	75.50	0.95
2.	FEBRUARY	26.3	7.7	17.0	84	43	63.50	0.80
3.	MARCH	30.5	11.9	21.20	81	33	57.00	2.40
4.	APRIL	37.2	18.8	28.00	71	30	50.50	3.50
5.	MAY	37.4	23	30.20	67	36	51.50	2.34
6.	JUNE	35.1	24.0	29.55	79	58	68.50	14.94
7.	JULY	35.7	26.9	31.30	85	67	76.00	17.93
8.	AUGUST	34.9	26.0	30.45	82	58	70.00	Nil
9.	SEPTEMBER	37.7	24.1	30.90	76	43	59.50	Nil
10.	OCTOBER	34.6	19.8	27.20	84	38	61.00	Nil
11.	NOVEMBER	30.2	12.1	21.15	88	33	60.50	0.90
12.	DECEMBER	23.9	8.2	16.05	88	45	66.50	Nil

TABLE 3 : INCIDENCE OF POLLEN GRAINS BASED ON HABIT OF PLANTS FOR THE YEAR 2000

SNo.	Habit		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1.	HERBS	Num	335	402	1142	948	704	724	942	1136	879	1367	1227	257	10063
		%	79.95	68.36	73.39	69.30	76.94	90.16	91.46	91.84	87.20	83.30	89.89	76.95	82.05
2.	SHRUBS	Num	27	40	156	197	65	20	63	60	75	95	68	53	919

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		%	6.44	6.80	10.03	14.40	7.10	2.49	6.12	4.85	7.44	5.79	4.98	15.87	7.49
3.	TREES	Num	54	139	254	221	136	52	17	34	49	173	61	12	1202
		%	12.89	23.64	16.32	16.15	14.86	6.48	1.65	2.75	4.86	10.54	4.47	3.59	9.80
	UnIdentified		3	7	4	2	10	7	8	7	5	6	9	12	80
	TOTAL		419	588	1556	1368	915	803	1030	1237	1008	1641	1365	334	12264

TABLE 4 : INCIDENCE OF POLLEN GRAINS BASED ON HABIT OF PLANTS FOR THE YEAR 2001

SNo.	Habit		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1.	HERBS	Num	367	627	941	1050	982	769	832	1061	1043	1517	810	169	10168
		%	75.98	74.20	65.30	67.31	74.17	87.09	88.32	89.54	84.59	88.61	78.95	62.83	78.80
2.	SHRUBS	Num	17	91	213	176	122	42	44	48	124	72	119	59	1127
		%	3.52	10.77	14.78	11.28	9.21	4.76	4.67	4.05	10.06	4.21	11.60	21.93	8.73
3.	TREES	Num	97	120	279	323	208	63	56	63	60	116	88	369	1509
		%	20.08	14.20	19.36	20.71	15.71	7.13	5.94	5.32	4.87	6.78	8.58	13.38	11.69
	UnIdentified		2	7	8	11	12	9	10	13	6	7	9	5	99
	Total		483	845	1441	1560	1324	883	942	1185	1233	1712	1026	269	12903

VI. RESULTS

1. Annual and monthly distribution of airborne pollen

The supplied monthly totals indicate 12,264 pollen grains in 2000 and 12,903 pollen grains in 2001. The difference between these totals is 639 grains, equivalent to an increase of approximately 5.21% in the reported annual total in 2001 relative to 2000.

In 2000, the highest monthly count was recorded in October, with 1,641 grains, followed by March (1,556), April (1,368), and November (1,365). December recorded the lowest count (334), followed by January (419) and February (588).

In 2001, October again recorded the highest monthly count, with 1,712 grains, followed by April (1,560), March (1,441), and May (1,324). December recorded the lowest count (269), followed by January (483) and November (1,026).

These observations indicate that October was the principal month of maximum pollen catch in both years. March and April also represented important periods of high pollen occurrence. December consistently showed the lowest monthly pollen catch in the supplied records.

The monthly pattern was not identical between the two years. For example, April recorded 1,368 grains in 2000 and 1,560 in 2001, whereas November recorded 1,365 grains in 2000 and 1,026 in 2001. These differences indicate interannual variation in the recorded monthly pollen assemblage.

2. Pollen distribution according to plant habit

The supplied habit-based tables identify herbs as the largest contributor to the airborne pollen assemblage in both years. The reported annual contribution of herbs was 82.05% in 2000 and 78.80% in 2001. Trees were reported to contribute 9.80% and 11.69%, respectively, while shrubs contributed 7.49% in 2000 and 8.73% in 2001.

The reported values suggest that herbs were the predominant habit category, while the relative contribution of trees increased in 2001. The reported shrub contribution also increased between the two years..

3. Diversity and frequency of pollen types

According to the supplied taxonomic summary, 39 pollen types were identified in 2001, comprising 37 angiosperm types and two gymnosperm types. The corresponding monthly taxonomic records indicate substantial variation in pollen-type richness.

For 2000, the highest reported monthly pollen-type richness occurred in March and April, with 32 types recorded in each month. February and May each reportedly contained 27 types. July had the lowest reported richness, with 14 types, followed by June, with 18 types.

For 2001, April had the highest reported richness, with 32 pollen types. March and October each reportedly contained 29 types. July had the lowest richness, with 13 types, followed by June, with 19 types.

These records suggest that the months with higher pollen-type richness generally included the spring period and, in some instances, autumn.

4. Dominant pollen families

The preliminary summary identifies Asteraceae as the dominant pollen family in both years, with reported contributions of 36.02% in 2000 and 35.84% in 2001 in one section of the original results.

Poaceae was reported as another major component of the pollen assemblage. The preliminary annual summary for 2001 lists the following additional contributions:

Euphorbiaceae: 3.26%

Malvaceae: 2.63%

Cannabinaceae: 4.27%

Myrtaceae: 4.20%

Amaranthaceae and Brassicaceae were reported as important contributors despite not being recorded throughout the entire year, with reported contributions of 1.56% and 1.48%, respectively.

The supplied records indicate that Cyperaceae, Chenopodiaceae, Verbenaceae, Solanaceae, Convolvulaceae, and Cupressaceae were observed during more than eight months. Caricaceae, Proteaceae, and Betulaceae were reported in only three to four months. The preliminary summary also describes Caricaceae, Lamiaceae, and Cuscutaeae as groups with low pollen occurrence.

5. Seasonal patterns

The original interpretation identifies spring as the season with the greatest pollen occurrence, followed by the rainy season and autumn. However, the supplied monthly totals show that October had the highest count in both years, and October–November also contributed substantially to the annual totals.

This indicates that the seasonal interpretation requires a clearly defined seasonal classification and a consistent calculation of season-wise totals. The monthly data support the importance of spring and autumn pollen periods, but the relative ranking of the seasons cannot be established conclusively without recalculating totals using an explicitly defined seasonal calendar.

6. Meteorological conditions

The supplied meteorological records show substantial monthly variation in temperature, relative humidity, and rainfall during both study years.

In 2000, the highest listed average temperature was 32.85°C in May, while the lowest was 13.75°C in January. The largest rainfall total was recorded in July (272.0 mm), followed by August (190.5 mm) and February (108.8 mm). The average temperature declined during the autumn and winter months.

In 2001, the supplied average-temperature column includes values that require verification, particularly November (21.15°C) and December (16.05°C), which appear inconsistent with the corresponding maximum and minimum temperatures. The listed monthly rainfall values are substantially lower than those reported for 2000, with the largest monthly value being 17.93 mm in July.

7 Relationship between pollen occurrence and meteorological conditions

The monthly records provide a basis for examining possible relationships between atmospheric pollen catch and weather conditions. The high pollen counts in March–April and October suggest that pollen occurrence was not restricted to a single flowering period.

Rainfall may reduce the airborne concentration of pollen by wet deposition, as discussed in earlier aerobiological studies, including Satpute et al. (1983). However, rainfall can also influence plant growth and flowering, so its net effect may differ depending on the timing of the observation and the plant taxa involved.

Temperature and relative humidity may also influence flowering phenology, pollen release, transport, and deposition. The supplied data do not, however, establish a single optimum temperature or humidity range for pollen occurrence in Meerut. The current results therefore support a descriptive comparison of monthly pollen counts and meteorological conditions.

VII. DISCUSSION

1 Historical significance of the pollen record

The Meerut observations provide a two-year record of airborne pollen occurrence during 2000–2001. The annual totals and monthly distribution show that pollen was recorded throughout the year, with substantial differences in abundance between months. October was the highest-count month in both years, while December had the lowest count.

The repeated October maximum is an important feature of the dataset. It suggests that autumn was a major period of pollen occurrence at the sampling location, alongside the elevated counts recorded during spring. The observations from Dehradun reported by Singh et al. (1987), which identified February–April and August–October as principal pollen periods, provide a useful regional comparison. However, the differences in location, vegetation, sampling apparatus, and sampling period prevent direct equivalence between the two studies.

Interpret historical observations within their original temporal and methodological context. The Meerut dataset cannot establish how pollen abundance has changed since 2001, but it can provide a reference for future studies using comparable identification criteria and sampling procedures.

2 Contribution of plant-habit categories

The preliminary results identify herbs as the predominant plant-habit category in both years. This may reflect the presence of herbaceous vegetation in the surrounding environment, the flowering schedules of locally occurring plants, and differences in pollen production and atmospheric transport.

The contributions of trees and shrubs were lower in the supplied annual summaries. However, pollen counts do not necessarily reflect the relative abundance of plants in the landscape. A plant's contribution to airborne pollen depends on several factors, including the number of flowering individuals, the quantity of pollen produced, the release mechanism, dispersal characteristics, and distance from the sampler.

3. Meteorological influences on airborne pollenss

Meteorological variables can affect the production, release, transport, and removal of airborne biological particles. Gregory (1961) discussed the atmospheric behaviour of biological particles, while Jones and Harrison (2004) reviewed the effects of meteorological factors on bioaerosol concentrations. Both provide a conceptual basis for interpreting pollen observations in relation to weather.

Rainfall may remove airborne pollen through wet deposition, and Satpute et al. (1983) discussed the possible washing effect of heavy rainfall in their study of Shillong. However, rainfall does not invariably produce low pollen counts. The

timing of rainfall relative to flowering and sampling, the intensity of precipitation, and the pollen-release mechanisms of individual taxa can influence the observed outcome.

Temperature may be associated with flowering and pollen release, while humidity can influence pollen hydration and atmospheric behaviour. Wind is also important because it affects the dispersal and transport of pollen grains. Since wind measurements were not included in the supplied meteorological tables, its role cannot be assessed directly in the present analysis.

VIII. CONCLUSION

The historical aerobiological observations from Meerut during 2000–2001 document substantial monthly variation in airborne pollen occurrence. The supplied annual totals were 12,264 grains in 2000 and 12,903 grains in 2001. October recorded the highest monthly pollen count in both years, while December recorded the lowest. March and April were also important months of pollen occurrence.Herbs were reported as the principal plant-habit category, and Asteraceae and Poaceae were identified as major components of the pollen assemblage. The monthly meteorological records provide useful environmental context for interpreting the observed variation, but the available evidence does not establish causal relationships between individual weather variables and pollen concentration. Despite its historical nature, this dataset can contribute to the documentation of regional aerobiological patterns and provide a reference for future comparative studies.

REFRENCES

1. Anderegg, W. R. L., Abatzoglou, J. T., Anderegg, L. D. L., Bielory, L., Kinney, P. L., & Ziska, L. (2021). Anthropogenic climate change is worsening North American pollen seasons. *Proceedings of the National Academy of Sciences, 118*(7).
2. Gregory, P. H. (1961). *The microbiology of the atmosphere*. Leonard Hill.
3. Hirst, J. M. (1952). An automatic volumetric spore trap. *Annals of Applied Biology, 39*(2), 257–265.
4. Jones, A. M., & Harrison, R. M. (2004). The effects of meteorological factors on atmospheric bioaerosol concentrations—A review. *Science of the Total Environment, 326*(1–3), 151–180.
5. Satpute, M., Dutta, B. K., & Rao, R. R. (1983). Contributions to the aerobiology of Shillong. I. Studies on the seasonal variations of atmospheric pollen and fungal spores. *Proceedings of the Indian National Science Academy, Part B: Biological Sciences, 49*(6), 675–686.
6. Schramm, P. J., Brown, C. L., Saha, S., Conlon, K. C., Manangan, A. P., Bell, J. E., & Hess, J. J. (2021). A systematic review of the effects of temperature and precipitation on pollen concentrations and season timing, and implications for human health. *International Journal of Biometeorology, 65*(10), 1615–1628.
7. Singh, B. P., Singh, A. B., Nair, P. K., & Gangal, S. V. (1987). Survey of airborne pollen and fungal spores at Dehra Dun, India. *Annals of Allergy, 59*(3), 229–234.