

Seasonal Aeropalynology and Pollen Calendars of Malda District, West Bengal: Implications for Environmental Health and Allergy Management

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Abstract

Aeropalynology is the study of airborne pollen and spores that constitute an important component of atmospheric bioaerosols. Airborne pollen plays a significant role in environmental health as it is one of the major causes of allergic disorders, including allergic rhinitis and asthma. Understanding the seasonal distribution of pollen is therefore essential for assessing allergenic risks and developing effective management strategies.

This study highlights the importance of seasonal aeropalynology and pollen calendar development with special reference to Malda District, West Bengal. Previous aeropalynological investigations have demonstrated that pollen abundance and diversity vary throughout the year depending on vegetation composition and flowering periods. Pollen calendars provide valuable information regarding the occurrence and peak dispersal of allergenic pollen taxa, helping to identify periods of increased exposure. The study emphasizes the relevance of airborne pollen monitoring for environmental health assessment and allergy management. It also highlights the need for region-specific aeropalynological data from Malda District to support future research, public health planning, and the development of effective pollen forecasting systems.

Keywords: Aeropalynology, Airborne Pollen, Pollen Calendar, Allergy Management, Environmental Health, Malda District.

Introduction

Aeropalynology is the branch of palynology that deals with the study of airborne pollen grains and spores present in the atmosphere. These biological particles form an important component of atmospheric bioaerosols and provide valuable information regarding vegetation composition, flowering patterns, and environmental conditions. The distribution and abundance of airborne pollen vary seasonally and are influenced by local flora, climatic factors, and land-use practices. As a result, aeropalynological studies have become an important tool for understanding plant biodiversity and monitoring environmental changes.

Airborne pollen is widely recognized as one of the major causes of allergic disorders, including allergic rhinitis, asthma, and other respiratory ailments. Exposure to allergenic pollen may trigger hypersensitivity reactions in susceptible individuals, affecting their quality of life and public health. Consequently, numerous aeropalynological investigations have been conducted worldwide to identify dominant pollen types and determine their seasonal occurrence. Such studies help in assessing periods of increased allergenic risk and contribute to the development of effective healthcare and allergy management strategies.

Pollen calendars are among the most valuable outcomes of aeropalynological research, providing month-wise information on the occurrence and peak dispersal periods of different pollen taxa. These calendars assist clinicians, environmental scientists, and allergy sufferers in predicting high-risk periods of pollen

exposure. Malda District of West Bengal possesses diverse vegetation and extensive agricultural landscapes that contribute significantly to the atmospheric pollen spectrum. However, information on seasonal pollen distribution and pollen calendar development in this region remains limited. Therefore, understanding the seasonal aeropalynological profile of Malda District is essential for environmental health assessment and effective allergy management.

Seasonal Pattern of Airborne Pollen

The concentration and composition of airborne pollen in Malda District exhibit distinct seasonal variations throughout the year. These variations are primarily influenced by the flowering phenology of regional vegetation, including grasses, weeds, orchard plants, and forest trees. Different plant taxa release pollen during specific periods of the year, resulting in fluctuations in atmospheric pollen abundance and diversity. Consequently, seasonal pollen distribution reflects the vegetation dynamics and ecological characteristics of the region.

Among the dominant airborne pollen groups, members of the family Poaceae (grasses) contribute substantially to the atmospheric pollen load throughout the year. Weed pollen belonging to Asteraceae (*Parthenium*) and Amaranthaceae (*Amaranthus*) also forms an important component of the pollen spectrum, particularly during periods of active flowering. Tree pollen derived from Moraceae (*Morus* spp.), Fabaceae (*Cassia* spp. and *Albizia* spp.), and Anacardiaceae (*Mangifera indica*) shows marked seasonal peaks associated with their respective flowering seasons. As a result, higher pollen concentrations are generally observed during spring and early summer months.

Understanding the seasonal pattern of airborne pollen is essential for the development of region-specific pollen calendars and the identification of periods of increased allergenic risk. Such information provides valuable support for environmental health assessment, allergy forecasting, and public health planning. Continuous monitoring of airborne pollen can therefore contribute significantly to effective allergy management and a better understanding of seasonal bioaerosol dynamics in Malda District, West Bengal.

Pollen Calendars and Their Applications

A pollen calendar is a systematic representation of the seasonal occurrence, abundance, and peak dispersal periods of airborne pollen taxa within a specific geographical region. It provides month-wise information on the atmospheric distribution of different pollen types and serves as an important tool in aeropalynological research. Since the flowering periods of plant species vary throughout the year, pollen calendars help in understanding seasonal pollen dynamics and identifying periods of increased pollen concentration. In regions such as Malda District, where diverse vegetation, agricultural crops, and orchards contribute to the atmospheric pollen spectrum, pollen calendars can provide valuable information on seasonal pollen trends.

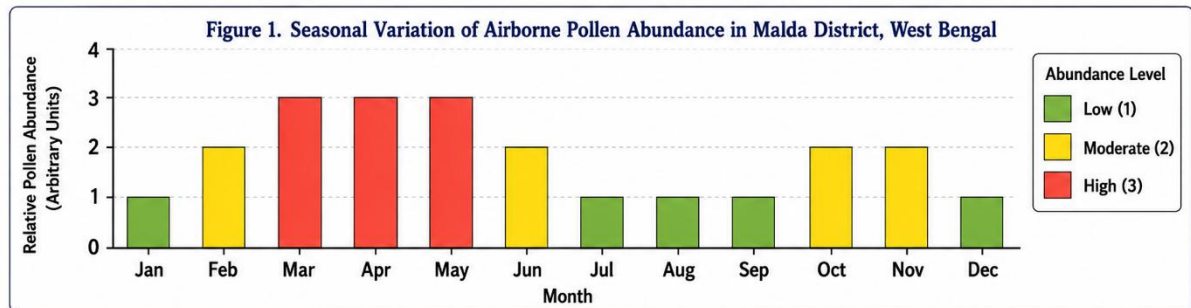
Pollen calendars have significant applications in environmental health and allergy management. They assist clinicians and allergists in predicting periods of high allergenic pollen exposure and support the diagnosis and treatment of pollen-induced allergic disorders such as allergic rhinitis, conjunctivitis, and bronchial asthma. Individuals sensitive to airborne pollen can also use pollen calendars to take preventive measures during peak pollen seasons. Furthermore, these calendars contribute to public health awareness by helping communities recognize potential periods of increased allergenic risk.

In addition to their medical importance, pollen calendars are valuable tools for environmental monitoring and biodiversity assessment. They provide insights into local vegetation composition, flowering phenology, and seasonal bioaerosol dynamics. The development of a region-specific pollen calendar for Malda District can therefore contribute to environmental health surveillance, allergy forecasting, and future aeropalynological research. Such information may also support policymakers and healthcare professionals in planning effective strategies for managing pollen-related health issues within the region.

Table 1. Illustrative Pollen Calendar of Major Allergenic Pollen Families in Malda District, West Bengal

POLLEN FAMILY / TAXA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Poaceae (Grasses)	+	++	+++	+++	++	++	+	+	+	++	++	+
Asteraceae (<i>Parthenium</i>)	+	+	++	++	+++	++	+	+	+	++	++	+
Amaranthaceae (<i>Amaranthus</i>)	+	++	++	+++	++	++	+	+	++	++	+	+
Moraceae (<i>Morus</i>)	–	+	++	+++	+++	++	+	–	–	–	–	–
Fabaceae (<i>Cassia</i> , <i>Albizia</i>)	–	+	++	++	+++	++	+	+	–	–	–	–
Anacardiaceae (<i>Mangifera indica</i>)	–	+	++	+++	+++	++	+	–	–	–	–	–

Legend: + Low abundance ++ Moderate abundance +++ High abundance – Absent



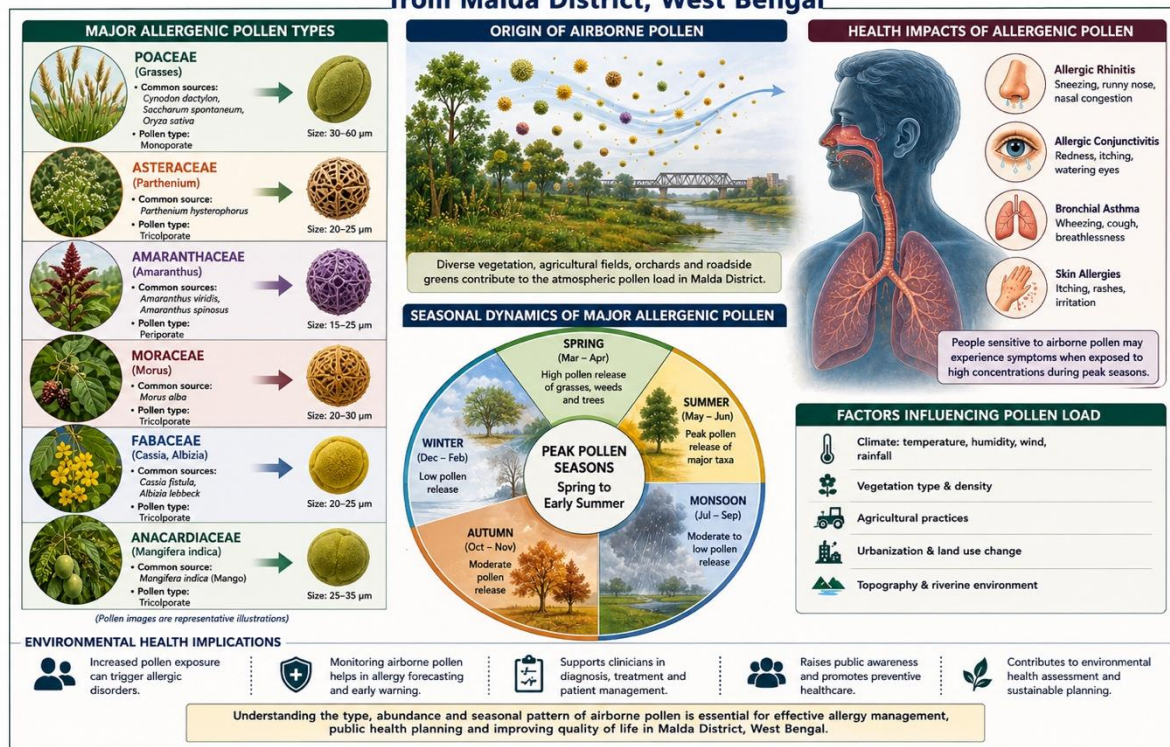
Note: This pollen calendar is based on reported flowering phenology, regional vegetation and aeropalynological observations from Malda District and surrounding areas.

Major Allergenic Pollen Types Reported from Malda District, West Bengal

Malda District, located in the northern part of West Bengal, is characterized by diverse vegetation, extensive agricultural lands, mango orchards, grasslands, and urban green spaces. These varied habitats contribute significantly to the atmospheric pollen spectrum of the region. Airborne pollen grains originating from different plant taxa form an important component of atmospheric bioaerosols and may cause allergic disorders such as allergic rhinitis, conjunctivitis, and bronchial asthma in susceptible individuals.

Among the major allergenic pollen types reported from Malda District, members of the family Poaceae (grasses) constitute a significant proportion of the airborne pollen load throughout the year. Weed pollen belonging to the families Asteraceae and Amaranthaceae, represented by taxa such as *Parthenium* and *Amaranthus*, are also important contributors to seasonal pollen abundance and allergenic exposure. In addition, tree pollen from the families Moraceae (*Morus* spp.), Fabaceae (*Cassia* spp. and *Albizia* spp.), and Anacardiaceae (*Mangifera indica*) contributes substantially to the atmospheric pollen spectrum during their respective flowering seasons.

The abundance and distribution of these pollen taxa vary seasonally according to flowering phenology and vegetation patterns. Higher pollen concentrations are generally observed during spring and early summer when many grasses, weeds, and tree species undergo active flowering. Identification of dominant allergenic pollen types is therefore essential for understanding seasonal allergy trends and preparing region-specific pollen calendars. Such information can support environmental health assessment, allergy forecasting, and the development of effective preventive healthcare strategies in Malda District.

Figure 2. Major Allergenic Pollen Types Reported from Malda District, West Bengal

Environmental Health Implications

Airborne pollen constitutes an important component of atmospheric bioaerosols and has significant implications for environmental health. The presence of allergenic pollen in the atmosphere can adversely affect sensitive individuals by triggering respiratory and allergic disorders such as allergic rhinitis, conjunctivitis, and bronchial asthma. In regions with diverse vegetation and extensive agricultural activities, including Malda District, seasonal fluctuations in pollen abundance may influence the frequency and severity of allergy-related health problems. Therefore, understanding the distribution and seasonal dynamics of airborne pollen is essential for assessing environmental health risks.

The major allergenic pollen families reported from Malda District, including Poaceae, Asteraceae, Amaranthaceae, Moraceae, Fabaceae, and Anacardiaceae, contribute substantially to the atmospheric pollen load during their flowering periods. Increased concentrations of these pollen types may lead to higher exposure levels among local populations, particularly during spring and early summer seasons. Continuous exposure to allergenic pollen can affect daily activities, reduce quality of life, and increase the burden on healthcare services. Consequently, monitoring airborne pollen becomes an important component of environmental health surveillance.

Aeropalynological studies and pollen calendars provide valuable information for identifying periods of increased pollen exposure and potential allergenic risk. Such information can support allergy forecasting, public health awareness programs, and preventive healthcare strategies. Furthermore, region-specific pollen data can assist healthcare professionals, environmental scientists, and policymakers in developing effective measures for allergy management and environmental monitoring. Thus, the integration of aeropalynological research into environmental health assessment can contribute significantly to improving public health and quality of life in Malda District, West Bengal.

Relevance and Future Prospects

The study of airborne pollen and the development of pollen calendars are highly relevant for understanding environmental health risks and managing pollen-related allergic disorders in Malda

District, West Bengal. As the district possesses diverse vegetation, extensive agricultural lands, orchards, and urban green spaces, the atmospheric pollen spectrum exhibits considerable seasonal variation. Knowledge of major allergenic pollen types and their seasonal occurrence can assist clinicians, environmental scientists, and public health authorities in predicting periods of increased allergenic risk and implementing appropriate preventive measures. Furthermore, pollen calendars serve as valuable tools for allergy forecasting, public health awareness, and environmental monitoring, thereby contributing to improved quality of life for sensitive individuals.

Future research should focus on systematic and long-term aeropalynological monitoring across different locations of Malda District to generate comprehensive region-specific pollen data. The establishment of standardized pollen calendars, identification of dominant allergenic taxa, and assessment of seasonal pollen dynamics would enhance environmental health surveillance and support evidence-based healthcare planning. Such studies may also contribute to biodiversity assessment, ecological monitoring, and the development of effective allergy management strategies. Therefore, continued aeropalynological investigations are essential for strengthening environmental health research and promoting sustainable public health initiatives in the region.

Conclusion

Airborne pollen represents an important component of atmospheric bioaerosols and plays a significant role in environmental health and allergy management. The present study highlights the seasonal variation of airborne pollen and emphasizes the importance of pollen calendars in understanding periods of increased pollen exposure. Major allergenic pollen families, including Poaceae, Asteraceae, Amaranthaceae, Moraceae, Fabaceae, and Anacardiaceae, contribute substantially to the atmospheric pollen spectrum of Malda District and may influence the occurrence of pollen-related allergic disorders among susceptible individuals.

The development of region-specific pollen calendars provides valuable information on seasonal pollen dynamics and helps identify periods of elevated allergenic risk. Such information can support allergy forecasting, environmental monitoring, public health awareness, and clinical management of allergic diseases. Furthermore, aeropalynological investigations contribute to a better understanding of local vegetation patterns and their relationship with atmospheric pollen distribution.

Overall, the study demonstrates the relevance of aeropalynology in environmental health assessment and highlights the need for continued pollen monitoring in Malda District, West Bengal. The integration of aeropalynological data into public health and environmental management programs can facilitate effective allergy prevention strategies and contribute to improved quality of life for the local population.

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