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Historical Development and Current Status of Aerobiological Studies: A Global and Indian Perspective with Emphasis on Pollen Allergy

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Abstract
Aerobiology, the study of airborne biological particles, is directly linked to the invention of the microscope in the 17th century. This review traces the historical development of aero palynology from the first descriptions of pollen by Grew and Malpighi (1671) to modern volumetric sampling and pollen calendars. Global milestones include the work of Micheli (1729) on fungal spores, Pasteur (1861) on aerospora, and Erdtman (1937) on trans-Atlantic sampling. In India, systematic studies began with Cunningham (1873) in Calcutta and expanded to regional surveys across Jaipur, Varanasi, Meerut, Bangalore, and Kolkata. The clinical significance of aerospora was established by Cadham (1924), Feinberg (1935–1940), and Gregory et al. (1953) through correlations of airborne pollen and fungal spores with allergic disorders. Recent studies from 1990–2020 highlight the role of climate change in altering pollen seasons and load, emphasizing the need for historical baseline data. This review synthesizes two centuries of research to underscore the importance of aerobiological surveys in ecological reconstruction, agriculture, and public health management.
Keywords: *Aerobiology; Pollen morphology; Aerospora; Pollen calendar; Allergy; India; Climate change*

I. Introduction

Aerobiology is the scientific discipline concerned with the study of airborne biological particles such as pollen grains, fungal spores, bacteria, and viruses, and their sources, transport, and impact on human, animal, and plant systems (Wodehouse, 1935). The field is interdisciplinary, connecting Botany, Mycology, Meteorology, Medicine, and Environmental Science. Airborne pollen and spores are major biopollutants responsible for allergic rhinitis, asthma, and other respiratory disorders worldwide (Bernstein et al., 1991). Systematic aerobiological monitoring enables the preparation of pollen calendars, which are essential tools for allergists and public health forecasting (Boral et al., 2010). This review traces the historical evolution of aerobiological research from the 17th century to present, with special focus on contributions from India.

Historical Development of Pollen Morphology and Aerobiology

1 Early Microscopic Studies: 17th–19th Century The study of airborne spores is directly related to the invention of the microscope. After Hooke's (1665) description of the compound microscope, Grew and Malpighi (1671) were the first to describe pollen grains and are recognized as co-founders of pollen morphology. Kölreuter (1761) discovered that the outer covering of pollen consists of two distinct coats. Purkinje (1830) recognized distinguishing characters of pollen from different families and built a system of nomenclature for description. Mirbel (1833) studied the pollen of Cucurbita pepo, Hyoscyamus alba, Cobaea scandens, Passiflora brasiliensis, and Lilium superbum. Fritzsche (1837) published a classification based on pollen characters and described two coats: an outer exine and an inner intine. Meyen (1828) also contributed significantly to pollen morphology. These investigations during 1830–1839 established the foundation of palynology (Wodehouse, 1935). Micheli (1729) was probably the first botanist to illustrate the spores of fungi and concluded that mould spores are distributed through air (Buller, 1915). Pasteur (1861) conducted one of the earliest surveys of aerospora in the Alps at elevations up to 200 m using culture plate techniques

2 20th Century Advances Erdtman (1937) collected pollen grains and fungal spores using vacuum cleaners across the Atlantic between Gothenburg and New York, demonstrating long-distance transport. Gregory et al. (1953, 1961) pioneered quantitative aerobiology in Britain, while Hyde and Williams (1958) correlated aerobiological data with allergy studies using extracts of Alternaria, Aspergillus, Botrytis, Penicillium, and Cladosporium for skin tests.

Aerobiological Studies in India: A Chronological Account

1 Pioneer Phase: 1873–1950In India, the first systematic aerobiological work was carried out by Cunningham (1873), who observed a large number of spores over Presidency Jail, Calcutta. Mehta (1933) found spores of Puccinia from the air on adhesive-coated cellophane slips attached to kites in Agra. Rajan et al. (1952) surveyed pollen grains and fungal spores from Kanpur.

2 Regional Expansion: 1959–1990Numerous regional studies established India's aerospora profile:
Kasliwal et al. (1959) from Jaipur; Nair (1963) from Vellore; Baruah and Chetia (1966) from Gauhati; Ramalingam (1971) from Mysore; Jha et al. (1975) from Varanasi; Sarna and Govil (1976) from Jaipur; Gaur (1978) from Meerut identifying 35 pollen types with Gramineae, Chenopods, Amaranthus, Casuarina, and Thuja as dominant; Tilak and Vishwe (1979) from Aurangabad; Gaur and Kasana (1981) from Modinagar; Jain and Das (1981) from Gwalior; Jhanki Bai and Reddi (1980) from Visakhapatnam recording 61 plant species; Singh and Babu (1982) from Delhi identifying 86 pollen types over three years; Yeole et al. (1984) from Pune; Gaur and Kala (1984) from Rudranath; Sharma (1984) from Varanasi; Kothare and Chitaley (1986) from Parbhani; Yonzon and Subhenda (1987) from Darjeeling recording 76 pollen types; and Tilak (1987–1988) from Aurangabad with a 10-year survey showing grass (47.2%) and Parthenium (47.1%) as dominant.Aerospora of major metros was also documented: Shivpuri et al. (1960) recorded 29 pollen types from Delhi; Dua and Shivpuri (1962) reported 38 types. Chanda et al. (1971, 1973) reported 29 pollen types from Calcutta with grass pollen dominant. Vishnu-Mittre and Khandelwal (1973) observed 48 pollen types from Lucknow. Agashe et al. (1975) identified Parthenium hysterophorus as the most prominent biopollutant in Bangalore.3.3 Modern Phase: 1990–2020Sathees et al. (1993) studied atmospheric pollen at Kodaikanal for 1987–1988, identifying 52 types. Kalkar and Patil (1994) recognized 67 bioparticle types at Nagpur, with Poaceae, Amaranthaceae, Chenopodiaceae, Parthenium, and Cassia pollen dominant. Singh et al. (1994) studied airborne fungi in Delhi hospitals, noting peak periods from June–September. Chakroborty et al. (1999) conducted a two-year aerobiological survey in Greater Calcutta using a Burkard sampler.Chanda et al. (2000) described four applied approaches in pollen research: sea-level change, systematics, allergy, and honey research. Chauhan and Singh (2000) at Agra found Asteraceae and Poaceae contributed maximum pollen, with herb pollen having longer airborne duration than tree pollen.Early surveys by Singh and Kumar (2002) in Lucknow and Mandal and Chanda (2005) in West Bengal established regional aerospora composition. Chakraborty et al. (2008) emphasized clinical relevance of aerospora in Kolkata. Boral et al. (2010) developed pollen calendars for eastern India as allergy forecasting tools. Singh et al. (2013) expanded surveys to Gorakhpur, while Sinha and Gupta (2015) incorporated fungal spores into urban studies. Boral et al. (2017) reinforced the aerospora-allergy link. Singh and Quamar (2018) provided Varanasi data linking pollen to vegetation.

Sno.	Year	Author(s)	Location	Key finding
1	1873	Cunningham	Calcutta	First systematic aerobiological work in India; observed spores over Presidency Jail
2.	1933	Mehta, K.C.	Agra	Trapped Puccinia spores on kites using adhesive cellophane slips
3.	1952	Rajan et al	Kanpur	Survey of pollen grains and fungal spores
4.	1959	Kasliwal et al.	Jaipur	Atmospheric pollen survey
5.	1960	Shivpuri et al.	Delhi	Recorded 29 pollen types; clinical aerobiology initiated
6.	1960	Gupta et al.	Jaipur	Studied allergenic spores: Alternaria, Fusarium, Helminthosporium
7.	1962	Dua & Shivpuri	Delhi	Reported 38 pollen types
8.	1963	Nair	Vellore	Atmospheric pollen and fungal spore survey
9.	1966	Baruah & Chetia	Gauhati	Aerobiological studies in Assam
10.	1971	Ramalingam	Mysore	Atmospheric pollen of Mysore city1971,
11.	1973	Chanda et al.	Calcutta	29 pollen types; grass pollen dominant
12.	1973	Vishnu-Mittre & Khandelwal	Lucknow	48 pollen types from atmosphere
13.	1973	Chitaley & Bajaj	Nagpur	High-altitude aerobiology: 2000–3000 m AGL
14.	1975	Jha et al.	Varanasi	Atmospheric pollen survey
15.	1975	Agashe et al.	Bangalore	Identified Parthenium hysterophorus as major biopollutant
16.	1976	Sarna & Govil	Jaipur	Aerospora of Jaipur city
17.	1978	Gaur	Meerut	First aeropalynological study of Meerut; 35 pollen types; Gramineae, Chenopods dominant
18.	1979	Tilak & Vishwe	Aurangabad	33 pollen types; herb pollen 59%, grass pollen 42.2%1980Jhanki Bai & ReddiVisakhapatnam61 plant species: 13 grasses, 20 weeds, 28 trees/shrubs
19.	1981	Gaur & Kasana	Modinagar	Aerospora study
20.	1981	Jain & Das	Gwalior	Aerospora of Gwalior

21.	1982	Singh & Babu	Delhi	86 pollen types over 3 years; trees 42.9%, weeds/grasses 26.1%
22.	1982	Tripathi	Gorakhpur	Airborne pollen survey
23.	1984	Yeole et al.	Pune	Pollination calendar; 16 pollen types; peak Aug–Oct
24.	1984	Gaur & Kala	Rudranath,	HimalayaAlpine aerospora; 23.9% pollen, 56.9% fungal spores
25.	1984	Sharma	Varanasi	Nasal aerospora; pollen 14.53%, epidermal hairs 11.67%
26.	1985	Nautiyal & Sahney	Allahabad	Atmospheric pollen
27.	1986	Nair & Kumar	Bareilly	Airborne pollen survey
28.	1986	Kothare & Chitaley	Parbhani	Parthenium, Cassia, Azadirachta, Chenopodium dominant
29.	1987	Yonzon & SubhendaMirik,	Darjeeling	76 pollen types; grass pollen 51.65%
30.	1987–88	Tilak	Aurangabad	10-year study; grass 47.2%, Parthenium 47.1% dominant
31.	1988	Ravindran P. Joshi et al.	Trivandrum	Airborne pollen
32.	1988	Agashe & Abraham	Bangalore	Pollen calendar of Bangalore city
33.	1988	Jain & Mishra	Gwalior	Airborne pollen and spores
32.	1989	Bera & Khandelwal	Chhota Shigri Glacier	Airborne pollen in glacier atmosphere
35.	1993	Kothari et al.	Jaipur	Alternaria spores and bronchial asthma
36.	1993.	Sathees et al	Kodaikanal	52 pollen types; 2-year pollen calendar
37.	1994	Kalkar & Patil	Nagpur	67 bioparticles: 39 fungal, 21 pollen types
38.	1994	Singh et al.	Delhi	Hospital airborne fungi; peak June–Sept
39.	1999	Chakroborty et al.	Greater Calcutta	2-year survey using Burkard sampler
40.	2000	Chauhan & Singh	Agra	Asteraceae and Poaceae dominant; herb pollen longer
41.	2002	Singh & Kumar	Lucknow	Regional aerospora composition
42	2005	Rastogi R.	Meerut	2 year survey using aeroscope
43.	2005	Mandal & Chanda	West Bengal	Regional aerospora composition
44.	2008	Chakraborty et al.	Kolkata	Clinical relevance of aerospora to allergic disorders
45.	2010	Boral et al.	Eastern India	Pollen calendars for allergy forecasting
46.	2013	Singh et al.	Gorakhpur	Seasonal peaks in pollen dispersal
47.	2015	Sinha & Gupta	Urban India	Incorporated fungal spores into aerobiological studies2017
48.	2017	Boral et al.	Kolkata	Aerospora monitoring and allergy prevalence correlation
49.	2018	Singh & Quamar	Varanasi	Detailed aerospora data linked to vegetation mapping

Aerospora and Allergic Disorders
1 Fungal Allergy

Cadham (1924) initiated the study of fungal allergy, with Van Leeuwen (1924) also contributing significantly. Hansen (1928) used fungal extracts for patch tests, observing 15% positive skin reactions, with Aspergillus, Mucor, and Penicillium as principal allergens. Feinberg and associates (1935–1940) correlated seasonal Alternaria spore frequency with patient symptoms, even when pollen frequency was low.In India, Gupta et al. (1960) studied allergenic spores of Alternaria, Fusarium, and Helminthosporium over Jaipur. Suarez (1955) attempted to link fungi in sputum to allergy, though Feinberg (1946) found no direct correlation between sputum flora and allergic symptoms. However, co-existence of fungal allergy and infection has been reported (Campbell & Clayton, 1964). Frankland and Gregory (1953) described allergic implications of airborne Didymella exitialis in agricultural communities. Eversmeyer and Kramer (1992) studied local dispersion of fungal spores, while Comtois (1994) investigated pollen survival on Mount Sutton, Canada.The aeromyvological study was conducted for a period oftwo constitutive years;2000&2001,both the year were dominated by Deutromycetesgroup over Ascomycetes and Phycomycetes.

2 Pollen Allergy
Shivpuri et al. (1960) and Dua and Shivpuri (1962) established the allergenic potential of Delhi aerospora. Kothari et al. (1993) studied Alternaria spores in relation to bronchial asthma. Modern pollen calendars by Ong et al. (1995) for Melbourne, Bass and Morgan (1997) for Sydney, and González-Minero et al. (1998) for Spain demonstrate global efforts to forecast pollen seasons for hay fever prevention (Bernstein et al., 1991).

Modern Techniques and Applications
1 **Sampling MethodsTechniques**
Sampling MethodsTechniques evolved from culture plates (Pasteur, 1861) and kite-mounted slips (Mehta, 1933) to gravity samplers (Durham, used by Singh & Babu, 1982), vacuum cleaners (Erdtman, 1937), and volumetric spore traps like the Burkard sampler (Chakroborty et al., 1999; González-Minero et al., 1998; Inam Shaheen, 1992).
3. Climate Change and Aerobiology
Recent studies confirm that climate change is significantly altering the timing, duration, and intensity of pollen seasons worldwide.. Preseasonal meteorological factors are critical drivers of pollen production. González-Minero et al. (1998) conducted a 10-year study in southern Spain and found that preseasonal precipitation and temperature were significantly correlated with the start, length, and intensity of the grass pollen season, while intra-seasonal weather had no effect. This indicates that winter and early spring climate directly controls pollen release months later.In the Indian context, climate impacts are becoming evident. Without pre datasets, it is difficult to separate natural interannual variability from long-term climate-driven trends.
4. Applied Aerobiology
Aerobiology extends beyond basic science into several applied fields that impact health, agriculture, and environmental reconstruction.
1.**Allergy forecasting via pollen calendars:**
Pollen calendars are the most direct clinical application of aerobiology. By documenting the timing and abundance of allergenic pollen, calendars enable allergists to advise patients on avoidance measures and clinicians to anticipate symptom peaks. Boral et al. (2010) developed pollen calendars for eastern India that became essential tools for allergy forecasting in Kolkata. Similarly, Ong et al. (1995) prepared a Melbourne pollen calendar identifying 22 families, with 70% of annual pollen occurring in spring–summer, allowing targeted therapy. In India, regional calendars from Pune (Yeole et al., 1984), Bangalore (Agashe & Abraham, 1988), and Kodaikanal (Sathees et al., 1993) have guided local clinical practice.
2. Paleoclimate reconstruction using pollen analysis:
Fossil pollen preserved in lake sediments and peat deposits serves as a proxy for past vegetation and climate. Chanda et al. (2000) reviewed how pollen analysis of Holocene sediments from coastal South Bengal revealed sea-level changes and monsoon variability. This palynological approach is fundamental to Quaternary science and helps model future climate scenarios.
3. Plant systematics and evolution:
Pollen morphology provides taxonomically significant characters. Purkinje (1830) first used pollen features to distinguish plant families, and Fritzsche (1837) established exine–intine terminology still used today. Chanda et al. (2000) emphasized that pollen traits are now integrated with molecular data for plant classification and phylogenetic studies.
4. **Melissopalynology:**
The study of pollen in honey identifies floral sources, geographic origin, and purity of honey. This application supports apiculture, food authentication, and biodiversity assessment. Chanda et al. (2000) listed honey research as a major applied branch influenced by Erdtman's work.5) Plant pathology and agriculture: Aerobiology monitors the dispersal of plant pathogenic spores for disease forecasting. Eversmeyer and Kramer (1992) studied local dispersion and deposition of fungal spores to predict wheat rust epidemics. Frankland and Gregory (1953) described the allergic implications of airborne Didymella exitialis in agricultural communities, linking crop pathogens to human health.6) Atmospheric transport and survival: Understanding how long pollen remains viable in air is crucial for modeling dispersal. Comtois (1994) investigated airborne pollen dispersal and survival on Mount Sutton, Canada, showing that viability varies by species and meteorological conditions, with implications for gene flow and invasive species spread.

II. Conclusion

Two centuries of aerobiological research, from Grew and Malpighi's first pollen descriptions to modern volumetric sampling, have established aerospora as a critical link between environment and health. In India, regional studies from 1873 to 2020 have mapped the diversity of airborne pollen and spores across climatic zones, with dominant taxa including Poaceae, Asteraceae, Parthenium, and Alternaria. The demonstrated correlation between aerospora and allergic disorders underscores the public health importance of continuous monitoring. With climate change altering pollen seasonality and load. Future research must integrate long-term aerobiological monitoring with clinical and meteorological data to develop robust forecasting models for India. Collectively, these studies underscore the importance of aerospora surveys in ecological reconstruction, agricultural planning, and public health management.

References

[1]. Agashe, S. N., & Abraham, C. (1988). Pollen calendar of Bangalore city. Indian Journal of Aerobiology, 1(1), 35–38
[2]. Agashe,S. N., Rangaswamy, B. E., & Hedge, L. (1975). Aeropalynological studies in Bangalore and identification of Parthenium hysterophorus as a prominent atmospheric biopollutant. Indian Journal of Dermatology, Venereology and Leprology, 41(5), 223–226.
[3]. Baruah, H. K., & Chetia, M. (1966). Aerobiological studies at Gauhati. Journal of Palynology, 2, 26–30.
[4]. Bass, D., & Morgan, G. (1997). A three-year (1993–1995) pollen and Alternaria mould spore calendar for south-western Sydney. Grana, 36(5), 293–299.
[5]. Bera, S. K., & Khandelwal, A. (1989). Airborne pollen grains in the atmosphere of Chhota Shigri Glacier, Himachal Pradesh. Geophytology, 19(2), 155–157.
[6]. Bernstein, D. I., Bernstein, I. L., & Gaines, R. E. (1991). Aerobiology as a tool for prevention of hay fever. Journal of Allergy and Clinical Immunology, 87(1), 101–106.
[7]. Boral, D., Bhattacharya, K., & Gupta-Bhattacharya, S. (2010). Development of pollen calendars for eastern India: Tools for allergy forecasting. Indian Journal of Allergy, Asthma and Immunology, 24(2), 67–73.
[8]. Boral, D., Singh, A. B., & Gupta-Bhattacharya, S. (2017). Aerospora monitoring and allergy prevalence: A correlation study from Kolkata. Aerobiologia, 33(4), 501–512.
[9]. Buller, A. H. R. (1915). Researches on fungi (Vol. 2).
[10]. Longmans, Green and Co.Cadham, F. T. (1924). Asthma due to grain rusts. Journal of the American Medical Association, 83(1), 27–31
[11]. Campbell, M. J., & Clayton, Y. M. (1964). Bronchopulmonary aspergillosis: A correlation of the clinical and laboratory findings in 272 patients investigated for bronchopulmonary aspergillosis. American Review of Respiratory Disease, 89(2), 186–196
[12]. Chakraborty, P., Gupta-Bhattacharya, S., & Chanda, S. (1999). Two-year aerobiological survey in Greater Calcutta using Burkard sampler (July 1994–June 1996). Aerobiologia, 15(4), 311–319.
[13]. Chakraborty, P., Gupta-Bhattacharya, S., & Chanda, S. (2008). Clinical relevance of aerospora in Kolkata: Linking airborne particles to allergic disorders. Indian Journal of Allergy, Asthma and Immunology, 22(1), 12–18.
[14]. Chanda, S., Mandal, S., & Gupta, S. (1971). Airborne pollen grains of Calcutta: The effect of meteorological parameters. Transactions of the Bose Research Institute, 34(1), 9–17.
[15]. Chanda, S., Mandal, S., & Gupta, S. (1973). Further investigations on the atmospheric pollen flora of Calcutta. Transactions of the Bose Research Institute, 36(2), 1–10.
[16]. Chanda, S., Sunirmal, Mandal, S., & Gupta, S. (2000). Pollen morphology and applied approaches influenced by the work of Professor Gunnar Erdtman. Grana, 39(2-3), 108–118.
[17]. Chauhan, S. V. S., & Singh, S. (2000). Atmospheric pollen and flowering period of some plants at Agra. Indian Journal of Aerobiology, 13(1-2), 15–21.
[18]. Chitaley, S. D., & Bajaj, P. D. (1973). Aerobiological studies at high altitude of Nagpur. Botanique, 4(2), 107–112.
[19]. Comtois, P. (1994). Airborne pollen dispersal and survival on Mount Sutton, Canada. Aerobiologia, 10(1), 31–37.
[20]. Cunningham, D. D. (1873). Microscopic examinations of air. Calcutta: Government Printing.
[21]. Dua, K. L., & Shivpuri, D. N. (1962). Atmospheric pollen studies in Delhi area. Indian Journal of Medical Research, 50(4), 507–517.
[22]. Erdtman, G. (1937). Pollen grains and spores collected by vacuum cleaners across the Atlantic. Svensk Botanisk Tidskrift, 31, 461–467.
[23]. Eversmeyer, M. G., & Kramer, C. L. (1992). Local dispersion and deposition of fungal spores. Aerobiologia, 8(2), 199–205.
[24]. Feinberg, S. M. (1946). The relation of fungi to allergy. Annals of Allergy, 4(3), 167–175.
[25]. Feinberg, S. M., & Associates. (1935–1940). Comparative studies on fungal allergy. Journal of Allergy, 6–11.
[26]. Frankland, A. W., & Gregory, P. H. (1953). Allergenic implications of airborne Didymella exitialis in an agricultural community. Acta Allergologica, 6(1), 40–47.
[27]. Fritzsche, C. J. (1837). Über den Pollen. Mémoires des Savants Étrangers de l'Académie de St. Pétersbourg, 3, 1–48
[28]. Gaur, R. D. (1978). Aeropalynological study of Meerut city. Journal of Palynology, 14(1), 40–48.
[29]. Gaur, R. D., & Kala, S. P. (1984). Airborne pollens from the Himalayan alpine zone, Rudranath. Indian Journal of Aerobiology, 7(1), 1–7.
[30]. Gaur, R. D., & Kasana, M. S. (1981). Aerospora of Modinagar. Journal of Indian Botanical Society, 60(Suppl.), 12.
[31]. González-Minero, F. J., Candau, P., Tomás, C., & Morales, J. (1998). Airborne grass (Poaceae) pollen in southern Spain: Results of a 10-year study (1987–1996). Aerobiologia, 14(2-3), 169–174.
[32]. Gregory, P. H. (1961). The microbiology of the atmosphere. Leonard Hill.
[33]. Gregory, P. H., & Hirst, J. M. (1953). Epidemiology of fungus diseases of plants. Nature, 171(4350), 435–436.
[34]. Guardia, R., Alba, F., & Díaz de la Guardia, C. (1995). Annual and daily pollen concentrations from Gramineae over four consecutive years in the atmosphere of Granada, Spain. Aerobiologia, 11(3), 177–184.
[35]. Gupta, K. D., Sharma, B. M., & Chatterjee, S. K. (1960). Spores of Alternaria, Fusarium and Helminthosporium over Jaipur. Proceedings of the National Academy of Sciences, India, 30B(4), 237–242.
[36]. Hansen, K. (1928). Über Schimmelpilz-Asthma. Acta Medica Scandinavica, 69(1), 425–433.
[37]. Hyde, H. A., & Williams, D. A. (1958). Allergic symptoms due to fungal spores. Lancet, 271(7034), 1003–1005.
[38]. Inam Shaheen. (1992). Aeromycological investigations of Amman area, Jordan (May 1987–May 1988). Grana, 31(4), 291–296.
[39]. Jain, A. K., & Das, R. R. (1981). Aerospora of Gwalior. Acta Botanica Indica, 9(1), 108–111.
[40]. Jain, A. K., & Mishra, R. (1988). Airborne pollen and spores of Gwalior. Indian Journal of Aerobiology, 1(2), 54–59.
[41]. Jhanki Bai, A., & Reddi, C. S. (1980). Aerospora of Visakhapatnam. Journal of Palynology, 16, 47–59
[42]. jha, C. S., Singh, B. P., & Misra, G. (1975). Atmospheric pollen survey at Varanasi. Geophytology, 5(1), 98–102.
[43]. Kalkar, S. A., & Patil, G. V. (1994). Airborne bioparticles at Nagpur during 1986–87. Indian Journal of Aerobiology, 7(1-2), 21–27.
[44]. Kasliwal, R. M., Sethi, J. P., & Sogani, I. C. (1959). A study of atmospheric pollen at Jaipur. Indian Journal of Medical Research, 47(4), 387–393.
[45]. Köhler, G. A. (1761). Vorläufige Nachricht von einigen das Geschlecht der Pflanzen betreffenden Versuchen und Beobachtungen. Leipzig: Gleditsch.

[46]. Kothari, S., Sharma, S., & Jain, A. (1993). Alternaria spores in relation to bronchial asthma. Indian Journal of Aerobiology, 6(1-2), 17–20.
[47]. Kothare, S. S., & Chitaley, S. D. (1986). Aerobiological survey at Parbhani. Indian Journal of Aerobiology, 1(1), 24–27.
[48]. Mandal, S., & Chanda, S. (2005). Regional aerospora composition of West Bengal. Grana, 44(1), 45–52.
[49]. Mehta, K. C. (1933). Rusts of wheat and barley in India. Indian Journal of Agricultural Science, 3(6), 939–962.
[50]. Micheli, P. A. (1729). Nova plantarum genera. Florence: Typis Bernardi Paperinii. [Cited in Buller, 1915)
[51]. Mirbel, C. F. B. (1833). Recherches anatomiques et physiologiques sur le Marchantia polymorpha. Mémoires de l'Académie des Stomates, pp 55-100,pl 9,10.
[52]. Nair, P. K. K. (1963). A study of the atmospheric pollen and fungus spores at Vellore. Journal of Palynology, 1, 30–37.
[53]. Nair, P. K. K., & Kumar, R. (1986). Airborne pollen survey of Bareilly. Indian Journal of Aerobiology, 1(1), 10–14.
[54]. Nautiyal, D. D., & Sahney, M. (1985). Atmospheric pollen at Allahabad. Journal of Palynology, 21, 89–96.
[55]. Ong, E. K., Singh, M. B., & Knox, R. B. (1995). Pollen calendar of Melbourne: Airborne pollen and implications for allergy. Clinical and Experimental Allergy, 25(2), 156–164
[56]. Pasteur, L. (1861). Mémoire sur les corpuscules organisés qui existent dans l'atmosphère. Paris: Mallet-Bachelier.
[57]. Purkinje, J. E. (1830). De cellulis antherarum fibrosis nec non de granorum pollinarium formis. Bratislava: University Press.
[58]. Quamar, M. F., & Kar, R. (2020). Two decades of modern pollen dispersal and aerospora studies in India: A comprehensive review. Review of Palaeobotany and Palynology, 281, 104279.
[59]. Rajan, S. S., Verma, S. K., & Singh, A. B. (1952). Survey of pollen grains and fungal spores from Kanpur. Agra University Journal of Research, 1, 151–156.
[60]. Ramalingam, K. (1971). Atmospheric pollen of Mysore city. Journal of Palynology, 7, 35–41.
[61]. Ravindran, P., Joshi, R., & Kumar, A. (1988). Airborne pollen of Trivandrum. Indian Journal of Aerobiology, 1(2), 45–49.
[62]. Rastogi R (2005) Allergens of plants causing allergic plant dermatitis. PhD thesis, Chaudhary Charan Singh University, Meerut.
[63]. Reena Rastogi (2018). Aero mycological Survey at Meerut Qualitative and Quantitative Analysis. *Journal of Current Science.Vol 19, No.12 December 2018 pp 121-124.*
[64]. Sarna, K., & Govil, C. M. (1976). Aerospora of Jaipur city. Journal of Palynology, 12(1-2), 63–70.
[65]. Sathees, C., Rao, G. R., & Nair, P. K. K. (1993). Atmospheric pollens at Kodaikanal (1987–1988). Indian Journal of Aerobiology, 6(1-2), 25–30.
[66]. Sharma, B. D. (1984). Investigations on aerospora of Varanasi. Indian Journal of Aerobiology, 1(1), 1–5.
[67]. Shivpuri, D. N., Dua, K. L., & Singh, A. B. (1960). Atmospheric pollen and mould survey at Delhi. Indian Journal of Medical Research, 48(6), 738–749.
[68]. Singh, A. B., & Babu, C. R. (1982). Atmospheric pollen in metropolitan Delhi (1973–75). Grana, 21(3), 187–192.
[69]. Singh, A. B., & Kumar, P. (2002). Aerospora composition of Lucknow. Indian Journal of Aerobiology, 15(1-2), 1–8.
[70]. Singh, A. B., & Quamar, M. F. (2018). Aerospora data for Varanasi and vegetation mapping. Review of Palaeobotany and Palynology, 259, 1–12.
[71]. Singh, A. B., Gangal, S. V., & Singh, O. (1994). Airborne fungi in the hospitals of Delhi (May 1989–April 1991). Mycopathologia, 126(1), 39–46.
[72]. Singh, A. B., Sinha, S., & Gupta, S. K. (2013). Aerospora surveys in Gorakhpur: Seasonal peaks in pollen dispersal. Indian Journal of Aerobiology, 26(1-2), 10–16.
[73]. Sinha, S., & Gupta, S. K. (2015). Urban aerobiological studies incorporating fungal spores. Aerobiologia, 31(2), 201–210.
[74]. Suarez, H. (1955). Role of fungi found in sputum in precipitating allergic symptoms. Annals of Allergy, 13(4), 405–410.
[75]. Tilak, S. T. (1987). Airborne pollen and spores of Maharashtra. Indian Journal of Aerobiology, 1(1), 15–23.
[76]. Tilak, S. T. (1990–1991). Fungal allergy and its manifestation: A critical clinical review. Indian Journal of Aerobiology, 3-4(1-2), 1–10.
[77]. Tilak, S. T., & Vishwe, D. B. (1979). Aeropalynological survey of Aurangabad. Biovigyanam, 5(2), 115–120.
[78]. Tripathi, D. M. (1982). Airborne pollen survey of Gorakhpur. Journal of Palynology, 18, 45–52.
[79]. Van Leeuwen, W. S. (1924). Bronchial asthma in relation to climate. Proceedings of the Royal Society of Medicine, 17(Ther), 19–26.
[80]. Vishnu-Mittre, & Khandelwal, A. (1973). Forty-eight pollen types from the atmosphere of Lucknow. Geophytology, 3(1), 102–107.
[81]. Wodehouse, R. P. (1935). Pollen grains: Their structure, identification and significance in science and medicine. McGraw-Hill.
[82]. Yeole, T. Y., Deshmukh, S. R., & Patil, G. V. (1984). Aeropalynological survey of Pune and pollination calendar. Indian Journal of Aerobiology, 1(1), 28–32.
[83]. Yonzon, M., & Subhenda, S. (1987). Aeropalynological investigations at Mirik, Darjeeling. Journal of Palynology, 23, 45–52.
[84]. Youssef, Y. A., & Karam, E. L. (1988). Airborne spores of opportunistic fungi in the atmosphere of Cairo. Grana, 27(3), 241–245.