CHAPTER-I
INTRODUCTION

Air functions as strongest medium for the dispersal and survival of microbial spores, pollen grains, pollutant, aerosol, water vapour, dust and mist particles in the atmosphere. The differences in its composition variously supports variety of aeroflora. F.C. Meier (1893-1939) of Agriculture department of U.S.A., collectively use the term aerobiology for the studies of airspora including airborne fungal spores, pollen grains, trichomes, bacteria and other microorganisms which later on get elaborated to include dispersion of insect populations and viruses (Jacob 1951) etc.

The International Biological Programme (IBP) in 1964 has included the air pollutants such as gasses of specific biological significance. Aerobiology is a branch of science, deals with the study of source, discharge, dissemination, sedimentation and impact of airborne propagules on the other living and non living systems.

The airborne fungal spores hyphal fragments, conidia, sporangia and sporangiophores become airborne while in actively metabolizing phase and are generally imperceptible in ambient air are known as aerofungi. The fungi more commonly occur as spore are hardier metabolically less active and often better accomodated to aerial dispersal. These microscopic fragments may be single cell or multicelled consisted or incompletely separated by perforated septa of various shapes and sizes, move in the air in suspended from. Giant form of fungal spores and fragments are generally settle down on the substratrum and are not considered as a component of aeromycoflora. (Prasad 1991).
Fungal spores were detached from their stalks and are dispersed into the atmosphere, generally constitute the major component of the airspora. Total concentration of aerofungi fluctuates due to variation in weather conditions such as temperature, relative humidity, rainfall, wind velocity and wind direction etc. Distance covered by spores largely based on the size and weight of the spores are subjected to the physical conditions prevailing in the atmosphere at ant time, which are solely responsible for the air movement of spores and pollen grains. These are suspended in the atmosphere for longer period at lower temperature, humid air than that of higher temperature and dry air. Hence there is a close relationship between aerobiological behaviour and meteorological conditions. These particles are mainly confined to the troposphere layer of the (extending from earth surface upto a height of approximately 10Km) atmosphere. Hence the quality and quantity of aerofungi are subjected to the various meteorological changes of the lower layer of the ambient air.

The aeroflora is significant in the atmosphere because of-

(i) Fungi may decompose number of biological material in the atmosphere or nature.

(ii) Most of the saprophytic aerofungi are biodeterioraters.

(iii) Some of the aerofungi are allergenic to human beings and domestic animals.

(iv) Many fungal pathogen are airborne.

(v) Aeroflora may be used as defence material in biological war by the dissemination of some virulent forms in the opponent atmosphere.
INTRODUCTION

AEROMYCOLOGICAL STUDIES IN ABROAD

The role of contaminated air with large number of living microorganisms was first of all noticed by Lecretius (55BC). He concluded that the moving motes are baleful particles responsible for spontaneous generation of large number of microbes pathogenic or otherwise. After this significant observation, men had to wait for a long time, until the invention of microscope by Antony Von Leeuwenhoek in 17th century.

Neapolitan botanist Porta first of all observed the fungal spore in past 16th century but it was Micheli (1679-1737) a botanist of Florence who first collected the seeds of mushrooms cup fungi, truffles, moulds and slime moulds. He also concluded that the mould spores are distributed through air.

Floyer (1726) reported the first case of fungal allergy sensitivity. Pasteur (1861) predicted that a minute quantity of air contains a large number of microbes. Salisbery (1866) recognized the connection of airspora with malaria in the Ohio and Mississippi valleys by the exposure of glass sheets above marshy places.

Blackley (1873) reported a number of mould spores on slides exposed with the help of kites for pollen counting Cristiani (1893) found bacteria and few moulds by volumetric sampling from a balloon at 1300 meters above ground level in Geneva. Harz (1904) observed few moulds and bacterial concentration on nutrient gelatine over southern Bavaria at altitudes of 1500-2300 meters.

Stakman et. al. (1923) was first of all exposed vaseline coated slides over the Mississipi valley to trap cereal rust spores by using aeroplanes. Mischustin (1926); Weston (1929); Browne (1930); Cotter (1931);
Macquiddy (1935); Maclachlan (1935); Tarsuqi & Kurosawa (1938) studied the distribution of bacteria, mould spores and pollen separately from different places and found different concentrations of spores at different heights.

The aeroflight over the United States by Meier et al. (1935) showed a varied spore population. They identified *Acremoniella, Alternaria, Aspergillus, Chaetomium, Cladosporium, Coniothyrium, Dematium, Epicoccum, Fumago, Fusarium, Helminthosporium, Penicillium, Pestalozzia, Sclerotinia, Stachybotrya, Stemphylium* and *Trichoderma*.

Large (1940) reported that the crop diseases were repeated out due to wind by airborne fungus. Pady & Kapica (1953) concluded that the streptomycetes, Yeast and actinomycetes were common in the aerobiological survey of Montreal.

Ainsworth (1952) studied the incidence of airborne Cladosporium spores in London region by petridish exposure technique. Gregory (1952) & Hirst (1959) studied the mean spore concentration at two meters by using Hirst automatic Volumetric spore trap.

Menna (1955) made a quantitative study of intramural and extramural airborne fungal spores in Dunodin, New Zealand by using culture plate method and obtained least yield during winter and highest in summer. Hyde (1956) reported the presence of flowering plant's pollen at the altitude of 38 meters from the sea level by the use of gravity slide method.

Gregory (1961) thoroughly studied the dissemination as well as impaction of bioparticles of agricultural crops and concluded that only 10% of the spores released by any source are diffuse upwards and rest were deposited on the same or different crops.
Upsher and Griffiths (1973) recognized 119 genera with distinct and seasonal variations in Queensland, Australia by exposed plate method. Lacey (1975) studied the airborne spores in the pastures land at Rathamsted and found that Cladosporium species was predominant and represented by 90% of the total fungal population.

Row; Farley and Coplin (1977) studied the airborne spore dispersal and recolonization of steamed soil by Fusarium- oxysporum in tomato green house. Chastaner et.al. (1978) observed the dispersal of conidia of Botrytis-cinera in tomato fields.

Kilironomas et.al. (1997) have reported the increased level of airborne fungal spores in response to Populus-tremuloides grown under elevated atmospheric carbon dioxide. Danin and Ganor (1997) have investigated the trapping technique of airborne dust with the help of Eig's meadow grass (Poa-eigii) in the Judean desert Israel.

Garty et.al. (1998) have studied the integrity of lichen cell membrane in relation to concentration of airborne elements. Eduard & Heederik (1998) introduce the method of quantitative assessment of airborne levels of non-infectious microorganisms in highly contaminated enviroments.

Heuer and Smalla (1999) investigated the bacterial phyllosphere communities of Solanum turberoum L. and T4 lysozyme producing transgenic variants.

Brighigna et.al. (2000) reported the influence of air pollution on the phyllosphere micoflora composition of Tillandsia (Bromeliaceae) leaves. Fiss et.al. (2000) reported the isolation and characterization of epiphytic fungi.
INTRODUCTION

from the phyllosphere of apple as potential biocontrol agent against apple scab. Mclean and Prakinson (2000) collected the field evidence of the effects of the epigeic earthworm Dendrabaena-octaedra on the microfungal community in pine forest floor.

Yang et. al. (2001) reported that the microbial phyllosphere population are more complex than previously realized. Effect of solar uv-β radiation on a phylloplane bacterial community was studied by Jacob and Sundin (2001). Parvaneh et. al. (2001) proposed a new method for collecting airborne allergens. Airborne viable fungi in Riyadh and allergenic response of their extract were presented by Alsuwaini et. al. (2001). A rapid method for assessing the viability of fungal spores were recently introduced by Chen and Swartz (2002).

DEVELOPMENT OF AEROMYCOLOGY IN INDIA:

The first report of a comprehensive aeromycological work in India was published in 1873 by Cunningham dealing with the atmosphere of Calcutta, then capital of India, in view of its increasing urbanisation. It is revived almost after a century by K.C. Mehta (1940-42) with reference to the recurrence of wheat rusts in plains. At the same time, work started in two other centres, one at Kanpur and other is South east region of the country by Rajan and Coworkers (1952) and Padmanabhan et. at. (1953) respectively. In western region it started through the work of Kalra & Dumbry (1957) in the compus of Medical college, Pune and Tilak and Coworkers (1982) in Aurangabad.

Aeromycological works done in India are briefly given below: In view of the climatic topographical and ecological diversities and for the sake of convenience, the entire country has been divided in to five biozones,
namely- (i) Northern, (ii) Eastern, (iii) Central, (iv) Western and (v) Southern regions.

(i) **NORTHERN REGION**:

Mehta and his coworkers, while working for the recurrence of stem rust of wheat in Northern India, performed experiments (1940-42) by using aeroscope at 62 stations located at different parts of the country. Rajan et. al. (1952) recorded 38 species of fungi from the air in Kanpur, the most common being species of *Aspergillus*. Bharat Rai (1969) isolated 1147 spores, belonging to 41 spore types from Varanasi. Mishra and Kamal (1971), Mishra (1972) Mishra and Srivastava (1970-71), studied air fungal population of Gorakhpur, from January to December, covering all the seasons. In Lucknow the work of aerobiology was started by Lakhanpal & Nair (1954) who in their preliminary work survey the atmospheric pollen by slide exposure (Aeroscopes). Vishnumittre and Khandelwal (1969-74) isolated both pollen and fungal spores from the atmosphere at 30 feet height at Birbal sahni institute of Palaeobotany Lucknow. Agnihotri & Singh (1971) published their observation on pollinosis in Lucknow. In an analysis of fungal spores of B.S.I.P. Lucknow Wardhwani (1979) reported 26 fungal taxa belonging to different group of fungi. Srivastava & Wadhwa (1986) analysed the fungi over four fruits and vegetable market of Lucknow namely- Chowk, Kaiserbagh, Rakabganj and Daliganj.

Nautiyal and Midha (1978) reported maximum contribution of *Cladosporium* and *Alternaria* in the aeromycoflora of Allahabad along with pollen. Gaur (1980) from Meerut reported two years of fungal spores started from October 1966 to September 1968. Gaur and Kasana (1981) surveyed the
AEROMYCOLOGICAL CENTRE OF INDIA

A. (1-13) North Zone
   1. Amritsar
   2. Dehradun
   3. Muzaffar Nagar
   4. Meerut
   5. Modi nagar
   6. Delhi
   7. Agra
   8. Bareilly
   9. Kanpur
   10. Lucknow
   11. Varanasi
   12. Gorakhpur
   13. Allahabad

B. (14-18) East Zone
   14. Gauhati
   15. Shillong
   16. Kolkata

C. (19-22) Central Zone
   17. Vishakhapatnam
   18. Cuttuck
   19. Sagar
   20. Bhopal
   21. Mannmad
   22. Nagal
   23. Jaipur
   24. Mumbai
   25. Aurangabad

D. (23-26) West Zone
   26. Pune
   27. Bangalore
   28. Mysore
   29. Vellore
   30. Chennai
   31. Trivendram

E. (27-31) South Zone
   32. Banglore
   33. Mysore
   34. Vellore
   35. Chennai
   36. Trivendram
atmospheric microbial population of Modinagar, a semi-industrial area situated in western Uttar Pradesh. Kumar and Gupta (1976-77) and Kumar (1984) gave a very comprehensive account on fungal spores in the air of Dehradun city. Kumar and Nair (1985-86) studied aeromycoflora of Bareilly and compared their occurrence in other places.

In Punjab, at Amritsar, Sandhu & Randhawa (1979) reported airborne fungal spores in relation to keratomycosis. Extensive studies by Shivpuri and coworkers (1960-75) at Delhi enabled them to evolve a pollination calendar. Agarwal and Shivpuri (1974) reported that the atmosphere was never free from fungal spores of *Alternaria, Cladosporium* and *Helminthosporium* in Lucknow city and surrounding area.

(ii) **EASTERN REGION:**

The first systematic study on aerobiology in eastern region was carried out by Cunningham (1837). He studies airborne biological materials over the Calcutta Jail. This work was revived by Chanda and his coworkers (Chanda and Nandi 1971; Chanda and Sarker 1972-74; Chanda 1973) and their studies of eight years, resulted in the preparation of pollination calendar for Calcutta. Chakravorty (1974) reported 31 spore types from urban and rural localities of West Bengal. Saha et. al. (1980) reported the presence of 178 aeromycoflora from southern Bengal. Santra and Chanda (1981) studies the indoor airborne fungal flora of Calcutta. Mandal and Chanda (1981) published an extensive data on aeroallergens of West Bengal.

Padmanabhan et al. (1953) estimating airborne conidia of *Helminthosporium oryzae* in paddy fields of Cuttack (Orissa). Konger and Baruah (1958) have reported airborne fungal spores in and around Shillong.
INTRODUCTION

(Meghalaya). Bharuch and Chetia (1966) used culture plate technique and reported the presence of *Aspergillus Cladosporium, Curvularia* and *Penicillium* from Gauhati (Assam).

Sahay (1983) has worked on the mycoflora of Gaya and found that the *Aspergillus-niger* is the most dominant airborne fungus of Gaya. She also worked on the seasonality and circadian effect on the suspended and settled dust mycoflora of Gaya.

Sinha (1986) has observed aerofungi, pollen grains, trichomes and miscellaneous biota with a maximum representation of aerofungi from Deuteromycetes in Magadh University BodhGaya by the use of petriplate exposure technique.

Sinha and Mishra (1988) have identified 29 fungal species over tropical and rural site of Gaya. Maximum aerofungal spore concentration was recorded during summer month followed by rainy and winter season respectively.

Kumar (1990) has isolated 135 species from 50 genera of aerofungi at Nawada, Bihar by the petriplate exposure technique from May 1984 to April 1986.

Prasad et. al. (1990) reported 48 genera and 119 species during aeromycological study in rural area of Nalanda. *Aspergillus, Cladosporium, Alternaria, Penicillium* and *Curvularia* was dominant species while *Cercospora, Torula, Nigrospora* and *Trichothecium* were rare species.

Prasad (1991) has worked on aerofungi of Bihar sharif and reported 176 species and 71 genera from August 1988 to July 1990 in which
Deuteromycetes members were more common than Ascomycetes and Phycomycetes.

Singh (1991) has reported altogether 76 species belonging to 31 genera over paddy field of Nawada from June 1987 to May 1989. Ghani and Kale (1992) have sampled aeromycospora of Bhagalpur. The most common fungal forms were *Aspergillus*, *Alternaria*, *Curvularia*, *Penicillium* and *Rhizopus* etc.

(iii) CENTRAL REGION:

Tripathi et. al. (1977) have reported the atmospheric pollen from Bhopal. Atmosphere was found to be loaded with tree pollens (15%) followed by herb (46%) and shrub (3%).

Verma and her coworkers work thoroughly on aerobiology at Jabalpur since 1981. Verma & Khare (1987) have studied the airspora around Jabalpur University Campus. Air spora of Nimadganj (Jabalpur) vegetable market area at Jabalpur was reported by Verma & Sheore (1989). Verma and Srivastava have made a volumetric survey of atmospheric fungal spores in 1992. She and Soni (1997) reported allergenicity of certain airborne fungal spores at Jabalpur with reference to respiratory allergy. Verma has also made some observation on the aeromycoflora using a combination of vertical Durham and Rotorod samplers, in 1998. Verma along with George (1999-2000) have studied the seasonal and diurnal variation of airborne fungal spores of Jabalpur and its Volumetric estimation.

(iv) WESTERN REGION:

Kalra and Dumby (1957) reported the occurrence of mites as one of the components of air pollutants in Pune. Chaubal and Deodikar (1964)
found that the most common spores in the air of Pune were *Alternaria*, *Helminthosporium*, *Curvularia* etc.

Chitaley and Bajaj (1973, 74, 45) carried out systematic aerobiological studies at Nagpur. Pande (1983) studied atmospheric concentration of urediniospores of total airspora over groundnut field at Nanded.

D, Silva and Freitas (1982) reported that the spore concentration of *Aspergillus*, *Penicillum* and *Cladosporium* together formed 75 to 80% of total load in aerofungal flora of Mumbai.

Guikwal and Sankaya (1984) have studied air spora of Maharashtra, isolated 34 spores type, 10 belonging to Ascomycotina 4 to basidiomycotina and 20 Deuteromycetes.

Chaubal and Kotmire (1985) have reported 7 new types in aeromycoflora out of 88 fungal in the hospital premises at Kolhapur. Jagdanand (1987) has reported the airspora over jowar fields and Ramchander Rao (1987) has studied the airsporal component over bajara and sunflower fields at Aurangabad. Reddy (1988) has studied the airspore over sunflower fields at Aurangabad.

Under the guidance of S.T. Tilak and advancement in aerobiological studies took place with the fabrication of an air sampler, almost in all the regions of Maharashtra especially Marathwada. The studies were carried out the crop fields and in relation to plant disease (Kulkarni 1997; Chitaley 1977; Wadje and Despande 1977; Tilak and Kulkarni 1978; Lakhe 1980) in sheep shed, poultry and green house (Tilak 1974; Patil 1979; Tilak and Bhalke 1979; Babu 1983; Tilak and Babu 1983) and in relation to air population and
INTRODUCTION

diurnal periodicity of spores belonging to different groups (Tilak and Chakre 1974; Tilak and Babu 1986).

Gupta et. al. (1960) have prepared a pollination calendar during aeropalynological study on Jaipur. These studies also reported *Alternaria, Fusarium* and *Helminthosporium* as airborne spores (Gupta et. al. 1983).

(v) SOUTHERN REGION:


OBJECTIVES:

If the three essential conditions for disease development i.e. susceptible host, a virulent pathogen and favourable environment is present, the plants may suffer to serious diseases. The airborne microorganisms thus have a vital and significant impact on the plant productivity and damage caused by them is enormous and are difficult to assess. The more we know about the airborne microorganisms more we would be in a position to deal with the consequences.

No information about the various microflora of air causing serious damage to our ornamental, woody and economically important crop plants is available. The present work has been planned to collect the real information about the microbial population in the polluted and unpolluted atmosphere.
INTRODUCTION

of Jaunpur. The set goals will be achieved by the following objectives:

1. General survey about the air pollution status of Jaunpur city.

2. Taxonomic analysis of mycoflora inhabiting in phyllosphere of different tree species.

3. Analysis of nutrient composition of phyllosphere and phylloplane of three tree species i.e. (M.indica, A.hetrophyllus and D.sissoo).

4. Qualitative estimation of airmicrobes present in the air of different study sites.

5. Quantitative estimation of mycoflora at five (VBS, RSS, SMS, BPS and MTS) present in different study sites.

6. Germination performance of fungal spores under culture conditions.

7. Statistical analysis to assess the significance values of observed data and their correlation with other parameters.