CHAPTER I
INTRODUCTION

Aerobiology is a scientific and multidisciplinary approach focused on the transport of organisms and biologically significant materials by the atmosphere.

Aerobiology is a recently developed multidisciplinary science dealing with aerial bio-particles present both in outdoor and indoor environment and their impact on plants, animals and human system and also to provide means for preventing and controlling air borne diseases. The bio-particles include pollen grains, fungal spores and microscopic particles like insect parts, cuticles and other biologically significant materials. The pollen grains and fungal spores together have enormous importance in inciting the disorders in human beings which is growing concern of human health hazard. The fungal spores in the atmosphere are considered to be the most important bio-pollutant which incites the disease over several important crops in turn causing severe loses both in quality and quantity of the yield which directly affect the economy of the farmer.

The importance of aerobiology was realized since 1840 when the mycota nature of ring-worm and certain epidemic disease of man were observed. Microbes around us particularly in the air high up, around our dwellings, over forests and agricultural fields, above seas and mountains, have been in existence for ages.

In present era of increasing industrialization, vehicular transport, we are facing health hazards due to polluted air, smoke and adsorption/desorption of heavy metals in environment. The air in metropolitan cities is offensive with particulate level enough to cause health concern. The inhalation of organic agricultural and industrial dust is the principal cause of occupational respiratory allergy (Dutkiewicz, 1997).

In recent years plant diseases have become severe on important crops
cultivated in India. The position can be attributed to release of high yielding varieties, intense cultivation by farmers, availability of irrigation over-wide stretches of land and application of fertilizer in large quantities. As a result, host plants for several plant pathogens are available almost all round the year. When the weather condition favors the large scale appearance of diseases, in many places large stretches of crops were wiped out. These epiphytotic diseases brought home the need for taking timely controlling measures and evolving resistant varieties to control further spread of disease. Fungicides are available for preventing their further spread but success in control them depends upon the timely application of fungicide. For determining the timely application, adequate amount of inoculation of pathogen in the air is necessary.

The existence of microbes around us was first detected at observatory Montouries in Paris by Miquel (1850-1927) who developed techniques to isolate bacteria present in atmosphere. Salisbury (1866) while studying the airport in connection with malaria in Mississippi valley collected the information regarding nature and composition of airport. Ehrenberg (1872) first published report on microorganisms collected from the atmosphere. However, Cunningham (1873) was first who initiated an analytical approach to microscopic components of air over Presidency Jail, Calcutta. The experimental aerobiology began with the experiments of Miquel (1883) at Paris. Probably he was the first person to carry the long term survey of microbial content of atmosphere by volumetric method. Other important contribution reported during these period were those Frankland (1886 and 1887), who was the first to study the effect of aerodynamics on the airport and also stated the aerodynamic effect are of major importance in devising the techniques for trapping the air-borne particles. It is in the beginning of present century, Satio (1904, and 1922) in Japan, Buller and Low (1911) in Canada, applied various methods to study
the components of airport. However credit goes to Meier et al., (1933) of United States and Stepanov (1935) of U.S.S.R., for establishing microbiology of the atmosphere as a special discipline. Since then this branch of science concerning the atmosphere stated gaining interest and importance and by the mid of the century flurry of contributions poured in, from the research workers from different concerns of the world.

The term aerobiology was coined in the thirties by American plant pathologist; Fred Campbell Meier 1935 (cit. Singh et al., 1994) of University Department of Agriculture, U.S.A. Extensive study on airport has been carried out by Gregory (1952 and onwards) from U.K. equivalent to ‘aerobiology”.

Aerobiology is a branch of science which draws information from various disciplines like ecology, mycology and plant pathology, bio-chemistry, immunology and clinical medicine.

The aerobiological investigations are broadly classified into two categories depending upon the nature of the place of investigation. If the aerobiological experiments are conducted inside the building or in a rather closed atmosphere for the detection and trapping of the airborne biologically significant organisms or particles then it is called “indoor or intramural aerobiology”. If the investigation is carried out in the outdoor, for detection and trapping of the air-borne micro-organisms present in the atmosphere; it is called as “outdoor or extramural aerobiology”.

The practical utility of investigation the indoor atmosphere is to detect the various organisms present inside the buildings like dwellings, libraries, warehouses, cattle shades, sheep shades, poultry shades, vegetable markets, fruit markets, cinema halls etc. which are harmful or detrimental to the living of the human
beings, the books, stored grains, animals, poultry, vegetables and fruit markets. Investigating the outdoor atmosphere for the detection of micro-organisms present in the outdoor atmosphere has got manifold practical significance and utility. The aerobiological investigations of the outdoor atmosphere involved the experiments can conduct for the detection of the aero allergenic pollen, fungal spores and other biologically significant particles which have their impact on human health as a part of the general aerobiological experiments. Another important and widely known aspect of conducting aerobiological experiments in the outdoor atmosphere is the aerobiological investigations involving detection and trapping of the significant plant pathogenic air-borne fungi over several crop fields which are ultimately helpful in formulating a better and efficient forecasting system.

**Scope:**

The scope of aerobiological studies is very wide because the investigations in aerobiology have direct application in various fields like plant pathology, veterinary science, medicine, meteorology, ecology, palaeontology, forestry and defense organizations. Fungal spores are found in the atmosphere in all seasons. The occurrence of fungal air-spora varies from time to time and from place to place. Variations of air-spora are largely determined by climatic conditions, geographical situation of the region and the type of crop over which such air-spora study is carried out. This indicates that there is wide scope for the study of air-spora at any given season and place.

**Aeromycology:**

Within the group of micro-organisms fungi are dominant in the air followed by pollen grains, bacterial spores, etc. Fungal spores are always present in the air, although fungal spore concentration and types are naturally highly variable
according to time, season, geographical factors (Lacey 1981; Su, Wu, Chen, Lee and Lin, 2001), climatic and physical factors (Hjelmroos, 1993). Aerobiological studies when confined to fungal spores are known as aeromycology. It is known that majority of the pathogenecity is caused by fungi. In tropical and sub-tropical climates, crops can be the sources as the air-borne bio-pollutant causing plant diseases resulting in extensive crop lose. Spores transport shorter distance is too important and effective in causing diseases than long distance in phytopathology. Among the plant pathogen wheat rust is the best aerobiological investigated one. Prasad (1972), confirmed wheat rust in India may have its source in West Asia, this is because aerial roots assume significant importance in India.

Aerobiological investigation have been carried out with reference to disease of rice, wheat, jowar, bajra, sugarcane, citrus, cotton, potato, grapes, vegetables and other crops by various workers, Sreeramulu (1958, 1961, 1962 and 1970), Sreeramulu & Ramalingam (1963, 1964, and 1966), Sreeramulu & Vittal (1966). It is thus evident that most of the aerobiological investigations have been confined to agricultural crops apart from allergic disorders. Von Leeween (1924), proved that 0.5-1% of population suffer from inhalation of fungal spores present in the air.

Codham (1924) recorded three cases of agricultural workers who developed severe asthma on exposure to dust from rusted grain, straw, casual organism *P. graminis*. Feinberg (1946) proved that not only *P. graminis* but also *Alternaria, Cladosporium*, are very much effective to act as allergic reagents. Benton (1930) in U.S.A. noted the association of *Aspergillus fumigatus* with asthma. Ainsworth (1952) made an opinion that the suffering of mould allergy for the whole year is due to the presence of mould spores, such as *Aspergillus & Penicillium*, in air.
through out the year. Cobe (1932) described a cause of asthma due to tomato leaf mould fungus *Cladosporium flavum*. The identification and quantification of atmospheric fungal spores is of great interest from clinical point of view, as many species are a trigger for allergic reactions (Caretta, 1992; D’ Amato and Spieksma, 1995; Herxheim, Hyde, and Williams 1969; Lehrer and Horner, 1990; Lopez, Salvaggio, and Butcher, 1976, Santilli, Rockwell and Collins, 1985). Air-borne fungi have been found to be associated with certain respiratory illness and allergy (Kowalski and Behnfleth, 1998) while exposure to fungi and other microbes, their fragments and metabolites may constitute a health risk, for example, increases in asthma attacks and bronchial hyperactivity and other respiratory systems such as lung cancer have been correlated to increased microbial and particulate levels in the aerosphere (Ross *et al.* 2000; World Health Organization, 2000). Fungal spores are important agents for spreading plants, animals and human diseases and known to cause Human allergic reactions (Madelin, 1994; Burge and Rogers, 2000). *Alternaria, Aspergillus, Cladosporium* and *Penicillium* species are the most prevalent aeroallergens (Tee, Gordon, and Taylor, 1987; Simeray, Mandin and Chaumont, 1997). More than 80 genera have been linked with symptoms of respiratory tract allergies (Horner, Helbling, Salvaggio, and Lehrer, (1995), with the most common allergic genera being *Cladosporium, Alternaria, Aspergillus*, and *Fusarium*. Exposure to large concentrations of the spores of these four genera causes aspergillosis, (Anderson, Morris and Kennedy, 1996) asthma and pneumonitis (Cujipers, Swaen, Wesseling Sturmans and Wouters, 1995; Hu, Persky, Flay and Richardson, 1997), allergic alveolites and toxicosis (Flannigan, Mc-Cabe, and Mc-Garry, 1991). Concurrently, fungal metabolites are also believed to irritate the respiratory system.

Aerobiological studies when confined to pollen grains spores are
known as aeropalynology. Erdtman (1952) coined the term “Aeropalynology”.

Pollen grains are male gametophytes of flowering plants. They are carried to the female flower by various agencies. The pollen must be strong enough to protect the male gametes on their journey. The outer wall of the pollen grain, called the exine, is composed of a very unusual substance called sporopollenin which is very tough. The inner layer is made up of cellulose and is similar in constitution to an ordinary plant cell wall. Pollen grains are microscopic, usually about 15-100 microns just a pinch of pollen powder contains thousands and thousands grains are liberated and dispersed by wind, insects and water. The two vector viz. air and insects are chiefly responsible for their release in the atmosphere. Study of airborne pollen is of immense interest due to its application in the field of human allergy, forestry, agricultural, palaeobotanical and so on. It is well established that some of the airborne pollen grains initiate allergic diseases in susceptible human beings. The significance of pollen allergen was started in 1766, when Kolreuter reported dissemination of pollen by wind. John Bostock (1819) for the first time established the pollen grains as responsible in causing hay fever. Since then considerable amount of work carried out on the line. Scheppegrell (1916) from U.S.A first realized the importance of field exploration and aerial survey to recent allergically significant bioparticles present in the air. Later, aerobiological investigation carried out by Ordman (1945), Feinberg (1946), Durham(1954), Saad(1958a,1958b,1959), Ogden(1960), Gregory(1961), Lewis (1984), Moral del Gregorio et al., (1998), Nitiu D.S. and Mallo A. (2002). Herminia Garcia and Carmen Galen et al., (2005), established that pollen play a significant role in causing diseases like asthma, hay fever, allergic rhinitis, etc. Atmospheric pollen is a major cause of allergies especially in developed countries (D, Amato, (2001); Kovats et al., (2003).
Aerobiological studies are of a great interest from an ecological and agricultural point of view, but they are of special interest to clinicians and allergy patients as a means of establishing a chronological correlation between the air pollen concentration and hay-fever. According to Gupta and Chanda (1994) the studies of airborne pollen grains have gained significant importance because of their application in diagnosis and treatments of patients suffer from allergic disorders. Tilak (1998) reported that allergic pollen producing plants are widely distributed in the tropical and temperate regions. This is especially true at the present time due to climate change impacts on air borne pollen (Beggs, 2004; Galen et al., 2005). In each geographical area, there is a succession of different flowering species through out the year. Plant phenology is genetically determined and controlled by meteorological parameters. Consequently, any evaluation of the pollen allergenic risk of a given area will require not only a detail knowledge of local vegetation but also of the floral phenology and the influence of weather variations. According to Kumar, et al., (1986), the incidence of airborne pollen is directly related to the flowering plants in the ground flora because pollen of most flowering plants in the area found in the atmosphere near the sources. In order to identify the pollen grains responsible for allergic disorders, continuous monitoring of airborne pollen is important with particular references to their prevalence and dispersion. Therefore, pollen calendar of an area concerned is a pre-requisite for diagnosis and treatment of allergic patients (Singh and Shivpuri, 1971), Singh, et al., (1978). It is believed that most of the anemophilous pollen grains are air-borne, as they are very light, produced in large number and have smooth exine and present in the air sometimes after dispersion. Contrary to the belief that entomophilous pollen does not become airborne, there are several reports of aeropalynological survey in which such pollen has been reported from airspora both
from India and abroad (Tilak, 1984). There are several entomophilous and amphiphilous pollen which are not only airborne but also allergic in nature. It is evident that insignificant emission of entomophilous pollen in the air is highly potentially allergenic and may cause considerable discomfort to a sensitive individual (Tilak, 1984). According to Tilak (1998), aeropalynological study of a locality involves the following aspects-

1. Determination of flowering phenology,

2. Quantitative analysis of the pollen grains in the atmosphere, and

3. Determination of weather parameters influencing the processes of anther dehiscence and dispersal of pollen grains.

Knowledge of the pollen and spores present in an area can enhance the practice of clinical allergy. In areas where there has not been extensive sampling, aeroallergen samples provide basic data on what is present that can serve as a guide for the selection of specific allergy tests. Pollen counts allow the physician to relate patients, severity of symptoms to aero allergen exposure and thus trace the efficacy of treatment.