INTRODUCTION

History of aerobiology is an interesting aspect. It dates back to the period of Hippocrates, with the invention of simple magnifying lens devised by Anton-von Leeuwenhoek. That the dynamic nature of air pulsating with the presence of life was definitely proved in the early 17th Century, which also lead to establishment of the presence of minute organisms in air by the end of 18th Century.

However, the experiments to study the role of microorganisms in the atmosphere was seldom attempted and remained obscure for a long time. It is after a long gap, Louis Pasteur (1861), while stating his "germ theory of disease" demonstrated the existence of definite community of living entities in air and proved that air is carrier of many germs.

Salisbury (1866), studied the airspora in connection with malaria in Missippi-valleys by exposing glass sheets and since then, the data and information regarding the nature and composition of airspora began to accumulate. Ehrenberg (1872) first published report on microorganisms collected from the atmosphere. However, Cunningham (1873) was first to initiate an analytical approach to the microorganic components of air over Calcutta Jail in India. It is with the experiments of Miquel (1883), the experimental aerobiology started and he elaborated the technique to
analyse the microbial contents of the atmosphere. Probably he was the first person to conduct the long term experiments to study the microbial components of the atmosphere, by volumetric method. Other important contributions made to aerobiology during this period were those of Frankland (1886 and 1887) who was the first to study the effect of aerodynamics in the airspora and also stated that aerodynamic effects are of major importance in devising the techniques for trapping the airborne particles. It is in the beginning of present century Saito (1904 and 1922) in Japan, Buller and Low (1911) in Canada, applied various methods to study the components of airspora.

The term 'aerobiology' came in to existence during 1930 as a collective term for studies in airspora like airborne fungal spore, pollengrains and other microorganisms. So, credit goes to Meier et. al. (1933) of United States and Stepanov (1935) of USSR for establishing the subject of microbiology of the atmosphere as a special discipline. Since then, this branch of science concerning the 'atmosphere' started gaining interest and importance and by the midcentury a flurry of contributions poured in from the research workers from different corners of the world.

Aerobiology defined as a science which deals with the source of organisms or materials, release of organisms or materials into the atmosphere, dispersion, deposition and impact on plants, animals and human life. It can also be
defined as the microbiology of the atmosphere. According to Jacobs (1951), it includes the dispersion of fungal spores, insect population, pollen, bacteria, viruses. In fact all life forms belonging to both plants and animals are borne high up and transported partly or wholly in the atmosphere. Edmonds (1979) stated that aerobiology is a scientific and multidisciplinary approach focussed on the transport of organisms and biological significant material.

In the earlier years the activities of aerobiologists were restricted without much reference to meteorology. Biologists were mainly interested in the problems of trapping, identification and enumeration of transported biological materials in the atmosphere, which served as an important medium of dispersal of microbes. The meteorologist on the other hand had shown little interest in the results of biological investigations, though it would have perhaps helped possibly to know more about the mixing process in the atmosphere and the movements of air masses.

However, now there has been ever increasing interest in this field by botanist, plant pathologists, palynologists, geneticists, meteorologists and more recently by the defence organisation on the atmosphere dissemination of organisms which include insects, pests, allergens or pathogens.

Another factor influencing the outbreak of epiphytotics is the prevalence of favourable weather. Earlier in the study of aerobiology, meteorology was not taken into account
but ever since impact of climatic factors on plant disease is known, biologists are interested to interpret the results of aerobiological investigation with the help of meteorology, as weather conditions plays a significant role. The probable weather condition likely to prevail in a tract can be forewarned with some degree of accuracy on the data gathered in that place during past several years. The availability of adequate amount of inoculum of pathogen is obtained by aerobiological studies. In India an intensive and exhaustive work has been done on aerobiology of important plant pathogenic fungi affecting several commercial crops. This data can be used for practical disease management by alarming farmers about the attack of some of the important airborne diseases. Aerobiology offers a valuable tool in plant disease forecasting, identification of new races of pathogenic fungi entering a state and detection of diseases. Further it is desirable to study the airspora in a season so that as soon as the presence of spores in the air is first noticed, the crop can be protected by taking the use of proper fungicide spray, dust or even pesticides too.

The aerobiological investigations have been broadly classified into two categories depending upon the nature of the place and site of investigation. If the aerobiological experiments are conducted inside the buildings 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 investigations are carried out in the open fields for the detection and trapping of the airborne microorganisms then it is called 'outdoor' or 'extramural aerobiology'. The former deals with the dispersion of microbes in closed atmosphere i.e. in green house, caves, glass houses, cattle sheds, poultry, grains storage godowns and library building having deterioration of library material etc., whereas the later deals with dispersal or microorganisms in the open atmosphere causing plant diseases, dispersion of pollen, mites causing allergic reaction on animal and human beings. Investigating the outdoor atmosphere for the detection of the microorganisms present in the outdoor atmosphere has got manifold practical significance and utility. Another important and widely known aspect of conducting aerogiological experiments in the outdoor atmosphere is the aerobiological investigation involving the detection and trapping of the significant plant pathogenic airborne fungi over several crop fields, which is ultimately helpful in formulating a better and efficient forecasting system.

Many workers have focussed their attention in conducting the experiments in the outdoor atmosphere and in particular the aeromyccological surveys in general and in relation to phytopathological problems.
AEROBIOLOGY IN ABROAD

The aerobiological investigation have been carried out extensively in countries like United Kingdom, U.S.A., New-Zealand, Australia, Canada etc.

Bernstein and Peinberg (1942), considered a five year survey of the daily fungal spore components of the air over Chicago. Harsh and Allen (1945), studied the fungal spore concentration of the air of San-Diego and Vicinity. Gregory (1945 and onwards) in the United Kingdom, Hyde and Williams (1949), studied a census of mould spores in the atmosphere of Cordiff. Amber and Vernon (1951), studied the atmospheric load with reference to the mould spores in Auckland city and suburban area. Dye and Vernon (1952), conducted a two years survey for the airborne mould spores at 23 different localities in New Zealand. Hirst (1952 and onward) in United Kingdom, Ainsworth (1932), studied incidence of airborne Cladosporium in London region. Collins and Best (1955), reported atmospheric count in Toranto (Canada). Di-Meena (1955), studied the airspora of Dunedin (New Zealand). Cammack (1955), reported the seasonal changes in the airspora components of Southern Nigeria. Pady, Kramer and his coworkers (1951 and onward) in United States, Meredith (1961 and onward) in the West indies, Davies et. al. (1963) studied the airspora at London and Liverpool. Rees (1964) studied the airspora of Brisbane. Shapiro et. al. (1965), reported the importance of field studies and meteorological
factors in mould survey of southern California. Milton
Dworin (1966), conducted a study of atmospheric mould
spores in Tucson, Arizona. Faria (1967), studied the
airborne fungi in the city of Belo-Horizonte, Brazil.
Bartzokas (1975), studied the relationship between the
meteorological parameters and the airborne fungal spores of
Athens Metropolitan area. Moustafa and Kamal (1976),
studied the fungal spore population in the atmosphere of
Kuwait. Harire et al. (1978), studied the airborne fungal
spores in Ahwaz (Iran). Calvo et al. (1979 and 1981)
reported the airborne fungi in the air of Barcelona (Spain).
Pennycook (1980), reported the airpsora of Auckland city
(New Zealand). Ramiraz et al. (1980) reported the airspora
components of Madrid Spain.

Other noteworthy contributions on aeromycological
studies were of Gregory and Hirst (1957) on airspora of
Rothamsted, Dransfield (1966) on airspora of Samaru, Turner
(1966) on airspora of Hongkong, Long and Kramer (1972) on
airspora of two contrasting sites in Kansas. Meredith
(1966, 1970 and 1971), Pady et al. (1965), Jack and Daniel
(1974) studied the aerobiology of various plant diseases in
United States. The correlation of the airborne rust
inoculum with meteorological condition was studied by Green
(1978).

AERIOBIOLOGY IN INDIA

The first report of a comprehensive aerobiological
work in India was published by Cunningham (1873) at Calcutta dealing with the atmosphere of Calcutta, the then Capital of India, in view of increasing urbanization. He has published his work in the form of hand book entitled "Microscopic Examination of Air". He realised the importance and impact of airborne particles, both organic and inorganic, as a source of danger to human health. After a long gap, studies in airspora in relation to phytopathological problems were initiated by Mehta (1940 and 1952) of Agra College, Agra. Mehta reported that rust spores were incapable of surviving during the high temperature of summer in the plains of North India. Our present knowledge of rust cereals in India is due to extensive aerobiological researches carried out by Mehta, who has been credited with finding out the source of perennation of the rust through uredial stage. His findings proved to be a guideline and milestone in solving rust problem in India.

Later on many plant pathologists started conducting experiments in these lines in order to understand the spore concentration of pathogenic fungi in the atmosphere and their role in causing epiphytotics. Hypothetically aerobiology in view of climatic topographical and ecological diversities is divided into 5 biozones namely Eastern, Western, Northern, Southern and Central zones. 

Eastern zone

Baruah and Konger (1958), studied the aerobiology in
the atmosphere of Shilong. Baruah (1961), Baruha & Chettia (1966) used slide and culture plates in Gauhati for aerobiological studies. Chakravarty and Nandi (1972) studied the seasonal periodicity of Cladosporium in Calcutta. Aeromycoflora of Indian Botanical Garden (Calcutta) was studied by Chakravarty (1976). Santra and Chanda (1981) studied the indoor airborne fungal spores of Calcutta. Singh and Singh (1987) reported the fungal airspora over a rice field in Imphal and its seasonal fluctuations associated with changes in weather condition. Further extensive research work in the field of aerobiology in Manipur was initiated by Singh (1987) and Singh et. al. (1987) over pea field and mustard field in Imphal.

Western India and Marathwada

In Maharashtra, however aerobiological studies were first initiated at Poona in Army Medical College, Poona by Kalra and Dumbrey (1957). Later on Karnik (1962), Chaubal and Deodikar (1964) studied the airspora of Jalgoan and Poona respectively. At Nagpur, aerobiological studies began with reports of Chitaley and Bajaj (1973-75), Patil (1981) and Kalkar and Patil (1994). In Maharashtra, However, extensive studies on aerobiology were started by Tilak and his coworkers. His long and sincere dedication to the research and development of this subject has yielded into an active school of aerobiologists at Aurangabad under his competent leadership. Tilak has so far published many
research papers and published few books and has developed spore sampler as "Tilak spore sampler". His work on the deterioration of valuable status of Ajanta caves near Aurangabad is very famous. It is in the token of this he has been awarded the President's in 1972.


(1990) on fungal spores and allergy, current perspective in Palynology research, in the same year on Aeromycology-aspects and prospects and also in (1990) on air borne spores as bioindicators.


Some other workers also conducted the aerobiological studies at Maharashtra. Talde (1969), studied airspore over banana field at Parbhani. Kulkarni (1971) reported the airspora over vegetable fields from Aurangabad. Gaikwad (1974), studied airspora over Sorghum field at Ahmedpur, Pandey (1976), studied the airspora over orange, mung and hybrid Jowar (CSH-1) at Nanded. Mane (1978) reported the airspora over bajra and wheat field at Vaijapur. Vishw
(1979), reported aerobiological survey of Aurangabad atmosphere. Chakre (1979), recorded the relationship between aerospora population over bajra fields and incidence of ergot disease. Bhalke (1981), studied the airspora over sugarcane field and Shastri (1981) made aerobiological surveys over maize fields and vegetable market at Aurangabad.


**North zone:**

Rajan et al. (1952), studied the fungal flora of Kanpur. Gupta et al. (1960), reported airborne spores from Jaipur. Shivpuri and Aqarwal (1969), carried out extensive
aerobiological studies at Delhi atmosphere. Seasonal variation in the airborne fungal spores had been studied by Mishra and Kamal (1971) at Gorakhpur. Mishra and Shrivastava (1971 and 1972) at Gorakhpur observed the spore content over paddy, wheat and barley fields. The airspora of Lucknow was studied by Vishnu Mittre and Khandelwal (1973). Nautiyal and Midha (1978) studied the aerospora of Allahabad. Chaturvedi et al. (1981) studied the indoor fungal flora in library at Lucknow.

South zone

Padmanabhan (1953) studied the incidence of the conidia of *Helminthosporium oryzae* in the airspora over paddy field at Cuttack and also gave useful information about the epidemiology of blast diseases. Sreeramulu and Seshvataram (1962) studied the airspora over paddy fields at Pentapadu (A.P.). Nair (1963) reported the fungal flora of Vellore. Sreeramulu and Vittal (1966) carried out their air monitoring work over rice false smut. Ramalingam (1971) reported airborne fungal spore types from Mysore. Sreeramulu and Ramakrishna (1971) studied the airspora over the fields of rice, sugarcane, *Sorghum* and banana plantation in coastal districts of A.P. and the relevance of aerial transmission of airborne fungal pathogen and disease epidemics. Reddi (1970-74) reported 21 fungal spore types from the air of Anakapalle and Vishakhapatnam. Bhaskar Rao and Mallaiah (1981) carried out extensive aeromycological studies over
black gram fields at Nagarjunnagar (A.P.). Survey of airspora of an agricultural farm at Madras was carried out by Vittal and Krishnamoorthi (1981). Agashe et al. (1983) reported the air spores of Bangalore. Jayaprakash and Ramalingam (1983) recorded the incidence of spores of Aspergillus ochraceus in the air of working environments at Mysore. Vittal and Glory (1985) also recorded airborne fungal spores of library from Indian subcontinent. Nair et al. (1986) compilation the work of Indian aerobiological reports upto 1985 which has been published by CSIR.

Central zone

In Madhya Pradesh aerobiological studies have been carried out by different workers in different places. Extensive studies on aerobiological aspects have been made in Madhya Pradesh at various places i.e. Bhopal, Gwalior, Jabalpur, Raipur Sagar and Rewa according to Jain (1994).


Aerobiological studies and incidence of allergic disorder conducted by Jain et al. (1989) and Jain et al. (1991) recorded allergic pollen at Gwalior. Aeromycoflora at Gwalior studied by Datta and Jain (1993) in relation to allergic disorder.


In Chhattisgarh region (M.P.) the credit for developing the aerobiological research work goes to Tiwari and his coworkers. Pandey and Tiwari (1991) recorded aeromycoflora from environment of Raipur. Airspora of Raipur observed by

Apart from above aspects indoor aerobiological study also reported by Pandey and Tiwari (1994) and Tiwari et al. (1995) over library and green house environments. Tiwari and Jadhav (1995) concluded the interrelationship between aerobiology and home-science. Jadhav et al. (1996) reported indoor aerobiology of Chemistry lab at Balodabazar.

Deshmuk and Shukla (1984) studied thermophilic fungi in the airspora at Sagar. Chowdhary (1992) was observed antigonist fungi in airspora and phylloplane of soyabean at Durg.

In the present investigation four aspects of the aeromycological studies over paddy field have been studied.
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at Balodabazar (Raipur). These aspects are as follows:

1. Survey of the aeromycoflora over paddy field with the help of
   1. Tilak air sampler
   2. Gravity petriplate method.


4. Data analysed statistically.