I: General Introduction

The air surrounding us forms a major part of the global ecosystem and, depending upon its constituents, it regulates the quantity of the environment. It has long been known that there are different types of particles present in the atmosphere. These particles may be biological (e.g., pollen grains, fungal spores, viruses, actinomycetes and bacteria, fern and moss spores, algal forms, plant fragments, small seeds, protozoa, mites and insect fragments) or non-biological (e.g., soot, diesel exhaust particles, ashes, sand and mineral fragments such as silicate minerals). Eighty years have passed since F.C Mier of the U.S. Department of Agriculture first used the word “Aerobiology” (Frenguelli, 2013). He defined Aerobiology as a multidisciplinary biological science, which deals with the source, release, dispersion, and deposition of different microorganisms found in the air and their impact on the ecosystem or life of plants, animals and human beings (Edmonds, 1979; Sharma, 2005). The first systemic aerobiological work in India was carried out by David C. Cunningham, a British army medical officer. His work was quite comprehensive and monumental (Singh, 1998). In Manipur, Singh and his co-workers are actively engaged in the field of aerobiology using various techniques with reference to airspora inside bakery, hostel kitchen, saw mill, library, rice mill, rice grains store cum sale shops, cowshed, etc. besides airspora of crop fields (Devi, 2013). In Southern Assam, Dutta and his co-workers had initiated aerobiological works in and around paper mill, Hospitals, residential dwellings of allergic patients etc. (Sharma et al., 2007 and Dutta, 2008).
Aerobiology is a scientific discipline that deals with the transport of organisms and biologically significant materials through the atmosphere (Isard and Gage, 2001). Aerobiology also embodies the generation, uptake, translocation, dispersion, viability, deposition and infection/infestation of seeds, viruses, fungi, bacteria and other agents including insects. Aerobiological investigations can be broadly distinguished as **Outdoor or Extramural aerobiology** and **Indoor or Intramural aerobiology**. The study of contamination in closed system like building, hospitals, industrial environment with reference to airborne microbial contaminants is known as **Indoor aerobiology** as against the **Outdoor aerobiology** which is concerned with the survey of biological materials in open area like field and forest (Tilak, 1982). The inter and multidisciplinary nature of aerobiology is demonstrated by subjects like microbiology, palynology, meteorology, medicine, phytopathology, ecology, environmental science, aerophysics and so on. Aerobiology serves as a tool to obtain ecological information, which in turn is useful to know about the distribution of biota and protection against their harmful impact on healthy environment. Ecology is the study of processes of organism- environment interaction. The contribution of aerobiology to ecology is manifold and diverse. An interdisciplinary team, comprising plant pathologists, entomologists, agronomists, animal scientist, etc., and an air pollution chemist, meteorologist and systems mathematician, could form the nucleus of an aerobiology unit which could offer: A research unit to investigate airborne biota, in particular the generation, release, dispersion, viability, deposition and infection stages.
Majority of the plant pathogens which cause diseases are airborne. The damage cause is enormous and often these have far reaching social effects which are difficult to assess. The information of the pathogen is obtained about its release, dissemination and spread, infective ability and seasonal variation, it would be ultimately helpful in reducing the crop losses. In phytopathology, the short distance transport of spores is much more important and effective in causing diseases than long distance transport. Aerobiology starts from phytopathological point of view with the release of viable spores and ends with their deposition on surface. Aerobiology, thus is useful both to the agriculturists and plant pathologists in their ultimate aim of protecting the crops. The spore of plant pathogenic fungi formed the most interesting groups of microorganisms in the atmosphere. Many plants are adapted for aerial transport. Some are equipped with ingenious mechanism which brings their propagules into the turbulent air.

Fungal pathogens of plants are many and diverse. They occur in most taxonomic groups. Only a few, such as rusts (Uredinales), powdery and downy mildews (Erysiphaceae and Peronosporaceae), are obligate parasites (biotrophs), obtaining their nutrition directly from living plant tissue. A preliminary diagnosis of a fungus disease is sometimes possible from the symptoms, though non-related pathogens and abiotic environmental affects may produce similar type of damage. Identification of the source of a fungal pathogen is a key step in devising efficient disease control as this may permit elimination or reduction of the source before disease epidemics can begin (Waller et al., 2002 and Patil, 2013).
For general aerobiological surveys, as well as usually in plant pathology, a trapped spore should deal equally with a mass of large pollen, the range of fungal spores and the minute spores of actinomycetes. The previously used freely-exposed surface trapped method caught very few of the smaller spores and the efficiency of the deposition of all was extremely variable depending on the wind speed and was also affected by the size and orientation of the trapped spore (Hirst, 1991).

Allergy is one of the ancient health problems associated with human beings. The term “allergy” was first coined by Clemens Von Pirquent in 1906 to describe an altered or changed reactivity of the immune system to foreign proteins (Kay, 2006) irrespective of whether this resulted in immunity or harmful affects. Allergy can also defined as the exaggerated response of the immune system to foreign proteins (Blumenthal and Rosenberg, 1999). Atmospheric allergens play an important role in the pathogenesis of causing allergic human diseases and fungal spores are one of the chief components of aeroflora known to induce various allergic disorders in human beings (Sahney et al., 2007). It is important to know the prevalence of allergens in one’s area for proper diagnosis and effective management. Aerobiology, today is a vast multidisciplinary field where botanists, aerobiologists, microbiologists, plant pathologists, mycologists, meteorologists, medical specialists and epidemiologists have some role to play. The importance of aerobiological knowledge in Environmental planning and monitoring is thus, realized which should lead to the establishment of proper biopollution safeguards (Saroja et al., 2005).
From the early years of this century, Aerobiology have devoted more energy to others researches, broadening their interests, so the majority of the work that the aerobiology of the century has produced have concentrated primarily on the following areas: presence in the atmosphere of pollen and fungal allergens, models of long-range transport, modeling the presence of pollens or fungal spores in the atmosphere, influence of air pollution and climate change on bioparticulate, plant phenology as a source of allergenic pollen, appearance in the atmosphere of pollen and fungal released by alien species, diseases of agricultural environments, productivity of forest species, indoor monitoring for the protection of human health and for the protection of cultural heritage (Pastuszka, 2000; Frenguelli, 2013 and Nayak, 2014).

**About the Study Area**

**Physiography, Climate and Seasons of Moreh, Manipur**

The Chandel district (formerly known as Tengnoupal district) came into existence on 13-5-1974. The district occupies the south eastern part of the state of Manipur. It is the border district of the state. Its neighbours are (erstwhile Burma) on the south, Ukhrul district on the east, Churachandpur district on the south and west, and thoubal district on north. It is about 64 km away from Imphal. The National Highway No. 39 passes through this district.

The Moreh town (184.8 sq.km area, lies between 24°13′5″ - 24°26′ N latitude and 94°23′51″E longitude, 276m-888 m asl.). The international trade center of the state falls in the southernmost part of the district. It is a predominantly Kuki ethnic inhabited town
with sizeable population of Tamil, Nepali, Meitei and Muslims under Chandel district of Manipur. It is a rapidly developing and an important trade point in India on the border with Myanmar, with the town of Tamu being close to the Indian Myanmar Border.

Already being a huge commercial hub, economists suggest that Moreh town could transform into another bustling city in the next couple of decades. Moreh today is known as the commercial capital of the state and also called India’s Gateway to South East Asia. Manipur represents a peculiar physiographic situation in the eastern Himalayas. Chandel district of Manipur is endowed with an enormously diverse heritage of orchids, ornamental plants, etc.
Fig. 1: Map of India showing Manipur and location of Moreh the study area of Chandel District, Manipur
Climate

Moreh (Chandel district) experiences low to moderate climate of sub-tropical monsoon type. The summer months are hot and wet while the winter months are cold and dry in the district. The maximum rainfalls occur due to southwest monsoon during May to August. The sunshine hours are limited up to 5 hours during rainy seasons. The temperature varies from 5°C to 35°C. The area experiences the average temperature in the summer months from 32 to 35°C while in winter, the temperature is normally around 4 to 6°C. January is the coldest month and April is the hottest. Fog and frost are common features during the mornings in the winter months but snowfall is rare. The average rainfall in the district is 1, 036mm.

The relative humidity in the region is moderate to high throughout the year. The winter month is very less humid. Wind is generally light during the monsoon season. In the rest of the year, wind is generally moderate.

Seasons

The type of seasons in the area are

(i) **The cold season** (December, January, February) :

Winter season commences early in the December and continues upto the mid of February. This is a cold weather season. The temperature decreases from the last part of November. During this season the, temperature ranges minimum (4.9°C) and maximum (26.6°C) respectively. The relative humidity ranges from 85.7% to 88.7%. Velocity of wind speed is generally slow. Rainfall is very low.
(ii) **The hot dry season** (March, April):

This season is a transitional period between the winter and monsoon season. This season is also known as summer season or pre-monsoon period. The temperature rises from the mid of February. The maximum temperature comes up to 39.9°C. The wind speed reaches to its highest point.

(iii) **The rainy season** (May, June, July, August, September):

During this season, rain begins from the first week of May and it continues up to the mid of September. With wide spread of rainfall, the weather becomes wet and the relative humidity is found high. The average temperature of this season is generally low.

(iv) **The retreating monsoon season** (October, November)

During this season the occurrence of rainfall gradually decreases. The average temperature of this season ranges from 13.4°C to 29°C.

**Soil:**

Two major types of soils are found in this district, viz., residual and transported, which cover both the hill and plain. The residual soils are either laterised or non-laterised. The transported soils are of two types, viz., alluvial and organic. The soils have general clayey texture and grey to pale brown colour. It contains a good proportion of potash and phosphate, a fair quantity of nitrogen and organic matter and is less acidic in nature. The organic soils cover the low lying area of the valley. With dark grey colour and clayey loam texture, these peaty soils have acidity, abundance of organic matter, a
good amount of nitrogen and phosphorous but poor in potash. The hill soil are more or less rich in organic carbon (1 to 3%) in the top soil, but poor in available phosphorous and potash. They are acidic in nature.

The oldest rocks found in the state are mainly confined in this district close to Indo-Myanmar border - Moreh and the rocks are grouped as Cretaceous rocks consisting of chromite (Epilates), serpentine, etc. It is observed that Inceptisols are the dominant soils followed by Utisols, Entisols and Alfisols and occupy 38.4%, and 36.4% and 23.1% respectively of the total geographical area of Manipur.

Main soil classifications in the district are

i) Older alluvial soil
ii) Red gravelly sandy and loamy soil
iii) Peaty and saline soil.