CHAPTER - VI
Uddin and Chakravarty (1995) recorded *Aspergillus, Curvularia, Cladosporium* and *Penicillium* as the dominant genera in a paddy field of West Bengal.

During investigation *Cladosporium* was recorded as the dominant spore type and was present throughout both the rice seasons. During the study period, three species of *Cladosporium* were observed viz. *C. herbarum* and *C. sphaerospermum* and *Cladosporium* sp. Among them, *C. herbarum* was very common and dominant type during sowing, growing and harvesting period of both the rice varieties. Sreeramulu and Ramalingam (1966) recorded *Cladosporium* as "universal dominant". Among the fungal genera *Cladosporium* dominated outdoor mycoflora all over the world (Grinn-Gofron, 2007). It was observed that *Cladosporium* was reported more or less equally throughout the year but comparatively a higher trap was recorded from October to February. Spores of *Cladosporium* were most common in air due to wet and warm season. Halwagy (1989) also recorded maximum spore count in the month of October.

Next to *Cladosporium, Aspergillus* was recorded as second dominant type present throughout the period of rice cultivation. The present investigation recorded four species of *Aspergillus* viz. *A. fumigatus, A. clavatus, A. niger* and *Aspergillus* sp. Vittal and Chinnaraj (1990) employing Burkard Sampler reported *Aspergillus* spore type as the dominant contributor (72.17%) in straw store house followed by hyphal fragments. Nanda *et al.*, (1996) reported *Aspergillus* and *Penicillium* as the dominant species before harvesting in paddy field. Among different species of *Aspergillus, A. niger* was very common and recorded throughout the period of rice cultivation but considerably high concentration was recorded during sowing period of Winter variety and harvesting period of Spring variety. High incidence of *A. niger* may be attributed to its ability to tolerate high temperature
regime and its ability to colonise diverse substrate including food materials (Pitt and Hocking, 1985). Munoz et al., (2010) reported Aspergillus as one of the pre-dominant genera of rice growing areas.

The study revealed the presence of 3 species of Curvularia viz. C. lunata, C. pallescens and Curvularia sp over rice field. The most common sp. encountered was C. lunata. The result is also supported by Chetia (1965). C. lunata was recorded more or less equally throughout the rice season but a higher trap was observed during Spring rice season over rice field in Jalukbari. Bhatt et al., (2009) reported C. lunata as dominant causal agent of glume discoloration of rice.

Alternaria, an important dominant type was observed throughout the rice season. 5 species of Alternaria viz. A. alternata, A. dennisii, A. petroselini and A. solani and Alternaria sp. were recorded. Out of 5 species, 2 species were very common viz. A. petroselini and A. solani. However, Nanda et al., (1996) reported contribution of A. solani and A. alternata less than 1% of total airspora. Alternaria showed peak period during the harvesting period of Spring variety and sowing period of Winter variety. Oliveira et al., (2005) reported lower concentration of Alternaria spores in winter and higher concentration in summer and early winter. Bhatt et al., (2009) recorded Alternaria sp. with percent frequency of 18.59.

Two species of Penicillium were recorded viz. P. italicum and Penicillium sp. Both the species were recorded throughout the period of rice cultivation but maximum concentration was observed during sowing period of Winter rice variety.
Helminthosporium was recorded throughout the period and reached peak concentration during harvesting period of Winter rice variety. Helminthosporium oryzae was reported as pre-dominant one caused glume discolouration in rice and recorded with a percent frequency of 20.94 (Bhatt et al., 2009).

Fusarium oxysporum was recorded as one of the dominant spore type and reached peak concentration during harvesting period of Winter rice variety. Nanda et al., (1996) reported Fusarium as dominant before harvesting in paddy field. Ascospores were recorded as dominant types but were not present throughout the rice season. They were recorded during sowing and growing periods of Winter rice variety. Periconia was recorded throughout the period of investigation. During investigation period three species were recorded viz. P. byssoides, P. circinata and Periconia sp. Epicoccum was observed throughout the period of investigation except sowing period of Spring rice variety. Highest concentration was recorded during harvesting period of both the rice varieties. The present study recorded Aureobasidium with a peak in harvesting period of Spring rice variety. Corynespora was observed during sowing and growing period of Winter rice variety. Drechslera recorded during sowing and growing period of Spring rice variety with a peak in sowing period. Leptosphaeria was present during Spring season with a peak in harvesting period. Nigrospora was recorded throughout the period of Winter rice variety. Two species of Torula viz. T. herbarum and Torula sp. were recorded during harvesting period of Spring rice variety and throughout the Winter season. Tricoderma showed peak concentration during sowing period of Winter rice variety. Uredosporous were recorded in a significant number though they were not present throughout the investigation period but
dominant during harvesting period of Winter rice variety and sowing period of Spring rice variety.

*Apophysomyces elegans, Beltrania, Bispora, Monodictys, Pestalotia, Pithomyces maydecus, Pringsheinia, Rhizopus, Thecaphora, Trichoconis* and *Ulocladium* were recorded occasionally.

Incidence of maximum concentration of species like *Alternaria, Cladosporium, Curvularia, Periconia* and *Helminthosporium* in the air was simply because of their saprobic habit, their high degree of vegetative reproduction by fragmentation, budding and asexual reproduction by developing conidia directly on fruiting bodies with passive spore liberation. The impact of vegetation and crop field on saprophytic microflora in air was well emphasized (Panda and Behera, 1991) and application of this knowledge would be one of the best strategies of plant disease control (Fokkema, 1973).

During present investigation, different phytopathogenic fungi viz. *Alternaria, Curvularia, Drechslera, Epicoccum, Fusarium, Helminthosporium, Nigrospora* and *Pyricularia* were observed over rice fields. *Helminthosporium oryzae* caused brown spot disease in paddy. This disease occurs in all rice growing areas of the world, especially under semi-dry condition (Jeeva and Ramabadran, 1992). *Pyricularia oryzae* is considered to be one of the main causal agent of rice blast disease (Mackill and Bonman, 1986). Dar (1966) and Ou (1972) emphasized that under special condition *Nigrospora* could caused ear blight and blackening of ears while *Epicoccum* caused the red blot of rice grains.

During investigation, many allergenically significant fungal spore types were isolated. An increase in high concentration of mould spores during harvesting period may
increase a high risk to those persons who are involved in harvesting and haymaking because the mould spores can enhance allergic disorder to susceptible individuals (Rati et al., 1980).

High incidence of sterile colonies or hyphal fragments was observed during investigation. This result was supported by previous workers. (Pugalmaran and Vittal, 1999; Das and Gupta-Bhattacharya, 2007; Debnath and Baruah, 2008; Usha et al., 2010).

Maximum concentration of fungal spore types forming colonies were observed in the month of November (781.87 CFU/ m³) in Rice Field in Jalukbari for the period 1st June’08 to 31st May’09. While minimum catch observed in the month of July (228.43 CFU/ m³) over Rice Field in Madanpur for the period 1st June’09 to 31st May’10. During the month of October, November, December, March and April maximum spore count was recorded from all the three sampling sites. Moreover, October and November were the months of highest incidence recorded during the study period. Reddy and Reddy (1996) recorded highest number of fungal spores in the month of November and October. Poor incidence of fungal spores from June to August could be attributed to the washing off the fungal spores due to heavy precipitation. Agarwal and Shivpuri (1974) reported that extreme hot and extreme cold are unfavourable for the development of fungal spores. However, Rastogi and Chandel (1996) observed maximum spore count in the month of August. Devi and Sarma (2007) recorded major fungal peaks from August to December. By using Burkard Sampler too, maximum number of spores was trapped during the month of October, November and December. The lowest count was observed during June-August.
A comparative study of the airspora using Andersen Sampler and Burkard Sampler showed that there were similarities between both the methods - (i) Patterns of incidence of fungal spores according to month and season were almost similar by both the methods in each sampling site. A rise in spore count in the month of October, November and December was observed. (ii) Both the methods detected the similar predominant group. (iii) 33 fungal types were trapped by Andersen Sampler whereas, by using Burkard Sampler 26 spore types were recorded. But both the samplers have their respective limitations (i) Quantitatively large number of fungal spores were detected by using Burkard Sampler. So, Burkard Sampler provided a picture of total number of spores. (ii) The spore types recorded by Andersen Sampler could be identified up to the species level whereas, by Burkard Sampler only genera could be identified. (iii) Through Burkard Sampler it was not possible to distinguish the difference between the spores of Aspergillus & Penicillium and Mucor & Rhizopus. Therefore, they were commonly named as Aspergilli/ Penicilli type and Mucor/ Rhizopus respectively.

Highest fungal diversity was observed during September with 23 fungal spore types forming colonies using Andersen Sampler. During September though highest diversity was observed but spore count was low. This may be explained that due to extreme hot most of the fungal spores could not survive although they were produced in enormous number. The lowest diversity was observed during the month of January and February each with 8 fungal spore types using Burkard Personal Sampler.

It was evident that, Deuteromycotina contributed highest percentage to the total airspora. Similar result was obtained by Kshirsagar and Pande (2011) over sunflower field. The group Deuteromycotina was followed by Ascomycotina and Zygomycotina.
During the study period 33 fungal types were recorded by using Andersen sampler while only 26 fungal spore types were recorded by using Burkard sampler. By using Andersen sampler the maximum number of fungal spores were recorded over Rice Field in Jalukbari (5922.21 CFU/m³) for the year 1st June’08 to 31st May’09. Minimum number of fungal spores were recorded over Rice Field in Madanpur (4282.71 CFU/ m³) for the year 1st June’09 to 31st May’10. While by using Burkard sampler maximum concentration of fungal spores were recorded over Rice Field in Sonapur (8055.40 No./ m³) for the year 1st June’08 to 31st May’09. Minimum number of fungal spores were recorded over Rice Field in Madanpur (6919.40 No./ m³) for the year 1st June’09 to 31st May’10.

Based on rice season, it was observed that maximum number of fungal colonies was recorded during 1st year of investigation in Winter season over Rice Field in Jalukbari by using Andersen Sampler while by using Burkard Personal Sampler maximum number of fungal spore was observed during Winter season for the period 1st June’08 to 31st May’09 over Rice Field in Sonapur. Both the samplers recorded the highest number of fungal spores during harvesting period of rice cultivation. This might be attributed that the change in community structure of vegetation during harvesting period favoured the growth and sporulation of large number of fungi. Ingold (1971) reported the occurrence of more fungal spores during harvesting period. He stated that this might be due to agitation of paddy that dislodged the spore mass of the fungi growing over that.

Analysis of variance test resulted the significance of Apophysomyces elegans, Cladosporium sphaerospermum, Curvularia pallescens and Nigrogspora sp. by using Andersen Sampler while by using Burkard Sampler Monodictys sp. Mucor/ Rhizopus,
Pestalotia sp., Pithomyces sp., Pyricularia sp. and Ulocladium sp. were found to be significant.

Statistical analysis showed that the correlation between temperature and monthly total fungal spores was not significant. But, by observing Monthwise variations it was noted that concentration of fungal spores was negatively correlated with minimum temperature. During the study period, October, November and December showed maximum catch of fungal spores when temperature was moderate. Comparatively low spore count was observed during July, August when the mean maximum temperature reached highest point. Rastogi and Chandal (1996) recorded maximum incidence of fungal spores during the month of August and October and correlated positively with high relative humidity and warm temperature.

Pearson's correlation coefficient was not significant between relative humidity and monthly total fungal spore count. However, during the month of November, December high relative humidity coincided with high fungal spore count. According to Jafar et al. (2008) relative humidity was positively correlated to fungal spore concentration. From the study of Cholke and Mahajan (2008) the coefficient of correlation was found highly significant with relative humidity.

The result of correlation coefficient showed rainfall as the only climatic factor having influence on the occurrence of monthly total fungal spore count. It showed significant negative correlation during the 1st year of investigation in all sampling sites. In the month of June, July and August high rainfall coincided with low fungal spore count in all the sampling sites. While low rainfall in the month of November and December
coincided with high fungal spore count. Low spore count in rainy period was because rain may wash away most of the spores. Tilak and Vishwe (1976) stated that rainfall has direct relationship with spore concentration. However, in the month of September and October, rainfall was comparatively less and the spore count was high due to dry climate which favours the dispersal and survival of fungal spores in the air. Devi et al., (2009) reported that fungi have negative correlation with temperature and rainfall.

A fungal calendar was prepared based on two years air monitoring. The fungal calendar highlighted the seasonal incidence of various spore types which can be effectively utilized in meaningful prediction of the recurrence of various types of plant diseases and also can be effectively utilized by local physicians for proper diagnosis and clinical treatment of various allergic disorders. This also suggests that during investigation, diagnosis and treatment of allergy to airborne mould spore, the most important prerequisite is thorough understanding of the mould spore count of air.

On the basis of phenological data obtained by ground flora survey, a flowering calendar was prepared. Present flowering calendar recorded 119 species belonging to 51 families. Devi et al., (1996) prepared flowering calendar of tree species of Guwahati with special reference to their allergic significance.

In the present study, a total of 33 pollen types were recorded by using Burkard sampler. Among them, 2 belonged to pteridophytes, 1 to Gymnosperms, 3 to Monocotyledons and 27 types to Dicotyledons.

The dominant pollen types recorded during study periods for all the sampling sites were, Poaceae, Asteraceae, Amaranthaceae/ Chenopodiaceae, *Mimosa pudica* Linn.,
Eucalyptus maculata Hook, Terminalia cuneata Roth, Malvaceae, Cassia sophera Linn. and Euphorbia hirta Linn. Pollen grains belonging to families like Poaceae, Asteraceae, Amaranthaceae/ Chenopodiaceae, Mimosaceae, Malvaceae were recorded throughout the investigation period. Sharma et al., (2010) recorded Poaceae, Asteraceae and Mimosaceae as the dominant pollen types.

In the present study pollen grains of Poaceae represented the highest percentage in total pollen identified. Poaceae was an anemophilous and stenopalynous family. Thus the aerial incidence of pollen grains of Poaceae represented collective contribution made by numerous grasses belonging to various species which resulted in their dominance in the air. Bora and Baruah (1980) reported the highest incidence of Poaceae pollen from Guwahati. At Lucknow Poaceae occupied third position in pollen spectrum (Chaturvedi et al., 1989). While in Allahabad Poaceae was represented as second dominant type (Sahaney and Chaurasia, 2008).

Second dominant pollen type recorded was Asteraceae pollen. It was recorded throughout the investigation period but maximum concentration was observed from growing to harvesting period of Spring rice variety i.e. from March to June. Domination of Asteraceae pollen in air was also reported by Devi et al., (2002).

Third dominant pollen type was Amaranthaceae/ Chenopodiaceae. Waqar et al., (2010) reported Amaranthaceae/ Chenopodiaceae as the second dominant pollen type. Airborne pollen grains belonging to Amaranthus sp. and Chenopodium sp. were included in one category Amaranthaceae/ Chenopodiaceae because of their morphological similarities. This type was recorded throughout the investigation period with a maximum concentration.
during harvesting period of Spring rice variety. A higher trap of Amaranthaceae/Chenopodiaceae was observed in the month of April.

Dominant pollen type *Mimosa pudica* Linn. was recorded from April to November which coincided with the flowering period. *Eucalyptus maculata* Hook pollen was observed throughout the study period over Rice Field in Madanpur but peak concentration was observed during growing period of Winter rice variety. A higher trap was observed during September. Sudha and Agashe (1996) reported *Eucalyptus* as fourth dominant pollen type. A small fraction of pollen grain trapped could not be identified.

A total of 26 families were identified. Among them, 2 families belong to pteridophytes, 1 to Gymnosperms and rest 2 Angiosperms of which 2 are Monocotyledons and 21 are Dicotyledons. Pollen of Poaceae, Asteraceae and Amaranthaceae/Chenopodiaceae could not be identified upto species level.

Maximum number of pollen grains was recorded during the month of March, April, May, October and November. In Rice Field in Jalukbari maximum number of pollen grains was recorded in the month of March in both the years of investigation while in Rice Field in Madanpur maximum number of pollen grains was recorded in the month of October and November during the period from 1st June’08 to 31st May’09 and from 1st June’09 to 31st May’10 respectively. Maximum number of pollen grains was recorded in the month of April and May over Rice Field in Sonapur during the period from 1st June’08 to 31st May’09 and 1st June’09 to 31st May’10 respectively. Devi (2003) recorded maximum number of pollen grains during the month of March to April. Devi and Sarma (2007) observed the highest pollen catch in the month of April. Sahney and Chaurasia (2008)
reported the maximum incidence of pollen grains during the month of February to May and September to October.

Based on rice season, Poaceae pollen grains contributed the highest number of pollen during two rice seasons.

The analysis of pollen grain on the basis of habit type showed that herbaceous pollen contributed the highest number of pollen grains followed by tree pollen. The maximum pollen grain contributed among herbs was Poaceae type. Similar result was obtained by Oommachan et al. (1996) and Sharma et al.,(2000).

It was observed that pollen from entomophilous taxa were pre-dominant during the study period. Tilak (1982) reported a large number of entomophilous pollen in the atmosphere of Aurangabad. Higher entomophilous pollen count was well supported by the study made by Boral and Bhattacharya (1999). It may be mentioned that, pollen grains of some entomophilous plants are small to medium in size and they are lightly ornamented like spinulose or finely reticulate which may have facilitated their suspension in air after their detachment from the vector. During present investigation anemophilous pollen ranked second dominant type. It is well known that chief source of atmospheric pollen are anemophilous plants which produce huge amount of pollen grains. Their small size, smooth, dry and nonsticky nature of spore wall facilitates easy dispersal in air. A probable reason for low anemophilous spore in present study may be due to restricted occurrence of anemophilous plants.

Present investigation recorded many allergenically significant pollen types. The pollen grains of the family Poaceae was demonstrated as significant allergen (Tilak, 1989).
The pollen grains of other families such as Asteraceae, Euphorbiaceae, Amaranthaceae/Chenopodiaceae are considered to be allergenically highly potent. Among the genera some significantly allergenic pollen types recorded from the study area were *Acacia auriculaeformis* A.Cunn. ex Benth., *Baugainvillea spectabilis* Willd, *Bombax ceiba* Linn., *Cassia* sp., *Eucalyptus maculata* Hook and *Mangifera indica* Linn. The allergenicity of these pollen have been reported by various workers like Nair *et al.*, (1986) and Tilak (1998).

ANOVA for airborne pollen types was carried out. ANOVA result has shown that when $p<0.05$, 'F' is significant. The significant pollen types were *Adiantum caudatum* Linn., *Eucalyptus maculata* Hook and *Pinus kesiya* Linn.

From statistical analysis, it was found that the correlation between the temperature and rainfall with monthly total pollen grains showed that the value of Pearson’s correlation coefficient was not significant. According to Jafar *et al.*, (2008), there was no statistical significant correlation between temperature and pollen count but windy weather increased the pollen count as pollens spread through air. Considering negative correlation between temperature, rainfall and monthly total pollen count, it was evident that in the month of July’08 (sampling site Rice Field in Madanpur) high rainfall and mean maximum temperature coincided with low pollen count. Sharma *et al.*, (2010) observed insignificant correlation between monthly pollen distribution and mean temperature.

During the 1st year of study, a significant negative correlation was found between relative humidity and monthly total pollen count. Hazarika (2010) observed a significant
negative correlation between relative humidity and daily variation in the concentration of pollen grains, which was in agreement with the observation of present study.

A pollen calendar was prepared on the basis of various pollen types recorded. The calendar showed the occurrence of some pollen types the year round while some other fluctuated sporadically.