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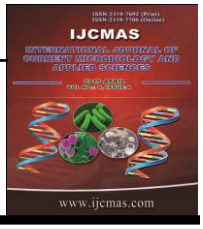

Original Research Article

Air monitoring of fungal spores inside the B. J. Wadia Library, Pune, India

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Keywords

Air monitoring, Fungal airspora, Library, Bio-deterioration, Pune

A B S T R A C T

Air monitoring in the B. J. Wadia library of Fergusson College, Pune, India was carried out by using Rotorod air sampler daily in the morning during rainy season from June 2011 to September 2011. Total 79 types of biocomponents were recorded out of which 70 were fungal spore types and 9 other types. Fungal spores belonging to Myxomycotina (1.81 %), Phycomycotina (8.47 %), Ascomycotina (5.48 %), Basidiomycotina (4.37 %), Deuteromycotina (60.78 %) and other types (19.09 %) were trapped due to high relative humidity and moderately low temperature in the library environment. The average percentage contribution of some of the dominant fungal spores observed were viz., *Aspergillus* (15.30 %), *Cladosporium* (12.44 %), *Alternaria* (8.63 %), *Penicillium* (8.07 %) and cellulose fibre (7.38 %). This investigation was undertaken to identify and find out the composition and percentage contribution of various airborne fungi inside the library and their relevance to biodeterioration and health problems.

Introduction

The airborne fungal spores show great variation in composition, concentration and may vary from place to place. The types and concentration of fungal spores is determined by time, day, weather parameters and seasons. The fungal spores play a major role in biodeterioration which occurs in library materials and it is worldwide problem causing great damage especially to unique manuscripts and books stored in the libraries (Zyska, 1993). The biodeterioration occurs mainly because of substrates like paper which is a main source of cellulose, and also binding glue, canvas cloth covering and in some cases leather as a binding material. All these substrates support active fungal growth and sporulation. The fungal spores are of immense importance in inciting the disorders in human beings. The allergy may occur to sensitive visitors due to handling of such biodeteriorated books and dust accumulated on the books. The students, visitors and teaching faculties who visit the library may suffer from lung infection that causes respiratory problems leading to allergy or cardiac diseases and dermatitis. The B. J. Wadia library of Fergusson College is one of the largest academic and historical libraries in Asia, known for its rare and valuable collection. The library is

enriched with rare books, journals and manuscripts etc which are referred by many visitors daily. So, the objective of present study is to analyze airborne fungi inside the B. J. Wadia library of Fergusson College by the air sampling technique and to explore biodeteriogens and allergens.

Materials and Methods

The present study was conducted in the B. J. Wadia library of Fergusson College, Pune, India which lies between 18° 28' 25" north latitude, 73° 47' 52" East longitude and 560 meters altitude. It has a tropical wet and dry climate with average temperatures ranging between 20 to 28°C.

The B. J. Wadia library of Fergusson College is located in the heart of the Pune city. The library covers an area 11,716 sq. ft. The total overall present collection of library is 2,69,000 (approx.). The library materials like books, periodicals, journals, manuscripts, news papers, wooden shelves, racks, tables and the intramural aeromicrobiota grown over them was studied by air sampling method.

Sampling method - The air sampling was carried-out inside the B. J. Wadia library of Fergusson College Pune with the help of battery operated Rotorod air sampler of Perkins (1957) modified by Harrington *et al.* (1959), operated daily in morning at 9.00 a.m. and 60 mins for a four month period from June to September, 2011.

The sampler is a portable device which relies upon high efficiency where small airborne particles are deposited on narrow rods oriented at right angles to high velocity winds. The sampler consists of a battery operated small motor with constant speed is used to whirl thin sticky coated brass rods about its axis at a constant high speed. The motor operating with 6 to 9 volts battery and gives a rotation speed of sampling rods approximately 2300 rpm. On the two vertical rotating bars of the rods the transparent cello-tape was fixed which was trimmed back to the width of the rods, petroleum jelly was applied on the tape as an adhesive for the spores. After sampling for 60 min the tapes were removed from the arms and mounted on clean glass slide using melted glycerin jelly and covered with 22x60 mm cover glass, permanent slides were prepared for the microscopic examination. The slides were scanned and spores were counted and expressed as number/m^3 of air by multiplying with the conversion factor 5.

Result and Discussion

The present aeromycological investigation was undertaken to analyze the indoor aeromycoflora qualitatively and quantitatively inside the B. J. Wadia library of Fergusson College. A total of 79 types of airborne biocomponents were observed and their total concentration is found to be 32510/m^3 of air. Out of these biocomponents, 70 were fungal spore types recorded 26305/m^3 of air and 9 other types recorded 6205/m^3 of air.

Among 70 fungal spore types: 2 belonged to Myxomycotina, 4 belonged to Phycomycotina, 22 belonged to Ascomycotina, 4 belonged to Basidiomycotina, 38 belonged to Deuteromycotina and 9 other types of biocomponent. The group Deuteromycotina dominated the aerospora (60.78 %) followed by other types (19.09 %), Phycomycotina (8.47 %), Ascomycotina (5.48 %), Basidiomycotina (4.37 %), Myxomycotina (1.81 %) (Fig1).

Table.1 Some of dominant components of aerospora in library and their % contribution to the total airspora during study period from June to September 2011

Sr. No.	Spore type	June	July	August	September	Total No. of spores/m3 of air	Average Percentage contribution to the total airspora
1	*Aspergillus*	180	300	1010	3485	4975	15.30
2	*Cladosporium*	1595	605	860	985	4045	12.44
3	*Alternaria*	1735	960	70	40	2805	8.63
4	*Penicillium*	0	150	2475	0	2625	8.07
5	Cellulose fibre	155	180	680	1385	2400	7.38
6	*Albugo*	0	0	1330	1000	2330	7.17
7	Hyphal fragment	460	500	265	425	1650	5.08
8	*Curvularia*	555	490	165	85	1295	3.98

Figure.1 Average percentage contribution of each spore group to the total airspora in library during study period from June to September 2011

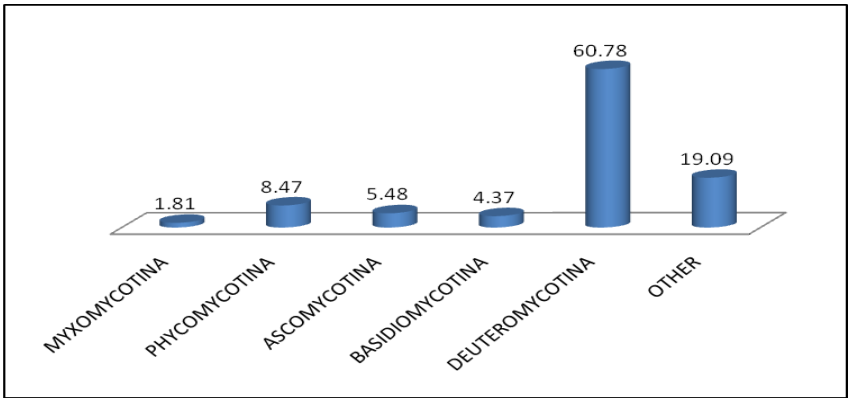


Figure.2 Percentage contribution of each spore group to the total airspora in June 2011

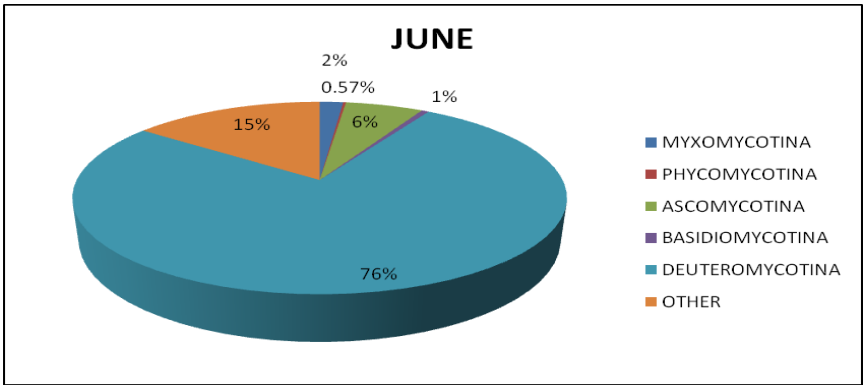


Figure.3 Percentage contribution of each spore group to the total airspora in July 2011

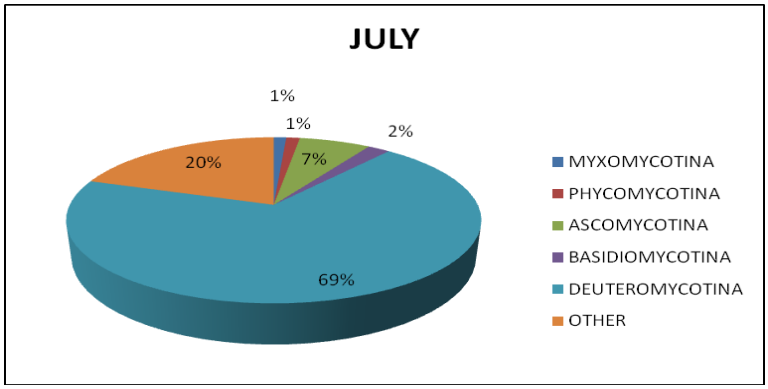


Figure.4 Percentage contribution of each spore group to the total airspora in August 2011

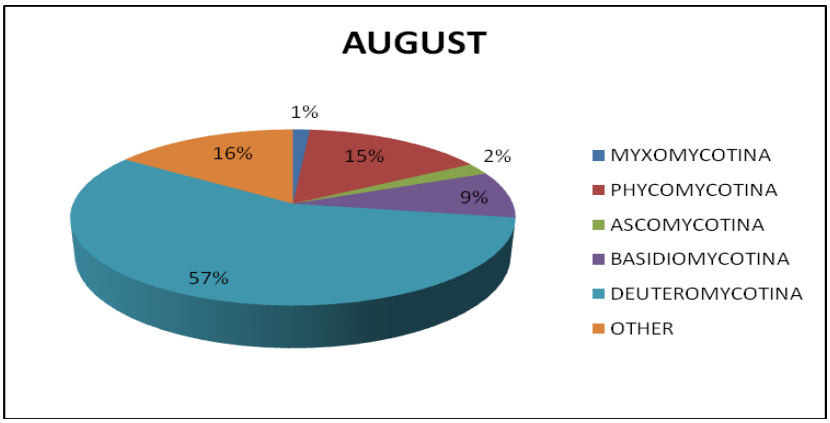
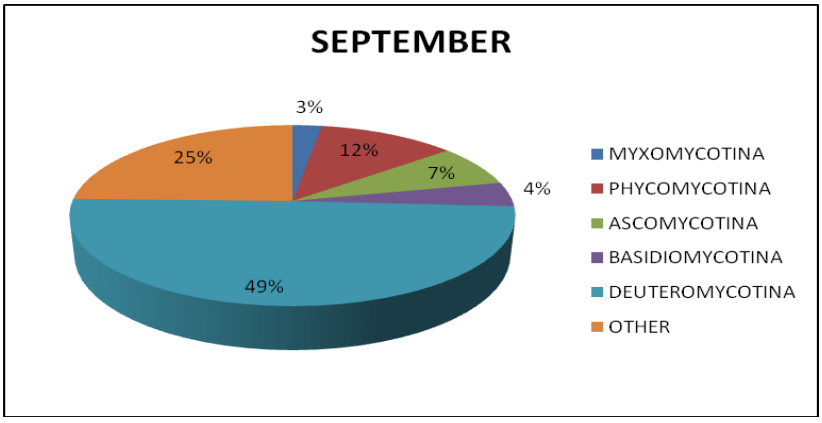


Figure.5 Percentage contribution of each spore group to the total airspora in September 2011



The percentage contribution of some dominant fungal spores in descending order are viz., *Aspergillus* (15.30 %), *Cladosporium* (12.44 %), *Alternaria* (8.63 %), *Penicillium* (8.07 %), Cellulose fibre (7.38 %), *Albugo* (7.17 %), Hyphal fragment (5.08 %), *Curvularia* (3.98%) The results of the investigation have been briefly presented in Table 1.

The location of library is ideal for such indoor study which is well ventilated by the windows and panes. All the adjoining sides of library consist of herbs, shrubs, grasses and trees. The botanical garden is situated very near to library which is rich with fungal diversity that can be harmful to the library collections and health of library visitors.

Aspergillus, *Cladosporium*, *Alternaria*, *Penicillium* these are most common biodeteriorating fungi in the indoor air of library. Tilak and Vishwe (1975) studied the microbial content of air inside library and concluded that air-borne microbes are responsible for deterioration of library materials. Predominance of *Aspergillus*, *Cladosporium*, *Alternaria*, *Penicillium* spore types in indoor air of library were also reported from other parts of India by Tilak and Vishwe (1975) from Aurangabad, Vittal and Glori (1985) from Madras, Tripathi (1987) from Gorakhpur, Saoji and Giri (1997) from Nagpur, Agashe and Anuradha (1988) from Bangalore, Sahney and Purwar, (2001) from Allahabad, Rane and Gandhe (2005) from Jalgaon. Dalal *et al.*, (2011) from Wardha, Ghosh *et al.* (2014) from Kolkata. The exposure to these spores may result in asthma, rhinitis, bronchopulmonary aspergillosis and extrinsic allergic alveolitis (Pande and Godbole, 2009). *Aspergillus* is an aero-allergen which is a ubiquitous fungus common in the environment with potential to cause a spectrum of diseases in human beings (Ghosh *et al.*, 2002).

The various biodeteriogens obtained during the rainy season have been found to cause biodeterioration of papers, stacked books, journals, manuscripts, news papers, binding materials, and wooden book racks etc. The library under study has a tropical climate and it does not have maintenance for temperature and humidity as per expected limit. In rainy season the environment is humid and warm because of which fungi can flourish well. So, these books and journals are liable to be attacked by many numbers of fungi which may cause deterioration and destruction of books and journals. Due to handling of such books and deteriorated materials by visitors it may cause health problems.

During the sampling period, the large numbers of airborne fungi were found inside the library which shows monthly fluctuation. A total of 79 types of biocomponents were observed. These belonged to different groups like Myxomycotina, Phycomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Among these Deuteromycotina was found to be dominant and most of them were found to be biodeteriogens causing damage to the library materials. Some of the fungal types have been found to cause allergy in sensitive individuals. So, the present study is significant to establish preventive strategies of biodeterioration of the books and to avoid the health hazards among the library staff workers and visitors.

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