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ECO-MANAGEMENT OF INDOOR AEROMYCOFLORA OF MUSEUM AREA, RAIPUR (C.G.), INDIA

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ABSTRACT

Air is the mixture of gases, dust particles, water vapour, bioparticles (bacteria, fungi, protozoa) and non living materials. It does not provide the necessary amount of moisture and all type of nutrients for growth and development of microorganisms. Fungal spores are the chief component of airspora but their composition and concentration depend on the source of contamination in the environment, location, types of vegetation and meteorological parameters of that region. Occurrence of fungal bio-deteriogens in open as well as in closed air and problems posed by them to different objects are considered. In addition, some preventive measures are also suggested to protect them from fungi. This study deals with the "Eco-management of Indoor Aeromycoflora of Museum Area, Raipur (C.G.)." In the aerobiological survey of museum, a total 77 fungal species were isolated in indoor environment of museum. Maximum number of fungi belonging to group Deuteromycotina (94.95%) followed by Sterile Mycelia (2.33%). Maximum numbers of fungal species 28 are observed in the month of January coincides the optimum temperature and humidity (28.7ºC, RH 85%) is favorable for the fungal growth. While minimum no. of 10 fungal species is recorded in the month of May and June, which are hot and dry months of Raipur city. Contribution of various fungal species were observed as *Cladosporium Sphaerospermum* (24.35%), *C. cladosporioides* (14.39%), *Aspergillus niger* (5.78%) and maximum percent frequency observed for *Cladosporium sphaerospermum* (83.33%), *Aspergillus niger* (75%), *A. japonicus*, *Curvularia oryzae* (66.66%), *Alternaria alternata*, *A. tenuissima*, *Aspergillus flavus* and *Nigrospora oryzae* (58.33%), *Syncephalastrum racemosum Aspergillus luchensis*, *A. versicolor*, *Cladosporium cladosporioides* and *Curvularia pallescence* (50%).

Key words: ***Ecomanagement, Aeromycoflora, Biodeterioration, Museum, Aspergillus, Fungi***

I INTRODUCTION

Aerobiology is often considered the microbiology of atmosphere. The study of bioparticles in air and their distribution pattern has helped in taking many decisions in cases of agricultural forecasting, ecological management of various monuments and museums, disease control etc. The air borne biological particles settles down due to gravity when the velocity of wind goes down or the activity due to which these particles become airborne ceases. These on getting favourable condition germinate and cause damage to museum articles where high humidity and temperature around 30º C is required. In these conditions the fungal spores if settled on surface having inorganic salts (stones ect.) or organic material will germinate. The growth of fungi on stones or

organic matters has huge consequences. Old buildings and monuments are made of stones. When the fungal spores settle on these, they grow and cause discolouring and sometimes break down of these structures likewise articles, paintings and wood work provide organic matter to the growing fungi. The fungi growing on such articles destroy the value of these articles. Museum and art galleries have articles like paintings and works of art made of wood. These provide ideal substrate for the growing fungal colonies. Once the colonies of fungi gain ground on these articles it becomes very difficult to remove them. Even after their complete remove the ascetic appear of these precious works of art may become permanently damaged.

The fungal growth is the biggest threat to precious items kept in the museums. The movement of audiences and air cannot be stopped inside any museum. The only safe guard from fungal attack is eco management of the indoor atmosphere of the museum. Eco management is the management of place taking into account the ecology of that particular place. Eco-management allows the control of unwanted organisms inside a closed environment while keeping the ecology of that place intact. Eco-management is necessary and need of the present hour. It helps in maintaining a balance between control practices and ecology of the place. It also helps in removing unwanted microorganisms which have gained access to the indoor environment without damaging the ecology and the health of the individuals inside the museum.

It is nearly impossible to stop the complete entry of microorganisms inside a museum as its main focus is the continuous flow of visitors inside it. Therefore good eco management practices try to develop such environment inside the museum which does not allow the germination of spores in any conditions which may have gained an entry. Such particle solely depend a maintaining low humidity and temperature level which discourage the growth of fungal colonies. Also an in out atmosphere during the night time alone with the humidity keep the place free form growth for long periods of time. In eco management elimination of all mycoflora is not the goal. This total elimination of the most harmful species is also not required. The basic tenant of eco-management is to mould the environment in such a manner that it totally discourages the growth of the fungal species without trying to completely eliminate those species. In this way the work of art in the museum become safe and ecological damage also avoided. Aerobiology also helps in maintaining record of different fungal species present in different season. This also help in eco-management practices as strategies can be formulated to take difference fungal flora in different season without compromising the real goal of the eco management, the different season different type of fungi are in abundance.

This call for change in approach of eco management actions accordingly as different fungal species would require different control action. Such different action can be developed as a part of large strategy only if the season variation, frequency & abundance of the particular atmosphere are known. This information is easly available while aerobiological study of atmosphere is performed. On the basis of such study the abundance & frequency along with types of fungal species can be know and eco management strategies can be developed accordingly.

II MATERIALS AND METHODS

Museum is the main environment where we keep article for long duration. These articles give knowledge about over historical backgrounds. The air of museum carry many microorganisms which is harmful for articles .Microorganisms enter in indoor environment through air current and contaminated in museum environment. In museum we keep precious articles which cannot founds again. Microorganism attacks on these articles for their foods for its growth and development. Museum articles are the main source of food for fungi.

Raipur city is the capital of city, Mahanadi river founded its East and dense forest in south and situated in 21^0 - 14' North latitude and 82^0–38' East longitude above 298.60 meter the sea levels. The climatic condition of Raipur city is divided by rainy seasons (July-October) winter (November-February) and summer season (March-June). Our study area "Guru Ghasidas Museum, Raipur (C.G.)" situated near the collectorate, court and central jail, therefore it is very crowded place of Raipur city.

III SURVEY OF AEROMYCOFLORA

For study of aeromycoflora, ten sterilized Petri plates containing PDA media are exposed 5 to 10 min. in indoor of museum area. These exposed Petri plates brought in to the laboratory and incubated at 28 ± 1^0C for incubation period. At the end of incubation period fungal colonies are counted, isolated and identified with the help of available literature and finally identified by the authentic authority.

IV ECOLOGICAL STUDIES

For ecological studies, at the end of the incubation period of the indoor and outdoor aeromycoflora, percentage frequency and percentage contribution of fungal flora is calculated (Jadhav and Tiwari, 1994) with the help of the following formula:

$$\text{Percentage frequency} = \frac{\text{Number of observation in which a species appeared}}{\text{Total no. of observation}} \times 100$$

$$\text{Percentage contribution} = \frac{\text{Total no. of colonies of a species in all observations taken togather}}{\text{Total no. of colonies}} \times 100$$

V RESULT AND DISSCUSSION

MYCOBIAL SURVEY

The present investigation deals with the Ecomanagement of Aeromycoflora of Guru Ghasidas museum area of Raipur by using gravity petriplates (containing PDA medium) method from July 2006 to June 2007.

SURVEY OF INDOOR AEROMYCOFLORA

77 fungal species (813 fungal colonies) belonging to 39 genera are observed at indoor environment of Guru Ghasidas museum at Raipur. Out of the 77 fungal species, 04 fungal species (10 fungal colonies) of 04 genera from Zygomycotina, 06 species (11 fungal colonies) of 05 genera from Ascomycotina, 61 fungal species (772 fungal colonies) of 28 genera from Anamorphic fungi, 05 species (19 fungal colonies) of 01 genera from Mycelia sterilia and 01 fungal colony of Unknown fungi are observed **(Table-2)**.

INDOOR AEROMYCOFLORA DURING RAINY SEASON:

In rainy season, a total of 47 fungal species (179 fungal colonies) are observed. Out of total 47 fungal species, 2species (04 fungal colonies) of 02 genera from Zygomycotina, 03 species (04 fungal colonies) of 02 genera from Ascomycotina, 39 fungal species (157 fungal colonies) of 19 genera from Anamorphic fungi and 03 species (14 fungal colonies) of 01 genera from Mycelia sterilia are observed **(Fig-1)**.

INDOOR AEROMYCOFLORA DURING WINTER SEASON:

In winter season, a total of 58 fungal species (456 fungal colonies) of 29 fungal genera are observed. Out of total 58 fungal species, 02 species (02 fungal colonies) of 02 fungal genera from Zygomycotina, 05 fungal species (05 fungal colonies) of 04 fungal genera from Ascomycotina, 48 fungal species (444 fungal colonies) of 21 fungal genera from Anamorphic fungi, 02 fungal species (04 fungal colonies) of 01 fungal genera from Mycelia sterilia and 01 fungal colony of Unknown fungi are recorded during winter season in indoor environment of museum **(Fig-2)**.

INDOOR AEROMYCOFLORA DURING SUMMER SEASON:

In summer season, a total of 42 fungal species (178 fungal colonies) of 19 genera are observed. Out of 40 fungal species, 03 fungal species (04 fungal colonies) from Zygomycotina, 02 fungal species (02 fungal colonies) from Ascomycotina, 34 fungal species (171 fungal colonies) from Anamorphic fungi and 01 fungal species (01 fungal colony) from Mycelia sterilia are observed **(Fig-3)**.

VI ECOLOGICAL STUDIES

During investigation period maximum percentage frequency reported for *Cladosporium sphaerospermum* (83.33%), *Aspergillus niger* (75%), *A. Japonicas* and *Curvularia oryzae* (66.66%), *Alternaria alternata*, *A. tenuissima*, *Aspergillus flavus*, *Nigrospora oryzae* (58.33%), *Syncephalastrum racemosum*, *Eupenicillium javanicum*, *Aspergillus luchensis*, *A. versicolor*, *Cladosporium cladosporioides*, *Curvularia pallescence* (50%). While minimum frequent fungal species (8.33%) are *Mucor hemalis*, *Rhizopus oryzae*, *Pleospora harbarum*, *Arthrinum pheospermum*, *Aspergillus albus*, *A. carneus*, *A. sclerotiorum*, *A. stillatus*, *Coleophoma crateriformis*, *Colletotrichum gloeosporioides*, *Curvularia pinnseti*, *Haplospheria deformans*, *Monodictys levis*, *Myrothecium verrucaria*, *Penicillium frequents*, *P. lilacinum*, *Pestalotiopsis disseminata*, *Phoma epicoccina*, *P. sorghina*, *Pithomyces chartarum*, *Pseuderotium zonatum*, *Tetracoccosporium paxianum*, *Trichobotrys effusa*,

Trichoderma atroviride, Mycelia sterilia (Peach and Blackish white) **(Table-1)**. *Aspergillus*, *Cladosporium*, *Curvularia* and *Penicillium* species have been reported as most common fungal types in all over the world. Similar results are also made by Emberlin *et al*. (1995) reported *Aspergillus* and *Penicillium* the most frequent in indoor environments at London. *Cladosporium* sp. is common and dominant in Croatia Cevntic and Peplinjak (1997) in Spain. Urzi *et al*. (2001) recorded that *Aspergillus*, *Penicillium*, *Fusarium*, *Alternaria*, *Cladosporium*, *Ulocladium*, *aureobasidium* and *Phoma* are most common isolates of terrace of Missina Museum at Sicily, Italy. Gorney *et al*. (2002) reported that *Aspergillus versicolor*, *Cladosporium cladosporioides* and *Penicillium* are most dominant in indoor environments of Poland. Shelton *et al*. (2002) reported that *Cladosporium*, *Penicillium*, *Aspergillus* and non-sporulating fungi are most frequent fungal species in the indoor and outdoor environments of United States. Shamsian *et al.* (2006) reported that *Aspergillus* and *Penicillium* are most common fungi of Asan Quds museum library, Mashhad, Iran. Singh (2006) reported that *Aspergillus niger* is found to be most frequent fungal species of the aeromycoflora. Abdel Hameed (2007) recorded that *Aspergillus niger*, *Aspergillus parasiticus*, *Alternaria*, *Cladosporium* and *Penicillium* are most frequent fungal species in the atmosphere of Giza, Egypt. Shabbir *et al.* (2007) reported that percentage occurrence of *Aspergillus niger* colonies are the highest (40%) on Demoiselle crane from Zoological museum of the Punjab University.

PERCENTAGE CONTRIBUTION OF INDOOR AEROMYCOFLORA:

Maximum percentage contributions of fungal species (56.08%) are observed in winter season, moderate percentage contribution (22.01%) in rainy season, while minimum percentage contributions (21.89%) are reported in summer season **(Fig-5)**. During the investigation period maximum percentage contribution of indoor environment of museum showed by *Cladosporium Sphaerospermum* (24.35%), *C. cladosporioides* (14.39%), *Aspergillus niger* (5.78%), *Nigrospora oryzae* (4.42%), *Cladosporium oxysporium* (4.05%), *Alternaria alternata* (3.93%), *Aspergillus versicolor* (3.81%), *Alternaria tenuissima* (3.56%), *Aspergillus flavus* and *A. luchensis* (1.84%) and *Curvularia oryzae* (1.72%). Moderate percentage contribution showed by *Aspergillus japonicus*, *Phoma glomerata* 1.35%, *Curvularia ovoidea*, *Phoma exigua* 1.23%, *Curvularia lunata var. aeria*, *C. pallescence*, *Diplococcium sp*., *Penicillium chrysogenum* 1.10%, *Aspergillus nidulans*, *Fusarium caucasicum*, *F. Pallidoroseum* 0.98%, *Drechslera tetramera* 0.86%, *Syncephalastrum racemosum*, *Aspergillus sydowii*, *Humicola grisea var. grisea*, Mycelia sterilia (White and Black) 0.73%. While minimum percentage contribution (0.12%) are observed for *Mucor hemalis*, *Rhizopus oryzae*, *Pleospora harbarum* , *Aspergillus albus*, *A. carneus*, *A. Sclerotiorum*, *A. stillatus*, *Coleophoma Crateriformis*, *Colletotrichum gleosporioides*, *Curvularia pinniseti*, *Monodictys levis*, *Myrothecium verrucaria*, *Penicillium frequants*, *Penicillium lilicinum*, *pestalotiopsis disseminata*, *phoma sorghina*, *Tetracoccosporium paxianum*, *Trichoderma atroviride*, Mycelia sterilia (Ash) and Unknown fungi**.(Table-1)**

A percentage contribution of fungal species has also been observed in different indoor environments in India and Abroad. *Cladosporium cladosporioides*, *Aspergillus versicolor* and *Alternaria alternata* are found to be the most dominated fungi during study period. Tilak and Kulkarni (1972) recorded the higher concentration of *Cladosporium* outside and inside caves at Aurangabad. Similar result also made Rati *et al*. (1980) in poultry shed at Mysore. Petushkova and kandyba (1999) have resulted *Penicillium*, *Aspergillus*, *Fusarium*, *Mucor*,

Alternaria, *Cladosporium* to be harmful fungal species of historical cultural heritage of Moscow cathedrals. Arya *et al*. (2001) have reported *Aspergillus flavus* as dominant fungus of mummy chamber where as other *Aspergillus* including *A. fumigatus* and *A. niger* and one telomorph, *E. nivea* are also observed. Abdullah and Al- Falih (2001) reported maximum contribution for *Cladosporium*, *Aspergillus*, *Alternaria* and *Curvularia* from school in Riyadh. *Cladosporium sphaerospermum* have shown maximum concentration at varallo sesia (near Vercelli) recorded by Nugari and Roccardi (2001).Similar result has also reported by Tiwari *et al*. (2009) at library at Raipur. Bervey and Thakre (2003) found *Alternaria fasiculata*, *Aspergillus flavus*, *A. fumigatus*, *A. niger*, *Culvularia sp*. and *Penicillium funiculosum* to be most dominant fungal flora on all the paintings from central museum Nagpur, (M.S.). Aher *et al*. (2004) observed the *Cladosporium* 17.64% in higher concentration followed by *Alternaria* 6.48% *Curvularia* 2.94% and *Helmenthosporium* 1.73% from aeromycological study of warehouse at Ahmednagar. Cetinkaya *et al*. (2005) observed maximum percentage contribution of *Cladosporium sp*. (31.9%) followed by *Aspergillus sp*. (18.6%), *Penicillium sp*. (15.5%) and *Alternaria sp*. (8.68%) in Turkey. Singh (2006) recorded the maximum percentage contribution shown by *Cladosporium cladosporioides* 24.88% followed by *Curvularia lunata* 6.99%, *Aspergillus japonicus* 6.38% and *Aspergillus niger* 5.60% Raipur. Abdel Hameed (2007) recorded *Alternaria* and *Cladosporium* as most predominant fungal genera from the atmosphere of Giza, Egypt. Aira *et al*. (2007) recorded *Alternaria*, *Aspergillus*, *Cladosporium* and *Penicillium* as most dominant fungal species of Cathedrals of Santiago de Compostela (Spain). Basilico *et al*. (2007) also reported the maximum contribution shown by *Cladosporium* (56.90%) and *Alternaria* (8.68%) in houses of Santa Fe City, Argentina. Shabbir *et al.* (2007) reported *Aspergillus niger* appeared to be the most dominant fungus of indoor environment of the Punjab University, Lahore, Pakistan. During the study period genus *Cladosporium* is observed as most dominant fungal flora of museum. Similar result has also reported in different environment by Ainsworth (1952) and Gregory (1973) from the atmosphere of England, Pady and Capica (1953) from Canada, Sahu and Tiwari (1994), Tiwari *et al*. (1995), Sharma (2001) and Singh (2006) from Raipur, Jadhav and Tiwari (1994) from Ravan village and Jadhav *et al*. (1996) from Balodabazar. Bhattacharjee *et al*. (2009) reported *Aspergillus* (24.93%) as most dominant fungal species followed by *Cladosporium* (19.75%), *Penicillium* (13.57%) and *Curvularia* (6.37%) in the G.U. library where as in Dhudnoi college library of Goalpara. *Aspergillus*(27.98%) as most dominant fungal species followed by *Cladosporium* 20.55%, *Penicillium* 15.33%, *Alternaria* 12.83% observed by Kalkar and Bhonde (2009) in the air of hospital and library. During the investigation period the total percentage contribution of each groups are also recorded here **(Table-3)**. Percentage contribution of Zygomycotina are (1.23%), Ascomycotina (1.35%), Anamorphic fungi (94.95%), Mycelia sterilia (2.33%) and Unknown fungi (0.12%) are recorded **(Fig-4**)

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TABLE -1 : SHOWING NUMBER OF FUNGAL COLONIES OF INDOOR AEROMYCOFLORA OF MUSEUM AREA, RAIPUR (C.G.)

S.No.	Name of Fungi	RAINY SEASON					WINTER SEASON					SUMMER SEASON					G.Total of Fungal Colonies	Percent frequency	Percent 0Contribution
		July	Aug.	Sept.	Oct	Total	Nov	Dec.	Jan	Feb	Total	Mar	Apr	May	Jun	Total			
	Zygomycotina																		
1.	*Choanephora cucurbitarum*	1	-	-	-	1	-	-	-	-	-	-	-	1	-	1	2	**16.66%**	**0.24**
2.	*Mucor hemalis*	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	1	**8.33%**	**0.12**
3.	*Rhizopus oryzae*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	**8.33%**	**0.12**
4.	*Syncephalastrum racemosum*	1	1	1	-	3	1	-	-	-	1	-	1	1	-	2	6	**50%**	**0.73**
Total no. of fungal colonies		**2**	**1**	**1**	**-**	**4**	**2**	**-**	**-**	**-**	**2**	**-**	**1**	**2**	**1**	**4**	**10**		
Total no. of fungal species		**2**	**1**	**1**	**-**	**2**	**2**	**-**	**-**	**-**	**2**		**1**	**2**	**1**	**3**	**04**		
	Ascomycotina																		
5.	*Ascotricha chartarum*	-	-	-	-	-	1	-	-	-	1	-	1	-	-	1	2	**16.66%**	**0.24**
6.	*Chaetomium globosum*	-	-	-	-	-	-	-	1	-	1	1	-	-	-	1	2	**8.33%**	**0.24**
7.	*Corynascus sepedonium*	-	1	1	-	2	-	-	-	-	-	-	-	-	-	-	2	**8.33%**	**0.24**
8.	*Eupenicillium javanicum*	-	-	-	1	1	1	-	-	-	1	-	-	-	-	-	2	**50%**	**0.24**
9.	*Eupenicillium purpurogenum*	-	-	1	-	1	-	1	-	-	1	-	-	-	-	-	2	**16.66%**	**0.24**
10.	*Pleospora herbarum*	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	1	**8.33%**	**0.12**
Total no. of fungal colonies		**-**	**1**	**2**	**1**	**4**	**3**	**1**	**1**	**-**	**5**	**1**	**1**	**-**	**-**	**2**	**11**		

Total no. of fungal species		**-**	**1**	**2**	**1**	**3**	**3**	**1**	**1**	**-**	**5**	**1**	**1**	**-**	**-**	**2**	**06**		
	Anamorphic fungi																		
11.	*Acremonium stictum*	-	-	1	-	1	2	-	-	-	2	-	-	-	-	-	3	**16.66%**	**0.36**
12.	*Alternaria alternata*	10	2	-	-	12	-	1	-	1	2	13	4	-	1	18	32	**58.33%**	**3.93**
13.	*Alternaria tenuissima*	-	-	-	1	1	-	1	2	6	9	12	6	1	-	19	29	**58.33%**	**3.56**
14.	*Arthrinum pheospermum*	-	-	-	-	-	-	-	2	-	2	-	-	-	-	-	2	**8.33%**	**0.24**
15.	*Aspergillus albus*	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	1	**8.33%**	**0.12**
16.	*Aspergillus carneus*	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	1	**8.33%**	**0.12**
17.	*Aspergillus flavus*	-	1	-	1	2	2	-	1	-	3	-	1	3	6	10	15	**58.33%**	**1.84**
18.	*Aspergillus fumigatus*	-	-	-	-	-	2	-	-	-	2	-	-	1	-	1	3	**16.66%**	**0.36**
19.	*Aspergillus japonicus*	1	1	1	-	3	-	1	-	-	1	1	2	1	3	7	11	**66.66%**	**1.35**
20.	*Aspergillus luchensis*	3	-	1	3	7	1	-	4	-	5	-	-	3	-	3	15	**50%**	**1.84**
21.	*Aspergillus niger*	7	3	4	5	19	1	-	-	2	3	5	-	7	13	25	47	**75%**	**5.78**
22.	*Aspergillus nidulans*	-	1	-	1	2	-	-	-	1	1	3	-	-	2	5	8	**41.66%**	**0.98**
23.	*Aspergillus ochraceus*	-	-	1	-	1	1	-	-	-	1	1	1	-	-	2	4	**33.33%**	**0.49**
24.	*Aspergillus sclerotiorum*	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	1	**8.33%**	**0.12**

25.	*Aspergillus stillatus*	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1	**8.33%**	**0.12**
26.	*Aspergillus sydowii*	1	-	1	-	2	-	-	-	1	1	3	-	-	-	3	6	**33.33%**	**0.73**
27.	*Aspergillus tamarii*	-	-	-	-	-	-	1	1	-	2	-	-	-	2	2	4	**25%**	**0.49**
28.	*Aspergillus terreus*	-	-	-	-	-	1	-	-	-	1	3	-	-	-	3	4	**16.66**	**0.49**
29.	*Aspergillus terreus var. aureus*	-	-	-	-	-	-	-	-	-	-	1	-	-	2	3	3	**16.66%**	**0.36**
30.	*Aspergillus ustus*	1	-	-	-	1	1	-	-	-	1	-	1	-	-	1	3	**25%**	**0.36**
31.	*Aspergillus versicolor*	-	8	3	7	18	8	-	4	-	12	-	-	1	-	1	31	**50%**	**3.81**
32.	*Cladosporium cladosporioides*	1	-	-	-	1	14	39	34	26	113	3	-	-	-	3	117	**50%**	**14.39**
33.	*Cladosporium oxysporum*	-	-	-	3	3	3	-	4	21	28	2	-	-	-	2	33	**41.66%**	**4.05**
34.	*Cladosporium sphaerospermum*	4	4	2	6	16	16	15	62	54	147	34	1	-	-	35	198	**83.33%**	**24.35**
35.	*Coleophama crateriformis*	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	1	**8.33%**	**0.12**
36.	*Colletotrichum gloeosporioides*	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	1	**8.33%**	**0.12**
37.	*Curvularia lunata var. aeria*	2	3	1	-	6	-	3	-	-	3	-	-	-	-	-	9	**33.33%**	**1.10**
38.	*Curvularia oryzae*	3	1	1	3	8	1	-	-	1	2	1	-	-	3	4	14	**66.66%**	**1.72**
39.	*Curvularia ovoidea*	-	8	-	-	8	-	2	-	-	2	-	-	-	-	-	10	**16.66%**	**1.23**
40.	*Curvularia pallescence*	-	-	1	-	1	-	1	1	1	3	-	1	4	-	5	9	**50%**	**1.10**
41.	*Curvularia pinniseti*	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	1	**8.33%**	**0.12**
42.	*Diplococcium sp.*	-	1	-	-	1	-	1	5	-	6	1	1	-	-	2	9	**41.66%**	**1.10**

43.	*Drechslera tetramera*	2	-	1	1	4	-	-	-	-	-	-	2	-	1	3	7	**41.66%**	**0.86**
44.	*Fusarium caucasicum*	2	-	-	-	2	2	-	-	4	6	-	-	-	-	-	8	**25%**	**0.98**
45.	*Fusarium chlamydosporum*	1	-	-	-	1	-	-	-	-	-	-	-	-	1	1	2	**16.66%**	**0.24**
46.	*Fusarium pallidoroseum*	-	1	-	1	2	-	-	3	1	4	-	2	-	-	2	8	**41.66%**	**0.98**
47.	*Haplospheria deformans*	-	-	-	-	-	-	-	-	5	5	-	-	-	-	-	5	**8.33%**	**0.61**
48.	*Humicola grisea var. grisea*	-	1	-	-	1	-	-	5	-	5	-	-	-	-	-	6	**16.66%**	**0.73**
49.	*Mamnoniella echinata*	-	-	-	-	-	-	-	1	-	1	-	1	-	-	1	2	**16.66%**	**0.24**
50.	*Monilia sp.*	1	-	-	-	1	-	-	-	-	-	1	-	-	1	2	3	**25%**	**0.36**
51.	*Monodictys levis*	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	1	**8.33%**	**0.12**
52.	*Myrothecium verrucaria*	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	**8.33%**	**0.12**
53.	*Nigrospora oryzae*	-	1	3	2	6	7	13	7	3	30	-	-	-	-	-	36	**58.33%**	**4.42**
54.	*Paecilomyces varioti*	-	-	-	-	-	-	1	1	1	3	-	-	1	-	1	4	**33.33%**	**0.49**
55.	*Penicillium chrysogenum*	-	-	2	1	3	2	-	3	-	5	-	1	-	-	1	9	**41.66%**	**1.10**
56.	*Penicillium citrinum*	-	-	2	-	2	-	1	-	-	1	-	-	-	1	1	4	**25%**	**0.49**
57.	*Penicillium frequentans*	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	**8.33%**	**0.12**
58.	*Penicillium lilacinum*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	**8.33%**	**0.12**
59.	*Penicillium notatum*	1	-	-	-	1	-	1	-	-	1	-	1	-	-	1	3	**25%**	**0.36**
60.	*Pestalotiopsis disseminata*	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	1	**8.33%**	**0.12**
61.	*Phoma epicoccina*	-	-	-	-	-	-	-	3	-	3	-	-	-	-	-	3	**8.33%**	**0.36**

62.	*Phoma exigua*	2	-	1	-	3	-	-	5	1	6	-	-	1	-	1	10	**41.66%**	**1.23**
63.	*Phoma glomerata*	-	2	-	1	3	-	3	4	1	8	-	-	-	-	-	11	**41.66%**	**1.35**
64.	*Phoma sorghina*	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	1	**8.33%**	**0.12**
65.	*Pithomyces chartarum*	-	-	-	-	-	-	-	2	-	2	-	-	-	-	-	2	**8.33%**	**0.24**
66.	*Pseudeurotium zonatum*	-	-	-	5	5	-	-	-	-	-	-	-	-	-	-	5	**8.33%**	**0.61**
67.	*Tetracoccosporium paxianum*	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	1	**8.33%**	**0.12**
68.	*Trichobotrys effusa*	-	3	-	-	3	-	-	-	-	-	-	-	-	-	-	3	**8.33%**	**0.36**
69.	*Trichoderma viride*	1	-	1	-	2	-	-	-	-	-	-	-	-	-	-	2	**16.66%**	**0.24**
70.	*Trichoderma atroviride*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	**8.33%**	**0.12**
71.	*Trichothecium roseum*	1	-	1	-	2	-	1	2	-	3	-	-	-	-	-	5	**33.33%**	**0.61**
Total no. of fungal colonies		**45**	**41**	**29**	**42**	**157**	**67**	**86**	**160**	**131**	**444**	**85**	**25**	**24**	**37**	**171**	**772**		
Total no. of fungal species		**19**	**16**	**19**	**16**	**39**	**19**	**17**	**26**	**18**	**48**	**16**	**14**	**11**	**13**	**35**	**61**		
	Mycelia sterilia																		
72.	Mycelia sterilia (White)	2	2	1	1	6	-	-	-	-	-	-	-	-	-	-	6	**33.33%**	**0.73**
73.	Mycelia sterila (Black)	-	4	1	-	5	-	-	-	-	-	-	-	1	-	1	6	**25%**	**0.73**
74.	Mycelia sterila back(Red)	-	-	-	-	-	-	2	-	1	3	-	-	-	-	-	3	**16.66%**	**0.36**
75.	Mycelia sterila (Peach)	-	-	-	3	3	-	-	-	-	-	-	-	-	-	-	3	**8.33%**	**0.36**
76.	Mycelia sterila (Ash colour)	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	1	**8.33%**	**0.12**
Total no. of fungal colonies		**2**	**6**	**2**	**4**	**14**	**-**	**2**	**1**	**1**	**4**	**-**	**-**	**1**	**-**	**1**	**19**		

Total no. of fungal species		**1**	**2**	**2**	**2**	**3**	**-**	**1**	**1**	**1**	**2**	**-**	**-**	**1**	**-**	**1**	**05**		
77.	Unknown fungi	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	1	**8.33%**	**0.12**
Total no. of fungal colonies		-	-	-	-	-	-	**1**	-	-	**1**	-	-	-	-	-	**01**		
Total no. of fungal species		-	-	-	-	-	-	**1**	-	-	**1**	-	-	-	-	-	**01**		
Grand Total of fungal colonies		**49**	**49**	**34**	**47**	**179**	**72**	**90**	**162**	**132**	**456**	**86**	**27**	**27**	**38**	**178**	**813**		
Grand Total of fungal species		**22**	**20**	**24**	**19**	**47**	**24**	**20**	**28**	**19**	**58**	**17**	**16**	**14**	**14**	**40**	**77**		

Table -2: Survey of indoor aeromycoflora of museum area, Raipur (C.G.)

S.No.	**Name of fungal groups**	**Fungal genera**	**Fungal species**	**Fungal colonies**
1	Zygomycotina	04	04	10
2	Ascomycotina	05	06	11
3	Anamorphic fungi	28	61	772
4	Mycelia sterilia	01	05	19
5	Unknown fungi	01	01	01
Total		**39**	**77**	**813**

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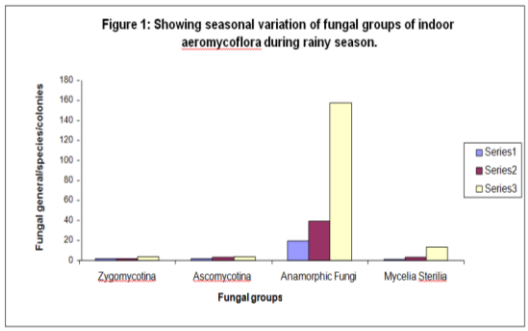
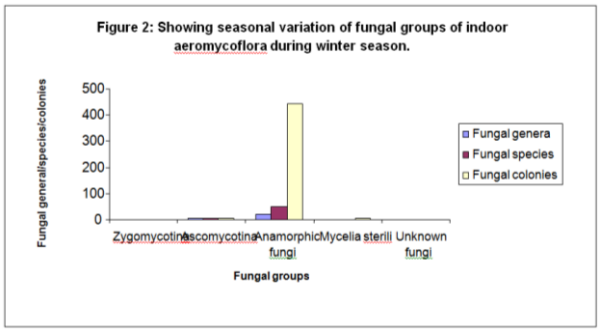
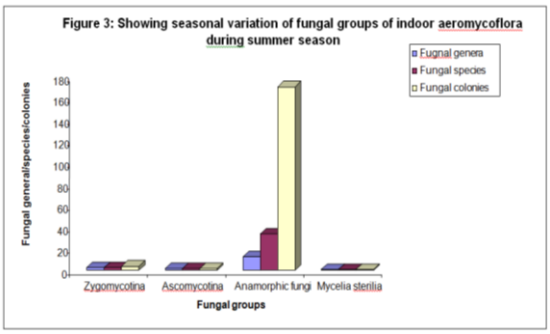
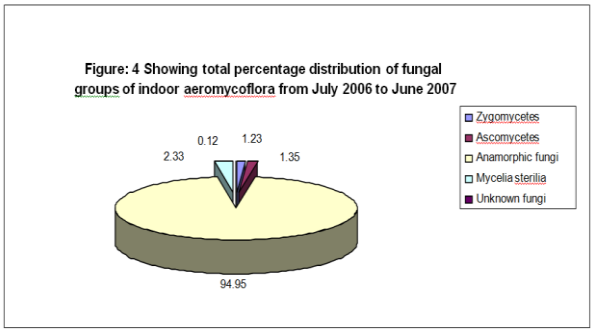
Table 3: Showing class wise total fungal colonies distribution of indoor aeromycoflora during July 2006 to June 2007

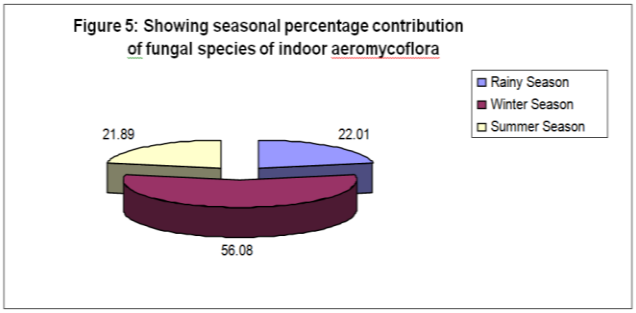
S. No.	Name of fungal groups	Total no. of fungal colonies	Percentage contribution
1	Zygomycotina	10	1.23
2	Ascomycotina	11	1.35
3	Anamorphic fungi	772	94.95
4	Mycelia sterilia	19	2.33
5	Unknown fungi	01	0.12
		813	











CONTROL OF AEROMYCOFLORA

Control of microorganisms in the museums can be done by maintaining a low humid and temperature environment. Also the nature of gas used in after time can be altered to discourage the growth of fungal species. The doors should be equipped with air curtains to disallow the entry of microorganism and to remove the entrants of the surface micro flora. The restoration work should be done by using such chemicals which disallow the growth of microorganisms. The windows and other ventilators should be sieved so that minimal entry to microbial should be allowed.

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