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

Agrawal M. , Tiwari K.L.

Aayush University Raipur (C.G.)

Gurukul Mahila Mahavidyalaya Kalibadi Road Raipur (C.G.)

Abstract

In our planet humans are sharing environment with microorganisms including bacteria, fungi, and viruses. In this study we are focussing on fungal diversity. Earlier studies reveal that numerous fungal species are present in our environment and both the humans and fungi are responsible to influence each other. Problems occurred due to occurrence of fungal biodeteriogens in indoor as well as outdoor air is discussed in detail. In addition to this, some of the anticipatory courses are also suggested which can help us to avoid undesirable impact of fungal diversity in human life. Present paper deals with the "Eco-management of Indoor Aeromycoflora of Museum Area, Raipur (C.G.)." In the aeromycological survey of museum, a total 77 fungal species were isolated in indoor environment of museum. Maximum number of fungi belonging to group Anamorphic fungi (94.95%) followed by Sterile Mycelia (2.33%). Maximum numbers of fungal species 28 are recorded in the month of January coincides the optimum temperature and humidity (28.7ºC, RH 85%) is favourable 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. Maximum contribution of various fungal species were observed as *Cladosporium Sphaerospermum* (24.35%), *C. cladosporioides* (14.39%), *Aspergillus niger* (5.78%) and maximum percent frequency was observed for *Cladosporium sphaerospermum* (83.33%), *Aspergillus niger* (75%), *A. Japonicus* and *Curvularia oryzae* (66.66%).

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

INTRODUCTION

Field of Aerobiology is often considered as 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 of museums and disease control etc. The growth of fungi on stones or organic matters has huge consequences. Whenever they are getting favourable condition they starts germinating and causes damage to museum articles where high humidity and temperature around 26 to28˚C is required. In such conditions if the fungal spores are settled on the solid surface having inorganic salts (stones etc.) or organic material, they starts germination, which we can easily observe in old buildings and monuments are made of stones. When the fungal spores settles down and

start growing can cause discolouring and sometimes break down of these structures likewise articles, paintings and wood works. It provides organic matter to the growing fungi. The fungi growing on such articles destroy the value of these articles. There are many possible reasons behind the presence of fungal diversity in indoor environment, such as Air passages from outside to inside, Employees of the museum ncluding their clothes, shoes and other dress material, Visitors of the museum, Humidity and Temperature inside/outside the museum and types of material are used to manufacture the artefact etc.

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. Aerobiology helps in study of different types of microbes which are present in the indoor atmosphere of the museum. This not only provides the data for the microorganisms while maintaining a healthy ecosystem of the place. But, 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. We cannot restrict the complete entry of microorganisms inside a museum. But, we can minimize the current situation at our best through scientific studies and various research approaches.

Therefore good eco management practices could help to develop such environment inside the museum which does not allow the germination of spores in any conditions which may have gained an entry. This study can help us to formulate various strategies of restricting microbial growth through controlling environmental factors that helps in microbial growth which includes humidity, temperature, source of ventilation and also surrounding atmosphere around the museum. Here we are considering every possible condition to maintain hygienic environment. Most importantly, not every kind of fungal species is responsible for destructing objects, but some of them are specific and they should be targeted.

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 leads us for change in approach of eco management actions in accordance with type of fungal species. This study reveals that the fungal species can be identified and eco management strategies can be developed as per need to restrict them, if necessary.

MATERIALS AND METHODS

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 collectorate, court and central jail, therefore it is very crowded place of Raipur city.

SURVEY OF AEROMYCOFLORA

For study of aeromycoflora, ten sterilized Petri plates containing PDA media are exposed for 5 to 10 min in indoor museum area. These exposed Petri plates brought into 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.

ECOLOGICAL STUDIES

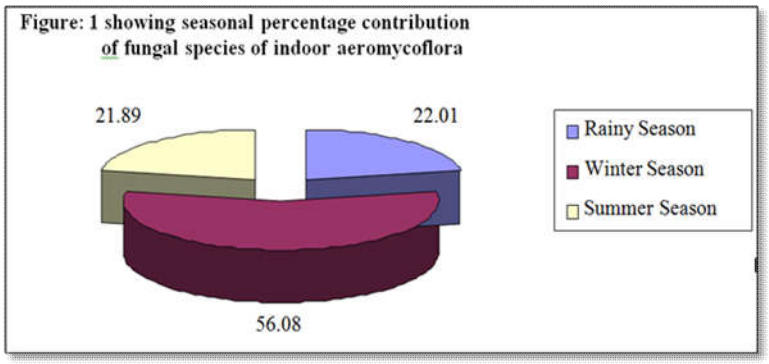
At the end, percentage frequency and percentage contribution of fungal flora is calculated (Jadhav and Tiwari, 1994) [5] with the help of the following formula:

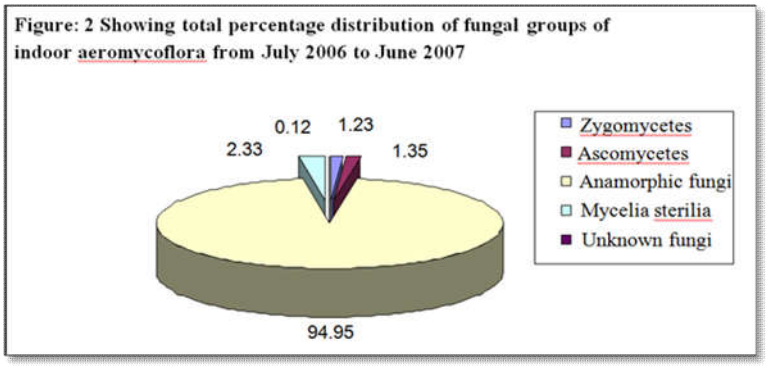
$$\text{Percentage frequency} = \frac{\text{Number of observation in which a species appeared}}{\text{Total no. of observation}} \times 100$$

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

Mycobial Survey

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





RESULT AND DISCUSSION

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 **(Table-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 **(Table-1)**.

Indoor aeromycoflora during summer season:

In summer season, a total of 40 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 **(Table-1)**.

ECOLOGICAL STUDIES

During investigation period maximum percentage frequency reported for *Cladosporium sphaerospermum* (83.33%), *Aspergillus niger* (75%), *A. japonicus*, *Curvularia oryzae* (66.66%), *Alternaria alternata*, *A. tenuissima*, *Aspergillus flavus*, *Nigrospora oryzae* (58.33%), *Syncephalastrum racemosum 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). *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[8]. *Cladosporium* sp. is common and dominant in Croatia Cevntic and Peplinjak (1997) in Spain[9]. 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[15]. Gorney *et al*. (2002) reported that *Aspergillus versicolor*, *Cladosporium cladosporioides* and *Penicillium* are most dominant in indoor environments of Poland[16]. 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.[17] Shamsian *et al.* (2006) reported that *Aspergillus* and *Penicillium* are most common fungi of Asan Quds museum library, Mashhad, Iran[21]. Singh (2006) reported that *Aspergillus niger* is found to be most frequent fungal species of the aeromycoflora [22]. Abdel Hameed (2007) recorded that *Aspergillus niger*, *Aspergillus parasiticus*, *Alternaria*, *Cladosporium* and *Penicillium* are most frequent fungal species in the atmosphere of Giza, Egypt [23]. 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 [24].

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-1)**. 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 Unkown fungi.

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 [3]. Similar result also made Rati *et al*. (1980) in poultry shed at Mysore [4]. Petushkova and kandyba (1999) have resulted *Penicillium*, *Aspergillus*, *Fusarium*, *Mucor*, *Alternaria*, *Cladosporium* to be harmful fungal species of historical cultural heritage of Moscow cathedrals [10]. Arya *et al*. (2001) have reported *Aspergillus flavus* as dominant fungus in mummy chamber where as the other *Aspergillus* sp. including *A. fumigatus* and *A. niger* with one telomorph, *E. nivea* are also observed [12]. Abdullah and Al- Falih (2001) reported maximum contribution for *Cladosporium*, *Aspergillus*, *Alternaria* and *Curvularia* from school in Riyadh [11]. *Cladosporium sphaerospermum* have shown maximum abundance at varallo sesia (near Vercelli) recorded by Nugari and Roccardi (2001) [13].Similar result has also reported by Tiwari *et al*. (2009) at library at Raipur[29], Barve 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.) [18]. 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 [19]. 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 [20]. 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) [25]. 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 [26]. 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) [1], Pady and Capica (1953) from Canada [2], Sahu and Tiwari (1994) [6], Tiwari *et al*. (1995) [7], Sharma (2001), [14], Singh (2006) from Raipur, Jadhav and Tiwari (1994) from Ravan village. 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.[27] *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.[28] During the investigation period the total percentage contribution of each groups are also recorded here **(Table-2)**. 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-2**).

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					Grand Total of Fungal Colonies	Percent Frequency	Percent Contribution.
		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**	**4**		
	Ascomycotina																		
5.	*Ascotricha chartarum*	-	-	-	-	-	1	-	-	-	1	-	1	-	-	1	2	16.66%	0.24
6.	*Chaetomium globosum*	-	-	-	-	-	-	-	1	-	1	1	-	-	-	1	2	16.66%	0.24
7.	*Corynascus sepedonium*	-	1	1	-	2	-	-	-	-	-	-	-	-	-	-	2	16.66%	0.24
8.	*Eupenicillium javanicum*	-	-	-	1	1	1	-	-	-	1	-	-	-	-	-	2	16.66%	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**	**6**		

S.No.	Name of Fungi	RAINY SEASON					WINTER SEASON					SUMMER SEASON					Grand Total of Fungal Colonies	Percent Frequency	Percent Contribution.
		July	Aug.	Sept.	Oct.	Total	Nov.	Dec.	Jan	Feb.	Total	Mar	Apr	May	Jun	Total			
	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

S.No.	Name of Fungi	RAINY SEASON					WINTER SEASON					SUMMER SEASON					Grand Total of Fungal Colonies	Percent Frequency	Percent Contribution.
		July	Aug.	Sept.	Oct.	Total	Nov.	Dec.	Jan	Feb.	Total	Mar	Apr	May	Jun	Total			
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

S.No.	Name of Fungi	RAINY SEASON					WINTER SEASON					SUMMER SEASON					Grand Total of Fungal Colonies	Percent Frequency	Percent Contribution.
		July	Aug.	Sept.	Oct.	Total	Nov.	Dec.	Jan	Feb.	Total	Mar	Apr	May	Jun	Total			
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

S.No.	Name of Fungi	RAINY SEASON					WINTER SEASON					SUMMER SEASON					Grand Total of Fungal Colonies	Percent Frequency	Percent Contribution.
		July	Aug.	Sept.	Oct.	Total	Nov.	Dec.	Jan	Feb.	Total	Mar	Apr	May	Jun	Total			
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	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	1	8.33%	0.12

S.No.	Name of Fungi	RAINY SEASON					WINTER SEASON					SUMMER SEASON					Grand Total of Fungal Colonies	Percent Frequency	Percent Contribution.
		July	Aug.	Sept.	Oct.	Total	Nov.	Dec.	Jan	Feb.	Total	Mar	Apr	May	Jun	Total			
	colour)																		
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**	**5**		
77.	Unknown fungi	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	1	8.33%	0.12
Total no. of fungal colonies		-	-	-	-	-	-	**1**	-	-	**1**	-	-	-	-	-	**1**		
Total no. of fungal species		-	-	-	-	-	-	**1**	-	-	**1**	-	-	-	-	-	**1**		
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**	**42**	**77**		

Table -2: 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	

CONCLUSION:

During the investigation period we used gravity petriplate method for the isolation of aeromycoflora in museum; isolated fungi were identified with the help of available literature and finally confirmed through authorized organization. During the investigation period we have also calculated frequency and contribution fungal species for the information of flora type and diversity. 77 fungal species (813 fungal colonies) belonging to 39 genera were observed from indoor environment of Guru Ghasidas museum Raipur (C.G.). Among them, 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 genus from Mycelia sterilia and 01 fungal species (01 fungal colony) of 01 genus from Unknown fungi were observed. Maximum number of fungal species was recorded for the group of Anamorphic fungi and the most contributed fungal species in indoor environment of museum were *Cladosporium sphaerospermum* (24.35%), *C. cladosporioides* (14.39%), *Aspergillus niger* (5.78%), *Nigrospora oryzae* (4.42%), *Cladosporium oxysporum* (4.05%), *Alternaria alternata* (3.93%), *Aspergillus versicolor* (3.81%), *Alternaria tenuissima* (3.56%), *Aspergillus flavus, A. luchensis* (1.84%) and *Curvularia oryzae* (1.72%). While minimum percentage contribution (0.12%) were 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 frequentans*, *P. lilacinum*, *Pestalotiopsis disseminata*, *Phoma sorghina*, *Tetracoccosporium paxianum*, *Trichoderma atroviride*, Mycelia sterilia (ash) and unknown fungi. Maximum 28 fungal species are observed in the month of January (2007) while minimum 14 fungal species were recorded in the month of May and June (2007). It was also observed that the most frequent fungal species were *Cladosporium sphaerospermum* (83.33%), *Aspergillus niger* (75%), *A. Japonicas* and *Curvularia oryzae* (66.66%). While *Mucor hemalis*, *Rhizopus oryzae*, *Pleospora harbarum*, *Arthrinum pheospermum, Aspergillus albus*, *A. carneus*, *A. sclerotiorum*, *A. stillatus*, *Coleophoma crateriformis*, *Colletotrichum gloeosporioides, Curvularia penniseti*, *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 ash) and unknown fungi were least frequent (8.33%) fungal species in indoor aeromycoflora. Minimizing the growth of microorganism in the museums can be done by maintaining a specific environmental condition along with some technical approaches likewise application of gas fumigation, air passages should be equipped with net and air filters.

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