



MYCO-ECOLOGICAL STUDY OF HISTORICAL SANDSTONE MONUMENTS, WITH SPECIAL REFERENCE TO MAMA BHANJA TEMPLE OF CHHATTISGARH

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Historical sand stone monuments, is subjected to degradation induced by diverse mycoflora. Fungi are among the most active microorganisms in these processes. Fungal ability in production of pigments and organic acids have crucial role in discoloration and degradation of different types of sandstone in historical monuments. This investigation focuses on myco-ecological analyses of microbial bio-film from Mama Bhanja temple of Chhattisgarh State. The seven (07) fungal organisms with specific distribution on sandstone monuments were isolated. Fungi from Ascomycotina as well as Deuteromycotina were more frequent. The most frequent isolated fungal species from these historical sandstone monuments are *Aspergillus niger*, *Curvularia lunata*, *Rhizoctonia solani* and *Aspergillus flavus*. *Aspergillus niger* was common in almost all the sandstone structures of this monument. The frequency and relative frequency of these fungal organisms associated with deteriorated sandstone monuments site provides valuable data for future studies.

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INTRODUCTION

Chhattisgarh is the land of ancient culture where a lot of ancient monuments, temples and forts etc. are located. Every nook and corner of Chhattisgarh has traditional heritage. There are numerous monuments in Bastar Division of Chhattisgarh state. One of such monuments, the Mama Bhanja temple is located in geographical area of Dantewada district of Chhattisgarh state and in the forested terrain which is highly affected by Naxlite (Terrorist) activities. The temple dedicated to Lord Shiva is built on a moulded base. The building of the temple is attributed to the two family members (Mama or uncle and Bhanja or nephew) of the Naga dynasty. The mandapa of the temple, however, has succumbed to the ravages of time. There is an image of Ganesh on the lalatabimba (lintel). The adhishtana and the door jambs are decorated with excellent carvings of foliage, lotuses etc. It is 16 meter in height with a well preserved imposing curvilinear Sikhara over the sanctum. An inscription in Telgu characters datable to the 13th Century A.D. is found on the temple platform¹⁻². This temple has several sculptures. The patches on monuments pertain to fungi that are part of the total vegetational growth over their surface.

Numerous factors affect the stone durability. Stone surfaces are continuously exposed to physical, chemical and biological degradation. Physical, chemical, and biological agents act in co-association, ranging from synergistic to antagonistic, leading to the deterioration. Among biological agents microorganisms have critical importance, in stone deterioration. They can cause various damages on the stone surface, such as: formation of bio-film, chemical reactions with substrate, physical penetration into the substrate as well as pigments production. Fungal ability in production of pigments and organic acids have crucial role in discoloration

and degradation of monuments. The microbial metabolites of bio-films are responsible for the deterioration of the underlying substratum and may lead to physical weakening and discoloration of sandstone³.



Figure 1. Mama Bhanja temple, Barsoor. a-Lateral view; b-front view

The aim of this work is to study the micro fungi community on monuments by using myco-ecological parameters and microscope observations in order to evaluate the variety richness and potential damage caused by fungal species.

MATERIAL AND METHODS

Sampling and Isolation of fungi

Totally 10 Samples were collected from various places of Mama Bhanja temple of Bastar (Chhattisgarh State) and brought to the laboratory under aseptic conditions. The isolation of microorganisms was done by culturing the

Table 1. The isolated fungi

Isolated fungi/Moss	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈	S ₉	S ₁₀	F, %	RF, %	d=S/√N
<i>Aspergillus niger</i>	+	+	+	-	+	+	+	+	+	+	90	25.0	0.70
<i>Aspergillus flavus</i>	-	+	+	+	-	+	+	-	-	-	50	13.8	
<i>Chaetomium piluliferum</i>	-	-	-	+	-	-	-	+	-	-	20	05.5	
<i>Curvularia lunata</i>	-	+	+	-	+	-	+	+	+	+	70	19.4	
<i>Fusarium oxysporum</i>	+	-	-	+	+	-	-	-	+	-	40	11.1	
<i>Rhizopus vigricans</i>	-	-	-	-	-	+	+	+	-	-	30	08.3	
<i>Rhizoctonia solani</i>	+	-	+	+	-	+	-	-	+	+	60	16.6	
Total											360	99.7	

samples and by direct incubation of samples in moist chamber. The purified fungal cultures were identified by using mycological techniques and were compared with the available authentic literature, reviews and mycological manuals⁴⁻⁷.

Calculations

Various myco-ecological characters have been calculated using the following formulae:

$$F = 100 \times \frac{N_1}{N_2}$$

Where

F is the total frequency of organism in %,

*N*₁ is the number of samples in which specific organism occurred

*N*₂ is the total number of samples examined

$$RF = 100 \times \frac{F_i}{F}$$

where

RF is the relative frequency in %

*F*_i is the frequency (in %) of individual organism

$$d = \frac{S}{\sqrt{N}}$$

where

d is the variety richness index

S is the total number of species.

N is the value of total relative frequencies of all fungal species.

RESULTS AND DISCUSSION

During screening for search of mycoflora, total seven species of fungal organisms were isolated from Mama Bhanja temple (Table 1). Composite result indicate that all the ten (10) samples were mainly dominated by different

species of *Aspergillus niger*, *Aspergillus flavus*, *Curvularia lunata* and *Rhizoctonia solani* due to their high percentage frequency.

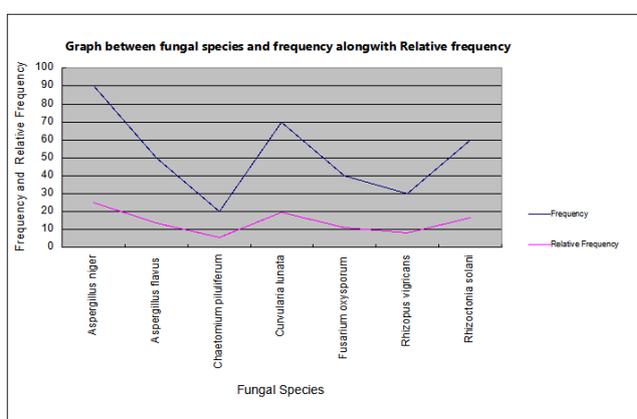
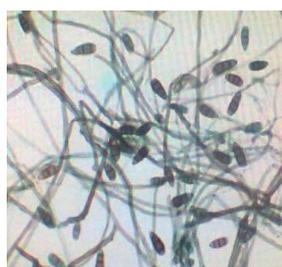
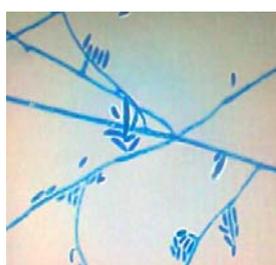


Figure 2. Frequency and relative frequency of the fungal species

Aspergillus niger shows maximum frequency followed by *Curvularia lunata* and *Rhizoctonia solani*. Some of the fungal species are confined to particular area. These confinements of fungal species depend on environmental conditions of the area, which varies from geographical area to area. In the present study *Aspergillus* species are the most common species found in the sites. The grey and black colour of the stone surfaces is not only due to dematiaceous fungi but very frequently it is due to the endolithic phototrophic microorganisms like cyanobacteria and algae. As in the case of fungi the dark pigments protect algal cells against UV radiation besides other stress factors⁸.

Value of index of variety richness i.e. 0.70 revealed that the studied fungal community was significant. In each fungal community all the species are not equally important. There are relatively only few of these, which determine the nature of the community⁹. These few species exert a major controlling influence on the community and also play important role in deterioration of various substrates.

The variation in the composition of fungal organism depends upon biochemical nature of host, degree of competition between the fungal organisms and the prevailing environmental conditions. The frequency and relative frequency are directly or indirectly correlated with meteorological data and climatic conditions¹⁰.

*Aspergillus niger**Aspergillus flavus**Curvularia lunata**Chaetomium piluliferum**Fusarium oxysporum**Rhizopus vigricans**Rhizoctonia solani*

It has also been shown in the laboratory that fungal species such as *Aspergillus niger* were able to solubilize powdered stone and chelate various minerals in a rich glucose medium because they produce organic acids such as gluconic, citric, and oxalic acids¹¹. The toxic metabolites produced by various species of fungal organisms function as chelating agents that can leach metallic cations, such as Iron, Magnesium etc. from the stone surface. Laboratory experiments have demonstrated that basic rocks are more susceptible to fungal attack than acidic rocks. In the present study *Aspergillus* are the most common species found in the sites. *Aspergillus niger* releases certain metal ions from the rock samples¹².

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