

Fungal involvement in bio- weathering of historical monument with reference to Rumi Darwazaat Lucknow (Uttar Pradesh), India

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Abstract

Fungi are complex communities of microorganisms that damage historic monuments. The present study was made to examine the diversity of fungi associated with deteriorated monument sites. In the present investigation, 10 samples were collected from various portions of deteriorating sites of Rumi Darwaza (gate) at Lucknow. Five fungal species isolated from deteriorated monument sites are reported in this paper. The most frequent isolated fungal species from the historic monument sites are *Aspergillus niger*.

Keywords: Bio-deterioration; Micro-organism; Fungi; Monument; Hyphae; Bio-film; Preservation; Conservation; Cultural property

1 Introduction

The Rumi Darwaza (Gate) is an incredible structure which stands imposingly between Bara Imambara and Chhota Imambara in Lucknow, Uttar Pradesh, India. Constructed in 1784 under the rule of Nawab Asaf-ud-Daula, it is a fine example of Awadhi architecture, or the Lucknow School of Architecture. It was a style adopted by the Nawabs of Awadh to preserve the Mughal architectural style while experimenting with newer styles and materials. The Rumi Darwaza, one of the heritage attractions in Uttar Pradesh, is also referred to as Turkish Gate because it bears a strong similarity in design to a gateway built in ancient Constantinople (today's Turkey) called Bab-i-Humayun. Standing at an impressive height of 60ft, it once served as the entrance to old Lucknow City. Rumi Darwaza is in no way related to the poet Rumi. It is so called because it was modelled after a similar gateway in Istanbul, which was then known as Constantinople under the Eastern Roman Empire. The construction of this structure was started by the Nawab as part of the food for work programme at a time when this region was suffering from famine. This place is generally very much busy all day and during weekends most of the tourists visit. The streets are redeveloped as it was earlier constructed of hard brick roadways. The design of the gate represents the most famous industry for which the city Lucknow itself is known for - 'Chikan kaari'. When the gate is looked upside down it resembles the v shaped neckline used in chikan clothing's. On the top of the gate some small pillars have been erected, they represent the spice- long which was used as one of the ingredients in "paan" of the Mughal kings. The gates were made massive so that when the emperor enters on his horses or elephants, they can easily come through. The Gate also has Matsya fishes engraved on it, that are also there in the state's (Uttar Pradesh's) emblem. The streets represent the very substance, of the city, hence Lucknow is also known as the 'City of Nawabs'. The people there are known for their *Tehzeeb* (respect towards others) and their very fine manners¹.

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1.1 Bio-weathering problem of the monument

Surfaces of the monument are continuously affected by physical, chemical and biological agents. Among biological agents, microorganisms are responsible for the destruction of cultural heritage²⁻⁴. They can cause damage on the monumental surface such as formation of biofilms, chemical reactions with the substrate, physical penetration in to the substrate as well as pigment production. Numerous studies have dealt with establishing the role of biological agents in the monument deterioration⁵⁻⁶. During recent decades there has been a growing concern about deterioration of historic building by chemical and physical factors as well as microbial growth on the surface of monument play an important role in this process⁷. Microbial colonization of stones depends on environmental factors such as water availability, pH, climatic exposure, nutrient sources and petrologic parameters such as mineral composition as well as the porosity and permeability of building material. The stone ecosystem is subject to harsh environmental changes, especially due to temperature and moisture⁸⁻⁹. All fungi need some organic source for their nutrition and growth, which is provided by metabolites of phototrophic organisms or by air-borne deposition. It has been shown that very low nutrient requirements of some rock inhabiting fungi may be fulfilled by remains of polluted air and rain or animal remains and secretion¹⁰.

2 Material and methods

2.1 Sampling and Isolation of Fungi

A total of 10 samples were collected from various places of monument and were brought to the laboratory under aseptic conditions. The isolation of micro-organisms was done by culturing the samples and by direct incubation of samples in moist chamber. The purified fungal cultures were identified (Table-1) by using mycological techniques and were compared with the available authentic literature, reviews and mycological manuals¹¹⁻¹⁴.

2.2 Calculations

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

$$\% \text{ of Frequency (F)} = \frac{\text{Number of samples in which specific organism occurred}}{\text{Total number of samples examined}} \times 100$$

$$\% \text{ of Relative Frequency (RF)} = \frac{\text{Frequency of an individual species}}{\text{TFrequencies of all species}} \times 100$$

Table 1 Observation

Isolated Fungal Organism	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈	S ₉	S ₁₀	F%	RF%
<i>Aspergillusniger</i> Van. Tiegh.	+	+	-	+	+	+	+	+	+	+	90	32.1
<i>Aspergillusydowi</i> Link.	-	+	+	+	+	-	+	+	-	+	70	25.0
<i>Fusarium species</i> Link.	+	-	-	+	-	-	-	+	+	-	40	14.2
<i>Memnoniellalevispora</i> Subram.	-	+	+	-	-	-	+	-	-	-	30	10.7
<i>Penicilliumcitrinum</i> Link.	+	+	+	-	-	+	-	+	-	+	60	21.4
Total											290	103.4

(+) represented to presence and (-) represented to absent of micro-organism in the samples

3 Results and discussion

The mentioned fungal species are typically soilfungi, which is in accordance with the results¹⁴ which noted a considerable number of the same genus and species. The identified micro fungi cause discoloration as well as mechanical exfoliation of building material that was analyzed through mechanical hyphae penetration and production of different pigments and organic acids. Previous researcher¹¹⁻¹² reported that a large number of fungi have great biochemical decay potential. Recently, it has been apparent that the ability of fungi to interact with minerals, metals, metalloids and organic compounds through biomechanical and biochemical processes, makes them ideally suited as

biological weathering agents of rock and building material. Biological and mycological investigations are a very important part of good conservation and cannot be ignored in the modern conservation concept, which includes close collaboration between art and science. This collaboration is the comparative study of the role of microbial colonization on the degradation of historic monuments¹³⁻¹⁴.



Figure 1 Rumi Darwaza (gate): front and backside showing micro- organism growth on the surface

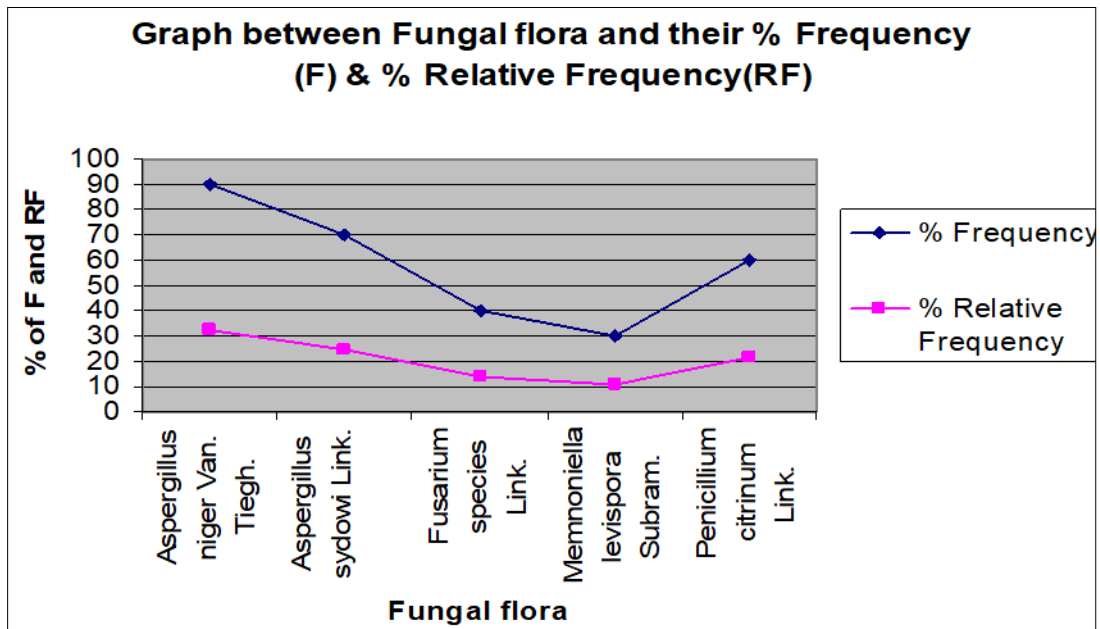


Figure 2 Graph between fungal flora and their % frequency (F) & % relative frequency (RF)

4 Conclusion

Cultural heritage is made up of a variety of material produced by nature and used by man. Cultural heritage objects are subjected to damage by fungi. The results of this study suggest that these fungi should not be ignored for their potential role in nutrient cycling by bio-deterioration of monuments. The possible outcome of this study is that valuable information about the diversity of fungi involved in the deterioration on monuments will be obtained.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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