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FUNGAL DETERIORATION OF MONUMENT WITH REFERENCE TO QUEEN'S MOSQUE AND TOMB AT SARANGPUR, AHMEDABAD, INDIA

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Abstract: Fungi have an important role in the biodegradation of monuments made of stone. The effect of fungi in the degradation of different types of stone has been widely investigated and demonstrated. Fungi can provide bio-protection for stone surfaces, act as a barrier against weathering, retain moisture, increase waterproofing, reduce thermal stress and corrosion, and absorb pollutants. Nevertheless, the evaluation of biodegradation versus bio-preservation cannot be generalized, as it may vary according to the behavior of different species, as well as that degradation may be influenced by both the lithotype and the environment. In addition to laboratory studies, more field studies of biological communities are needed, in order to analyze their establishment and succession under natural conditions and after conservation treatments. To guarantee the best decision for stone conservation, cleaning operations should not be based on a generalized approach, but on a careful evaluation of different aspects related to biodegradation and bio-preservation. In this research article, authors attempted to discuss the fungal degradation of the stone monuments i.e. Queen's mosque and Tomb at Sarangpur, Ahmedabad, Gujarat State and the role of said various fungi in the degradation based on a study jointly conducted by chemists from the Science Branch of Archaeological Survey of India, Vadodara and scientists from the National Research Laboratory for Conservation of Cultural Property, Lucknow.

Keywords: Biodegradation, Biodeterioration, Bioprotection, Color, Fungi, Lichens, Stone.

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INTRODUCTION

Queen's Mosque in Sarangpur was built by Malik Qiwam 'ul-Mulk Sarang. He was a Rajput converted to Islam under the influence of the Sultan and later rose to the status of the Governor of Ahmedabad in AD 1521, during the reign of Muzaffar Shah II. The Masjid probably built during the second half of the fifteenth century, measures 14.56 meters by 11.13 meters on the inside and has five large domes over as many square areas in the sanctuary, entered into through fine arched gateways, the central one being large, higher and with a richly carved arch-rim; the two large-sized minars standing on either

side of the centre or now unfortunately extant up to the roof only, resemble closely those of Bibi-ki-Masjid of Rajpur. The front wall behind the minars is raised on the central portion to about 2.74 meters along a stretch of 12.80 meters (Fig. 1) but on the interior, there is only a kind of balcony to the gallery resting on pillars of normal height (Fig. 2). This is further connected with the gallery under the central dome. The front wall has four perforated windows while on the back wall there are six, with two at the side walls.

The tomb is juxtaposed in front of the Masjid, as in the case of Rani Sipri's or Sayyid 'Uthman's and stands on a base 22.86 meters square. The outer fringe has 21.74 meters interspaced which had four pairs of coupled pillars on each face with the corner angles totally closed in stone walling while the 20.42 meters inner area was supported by squares of thirty-six, twenty-eight, twenty and twelve pillars raised to 3.96 meters height throughout up to the roof, the innermost square carrying the dome over it (Fig. 2). This had also jali-worked screens around it with an entrance on the south side. Twenty pillars which are in the inner square and carry an upper projection have a long gallery there around the central high dome, and have also small corner domes. The two tombs in the rauda had long since been stripped of their marble veneer. While one of them is obviously of Malik Sarang, the other is usually taken to be that of his wife. In its original condition, the rauda would have been very attractive (Gazetteer of the Bombay Presidency: Ahmedabad. Government Central Press, 1879).

Fig.1: Front view of Queen's Mosque showing fungal growth on the surface.

Bio-weathering problem of the monument

Monument surfaces are constantly affected by physical, chemical and biological factors. Among biological factors, microorganisms are responsible for the destruction of cultural heritage (Griffin *et al.,* 1991; Bock and Sand, 1993; Ciferri, 1999). They can damage monuments by forming bio-films on the surface of monuments, chemical reaction with the substrate, and physical penetration into the substrate as well as pigment production. Many studies have dealt with establishing the role of biological agents in monument degradation (Pochon and Jaton 1968; May *et al.,* 1993)

Currently, there is growing concern about the degradation of historical buildings and other monuments due to chemical and physical factors and the growth of microorganisms on the surface of monuments plays an important role in this process (Suihko *et al.,* 2007). The colonization of microorganisms on stones depends on the environmental factors (water availability, pH, climatic exposure), petroleum parameters such as source of nutrients and mineral composition as well as porosity and permeability of the building materials. The stone ecosystem is subject to drastic environmental changes, particularly highly affected by temperature and humidity (May, 2003; Warscheid and Braams, 2007). All fungi require some organic source for their nutrition and growth, which is provided by metabolites of phototrophic organisms or by air-borne deposition (Verma and Prakash, 2020). It has been observed that fungi living in the crevices of certain rocks or monuments have very low nutrient requirements, which are met by polluted air and raindrops or by animal remains and secretions (Hoffland *et al.,* 2004).

Fig. 2: Showing different Pillars inside the Mosque.

MATERIALS AND METHODS

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 (which is shown in table-1) by using mycological techniques and were compared with the available authentic literature, reviews and mycological manuals (Ellis, 1976; Alexopoulos, 1978; Barnett and Hunter, 1987; Gilman and Joseph, 2008).

Calculations

Various myco-ecological characters are calculated using the following formulae:

$$\% \text{ of Frequency (F)} = \frac{A}{B} \times 100$$

Where, A= Number of samples in which specific organism occurred
B= Total number of samples examined

$$\% \text{ of Relative Frequency (RF)} = \frac{C}{D} \times 100$$

Where, C= Frequency of an individual species
D= Frequencies of all species

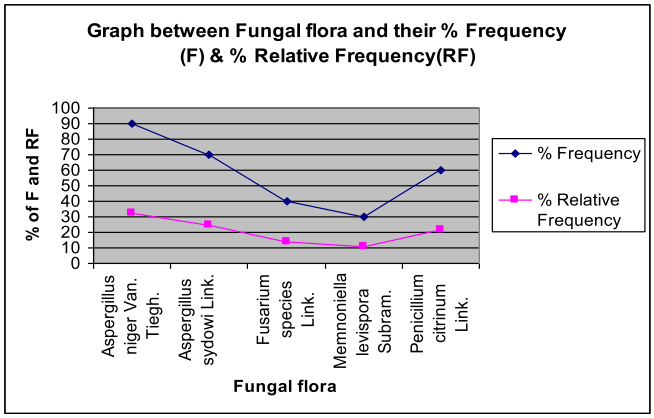
Table 1: Identified fungal culture.

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%
Aspergillus niger Van. Tiegh.	+	+	-	+	+	+	+	+	+	+	90	32.1
Aspergillus sydowi Link.	-	+	+	+	+	-	+	+	-	+	70	25.0
Fusarium species Link.	+	-	-	+	-	-	-	+	+	-	40	14.2
Memnoniella levispora Subram.	-	+	+	-	-	-	+	-	-	-	30	10.7
Penicillium citrinum Link.	+	+	+	-	-	+	-	+	-	+	60	21.4
Total											**290**	**103.4**

RESULTS AND DISCUSSION

The fungal species found in the analysis are typical soil fungi that showed a considerable number of fungi of the same genus and species. It is clear from the myco-ecological data that the relative frequency also increases with frequency of myco flora (Graph 1). The identified microscopic fungi can cause mechanical weathering as well as discoloration of the surface of monuments, which can be analyzed through mechanical hyphae penetration and production of various pigments and organic acids. Previous researchers including Alexopoulos (1978) and Barnett and Hunter (1987) found in their studies that a large number of fungi have a very high potential for biochemical decay.

Recent studies have also made it clear that the ability of fungi to form friendly associations with minerals, metals, metalloids and organic compounds through biomechanical and biochemical processes makes them ideally suitable as biological weathering agents of monuments and building materials. Biological and mycological investigations are very important part of good conservation and cannot be ignored in the modern conservation concept, which involves close collaboration between art and science. This analysis is a comparative study of the role of microbial colonization on the degradation of historical monuments, heritage and other cultural properties (Ellis, 1976), which proves beneficial for scientific conservation of cultural heritage.



Graph 1: Fungal flora and their % frequency (F) and relative frequency (RF).

CONCLUSION

Cultural heritage, monuments and artifacts are made up of various materials produced by nature and used by man. Objects of cultural heritage, property, monuments, ancient artifacts and other ancient properties are damaged by fungi. The results of this study suggest that these fungi should not be ignored for their potential role in nutrient cycling through bio-degradation of monuments. The expected outcome of this study is that it will provide valuable information about the diversity of fungi involved in the degradation of monuments.

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