ISSN: 2230-9926

*Available online at http://www.journalijdr.com*

IJDR

*International Journal of Development Research*
*Vol. 15, Issue, 01, pp. 67586-67588, January, 2025*
https://doi.org/10.37118/ijdr.29191.01.2025


RESEARCH ARTICLE OPEN ACCESS

# FUNGAL DETERIORATION OF MONUMENT WITH SPECIAL REFERENCE TO ASPERGILLUS: A CASE STUDY

***Sanjay Prasad Gupta and Sachin Kumar Agnihotri**

National Research Laboratory for Conservation of Cultural Property, Lucknow, India and Archaeological Survey of India, Vadodara, India

## ARTICLE INFO

***Article History:***

Received 20th November, 2024
Received in revised form
19th December, 2024
Accepted 22nd December, 2024
Published online 30th January, 2025

***Key Words:***

Biodegradation, Cultural heritage, Monument, Fungi, Micro-organism, Bio-deterioration.

****Corresponding author: Sanjay Prasad Gupta,***

## ABSTRACT

Fungal ability to produce pigments and organic acids has crucial role in discoloration and degradation of different types of stone in cultural property. Additionally, stone objects may support novel communities of microorganisms that are active in bio-deterioration process. This investigation focuses on mycological analysis of microbial bio-film from Queen's Mosque at Sarangpur, Ahmedabad of Gujarat State made of sandstone, and which was heavily colonized by fungi. The 12 fungal flora including filamentous micro fungi with specific distribution on sandstone substrate were isolated. During the investigation period it was observed that *Aspergillus sp.* was found as common. The identified micro fungi cause discoloration, as well as mechanical exfoliation of building stone material that was analyzed through mechanical hyphae penetration and production of dark pigments and organic acids.



***Citation*: *Sanjay Prasad Gupta and Sachin Kumar Agnihotri. 2025.*** *"*Fungal Deterioration of Monument with Special Reference to Aspergillus: A Case Study*". International Journal of Development Research*, 15, (01), 67586-67588.

# INTRODUCTION

The Centrally protected Queen's Mosque monument situated at Sarangpur, Ahmedabad of Gujarat State [Fig]. Queen's Mosque was built by Malik Qiwam-Ul-Mulk Sarang. A Noble of Sultan Mahmud Begada's court who was a rajput converted to Islam. The Mosque was built during second half of the 15th Century A.D. has five large domes, Which are entered through five large domes, Which are entered through five arched gateways. The two large sized minars on either side. The central mihrabs have a flat back. The Tomb is located in front of Queen's Mosque. It stands on a base; The outer fringe has inter-space which has four pairs of coupled pillars, While the inner area was supported by squares of 36, 28, 20 and 12 pillars respectively. The inner most square carries the dome over it. It also has jali screens around with an entrance on the south. The inner square of 20 pillars which carries an upper projection has a long gallery around the central part.

***Conservation Issues:*** The patches on the monument pertain to fungi that are part of the total vegetational growth over their surface [Fig]. Every nook and corner of Gujrat has traditional heritage. 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[1].

They can cause various damages on the stone surface, such as: formation of biofilm, 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[2].

**Fig. 1. Front View of Queen's Mosque Monument**

# MATERIAL AND METHODS

***Sampling and Isolation of fungi:*** Totally 15 Samples were collected from various places of the Queen's Mosqueand 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[3]. Two different agar media were taken for the selection of basal media. Media employed were Czapeck-Dox and Potato dextrose agar. Out of two media Czapeck's-Dox medium was selected as the basal medium for subsequent studies, because this medium supported good mycelial growth and excellent sporulation for all the best organisms and its composition is simple due to which modifications and substitution of various ingredients were possible. The purified fungal cultures were identified by using mycological techniques and were compared with the available authentic literature, reviews and mycological manuals[4-5].

***Percentage of frequency:***

Frequency occurrence was calculated as follows:

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

Based on the frequency occurrence the fungi were grouped as Rare (0-25% frequency), Occasional (26-50% frequency), Frequent (51-75% frequency), and Common (76-100% frequency) species.

***Deterioration process:*** The acids produced by various species of fungi function as chelating agents that can leach metallic cations, such as Iron, Magnesium etc. from the stone surface. These acids also react with alkali metal cations like Calcium. Oxalic acid can cause extensive corrosion of primary minerals and the complete dissolution of ferruginous minerals through the formation of iron oxalates and silica gels. Laboratory experiments have demonstrated that basic rocks are more susceptible to fungal attack than acidic rocks[6-7]. 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 acids[8]. Similar experiments involving stone have demonstrated the formation of oxalate crystals, which adhered to lichen and fungal hyphae or were deposited nearby.

# RESULT AND DISCUSSION

Twelve species of fungi was detected in the biofilm collected from the Mosque (showing in Table-1. Fungal species was found on the stone in a biofilm where their effect on the stone substrate led to the deterioration of the monument. These communities forming thick biofilms produced intense pigmentation varying from dark green to dark red which altered the aesthetic appearance of the stone (showing in Fig). The identified micro fungi cause discoloration as well as mechanical exfoliation of building stone material that was analyzed through mechanical hyphae penetration and production of different pigments and organic acids. Air borne fungi fail to settle on polished surfaces but the fungal hyphae can easily penetrate the porous and rough surfaces of the monuments. Though crevices are the favoured places, under optimal environmental conditions they colonize the entire surface as seen in monument. It was found that through electron microscopy fungi in association with bacteria widespread in deteriorating stone[8]. Fungus first settles on the weakest zone of the stone surface whereby stating that bio-receptivity is the essential prerequisite of the stone to be colonized[9]. In penetration phase fungus extends its hyphae into the inner part of the stone and establish as larger colonies. Two patterns of bio deterioration, inter crystalline growth of the fungi which bring out the detachment of the crystal (space between two rocks/ stones) and bio pitting. Ability of fungus to produce pits in stone. In the present study in many locations on the surface and crevices of the stone structures many pits were observed. In monument fungi have colonized penetrating the cracks often producing a deepening of the fissure[10]. Earlier researcher have reported that the design of buildings give some implications on the weathering of the surfaces and that the attack by microbes follows the initial physical and chemical weathering and that weathering is more rapid when microbes are involved[11].

# CONCLUSION

To conserve these monuments scientific treatment is very essential. Biological infections and the intensity of bio-deterioration processes are strongly influenced by water availability. The establishment of fungi on rocks is possible even without the pioneering participation of phototrophic organisms. Fungi are especially concentrated in stone crusts. They are able to penetrate into the rock material by hyphal growth and bio corrosive activity, due to excretion of organic acids or by oxidation of mineral forming cations, preferably iron and manganese. Their deterioration activities also include discoloration of stone surface, due to the excretion of melanin by dematiaceus fungi. Biological and mycological investigations are very important part of good conservation and cannot be ignored in modern conservation concept which includes close collaboration between art and science. In the present study aspergillus species are the most common species found in the sites. Aspergillus niger released certain metal ions from the rock samples[12]. The grey and black colour of the stone surfaces is not only due to dematiceous 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 factors[13]. Hence study of distribution patterns and colonization patterns are essential in formulating conservation works. The characterization of these microorganisms and a clear understanding of their role in the process of stone decay are essential for suitable restoration interventions.

***Acknowledgement:*** Authors are gratitude to Shri Janhwij Sharma, Director General, National Research Laboratory for Conservation of Cultural Property, Ministry of Culture, Government of India, Lucknow. Dr Virendra Nath former Scientist-G, NBRI-CSIR, Lucknow and Prof (Dr) Arun Arya, former HoD, department of Environmental Science for their help and valuable guidance.

# REFERENCES

Alexopoulos, C. J. 1978. Introductory mycology (2nd ed.). *Wiley Estern Ltd*. New Delhi.

Barnett, H.C. and Barry Hunter, B. 1987. Illustrated genera of important fungi. Macmillan Publishing Company. New York and Collier. Macmillon Publishers, London.

Boyle J. R. and Voight, G. K. 1973. Biological weathering of silicate minerals. Implications for tree nutrition and soil genesis. *Plant and Soil,* 38: 191-201.

Clara Urzi, Filomen De Leo, Sybren De Hoog and Sterflinger, K. 2000. Recent advances in the molecular biology and ecophysiology of meristematic stone inhabiting fungi. *Kluwer Academic Publishers,* New York, 3-20.

Eckhardt, F. E. W. 1988. Influence of culture media employed in studying microbial weathering of building stonesand monuments by heterotrophic bacteria and fungi. In: VI International congress on *Biodeterioration and Conservation of Stone:* Supplement, Torun, Poland: Nichalas Copernicus University press Department, 71-81.

Ellis, B.M. 1976. More Dematiaceous Hyphomycetes**.** *CMI,* Kew, England.

Gilman Joseph, C. 1973. Manual of Soil Fungi. *Print well publication,* Jaipur (India).

Lapidi, A. A. and Schipa, G. 1973. Some aspects of the growth of chemotrophic and heterotrophic bacteria from decayed stone. In: *Proceedings* of the 5th International Congress on deterioration and conservation of stone. (Ed) G.FelixLausanre, Switzerland, 633-640.

Mukerji, K.G. 1993. Biology of Lichen. *Aravali Books International*, New Delhi, 89-113.

Salvadori, O. 2000. Characterisation of endolithic communities of stone monuments and natural outcrops. *Kluwer Academic Publishers,* New York, 89-101.

Sharma, K. and Chelak, E. 2014. *J.Bio.Innov,* 3(5):257-260.

Sharma, K.R. 1974. Colonization of saprophytic micro fungi and bacteria on the aerial parts of Sesamum Orientale and Gossypium hirsutum. *Ph.D. Thesis,* Univ. of Delhi (India**).**

Sterflinger, K. and Krumbein, W. E. 1997. Dematiaceous fungi as a major agent for biopitting on Mechterranean marbles and limestones. *Geomicrobio. J.,* 14: 219-230.

*******