INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE

ISSN: 2067-533X Volume 2, Issue 2, April-June: 89-94 www.ijcs.uaic.ro

BIODETERIORATION AND PRESERVATION OF SITA DEVI TEMPLE, DEORBIJA, CHHATTISGARH, INDIA

Sanjay Prasad GUPTA[1*], Kavita SHARMA[2]

[1)] Archaeological Survey of India, Raipur Circle, Raipur, India.
[2)] Department of Botany Arts & Commerce Girls College, Raipur, India

Abstract

Chhattisgarh is a land of ancient culture, with many ancient monuments, temples and forts. Every nook and corner of Chhattisgarh has traditional heritage. There are numerous factors that affect the durability of stone. 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 and leading to deterioration. Among biological agents, micro-organisms are of critical importance in stone deterioration. They can cause various damages on the stone surface. Biodeterioration processes result from complex interactions of surface-invading microbes with each other, as well as with the surface material. The ability of fungi to produce pigments and organic acids is crucial for the discoloration and degradation of monuments. Air acts as a vehicle for the dispersion of microorganisms. They are introduced into air from different sources: soil, water, organic waste, plant leaves, sneezes and cough. This investigation focuses on the scientific conservation of The Sita Devi Temple of Deorbija DistricDurg, [Chhattisgarh]. The stone surface of the temple grew dark due to deposits of dust, dirt, dried vegetation and the growth of micro vegetation on the exterior as well as the interior portions.

Keywords: *Deorbija; Fungi; Biodeterioration; Archeology; Degradation; Microorganism.*

Introduction

There are few places that have such an amazing bio-diversity in nature, along with as exciting a cultural tradition and heritage as Chhattisgarh. The beauty of nature, the life style of tribes, the multifarious rock paintings, a rich culture of a primitive society, combined with an exciting geomorphology such as the natural caves, waterfalls and ever flowing river, create an ambiance that soothes the mind and nurtures the senses. Most significantly, the unique tradition and tribal culture and their music, dance and art are just some of the distinguished attractions. The historical monuments form ruined forts, tribal palaces and exquisitely carved temples with rock paintings and caves and hill plateaus. Each of those has a history, a special exciting tale related to all of the dynasties that ruled the erstwhile states. And if history is not ones favorite subject, then one can still check out the ancient sculptures and architecture of the temples, forts and of course the rock paintings.

There are many ancient monuments in Chhattisgarh, such as the Rajivlochan temple, the Laxaman temple, the Mahadeo temple, the Sita Devi temple, (Fig. 1) the Bhoramdeo temple and beautiful sculptures, such as Mahishasurmardani, at Sirpur, built between 6^{th} -14^{th} centuries. They are of Nagara style, while some have a Panchaytana plan.

* Corresponding author: guptasanjayprasad@gmail.com , +917714218484

a b

Fig. 1. Sita Devi Temple: a - before conservation; b – after conservation

These beautiful monuments, consist of thousands of sculptures and paintings. Most of them date from the 9th to the 11th century. The architectural beautifulness is amazing but there are environmental factors that cause deterioration [1]. The harmful effect of the micro-organisms colonizing the monuments is scientifically known as biodeterioration. So the original beauty and gracefulness are affected and slowly, in time, they diminish the value. If proper measures are not taken, these remains they may collapse due to moss, fungi, lichen etc. Fungi play an important role in the biodeterioration of monuments [2]. The biodeterioration of ancient buildings and monuments depends on many factors, including environmental factors like light, moistures, weather, temperature and certain types of micro-organisms. All these equally contribute to the biodeterioration of any monuments. The phototrophic microorganisms are common inhabitants of monuments.

The stone surface of the temples became blackish in appearance due to deposits of dust, dirt and dried vegetation and micro vegetation [4]. The deposit covered area seems to be very old due to the formation of secondary dull green, pale, white lichens, present all over the stone surface. Due to these deposits the aesthetic beauty of the temple is seriously affected. Moreover, these depositions are very harmful for the health of the stone surface. It is necessary to remove these accretions from the surface of the monument [3].

The material used for building is primarily stone. Stones are mainly of three types: igneous, sedimentary and metamorphic. The sedimentary type of sandstone in the Sita Devi temple is red coloured sand stone in which cementing material is calcite and the masonry is ashlars. The temple was built in 9-10th century A.D.

The Sita Devi temple is situated on the Durg-Bemetara Road, 60 km away from the district head quarter of Durg (Chhatishgarh) and 20 km from Bemetara Tahsil. The monument is situated in a remote area near a small village.

Conservation Issues

The Sita Devi temple was built of sand stone, which is porous in nature. The surface deposits seem to be very old due to the formation of secondary dull green pale white lichens ,

which are present all over the stone surface. Due to these deposits the aesthetic beauty of the temple is seriously affected. From a scientific point of view these depositions are very harmful for the health of the stone surface, because these micro organisms secrete an acid that dissolves the sand stone [5].

Materials and Methods

Isolation of Fungi

Potato dextrose agar (PDA) media was used to obtain a pure culture of fungi from the sample taken from the monuments. After 7 days colonies were observed. The fungi were identified at the National Centre of Fungal Taxonomy Delhi.

Table 1. Contribution of the flora

S.No	Name of fungi	Contribution, %
1	*Aspergillus flavus*	7.95
2	*A. fumigatus*	11.36
3	*A. niger*	10.22
4	*A.Scalrotium*	6.81
5	*A. temari*	5.68
6	*Cladosporium oxy*	6.81
7	*Curvularia lunata*	5.68
8	*Curvularia clavata*	4.54
9	*Fusarium sp.*	6.81
10	*Mucor sp.*	9.09
11	*Mycelia sterilia (white)*	6.81
12	*Paecilomyces varioti*	5.68
13	*Penicil. chrysogenum*	7.95
14	*Penicillium Sp.*	2.27
15	*Trichoderma viride*	2.27

Removal of Dust and Dirt Accretion

Measures were taken by the Archaeological Survey of India for the removal of dust and dirt accretion to keep the stone in neutral pH and to preserve and strengthen the stone by soft brushing (Fig. 4b). The moss, fungi and lichen were removed by applying 2-3% solution of ammonia in water and by scrubbing with a nylon brush [8]. Black patches of remains of micro-vegetational deposits appeared after removal of thick layer of moss, fungi and lichens which were washed out with the help of dilute solution of oxalic acid in water because due to very deep penetration of micro – vegetational growth inside the stone, only superficial cleaning done by using ammonical solution with the help of aid of soft nylon brushes. A diluted solution of a non ionic detergent with liquid ammonia was applied on the treated surface to remove dirt, dust and any traces of acid and ammonia left on the surface during the chemical treatment (Fig. 3b). To stop further growth of micro vegetation, 2% aq. solution of sodium pentachlorophenate was applied on the clean, dried surface. The brittleness and powdering of stones were preserved by the application (brushing and impregnation till saturation) of an ethyl silicate based coating material, which forms a glass like silica gel binder (SiO_2 aq.) with release of ethanol (by evaporation) as byproduct [6]. Noteworthy is that the intake of stone strengthener materials was comparatively higher in the case of damaged and pulverized stones (Fig. 2b). That can be attributed to the presence of more pores for penetration. The coating of stone strengthener was applied on the deteriorated and flaky stone surface by simple brushing and impregnation till saturation.

a b

Fig. 2. Sita Devi Temple detailed structure: a - before consolidation; b – after consolidation

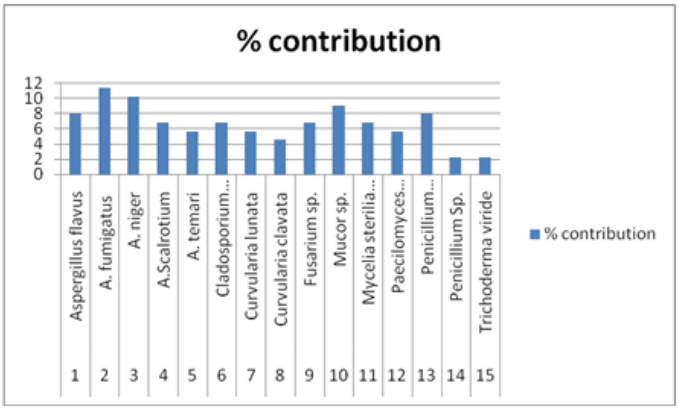
a b c

Fig. 3. Sita Devi Temple lateral view: a - before conservation; b – during conservation, c – after conservation

a b c

Fig. 4. Sita Devi Temple front view with stairs:
a - before conservation; b – during conservation, c – after conservation

Table 2. Fungal Species



Preservation Solutions

It is essential that the preservation solution applied on the monuments be of good quality. It should be colorless and transparent and must not turn yellow or become colored with age, but should be fairly stable for long period of time. It should also offer reasonable protection to the monument against moisture and its film should be hard and strong enough to protect the stone surface from damaging accretions. Therefore, for the preservation of the Sita Devi temple a silane-siloxane based compound (Wacker BS-290) was chosen, which was diluted with Mineral turpentine oil in a ratio of 1:16 and applied on the monument by soft painting brush. By using MTO as a solvent slight temporary darkening appears but preserved surface gradually get their original appearance because of slow evaporation of solvent. This compound is water proof and stops water from settling on the stone surface [8].

Future Prospects

As the synthetic fungicides and others chemicals which are applied to the monuments affecting fungi species has ill affect on monuments as well creates hazards for environment by creating pollution. In the future study we will try to extract products from medicinal plants that can be used effectively as fungicide to control over the monuments affecting fungi. These plants products will be eco-friendly as well as economic and easily available from surrounding forest area. This study will tell which medicinal plant has how much antifungal activity against which fungal species and how much amount of plant extract is lethal for fungal species.

Results and Discussions

During the present investigation 15 fungal flora were identified that caused deterioration of the monument (Table 1& 2). The fungal species *Cladosporium oxysporum*, *Fusarium* sp., *Mycelia sterilia Aspergillus*, *Penicillium*, *Curvularia*, *Cladosporium*, *Muco* , *Trichoderma* were observed. The results of the present investigation concur with various works done by researchers. Alka Jain et al., (2008) proved that excessive moisture in building materials supports microbial growth. Endolithic lichen and fungal growth can be used to describe the ecophysiological adaptation thereof to the environmental extremes of the rock as studied by Bungartz et al. [10]. The biodiversity of soil crust biota from different geographical regions is rather dissimilar and their determination is only rarely based on cultivated material in the case of cyanobacteria, algae and fungi [9].

Conclusions

To preserve these monuments conservation treatment is very essential. But it is more essential that the identification of the problem and the selection of chemicals be in compliance with the problem of the stone surface and the preservation solution applied on monuments be of good quality [7]. It should be colorless and transparent and should not turn yellow or become colored with age but should be fairly stable for long parried of time. It should offer reasonable protection to monuments and sculptures against moisture and its film should be hard and strong enough to protect the stone surface from damaging accretions.

Acknowledgements

The authors wish to thank Dr. P.K. Mishra, Superintending Archaeologist, at the Archaeological Survey of India, Raipur Circle, Raipur, Dr. K.S. Rana, Director (Science) at the Archaeological Survey of India, Dehradun for their encouragement and guidance and to the Chhattisgarh Council of Science and Technology, Raipur (C.G.) for their financial support.

References

[1] R. Kumar. and A.V. Kumar. *Biodeterioration of stone in tropical environment*: **An Overview**; published by Paul Gatty Trust, America, 1999, p.85.

[2] E. May, F.J. Lewis, S. Pereira., S. Taylor, M.R.D. Seaward, D. Allsopp. *Microbiol deterioration of building stone*: **A review: Biodeterioration Abstract 7**, 2, 1993, pp.109-123.

[3] W.H. Dukes, *Conservation of Stone: Chemical Treatments,* **The Architects' Journal Information Library**, **156,** 34,1972, pp. 433-438.

[4] N.R. Shah, A. Shah. *Studies on some fungal biodeterioration.* **Pub. G.P. Gautam, Bhartiya Kala Prakashan,** Delhi, 2000, pp.202-208.

[5] G. Torraca, *Porous Building Materials Science for Architectural Conservation,* **International Centre for the study of the Preservation and the Restoration of Cultural Property,** Rome, 1981, pp. 64-66.

[6] H.J. Plenderlith, A.E. Werner; **The Conservation of Antiquities and Works of Art and Repair** (Edition 2), Oxford University Press London, 1979.

[7] O.P. Agrawal, *Conservation of Cultural Heritage.The Challenges Before Us,* **Journal of Indian Museum,** New Delhi, **49,** 1993, pp.94.

[8] * * *, *Sillicone Division,* **Product Manual**, Wacker - Chemie GmbH, Munich, Germany 2002.

[9] E. P. Burford, M. Fomina, and , G. M.Gadd, *Fungal involvement in bioweathering and biotransformation of rocks and minerals,* **Mineralogical Magazine**, **67,** 2003, pp. 1127-1155.

[10] F. Bungartz, L. A. J. Garvie, & T.H. Nash, *Anatomy of the endolithic Sonoran Desert lichen Verrucaria rubrocincta Breuss*: **Implications for Biodeterioration and Biomineralization. Lichenologist, 36**, 2004, pp. 55–73.

Received: Mar 06, 2011
Accepted: May 21, 2011