

Biodeterioration of Cultural Heritage and Indigenous Methods Used for Preserving Cultural Heritage

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Abstract

The world is full of cultural heritage of all kinds. A large number of monuments, artefacts and manuscripts spread all over the world are finest example of rich cultural heritage and a symbol of men's cultural identity and continuity. Cultural heritage is unique and irreplaceable, which places the responsibility of preservation on the present generation. The different types of deterioration of heritage collection are reflected in wear and tear, shrinkage, cracks, brittleness, warping, bio-infestation, discoloration, abrasion, holes, dust, and dirt accumulation etc. The ravages of time, and extreme climatic conditions such as changes in temperature, humidity, intensity of light or even ignorance and most important biological agents, often destroyed priceless cultural property and records. It is therefore imperative that measures be taken at the earliest and in time to save and preserve these culture and heritage for posterity. The research work undertaken for an understanding of morphological and physiological characteristics of biological agents, required to identify accurately the biological species that have established themselves on the surface or within the material. With the exact characterization of the organisms, it is also necessary to assess the cause-effect of biodeterioration action of a specific identified biological agent. The identification of the microorganisms on the materials and further understanding of their involvement and causes in biodeterioration of art objects and manuscripts have to be evaluated to find possible measure to prevent and successfully solve the associated problems and restore our Cultural Heritage. Traditional Indigenous methods for conserving cultural method is seem beneficial as it did not have any side effect on the materials and also the cheap and best way in this fields. During the experiments it is observed that traditional way gives wonderful results in increase resistance development and prevent the growth of microorganisms on the surface.

Keywords: Traditional; Indigenous; Cultural Heritage.

Introduction

Heritage exists at different levels. We can say that humanity as a whole has inherited as a culture which may be called human heritage. Every nation also inherits a culture which may be termed as national cultural heritage. Cultural heritage includes all those values of culture transmitted to human beings by their ancestors from generation to generation. These cultural heritages are cherished, protected and maintained by them with unbroken continuity and they feel proud of it. The Taj Mahal, Sun Temple Konarak, Jagannath Temple, Puri, Lingaraja Temple, Bhubaneswar, Red Fort of Agra, Delhi's Qutub Minar, Mysore Palace, Jain Temple of Dilwara (Rajasthan)

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etc., are all important places of our heritage and are to be protected by all means. Besides the architectural creations, monuments, material artefacts, the intellectual achievements, philosophy, treasures of knowledge, scientific inventions and discoveries are

also the part of heritage. In India the contributions of Aryabhata, Baudhayana, Bhaskaracharya in the field of Mathematics, Nagarjuna in the field of

Chemistry, Astronomy and Astrology; Varahmihir in the field of Physics; Patanjali in the field of Yoga and Susruta and Charak in the field of Medicines are



Fig. 1: Biodeterioration in the (A) Madan Mohan temple (B) Gopinath temple (C) Govinddev Ji temple

profound treasures of Indian Cultural heritage. The Knowledge of these ancient saints firstly transfers orally through guru shishya parampar.

Later most of them recorded and preserved in the form of manuscripts. Culture is liable to change, but our heritage does not. As individuals, we belonging to a culture or a particular group sometime may be acquire or borrow certain cultural traits of other communities/cultures, but our belongingness to Indian cultural heritage will remain unchanged. Our Indian cultural heritage will bind us together e.g. Indian literature and scriptures namely Vedas, Upanishads Gita and Yoga System etc. have contributed a lot by way of providing right knowledge, right action, behavior and practices as complementary to the development of civilization.

Biodeterioration: The word biodeterioration has only been in used for few decades, but describes

process affected humankind ever since we began the process and use the materials. It refers to the negative impact of live-organisms activity. Biodeterioration is usually concerned with the action of small organisms i.e. microorganisms (bacteria, fungi etc.). The development of these biological species on the materials determined by nature and properties of material (pH, salinity, moisture content, minerals and texture) and also depends upon the some environmental factors (relative humidity, light, temperature, gases, atmospheric pollution, rainfall and wind). While the biological process are the primary causes of deterioration, in biodeterioration, the chemical and physical processes are the primary causes related to biodeterioration. Deterioration is a loss of structural capacity with time by the action of the external agents or material leaching (Saiz and Liaz 2000). Biodeterioration in its widely accepted form of definition is: "any undesirable change in the properties of a material caused by the vital activities

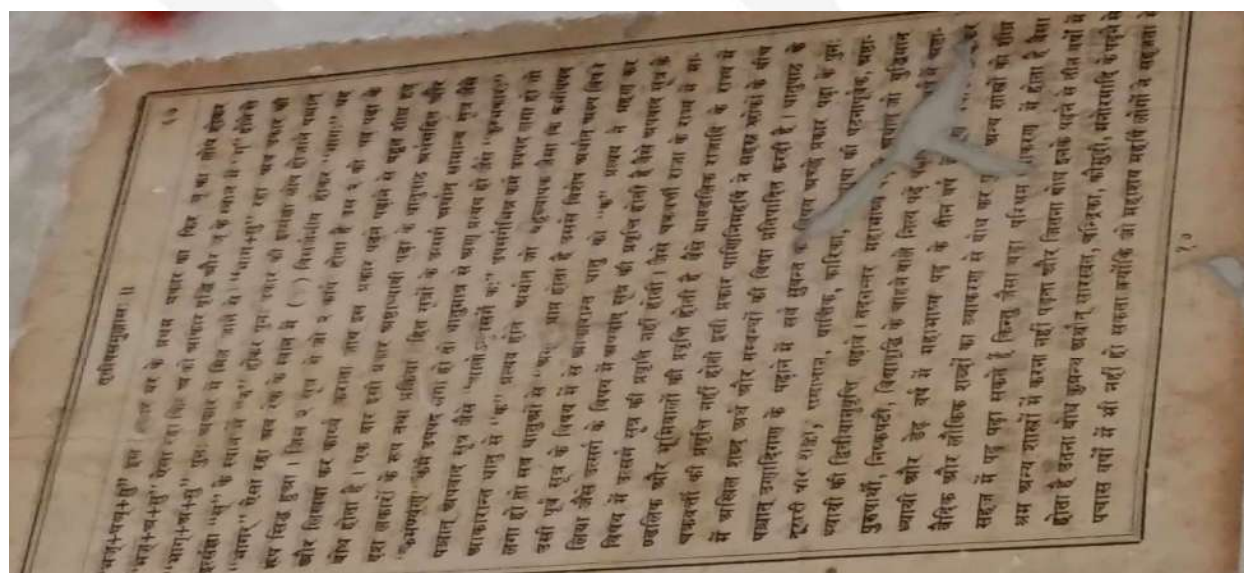


Fig. 2: Biodeterioration on paper manuscript

of organisms" (Hueck 1968). Rose defines "the process by which biological agents (i.e. live organisms) are the cause of the (structural) lowering in quality or value" (Rose 1981).

Biodeterioration can be classified into main three categories: (i) biophysical (ii) biochemical and (iii) aesthetic (Gaylarde *et al.* 2003). Biodeterioration depends up on biodeteriogens, the nature of material and environmental conditions, the above processes (biophysical, biochemical, aesthetic) may occur separately or simultaneously. Biophysical and biochemical deterioration directly affect the material and mechanical properties. This related to the process of growth or movement but not use the material as

food. Biochemical deterioration divided in to (i) assimilatory and (ii) dissimilatory. In assimilatory process organisms use the component as food, thus modify the properties. However in dissimilatory process waste products react chemically with components and affecting the material. Aesthetic biodeterioration is caused by the presence of organisms, their excreta, metabolic products, dead bodies forming a layer on the surface known as 'biofilm', and may cause physiochemical damage to the material.

Biodeterioration is an alteration process of an object in which the interaction takes place between the object and factor of destruction (Agarwal 1993). The objects

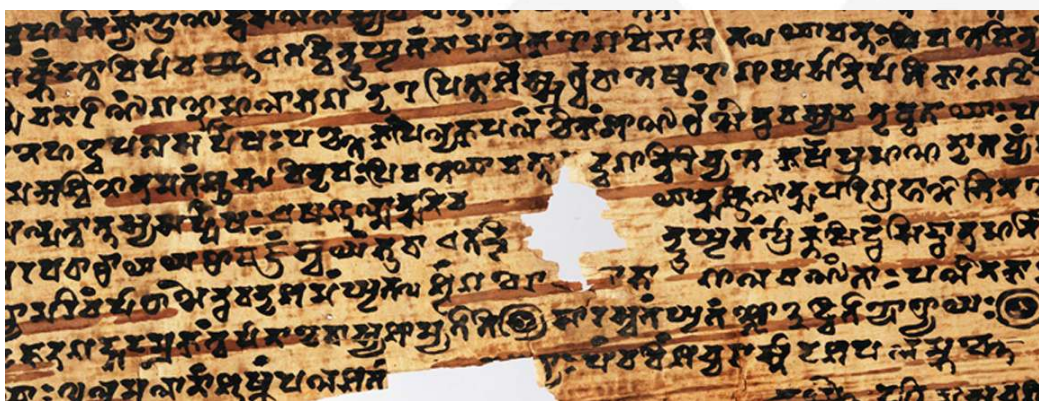


Fig. 3: Biodeterioration on birch bark manuscript

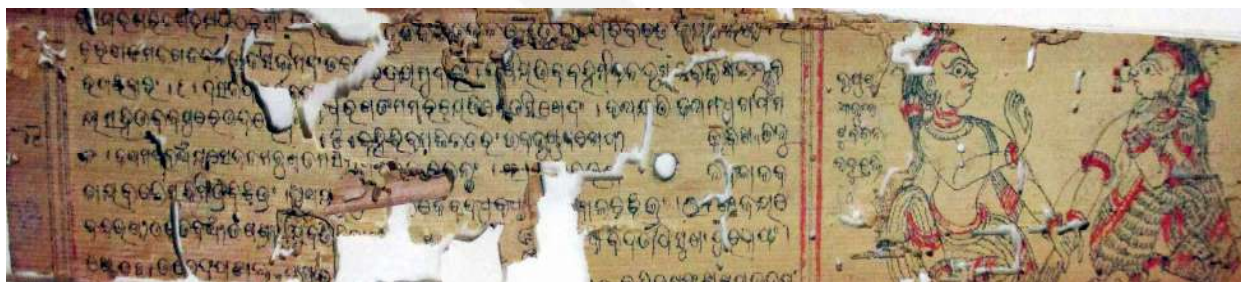


Fig. 4: Biodeterioration on palm leaf manuscript

made of organic substances are more susceptible to inevitable decay in due course of time. Therefore art objects made of organic substances need special care and preservation.

Material and Methods

Sample collection: The microorganisms' growth is collected from manuscripts sample by scrapping and direct plating method collected from the Vrindavan Research Institute, Ramanreti, Vrindavan, Mathura and K.M. Institute of Hindi and Linguistics, Dr. B.R. Ambedkar University, Agra. Sand stone sample are

collected from different temples in Vrindavan, Mathura namely Radha Madan Mohan Temple, Radha Gopinath, Radha Govinddev ji. These temples devoted to lord Krishna situated in the bank of river Yamuna or near by the River Yamuna. According to temple authority the temples are more than 550 years old but renovated time to time by different people or authority. Mathura and Agra both come under the subtropical/semiarid climate and prone to extreme as high as 46° Celsius in the summer and 2° Celsius during winter season. Annual rainfall is about 27 inch. And the most important factor for the biodeterioration is relative humidity in the range 70-80% in dry season and 90-100% during wet season (rainy season).

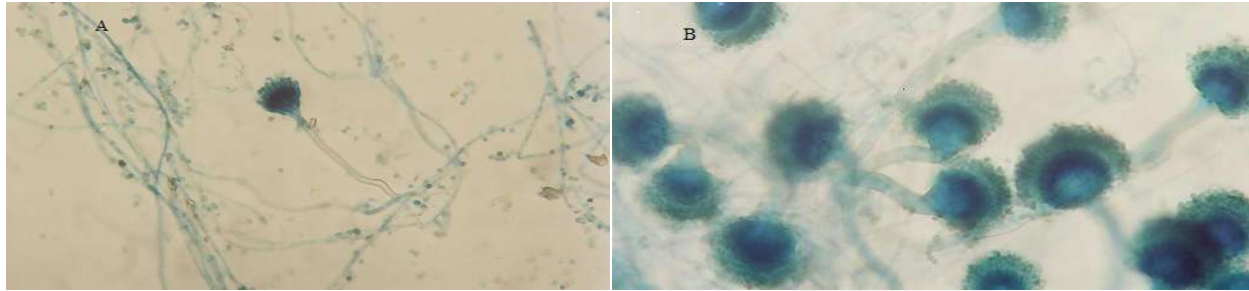


Fig. 5: Different Microorganisms found in abundant: A) *Penicillium Sp.* B) *Aspergillus Sp.*

Result and Discussion

Table 1: Occurrence of microorganisms on deteriorated pieces from different site

S. No.	Microorganisms	VRI	MM	RMT	RGT	RGVT
1.	<i>Achromobacter sp.</i>	++	+	++	++	+
2.	<i>Bacillus sp.</i>	+++	++	++	++	++
3.	<i>Chlorococcum sp.</i>	++	-	-	-	-
4.	<i>Flavobacterium sp.</i>	-	-	-	-	++
5.	<i>Pseudomonas sp.</i>	++	+	+	-	+++
6.	<i>Sarcina sp.</i>	-	-	-	-	+
7.	<i>Staphylococcus sp.</i>	+	++	++	+	++
8.	<i>Micrococcus sp.</i>	++	++	+	++	+++
9.	<i>Rhodobacterium sp.</i>	-	-	-	-	++
10.	<i>Micrococcus roseus</i>	-	-	-	-	+

+++ = Highly Abundant, ++ = Moderately abundant, + = Less abundant, - = Absent VRI= Vrindavan Research Institute, MM= Mathura Museum, RMT= Radha Madanmohan Temple RGT=Radha Gopinath Temple, RGVT= Radha Govind dev Temple

Table 2: Occurrence of microorganisms on deteriorated pieces from different site

S. No.	Microorganisms	Vrindavan Research Institute	K.M. Institute of Hindi & Linguistics
1.	<i>Alternaria alternate</i>	++	++
2.	<i>Aspergillus sp.</i>	++	+++
3.	<i>Clodosporium sp.</i>	-	+
4.	<i>Dematium sp.</i>	+	+
5.	<i>Fusarium sp.</i>	-	+
6.	<i>Mucor sp.</i>	+	-
7.	<i>Penicillium sp.</i>	++	++
8.	<i>Stemphylium sp.</i>	-	+
9.	<i>Trichoderma sp.</i>	-	-

+++ = Highly Abundant, ++ = Moderately abundant, + = Less abundant, - = Absent

Table 3: Changes in microflora of soil around the material at different duration

S. No.	Microorganisms	3		6		9		12	
		T.P.	%A	T.P.	%A	T.P.	%A	T.P.	%A
1.	<i>Alternaria alternate</i>	-	-	3	3.2	3	2.2	3	2.5
2.	<i>Aspergillus fumigatus</i>	8	8.8	2	2.1	4	2.8	8	6.6
3.	<i>Aspergillus flavus</i>	5	5.5	4	4.3	9	6.7	2	1.6
4.	<i>Aspergillus niger</i>	5	5.5	7	7.5	8	5.9	2	1.5
5.	<i>Botryotrichum</i>	-	-	6	6.5	8	5.4	6	.5
6.	<i>Curvularia lunata</i>	-	-	2	1.8	3	2.4	2	1.7
7.	<i>Clodosporium sp.</i>	-	-	6	6.5	8	5.9	6	5.0
8.	<i>Dematium sp.</i>	-	-	10	10	5	3.7	12	10
9.	<i>Fusarium oxysporum</i>	-	-	10	10	5	3.9	10	9.0
10.	<i>Geotrichum sp.</i>	-	-	-	-	1	0.7	-	-
11.	<i>Humicola sp.</i>	-	-	-	-	9	6.7	-	-
12.	<i>Mucor hiemalis</i>	10	11.1	5	5.4	10	7.4	1	0.8
13.	<i>Mucor globosum</i>	8	8.8	7	7.6	4	2.9	-	-
14.	<i>Penicillium chrysogenum</i>	15	16	6	6.5	12	8.9	18	15.1
15.	<i>Penicillium frequentans</i>	3	3.3	5	5.4	-	-	2	1.6
16.	<i>Rhizopus oryzae</i>	2	1.7	4	3.6	1	1.8	-	-
17.	<i>Streptomyces</i>	-	-	-	-	-	-	6.0	5.0
18.	<i>Trichoderma sp.</i>	-	-	2	2.1	2	2.1	-	-

T.P: Total Population, %A: Percentage Abundance

The samples collected have black patina Crust on the upper surface. Different methods used to the sample for observation such as SEM, Tropical Chamber test, material characterization by X-ray diffraction.

Why Indigenous Methods?

Boyaghchi (2009) has explained a scientific elucidation for Hanzal extracts used by Iranian artists in making old paper manuscripts. She finds the good results for Hanzal extracts to inhibit biodeterioration of paper manuscripts. Baruah *et al.*, (2008) reported that main sources of deterioration and degradation of library resources are the bacteria and fungi. Biodeterioration of library materials is a worldwide problem and it cause great damage especially to unique manuscripts and rare books that are stored in library. Bakkali *et al.*, (2008) observed essential oils are volatile, natural complex, secondary metabolites, characterized by a strong odour and have a generally lower density than that of water therefore can be used for the controlling the biodeterioration. At the present scenario there are no dearth of modern chemical pesticides and repellants for the safe upkeep of manuscripts. The advent of technology has also given rise to greater concerns of preservation of manuscripts by adopting modern technologies. Still beside the modern technology the traditional methods of preservation are in vogue, as these methods have their own merits:

- These methods are not hazardous for human health.
- The Indigenous methods do not have any adverse effect on the materials.
- The methods do not require much expertise, equipment and money.

In this context an attempt has been made to summarize the effectiveness of various traditional practices, Indian herbal pesticides and insect repellants which are being used by different organizations or could be used by the organizations to seize the growth of insect infestation in the manuscript repositories.

Traditional Preservation Methods

The art of preservation is not new to Indians. From the ancient times several indigenous methods have been used for preservation of manuscripts. The people were aware of the basic factors that cause deterioration of the manuscripts namely light, dust, heat and humidity. So in order to protect the manuscripts from these possible factors, the

manuscripts were usually covered by clothes. Most of time it is observed that red colored clothes used for this purpose as it also worked as repellents. Nevertheless some traditional practices, which were adopted by the custodians of manuscripts and observed that still, being practiced, are enumerated below:

1. Wrapping the manuscripts in clothes, protect them from worms, dust as well as to a great extent from variation in atmospheric humidity and absorption of acidic fumes.
2. Palm leaves are wrapped in red or yellow color clothes. It is believed that red is a repelling color for the insects and yellow color if, produced by turmeric itself work as repellent and possess some germicidal power that can repel the insects from getting in contact with the manuscripts.
3. Manuscripts in olden days are also wrapped in silk clothes as silk is remarkably free from bookworms for which its extensive use has been seen.
4. Exposing palm leaves in the kitchen have the scientific fact that smoke particles have the capacity to repel the insects. Though the smoke deposits bring out undesired changes on the leaves yet this system is very effective for prevention of insect attack over the palm leaf manuscripts.
5. Manuscripts are generally exposed to the Sun in the Lunar month of Bhadraba i.e. in August as the rays of the Sun in that particular month are very favorable. By this the worms are killed under the Sun.
6. At some places underground cells are prepared for preservation purpose of manuscripts.

1. Herbs and Natural Products used in preservation purpose

Boyaghchi (2009) has explained a scientific elucidation for Hanzal extracts used by Iranian artists in making old paper manuscripts. She finds the good results for Hanzal extracts to inhibit biodeterioration of paper manuscripts. Some of the plants and their products, which have been recognized since ancient times for their germicidal properties and insect repellency potentialities, have been mentioned below: Dried and powdered leaves of Aswagandha in small packets are kept with the manuscripts covered in clothes to repel insect attack. Along with bundles of manuscripts pieces of Vasambu or dried ginger are kept to save these from insect attack. Coatings of lemon-grass oil are given to strengthen the leaves

of manuscripts and destroy the growths of microorganisms. In some repositories people use vermilion or kumkum fruit powder (which is red in color) that act as a very good insect repellent. Powdered roots of dried sweet flag known as Bacha, filled in small bags are kept in cup-boards of manuscripts which has got very good medicinal value and insecticidal power. Oil extracts of some natural products like black pepper, sandal wood or clove facilitate in the restoration of flexibility to the palm leaf manuscripts. The use of fresh palm leaf extract has also the possibilities of imparting flexibility to the old and brittle leaves. Powdered Ajwain also acts as an insect killer and fungicide. Custard-apple seeds powder is used to kill the insects that thrive on manuscripts. The mixture of neem leaves, karanja, nirgundi and citronella are known to have insecticidal properties for which it could be used in the manuscript libraries.

Neem oil contains limonoids, a class of compounds that acts as anti-feedants or growth regulators in insects; they don't kill instantly but wipe out a whole generation of insects by preventing the young ones from maturing and adults from reproducing. Dried Neem leaves and seeds are also useful in keeping away insects. So its use has been widely recognized since ancient times.

Another natural product - Camphor (Karpura) is commonly used in India to protect valuable documents. Filled in small cloth bags it is kept inside the storage of manuscripts. Besides, synthetic Camphor Oil is also used to protect palm leaf manuscripts against insect attack.

Small bags of a sort grass - Panadi by name (which is grown in Jaisalmir and used in making perfumes) are placed among the bundles of manuscripts to save them from white ants.

Application of turmeric paste to the seasoned palm leaves is well known for its dis-infecting effect.

Conclusion

The safe upkeep of manuscripts has also been inscribed by the authors of manuscripts, generally written in the colophon which is evident from the following lines:

“Jaladraksha Tailadraksha raksha man shlatha vandhanat

Ashubhya parahastebhya Ebam badati pustakam”

That means: “The book itself appeals the owners to protect it from water, oil, slack binding, rats and

from the hands of other people who do not know proper handling”. Some of the authors also request to the user to treat the manuscripts as their own sons.

“Yatnen likhitam shashtram, Putravat paripalayet”

Making of manuscripts was very difficult task on that time, It take a long time and lot of patience. The people who worked on it were special as they conserve the cultural and other important information for the next generation. And that's why there is a responsibility to us to preserve their documentary heritage for our next generation.

Our cultural heritage is our identity and they reflect our richness. So it is necessary to protect them from further harm and deterioration. Microorganisms' attack, Climatic factors and the most important factor that deteriorate our cultural heritage is human negotiation. Many of our cultural property and documentary heritage are deteriorate day by day due to several reasons.

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