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Diversity of Macroflora Around The Khajuraho Monuments Distt. Chhatarpur (M.P.)

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Abstract

Khajuraho temples are unique for their specific artwork. The temples have a rich display of intricately carved statues. Distinct pattern of architect work on the monuments makes difference from the other monuments. Some species of higher plants have seen on the surface of the temples. The growth of the higher plants causes deterioration on the monumental surface. Mostly some species of grasses and some species of weeds are mainly grown on the surface of monuments. Higher plants have their real root system which penetrate in the surface of monuments and cause major damage of the monumental surface. This paper is mainly concern on the macro flora present around the monuments of the khajuraho group of temple.

Keywords: Deterioration, Macro Flora, Monuments.

Introduction

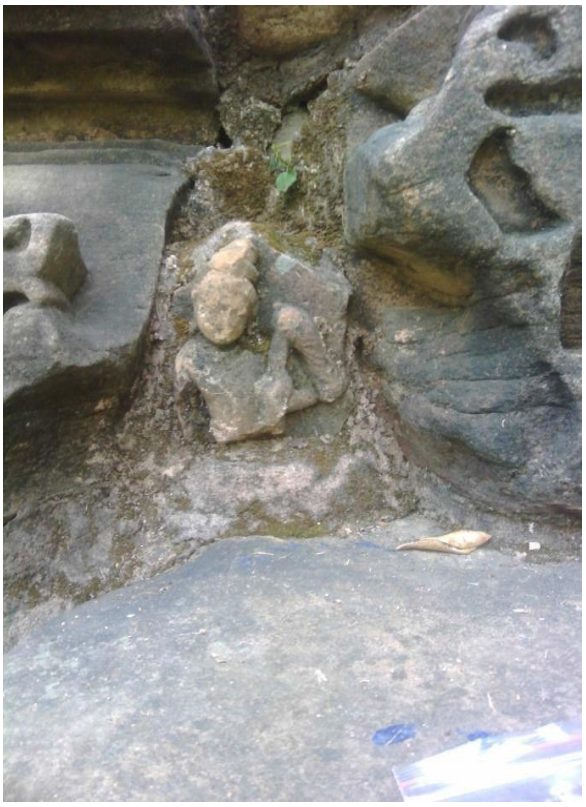
In tropical climate where high rainfall and temperature is greatly support to the development of macro flora on monuments. The growth of higher plants on the surface of monuments is not apart from the phenomenon of the biodeterioration. That has been found on many monuments. But only some researchers have concentrate on this type of phenomenon.

The decay of rocks and freshly exposed monumental stones is a complex process in which physical and chemical mechanisms are usually considered the main factors, it generally starts with alteration processes due to the synergetic action of rain, wind, sunlight and freezing/ thawing cycles. Thus the initial smooth and clean stone surface becomes progressively rough and more porous, with the formation of micro cracks and fractures within crystal grains. The main consequence of their metabolic activity, such as the excretion of enzymes, inorganic and organic acids and of complex forming substances, is the dissolution of minerals of the substratum. Moreover, the growth and the swelling of some vegetative structures (e.g.: roots and lichenic thalli) induce physical stresses and mechanical breaks.

Higher plants with a real root system and aerial vegetative apparatus may be of greater importance in the conservation of monuments, especially for the archaeological remains where they can obstruct both sight and accessibility (Tiano P. 1986) or for subterranean structures (Bettini C., Villa A. 1976). The action of these organisms may be physical, through the pressure exerted by roots growth (up to about 15 atm.) (Caneva G., Galotta G. 1994) and chemical through the production of acidity and exudates from their rootlets (Winkler E.M. 1975).The transfer of nutritive metal cations through a network of colloidal particles, by a contact exchange mechanism with the H+ ions of rootlets, starts with the attack of silicates and carbonates structures (Caneva G., Salvadori O. 1989). Among the organic exudates, secreted by roots, are found the chelating acids 2- ketogluconic, oxalic and citric (Keller N.D., Coleman N.T. 1952). The pH measurements made directly on the rootlets of some species present on monuments, (Parietaria diffusa, Capparis spinosa, Cymbalaria muralis and Sonchus tenerrimus) have shown values from 5.2 to 6.3. In temperate climates the most frequently recovery of ruderal plants are herbaceous or shrub species, with calciophilous, xerophilous and nitrophilous habitus (Cynodon dactylon, Melica minuta, Parietaria officinalis, Capparis spinosa, Ceterach officinarum, Hedera helix) (Monte M. 1993) and very rarely arboreal species (Allianthus altissima, Ficus

carica, Robinia pseudoacacia or Ulmusminor) (Caneva G., Altieri A. 1988; Caneva G. 1985).

The growth of higher plants with real root system has been reported by several workers to be a major cause of deterioration in several important monuments (Caneva G., Altieri A. 1988; Caneva G. and Roccardi A. 1991; Riederer J. 1981, Siswowiyanto S. 1981). The biophysical and biochemical decay cause by higher plants is because of growing and radial thickenings of the plants (Winkler E.M. 1975). The development of micro and macro flora is heavier and more noxious in tropical climates where high rainfall and temperature greatly increase the growth of vegetal, especially higher plants, on monuments (Tiano P., Caneva G. 1987; Fusey P. and Hyvert G. 1966). In some cases the roots can reach several metres (10 - 20) deep, as in the case of the very common rupicolous species (Capparis spinosa) which is able to penetrate into very compact substrata (Riedier J. 1984).



(1)

(2)

Fig. (1) Propaguel of Ficus benghalensis, and (2) Weed grown on monumental surface.

Material and Method

Present work has been according to the schedule and requirement. During the study period, four sites were selected from the khajuraho group of temple namely Matangeshwar, Vishwanath temple, Kandariya mahadev temple and Laxman temple (most visited temple). These temples were selected for the study of macroflora around the monuments area. The macrobiological study were fllowed by the collection and identification of the sample from the monumental area.

The macroflora found around the monuments collected and the identified with the help of their texonomic character (morphology, inflorescence etc.) All four different sites have found various macrofloral species at the site, some common grasses and weeds are the found, identified on the spot with their means of taxonomic character. Some species like propaguels of *Ficus benghalensis, Ficus religiosa* and *Azadiracta indica* also found. Grasses species like *Cynodon dactylon, Heteropogon centratus, Alluda, Oplismanis vermanii, Tridex procumbens, Parthinium* (exotic plant species), *Themeda, Cyperus rotundus, Euphorbia hirta, Euphorbia geniculata, Sida acuta, Sida cardifolia, Bothriocloa pertusa, Penicum species, Oxalis, Convolvulus, Launaea, Hilendia letigrosa, Oldenlendia, Malvestrum, Vernonia*, *Ageratum, Anagalis arvensis, Primula, Sonchus* etc. species are found around the monumental area .

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Table No. 1
Phytosociological Data of Study Sites (Mt, Vi, Kd, Lx) during Rainy Season

S. No.	Name of Species	Family	Feaquency					Density
			0-20%	20-40%	40-60%	60-80%	80-100%	
1	*Achyranthus aspera*	Achyranthaceae	--	--	--	Vi,Kd	--	1
2	*Anagelis arvensis*	Primulaceae	--	Kd,Lx	--	--	--	0.5
3	*Alicicarpus monolifer*	Compositae	Vi,Kd	--	--	--	--	0.5
4	*Agiratum species*	Compositae	--	--	Kd,Vi,Lx	--	--	0.5
5	*Boerhaavia diffusa*	Nyctaginaceae	--	--	Vi,Kd,Lx	--	--	1.5
6	*Bothriochloa pertusa*	Poaceae	--	--	--	--	Mt,Vi,Kd,Lx	2
7	*Cassia tora*	Ceasalpinaceae	--	Kd	Vi	Mt	--	1
8	*Convolvulous species*	Convolvulaceae	--	Lx	Mt, Vi	--	--	1.5
9	*Cynodon dactylon*	Glumaceae	--	--	--	Lx	Mt,Vi,Kd	2
10	*Cyperus rotundus*	Cyperaceae	--	--	--	--	Mt,Kd,Lx,Vi	2
11	*Echinochloa colunum*	Glumaceae	--	--	Lx	Mt,Kd, Vi	--	1.5
12	*Euphorbia hirta*	Euphorbiaceae	--	--	--	--	Mt,Kd,Lx,Vi	2
13	*Heteropogon contortus*	Poaceae	--	Mt, Vi	Kd, Lx	--	--	1
14	*Indigofera asteragalina*	Fabaceae	--	--	Kd, Lx	Mt.Vi	--	1.5
15	*Malvestrum coromandelianum*	Malvaceae	--	--	--	Mt,Kd,Lx,Vi	--	0.5
16	*Oplismenis burmannii*	Poaceae	--	--	--	--	Mt,Kd,Lx,Vi	1.5
17	*Oxalis trifolia*	Oxalidaceae	--	--	Mt, Lx	Kd, Vi	--	2
18	*Phyllanthus niruri*	Phyllanthaceae	--	--	Mt, Lx	Kd, Vi	--	2
19	*Ranunculus species*	Ranunculaceae	--	--	Mt,Kd,Lx, Vi	--	--	1
20	*Sida acuta*	Malvaceae	--	--	Lx	Mt,Kd,Vi	--	1.5
21	*Sida cardifolia*	Malvaceae	--	--	--	Mt,Kd,Lx,Vi	--	2
22	*Sporobolus indicus*	Poaceae	--	--	--	Mt,Kd,Lx,Vi	--	2
23	*Tridex procumbens*	Asteraceae	--	--	--	Mt,Vi	Kd.Lx	2
24	*Oldenlendia letibrosa*	Poaceae	--	Kd, Lx	Mt.Vi	--	--	1.5
25	*Parthenium species*	Compositae	--	--	Mt,Kd,Lx, Vi	--	--	1

Table No. 2
Phytosociological Data of Study Sites (Mt, Vi, Kd, Lx) during Winter Season

S. No.	Name of Species	Family	Feaquency					Density
			0-20%	20-40%	40-60%	60-80%	80-100%	
1	*Achyranthus aspera*	Achyranthaceae	--	--	Vi,Kd	--	--	1
2	*Agiratum species*	Compositae	--	--	Kd,Vi,Lx	--	--	1
3	*Anagelis arvensis*	Primulaceae	--	Kd,Vi	Lx	--	--	0.5
4	*Boerhaavia diffusa*	Nyctaginaceae	--	--	Kd,Vi,Lx	--	--	1
5	*Bothriochloa pertusa*	Poaceae	--	--	Kd,Mt	Vi,Lx	--	1.5
6	*Cassia tora*	Ceasalpinaceae	--	--	Kd,Mt	Vi,Lx	--	1.5
7	*Comelina species*	Euphorbiaceae	--	Kd,Vi,Lx	--	--	--	0.5
8	*Convolvulous species*	Convolvulaceae	--	--	Mt,Vi	Kd, Lx	--	1.5
9	*Cymbopogon martini*	Poaceae	--	Kd,Vi,Lx	--	--	--	0.5
10	*Cynodon dactylon*	Glumaceae	--	--	Kd,Vi,Lx,Mt	--	--	2
11	*Cyperus rotundus*	Cyperaceae	--	Kd,Mt	--	--	--	0.5
12	*Digera arvensis*	Amaranthaceae	--	Kd,Vi	Lx	--	--	0.5
13	*Euphorbia hirta*	Euphorbiaceae	--	--	Lx	Kd,Vi	--	2
14	*E. microphylla*	Euphorbiaceae	--	--	--	Mt,Kd	--	1.5
15	*Evolvulous species*	Convolvulaceae	--	--	Lx,Kd	--	--	0.5
16	*Gompherina species*	Poaceae	Lx	Kd	--	--	--	0.5
17	*Hylendia letibrosa*	Poaceae	--	Mt,Vi	--	--	--	0.5
18	*Hyptis suaveolens*	Labiatae	--	--	Kd,Vi	--	--	1
19	*Indigofera ovalifolium*	Paplionaceae	--	--	--	--	Mt,Kd,Vi,Lx	2

20	*Launaea species*	Asteraceae	--	--	Kd,Vi	--	--	0.5
21	*Oplismanis burmannii*	Poaceae	--	--	--	Mt,Kd,Vi,Lx	--	2
22	*Parthenium species*	Compositae	--	--	Mt,Kd,Vi,Lx	--	--	1
23	*Penicum humale*	Poaceae	--	--	Mt,Lx	Kd	--	1.5
24	*Vernonia species*	Asteraceae	--	Kd	Lx	--	--	0.5
25	*Sida acuta*	Malvaceae	--	--	--	Kd,Vi,Lx	--	1.5
26	*Sida cardifolia*	Malvaceae	--	--	--	Mt.Kd,Vi,Lx	--	2
27	*Xanthium strumarium*	Solanaceae	Kd	Vi,Lx	--	--	--	1

Table No. 3
Phytosociological data of study sites (Mt, Vi, Kd, Lx) during Summer season

S. No.	Name of Species	Family	Feaquency					Density
			0-20%	20-40%	40-60%	60-80%	80-100%	
1	*Achyranthus aspera*	Achyranthaceae	--	--	Vi,Kd	--	--	1
2	*Bothriocloa pertusa*	Poaceae	--	--	Mt,Vi,Kd	--	--	1
3	*Cynodon dactylon*	Gramineae	--	--	Mt.Kd,Vi.Lx	--	--	1
4	*Euphorbia hirta*	Euphorbiaceae	--	--	--	Mt,Kd,Vi,Lx	--	1.5
5	*E. geniculata*	Euphorbiaceae	--	--	--	Mt,Kd,Vi,Lx	--	1.5
6	*Ipomea palmate*	Convolvulaceae	--	--	Kd,Vi	--	--	0.5
7	Propagules of *Ficus religiosa*	Moraceae	--	Kd,Vi,Mt	--	--	--	0.5
8	Prapagules of *Ficus benghalensis*	Moraceae	--	Mt,Lx	--	--	--	0.5
9	Prapagules of *Azadiracta indica*	Meliaceae	--	Mt,Kd,Vi	--	--	--	0.5
10	*Sida acuta*	Malvaceae	--	Vi,Kd	--	---	--	0.5
11	*Tridex procumbens*	Asteraceae	--	Mt,Kd,Lx	--	Vi	--	1

Objectives

1. Survey of causes to deterioration on monuments at different sites of Khajuraho monuments.
2. To identify biological and environmental factors helping in deterioration on the monuments at Khajuraho.
3. To study the diversity of biological and ecological factors.
4. How can these monuments conserve by macroflora.
5. To provide related data for further study.

Conclusion

The role of plant species like grasses and weeds in the deterioration of stone monuments is now a well recognized phenomenon. In tropical countries like India, where the climatic conditions favor the growth of such species and these species might play a major role in stone decay. The stone monuments of Khajuraho are a sign of human civilization and concerned with „Nagra style" architecture so it is very important to preserve these world heritage for coming generation. From the history of Khajuraho, monuments are ignored for long time so the artworks are effected by deteriorable agents. Present investigations revealed that the stone monuments of world fame archaeological site of Khajuraho are under severe biodeterioration.

Result and Discussion

The result of present paper revealed that the stone monuments of world fame archaeological sites of Khajuraho are under the severe biodeterioration. Many researchers also studied in this type of study. Macro flora like grasses and weeds appeared as grown around the monumental area of Khajuraho monuments.These plant species cause severe damage of the monumental surface.

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