CHAPTER 2

Literature Review

The interrelationship between biodiversity and preservation of heritage is an important research area in the field of Museology. In the process of literature review, the researcher has gone through various related literatures from published and unpublished material, i.e., books, journals, manuscripts, etc., to study the works undertaken and thus identify the research gap which has prompted the researcher to undertake this research work. During the tenure of her research work, the researcher has come across the following literatures that inspired her to carry out intensive survey of the bio-components of a site. There are lots of evidences to indicate that the urge to love nature, environment and biotic entities existed since the primitive times. However, there has not been any significant work directly relating to the protection of the environment in a heritage site for the overall benefit and conservation of the sites.

2.1. Literary Evidence

The Aryans had a great inclination towards protection of nature, as well as forests, vegetation and flowers. Their religious books- the Vedas and the Upanishads, highlight the importance of forest and vegetation. In one of the verses of Rigveda, (Rv.X.81.4), not only the forest, but trees are mentioned. In Yajurveda, creepers and medicinal plants have been mentioned and Atharva veda too mentions about elements of greenery. Atharva veda also mentions that forests and plants on earth should have a pleasing effect on the people. The Brahmana texts also had great admiration for trees and plants. Of the Upanishads, the Brihadaranyaka Upanishad 3,9,28/1.2.3. describes forests, trees and plants (Nagar, 1993: 52).

Epics like Ramayana, Mahabharata also highlights forests, horticulture and greenery. In Ramayana, the ashramas were mainly located in forests and groves.
The concept of forests, horticulture, floriculture are also prominent in the 
Mahabharata. The exile period of Pandavas was mainly spent in forests bearing 
a great variety of plants and trees (Nagar, 1993: 53). While tracing the presence 
of the forestry or horticulture in Puranic literature, it is well understood that the 
composers of these texts were fully aware of the beauty of the natural 
surroundings of forests, groves or parks.

Bhattanarayana in his play Venisamhara, provides an overview of botanical 
trees and plants. There is a mention of an Abhinavavatika in the harem besides 
a fragrant Bakula grove. (Nagar, 1993: 56)

In the Nala Damyanti play by Vasudeva (Act-I, Sec-III), the king has been 
equated with a gardener and all his wide realm is his garden. ..."He has his 
plants to lay therein and his hedges to trim."

In Act-II, of Sri Harsha’s play called Nagananda, the beauty of flower garden 
has been described where “the droppings of the sandal tree cool the creeper 
bower with its terraced pavements and peacocks dance to the skill sound of the 
shower baths (Nagar, 1993: 56).

The Jaina literature and art mention about flora and fauna of that period.

In Uttarapurana, p.117, mention has been made of the tree-Asvastha, which 
has been associated with enlightenment of Anantanatha.

Floral designs appear on many Jaina images as well as miniatures of Jaina 
Kalpasutra.

Nagar further mentions that during -

..... the age of the Imperial Guptas the art of gardening 
flourished. Hieun Tsang, the Chinese pilgrim who visited 
India, soon after the fall of Gupta period (A.D.628) mentions 
about the botanical aspect of the landscape enumerating 
the trees he saw.... (Nagar, 1993: 59)
Chapter 2

2.2. Interrelationship Between Biodiversity And Heritage

The topic basically encompasses two important components- Biodiversity and Heritage.

Biological diversity or biodiversity refers to the variety of all life forms i.e. the different plants, animals and microorganisms, the genes they contain and the ecosystems of which they form a part. It is not static, but constantly changing and is increased by genetic change and evolutionary processes and reduced by processes such as habitat degradation, population decline and extinction. With the passage of time, biological diversity is undoubtedly declining at an undesirable pace with no chance of replenishment. There is a need to assess the magnitude and trend of loss of biodiversity on earth. But prior to that “.... it is most important to know the current status of biodiversity at national as well as regional level”. (Alfred, et. al., 2004: 1)

Alfred also states that –

It is also necessary to support our managers, planners and policy makers with baseline information so that they can identify the current weaknesses and utilize the knowledge and value of biodiversity in designing the future of mankind. (Alfred, et. al., 2004: 1)

The researcher intends to combine these two components- Biodiversity and Heritage to highlight how a Heritage site is dependent upon the surrounding environment encompassing the biological diversity of a zone for its protection. For natural heritage site, each of the components of the site itself bears individual capabilities of preservation of the sites.

Nagar, S.L. (1993) in his book *Protection, Conservation and Preservation of India Monuments* stresses the need of environmental development of cultural heritage in historical perspective in view of growing urbanization. He states that: “The environmental development of ancient edifices is an important aspect which contributes considerably towards their preservation and conservation”. He throws light on development of soil erosion safeguards and development of
Forestry, Horticulture, Botany and Floriculture in and around the monuments of cultural importance by saying -

".........another method of conservation of monumental edifices in the country has been to provide greenery and pleasing plants around the main structures with the twin purpose of preventing the soil from erosion and beautification, besides serving against the misuse and encroachment of monuments. (Nagar, 1993: 50)"

Nagar has reviewed the *genesis and evolution of horticulture, botany and Floriculture in India*.

Nagar (1993) further states that “*the main purpose for the development of a garden around an ancient edifice is to improve its environment.*” (Nagar, 1993: 67)

The gardens or horticulture works at archaeological sites are maintained by the concerned Archaeological Departments. The choice of plantation of shrubs and trees in the gardens around the monuments is quite a complex problem and one has to be quite selective in this regard, as mentioned by Nagar (1995).

Cassar, May (1995) in her book entitled *Environmental Management Guidelines for Museums and Galleries* states that “*the performance of buildings is affected by weather conditions*”. To maintain the building or heritage site, monitoring needs to be done. Cassar suggests “*Vegetation cover as a means to control and modify the effects of the weather*”. She also points out the role played by shelter belt of trees:

Shelter belts of trees are of proven benefit in modifying the effect of wind on exposed sites. In the British Isles, where the prevailing winds are usually from the West, south-west facing facades are best protected by shelter belts of trees. A penetrable bank of trees on the leeward side of trees will further help to reduce air turbulence. ......Trees give a
greater area of protection than solid barriers and this protection may extend as far as twenty times the height of trees. (Cassar, 1995: 35)\(^{10}\)

Thus the outer vegetation or plant diversity is the main line of defense against external weather conditions. It protects environment for both people and objects.

Significant works have been done, emphasizing the idea of Biomonitoring in protection of heritage. According to Das, T.M. et. al., (1986: 26)\(^{11}\), “the presence of lichen in and around the heritage sites is an important indicator of air pollution especially that brought about by sulphur dioxide”.


.... gardens and lawns around a museum play a significant role in the conservation of museum objects. Tall trees and hedges as well as the flowering plants and grassy lawns serve as a buffer, or the first line of defence against dust, serving as filter. Watering of the lawns make them moist which further reduces the incidence of dust. They also serve to lower the temperature of the surroundings. (Banerjee, 1990: 98)\(^{12}\)

This applies to heritage sites or monuments as well. The surrounding garden will influence the microclimate which in turn influences the macroclimate of that area.

A very informative and illustrative book – **Heritage Gardens : Care, Conservation and Management** by Sheena MacKellar Gouty (1993)\(^{13}\) informs about the necessity of maintenance of a garden side by side alongwith heritage buildings and presence of water bodies within heritage gardens forming an important feature.
Bhattacharya, A.K. (1994) mentions “……if applied to heritage zones, trees with proven resistance to air pollutants are essential to be grown as a belt …… as they will serve as a buffer zone to check and reduce air pollution”. (Bhattacharya, 1994: 659)\textsuperscript{14}


Situated in beautiful garden, with both the building and the park open to the general public, it provides a unique resource of “values” in a densely populated and congested urban setting. (Vaughen, 1997: 19)\textsuperscript{15}

He also remarks-…… “whether the Victoria Memorial and its environment will be conserved is ultimately for Calcutta to decide”.

Pokhriyal, T.C. et al. (1986) mentions “Trees play a crucial role in conserving soil and moisture” (Pokhriyal et al., 1986: 573)\textsuperscript{16}. At ecosystem level, under conditions of low dose of pollution, the vegetation and soils of ecosystem function as important sinks of air pollution.

Various roles of vegetation have been studied earlier by scientists like Ingold\textsuperscript{17}, in 1971, whereby it was shown that the efficiency of smaller leaves was found to be higher than larger leaves. 

Khoshoo and Ahmed (1981)\textsuperscript{18} reported that some plants have materials on their exterior that could react with and either fix or destroy the air pollutant.

According to some scientists, trees may be especially efficient filters of airborne particles because of their large size, high surface to volume ratio of foliage, petioles and twigs and frequently hairy or rough leaf, twig or bark surfaces. There are substantial evidences to the effect that trees remove gaseous contaminants from the atmosphere.
Studies have also been undertaken which have shown that shade loving / partial shade bearing, horticultural, ornamental tree species/shrubs should be introduced to develop a really effective green belt.

Sharma, R.K. et al. (1994) in their research paper in *Conservation of Cultural Property in India* (vol-27, 1994) rightfully brings into limelight the role of leaves of higher plant as efficient gatherers of air pollutants. In their experimental study, they have proved that –

…dust deposition on tree leaf is dependent upon the leaf size, nature of leaf surface and the curvature of lamina, epidermal and cuticular features, phyllotally and orientation of leaves. Evergreen trees with simple leaves, rough and pilose surface are better dust collectors than deciduous trees with compound leaves having flabrous surface.…. (Sharma, et al., 1994: 5)

The study was restricted to vegetation around Red Fort, Delhi and Taj Mahal, Agra. The researcher intends to take such studies in and around heritage sites of West Bengal.

The researcher intends to deal with various factors bringing about deterioration of the monuments or sites. Of the various factors bringing about deterioration of the sites, Atmospheric pollution has been identified as the major factor that not only is harmful for the site, but also accelerates the growth and development of other biological components causing negative effect on the sites. The surrounding bio-components themselves play individual roles in arresting air pollution.

Atmospheric pollution is one of the major factors bringing about deterioration of heritage sites or buildings. As pointed out by R.K.Sharma, et al. (1995)

Environmental parameters and the nature of the substrate both drastically influence the potential attack by biological population in relation to the presence of
favoring or limiting factors to their metabolic characteristics. (Sharma, et al., 1995: 65)\textsuperscript{20}

Sharma, et al. (1995) stresses the need for –

In-depth study to evaluate the influence of polluted environment that may cooperate to accelerate or retard the degradation and destruction of stone surface by micro vegetation. (Sharma, et al.1995: 65)\textsuperscript{21}

Sharma, et al. (1995) further states that:

The behavior of microvegetation is significantly influenced by sulphates, nitrates, gaseous pollutants, especially sulphur dioxide and nitrogen dioxide and in the polluted environment the synergic effect becomes very complex as the high levels of particulate matter contaminated with soluble salts may favour the growth of micro-vegetation. (Sharma, et al., 1995: 70)\textsuperscript{22}

Mishra, A.K. (1994) states that


\textit{...........a problem often encountered by the conservators when they carry out conservation treatment on monuments sculptures situated outdoors is the presence of algal growth on the surface. (Mishra, 1994: 31)}\textsuperscript{23}

The alga affects the aesthetic beauty of the structure and also brings about various forms of deterioration.

Trivedy, R.K. et al. (1995) highlights the concept of biomonitoring of atmospheric pollutants. He states that “\textit{Biomonitoring of pollution is using plants to detect the kind and level of pollution with or without measurement of air pollutants in that area}” (Trivedy, et al. 1995: 217)\textsuperscript{24}.
Aslam, M. (1996) in his paper “Acid Deposition and Stone Decay” emphasizes on the fact that the earth’s atmosphere has a reservoir of aggressive impurities like Sulphur dioxide ($\text{SO}_2$), Sulphur Trioxide ($\text{SO}_3$), Hydrogen sulphide ($\text{H}_2\text{S}$), Nitrogen oxides ($\text{NO}_x$), Carbon monoxide (CO), Carbon dioxide ($\text{CO}_2$), Ozone ($\text{O}_3$), Ammonia ($\text{NH}_3$), Hydrogen chloride ($\text{HCL}$), Hydrogen fluoride ($\text{HF}$), hydrocarbons, soot, dust etc. in the form of aerosol. … “when they become wet or get solubized in atmospheric moisture they undergo chemical interaction with stone ingredients” (Aslam, 1996). As per the opinion of Aslam –

The acidic pollutants deposited on the stone surface affect its durability. Dry deposition on stone surface results from settlement of airborne acidic gas or particulates from atmosphere transported by wind and turbulence. Wet deposition occurs as a result of deposition of acid precipitation which consists of sorption or dissolution of air pollutants in cloud droplets and subsequent removal by falling precipitation. (Aslam, 1996: 127)

As far as Indian monuments are concerned, the National Environmental Engineering Research Institute (NEERI) undertook an in-depth study of Victoria Memorial Hall, Kolkata in 1992 with a view to assess its deterioration due to atmospheric pollution and suggested certain short and long term measures for protection of the monument. Sir Bernard M. Fielden, architectural conservation consultant from UK, also made recommendations in the same year for restoration and conservation of the monument.

Similarly, Trivedy, R.K. et al. (1995) highlights the concept of biomonitoring of atmospheric pollutants. He states that –

Biomonitoring of pollution is using plants to detect the kind and level of pollution with or without measurement of air pollutants in that area. In biomonitoring of air pollution, presence/ absence/ abundance/ distribution/ morphology/ chemical characteristics of plants are used to arrive at a
Trivedy mentions several advantages of using plants as biomonitors like low cost, ability to analyse the sum total of all pollutants in an area. One of the earliest record of using plants for air pollution monitoring is in 1899 when plants in wooden boxes having uncontaminated soil were put in smoke filed areas to find out the impact of smoke on plants.

The presence of lichen in and around the heritage sites is an important indicator of air pollution especially that brought about by sulphur dioxide (Das, T.M. et al., 1986). A link between sparseness of lichens and air pollution had been recognized in the late eighteenth century. With the onset of industrialization in the early decades of the nineteenth century, a dramatic decline of this flora in and around major industrial cities was noticed which led to further researches on this aspect. In West Bengal, more than 350 species of lichens have been recorded. The species *Parmelia caperata* which was found on the roadside trees of Kolkata was reported to be most toxitolerant. The meteorological conditions and physicochemical characteristic of tree bark impart some effect on establishment and growth of lichen, most important factor is the effect of atmospheric pollution.

Soot particles themselves hardly have any effect on lichens (Ferry, et. al, 1973) but it cuts out light intensity and reduces photosynthesis of the phycobiont thus affecting lichen population.

Bhattacharya, A.K. (1994) mentions in his paper the work put forward by Chengappa (1982) that “*Trees reduce noise pollution in cities and also reduce thermal pollution by checking the heat buildup in the atmosphere by preventing the radiation of heat from base surfaces*”. Bhattacharya further states that “the efficacy of trees to absorb harmful gases and particulates varies according to the kind of tree, the region, and the growing conditions.”
Bhattacharya (1994) further states that:

.... thus, if applied to heritage zones, trees with proven resistance to air pollutants are essential to be grown as a belt..... as they will serve as a buffer zone to check and reduce air pollution. (Bhattacharya, 1994: 659)

Development of Green belt around heritage sites is noteworthy. As mentioned by Trivedy, et. al. (1995) green belt influences the microclimate of a region.

Green areas and parks are normally cooler than the surrounding areas. If the green belts are arranged radially in an urban area, it will promote flow of cooler fresh air from the surrounding.....along the green belts with the rise of urban air due to heat island effect. This will result in presence of fresh, cleaner and cooler air in the green areas. (Trivedy et. al., 1995: 218)

He further states that a “green area may be more effective in controlling the environment, if it consists of a variety of plants in different layers (such as trees of various heights and shrubs)……”

Sharma et. al. (1995) points out that, “some of the pollutants may cooperate to accelerate the growth of micro vegetation thereby increasing the rate of biodeterioration.”

Environmental pollution play a significant role in eliminating large number of lichen species, as they cannot tolerate soot and sulphate and thus have no chance to invade monuments in such areas. (Singh, A. & Sinha, G.P., 1993: 359)

Agarwal, P.K. (1989) mentions the various types of factors affecting the heritage monument and throws light upon the damaging effect of gaseous pollutants on the building surface. The damage caused by vegetation growth
within the building has also been mentioned. However, the biological species or
the role of surrounding garden and greenery is not mentioned in the paper.
In India, researches have been undertaken to highlight the effect of growth of
vegetation in important heritage buildings.

Bahadur, A.K. (1997) puts forward the statement that -

> Biodeterioration of stone or brick structure is the most
> commonly known phenomenon. This problem is not only
> confined to the tropical regions but occurs anywhere in
> the world and in any kind of object, whether inorganic or
> organic in nature whenever the environmental
> conditions are favourable. (Bahadur, 1997: 175)\(^\text{35}\)

Bhatia (1994) in his paper entitled *Deterioration of marble due to physical
reasons and its conservation: (Taj Marble- A Test Case)* discusses various
factors of deterioration of the culturally famous World Heritage Site-Taj Mahal.
One of the factors bringing about deterioration mentioned is Weeds growth. He
points out that –

> ……..pioneer species become established anywhere if
> suitable substrate and water source are found. Gutters,
> cracks in roof, walls and foundation. ……….Chinks in
> masonry or stones, roofs and ledges may accumulate
> moss and lichens. Where dust, soil or other debris
> accumulates in crevices……higher plants can take root.
> (Bhatia, 1994: 120)\(^\text{36}\)

Algal growth on exterior of buildings (brickwork or mortar) is commonly seen in
the tropics. Such growths can bring out serious disfigurement and such
disfigurement is known as aesthetic biodeterioration.

However, nowhere it is mentioned how the vegetation can be beneficial in
protection of the building. The positive side of plantation or greenery around the
monument needs to be highlighted.
An abiotic component of the ecosystem that not only stimulates the growth of biodiversity but also facilitates the preservation of the site is the presence of water-body within the heritage complex in the form of fountains, lakes, etc.

As pointed out by Goulty (2004: 97)³⁷ “Water features in many heritage gardens require specialist attention….” For large water bodies, one alternative means to check water enrichment by natural means “…..is to dump a bale of straw in the water”.

Cassar, M. (1995: 35)³⁸ points out that “….trees, shrubs, grass and expanses of water near buildings will damp down air fluctuations”.

Many authors have experimentally proved that the presence of water and fountains is capable of modifying a hot arid climate by providing shade and evaporation, as done by trees which grow around a building.

Similarly, works have been undertaken highlighting the role of the different trees and biological entities in preservation of the site itself.

In West Bengal, extensive research has been conducted on Mangroves of the natural heritage site-Sundarban by Naskar et.al. (1985 - 2010) considering all the above aspects to preserve cultural and natural heritage sites. However, the researcher intends to undertake the study from the museological aspect, thus linking heritage with biodiversity.

Allchin et. al. identifies digging of earth for various purpose, large scale irrigation works, expansion of settlements and rebuilding of existing settlements as some of the factors bringing damage to cultural heritage. Allchin et. al. further emphasizes “the uncontrolled growth of tourism, both domestic and foreign” to be a potential threat to cultural heritage. This factor also poses serious threat to any natural heritage site as well. “The sheer number of visitors, both local and foreign also causes increasing concern”, for they bring “…..wear and tear..” along with them and destroy the monuments or trees by”… gratuitous carving or daubing of names or initials” (Allchin et. al., 1989: 248)³⁹, taking the example of popular heritage sites like Humayun’s Tomb, New Delhi, Taj Mahal, Agra, Red
Chapter 2

Fort, New Delhi.. Allchin et. al. also mentions all sorts of pollution, including atmospheric and water that affects monuments in various ways. All these factors combine together and cause their effect on the sites. Allchin also believes that the “……same two basic forces, population growth and pressure of development…..” to be the most prominent forms of urban threat.

Even when individual monuments are spared, their fate may be threatened by developments taking place in adjacent lands, taking the example of Jantar Mantar, New Delhi, where the observatory of Jai Singh, which has survived for nearly three centuries as a carefully protected monument has been emasculated by the construction of high-rise blocks in its vicinity (Allchin et al., 1989: 248).

Indians should develop a better sense of responsibility and appreciation of their rich cultural heritage. Lack of awareness in preserving the monuments brings great loss to the cultural heritage. Visitors should be made aware of not damaging the sites “Since this heritage concerns the minds of men and is the fruit and bearer of their culture, it must be protected against varied dangers threatening it… ” (Conventions and Recommendations of UNESCO concerning the protection of the cultural heritage, 1985: 7).

The researcher seeks to involve Museums in creating mass awareness regarding the surrounding biodiversity of a region as a protective measure of heritage sites.

As per Recommendation of UNESCO concerning the Safeguarding of the Beauty and Character of Landscapes and Sites, (adopted by the general Conference at 12th session, Paris, 11 December, 1962)

“……Member states should facilitate the work of existing museums, with a view to intensifying the educational action ……………… and should consider the possibility of establishing special museums or specialized departments in existing museums, for the study and display of the natural and cultural features of particular regions.”
Goulty (1993:61) suggests fruitful methods of presentation and interpretative education about the garden heritage. She suggests the use of “...garden guides and guidebooks, cassette records for self-guided tours and video presentations...”. Such suggestions can be applied as mechanisms of awareness creation of heritage sites, monuments and their conservation and management strategies.

Xianyao, Li et al., (2010) mentions China’s Suzhou Garden Museum to be a good example showing how a garden can be brought to the limelight by developing a museum based on its design, architecture, history and existing biodiversity.

All the above mentioned studies were centred on Heritage monuments in India like Red Fort, Delhi and Taj Mahal, Agra or Heritage monuments located abroad. So far, very few museological literatures have come out highlighting area of research undertaken by the researcher. Since the domain of research work is vast, so the researcher intends to undertake such studies within West Bengal. It was felt necessary to work on the biodiversity of some selected Heritage sites of West Bengal as well as research on the need and necessity of biomonitoring of the selected sites.

There is a major gap in research on the biodiversity pattern affecting heritage sites especially in West Bengal; hence scopes for further research exist. The researcher emphasizes the need for Museums to undertake educational activities to create mass awareness about protecting the landscape encompassing the biological diversity alongwith the heritage site.

The National Environmental Engineering Research Institute (NEERI), Nagpur was entrusted with the work of conducting a thorough Environmental Assessment of the deteriorating factors affecting the marble structure. NEERI had conducted surveys in the year 1990, 2007 and 2012. This work served as a base for the researcher in conducting her surveys at Victoria Memorial Hall. NEERI had conducted intensive study on ambient air quality, water quality and have suggested names of species for green belt plantation. Adding on these
evaluations, the researcher has analyzed experimentally how the vegetation cover helps in protection of the marble monument.

Heritage is our legacy from the past, what we live with today, and what we pass on to future generations (UNESCO, 2008: 5). Cultural and Natural heritage are both irreplaceable and source of national pride. The present research work will be an in-depth survey of the biodiversity in and around the heritage sites of West Bengal identifying the key factors causing deterioration of the biodiversity and heritage sites. By understanding role of surrounding biodiversity in protecting the heritage site, people are expected to develop respect for the bio-entities and once the biological entities are protected, the environment will inevitably be preserved. Humble attempt has been made by the scholar to suggest certain measures by which museums and formal institutions can bring about awareness on the need for protection and preservation of the biodiversity around a monument.

The survey of literatures have therefore prompted the researcher to choose the topic of her research to fill the gap of the existing research works by conducting the study in respect to West Bengal as a model project.
REFERENCES:

2. Ibid, p.53
3. Ibid, p.56
4. Ibid
5. Ibid, p.59
7. Ibid
8. op.cit, Nagar, S.L., p. 50
9. Ibid, p.67


21. *Ibid*

22. *Ibid*, p.70

23. *op.cit*, Mishra, p.31


27. *op.cit*. Trivedy, R.K. p.217


31. *op.cit*, Trivedy, R.K. et.al., p.218

32. *op.cit*, Sharma et. al. 1995


37. *opcit*, Goulty, p.97
38. *op.cit*. Cassar, M., p. 35
40. *Ibid*.
42. *op.cit*, UNESCO. 1962.
43. *op.cit*, Goulty, p.61
44. Xianyao, Li et. al. 2010. China’s Museums, Beijing: China Intercontinental Press.