Introduction about the Botanic Garden
&
Biodiversity

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A Botanic Garden is an open museum of living collection of myriad of plants, where trees, shrubs, herbs, climbers, lianas etc. are scientifically arranged, properly labelled based on an internationally accepted classification, and more closely allied groups/plants are specially grown together for better understanding of species. Unlike parks, in Botanic Gardens trees conserved in Arboretum, Gymnosperms and Pine trees are grown in Pinetum, Pandanus (screw pine) in Pandanetum, orchids in Orchidarium, bamboos in Bambusetum, palms in Palmetum, cactus in Cactarium etc.

Primarily, the earlier Botanic Gardens were set up with a role to introduce, grow and multiply important economic plants from around the globe and to carry out acclimatization study in different trial plots so as to release for cultivation in newer areas. Further emphasise was given to develop improved varieties of economically important plants of the region for commercial exploitation by conducting various horticultural researches such as hybridization, selection, cross pollination, trial etc. It also acts as a data base of plants and a living repository of native and exotic species. Comparative study of living and preserved herbarium specimen also being made through Botanic Garden for clear understanding of particular species and further taxonomic advancement.

At present there are about 2000 Botanic Gardens in the world and India having about 120 (including university, municipal and regional gardens) among that the Indian Botanic Garden (IBG), Howrah formerly known as 'Company Bagan', the Royal Botanic Garden, Kolkata, at present AJC Bose Indian Botanic Garden (AJCBIBG), Howrah, is one of the best landscaped gardens in the world. The original history of IBG is almost similar to the Kew Garden in England which is situated on the bank of the river Thames, a few miles away from London. The Kew garden is about 50 years younger to IBG, Howrah which owes its interests in the Botany of Royalty but the latter has been established with economic and scientific aims. The Kew garden started initially with a meagre area of 15 acres of land in 1841 and during the course of time it grew further under the hands of a well-known botanist Sir William Hooker, the first director of Royal Botanic Garden, Kew and now it possesses 288 acres. The Royal Botanic Garden, Kolkata, on the contrary, situated on the bank of river Hooghly a few kilometres away from Kolkata, established by Col. Robert Kyd in 1787, in a vast area of about 300 acres of land and it was regarded as the largest and one of the oldest botanic gardens in the world till the middle of 19th century and now occupies an area of 273 acres.

The Great Banyan Tree of AJCBIBG, Howrah

The Kyd's Monument at AJCBIBG, Howrah

Currently, the garden with an area of 273 acres and being a living repository of 1377 species of plants possesses 25 divisions and 24 interconnected lakes, and the lakes are connected to the Ganges through sluices for the regular inlet and outlet of water. The garden is a unique place of learning & rich array of curiosity and occupies matchless

attractions like the 'Great Banyan Tree', a living wonder in the plant kingdom; the Large Palm House containing rich collection of palms including Lodoicea maldivica (the Double Coconut palm); Branching palm (Hyphane thebaica) introduced from Egypt; The century Palm (Corypha macropoda) ; The Giant Water Lily (Victoria amazonica) brought from Amazon river; The queen of flowering trees (Amherstia nobilis) a native of Burma; The mountain rose or Venezuelan rose (Brownea sp.); The Baobab tree or Kalpavriksh (Adansonia digitata) native of Africa; The Rosogolla tree (Chrysohyllum cainito); The Cannon ball tree (Couroupita guianensis); The African Sausage tree (Kigelia pinnata) and the mad tree (Pterigota alata var. irregularis); The 'Candle Stick Tree' (Permentiera cereifera) etc., are a few to mention.

Right now, Acharya Jagadish Chandra Bose Indian Botanic Garden is taken as a centre of conservation of plant resources from their extinction. This garden serves as a living repository of plants of a country and also of selected exotic species, and a 'safe abode' for the rare and endemic plants. As a result, it houses the germ plasm collection of selected economic, ornamental and medicinal plants and their wild progenitors. The garden also acts to promote educational programmes in order to generate awareness about the value of trees and other curious, beautiful, interesting plants with delightful landscaping and display. This garden also organises flower, foliage and plant shows etc.; exchange of viable seeds, seedlings and other propagules as well. As a whole, this garden acts as a data bank of information and documentation on holdings in the botanic garden.

During the time of establishment of this Garden in 1787, Bengal was reeling through the aftermath of 'Great Bengal Famine' and subsequent failure of crops. So the garden played a greater role for introduction of many crops and economic plants like Tea, Coffee, Mahogany, Teak, Cardamom, Cinchona, Cinnamon, Cotton, Indigo, Nutmeg, Pepper, Clove, Sugarcane, Potato, Sago, Cocoa etc., and other species used as food, vegetable, fodder, oil, fruit, fibre, timber and ornamental plants were first introduced into this historic Garden. Multiplication of most of the introduced species carried out in the Garden itself and distributed to different parts of the country for commercial cultivation. Such a way this garden has helped for the economic development of the country.

What is biodiversity?

The mother earth harbours tens or millions of plant and animal species, although we have identified and given names to slightly less than two million of them. Biodiversity refers to the number and variety of species and natural communities in a geographical area, and it directly correlates with the ecological health of the region. No plant or animal species operates in a vacuum; each is part of ecological system. The age of the Earth is about 4.54 billion years old. The earliest definite evidence of life on Earth dates at least from 3.5 billion years ago.

The number and variety of plants, animals and other organisms that exist in a geographical area is known as biodiversity. It is a measure of the variety of organisms present in different ecosystems.

The term 'biological diversity' was used first by a wildlife scientist and environmentalist Raymond F. Dasmann in the year 1968. E.O. Wilson first used the term "biodiversity" in 1988.

It is an essential component of nature and it ensures the survival of human species by providing food, fuel, shelter, medicines and other resources to mankind. The abundance of biodiversity depends on the climatic conditions and area of the region. All species of

plants taken together are known as flora and about 70,000 species of plants are known to date. All species of animals taken together are known as fauna which includes birds, mammals, fish, reptiles, insects, crustaceans, molluscs etc.

Biodiversity is not evenly distributed, rather it varies greatly across the globe as well as within regions. Among other factors, the diversity of all living things (biota) depends on temperature, precipitation, altitude, soils, geography and the presence of other species. Diversity consistently measures higher in the tropics and lower in polar regions.

Considering the importance of Biodiversity, The United Nations designated 2011-2020 as the United Nations Decade on Biodiversity.

Types of Biodiversity :
1. Species diversity
2. Genetic diversity
3. Ecosystem diversity or Ecological diversity

1. Species diversity : The number of species of plants and animals that are present in an area/region constitutes its species diversity. This diversity is seen both in natural ecosystem and in agricultural ecosystems. Some areas are richer in species than others.

2.Genetic diversity : Genetic diversity is dependent on the hereditary variation within and between populations of organisms. New genetic variation arises in individuals by gene and chromosome mutations, and in organisms with sexual reproduction it can be spread through the population by recombination. It has been estimated that in humans and fruit flies alike, the number of possible combinations of different forms of each gene sequence exceeds the number of atoms in the universe. Each of the estimated 109 different genes distributed across the world's biota does not make an identical contribution to overall genetic diversity.

3. Ecosystem or Ecological diversity : There exists much diversity in different ecosystems on earth, which have their own complement of unique inter linked species based on the differences in the habitat. Ecosystem diversity can be described for a specific geographical region, or a political entity such as a country, a state or a taluke. Distinctive ecosystems include landscapes such as forest, grasslands, deserts, mountains as well as ecosystems such as rivers, lakes and the sea. Ecosystem diversity is often evaluated through measures of the diversity of the component species. This may involve assessment of the relative abundance of different species as well as consideration of the types of species.

Ecosystem diversity has three perspectives :

a. Alpha (α) Diversity : It is the biodiversity within a particular area, community or ecosystem. It is usually expressed by the number of species in that ecosystem. This can be measured by counting the number of taxa within the ecosystem (e.g. Families, genera and species).

b. Beta (β) Diversity : Beta diversity is a measure of biodiversity which works by comparing the species diversity between ecosystems or along environmental gradients. This involves comparing the number of taxa that are unique to each of the ecosystems. It is the rate of change in species composition across habitats or among communities. It gives a quantitative measure of diversity of communities that experience changing environments.

c. Gamma (γ) Diversity : It refers to the total species richness over a large area. It is a measure of the overall diversity for the different ecosystems within a region. It is a product of alpha diversity of component ecosystems and the beta diversity between component ecosystems.

Biodiversity hotspots :

A biodiversity hotspot is a region with a high level of endemic species that has experienced great habitat loss. The term hotspot was introduced in 1988 by Norman Myers. While hotspots are spread all over the world, the majority are forest areas and most are located in the tropics. In India there are two hot spots; Western Himalaya and Western Ghats.

Biodiversity loss :

In 2007, German Federal Environment Minister Sigmar Gabriel mentioned assessments that up to 30% of all species in the globe will be extinct by 2050. Of these, about one eighth of known plant species are threatened with extinction. Evaluations reach as high as 140,000 species per year (based on Species-area theory).

Almost all scientists acknowledge that the rate of species loss is greater now than at any time in human history, with extinctions occurring at rates hundreds of times higher than background extinction rates. As of 2012, some studies suggest that 25% of all mammal species could be extinct in 20 years.

The planet has lost 52% of its biodiversity since 1970 according to a 2014 study by the World Wildlife Fund (WWF). The Living Planet Report 2014 claims that "the number of mammals, birds, reptiles, amphibians and fish across the globe is, on average, about half the size it was 40 years ago". Of that number, 39% accounts for the terrestrial wildlife gone, 39% for the marine wildlife gone and 76% for the freshwater wildlife gone. Biodiversity took the biggest hit in Latin America, plummeting 83 percent. High-income countries showed a 10% increase in biodiversity, which was cancelled out by a loss in low-income countries. This is despite the fact that high-income countries use five times the ecological resources of low-income countries, which was explained as a result of process whereby wealthy nations are outsourcing resource depletion to poorer nations, which are suffering the greatest ecosystem losses.

In 2006 many species were formally classified as Rare or Endangered or Threatened; moreover, scientists have estimated that millions more species are at risk which have not been formally recognized. About 40 percent of the 40,177 species assessed using the IUCN Red List criteria are now listed as threatened with extinction – a total of 16,119.

IUCN Red List : The IUCN Red List of Threatened Species (also known as the IUCN Red List or Red Data List), founded in 1964 in U.K, is the world's most comprehensive list of the global conservation status of biological species. Issued its first list of plant and animal species endangered worldwide in 1966.

Rare medicinal plant-Begonia tessaricarpa

As per the IUCN red list there are four main catagories of species/organisms –

Rare : A rare (R) species is a group of organisms that are very uncommon, scarce, or infrequently encountered. This title may be applied to either a plant or animal taxon, and may be distinct from the term endangered or threatened species.

Baobob Tree (Endangered Species)

Endangered : An endangered species is a species which has been categorized as likely to become extinct. Endangered(EN), as categorized by the International Union for Conservation of Nature (IUCN) Red List, is the second most severe conservation status for wild populations in the IUCN's plan after Critically Endangered (CR).

Threatened : Threatened(T) species are any species(includinganimals, plants, fungi, etc.) which are vulnerable to endangerment in the near future.

Threatened flora of India - *Aconitum ferox*

Extinct : A species, family, or bigger group having no living members. Extinction is the end of an organism or of a group of organisms, normally a species. The moment of extinction is generally considered to be the death of the last individual of the species.

Red Data Book : Russian Red Data Book is a state document established for documenting rare and endangered species of animals, plants and fungi, as well as some local subspecies that exist within the territory.

Some extinct species last seen

Species	Last seen
Giant Moa	1500
Chinese Elephant	1530
Dodo	1681
Spectacled Cormorant	1832
Right Whale	1900
Passenger Pigeon	1914

Causes of the loss of Biodiversity/Threats to Biodiversity :

The main cause of the loss of biodiversity can be recognized to the influence of human beings on the world's ecosystem, in fact human beings have deeply altered the environment, and have modified the territory, exploiting the species directly, for example by fishing and hunting, changing the biogeochemical cycles and transferring species from one area to another of the Planet. The threats to biodiversity can be summarized in the following main points :

1. Habitat destruction : Habitat destruction has played a key role in extinctions, especially related to tropicalforest destruction.The transformation of the natural habitats determines not only the loss of the vegetable species, but also a decrease in the animal species associated to them.

2. Introduction of exotic species and genetically modified organisms : Species originating from a particular area, introduced into new natural environments can lead to different forms of imbalance in the ecological stability.The number of species invasions has been on the rise at least since the beginning of the 1900s. Species are increasingly being moved by humans (on purpose and accidentally).

3. Pollution : Industrial pollution influences the natural environment producing negative, direct or indirect, effects that alter the flow of energy, the chemical and physical constitution of the environment and abundance of the species. Pollution directly affects the health of trees, forests, wild life and human beings.

4. Climate change / Global warming : The heating of the Earth's surface disturbs

biodiversity because it endangers all the species that adapted to the cold due to the latitude (the Polar species) or the altitude (mountain species). More than 99 percent of all species, amounting to over five billion species, that ever lived on Earth are estimated to be extinct. Global warming is also considered to be a major potential threat to global biodiversity in the future. For example, coral reefs - which are biodiversity hotspots - will be lost within the century if global warming continues at the current trend.

5. Overexploitation of resources : When the activities connected with capturing and harvesting (hunting, fishing, farming) a renewable natural resource in a particular area is excessively intense, the resource itself may become exhausted, as for example, is the case of sardines, herrings, cod, tuna and many other species that man captures without leaving enough time for the organisms to reproduce. Likewise, over exploitation of forests for food, fodder, timber, shelter and industry also enhances biodiversity destruction.

Holocene extinction :

The Holocene extinction, otherwise referred to as the Sixth extinction or Anthropocene extinction, is the ongoing extinction event of species during the present Holocene epoch mainly due to human activity. Since life began on Earth, five major mass extinctions and several minor events have led to large and sudden drops in biodiversity. The Phanerozoic eon (the last 540 million years) marked a rapid growth in biodiversity via the Cambrian explosion – a period during which the majority of multicellular phyla first appeared. The next 400 million years included repeated, massive biodiversity losses classified as mass extinction events. In the Carboniferous, rainforest collapse led to a great loss of plant and animal life. The Permian–Triassic extinction event, 251 million years ago, was the worst; vertebrate recovery took 30 million years. The most recent, the Cretaceous–Paleogene extinction event, occurred 65 million years ago and has often attracted more attention than others because it resulted in the extinction of the Dinosaurs.

Biodiversity conservation :

Conservation biology is reforming around strategic plans to protect biodiversity. Preserving global biodiversity is a priority in strategic conservation plans that are designed to engage public policy and concerns affecting local, regional and global scales of communities, ecosystems and cultures. Main areas to conserve biodiversity is.

Protected areas :

Protected areas is meant for giving protection to wild animals and their habitat which also includes forest reserves and biosphere reserves. Protected areas have been set up all over the world with the specific aim of protecting and conserving plants and animals.

1. National Parks : National park and nature reserve is the area selected by governments or private organizations for special protection against damage or degradation with the objective of biodiversity and landscape conservation. National parks are usually owned and managed by national or state governments. A limit is placed on the number of visitors permitted to enter certain fragile areas. Designated trails or roads are

Map showing National Parks in India

created. The visitors are allowed to enter only for study, cultural and recreation purposes. Forestry operations, grazing of animals and hunting of animals are regulated. Exploitation of habitat or wildlife is banned.

2. Biosphere Reserves : A biosphere reserve is an ecosystem with plants and animals of unusual scientific and natural interest. It is a label given by UNESCO to help protect the sites. The plan is to promote management, research and education in ecosystem conservation. This includes the 'sustainable use of natural resources'

3. Wildlife sanctuary : A wildlife sanctuary, is a naturally occurring sanctuary, such as an island, that provides protection for species from hunting, predation or competition; it is a protected area, a geographic territory within which wildlife is protected.

Map showing Biosphere Reserves in India

Wildlife sanctuary aims only at conservation of species and have the following features:

    a. The boundaries of the sanctuaries are not limited by state legislation.

    b. The killing, hunting or capturing of any species is prohibited except by or under the control of the highest authority in the department which is responsible for the management of the sanctuary.

4. Forest reserves : The forests play a vital role in harbouring more than 45,000 floral and 81,000 faunal species of which 5150 floral and 1837 faunal species are endemic. Plant and animal species confined to a specific geographical area are called endemic species. In reserved forests, rights to activities like hunting and grazing are sometimes given to communities living on the fringes of the forest, who sustain their livelihood partially or wholly from forest resources or products.

5. Zoological parks : In zoological parks or zoos, live animals are kept for public recreation, education and conservation purposes. Modern zoos offer veterinary facilities, provide opportunities for threatened species to breed in captivity and usually build environments that simulate the native habitats of the animals in their care. Zoos play a major role in creating awareness among common people about the need to conserve nature.

6. Botanical gardens : Botanical garden is a garden in which plants are grown and displayed primarily for scientific and educational purposes. It consists of a collection of living plants, grown outdoors or under glass in greenhouses and conservatories. In addition, it includes a collection of dried plants or herbarium and such facilities as lecture rooms, laboratories, libraries, museums and experimental or research plantings. Rare, Endangered and Threatened species are conserved in Botanic Garden for protection and awareness.

Protection and restoration techniques:

    • ***Biodiversity banking :*** Places a monetary value on biodiversity.

    • ***Gene banks :*** These are collections of specimens and genetic material. Some banks intend to reintroduce banked species to the ecosystem (e.g., via tree nurseries).

Legally binding treaties / agreements : Some international legally binding treaties/agreements also helps to protect biodiversity eg.

1. CBD (Convention on Biological Diversity) 1992 : Enforce strict norms on biodiversity usage.

2. Convention on International Trade in Endangered Species (CITES) : Restrict trade of

Endangered and threatened species.

3. Ramsar Convention (Wetlands) : Protects world wetlands legally.

4. World Heritage Convention etc. : Protects biodiversity heritage legally.

India also passed the Biological Diversity Act in 2002 for the conservation of biological diversity in India. The Act also provides mechanisms for equitable sharing of benefits from the use of traditional biological resources and knowledge.

Conclusion :

Conservation of biodiversity is the need of the hour. We must conserve our biodiversity through all means. It is the responsibility of all of us to conserve biodiversity for the future generation. Otherwise, there won't be anything left for them. Citizens must be made aware the need to conserve biodiversity and the children also be educated properly to carry this message forward.

Rare species - *Titan arum*

Endangered species - *Cirsium pitcheri*

Threatened species - *Platanthera praeclara*

Extinct species - *Mangifera casturi*

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