

Lecture 6. Bio-diversity: Definition, classification, threats to biodiversity and its conservation.

Variation is the law of nature. It occurs everywhere and every moment. The variations take place at micro levels. The variations may be linear or cyclic. The variety and variability of organisms and ecosystems is referred to as biological diversity. The world Commission on Environment and Development (WCED) constituted by the UN General Assembly published a report in 1987 which provided a boost and endorsement to the need for conserving the world's rich biodiversity. Despite conflicting views among nations, a broad consensus was reached after bitter negotiations, and 170 countries signed the Biodiversity Convention, which is now ratified by 104 countries.

Perhaps the greatest value of biodiversity is yet unknown. Scientists have discovered and named only 1.75 million species – less than 20 per cent of those estimated to exist. Of those identified, only a fraction has been examined for potential medicinal, agricultural or industrial value. Much of the earth's great biodiversity is rapidly disappearing, even before we know what is missing. Estimates vary, but the most widely accepted figure lies between 10 and 13 million species. Of these, biologists estimate that as many as 27,000 species are becoming extinct each year. This translates into an astounding 3 species every hour.

Types of Biodiversity (Diversity Indices):

Alpha (α) Diversity : Species diversity within a community or habitat, comprises two components i.e. species richness and evenness. Sometimes dominant of one vegetation stratum may affect the α diversity of the other strata.

Beta (β) Diversity : β diversity is the inter community diversity expressing the rate of species turnover per unit change in habitat.

Gamma (γ) Diversity : Gamma diversity is the overall diversity at landscape level includes both α and β diversities. The relationship is as follows:

$$\gamma = \alpha + \beta + Q$$

where, Q = Total number of habitats or communities, α = Average value of α diversities

β = Average value of β diversities

Levels of Biodiversity

Theoretically there are three levels of biodiversity.

1) Genetic diversity

It refers to the variation of genes within the species. This constitutes distinct population of the same species or genetic variation within population or varieties within a species.

2) Species diversity

It refers to the variety of species within a region. Such diversity could be measured on the basis of number of species in a region.

3) Ecological diversity

Ecological diversity is the intricate network of different species present in local ecosystem and the dynamic interplay between them. An ecosystem consists of organisms from many different species living together in a region that are connected by the flow of energy, nutrients, and matter that occurs as the organisms of different species interact with one another.

The Mega Diversity Regions

The World Conservation Monitoring Centre recognised 17 mega diverse countries in July 2000 including Australia, Brazil, China, Colombia, Democratic Republic of the Congo (DRC) (formerly Zaire), Ecuador, India, Indonesia, Madagascar, Malaysia, Mexico, Papua New Guinea, Peru, the Philippines, South Africa, the United States of America (USA) and Venezuela. Together, these 17 countries harbour more than 70% of the earth's species. Some of the very valuable "gene pool" from these countries have been identified and they have been utilized for the built up of modern agriculture and allied business.

Hotspots of Biodiversity

The earth's biodiversity is located in specific ecological regions. There are over a thousand major 'ecoregions' in the world. Of these, 200 are said to be richest, rarest and most distinctive natural areas. These areas are referred to as the 'Global 200'.

It has been estimated that 50,000 endemic plants, which comprise 20% of global plant life, probably occur in only 18 'hot spots' in the world. Countries have a relatively large proportion of these biodiversity hotspots are referred as 'mega-diversity nations'.

Global Species Diversity

Group	Number of described species
Bacteria and blue-green algae	4,760
Fungi	46,983
Algae	26,900
Bryophytes(Mosses and Liverworts)	17,000
Gymnosperms(Conifers)	750
Angiosperms(Flowering plants)	250,000
Protozoans	30,800
Sponges	5,000
Corals and Jellyfish	9,000
Roundworms and earthworms	24,000
Crustaceans	38,000

Insects	751,000
Other arthropods and minor invertebrates	132,461
Molluscs	50,000
Starfish	6,100
Fishes(Teleosts)	19,056
Amphibians	4,184
Reptiles	6,300
Birds	9,198
Mammals	4,170
Total : 1,435,662 species	

From: Conserving the world's Biological Diversity, WRI,IUCN,CI,WWF-YS,the World Bank.

India's biodiversity

India is exceptionally rich in biodiversity and is one of the twelve mega diversity centres of the world. With 10 biogeographic zones and 25 biotic provinces, all major ecosystems are represented. India is a land mass of nearly 33 lakh sq.km with a coastline of 7,616 km and 14 different types of climatic forests and the total forest coverage in India is about 6,50,000 sq.km. India is the home land of 13,000 species of flowering plants, 20,000 species of fungi, 50,000 species of insects, 65,000 species of fauna including 2000 species of birds, 350 mammals and 420 of reptiles. It covers nearly 7% of world's flora and 6.5% of world's fauna of which 33 % flora and 62% fauna are endemic. India has over 30 National parks that constitute about 1% of the landmass and 441 sanctuaries that constitute 3.5% of the area. India is a home of over 35,000 tigers and the umbrella of project tiger 23 specially demarcated project tiger reserves covering 33,000 sq.km representing different climatic forests are spread across the country.

India has a rich and varied heritage of biodiversity, encompassing a wide spectrum of habitats from tropical rainforests to alpine vegetation and from temperate forests to coastal wetlands. **India figured with two hotspots** - the Western Ghats and the Eastern Himalayas - in an identification of 18 biodiversity hotspots carried out in the eighties. Recently, Norman Myers and a team of scientists have brought out an **updated list of 25 hotspots**. In the revised classification, the 2 hotspots that extend into India are The Western Ghats/Sri Lanka and the Indo-Burma region (covering the Eastern Himalayas); and they are included amongst the top eight most important hotspots. In addition, **India has 26 recognised endemic centres** that are home to nearly a third of all the flowering plants identified and described to date.

Of the estimated 5–50 million species of the world's biota, only 1.7 million have been described to date, and the distribution is highly uneven. About seven per cent of the world's total land area is home to half of the world's species, with the tropics alone accounting for 5 million. India contributes significantly to this latitudinal biodiversity trend. With a mere 2.4% of the world's area, India accounts for 7.31% of the global faunal total with a faunal species count of 89,451 species. Some salient features of India's biodiversity have been mentioned below.

- India has two major realms called the Palaearctic and the Indo-Malayan, and three biomass, namely the tropical humid forests, the tropical dry/deciduous forests, and the warm desert/semi-deserts
- India has ten biogeographic regions including the Trans-Himalayan, the Himalayan, the Indian desert, the semi-arid zone(s), the Western Ghats, the Deccan Peninsula, the Gangetic Plain, North-East India, and the islands and coasts.
- As of date, there are 911 properties under the World Heritage List, which cover 711 cultural sites, 180 natural sites and 27 mixed properties encompassing 152 countries, including India. India is one of the 12 centres of origin of cultivated plants.
- India's first two sites inscribed on the list at the Seventh Session of the World Heritage held in 1983 were the Agra Fort and the Ajanta Caves. Over the years, 27 more sites have been inscribed, the latest site inscribed in 2012 being the Western Ghats. Of these 29 sites, 23 are cultural sites and the other six are natural sites. A tentative list of further sites/properties submitted by India for recognition includes 33 sites.
- India has 17 biosphere reserves, and 19 Ramsar wetlands. Amongst the protected areas, India has 102 national parks and 490 sanctuaries covering an area of 1.53 lakh sq. km.
- The wildlife sanctuaries in India are home to around two thousand different species of birds, 3500 species of mammals, nearly 30000 different kinds of insects and more than 15000 varieties of plants

The endemism of Indian biodiversity is high. About 33% of the country's recorded flora are endemic to the country and are concentrated mainly in the North-East, Western Ghats, North-West Himalaya and the Andaman and Nicobar islands. Of the 49,219 plant species, 5150 are endemic and distributed into 141 genera under 47 families corresponding to about 30% of the world's recorded flora, which means 30% of the world's recorded flora are endemic to India. Of these endemic species, 3,500 are found in the Himalayas and adjoining regions and 1600 in the Western Ghats alone. About 62% of the known amphibian species are endemic with the majority occurring in the Western Ghats. Nearly 50% of the lizards of India are endemic with a high degree of endemism in the Western Ghats. India is a centre of crop diversity - the homeland of 167 cultivated species and 320 wild relatives of crop plants.

Corals reefs in Indian waters surround the Andaman and Nicobar Islands, the Lakshadweep Islands, and the Gulf areas of Gujarat and Tamil Nadu. They are nearly as rich in species as tropical evergreen forests. India's record in agro-biodiversity is equally impressive. There are 167 crop species and wild relatives. India is considered to be the centre of origin of 30,000-50,000 varieties of rice, pigeon-pea, mango, turmeric, ginger, sugarcane, gooseberries etc and ranks seventh in terms of contribution to world agriculture.

Endemic species of plants

Group	No. of species
Pteridophyta	200
Angiosperms	4950

Endemic species of animals

Group	No. of species	Group	No. of species
Mollusca		Amphibia	110
Land	878	Reptilia	214
Freshwater	89	Aves	69
Insecta	16,214	Mammalia	38

Loss of Biodiversity

With the current rate of development, population growth and migration communities are increasingly unable to meet their sustained needs. However, the present day drastic changes in the environment and habitat due to population explosion and unmanaged developmental activities are so unnatural that the species are not getting full liberty of time and space for their survival and adaptive radiation, therefore, resulting in loss of biodiversity, which is a global crisis. It is high time that our natural wealth be preserved from loss.

Threats to Biodiversity

The diversity in India i.e .forests, grass lands, wetlands, mountains, deserts and marine ecosystems face many pressures. One of the major causes for the loss of biological diversity in India has been the depletion of vegetative cover in order to expand agriculture. Since most of the biodiversity rich forests also contain the maximum mineral wealth and also the best sites for water impoundment, mining and development projects in such areas have often led to destruction of habitats. Poaching and illegal trade of wildlife products too have adversely affected biological diversity.

Causal factors of threat

Causal factors of threat may be natural or man made. They are

1. Development pressure

- Construction
- Forest based industries
- Hydel/ Irrigation projects
- Mining
- Oil drilling
- Pollution
- Resource extraction
- Road & Transport

2. Encroachment

- a. Agriculture
- b. Expansion of forest villages

- c. Fishery
 - d. Grazing / increased domestic animals
 - e. Habitat depletion / change
 - f. New settlements
 - g. Shifting cultivation
- 3. Exploitation**
- a. Collection made by scientific/educational institutions
 - b. Exploitation by local authorities as revenue resources
 - c. Firewood collection
 - d. Food gathering and hunting
 - e. Poaching
- 4. Human induced disasters**
- a. Floods
 - b. Major oil spills/leakage
 - c. Epidemics
 - d. Forest fires
- 5. Management of Natural resources**
- a. Genetic uniformity
 - b. Inadequate water/ food for wildlife
 - c. Increased competition
 - d. Introduction of exotic species
 - e. Predation
- 6. Management of Human Resource**
- a. Change in people's lifestyle
 - b. Increasing demands
 - c. Dilution of traditional values
 - d. Human harassment
 - e. Inadequate trained human resources
 - f. Lack of effective management
 - g. In appropriate land use
- 7. Political and policy issues**
- a. Change in use / legal status
 - b. Civil unrest
 - c. Intercommunity conflict
 - d. Military activities

Categories of threat

The following categories of threat have been recognized by IUCN (International Union for Conservation of Nature and Natural Resources)

1. Endangered

The taxa in danger of extinction and whose survival is unlikely, the causal factors continue operation. The taxa whose number have been reduced to a critical level or whose habitats have been so drastically reduced that they are seemed to be in immediate danger of extinction (eg) *Nepenthes sp.*, *Vanda*, *Cycas beddomii*.

2. Vulnerable

Taxa likely to move into endangered category in near future, if the causal factors continue operating included taxa of which most or all the population are decreasing because of over exploitation, extensive destruction of habitats or other environmental disturbances. Eg. *Dioscoria deltoidea*

3. Rare

Taxa with small world population that are not at present endangered or vulnerable but are at risk. These taxa are usually localized within restricted geographical areas or habitat or are thinly scattered over more extensive range (eg) *Rauvolfia serpentina*

4. Threatened

The term threatened is used in the conservation for species which fall in one of the above three categories

Endangered plant and animal species

- 427 – endangered plant species (BSI) in **Red Data Book**
- Contributes to about 20% of India's floristic wealth of higher plants

Endangered plants

- *Acer laevigatum*
- *Phoenix rupicola*
- *Lactuca cooperi*
- *Carum villosum*
- *Amorphophallus bulbifer*
- *Dioscorea laurifolia*

Endangered animals

Andaman wild pig, Bison, Black buck, Blue whale, Cheetah, crab eating macaque, two horned antelope, giant squirrels, Hyaena, Lion tailed Macaque, musk deer, Nilgiri tahr, Sambar, rhinoceros, Siberian White crane

Conservation of Biodiversity

The very existence of human being is threatened due to continuous loss of biodiversity. Tropical rain forests have been the focal point of the debates on biodiversity conservation. In fact, the rain forest covers only 7% of the earth's geographical area but supports more than half of the world's identified

species. Of these, 15 rain forests have been identified as hot spots. Tropical deforestation will be the single greatest cause of species extinction in the next century.

Strategies of Conservation

Future strategy for Conservation has 4 goals

1. Maintenance of adequate resources
2. Conservation of resources through reduction in demand and achievement of greater end use
3. Maximum use of renewable resources
4. Reduction in dependency of non-renewable resources

***In situ* strategy**

This strategy emphasizes on the conservation work at original site of biodiversity i.e. in wild. Conservation of overall diversity of genes, populations, species, communities and the ecological processes comes under this strategy. There are 37,000 protected area in the world (World Conservation Monitoring Centre , WCMC). India has 17 biosphere reserves, and 19 Ramsar wetlands. Amongst the protected areas, India has 102 national parks and 490 sanctuaries covering an area of 1.53 lakh sq. km.

***Ex situ* Strategy**

This strategy says that conservation work should be done outside the natural habitat in form of botanical and zoological gardens, conservation stand, seed and seedling banks, pollen banks, germ plasm banks, tissue culture banks, gene and DNA banks etc. In India, conservation of genetic diversity of cultivated plants and their wild relatives is done by NBPGR (National Bureau of Plant Genetic Resources).

Reduction of Anthropogenic Pressure

Increasing population and it's demands pose remarkable threat to taxa important to human being. About 70% of identified medicinal plants of Indian Himalaya are exposed to destructive harvesting. Cultivation of such plants elsewhere would contribute to their conservation.

Restoration of endangered species

It is tough and difficult strategy. It requires specific knowledge about species and its surrounding. This strategy includes diagnosis of factors responsible for the decline of species, habitat conservation, captive breeding and restriction of harvesting etc. the strategy include:

- Reintroduction programmes in the original site of living
- Augmentation programmes to increase the existing population size and genetic diversity of a species
- Introduction programmes for a new area.

Endemic species

Endemic species are the plants, which are limited in their distribution i.e. they are restricted to a small area and are not found elsewhere in the world. Endemism of Indian biodiversity is significant. About 4,900 species of flowering plants and 33% of the recorded floras are endemic to the country. These are distributed over 141 genera belonging to 47 families. These are concentrated in the floristically rich areas of North East India, the western Ghats, North West Himalayas and the Andaman and Nicobar Islands. The Western Ghats and the Himalayas have two of the 18 hot spots identified in the world. It is estimated that 62% of the known amphibian species are endemic to India of which a majority occur in Western Ghats. Endemism may be due to:

- Poor adaptability of a species in a wide range of ecology
- Presence of some geographical barrier
- Failure of dispersal of reproductive organs
- The species might have comparatively been young and not have time to spread.

Biosphere Reserves

Biosphere reserve programme was launched by UNESCO in 1971 under its MAB (Man and Biosphere Programme). Biospheres are sites where protection is granted not only to the flora and fauna of the protected region, but also to the human communities who inhabit these regions, and their ways of life. Biosphere reserves are sites established by countries and recognized under UNESCO's Man and the Biosphere (MAB) Program to promote sustainable development based on local community efforts and sound science. Currently there are 580 sites across 114 countries. The Indian government has established 17 **Biosphere Reserves of India**. Seven of the seventeen biosphere reserves are a part of the World Network of Biosphere Reserves, based on the UNESCO Man and the Biosphere (MAB) Program list.

Biosphere reserves of India

S.No	Name of Biosphere Reserve	Location
1	Great Rann of Kutch	Gujarat
2	Nokrek	Meghalaya
3	Manas	Assam
4	Gulf of Mannar	Tamil Nadu
5	Sundarban	West Bengal
6	Nandadevi	Uttrakhand
7	Nilgiri	Tamil Nadu, Kerala and Karnataka
8	Dehang Debang	Assam
9	Panchmani	Madhya Pradesh
10	Amarkantak	Madhya Pradesh and Chattisgarh

11	Kanchenjunga	Sikkim
12	Agasthyamalai Biosphere Reserve	Kerala and Tamil Nadu
13	Great Nicobar Biosphere Reserve	Andaman and Nicobar
14	Dibru-Saikhowa	Assam
15	Cold Desert	Himachal Pradesh
16	Seshachalam Hills	Andhra Pradesh
17	Simplipal	Orissa

Important National parks and wild life sanctuaries in India

- Andra Pradesh – Pakhal, Povharam, kawal, kollaeru, pelicanary wild life sanctuary
- Arunachal Pradesh – Namidapha Wild life sanctuaries
- Assam – Kaziranga National Park, Manas Wild life sanctuaries
- Bihar – Hazaribagh National park
- Gujarat – Gir National Park
- Karnataka – Bandipur National park, Silent Valley National park
- Kerala – Periyar Wild life sanctuarie, Wyanad Wild life sanctuarie
- Orissa – Chilka Lake Bird sanctuary
- Tamil Nadu – Mudumalai Wild life sanctuarie, Vedanthangal Bird Sanctuary
- Uttar Pradesh – Corbett National park
- West Bengal – Jaldapara Wild life sanctuarie

Some of the policies, which can be taken into account for biodiversity conservation, are:

- Identifying and monitoring the important components of biological diversity that needs to be conserved and used sustainably.
- Establishing protected areas to conserve biological diversity while promoting environmentally sound development around these areas.
- Respecting, preserving and maintaining traditional knowledge of the sustainable use of biological diversity with the involvement of indigenous peoples and local communities.
- Educating people and raising awareness about the importance of biological diversity and the need to conserve it
- Promoting public participation, particularly when it comes to assessing the environmental impacts of development projects that threaten biological diversity and protecting the biodiversity hot spots from alien species.

Biodiversity conservation is an important step towards a successful disaster management and if policies are implemented to protect it, then we can get one step closer in making a Disaster Free World.

Lecture 6. Bio-diversity: Definition, classification, threats to biodiversity and its conservation.

1.	The levels of biological organization include	
	a) Genetic diversity	b) Species diversity
	c) Ecosystem diversity	d) All the above
2.	The location of Salim Ali College of Ecology	
	a) New Delhi	b) Kolkotta
	c) Mumbai	d) Pondicherry.
3.	Which of the following is not an estimate of species diversity?	
	a) Abundance	b) Turn over
	c) Chromosome banding	d) Richness
4.	Variation of genes within the species is	
	a) Species diversity	b) ecological diversity
	c) Genetic diversity	d) Population diversity
5.	The species richness and evenness is -----	
	a) α Diversity	b) β - diversity
	c) γ -Diversity	d) all the above
6.	India has -----	
	a) 10 recognised endemic centre	b) 26 recognised endemic centre
	c) 12 recognised endemic centre	d) 40 recognised endemic centre
7.	The richest, rarest and most distinctive natural areas in the earth's biodiversity is -----	
	a) universe 200	b) global 200
	c) planet 200	d) Biome 200
8.	The world's heritage sites located in West Bengal is	
	a) Kazirangal National part	b) Manos Wildlife sanctuary
	c) Sunderban National park	d) Sunderban Mangrooves
9.	In India conservation of genetic diversity of cultivated plant and their wild relative is done by	
	a) WCMC	b) NBPGR
	c) IUCW	d) WCED
10.	Plant species which are restricted to a small area and are not found elsewhere in the world is	
	a) Ecotone	b) Biome
	c) Endemism	d) Microcosm
11.	Vanda is a -----	
	a) Rare species	b) Endangered species
	c) Extinct species	d) Threatened species
12.	An undisturbed natural areas for scientific study as well as conditions of disturbance are under perfect control of	
	a) Wild life sanctuary	b) Biosphere reserve
	c) National park	d) Botanical garden
13.	Carbett National park is at	
	a) Uttar Pradesh	b) Tamil Nadu
	c) West Bengal	d) Gujarat
13.	Kaziranga national park and Manas wild life Sanctuaries are at	
	a) Assam	b) Bihar
	c) Uttar Pradesh	d) West Bengal

14.	Zoological Gardens are ----- method of conserving the resources	
	a) Exsitu	b) insitu
	c) Traditional	d) all the above
15.	A net work of different species present in a local ecosystem and interact between them is called	
	a) Ecological Diversity	b) Ecotone
	c) ecosystem	d) None of the above
16.	Endemism is due to	
	a) Poor adoptability	b) Geographical barrier
	c) Failure of reproductive organs	d) All the above
17.	A species deliberately introduced into an environment that does not historically belongs to its range is known as -----	
	a) Endemic	b) Exotic
	c) Wild species	d) none of the above
18.	Biodiversity is rich in	
	a) Temperate forest,	b) Grasslands,
	c) Tropical forest.	d) desert
19.	Species in danger of extinction whose survival is unlikely	
	a) Extinct	b) Endangered
	c) Rare	d) Threatened
20.	Nilgiri biosphere reserves covers	
	a) Tamil Nadu and Kerala	b) Tamil Nadu and Andhra Pradesh
	c) Karnataka and Tamil Nadu	d) Kerala, Karnataka and Tamil Nadu
21.	The animal which is fast becoming an endangered species in India	
	a) Lion	b) Tiger
	c) Wolf	d) Deer
22.	The first national park established in the World	
	a) Royal National park in Australia	b) Yellowstone National Park in North America
	c) Kruger national park	d) June Corbett national park.
23.	The shrub brought from Australia to decorate garden hedges in India that has become a weed	
	a) <i>Parthenium</i>	b) Lantana
	c) Elder	d) Bilberry
24.	The project tiger was launched in the year	
	a) 1980	b) 1985
	c) 1973	d) 1970
25.	Expand CITES ----- (Convention on International trade on Endangered Species)	
26.	The location of Salim Ali Centre for Ornithology is located at ----- (Coimbatore)	