# Biodiversity and Conservation

# Biodiversity

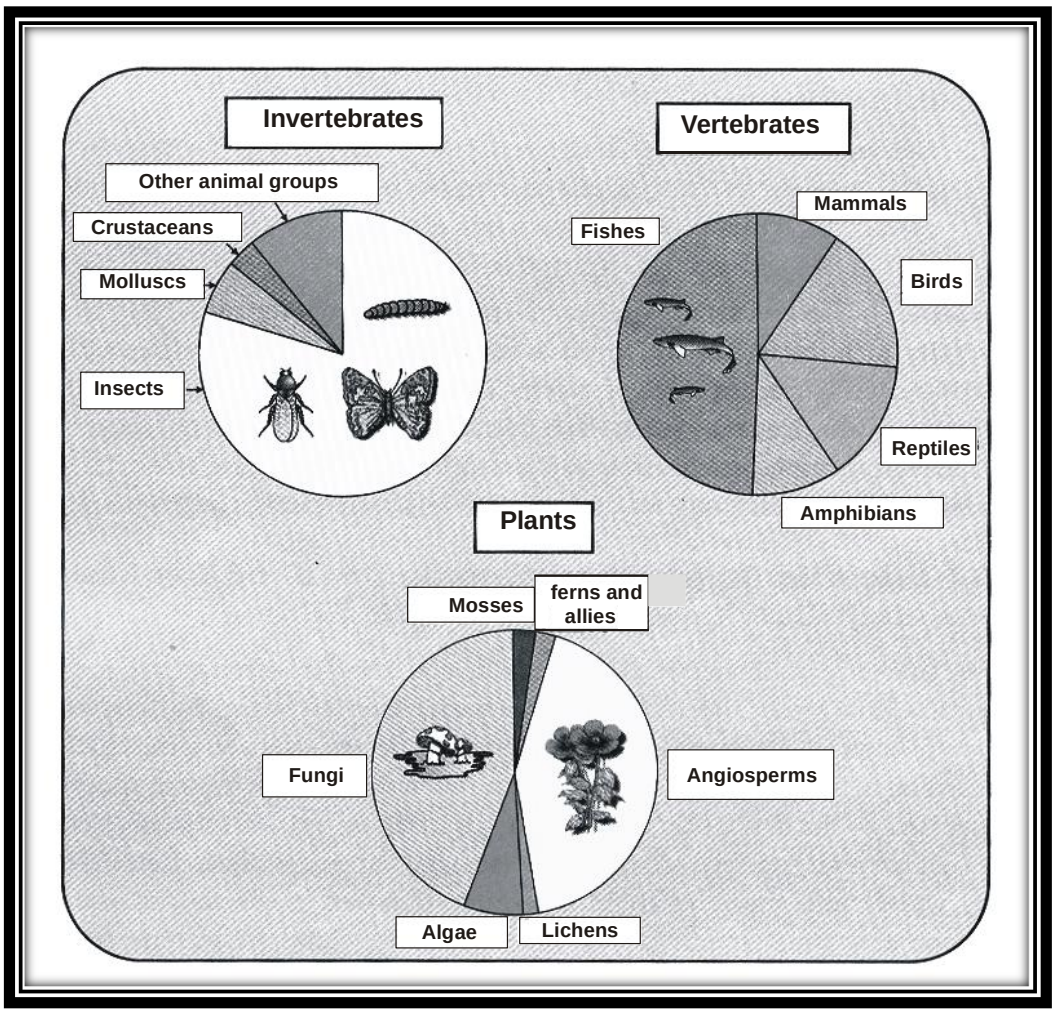
## BIODIVERSITY

### Introduction:

- It is the occurrence of different types of ecosystems, different species of organisms with their biotypes and genes adapted to different climates, environments alongwith their interactions and processes.
- The term "Biodiversity" coined by W.G. Rosen. Biodiversity is the term popularised by the sociobiologist Edward Wilson to describe the combined diversity at all the levels of biological organisation.

### Magnitude of Biodiversity in the world & India:

- According to Robert may global species diversity is about 7 million. But we are able to describe and identify only 1.5 million species (However, Taxonomists estimate the number of species between 1.7-1.8 million).
- Total 1.75 million species have been reported at present time including 12 lac animals (more than 70% of all the species) and 5 lac (22% of total species) plants.




- In India the number of species is 142000 or roughly 8.1% of the total species that occur in 2.4% land area.
- Out of these recorded species from India, 33% flowering plants, 10% mammals, 36% reptiles, 60% amphibians and 53% fresh water fish are endemic and exclusive to India.
- India with about 45000 species of plants and twice as many species of animals is one of the 12 megadiversity countries of the world.
- 15000 new species are being discovered per year.

| Number of Identified species in the World | | |
|---|---|---|
| 1 | Higher Plants | 2,70,000 |
| 2 | Algae | 40,000 |
| 3 | Fungi | 72,000 |
| 4 | Bacteria/Cyanobacteria | 4,000 |
| 5 | Viruses | 1,550 |
| 6 | Mammals | 4,650 |
| 7 | Birds | 9,700 |
| 8 | Reptiles | 7,150 |
| 9 | Fish | 26,959 |
| 10 | Amphibians | 4,780 |
| 11 | Insects | 10,25,000 |
| 12 | Crustaceans | 43,000 |
| 13 | Molluscs | 70,000 |
| 14 | Nematodes and Worms | 25,000 |
| 15 | Protozoa | 40,000 |
| 16 | Others | 1,10,000 |

**Levels of biodiversity:**

Combined diversity at all the levels of biological organization. The biodiversity can be studied at three levels.

(1) Genetic diversity

(2) Species diversity

(3) Community and Ecosystem diversity

**(1) Genetic diversity :**

- A species show high diversity at gene level over it's distributional range. For ex. Medicinal plant Rauwolfia Vomitoria growing in himalayan range show diversity in synthesis of chemical reserpine in concentraction and potential.

- India has 50,000 genetically different spacies of rice and 1000 varieties of mangos.

- Each species, varying from bacteria to higher plants and animals, stores an immense amount of genetic infromation. For example, the number of genes is about 450-700 in Mycoplasma, 4000 in Escherichia coli, 13000 in Drosophila melanogaster, 32000-50000 in Oryza sativa and 35000 to 45000 in Homo sapiens.

- Genetic diversity refers to the variation of genes within species; the differences could be in allels (different variants of same genes), in entire genes (the traits determining particular characteristics) or in chromosomal structures.

- The genetic diversity enables a population to adapt to its environment and respond to natural selection. If a species has more genetic diversity, it can adapt better to the changed environmental conditions.

- Lower genetic diversity in a species leads to uniformity, as in the case of large monocultures of genetically similar crop plants. This has advantage when increased crop production is a consideration, but can be a problem when an insect or a fungal disease attacks the field and posses a threat to the whole crop.

- The amount of genetic variation is the basis of speciation (evolution of new species). It has a key role in the maintenance of diversity at species and community levels. The total genetic diversity of a community will be greater if there are many species, as compared to a situation where there are only a few species. Genetic diversity within a species often increases with environmental variability.

**Species Diversity:**

- It is the variety in the number and richness of the species of a region.
- Number of individuals of different species represent species evenness.
- Number of species per unit area is called species richness.
- Species diversity is product of both species richness or evenness.

- Suppose, we are having three sample areas. In the sample area-I, there are three spacies of birds. Two species are represented by one individual each, while the third species has four individuals. In the sample area-2 that has the same three spacies, each spacies is represented by two individuals. This sample area show greater evenness, and there are equal chances for a species being represented in a sample. The sample area-2 will be considered more diverse than the first. In the sample area-3 the species are represented by an insect, a mammal and a birds. This sample area is most diverse as it comparises taxonomically unrelated species. In this example, we find equal number of spacies but varying number of individuals per species. In nature, both the number and kind of species, as well as the number of individuals per species vary, leading to greater diversity.

**Ecosystem or Community Diversity :**

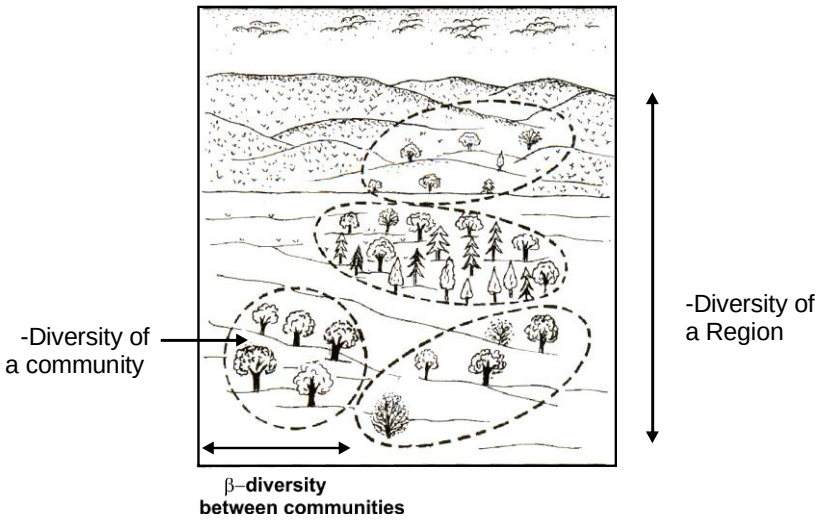



**Fig: Three types of Ecosystem Diversity**

According to Whittaker (1965) it is of three types

**(1) Alpha Diversity (a-diversity) :** It is found with in community and depends upon species richness and evenness.

**(2) Beta Diversity (b-diversity) :** It appears between two communities.

**(3) Gamma Diversity (g-diversity) :** It is regional diversity that shows total richness of species in all the habitats found within a region, geographical area or landscape.

## Magnitude of Biodiversity in world and India

- According to IUCN (2004) the total number of species of plants and animals described so far are about 1.5 million.
- According Robert May global species diversity is about 7 million.
- According to knowledge of earth's biodiversity-
- 70% of all species is of animals.
- 22% of all plants species (Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms)
- Among animals, insects are most species rich (number of species) constituting 70% of total animal species. ie., from every 10 animals, 7 are insects
- Prokaryotes are not counted in global biodiversity as the number of prokaryotic species in not known, conventional toxonic methods are not suitable for them and many species are not cultrable under laboratory conditions.
- India share 2.1% of world land area but share global species diversity is 8.1% which make India one of the 12 mega diversity countries of world. India has 45000 species of plants and twice number of species of animals and many more yet to be identified and discovered.
- According to Robert Mays global estimates, only 22% of the total species have been recorded so far. Applying this proportion to India more than 1,00,000 plant and 3,00,000 animal species yet to be discovered and described.

## PATTERNS OF BIODIVERSITY

### (i) Latitudinal gradients -

- The diversity of plants and animals is not uniform throughout the world but shows a rather unever distribution. In general, species diversity decreases as we move away from the equator towards the poles. With very few exceptions, tropics (latitudinal range of 23.5° N to 23.5° S) harbour more species than temperate or polar areas. Colombia located near the equator has nearly 1,400 species of birds while New York at 41° N has 105 species and Greenland at 71° N only 56 species. India, with much of its land area in the tropical latitudes, has more than 1,200 species of birds. A forest in a tropical region like Equador has up to 10 times as many species of vascular plants as a forest of equal area in a temperate region like the Midwest of the USA.

- Maximum diversity occurs in Amazon rain forest of south America with 40,000 species of plants, 3000 species of fish, 1300 birds, 427 mammals, 427 amphibians, 378 reptiles and more than 1,25,000 invertebrates.

**The reasons of higher diversity in tropical areas are as follows.**

**(i)** Frequent glaciation was quite common in temperate region in the past. This type of disturbance was absent in tropical latitudes therefore species continued to flourish and evolve undisturbed for millions of years and thus had a long evolutionary time for species diversification.

**(ii)** There are no unfavourable seasons in tropics. Tropical environments are less seasonal, more constant and predictable.

It helps to gain more niche specialisation for tropical organisms and greater species diversity

**(iii)** Environmental stability.

**Species-Area relationships :**

- Alexander von Humboldt exploring the wilderness of south american jungles and observed that species rich ness increased with increasing explored area but upto a certain limit. The relationship between species richness and area turned out to be rectangular hyperbola for a wide variety of taxa including birds, bats, fresh water fishes or flowering plants.

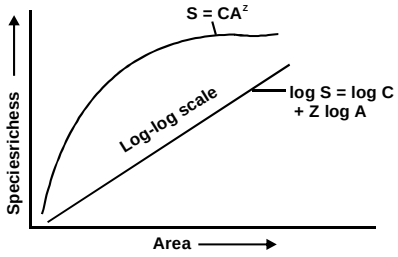



**Fig :- Species-Area relationship Which becomes linear on a log-log scale.**

This relationship is linear on a logarithmic scale.

$\log S = \log C + Z \log A$

S = species richness

Z=Slope of line or regression coefficient

C = y intercept

A = area.

- The value of Regression coefficient or Z is about 0.1-0.2 regardless of taxonomic group or region. When we discuss species-area relationship for a very large area like the entire continent, Z, slope of the line will be much steeper (The Z value is 0.6-1.2) e.g. For frugivorous birds and mammals of tropical forests of different continents, the slope of line is steeper with a Z value of 1.15.

**The importance of Species Diversity to the Ecosystem**

- The number of species in a community really matter to the functioning of the ecosystem. For many decades, ecologists believed that communities with more species, generally, tend to be more stable than those with less species.

**What exactly is stability for a biological community?**

- A stable community should not show too much variation in productivity from year to year; it must be either resistant or resilient to occasional disturbances natural or man-made), and it must also be resistant to invasions by alien species. [We don't know how these attributes are linked to species richness in a community, but David Tilman's long-term ecosystem experiments using outdoor plots provide some tentative answers. Tilman found that plots with more species showed less year-to-year variation in total biomass. He also showed that in his experiments, increased diversity contributed to higher productivity. ] Although, we may not understand completely how species richness contributes to the well-being of an ecosystem, we know enough to realise that rich biodiversity is not only essential for ecosystem health but imperative for the very survival of the human race on this planet.
- At a time when we are losing species at an alarming pace, one might ask– Does it really matter to us if a few species become extinct? Would Western Ghats ecosystems be less functional if one of its tree frog species is lost forever? How is our quality of life affected if, say, instead of 20,000 we have only 15,000 species of ants on earth?

- There are no direct answers to such näive questions but we can develop a proper perspective through an analogy (the 'rivet popper hypothesis') used by Stanford ecologist Paul Ehrlich. In an airplane (ecosystem) all parts are joined together using thousands of rivets (species). If every passenger travelling in it starts popping a rivet to take home (causing a species to become extinct), it may not affect flight safety (proper functioning of the ecosystem) initially, but as more and more rivets are removed, the plane becomes dangerously weak over a period of time. Furthermore, which rivet is removed may also be critical. Loss of rivets on the wings (key species that drive major ecosystem functions) is obviously a more serious threat to flight safety than loss of a few rivets on the seats or windows inside the plane.

## LOSS OF BIODIVERSITY/THREATS TO BIODIVERSITY

- According to IUCN red data book, earth has lost some 784 species during the last 500 years, including 338 vertebrates, 359 invertebrates and 87 plants.
- In the last two decades, 27 species have become extinct.
- The important recent extinctions are Dodo of mauritius, thylacine or Tasmania Wolf of Australia, Quagga of Africa or south african Zebra , Steller's Sea Cow of Russia and three subspecies of Tiger (Bali, javan and Caspian).
- At present time about 15,500 species worldwide are facing the threat of extinction in which 31% gymnosperms, 32% amphibians, 23% mammal species and 12% bird species involve. The current rate of extinction is 100–1000 times faster than pre-human times. It is considered as sixth extinction due to human activities.
- The loss in biodiversity in an region may leads to-
- Decline in plant production.
- Lowered the resistance to environmental changes like draught.
- Change the ecosystem processing like plant productivity, water use, pest and disease cycle.

### Cause of biodiversity loss

(i) Habitat loss and Fagmentation.
(ii) Over exploitation
(iii) Introduction of exotic species/ Alien species.
(iv) Co-extinction

**(i) Habitat loss and Fragmentation :** This is the most important cause driving animals and plants to extinction. The most dramatic example of habitat loss come from torpical rian forests. Once covering more than 14 percent of the earth's land surface, these rain forests now over no more than 6 percent. they are being destroyed fast. By the time you finish reading this chapter, 1000 more hectares of rain forest would have been lost.

- The Amazon rain forest (It is so huge that it is called the 'Lungs of the planet'.) harbouring probably millions of species is being cut and cleared for cultivating soya beans or for conversation to grassland for raising beef cattle.

- Besides total loss, the degradation of many habitats by pollution also threatens the survival of many species. When large habitats are broken up into small fragments due to various human activities, mammals and birds requiring large territories and certain animals with migratory habits are badly affected, leading to population declines.

**(ii) Over-exploitation** : Human have always depended on nature for food and shelter, but when 'need' turns to 'greed', it leads to over-exploitation of natural resources. Many species extinctions in the last 500 years (Stellr's sea cow, passenger pigeon) were due to exploitation by humans. Presently many marine fish populations around the world are over harvested, endangering the continued existence of some commercially important species.

**(iii)Alien species invasions :** When alien species are introduced unintentionally or deliberately for whatever purpose, some of them turn invasive, and cause decline or extinction of indigenous species.

- The Nile perch introduced into Lake Victoria in east Africa led eventually to the extinction of an ecologically unique assemblage of more than 200 species of cichlid fish in lake. You must be familiar with the environmental damage caused and threat posed to our native species by invasive weed species like carrot grass (*Parthenium*), Lantana and water hyacinth *(Eicchornia*).

- The recent illegal introduction of the Africa Catfish *Clarias gariepinus* for aquaculture purposes is posing a threat to the indigenous catfishes in our rivers.

**(iv)Co-extinctions :** When a species becomes extinct, the plant and animal species associated with it in an obligatory way also become extinct even the assemblage of parasites also meets the same fate.

Another example is the case of a coevolved plant-pollinator mutualism where extinction of one invariably leads to the extinction of the other.

**Type of Extinction of species :**

**(i) Natural extinction :** Due to change in environmental condition.

**(ii) Mass extinction :** Due to catastrophs.

**(iii) Anthropogenic extinction :** Due to human activities like hunting.

**The characteristics of species particularly susceptible to extinction are :-**

- Large body size, small population size, low reproductive rate, feeding at high trophic levels in the food chain, Fixed migratory routes and habitat and localized and narrow range of distribution.

**Red Data Book of IUCN :**

- IUCN (International union for conservation of Nature and Natural Resources) or WCU (World conservation Union) maintains this book including a catalogue of threatened plants and animals facing risk of extinction.

**Threatened species (T):** They become extinct if they are not provided with proper habitat, food, protection.

- The IUCN 2000 Red list perform assessment of 18,000 species out of which 11096 species (5485 animals and 5611 plants) are on the threatened list world-wide. Out of these 925 animal species and 1014 plant species are critically endangered.

On the basis of distribution, decline in number of population, habitat and value of the species, Red list involves following 8 catagories.

**(i) Extinct (E or EX) :** A species / taxon is called extinct it is completely disappeared from all the parts of earth. e.g. Dodo, passenger pigeon.

**(ii) Extinct in Wild (EW) :** The species / taxon is disappeared from its natural habitats e.g. Ginkgo biloba. A number of domesticated animals and plant have become extinct in the wild.

**(iii) Critically Endangered (CR) :** It is facing very high risk of extinction in the wild and can become extinct any moment in the immediate future. e.g. Berberis nilghiriensis, Sus salvanius, Podopohyllum.

**(iv) Endangered (EN or E) :** Species / taxon is facing a high risk of extinction in the wild in the near future due to decrease in its habitat, excessive predation or poaching. e.g. Red Panda (Ailurus fulgens), Bentinckia nicobarica, Indian Aconite, Lion Tailed macaque, lemur idri idri of madagascar, Asiatic Wild Ass (Asinus hemionus khur now restricted to Rann of Kutch and Pakistan),Great Indian Bustard, Nepenthes.

**(v) Vulnerable (VU OR V) :** A Species / taxon bear sufficient population but is undergoing depletion due to some factors so that it is facing risk of extinction in medium term future. e.g. Anitlope cervicapra (Black Buck, Indian Gazelle), Cupressus cashmeriana.

**(vi) Lower Risk (LR) :** Near Threatened.

**(vii) Data deficient (DD) :**

**(viii) Not Evaluated (NE) :** Out of them, four categories of species (CR, E, V and LR) are included under threatened species (T).