BIODIVERSITY OR HETEROGENEITY

Biodiversity: The combined diversity at all the levels of biological organisation ranging from biomacromolecules to biomes is known as biodiversity or heterogeneity.

The term "Biodiversity" was popularised by a sociobiologist Edward Wilson.

Levels of Biodiversity

(i) Genetic diversity :

It includes diversity at the genetic level i.e., number and types of chromosomes, genes and their alleles in a species or another taxon.

Genetic diversity of a species might show high diversity over its distributional range e.g., the genetic variation shown by the medicinal plant *Rauwolfia vomitoria* growing in different Himalayan ranges might be in terms of the potency and concentration of Reserpine (an active chemical that the plant produces).

Rice → More than 50000 Strain

Mango → 1000 Varieties

(ii) Species diversity: The diversity at the species level (i.e., number and types of species in an area) can be represented by following terms

The Western Ghats have a greater amphibian species diversity than the Eastern Ghats.

(iii) Ecological diversity: It represents biodiversity at the level of communities

India, has a greater ecosystem diversity than scandinavian country Norway because India has a wide variety of ecosystems like deserts, rain forests, mangroves, coral reefs, wetlands, estuaries, and alpine meadows etc.

Species Diversity of the World

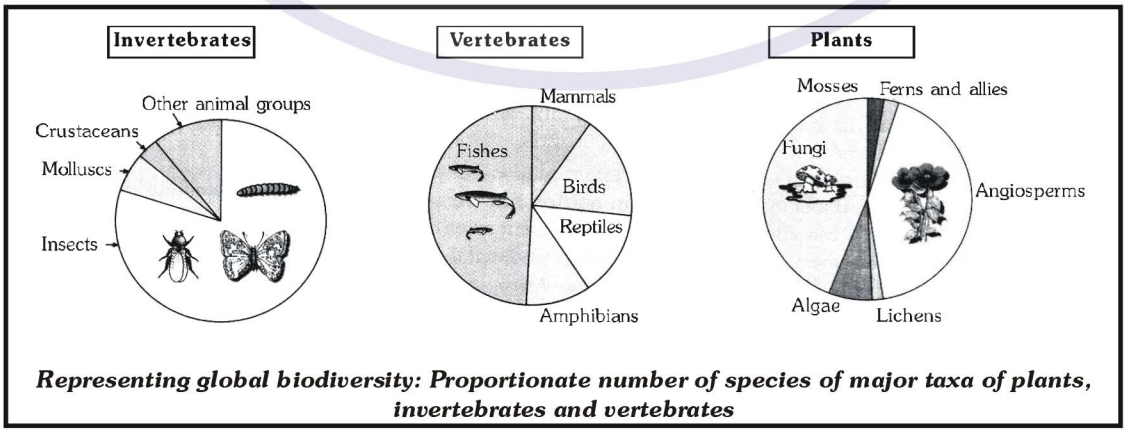
- According to the IUCN (2004), the total number of plant and animal species described so far is slightly more than 1.5 million, but we have no clear idea of how many species are yet to be discovered and described.

Estimates of Biodiversity:

(i) Species diversity of the world may ranges from 20 to 50 million.

(ii) According to Robert May it is about 7 million and it seems to be more conservative and scientific.

(iii) For many taxonomic groups, species inventories are more complete in temperate than in tropical coun tries. Considering that an overwhelmingly large proportion of the species waiting to be discovered are in the tropics.



Representing global biodiversity: Proportionate number of species of major taxa of plants, invertebrates and vertebrates

Data of Species diversity:

1. More than 70 per cent of all the species recorded are animals.
2. Among animals, insects are the most species-rich taxonomic group, making up more than 70 per cent of the total. That means, out of every 10 animals on this planet, 7 are insects.
3. The number of Fungi in the world is more than the combined total of the species of Fishes, Amphibians, Reptiles and Mammals.
4. Plants are not more than 22 per cent of the total species.

Species Diversity of India

- India is one of the 12 mega diversity countries of the world because it has only 2.4 per cent of the world's land area but its share of the global species diversity is an impressive 8.1 per cent.
- Nearly 45,000 species of plants and 90,000 species of animals have been recorded from India.
- If we accept Robert May's global estimates, only 22 per cent of the total species have been recorded so far. Applying this proportion to India's diversity figures, we estimate that there are probably more than 1,00,000 plant species and more than 3,00, 000 animal species yet to be discovered and described.

PATTERNS OF BIODIVERSITY

Latitudinal gradients :

(i) In general, species diversity decreases as we move away from the equator towards the poles.

(ii) With very few exceptions, tropics (latitudinal range of 23.5° N to 23.5° S) harbour more species than temperate or polar areas.

(iii) 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.

(iv) India, with much of its land area in the tropical latitudes, has more than 1,200 species of birds.

Species diversity of Tropics:

- 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.
- Biodiversity in Amazonian Rain forest

Group	Biodiversity
Plants	More than 40000
Fishes	3000
Birds	1300
Mammals	427
Amphibians	427
Reptiles	378
Invertebrates	More than 125000

- Scientists estimate that in these rain forests there might be at least two million insect species waiting to be discovered and named.
- Reason for higher biodiversity in tropics :

(a) Speciation is generally a function of time. Unlike temperate regions subjected to frequent glaciations in the past, tropical latitudes have remained relatively undisturbed for millions of years and thus, had a long evolutionary time for species diversification.

(b) Tropical environments, unlike temperate ones, are less seasonal, relatively more constant and predictable. Such constant environments promote niche specialisation and lead to a greater species diversity.

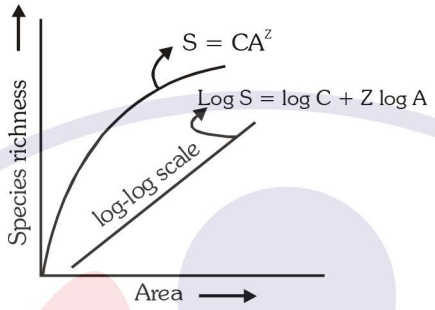
(c) There is more solar energy available in the tropics, which contributes to higher productivity; this in turn might contribute indirectly to greater diversity.

Species-Area relationships:

(i) Explain by German naturalist and geographer Alexander von Humboldt while working in the forests of South America.

(ii) Suggested that "within a region species richness increased with increasing explored area, but only up to a limit".

(iii) In fact, the relation between species richness and area for a wide variety of taxa turns out to be a rectangular hyperbola.



- On a logarithmic scale, the relationship is a straight line described by the equation

  log S = log C + Z log A where

  S = Species richness A= Area

  Z = slope of the line (regression coefficient)

  C = Y-intercept

- The value of Z lies in the range of 0.1 to 0.2, for the plants in Britain, birds in California or molluscs in New York state.
- But, for very large areas like the entire continents, the slope of the line is much steeper (Z values in the range of 0.6 to 1.2). For example, for frugivorous (fruit-eating) birds and mammals in the tropical forests of different continents, the slope is found to be 1.15.

THE IMPORTANCE OF SPECIES DIVERSITY TO THE ECOSYSTEM

(i) Communities with more species, generally, tend to be more stable than those with less species.

(ii) A stable community should not show too much variation in productivity from year to year.

(iii) 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.

- **Experiment by David Tilman:** David Tilman explained 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.
- **Rivet Popper Hypothesis:** It was proposed by Paul Ehrlich an ecologist of Stanford. In an aeroplane all parts are joined together using thousands of rivets.

Aeroplane	= Ecosystem
Removal or Popping of rivets	= Extinction of species
Flight safety	= Proper functioning of the ecosystem
Rivets on the wings	= Key species that drive major functions of the ecosystem.

LOSS OF BIODIVERSITY

- The IUCN Red List (2004) documents the extinction of 784 species (including 338 vertebrates, 359 inverte brates and 87 plants) in the last 500 years.
- The colonisation of tropical Pacific Islands by humans is said to have led to the extinction of more than 2,000 species of native birds.

- The last twenty years alone have witnessed the disappearance of 27 species.
- Some examples of recent extinctions include the Dodo (Mauritius), Quagga (Africa), Thylacine (Australia), Steller's Sea Cow (Russia) and three subspecies (Bali, Javan, Caspian) of Tiger.
- Extinctions across taxa are not random; some groups like Amphibians appear to be more vulnerable to extinction.
- More than 15,500 species world-wide are facing the threat of extinction.
- Presently, 12 per cent of all bird species, 23 per cent of all mammal species, 32 per cent of all amphibian species and 31per cent of all gymnosperm species in the world are facing the threat of extinction.
- In general, loss of biodiversity in a region may leads to

  (a) Decline in plant production,

  (b) Lowered resistance to environmental perturbations such as drought

  (c) Increased variability in certain ecosystem processes such as plant productivity, water use, and pest and disease cycles.

Causes of Biodiversity Loss

Following are the four major causes of loss of biodiversity which are collectively known as "The Evil Quartet "–

(a) **Habitat loss and fragmentation**

(i) This is the most important cause driving animals and plants to extinction.

(ii) The most dramatic examples of habitat loss come from tropical rain forests. Once covering more than 14 per cent of the earth's land surface, these rain forests now cover no more than 6 per cent. They are being destroyed fast. 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 conversion to grasslands for raising beef cattle.

(b) **Over-exploitation**

(i) Many species extinctions in the last 500 years (Steller's Sea Cow, Passenger Pigeon, Dodo, three sub species of Tiger etc.) were due to overexploitation by humans.

(ii) Presently many marine fish populations around the world are over harvested, endangering the continued existence of some commercially important species.

(c) **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. Some important examples are given below–

(i) Water Hyacinth (*Eichhornia crassipes*) was introduced in Indian waters to reduce pollution. It has clogged water bodies including wetlands at many places resulting in death of several aquatic plants and animals.

(ii) Nile Perch (a predator fish) was introduced in lake Victoria of South Africa. It killed and eliminated ecologically unique assemblage of over 200 native species of small Cichlid Fish.

(iii) *Lantana camara* has replaced many species in forests of U.P. and M.P.

(iv) *Parthenium hysterophorus* has pushed out several herbs and shrubs from open places in the plains.

(v) African Catfish, *Clarias gariepinus*, has been illegally introduced for aquaculture in India. It is threatening native Catfishes (e.g., *Clarias bacterachus*) of Indian rivers.

(d) **Co-extinctions**

When a species becomes extinct, the plant and animal species associated with it in an obligatory way also become extinct. When a host fish species becomes extinct, its unique 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.

BIODIVERSITY CONSERVATION

Methods of biodiversity conservation

(A) ***ex-situ* conservation:** In this approach, threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care.

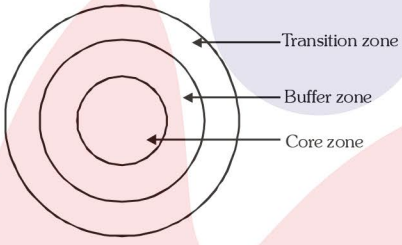
ex- Zoological parks, botanical gardens, wildlife safari parks, gene banks, germ plasm bank, seed bank and cryopreservation.

(B) ***in-situ* conservation**: is the protection of species (wild life) in their natural habitat by making their habitats protected areas for example– National parks, Sanctuaries, Biosphere Reserves etc.

National Park : Cultivation, grazing, forestry and habitat manipulation are not allowed. There are 90 national parks in India.

Sanctuaries : Collection of forest products, harvesting of timber, private ownership of land, tilling of land, etc. are allowed.There are 515 wildlife sanctuaries in India.

Biosphere Reserves: India now has 17 biosphere reserves.



Hot Spots : Norman Myers developed the hot spot concept in 1988. This is a mega diversity zone, where large number of species are found. It is an area of the richest and the most threat ened reservoirs of plant and animal life on the earth. Initially 25 biodiversity hot spots were identified in world, now number of biodiversity hot spot in the world are 34, out of these 3 hotspots are found in India–

(1) Western Ghats and Sri Lanka, (2) Indo-Burma (3) The Himalayas

- The key criteria for determining a hot spot are
  (i) Number of endemic species
  (ii) Degree of threat to Habitat
  (iii) High Species Richness
- Although all the biodiversity hotspots put together cover less than 2 percent (approximately 1.4%) of the earth's land area, the number of species they collectively harbour is extremely high and strict protection of these hotspots could reduce the ongoing mass extinctions by almost 30 per cent.

India has also a history of religious and cultural traditions that emphasised protection of nature. In many cultures, tracts of forest were set aside, and all the trees and wildlife within were venerated and given total protection. Such sacred groves are found in Khasi and Jaintia Hills in Meghalaya, Aravalli Hills of Rajasthan, Western Ghat regions of Karnataka and Maharashtra and the Sarguja, Chanda and Bastar areas of Madhya Pradesh. In Meghalaya, the sacred groves are the last refuges for a large number of rare and threatened plants.

Efforts for Biodiversity conservation

Biodiversity knows no political boundaries and its conservation is therefore a collective responsibility of all nations. The historic Convention on Biological Diversity ('The Earth Summit') held in Rio de Janeiro in 1992, called upon all nations to take appropriate measures for conservation of biodiversity and sustainable utilisation of its benefits. In a follow-up, the World Summit on Sustainable Development held in 2002 in Johannesburg, South Africa, 190 countries pledged their commitment to achieve by 2010, a significant reduction in the current rate of biodiversity loss at global, regional and local levels.

RED DATA BOOK

This Book is maintained by the **IUCN** [International Union of Conservation of Nature and Natural Resources], which is now called World Conservation Union (WCU). Red data book or red list was initiated in 1963. Red list has following eight categories of species–

1. **Extinct**
2. **Extinct in Wild**
3. **Critically Endangered**
4. **Endangered**
5. **Vulnerable (Depleted Species)**
6. **Lower Risk**
7. **Data Deficiency**
8. **Not Evaluated**

Out of these, four categories of species are included under threatened species-- critically endangered, endangeed, vulnerable and lower risk species.