

BIODIVERSITY AND CONSERVATION



(1) INTRODUCTION

- The rich variety of living organisms with which we share this planet never ceases to astonish and fascinate us.
- There are more than 20,000 species of ants, 3,00,000 species of beetles, 28,000 species of fishes and nearly 20,000 species of orchids.

(3) HOW MANY SPECIES ARE THERE ON EARTH AND HOW MANY IN INDIA?

- According to IUCN (2004), the total number of plant and animal species described so far is slightly more than 1.5 million.
- For many taxonomic groups, species inventories are more complete in temperate than in tropical countries.
- Some extreme estimates range from 20 to 50 million, but a more conservative and scientifically sound estimate made by Robert May places the global species diversity at about 7 million.

Interesting Aspects of Earth's Biodiversity:

- a. More than 70 % of all species recorded are animals, while plants (including algae, fungi, bryophytes, gymnosperms and angiosperms) comprise no more than 22 % of the total.
 - b. Among animals, insects make more than 70 % of total, i.e., out of every 10 animals on this planet, 7 are insects.
 - c. Number of fungi species is more than fishes, amphibians, reptiles and mammals combined.
- Biologists are not sure about how many prokaryotic species there might be, as conventional taxonomic methods are not suitable for identifying microbial species and many are not culturable under laboratory conditions. Their diversity alone might run into millions.
 - Although, India has only 2.4 % of world's land area; its share of the global species diversity is an impressive 8.1 percent.
 - India is one of the 12 mega diversity countries of the world. Nearly 45,000 species of plants and twice as many of animals have been recorded from India.
 - If we accept May's global estimates, only 22 percent of the total species have been recorded so far, then, India has more than 1,00,000 plant species and 3,00,000 animal species yet to be discovered.

(2) BIODIVERSITY

- Immense diversity (or heterogeneity) exists not only at the species level but at all levels of biological organisation ranging from macromolecules within cells to biomes.
- The term 'Biodiversity' was popularised by the socio biologist Edward Wilson. The most important of them are

Genetic Diversity

- A single species might show high diversity at genetic level over its distributional range.
- E.g., Genetic variation shown by *Rauwolfia vomitoria* in different Himalayan ranges in potency and concentration of reserpine

Species Diversity

- Diversity at the species level
- E.g., Western ghats have a greater amphibian species diversity than Eastern ghats.

Ecological Diversity

- At the ecosystem level
- E.g., India with its deserts, rain forests, mangroves, coral reefs, wetlands, estuaries and alpine meadows has a greater ecosystem diversity than a Scandinavian country like Norway.
* India has more than 50,000 genetically different strains of rice, and 1,000 varieties of mango.

(4) PATTERNS OF BIODIVERSITY

A. Latitudinal gradients

- Species diversity decreases as we move from equator towards the poles.
- Tropics (23.5° N to 23.5° S) harbour more species than temperate or polar areas.

Eg., Colombia	Newyork	Greenland	India
Near Equator	41° N temperate	71° N poles	Tropics
1,400 bird species	105 bird species	56 bird species	1,200 bird species

- A forest in a tropical region like Equador has upto 10 times more vascular plants, as a forest of equal area in temperate mid west of USA.
- Scientists estimate that in the Amazon rain forests, there might be at least two million insect species waiting to be discovered and named.

Ecologists and Evolutionary biologists have proposed various hypotheses to explain greater biological diversity at the tropics.

- A.** Unlike temperate regions subjected to frequent glaciations in the past, tropical latitudes remained undisturbed, having long evolutionary time for species diversification.

LARGELY TROPICAL AMAZON RAIN FOREST IN SOUTH AMERICA- has greatest biodiversity on Earth.

- 40,000 species of plants
- 3,000 of fishes
- 1,300 of birds
- 427 of mammals.
- 427 of amphibians
- 378 of reptiles
- More than 1,25,000 invertebrates

- B.** Constant, less seasonal tropical environments promote niche specialisation and lead to greater species diversity.
- C.** More solar energy in tropics contributes to higher productivity and might contribute indirectly to greater diversity.

B. Species–Area Relationships (by German naturalist Alexander Von Humboldt)

- Species richness within a region increased with increasing explored area, but only up to a limit.
- The relation between species richness and area for a wide variety of taxa (angiosperms, birds, bats, freshwater fishes) is a rectangular hyperbola. On a logarithmic scale, it 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 regardless of region or taxa.
- The slope of the line is much steeper in very large areas like the entire continents. e.g., for frugivorous birds and mammals in tropical forests the slope is 1.15.

(5) IMPORTANCE OF SPECIES DIVERSITY TO THE ECOSYSTEM

- Communities with more species, tend to be more stable than those with less species. A stable community should not show too much variation in productivity from year to year; it must be resistant or resilient to occasional disturbances (natural or man-made) and it must also be resistant to invasions by alien species.
- David Tilman's long-term ecosystem experiments using outdoor plots show that plots with more species showed less year-to-year variation in total biomass and increased diversity contributed to higher productivity.
- Rich biodiversity is essential for ecosystem health and imperative for the very survival of human race on this planet.
- The 'Rivet Popper Hypothesis' of Stanford ecologist Paul Ehrlich, puts the importance of a species in proper perspective.

AIR PLANE	ECOSYSTEM
Rivets	Species
Rivet on the wings	Key species

- (i) Popping a rivet (causing a species to become extinct) may not affect flight safety (proper functioning of ecosystem) initially, but if more rivets are removed the plane will become dangerously weak.
- (ii) Loss of rivets on the wings (Key species, that drive major ecosystem functions) will be serious. So each species is important for the ecosystem

(6) LOSS OF BIODIVERSITY

- The colonisation of tropical pacific islands by humans led to extinction of more than 2,000 species of native birds. The IUCN red list (2004) documents extinction of 784 species (including 338 vertebrates, 359 invertebrates and 87 plants) in the last 500 yrs.
- The last 20 years alone witnessed disappearance of 27 species.
- Amphibians appear more vulnerable to extinction.
- 15,500 species world-wide are facing threat of extinction.
- There were five episodes of mass extinction of species in the past, before humans appeared.
- The 'Sixth Extinction' presently in progress is 100 to 1000 times faster than pre-human times and our activities are responsible for the faster rates.
- If the present trends continue, nearly half of all species on earth might be wiped out within the next 100 years.
- Loss of biodiversity in a region may lead to (a) decline in plant production, (b) lowered resistance to environmental perturbations like drought, and (c) Increased variability in plant productivity, water use and pest and disease cycles.

Recent Extinctions

1. Dodo	-	Mauritius
2. Quagga	-	Africa
3. Thylacine	-	Australia
4. Steller's sea cow	-	Russia
5. Three sub-species of tiger	-	Bali, Javan & Caspian

Species Facing Threat of Extinction in World

12 % Birds
23 % Mammals
32 % Amphibians
31 % Gymnosperms

**(7) CAUSES OF BIODIVERSITY LOSSES:
THE EVIL QUARTET IS THE SOBRIQUET USED TO DESCRIBE
THEM-FOUR MAJOR CAUSES**

Habitat Loss and Fragmentation

- Most important cause.
- Tropical rain forests once covered more than 14 % of earth's land, now it is just 6 %.
- Amazon rain forest (lungs of the planet), being cut for soyabeans cultivation and grasslands for raising beef cattle.
- Mammals and birds requiring large territories and animals with migratory habits are badly affected, leading to population declines.

Over-Exploitation

- When need turns to greed, there is over-exploitation.
- In the last 500 years steller's sea cow, passenger pigeon became extinct due to over-exploitation.
- Marine fish populations are over harvested, endangering commercially important species.

Alien Species invasions

- Nile perch introduced in Lake Victoria in East-Africa led to the extinction of 200 sps of Cichlid fish in the lake.
- Carrot grass (*Parthenium*), *Lantana* and water hyacinth (*Eichhornia*) are invasive weeds.
- African catfish *Clarias gariepinus* are posing threat to indigenous cat fishes.

Co-Extinctions

- Seen in obligatory associations.
- When a host species becomes extinct, its parasites meets the same fate.
- Co- evolved plant-pollinator mutualism is another example

(8) BIODIVERSITY CONSERVATION

Why should we conserve biodiversity?

Narrowly Utilitarian Arguments

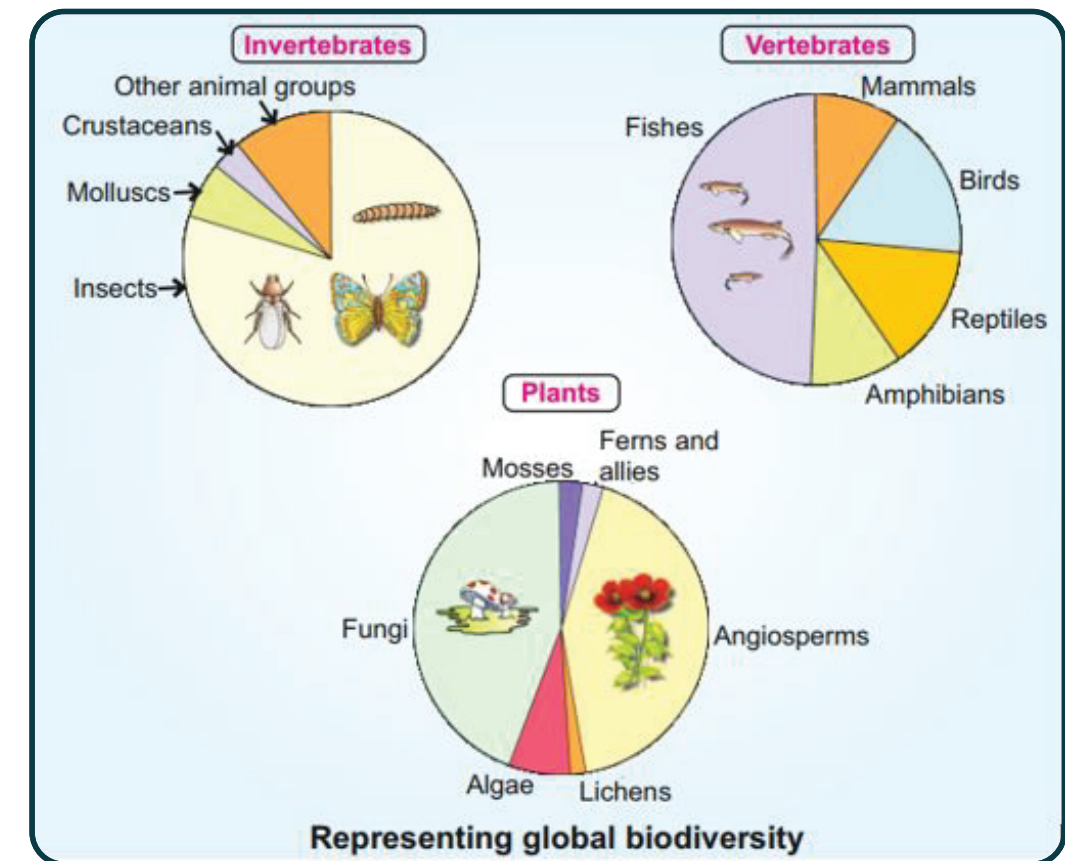
- Humans derive countless direct economic benefits from nature food, firewood, fibre, construction material, industrial products and medicinal products.
- More than 25 % drugs are derived from 25,000 species of plants.
- Nations endowed with rich biodiversity can reap enormous benefits by 'bioprospecting' exploring molecular, genetic and species level diversity for products of economic importance.

Broadly Utilitarian Arguments

- Biodiversity plays a major role in many ecosystem services that nature provides.
- Amazon rain forest produce approx 20 % of total oxygen of Earth's atmosphere by photosynthesis.
- Pollination by bees, bumble-bees, birds and bats.
- Aesthetic pleasures of walking through woods, watching spring flowers bloom, waking upto a bulbul's song etc.

Ethical Arguments

- Philosophically or spiritually we have to understand that each species has a intrinsic value.
- We have a moral duty to care for their well-being.
- We need to pass on our biological legacy in good order to future generations.



(9) HOW DO WE CONSERVE BIODIVERSITY?

When we conserve and protect whole ecosystem, i.e., saving the entire forest to save the tiger it is called in-situ (on site) conservation and organisms facing a very high risk of extinction in the wild, in near future, needs urgent measures to save it from extinction, then ex-situ (offsite) conservation is desirable.

In-situ Conservation

- **Biodiversity Hot Spots:** Regions with very high levels of species richness and high degree of endemism (species confined to a particular region & not found anywhere else).
Total number are 25 (initially) +9 (added later) = 34.
Three of these – western ghats and Sri Lanka, Indo-Burma & Himalaya – Cover our country's regions. They (all 34) cover less than 2 % of Earth's land area and their strict protection could reduce the ongoing mass extinctions by 30 %.
- 14 biosphere reserves, 90 National Parks and 448 wild life sanctuaries provide legal protection in India.
- Sacred groves in Khasi and Jaintia Hills of Meghalaya, Aravalli Hills (Rajasthan), Western Ghats, Sarguja, Chanda and Bastar regions (Madhya Pradesh) are the last refuges of rare and threatened plants.

Ex-situ Conservation

- Zoological Parks, Botanical gardens and wildlife Safari parks serve this purpose.
- Many animals have become extinct in the wild but are maintained in zoological parks.
- **Cryopreservation**- to protect and preserve gametes of threatened species in viable and fertile condition.
- Plants can be propagated using tissue culture methods.
- Seeds of different genetic strains, of commercially important plants can be kept for long periods in seed banks.

- The historic Convention on Biological diversity (The Earth Summit) was held in Rio de Janeiro (1992) for biodiversity conservation and sustainable utilisation of benefits.
- World summit on sustainable development (WSSD) held in 2002 in Johannesburg pledged for significant reduction in current rate of biodiversity loss at global, regional and local levels by 2010.
- If the present trend of species extinction continues nearly half of all species on Earth might be wiped out within the next 100 years.
- More than 1.5 m species have been recorded in the world but there might still be nearly 6 million species on earth waiting to be discovered and named.
- The group fungi has more species than all the vertebrate species combined.
- Earth's fossil history reveals incidence of five mass extinctions in the past, but the present rates of extinction, largely attributed to human activities, are 100 to 1000 times higher.
- Earth's rich biodiversity is vital for the survival of mankind.
- Nearly 700 species have become extinct in recent times and more than 15,500 species (of which > 650 are from India) currently face the threat of extinction.
- In many cultures, tracts of forests were set aside, and all the trees and wildlife within were venerated and given total protection, they are sacred groves.
- Biodiversity hot spots are the regions of accelerated habitat loss.