



মহাশিক্ষা বিভাগে ন্যায়বিচার (৫০৩)

DEPARTMENT OF EDUCATION (S)

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CHAPTER- 15: BIODIVERSITY AND CONSERVATION

BIODIVERSITY or BIOLOGICAL DIVERSITY: can be defined as the vast diversity of species and varieties of all the life forms existing on earth or it can be defined as the totality of genes, species and ecosystems of a given region.

- Diversity ranges from macromolecules to biomes.
- They include the species of micro-organisms, algae, fungi, plants, animals etc. occurring on the earth in various habitats and ecological complexes and niches of which they are a part.
- The term 'biodiversity' was popularized by the sociobiologist, Edward Wilson.

Magnitude of biodiversity: The three important diversity at all levels of biological organisation are

I) Genetic diversity: It refers to the total number of genes in the genetic make up of a species or it may be defined as the genetic variability or diversity within a species.

- Greater the genetic diversity among organisms of a species, more sustenance it has against environmental perturbations.
- It helps in speciation or evolution of new species.
- *Rauwolfia vomitoria* shows genetic variation which might be in terms of the potency and concentration of the active chemical (reserpine).
- India has more than 50,000 genetically different strains of rice and 1,000 varieties of mango.

II) Species diversity: It is diversity at the species level.

- It represents the number of different species found in a given community.
- Eg: the Western Ghats have greater amphibian species diversity than the Eastern Ghats.
- It is a measure of community complexity and is a function of both the number of different species in the community (**species richness**) and their abundances (**species evenness**).
- Larger number of species and more even abundances of species lead to higher species diversity which ensures natural sustainability for all life forms.



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III) Ecological diversity: It refers to the variety of ecosystems that are present in the biosphere.

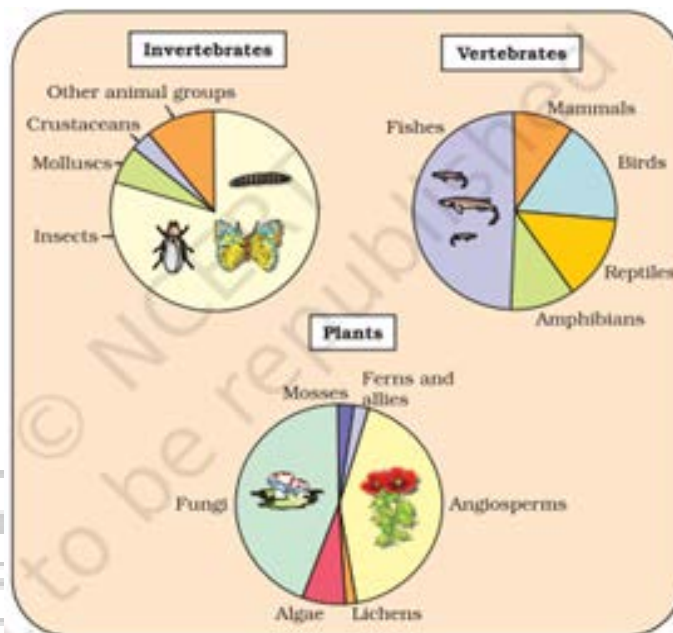
- Eg: India has greater ecosystem diversity than a Scandinavian country like Norway as India has several biomes like deserts, rain forests, mangroves, coral reefs, wetlands, estuaries and alpine meadows.
- Ecological diversity has three parts viz:
 - **Alpha (α) diversity** (within community diversity)
 - **Beta (β) diversity** (between community diversity) and
 - **Gamma (γ) diversity** (overall diversity of all communities)
- ❖ It has taken millions of years of evolution to accumulate this rich diversity in nature, but it could be lost in less than two centuries if the present rates of species losses continue.
- Biodiversity and its conservation are now vital environmental issues of international concern.

BIODIVERSITY ON EARTH

- According to the IUCN (2004), the total no. of plants and animal species described so far is slightly more than 1.5 millions but there are many more species yet to be discovered and described.
- 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.
- More than 70% of all the species recorded are animals while plants (including algae, fungi, bryophytes, gymnosperms and angiosperms) comprise no more than 22% of the total.
- Among animals, insects are the most species rich taxonomic group making up more than 70% of the total.
- The number of fungi species in the world is more than the combined total of the species of fishes, amphibians, reptiles and mammals.

These estimates do not give any figures for prokaryotes for the following reasons.

- Conventional taxonomic methods are not suitable for identifying microbial species.
- Many species are simply not culturable under laboratory conditions.
- Biochemical and molecular biology techniques would put their diversity into millions.



BIODIVERSITY IN INDIA

- India is one of the 12 mega diversity countries of the world.
- It is because it shares 8.1% of the global species diversity although it has 2.4% of the world's land area.
- India has recorded nearly 45,000 species of plants and twice as many species of animals.
- New species are yet to be discovered and named.
- According to may's global estimates, only 22% of the total species have been recorded so far and India has probably more than 1, 00,000 plant species and more than 3,00,000 animal species yet to be discovered and described.
- But a large fraction of these species faces the threat of becoming extinct even before we discover them.

PATTERNS OF BIODIVERSITY

- Biodiversity is not uniform throughout the world but varies with latitude and altitude.

Latitudinal gradients: In general, species diversity decreases from the equator towards the poles.

- The tropics harbour more species than temperate and polar areas.



- Eg: Colombia located near equator has nearly 1,400 species of birds while New York at 41° N has 105 sps. and Greenland at 71° N only 56 sps.
- India with much of its land area in the tropical latitudes has more than 1,200 species of birds.
- The number of species of vascular plants in a tropical forest like Equador has upto 10 times more species than that of any temperate forest like the Midwest of the USA.
- The tropical Amazonian rain forest in South America has the greatest biodiversity on earth.
 - It is home to more than 40,000 species of plants, 3,000 fishes, 1,300 of birds, 427 of mammals, 427 of amphibians, 378 of reptiles and of more than 1,25,000 invertebrates and at least 2million insect species waiting to be discovered and named.

Some important hypotheses that might account for the greater biological diversity of the tropics.

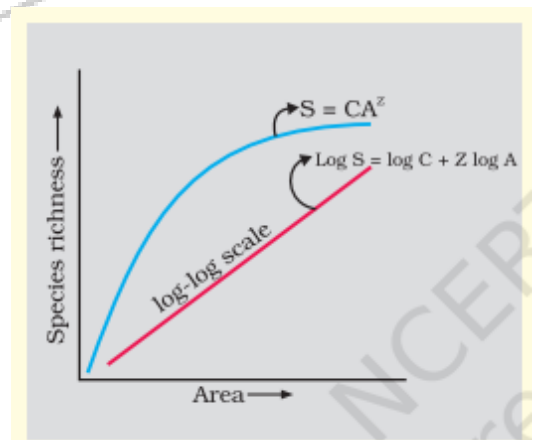
a) Speciation is generally a function of time, unlike temperate regions subjected to frequent glaciations in the past, tropical latitudes have remained relatively undisturbed for millions of years and thus had a long evolutionary time for diversification.

b) Tropical environment unlike temperate ones are less seasonal and more constant and predictable which promote niche specialization and lead to a greater species diversity.

c) There is more solar energy available in the tropics which contribute indirectly to greater diversity.

Species- Area relationships

- German naturalist and geographer, Alexander Von Humboldt during his explorations in the wilderness of South American jungles observed that within a region, species richness increased with increasing explored area, but only upto a certain limit.
- The relationship between species richness and area turns out to be a rectangular hyperbola for a wide variety of taxa viz.





angiospermic plants, birds, bats, freshwater fishes etc (Fig2).

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

$$\text{Log } S = \log C + Z \log A$$

Where, S = species richness

C = Y intercept

Z = slope of the line/regression
coefficient

A = Area

- Ecologists have discovered that the value of Z lies in the range of 0.1 to 0.2 regardless of taxonomic group or the region, i.e., the slopes of the regression line are amazingly similar.
- **Regression coefficient, Z** is generally 0.1-0.2 regardless of taxonomic group or the regions.
E.g., plants in Britain, birds in California or molluscs in New York state.
- However, when the species-area relationship is considered for a very large area like the entire continents, regression coefficient Z, comes to have values in the range of 0.6-1.2 i.e., the slope of line is found to be much steeper.
- E.g., frugivorous birds and mammals of tropical forests of different continents, the slope is found to be 1.15.
- (*Steeper slope signifies that number of species found increases faster than the area explored in very large areas like the entire continent).

The Importance of Species Diversity to the Ecosystem :

- Ecologists believed that communities with more species generally tend to be more stable than those with less species.
- **Attributes of a stable community –**
 - It 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.
- How these attributes are linked to species richness in a community was shown by David Tilman by his long-term ecosystem experiments.
 - He found that plots with more species showed less year-to-year variation in total biomass.
 - Increased diversity contributed to higher productivity.



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- Hence, we realize that rich biodiversity is not only essential for ecosystem health but imperative for the very survival of the human race on this planet.

RIVET-POPPER HYPOTHESIS :

- Proposed by Paul Ehrlich, the hypothesis suggests the importance of species richness in the maintenance of the ecosystem.
- The hypothesis uses the analogy of rivets in an airplane to compare the increasingly critical effect that the loss of each species will have on the function of an ecosystem.
- The hypothesis explains the ecosystem to be an airplane and the species to be the rivets joining all parts together.
- If every passenger travelling in the airplane start taking rivets home (causing a species to become extinct), initially it may not affect flight safety (proper functioning of ecosystem).
- But over a period of time, the plane becomes weak and dangerous (species become endangered and the ecosystem will ultimately collapse).
- Furthermore, loss of rivets on the wings may also be critical and is obviously a more serious threat to flight safety than loss of other rivets (key species that drive major ecosystem functions).

LOSS OF BIODIVERSITY

- The biological wealth of our planet has been declining rapidly mostly due to anthropogenic disturbances.
- The colonization of tropical Pacific Islands by humans is said to have led to the extinction of more than 2,000 species of native birds.
- **The IUCN Red List (2004)** documents the extinction of 784 species.(including 338 vertebrates, 359 invertebrates and 87 plants) in the last 500 years.
- Some examples of recent extinctions include the Dodo (Mauritius), Quagga (Africa), Thylacine (Australia), Steller's Sea Cow (Russia) and three sub-species (Bali, Javan, Caspian) of tiger.
- The last twenty years alone have witnessed the disappearance of 27 species.
- Some groups like amphibians appear to be more vulnerable to extinction.
- More than 15,500 species worldwide are facing the threat of extinction.
- Presently, 12% of all bird species, 23% of all mammal species, 32% of all amphibian species and 31% of all gymnosperm species in the world face the threat of extinction.



- The current species extinction rates are estimated to be 100 to 1000 times faster than in the pre-human times and if the present trends continue, nearly half of all the species on earth might be wiped out within the next 400 years.
- In general, loss of biodiversity in a region may lead to
 - (a) decline in plant production.
 - (b) lowered resistance to environmental perturbations such as draught and
 - (c) increased variability in certain ecosystem processes such as plant productivity, water use and pest and disease cycles.

CAUSES OF BIODIVERSITY LOSSES

- The accelerated rates of species extinctions that the world is facing now are largely due to human activities.
- There are 4 (four) major causes (“The Evil Quartet”):
 - **(i) Habitat loss and fragmentation:**
 - Destruction of habitat is the primary cause of extinction of species.
 - The tropical rainforests initially covered 14% of land but now cover no more than 6%.
 - The Amazon rainforest (called lungs of the planet because of its huge size) harbouring probably millions of species is being cut and cleared for cultivating soya beans or for conversion of grasslands for raising beef cattle.
 - Besides, pollution also threatens the survival of many species.
 - When large habitats are fragmented due to human activities, mammals and birds requiring large territories and certain animals with migratory habits are badly affected, leading to population declines.
 - **(ii) Over-exploitation:**
 - Humans have always depended on nature but when “need” turns to “greed”, it leads to over-exploitation of natural resources.
 - E.g., Steller’s Sea Cow, passenger pigeon. Present marine fish harvesting is endangering the continued existence of some commercially important species.
 - **(iii) Alien Species Invasions:**
 - Introduction of alien species sometimes some of them turn invasive, and cause decline or extinction of indigenous species.



- The Nile Perch (a predator fish) 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 the lake.
- Invasive weed species like carrot grass (*Parthenium*), *Lantana* and water hyacinth (*Eicchornia*) damaged our environment and posed threat to our native species.
- Illegal introduction of the African 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.
 - E.g., when a host fish species becomes extinct, its unique assemblage of parasites also meets the same fate.
 - A co-evolved plant-pollinator mutualism where extinction of one invariably leads to the extinction of the other.

BIODIVERSITY CONSERVATION

- Reasons for conservation of biodiversity can be grouped into three categories

1. Narrowly utilitarian

- Human derive countless direct economic benefits from nature.
- Food (cereals, pulses, fruits), firewood, fibre, construction material, Industrial products of medicinal importance.
- More than 25% of the drugs are derived from plants and more than 25,000 species of plants are used by natives for traditional medicines while many more plants in tropical rain forests are waiting to be explored.
- With increasing resources put into 'bioprospecting' nations endowed with rich biodiversity can expect to reap enormous benefits.
- Bioprospecting- process of exploring molecular, genetic and species level-diversity for products of economic importance.

2. Broadly utilitarian

- Biodiversity plays an important role in maintaining and sustaining supply of foods and services.
- Amazon forests contribute 20% of the total Oxygen in the earth's atmosphere.



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- Pollination is another service, ecosystems provide through pollinators layer-bees, bumblebees, birds, bats etc.
- Other intangible benefits that we derive from nature includes the aesthetic pleasures of walking through thick woods, watching spring flowers in full bloom or waking upto a bulbul's song in the morning.

3. Ethical

- Conservation of biodiversity is important because we owe to millions of plants, animals and microbe species for the benefits we derived from them for our existence.
- Philosophically or spiritually, we need to realise that every species has an intrinsic value, even if it may not be of current or any economic value to us.
- We have a moral duty to care for their well-being and pass on our biological legacy in good order to future generations.

CONSERVATION OF BIODIVERSITY

- Two basic approaches towards conservation of biodiversity are

1) In situ conservation: When we conserve and protect the whole ecosystem, its biodiversity at all levels is protected. This approach is called in sites (on site) conservation.

-- Eg: We save the entire forest to save the tiger.

- Eminent conservationists address the problem of conflict between development and conservation and the number of species waiting to be saved from extinction exceeding the conservation resources by identifying 'biodiversity hotspots' regions for maximum protection.
- **'Biodiversity hotspots'** – are regions with very high levels of species richness and high degree of endemism. They are also regions of accelerated habitat loss.
- **Endemism**- species confined to that region and not found anywhere else.
- Initially 25 biodiversity hotspots were identified but now the number has increased to 34 after subsequent addition of 9 more to the list.
- **Three hotspots** cover our country's exceptionally high biodiversity regions.
 - 1) Western Ghats and Sri Lanka
 - 2) Indo-Burma and
 - 3) Himalaya
- Although all the biodiversity hotspots cover less than 2% of the earth's land area, the number of species they collectively harbour is extremely high.



- Therefore strict protection of these hotspots could reduce the on-going mass extinctions by almost 30 percent.
- In India, ecologically unique and biodiversity- rich regions are legally protected as
 - a) **Biosphere reserves** (now 14 in number)
 - b) **National parks** (90) and
 - c) **Sanctuaries** (448)
- India has also a history of religions and cultural traditions that emphasised protection of nature viz sacred groves.
- **Sacred groves:** In many cultures, tracts of forest were set aside, and all the trees and wildlife within were venerated and given total protection.
- They are found in Khasi and Jaintia Hills in Meghalaya (last refuges for a large no. of rare and threatened plants), Aravalli Hills of Rajasthan, Western Ghats regions of Karnataka and Maharastra. Sarguja, Chanda and Bastar areas of Madhya Pradesh.

2) Ex situ conservation: In this method, threatened animals and plants are taken out from their natural habitat and placed in special settings where they can be protected and given special care.

- Eg: Zoological parks, botanical gardens and wildlife safari parks.
- Now gametes of threatened species can be preserved in viable and fertile condition for long periods using cryopreservation techniques.
- Eggs can be fertilized in vitro, and 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”)** held in Rio de Janeiro in 1992, called upon all nations to take appropriate measures for conservation of biodiversity and sustainable utilization of its benefits.
- **The World Summit on sustainable development** held in 2002 in Johannesburg, South Africa
 - In this Summit, 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.