CHAPTER-13

BIODIVERSITY AND ITS CONSERVATION

Topic-1

Biodiversity and its Patterns

Concepts Covered ● *Biodiversity, different levels of biodiversity, importance of biodiversity, causes of biodiversity loss.*

📝 Revision Notes

➤ **Biodiversity :** It is the diversity (or heterogeneity) of biological organisation ranging from cellular macromolecules to biomes.

➤ **Edward Wilson :** Popularized the term 'biodiversity' to describe the combined diversity at all levels of biological organization.

➤ **Levels of Biodiversity**
  ● Biodiversity has been divided into three hierarchical levels of biological organization.
  1. Genetic diversity
   (a) Diversity shown by a single species at the genetic level. e.g., *Rauwolfia vomitoria* in Himalaya shows genetic variation in the potency and concentration of the chemical, reserpine.
   (b) India has more than 50,000 different strains of rice and 1,000 varieties of mango.
  2. Species diversity
   Diversity at the species level. e.g., Western Ghats have greater amphibian species than the Eastern Ghats.
  3. Ecological diversity
   Diversity at ecosystem level. For e.g., In India, deserts, rain forests, mangroves, coral reefs, wetlands, estuaries & alpine meadows, all can be seen, whereas the Scandinavian countries (like, Norway, Sweden) have less ecological diversity.

➤ **Number of Species on Earth (Global Species Diversity)**
  ● According to IUCN or International Union for Conservation of Nature & Natural Resources (2004) more than 1.5 million species have been described so far.

  ● According to Robert May, the global estimate is about 7 million (considering the species are to be discovered in the tropics. i.e., only 22% of the total species have been recorded so far).
  ● Animals are more diverse (above 70%) than Plants including plantae and fungi (22%).
  ● Most species-rich taxonomic group among animals are : Insects (70%, i.e., out of every 10 animals, 7 are insects).
  ● Number of fungal species is more than the combined total of the species of fishes, amphibians, reptiles and mammals.
  ● Biologists are not sure about total number of prokaryotic species because :
   (a) Conventional taxonomic methods are not suitable for identifying microbial species.
   (b) Many species are not culturable under laboratory conditions.
  ● India has only 2.4% of the world's land area, but has 8.1% of the species diversity.
  ● 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.
  ● Applying May's global estimate, India would have more than 1 lakh plant species and 3 lakh animal species.

➤ **Patterns of Biodiversity**
  ● Biodiversity is not uniform throughout the world. It varies with the change in latitude and altitude, it is affected by latitudinal gradients and species-area relationship. Following are the main patterns of biodiversity.
  (a) Latitudinal Gradients
  ● Species diversity decreases from the equator to the poles.
  ● Tropics (latitudinal range of 23.5° N to 23.5° S) have more species than temperate or polar areas.
   (i) Colombia (near equator) has about 1400 species of birds.
   (ii) New York (41° N) : 105 species of birds
   (iii) Greenland (71° N) : 56 species of birds
   (iv) India (tropical latitudes) : > 1200 species
  ● Tropical forest region like Ecuador has up to 10 times species of vascular plants as compared to a forest of equal area in a temperate region like the Midwest of USA.

📑 Key Facts

• The current observed extinction rate is 2.6 vertebrate species per 10,000 yearly.
• About one million plant and animal species are facing the threat of extinction.

  ● Tropical Amazonian rain forest (South America) has the greatest biodiversity on earth. It contains :
   (i) 40,000 species of plants
   (ii) 3,000 species of fish
   (iii) 1,300 species of birds
   (iv) 427 species of mammals
   (v) 427 species of amphibians
   (vi) 378 species of reptiles
   (vii) 1,25,000 species of invertebrates
  ● Biodiversity (species richness) is highest in tropics because
   (i) Tropics had more evolutionary time.
   (ii) Relatively constant environment (less seasonal).
   (iii) They receive more solar energy which contributes to greater productivity.
  (b) Species - Area Relationship
  ● According to the study of Alexander von Humboldt (German naturalist & geographer) in South American jungles, within a region, species richness increases with an increase in explored area, but only up to a limit.

- Relation between species richness and area for a wide variety of taxa (like, angiospermic plants, birds, freshwater fishes) gives a rectangular hyperbola.
- On a logarithmic scale, the relationship is a straight line or linear, described by the equation :
  $log\ S = log\ C + Z\ log\ A$
  where, S = Species richness, A = Area, C = Y-intercept, Z = slope of the line (regression co-efficient)
- The value of Z lies in the range of 0.1 to 0.2.
- In the species-area relationship among the large areas like entire continents, the slope of the line is steeper (Z value : 0.6 to 1.2). e.g., for frugivorous birds and mammals in the tropical forests of different continents, the slope is 1.15.

➤ **Importance of Species Diversity to the Ecosystem**
- For many decades, ecologists believed that communities with more species, generally, tend to be more stable than those with fewer species.
- 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.
- **David 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.
- A rich biodiversity is not only essential for ecosystem health but imperative for the survival of the human race on this planet.
- Stanford ecologist **Paul Ehrlich** explained the effect of loss of species through his 'rivet popper hypothesis'.

➤ **Loss of Biodiversity**
- IUCN Red List (2004) says that 784 species (338 vertebrates, 359 invertebrates and 87 plants) became **extinct** in the last 500 years. e.g., Dodo (Mauritius), Quagga (Africa), Thylacine (Australia), Stellar's sea cow (Russia) and 3 subspecies (Bali, Javan, Caspian) of the tiger.
- 27 species have disappeared in the last 20 years.
- The extinctions across taxa are not random. Some groups (like amphibians) appear to be more vulnerable to extinction.

🔑 Key Words

Biodiversity : It includes all different life forms in one given area, from humans to organism like microbes, fungi and invertebrates.

Extinct : The species which no more exist on the Earth.

- More than 15,500 species are facing the threat of extinction.
- 12% birds, 23% mammals, 32% amphibians, 31% gymnosperm species face the threat of extinction.
- On earth, there have been five mass extinctions of species and at present 'Sixth Extinction' is in progress.
- The current extinction rate is 100 - 1000 times faster than in pre-human times. If this trend continues, nearly 50% species might be extinct within the next 100 years.

➤ **Impacts of Loss of Biodiversity**
(a) Decline in plant production.
(b) Lowered resistance to some environmental perturbations such as drought.
(c) Increased variability in ecosystem processes such as plant productivity, water use and pest and disease cycles.

🔑 Key Words

Alien species : A species which is introduced outside its natural part or present distribution. It includes any part such as gametes, seeds, eggs, etc., which might survive and subsequently reproduce.

Aquaculture : It is a controlled cultivation of aquatic organisms such as fish, algae, etc.

➤ **Causes of Biodiversity Losses ('The Evil Quartet')**
- "The Evil Quartet" is the phrase coined by Jared Diamond to describe the four human induced causes of extinction.

(a) **Habitat Loss and Fragmentation**
- It is the most important cause. For e.g., Tropical rain forests (loss from 14% to 6%).
- Thousands of hectares of rain forests are being lost within hours.
- The Amazon rain forest ('lungs of the planet') is being cut for cultivating soya beans or for the conversion of grasslands for cattle.

- 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 decline.

(b) Over-exploitation

- The dependence of humans on nature for food and shelter led to the over-exploitation of natural resources.
- **Example :** Many species like Stellar's sea cow, Passenger pigeon, etc, became extinct due to over-exploitation.
- 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, some of them turn invasive, and cause the decline or extinction of indigenous species.
- These alien species cause decline or extinction of indigenous species.
- Example : **(a)** The Nile Perch introduced in Lake Victoria (East Africa) caused extinction of more than 200 species of cichlid fish.
  (b) Invasive weed species like carrot grass (*Parthenium*), *Lantana* and water hyacinth (*Eichhornia*) caused damage to our native species.
  (c) The illegal introduction of the African Catfish (*Clarias gariepinus*) for **aquaculture** is posing a threat to the indigenous catfish (*Clarias batrachus*) in our rivers.

(d) Co-extinction

- When a species becomes extinct, the plant and animal species associated with it also become extinct.
- **Example :**
  (a) Extinction of the parasites takes place when the host is extinct.
  (b) In co-evolved plant-pollinator mutualism extinction of one leads to the extinction of the other.

Mnemonics

Concept: Components of Biodiversity
Mnemonic: Grand **S**chool **E**xhibition
Interpretation: **G**enetic diversity, **S**pecies diversity, **E**cological diversity

Example

Q. Mention the kind of biodiversity of more than a thousand varieties of mangoes in India represent. How is it possible.

Sol. More than a thousand varieties of mangoes in India represent the genetic diversity. It is because :

(i) a single species show high diversity at genetic level over its distributional range.
(ii) different varieties grow in different geographical regions and climatic condition. This is also possible because of breeding and mutations.

Topic-2 Conservation of Biodiversity

Concepts Covered ● *Conservation processes, Types of Conservation*

Revision Notes

Conservation Processes

► **There are three main reasons for conserving the biodiversity which are categorized as follows :**
   (a) Narrowly Utilitarian Arguments
   - Humans derive economic benefits from nature such as food, firewood, fibre, construction material, industrial products (tannins, lubricants, dyes, resins, perfumes) and medicines.
   - More than 25% of the drugs are derived from plants.
   - 25,000 species of plants have medicinal value.

- Exploring molecular, genetic and species-level diversity for i.e., 'bioprospecting' products of economic importance may enormously benefit nations with rich biodiversity.

(b) Broadly Utilitarian Arguments
- Biodiversity has many ecosystem services.
- Amazon forest produces 20% of total O_2 in the earth's atmosphere by the process of photosynthesis.
- Pollination service takes place through bees, bumblebees, birds and bats.
- Aesthetic pleasures such as walking through thick woods, watching spring flowers in full bloom or waking by hearing a bulbul's song in the morning.
- Other indirect benefits are pest control, climate moderation and flood control.

(c) Ethical Arguments
- Every species has an intrinsic value.
- We have a moral duty to take care for their well-being.

📖 Key Facts

- Species density is greater in the Southern Hemisphere.
- The entire Hindu- Kush Himalayan belt has around 25,000 plant species, comprising 10 per cent of the world's flora.

➤ **Conservation of Biodiversity**

Types of Conservation

(a) *In situ* conservation (on site)
- It is the conservation of genetic resources within natural or human-made ecosystems in which they occur.
- Examples: Protected areas such as National Parks, Sanctuaries, Biosphere reserves, cultural landscapes, national monuments.

(i) National Park
- Strictly reserved for the welfare of the wildlife where private ownership, cultivation, grazing, etc., are prohibited.
- There are 90 national parks in India.

(ii) Sanctuary
- Here, protection is given only to the animals.
- Collection of timbers, minor forest products and private ownership are allowed so long as they do not harm the animals.
- There are 553 wildlife sanctuaries in India.

(iii) Biosphere Reserves
- Areas of land or coastal environments to conserve the ecosystem and genetic resources contained therein.
- There are 18 biosphere reserves in India.

(iv) Sacred Forests (Sacred Groves)
- Sacred groves are highly protected forests because of religious and cultural traditions.
- Sacred groves in Khasi and Jaintia Hills in Meghalaya.
- Aravalli Hills of Rajasthan.
- Western Ghat regions of Karnataka & Maharashtra.
- 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.

(v) Hotspots
- These are the richest and the most threatened reservoirs of plant and animal life on earth.
- There are 36 hotspots in the world.
- In total, all the biodiversity hotspots cover less than 2% of the earth's land area but could reduce the ongoing extinctions by almost 30%.
- Three main hotspots (Western Ghats and Sri Lanka, Indo-Burma and Himalaya) cover India's biodiversity regions.

(b) *Ex situ* conservation (off site)
- It is the conservation of organisms outside their habitats.
- In this approach, threatened animals and plants are taken out from their natural habitat and placed in a special setting where they can be protected and given special care. For e.g., genetic resource centres, zoological parks, botanical gardens, gene banks etc.

- In recent years, *ex-situ* conservation has advanced by preserving the gametes of threatened species in viable and fertile condition for long periods using **cryopreservation** techniques, eggs can be fertilised *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.

🔑 Key Words

Hot spots : It is a biogeographic region which serve as significant reservoir of biodiversity but they are threatened due to degradation, illegal logging, etc.

Cryopreservation : The process of preserving cells, tissues, organs at very low or freezing temperatures.

Tissue culture : Growing cells and tissues in an artificial medium.

Sustainable development: Development meets the needs of the present generation without compromising the ability of future generation.

➤ **International Efforts for Conserving Biodiversity**
- **The Earth Summit (Rio de Janeiro, 1992) - Three objectives :**
  (a) Conservation of biodiversity
  (b) Sustainable use of biodiversity
  (c) Sharing of benefits in the utilization of genetic resources.
- The World Summit on **Sustainable Development** (Johannesburg, South Africa, 2002) : 190 countries pledged to reduce the current rate of biodiversity loss.

🧠 Mnemonics

Concept: Conservation of Biodiversity (*In-situ* conservation)

Mnemonic: National **S**ervice **B**est **S**ervice **H**ai

Interpretation: National park**,** Sanctuary**,** Biosphere reserve**,** Sacred forest**,** Hotspots

❏❏