

## **Biodiversity and Conservation**

### **Biodiversity**

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.

Biodiversity is the term popularized by the sociobiologist **Edward Wilson** to describe the combined diversity at all the levels of biological organization

**Biodiversity can be described as the sum total of genes, species and ecosystem of a region**

#### **(i) Genetic diversity**

A single species might show high diversity at the genetic level over its distributional range

Eg: 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 the active chemical (**reserpine**) that the plant produces.

- India has more than **50,000** genetically different strains of **rice**, and **1,000 varieties of mango**.

#### **(ii) Species diversity:**

The diversity at the species level.

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

#### **(iii) Ecological diversity:**

The diversity at the ecosystem level.

Eg: India has variety of ecosystem like deserts, rain forests, mangroves, coral reefs, wetlands, estuaries, and alpine meadows has a greater ecosystem diversity than a Scandinavian country like Norway.

### **How Many Species are there on Earth and How Many in India?**

According to the **IUCN (2004)**, the total number of plant and animal species described so far is slightly **more than 1.5 million**.

According to **Robert May** total the global species diversity is about **7 million**.

- More than **70 per cent** of all the species recorded are **animals**, while plants

Navas cheemadan

(including algae, fungi, bryophytes, gymnosperms and angiosperms) comprise no more than **22 per cent** of the total.

- Among animals, **insects** are the most species-rich taxonomic group, making up more than **70 per cent** of the total (**it means that, out of every 10 animals on this planet, 7 are insects.**)

- **The number of fungi species in the world is more than the combined total of the species of fishes, amphibians, reptiles and mammals.**

- **The number of fishes among vertebrates are more than total number of mammals, Birds, reptiles and Amphibians !**

- Biologists are not sure about how many prokaryotic species there might be India has only **2.4 per cent** of the world's land area, its share of the global species diversity is an impressive **8.1 per cent**. (This makes our country 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 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**

##### **(i) Latitudinal gradients:**

The diversity of plants and animals is not uniform throughout the world.

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.

➤ The largely 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 of fishes, 1,300 of birds, 427 of mammals, 427 of amphibians, 378 of reptiles and of more than 1,25,000 invertebrates. Scientists estimate that in these rain forests there might be at least **two million insect species waiting to be discovered and named !!!!**

### **Reason for the great diversity in the tropical regions**

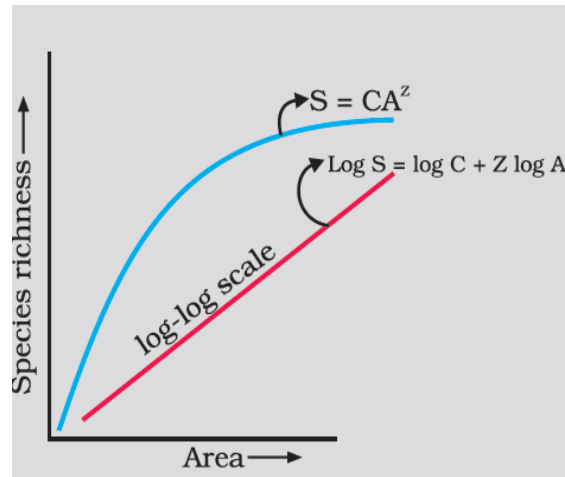
(1) Tropical regions have remained relatively undisturbed for millions of years and thus had a long time for species diversification.

(2) 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.

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

### **(ii) Species-Area relationships:**

According to German naturalist and geographer **Alexander Von Humboldt**, species richness increased with increasing explored area, but only up to a limit. The relationship between species richness and area for a wide variety of taxa (angiosperm plants, birds, bats, freshwater fishes) 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**

✓ Ecologists have discovered that the value of Z lies in the range of **0.1 to 0.2**, regardless of the taxonomic group or the region (whether it is the plants in Britain, birds in California or molluscs in New York state, the slopes of the regression line are amazingly similar)

✓ The species-area relationships among very large areas like the entire continents, you will find that the slope of the line to be 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**

■ A community with more species tend to be more stable than those with less stable.

■ A community which should not show too much variation in productivity from year to year called **Stable community**. **Such community are resistant to occasional disturbance ( natural or man made) and resistant to alien species invasion.**

**David Tilman** conducted some long term experiments using outdoor plots, explained that increased diversity contributed to higher productivity. Rich diversity and higher productivity are not

only essential for a healthy ecosystem but also important for the survival of human race

### ■ **RIVET POPPER HYPOTHESIS**

Proposed 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**

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 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 subspecies (Bali, Javan, Caspian) of tiger.**



- The last twenty years alone have witnessed the disappearance of 27 species
- more than **15,500 species** world-wide 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**.
- Loss of biodiversity in a region may lead 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 cycle.**

### **Causes of biodiversity losses:**

There are four major causes (**'The Evil Quartet'** is the sobriquet)

#### **(i) Habitat loss and fragmentation:**

This is the most important cause driving animals and plants to extinction. The most dramatic examples of habitat loss come from **tropical rain forests**. Once covering more than **14 % of the earth's land surface**, these rain forests now cover **not more than 6 %**. They are being destroyed fast. By the time you finish reading this Printout of zoology, **100 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 conversion to grasslands 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:**

Humans have always depended on nature for food and shelter, but when 'need' turns to 'greed' it leads to **over-exploitation of natural resources**.

Eg: Many species extinctions in the last 500 years (**Steller's sea cow, passenger pigeon**) were due to overexploitation by humans.

#### **(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.

**Eg 1: 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 the lake**.

**Eg 2:** the environmental damage caused and threat posed to our native species by invasive weed species like **carrot grass (Parthenium), Lantana and water hyacinth (Eicchornia)**.

**Eg 3:** The recent **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.**



**Eg 1:** When a host fish species becomes extinct, its unique assemblage of parasites also meets the same fate.

**Eg 2:** a coevolved plant-pollinator mutualism where extinction of one invariably leads to the extinction of the other.

## **BIODIVERSITY CONSERVATION**

### **Why Should We Conserve Biodiversity?**

The great biodiversity on Earth is vital for the existence of mankind. The reason for conserving biodiversity are the following

#### **a) Narrow Utilitarian**

The **narrowly utilitarian** arguments for conserving biodiversity are obvious; humans derive countless direct economic benefits from nature food (cereals, pulses, fruits), firewood, fibre, construction material, industrial products (tannins, lubricants, dyes, resins, perfumes ) and products of medicinal importance.

- More than **25 %** of the drugs currently sold in the market worldwide are derived from plants and **25,000** species of plants contribute to the traditional

medicines used by native peoples around the world.

- With increasing resources put into **'bioprospecting' (exploring molecular, genetic and species-level diversity for products of economic importance)**, nations endowed with rich biodiversity can expect to reap enormous benefits.

#### **b) Broadly utilitarian:**

The **broadly utilitarian** argument says that biodiversity plays a major role in many ecosystem services that nature provides. The fast- dwindling **Amazon forest (Lungs of Planet)** is estimated to produce, through photosynthesis, **20 per cent** of the total oxygen in the earth's atmosphere.

Pollination (without which plants cannot give fruits or seeds) is another service, ecosystems provide through pollinators layer - bees, bumblebees, birds and bats.

There are other intangible benefits - that we derive from nature-the aesthetic pleasures of walking through thick woods, watching spring flowers in full bloom or waking up to a bulbul's song in the morning etc give pleasure

#### **c) Ethical argument**

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.

### **How do we conserve Biodiversity?**

Conservation of biodiversity can be done by two ways

- a) In-situ conservation
- b) Ex-situ conservation

#### **a) In-situ (On site) conservation**

The conservation of genetic resources through their maintenance within natural or even human-made ecosystem in which they occur is called In-situ conservation.

Eg: National park, Sanctuaries, Biosphere reserves, Natural monuments, Hot spots, sacred grooves, cultural landscapes

- ✓ India has **14 biosphere reserves, 90 national parks and 448 wildlife sanctuaries.**

- ✓ **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

### **Hotspots:**

Scientists identified certain regions with very high level of species richness and high degree of **Endemism (species that is confined to that region and not found anywhere else)** to protect biodiversity. Hot spots are the richest and most threatened reservoirs of plants and animal life on earth.

- Initially 25 biodiversity hotspots were identified but subsequently nine more have been added to the list, bringing the total number of **biodiversity hotspots in the world to 34.** These hotspots are also regions of accelerated habitat loss.

- Three of these hotspots – **Western Ghats and Sri Lanka, Indo-Burma and Himalaya** – cover our country's exceptionally high biodiversity regions.

- Although all the biodiversity hotspots put together cover less than **2% 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.**

### **(b) Ex situ (off site) Conservation**

Conservation outside their habitat is called 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.

Eg : Cryopreservation, Zoological parks, botanical gardens and wildlife safari parks

### **Cryopreservation**

Storage of materials (Like seeds, gametes) at very low temperature is called cryopreservation.

Gametes of threatened species can be preserved in viable and fertile condition for long periods using cryopreservation techniques.

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.**

