# **BIODIVERSITY AND CONSERVATION**

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Why should be conserve Biodiversity?

Uses of Biodiversity :

(A) Narrowly utilitarian

(B) Broadly Utilitarian / Ecosystem Services

(C) Ethical / Aesthetic and Cultural Benifits

### (A)Narrowly utilitarian :

As source of food, medicin, pharmaceutical drugs, fibers, rubber and timber.

As source of food and improved varities. The biodiversity used in modern agriculture in three ways-

(a) As a source of new crops.

(b) As a source of material for breeding improved varieties.

(c) As a source of new biodegradable pesticides.

- Less than 20 plant species are cultivated to produce about 85% of world food. Wheat, Corn and Rice are three major carbohydrate crops yield nearly of food sustaning the human population.
- The commercialy domestiated species are cross breed with their wild relatives to improve their fruits.
- Genes of wild species are used to introduce new properties like disease resistance and high yield. for Example, rice grown in Asia is protected from four main disease by genes received from a single wild rice species (oryza nivara) from India.
- Drugs and Medicines Biodiversity is rich source of substance with medicinal value.
- Morphine From papaver sominiferum
- Quinine From Cinchona
- Taxol From bark of yew tree (Taxus brevifolia, T.baccata)
- 25% of drugs are derived from 120 species of plants.
- Botanochemicals Plant chemicals used in preparation of synthetic products.

#### (B) Broadly Utilitarian :

- Diversity is essental for the maintenance and sustainable utilization of goods and services of ecosystem or individual species. The ecosystem services are -
- Gaseous exchange Amazon forest is estimated to produce through photosynthesis. 20% of total oxygen of earth atmosphere. So these forest are considerd as "Lungs of Earth".
- Pollination by bees, bumblebees, birds, bats, ants and various insects.
- Climate control by forest and oceanic ecosystem (Hydrological Cycles)
- Natural pest control.
- Protection of soil.
- Conservation and purification of water.
- Nutrient cycling.
- These ecosystem services have been valued in range of 16 to 54 trillion  $(10^{12})$  (average 34 Trillion) US dollars per year. Robert Constanza and his colleagues recently tried to put price tag on nature's life support services, which is about 33 trillian US dollar on an average. Out of total cost of various ecosystem services the soil formation accounts for 50%, Recreation & nutrient cycling < 10%, Climate regulation 6%, Habitat for wild life 6%.

### (C) Ethical / Aesthetic and Cultural Benifits -

- Ecotourism.
- Bird Watching
- ✤ Wild life
- Pet keeping, Gardening.
- Cultural and religious beliefs like in India Ocimum Sactum (Tulsi), Ficus religiosa (Pipal), Prosopis Cineanaria (Khejri) and many more plants and animals like Rat (Lord Ganesha), Lion (Jai mata di), Owl (Laxmi ji), Swan (Saraswati ji), Peacock (Kartikaya ji) Snakes (Shiv Ji) are considered as scared and worshiped.
- The plants and animals are symbol of our cultural heritage and national pride.
- Philosophically and spiritually we need to realize that every species has an intrinsic value, even if it may not be of current or any economic value to us. It is our moral

duty to care for their well being and pass on our biological legacy in good order of future generation.

## How do we conserce biodiversity?

It involves two types of strategies

(1) In situ Conservation

(2) Ex situ Conservation

## In situ (on site) Conservation:

This type of conservation performs inside the natural habitat or man made ecosystems. Two alternate methods are being used to save biodiversity (i) Protected areas

(ii) Hot spots

(i) Protected areas: These areas are legally conserved for the protection & maintenance of biodiversity.

- World Conservation Monitoring Centre has recognised 37,000 protected areas worldwide.
- In 2005, (90) National parks (AIPMT-2015), (448) Wildlife sanctuaries, 14 Biosphere reserves were established in India and many sacred groves covering 4.7% land surface.

(a) National parks: These are larger areas maintained for scientific, educational and recreational use, They are not usually used for commercial extraction of resources. There are 100 national parks in India occupying nearly 1.1% of geographical area.

**(b) Wildlife sanctuaries:** These are tracts of land with or without lake where wild animals/fauna can take refuge without being hunted. Other activities like collection of forest products, harvesting of timber, private ownership of land, etc. are allowed. India has 551 sanctuaries occupying over 3.6% of geographical area (India 2005).

(c) Biosphere reserves: Under MAB (Man and Biosphere programme) of UNESCO, Biosphere reserves established in1975 (408 biosphere reserves established till may 2002).

 Biosphere Reserves (BR)are multipurpose protected areas of land / coastal environments which are meant for preserving genetic diversity in representative ecosystems of various natural biomes and unique biological communities by protecting wild populations, traditional life style of tribals and domesticated plant/animal genetic resources. In India, 18 biosphere reserves have been set up by now.

#### Each biosphere reserve has three zones

(a) Core zone : No human activity is allowed.

(b) Buffer zone : Limited human activity is allowed like resource use strategies, research and education.

(c) **Transition zone :** Activities like settlements, cropping, grazing, foresty and tourism are allowed in this zone.



Fig: Zonation in terrestrial biosphere.

(ii) Hot spots :

- Hot spots are areas with high density of biodiversity or megadiversity which are also the most threatened ones.
- It is also defined as geographical zone or ecological niche with a large number of endemic plants.

#### Ecologoically hot spots are determined by four factors as:

(a) Number of species / species diversity.

(b) Degree of endemism.

(c) Degree of threat to habitat due to its degradation and fragmentation.

(d) Degree of exploitation.

- Myers initially identified 12 hot spots with 14% of plant species in a area of only 0.2%. Four more hotspots were added by Myers. Today the number of hotspots identified by ecologists is 34 covering an area less than 2% of land surface with about 20% of human population living there.
- India is even otherwise a country of megadiversity with 2.4% of land area and having 8.1% of global diversity. Major centres of biodiversity are Agasthymalai hills, silent valley and Amambalam Reserve.
- India has three hotspots Indo : Burma, Himalayas and Western Ghats Sri lanka.
- There is high degree of endemism as well as richness of species of flowering plants, amphibians, reptiles, some mammals and butterflies.
- Valleys of this region are rich in endemic species. It has been an active centre of evolution of flowering plants, being rich in primitive angiosperm genera (e.g. members of family Magnoliaceae, Winteraceae).

(3) Sacred forests and sacred lakes : A traditional strategy for the protection of biodiversity has been in practice in India and some other Asian countries in the form of sacred forests. These are forest patches of varying dimensions protected by tribal communities due to religious sanctity accorded to them.

- The sacred forests represent islands of pristine forests (most undistributed forest without any human impact) and have been free from all disturbances; though these are frequently surrounded by highly degraded landscapes.
- In India, sacred forests are located in several part, eg., Karnataka. Maharashtra, Kerala, Meghalaya etc., and are serving as refugia for a number of rare, endangered and endemic taxa. Similarly, several water bodies (eg., Khecheopalri lake in Sikkim) have been declared sacred by the people, leading to protection of aquatic flora and fauna.

### Ex-situ Conservation Strategies

• The ex-situ conservation strategies include botanical gardens, zoos, conservation stands and gene, pollen, seed, seedling, tissue culture and DNA banks. Seed gene

banks are the easiest way to store germplasm of wild and cultivated plants at low temperature in cold rooms. Preservation of genetic resources is carried out in field gene banks under normal growing conditions.

- In vitro conservation, especially by cryopreservation in liquid nitrogen at a temperature of -196°C, is particularly useful for conserving vegetatively propagated crops like potato. Cryopreservation is the storage of material at ultra-low temperature either by very rapid cooling and simultaneous dehydration at low temperature (used for tissue culture). The material can be stored for a long period of time in compact, low maintenance refrigeration units.
- Conservation of biological diversity in botanical gardens is already in practice. There are more than 1500 botanical gardens and arboreta (botanical gardens where specific tree and shrub species are cultivated) in the world containing more than 80,000 species. Many of these now have seed banks, tissue culture facilities and other ex situ technologies. Similarly, there are more than 800 professionally managed zoos around the world with about 3,000 species of mammals, birds, reptiles and amphibians. Many of these zoos have well developed captive breeding programmes.
- The conservation of wild relative of crops plants and the off-site conservation of crop varieties or cultures of micro-organisms privdes breeders and genetic engineers with a ready source of genetic material. Plants and animals conserved in botanical gardens, aroboreta, zoos and aquaria can be used to restore degraded land, reintroduce species into wild and restock depleted populations.
- International Efforts for conserving biodiversity:
- Earth Summit at Rio de janerio (1992), Brazil, promoted Convention on biological Diversity (CBD) which was signed by 152 nations. Its recommendations came into effect on 29th Dec. 1993. India became a party to this Convention on Biological Diversity in May, 1994. Agenda 21, a product of Earth Summit, is a blue print for encouraging sustainable development of diversity through social, economic and environmental measures in the 21 st century.

#### The various commitments were:

- (i) Adaption of ways and means to conserve biodiversity.
- (ii) Managing biodiversity for sustainable use.

(iii) Ensuring equitable sharing of benefits from biological diversity including utilisation of genetic resources.

- A second World Summit was held in 2002 in Johannesberg, South Africa, 190 countries attending the Summit pledged to significantly reduce the current rate of biodiversity loss at global, regional and local levels by 2010.
- Some nongovernmental organisations (NGO's) like green peace provide international support for conservation.
- World Consevation union (former IUCN) is an international independent organisation which provides leadership, common approach and expertise in area of conservation.
- Another similar organisation is World Wild fund for Nature (WWF).
- Covention in International Trade in Endangered species (CITES) helps in restricting poaching and loss of rare species. Restriction on trading in animal products is believed to have saved the elephant from extinction.

#### Biodiversity Conservation in India :

- Indian region has contributed significantly to the global biodiversity. India is a homeland of 167 cultivated species and 320 wild relatives of crop plants. It is the centre of diversity of animal species (zebu, mithun, chicken, water, buffalo, camel); crop plants (rice, sugarcane, banana, jackfruit, cucurbits), edible diascoreas, alocasia, colocasia; spices and condiments (cardamom, black paper, ginger, turmeric); and bamboos, brassicas, and tree cotton. India also represents a secondary centre of domestication for some animals (horse, goat, sheep, cattle, yak and donkey) and plants (tobacco, potato and maize).
- In situ conservation of biodiversity is being carried out through Biosphere Reserves, National Parks, Wild Life Sancturies and other protected areas by the Ministry of Environment and Forests.
- The joint forest management systems involve forest departments and local communities. This enables the tribles the tribal people and local communities to have access to non-wood forest products, and at the same time protect the forest resources.

- The National Bureau of Plant, Animal and Fish Genetic Resources has a number of programmes to collect and conserve the germplasm of plants and animals in seed gene banks, and field gene banks for in *vitro* conservation.
- Botanical and Zoological gardens have large collections of plant and animal species in different climatic regions of India.
- The land races and diverse food and medicinal plants are also being conserved successfully by the tribal people and women working individually, or with various non-governmental agencies. The women particularly have an important role in the conservation of agrobiodiversity.
- In India, a programme is underway to develop a system of community registers of local informal innovations related to the genetic resource, as well as natural resource management in general.

## NATIONAL PARKS AND MAIN SANCTUARIES IN INDIA

### National Parks :

In national parks both plants and animals are protected. There are 90 National Parks (in 2004) which occupy about 4.7% of the country's total geographical area.

### Sanctuaries -

The are 448 wildlife Sanctuaries (as on Sept. 2004) which occupy about 3.2% of the country's total geographical area.

## ANDAMAN AND NICOBAR ISLANDS

- 1. Marine National Park
- 2. North Button Island National Park (Andaman)
- 3. Saddle Peak National Park (Andaman)
- 4. South Button Island National Park (Andaman)
- 5. Narcondum Sancutrary (Bay of Bengal)
- 6. North Reef Island Sanctuary (Bay of Bengal)
- 7. South Sentinel Island Sanctuary (Bay of Bengal)

## ANDHRA PRADESH

- 1. Coringa Sanctuary (East Godavari)
- 2. Nagarijunasagar Srisailam Sanctuary (Guntur, Kurnool) [Largest tiger reserve]
- 3. Pakhal Sanctuary (Warangal)
- 4. Papikonda Sanctuary (East and West Goddavari)

## ARUNACHAL PRADESH

1. Namdapha National Park

### BIOLOGY

2. Pakhui Sanctuary

## ASSAM

- 1. Kaziranga National Park (Sibsagar and Nowgong)
- 2. Manas National Park (Barpeta)
- 3. Garampani Sanctuary

## JHARKHAND

1. Palamau National Park (Dalton Ganj)

## BIODIVERSITY

Term given by Edward Wilson.

Combined diversity at all the levels of biological organization. The biodiversity can be studied at three levels.

(1) Genetic diversity

- (2) Species diversity
- (3) Community and Ecosystem diversity

## (1) Genetic diversity :

- A species show high diversity at gene level over it's distributional range. For ex. Medicinal plant Rauwolfia Vomitoria growing in himalayan range show diversity in synthesis of chemical reserpine in concentraction and potential.
- > India has 50,000 genetically different spacies of rice and 1000 varieties of mangos.
- Each species, varying from bacteria to higher plants and animals, stores an immense amount of genetic infromation. For example, the number of genes is about 450-700 in Mycoplasma, 4000 in Escherichia coli, 13000 in Drosophila melanogaster, 32000-50000 in Oryza sativa and 35000 to 45000 in Homo sapiens.
- Genetic diversity refers to the variation of genes within species; the differences could be in allels (different variants of same genes), in entire genes (the traits determining particular characteristics) or in chromosomal structures.
- The genetic diversity enables a population to adapt to its environment and respond to natural selection. If a species has more genetic diversity, it can adapt better to the changed environmental conditions.
- Lower genetic diversity in a species leads to uniformity, as in the case of large monocultures of genetically similar crop plants. This has advantage when increased

crop production is a consideration, but can be a problem when an insect or a fungal disease attacks the field and posses a threat to the whole crop.

The amount of genetic variation is the basis of speciation (evolution of new species). It has a key role in the maintenance of diversity at species and community levels. The total genetic diversity of a community will be greater if there are many species, as compared to a situation where there are only a few species. Genetic diversity within a species often increases with environmental variability.

#### (2) Species diversity :

- Diversity at species level.
- > Ex.: Western Ghat have greater species diversity of amphibians than Eastern Ghat.
- Species are distinct units of diversity, each playing a specific role in an ecosystem. Therefore, loss of species has consequences for the ecosystem as a whole.
- Species diversity refer to the variety of species within a region. Simplest measure of species diversity is species richness, i.e., the number of species per unit area. The number of species increases per unit area of the site.
- Generally, greater the species richness, greater is the species diversity. However, number of individuals among the species may also vary, resulting into differences in evenness or equitability and consequently in diversity.
- Suppose, we are having three sample areas. In the sample area-I, there are three spacies of birds. Two species are represented by one individual each, while the third species has four individuals. In the sample area-2 that has the same three spacies, each spacies is represented by two individuals. This sample area show greater evenness, and there are equal chances for a species being represented in a sample. The sample area-2 will be considered more diverse than the first. In the sample area-3 the species are represented by an insect, a mammal and a birds. This sample area is most diverse as it comparises taxonomically unrelated species. In this example, we find equal number of spacies but varying number of individuals per species. In nature, both the number and kind of species, as well as the number of individuals per species vary, leading to greater diversity.

### (3) Community and Ecosystem diversity :

Diversity at ecosystem and community level.

- Ex. India have diverse kind of ecosystem like desert, rain forests, mangrovs, coral reefs, wetlands, estuaries and alpine meadows, than the Norway.
- Diversity at the level of community and ecosystem has three perspectives. Alpha diversity (within-community diversity) refers to the diversity of organisms sharing the same community/habitat.
- A combination of species richness and equitability/evenness is used to represent diversity within a community or habitat. Species frequently change when habitat or community changes. The rate of replacement of specis along a gradient of habitats or communities is called beta diversity (between -community diversity). There are differences in species composition of communities along environmental gradients, eg., altitudinal gradient, moisture gradient, etc.
- Higher the heterogenecity in the habitats in a region or greater the dissimilarity between communities, higher is the beta diversity.
- Diversity of the habitats over the total landscape or geographical area is called gamma diversity.
- Ecosystem diversity describes the number of niches, trophic levels and various ecological processes that sustain energy flow, food wabs and the recycling of nutrients. It has a focus on various biotic interactions and the role and function of keytone species. Studies in temperate grasslands have shown that diverse communities are functionally more productive and stable even under environmental stresses such as prolonged dry conditions.
- Magnitude of Biodiversity in world and India
- According to IUCN (2004) the total number of species of plants and animals described so far are about 1.5 million.
- According Robert May global species diversity is about 7 million.
- According to knowledge of earth's biodiversity-
- 70% of all species is of animals.
- 22% of all plants species (Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms)

- Among animals, insects are most species rich (number of species) constituting 70% of total animal species. ie., from every 10 animals, 7 are insects
- Prokaryotes are not counted in global biodiversity as the number of prokaryotic species in not known, conventional toxonic methods are not suitable for them and many species are not cultrable under laboratory conditions.
- India share 2.1% of world land area but share global species diversity is 8.1% which make India one of the 12 mega diversity countries of world. India has 45000 species of plants and twice number of species of animals and many more yet to be identified and discovered.
- According to Robert Mays global estimates, only 22% of the total species have been recorded so far. Applying this proportion to India more than 1,00,000 plant and 3,00,000 animal species yet to be discovered and described.
- Approximate Numbers of Species which have been Described and Identified from all over the World
- India has 10 biogeographical regions among them Deccan Peninsula has the most extensive coverage of landmass (42%).
- The most biodiversity rich zone are Western Ghat and North East Himalaya account for 4% and 5.2% of geographical area respectively.
- Each biogeographical area have several habitats, biotic communities and ecosystem .
- A large number of species (both plants and animals) are present in these zone which are endemic (exclusive to India).
- About 33% of flowering plants are endemic to India.
- Among animals, out of recorded vertebrates, 53% Fresh water fishes, 60% Amphibians,
   36% Reptiles, 10% mammalian fuana are endemic to India which are mainly distributed in North - East, Western Ghats and Nicobar Islands.
- A very high number of Amphibian species are endemic to western ghat.

 Biological diversity in ecosystems like deep oceans, wetlands, lakes and habitats like tree canopy and soil of tropical rain forest in India yet to be explored.

## Gradients / Pattern of Biodiverity :

**(A)**The pattern of biodiversity is decided by latitudes (Distance from equator), altitude (Height from sea level).

- As we move from high to low latitudes ie., from poles to the equator the biological diversity decreases. ie., equator towards the pole for example, Tropics (latitudinal range of 23.5°N to 23.5°S) harbour more species than temperate or polar areas. Colombia located near equator has about 1400 species of birds while Newyork at 41°N has 105 species and greenland at 71°N only 56 species and Greenland at 71°N only 56 species of birds.
- India located in tropical latitude has more than 1200 species of birds.
- A forest in tropical region like Equator has 10 times more species of vascular plants than temperate region like midwest of USA.
- The largly tropical Amazonian rain forest in South America has greatest biodiversity on earth. It home to more than 40,000 species of plants, 3000 fishes, 1,300 birds, 427 mammals,

427 Amphibians, 378 reptiles and more than 1,25,000 invertebrates.

Tropics have very high biodiversity due to -

(a) Speciation (Formation of new species) is the function of time and unlike temperate regions which are subjected to frequent glaciations in past the tropical latitudes have remained undisturbed for millions of years. so have long evolutionary time for species diversification.

(b) Tropical environment unlike temperate one are less seasonal, relatively more constant and predictable which promotes niche specialisation and leads to greater species diversity.

(c) There is more solar energy available in tropics, which contributes to higher productivity and indirectly contribute to greater diversity.

- Decrease in species at altitudes, from lower to higher altitude on a mountain.
- 1000 m increase in altitude results in temperature drop of about 6.5°C. This drop in temperature and great seasonal variability at higher altitude are a major factor that reduce biodiversity.
- The latitudinal and altitudinal gradients of species divesrity are two master gradients.
- Also more complex and heterogenous the physical envrironment, more complex and diverse will be the flora and fauna.

#### Latitude and types of forest in world and India :

- In Northern hemisphere as we moves from equator north world to arctic region consecutive belts of coniferous.
- ✓ Tropical rain forest :  $0 20^{\circ}N$
- ✓ Tropical deciduous forest :  $20 40^{\circ}N$
- ✓ Temperate deciduous / Temperate broad leaf forest : -40 60⁰N
- ✓ Temperate coniferous/ temperate needle leaf forest or Alpines : -50 60<sup>o</sup>N
- ✓ Tundra biome :  $60^{\circ}N$

#### (B) Species Area Relationship

- German naturalist and geographer Alexander Von Hemboldt observed that within a region, species richness increased with increasing explored area, but only upto a limit.
- Generally the value of Z-line is in range of 0.1 to 0.2 regard less of taxonomic group or region.

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to care for their well being and pass on our biological legacy in good order of future generation. as we Indians belives in :

- Importance of species diversity to the Ecosystem :
- The number of species in a community is important for a ecosystem. It is belives that communities with more species are more stable and with less species are less stable.
- A stable community mean-
- Not show to much variation in productivity year to year.
- It must be resistant to occasional disturbances (Natural or Man made).
- It must be resistant to invasion by alien species.
- How these attributes are linked to species richness in a community?
- According to David Tilman's by the long term ecosystem experiment using outdoor plots concluded that plots with more species shows less year to year variation in total biomass and increased diversity contributed to higher productivity.
- Rich biodiversity is not only essential for ecosystem health, but also necessory for survival of human race on this planet.
- How a species extinctintion anywhere on this planet affect the human race is explained by Stanford ecologist paul Ehrlich by Rivet Popper Hypothesis.
- He compare aeroplane as ecosystem joined togather by thousends of rivets as species. If passenger travelling in it starts popping a rivet to take home (causing species to become extinct) if may not affect flight safety (proper functioning of ecosystem) initially, but as more or more rivets are removed, the plane become dangerously weak over a period of time.
- The removal of rivat of fan is more dangerous than seat or wind rivets. The rivet of fan means dominant species of ecosystem.

#### LOSS OF BIODIVERSITY/THREATS TO BIODIVERSITY

- The loss in biodiversity in an region may leads to-
- Decline in plant production.

- Lowered the resistance to environmental changes like draught.
- Change the ecosystem processing like plant productivity, water use, pest and disease cycle.

### Cause of biodiversity loss :

(i) Habitat loss and Fagmentation.(ii) Over exploitation(iii) Introduction of exotic species/ Alien species.(iv)Co-extinction

(i) Habitat loss and Fragmentation : This is the most important cause driving animals and plants to extinction. The most dramatic example of habitat loss come from torpical rian forests. Once covering more than 14 percent of the earth's land surface, these rain forests now over no more than 6 percent. they are being destroyed fast. By the time you finish reading this chapter, 1000 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 conversation to grassland 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 : Human have always depended on nature for food and shelter, but when 'need' turns to 'greed', it leads to over-exploitation of natural resources. Many species extinctions in the last 500 years (Stellr's sea cow, passenger pigeon) were due to exploitation by humans. Presently many marine fish populations around the world are over harvested, endangering the continued existence of some commercially important species.

(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.

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 lake. You must be familiar with the environmental damage caused and threat posed to our native species by

invasive weed species like carrot grass (Parthenium), Lantana and water hyacinth (Eicchornia).

The recent illegal introduction of the Africa 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 even the 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.

## Type of Extinction of Species :

Extinction is a natural process. Species have disappeared and new ones have evolved to take their places over the long geological history of the earth. It is useful to distinguished three types of extinction processes.

**Natural Extinction :** With the change in environmental conditions, some species diappear and others, which are more adapted to changed conditions, take their place. This loss of species which occured in the geological past at a very slow rate, is called natural or background extinction.

**Mass extinction :** There have been saveral periods in the earth's geological history when large number of species become extinct because of catastrophes. Mass extinctions occured in millions of years.

**Anthropogenic extinction :** An increasing number of species are disappearing from the face of the earth due to human activities. This man-made mass extinction represents a very severe depletion of biodiversity, particularly because it is occuring within a short period of time.

**Susceptibility to Extinction :** The characteristics of species particularly susceptible to extinction are : large body size (Bengal tiger, Lion and Elephant); small population size and low reproductive rate (Blue whale and Giant panda). Feeding at high tropic levels in the food chain (Bengal tiger and Bald eagle), fixed migratory routes and habitat (Blue whale and Whooping crane) and localised and narrow range of distribution (woodland caribou; many island species) also make the species susceptibel to extinction.

### The IUCN Red List Categoris

The IUCN Red List (which is started in 1963) is a catalogue of taxa that are facing the risk of exctinction. It is important to understand that the Red List aims to impart information about the urgency and scale of conservation problems to the public and policy makers. The uses of the Red List are -

(i)Developing awarness about the importance of threatened biodiversity;

(ii) Identification and documentation of endangered species;

(iii)Providing a global index of the decline of biodiversity;

(iv) Defining conservation priorities at the local level and guiding conservation action.

The World Conservation Union (formerly known as International Union for the Conservation of Nature and Natural Resource, IUCN) has recognised eight Red List Categories of species; Extinct, Extinct in the wild, Critically endangered, Endangered, Vulnerable, Lower Risk, Data Deficient and Not Evaluated. These categories are difined in Table below.

**Threatened (T) :** The term is used in context with conservation of the species which are in any one of the above 3 categores (E, V, R). **Threatened = Endagered + Vulnerable + Rare** 

**1. Endangered (E) :** Those species which are in the immediate danger of extinction and whose survival is unlikely whose number have been reduced to a critical level, if the casual factors continue to be operating.

**2. Vulnerable (V) :** The species likely to move into the endangered category in the near future if the casual factors continue to operate. Their population is still abundant but are under threat throughout their range.

**3. Rare (R) :** These are species with small population in the world. These are not at present endangerd and vulnerable, but are at risk due to their less number. These species are usually localised within restricted geographical areas or habitals.

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. Careful analysis of records shows that extinctions across taxa are not random; some

groups like amphibians appear to be more vulnerable to extinction. Adding to the grim scenario of extinctions is the fact that 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 face the threat of extinction. From a study of the history of life on earth through fossil records, we learn that large-scale loss of species like the one we are currently witnessing have also happened earlier, even before humans appeared on the scene.
- During the long period (> 3 billion years) since the origin and diversification of life on earth there were five episodes of mass extinction of species. How is the 'Sixth Extinction' presently in progress different from the previous episodes? The difference is in the rates; the current species extinction rates are estimated to be 100 to 1,000 times faster than in the pre-human times and our activities are responsible for the faster rates. Ecologists warn that if the present trends continue, nearly half of all the species on earth might be wiped out within the next 100 years.

### Some Important Examples of Threatened species in India

Note : Rauwolfia serpentiana (medicinal plant) is endangered.

### **BIODIVERSITY CONSERVATION**

It is of two types In situ (On site) and Ex situ (Off site) conservation.

### In situ Conservation Strategies :

 The in situ strategies emphasise protection of total ecosystems. The in Situ approach includes protection of a group of typical ecosystems through a network of protected areas.

(1) Protected Areas : These are areas of land and/or sea, especially dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources. These are managed throught leagal or other effective means. Examples of protected areas are National Parks and Wildlife Sancturies. The earliest national parks, the Yellowstone in USA and the Royal near Sydney, Australia.

 Many similar areas throughout the world now protect rare species or wilderness areas. World Conservation Monitoring Centre has recognised 37,000 protected areas around the world. As of September 2002, India has 581 protected areas (89 National Parks and 492 Wildlife Santuries), covering 4.7% of the land surface, as against 10% internationally suggestednorm. The • Jim Corbett National Park was the first National Park established in India.

#### Some of the main benefits of protected areas are :

(i) Maintaining viable populations of all native species and subspecies.

(ii) Maintaining the number and distribution of communities and habitats and conserving the genetic diveristy of all the present species.

(iii)Preventing human caused introductions of alien spacies; and

(iv)Making it possible for species/habitats to shift in response to environmental changes.

(2) Biosphere Reserves : Biosphere reserves are special category of protected areas of land and/or coastal environments, where in people are an integral component of the system. These are representative examples of natural biomes and contain unique biological communities. The concept of Biosphere Reserve was launched in 1975 as a part of UNESCO's Man and Biosphere Programme (MAB), dealing with the conservation of ecosystems and the genetic resources contained therein. Till May 2002, there were 408 biosphere reserves located in 94 countries. There are 16 biosphere reserves in India and are shown in figure below.

In India, Biosphere Reserve are also notified as National Parks. A Biosphere Reserve consists of core, buffer and transition zones. The natural or core zone comprises an undisturbed and legally protected ecosystem. The buffer zone surrounds the core area, and is managed to accomodate a greater variety of resource use strategies and research and educational activities.

The transition zone, the outermost part of the Biosphere Reserve, is an area of active cooperation between reserve management and the local people, wherein activities like settlements, cropping, forestry and recreation and other economic uses continue in harmony with conservation goals. The main fucntions of biosphere reserves are :

(i) **Conservation :** To ensure the conservation of landscapes, ecosystems, encourages traditional resource use.

(ii) **Development** : To promote economic development which is culturally, socially and ecologically sustainable.

(iii) Scientific research, monitoring and education : The aim is to provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development.

(3) Sacred forests and sacred lakes : A traditional strategy for the protection of biodiversity has been in practice in India and some other Asian countries in the form of sacred forests. These are forest patches of varying dimensions protected by tribal communities due to religious sanctity accorded to them.

- The sacred forests represent islands of pristine forests (most undistributed forest without any human impact) and have been free from all disturbances; though these are frequently surrounded by highly degraded landscapes.
- In India, sacred forests are located in several part, eg., Karnataka. Maharashtra, Kerala, Meghalaya etc., and are serving as refugia for a number of rare, endangered and endemic taxa. Similarly, several water bodies (eg., Khecheopalri lake in Sikkim) have been declared sacred by the people, leading to protection of aquatic flora and fauna.

### Ex-situ Conservation Strategies

- The ex-situ conservation strategies include botanical gardens, zoos, conservation stands and gene, pollen, seed, seedling, tissue culture and DNA banks. Seed gene banks are the easiest way to store germplasm of wild and cultivated plants at low temperature in cold rooms. Preservation of genetic resources is carried out in field gene banks under normal growing conditions.
- In vitro conservation, especially by cryopreservation in liquid nitrogen at a temperature of -196°C, is particularly useful for conserving vegetatively propagated crops like potato. Cryopreservation is the storage of material at ultra-low temperature either by very rapid cooling and simultaneous dehydration at low temperature (used for tissue culture). The material can be stored for a long period of time in compact, low maintenance refrigeration units.
- Conservation of biological diversity in botanical gardens is already in practice. There are more than 1500 botanical gardens and arboreta (botanical gardens where specific tree and shrub species are cultivated) in the world containing more than 80,000 species. Many of these now have seed banks, tissue culture facilities and other ex situ technologies. Similarly, there are more than 800 professionally managed zoos

around the world with about 3,000 species of mammals, birds, reptiles and amphibians. Many of these zoos have well developed captive breeding programmes.

 The conservation of wild relative of crops plants and the off-site conservation of crop varieties or cultures of micro-organisms privdes breeders and genetic engineers with a ready source of genetic material. Plants and animals conserved in botanical gardens, aroboreta, zoos and aquaria can be used to restore degraded land, reintroduce species into wild and restock depleted populations.

## Hot Spots of Biodiversity :

Biodiversity is not uniformly distributed across the geographical regions of the earth. Certain regions of the world are mega diversity zones where a very large number of species are found. For example, India accounts for only 2.4% of the land area of the world, but it

#### Contributes

approximately

8% species to the global diversity.

Norman Mayers developed the hot spots concept in 1988 to designate priority areas for in situ conservation. the hot spots are the plant and animal life on earth. The key criteria for determining a hot spote are :

(i) Number of endemic species, i.e., the species which are found nowhere else, and

(ii) Degree of threat, which is measured in terms of habitat loss.

- Twenty five terrestrial hot spots for conservation of biodiversity have been identified worldwide. These hot spots together, now cover 1.4% of the earth's land area. Tropical forests appear in 15 hot spots, Mediterranean type zones in 5, and 9 hot spots are completely made up of islands. As many as 16 hot spots are in the tropics. About 20% of the human population lives in the hot-spot regions. Now total number of hot spots are 34.
- Among the 34 hot spots of the world, two (Western Ghats and Eastern Himalayas) are found in India, and these extend into the neighbouring countries also.Srilanka and Indo-Burma These areas are rich in flowering plants, also in reptiles, amphibians, swallow-tailed butterflies and some mammals; and also show a high degree of endemism.
- The eastern Himalayan hot spot exteds to the north-eastern India and Bhutan. the temperate forests are found at altitudes of 1780 to 3500 meters. Many deep and semiisolated valleys found in this region are exceptionally rich in endemic plant species. Besides being an active centre of evolution and rich diversity of flowering plants, the

numerous primitive angiosperm families (eg., Magnoliaceae and Winteraceae) and primitive genera of plants, like Magnolia and Betula are found in Eastern Himalaya.

 The Western Ghat region lies parallel to the western coast of Indian peninsula for almost 1600 km, in Maharashtra, Karnataka, Tamil Nadu and Kerala. The forests at low elevation (500m above means sea level) are mostly evergreen, while those found at 500-1500 meter height are generally semi-evergreen forests. The Agasthyamalai hills, the Silent Valley and the new Amambalam Reserve, are the two main centres of diversity.

Tropical Andes, 2.Mesoamerica, 3.Caribbean, 4.Brazils's Atlantic Forests,
 Choco/Darien/Western Ecuador, 6.Brazil's Cerrado, 7.Central Chile,
 California Floristic Province, 9.Madagascar, 10.Eastern Arc & Coastal Forests of
 Tanzania/Kenya, 11. West African Forests, 12. Cape Floristic Province,
 Succulent Karoo, 14.Mediterranean Basin, 15. Caucasus, 16. Sundland, 17.WAllacea,
 Phillippines,19.Indo-Burma, 20.South-Central China, 21. Western Ghats/Sri Lanka,
 Southwest Australia, 23. New Caledonia, 24. New Zealand, 25. Polynesia/Micronesia.

## Fig. The terrestrial biodiversity hot spots

#### International Efforts for Conserving Biodiversity :

The Earth Summit held in 1992 at Rio de Janeiro result into a Convention on Biodiversity, which came into force on 29 December, 1993. The convention on has three key objectives: **(i)**Conservation of biological diversity.

(ii) Sustainable use of biodiversity and

(iii) Fair and equitable sharing of benefits arising out of the utilisation of genetic resources.

 The World Conservation Union and the World Wide Fund for Nature (WWF) support projects worldwide to promote conservation and appropriate development of Biosphere Reserve.

#### **Biodiversity Conservation in India :**

- Indian region has contributed significantly to the global biodiversity. India is a homeland of 167 cultivated species and 320 wild relatives of crop plants. It is the centre of diversity of animal species (zebu, mithun, chicken, water, buffalo, camel); crop plants (rice, sugarcane, banana, jackfruit, cucurbits), edible diascoreas, alocasia, colocasia; spices and condiments (cardamom, black paper, ginger, turmeric); and bamboos, brassicas, and tree cotton. India also represents a secondary centre of domestication for some animals (horse, goat, sheep, cattle, yak and donkey) and plants (tobacco, potato and maize).
- In situ conservation of biodiversity is being carried out through Biosphere Reserves, National Parks, Wild Life Sancturies and other protected areas by the Ministry of Environment and Forests.
- The joint forest management systems involve forest departments and local communities. This enables the tribles the tribal people and local communities to have access to non-wood forest products, and at the same time protect the forest resources.
- The National Bureau of Plant, Animal and Fish Genetic Resources has a number of programmes to collect and conserve the germplasm of plants and animals in seed gene banks, and field gene banks for in vitro conservation.
- Botanical and Zoological gardens have large collections of plant and animal species in different climatic regions of India.
- The land races and diverse food and medicinal plants are also being conserved successfully by the tribal people and women working individually, or with various non-governmental agencies. The women particularly have an important role in the conservation of agrobiodiversity.
- In India, a programme is underway to develop a system of community registers of local informal innovations related to the genetic resource, as well as natural resource management in general.

### SPECIAL POINTS

- The Amazon rain forest is so huge that is called "Lungs of the Planet".
- ✤ Biodiversity Day 22<sup>th</sup> May.
- Year 2010 is declared as Biodiversity Conservation year by UNO.
- Year 2011 is declared as International Forest Year by UNO.

**Note :** 408 Biosphere reserves are located in 94 countries. In India following 14 sites have been identified as potential biosphere reserves together with their locations :

### NATIONAL PARKS AND MAIN SANCTUARIES IN INDIA

### National Parks :

 In national parks both plants and animals are protected. There are 90 National Parks (in 2004) which occupy about 4.7% of the country's total geographical area.

### Sanctuaries -

The are 448 wildlife Sanctuaries (as on Sept. 2004) which occupy about 3.2% of the country's total geographical area.

### ANDAMAN AND NICOBAR ISLANDS

- 1. Marine National Park
- 2. North Button Island National Park (Andaman)
- 3. Saddle Peak National Park (Andaman)
- 4. South Button Island National Park (Andaman)
- 5. Narcondum Sancutrary (Bay of Bengal)
- 6. North Reef Island Sanctuary (Bay of Bengal)
- 7. South Sentinel Island Sanctuary (Bay of Bengal)

### ANDHRA PRADESH

- 1. Coringa Sanctuary (East Godavari)
- 2. Nagarijunasagar Srisailam Sanctuary (Guntur, Kurnool) [Largest tiger reserve]
- 3. Pakhal Sanctuary (Warangal)
- 4. Papikonda Sanctuary (East and West Goddavari)

#### BIOLOGY

#### ARUNACHAL PRADESH

- 1. Namdapha National Park
- 2. Pakhui Sanctuary

### ASSAM

- 1. Kaziranga National Park (Sibsagar and Nowgong)
- 2. Manas National Park (Barpeta)
- 3. Garampani Sanctuary

## JHARKHAND

1. Palamau National Park (Dalton Ganj)

## CHANDIGARH

1. Sukhna Sanctuary

## DELHI

1. Indira Priyadarshini Sanctuary

## GOA

1. Cotigao Sanctuary

## GUJARAT

- 1. Gir National Park (Junagarh)
- 2. Nalsarovar Sanctuary (Ahmedabad)

## HARYANA

- 1. Bhindawas Sanctuary
- 2. Chotala Sanctuary
- 3. Sultanpur Sanctuary (Gurgaon)

### HIMACHAL PRADESH

- 1. Great Himalayan National Park
- 2. Pin Valley National Park
- 3. Manali Sanctuary (Manali)

## JAMMU AND KASHMIR

- 1. Dachigam National Park (Srinagar)
- 2. Salim Ali National Park
- 3. Karakoram Sanctuary

## KARNATAKA

- 1. Bandipur National Park (Mysore)
- 2. Ghataprabha Sanctuary (Belgaun)

## KERALA

- 1. Periyar National Park (Idukki)
- 2. Silent Valley National Park (Palghat)
- 3. Idikki Sanctuary (Idikki)

## MADHYA PRADESH

#### BIOLOGY

- 1. Bandhavagarh National Park (Shadol)
- 2. Fossil National Park
- 3. Kanha National Park (Mandla and Balaghat)
- 4. Panna National Park (Panna)
- 5. Ghatigao-Great Indian Bustard Sanctuary
- 6. Singhori Sanctuary

## MAHARASHTRA

- 1. Chandoli Sanctuary
- 2. Chaprala Sanctuary
- 3. Great Indian Bustard Sanctuary
- 4. Nagzira Sanctuary
- 5. Tansa Sanctuary

## MEGHALAYA

- 1. Balphakram National Park
- 2. Nokrek National Park

## MIZORAM

1. Dampa Sanctuary

## NAGALAND

1. Fakim Sanctuary

## ORISSA

1. Balukhand Sanctuary

### PUNJAB

1. Harike Lake Sanctuary

## RAJASTHAN

- 1. Desert National Park (Jaisalmer and Barmer)
- 2. Keoladeo Ghana National Park (Bharatpur)
- 3. Ranthambore National Park (Sawai Madhopur)
- 4. Sariska National Park (Alwar)
- 5. Sariska Sanctuary (Alwar)

### SIKKIM

- 1. Kanchanjunga National Park (Gangtok)
- 2. Van Vihar Sanctuary

## TAMIL NADU

- 1. Guindy National Park (Madras)
- 2. Marine National Park (Gulf of Mannar)

## TRIPURA

1. Trishna Sanctuary

#### BIOLOGY

#### UTTRANCHAL AND U.P.

- 1. Corbett National Park (Nainital) (Uttaranchal)
- 2. Dudhwa National Park (Lakhimpur Kheri) U.P.
- 3. Nanda Devi National Park (Chamoli) (U.P.)
- 4. Valley of Flowers National Park (Chamoli)
- 5. National Chambal Sanctuary

#### WEST BENGAL

- 1. Sunderban National Park (24-Parganas)
- 2. Jaldapara Sanctuary (Jalpaiguri)
- 3. Senchal Sanctuary

### SOME IMPORTANT SANCUTARIES OF INDIA

Name of Location	Area in sq.kı	n. Important Animals
1.Keoladeo Ghana Bird Sanctuary Bharatpur (Rajasthan) Famous four birds	29	Siberian crane, egrets, herons spoon bill etc.
2.Annamalai Sanctuary Coimbatore (Tamil Nadu)	958	Tiger, elephant, gaur, spotted deer,wild dog, southbear, sambhar,panther.
3.Jaldapara Sanctuary Madarihat (West Bengal)	1155	Rhino,elephant,tiger,leopard,deer, sambhar, and different kinds of birds.
4.Sultanpur Lake Bird Sanctuary Gurgaon (Haryana)	12	Crane, sarus, spotbill, duck, drake, green pigeon, wild bear, crocodile,python.
5.Bir Moti Bagh Wildlife Sanctuary Patiala (Punjab)	y 8.3 blue jackal,pe	Nilgai,wild boar, hog deer, black buck, afowl, partidge, sparrow, myna,pigeon, dove
6.Shikari Devi Sanctuary Mandi (Himachal Pradesh)	213	Black bear, snow leopard, flying fox, barking deer, musk deer, chakor, partridge
7.Dachigam Sanctuary Srinagar (Jammu and Kashmir)	89	Hangul or Kashmir stag, musk deer, snow leopard, black bear, brown bear

8.Mudumalai Wildlife Sanctuary Nilgiri (Tamil Nadu)	520 Elephant, gaur, sambhar, chital, barking deer, mouse deer, four horned antelope, langur, gaint squirrel, flying squirrel, wild dog, wild cat, civet, sloth bear, porcupine, python, rat snake, monitor lizard, flying lizard.	
9.Nagarjuna Sagar Sanctuary Guntur Kamool and Nalgonda (Andhra Pradesh)	3,568 Tiger, panther, wild bear, chital, nilgai, sambar,black buck, fox, jackal, wolf, crocodile.	
10. Periyar Sanctuary (Kerala)	777 Elephats, gaur, leopard, sloth bear, sambhar, bison, black langur, hornbill, egret. It is famous for elephants	
11. Chilka Lake Brid Sanctuary Balagaon (Orissa) (Largest brackish water lagoon in Asia)	900 An oasis of bir is like water fowls, ducks, cranes, Golder plovers, sand pipers, flamingoes	
12. Manas Wildlife Sanctuary Kamrup (Assam)	Tiger, panther, rhino, gaur, wild buffalo, sambhar, swamp deer, golden langur, wild dog wild bear.	

### INFORMATION RELATED TO NATIONAL PARKS AND SANCTUARIES

### India's Famous Tiger Reserve -

- Jim Corbett National Park Nainital (Uttaranchal)
- Dudhwa National Park Lakhimpur Kheri (U.P.)
- Kanha National Park Mandala and Balghat (Madhya Pradesh)
- Indrawati National Park (Chattishgarh)
- Simli National Park (Orissa)

## Some Special Animals -

- > Asiatic wild ass (Endangered) Found in runn of Kutch and Pakistan
- > Red Panda (Endangered) Found in Kanchanjunga (Sikkim)
- Hangul Kashmir Stag (Endangered) Found in Dachigam (Sri-Nagar Jammu and Kashmir)
- Siberian Crane (Endangered) Found in Keoladeo (Ghana) National Park

The Great Indian Bustard is a huge ground bird with a long and long bare legs. It is an inhabitant of the semi-arid areas of Rajasthan, Gujarat and Maharashtra. Hunting for its flesh has reduced its population to over 800. It is a highly endangered bird.

1. The world's first National Park (America) - Yellow stone National Park

2. India's first National Park - Jim Corbett National Park - Nainital (Uttaranchal)

3. Smallest tiger reserve in India - Ranthambore National Park - Sawaimadhopur (Rajasthan).

It is famous for Asiatic wild ass.

4.**Largest Tiger reserve in India -** Nagarjuna Sagar Saisailum Sanctuary - Guntoor – Andhra Pradesh.

5. Nandan-Kanan zoo is known for - White tiger.

Note : Tahr and Sunderbans (W. Benal) is also famous for tigers.

6.Periyar wild life Sanctuary (kerala) - Famous for elephant and ohters.

7. Valley of flower National Park - It is situated at Chamoli-Garhwal (Uttaranchal)

8. Flamingoes are protected in Chilka lake Balagaon (Orissa)

9. Rachel carson written a book "Silent Spring" - concerned with awareness about "Nature

conservation and Enviroment'' - 1962.

- **Note :** In it was mentioned the effect of DDT on birds. The population of Lady bird bettle declined.
- 10. **The black buck** is one of the most graceful antelopes native of India. The male possesses a pair of spirally twisted horns. Once abundant in several parts of India. Its population had come untill the enforcement of the wild life (Protection) Act.

### SOME IMPORTANT INFORMATIONS

- 1. (i) Natinal Forest Policy revised in 1988.
  - (ii) Biodiversity act of India was passed by the Parliament in the year-2002.
  - (iii)Forest Act-1927.

## 2. Wild life protection act 1972 (Revised in 1991) :

Objectives :

- (1) Restriction and Prohibition on hunting of animals.
- (2) Protection of specified plants.
- (3) Setting up and managing Sanctuaries and National parks.
- (4) Empowering zoo authority.
- (5) Control of trade and commerce of wildlife.

**3.**Chipko Movement was born in March-1973 at Gopeshwar in Chamoli district. The movement had two leaders - Sundarlal Bahuguna of Silyara in Tehri and Chandi Prasad Bhatt of Gopeshwar.

Appiko Movement - Similar type movement Appiko movement was under taken by Poundurang hegde in south in 1983.

### SPECIAL WILDLIFE PROJECTS IN INDIA

Project tiger - Running since 1 April 1973 - Central Government.
The Gir Lion Sanctuary Project - Running since 1972-Central Govt. and Gujrat Govt.
Himalayan Musk Deer Project - U.P. Govt. IUCN and Central Govt.
The Manipur Brow - Antlered Deer Project - Running since 1977
Project Hangul - Since 1970 - J. & K. Govt. IUCN, WWF.
Crocodile Bredding Project - Since 1975 UNDP, Central Govt.
Project Elephant - Recently started.

### ABOUT WILDLIFE

**Red Data Book :** This book contains a record of animals and plants which are known be in danger. This Book is maintained by the IUCN (International Union of Conservation of Nature and Natural Resources).

**Green Data Book :** A book containing a list of stratagies for sustainable development for developing countries. It is released by UN Commission on sustainable development..

**Silent Valley :** It is tropical evergreen forest in Kerela (Palghat) declared as National Reserve Forest. It is called silent valley because there is no noise in the forest during night, even that of cicadas, as they are not found there. It is related to conservation of forest.

**Butterfly Park :** India's first and only butterfly park was established in 1992 near Gangtok (Sikkim)

## BIOLOGY