(*a*) Insectivores plants, like Pitcher plant and Sundew plant. The Pitcher plant has enlarged pitcher shaped leaves which contain a liquid that attracts, drowns and absorb insects. Whereas, the Sundew plant secretes a sticky liquid on its leaves that entraps the insects.

(*b*) Carnivores predators like snake, lion, tiger, wolf, and many more feed upon other animals for their survival.

8.7 BIODIVERSITY

Biodiversity means variation and abundance of species and their habitats. In simple terms biodiversity means the large variety of flora and fauna on this planet earth. According to the World Resources Institute—"Biodiversity is the variety of the world's organisms, including their genetic diversity and the assemblage they form. It is the blanket term for natural biological wealth that undergirds human life and well-being. The bredth of the concept reflects the inter-relatedness of genes, species and ecosystems. Because genes are the components of species and species are the components of ecosystems. Therefore, altering the make-up of any level of this hierarchy can change the others—species are central to the concept of biodiversity."

Total species estimates for earth vary from 3 to 30 million. But only less than 2 millon of these species have been identified and described. India's rich biological diversity—its immense range of ecosystems (forests, wetlands, grasslands, deserts, marine areas, coral reefs, etc.), species (about 1.3 lakh recorded and many more not yet discovered) and genetic forms (50,000 varieties of rice alone)—is by virtue of its tropical location, climate and physical features. India's biogeographical composition is unique as it combines living forms from three major biogeographical realms, namely—the Indo-Malayan, the Agro-Tropical, and the Eurasian.

So far 15,000 species of flowering plants ; 67,000 species of insects ; 4,000 species of molluscs ; 6,500 species of other invertebrates ; 2,000 species of fishes ; 1,200 species of birds ; 420 species of reptiles ; 340 species of mammals ; and 140 species of amphibians have been identified. India is designated as one of the twelve mega-diversity nations in the world. Of the twelve biodiversity places of the world facing massive threat to flora and fauna, India has two within its boundaries, viz., N-Eastern region and the Western Ghats.

8.7.1 Importance of Biodiversity

Biodiversity is of both aesthetic as well as of practical importance. Maintaining this precious diversity is considered by scientist to be a key factor for sustainable development. Some of its importance are discussed under :

(*i*) Biodiversity provides us valuable natural resources to satisfy the needs of human beings, including—livestock, food, clothings, shelter, and a host of other useful products derived from a variety of living organisms (plants and animals).

(*ii*) Diverse species of plants, animals and micro-organisms provide us invaluable and indispensable ecological services. Such as recycling of wastes, maintaining the chemical composition of atmosphere, determining the climate of different parts of the world, and so on.

(*iii*) Biological diversity is crucial for the survival of an ecosystem. It helps in maintaining a healthy ecosystem. The loss of even one or a few species, in a simple ecosystem, could be disastrous for it because of the lack of alternatives. However, in a complex ecosystem (having several trophic levels) loss of one or more species might not cause any serious problems as alternatives available can maintain the functionality of the ecosystem (explained earlier).

(*iv*) Biological diversity is a valuable genetic resource. Most of the hybrid varieties of crops under cultivation have been developed by incorporating useful genes from different species of plants to produce better quality of the produce with longer self-life or having better resistance to pests. Though such breeding techniques are unlimited in scope ; but, for getting better strains in future, it is essential to build-up a gene-pool because the quality, yield, and resistance to pests, diseases and adverse climatic conditions mostly depend on genetic factors and combination of genes which may be different in different strains/varieties of species. There are hundreds of examples which illustrate how genetic modification helped in improved quality of the product. A few of them are mentioned as under :

(*a*) The genes from a wild variety of melon grown in U.P. helped in imparting resistance to powdry mildew in musk-melons grown in California (USA).

(*b*) The genes from the Kans grass (Saccharum Spontaneum) grown in Indonesia helped in imparting resistance to red rot disease of sugarcane.

(*c*) A wild variety of rice from U.P. saved millions of hectares of paddy crop from Grossy-Stunt virus.

(*v*) Enormous genetic diversity contained within the wild populations of fauna and flora is of enormous value for the continuing R & D in the field of agriculture, industry and medicine.

(*vi*) The insect fauna contain a large number of species which are potentially superior weed-control agents, crop-pollinators and are parasites on pests.

(*vii*) There are plant species which are edible and superior than those which are currently in used. For example, Katemfe, a plant found in W. Africa, produces proteins that are 1,600 times more sweeter than sucrose.

(*viii*) There are several plant species which have potential medicinal applications. For example—Neem, Tulsi, etc. We must not forget that about one-third of the present day description drugs contain chemical compounds that plants have evolved with the passage of time to protect themselves from their enemies/parasites.

(*ix*) There are number of species which plays important role in a natural ecosystem. For example :

- Earthworms help in aerating soils and increasing soil fertility by turning it upside down.
- Frog is supposed to consume insects equaling its own weight per day. A recent study indicates that the decrease in frog population in India and Pakistan might be the cause of increased damage of crops by pests and recurrence of Malaria.
- Snakes protect the damage to grains from rodents.

In fact, each species in nature has its own function in an ecosystem for the maintenance of ecological balance in nature.

(*x*) Biodiversity helps in the preservation of socio-economic, aesthetic, cultural and religious values of ecosystems.

(*xi*) Diversity of biological communities in ecosystems (such as lakes, forests, wildlife sancturies, mangrooves, etc.) are useful for picnicks, fishing, and other recreational activities.

For other benefits/importance of biodiversity refer article 8.9 and 8.10 on effects of deforestation and killing of animals.

8.7.2 Factors Responsible for Loss of Biodiversity

The major causes responsible for the reduction in biodiversity are as under :

(*i*) Degradiation and destruction of habitats due to colonisation and clearing of forest areas for settlement or agricultural expansion, commercial expansion, hydel schemes, fire, human and livestock pressure, etc.

(*ii*) Hunting and over-exploitation, mainly for commercial and often illegal purposes.

(*iii*) Introduction of exotic species (accidentally or deliberately) that threaten native flora and fauna directly by predation or by competition and also indirectly by altering the natural habitat or introducing diseases. This is termed as 'ecological cancer'.

(iv) Pollution and poisoing stress on ecosystems.

(v) Due to global warning, suitable climate for given species is changed and thus putting pressure on species with regard to their adaptability. Hence, making them vulnerable to extinction.

(vi) Improper use of agro-chemicals, increase in human population, inequitable land distribution and economic and political policies, and constraints are also responsible for loss of biodiversity to a greater extent.

8.7.3 Conservation of Biodiversity

The loss of biodiversity is not only an ethical tragedy, but also a great social, economic and cultural one. The genetic wealth encoded in this diversity, hardly tapped as yet, is also our insurance against agricultural disasters and crippling diseases. And we all depend on the ecosystem services provided by a biologically rich nature, including water and fresh air. In fact, without biological diversity we would perish.

Efforts have been initiated to save biodiversity both by ex-situ and in-situ conservation.

In-situ conservation means conservation of species in its natural ecosystems or even in man-made ecosystems (*i.e.*, Artificial ecosystems). This type of conservation applies only to wild fauna and flora, and not to the domesticated animals and plants because conservation is possible by protection of population in nature. This is being done by declaring the area as 'protected area' (for example national parks, sancturies, biosphere reserves, etc.) with emphasis either to save the entire area or an endangered species. According to World Conservation Union, protected area is defined as—"An area of land and/or sea specially dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources and managed through legal or other effective means".

At the international level, conventions such as Ramsar Convention on Wetlands, World Fleritage Convention and the recent Bia-Diversity Treaty are of much significance to accelerate conservation. Under the Ramsar Convention, six internationally significant wetlands of India have been declared as Ramsar sites (mentioned earlier). Under World Heritage Convention, five natural sites in India have been declared as world heritage sites. These are Kaziranga National Park (Assam), Manas Wildlife Sanctury (Assam), Sunderbans National Park (West Bengal), Nand Devi National Park (UP) and Keolades National Park (Rajasthan).

Ex-situ conservation means conservation of species (sample of genetic diversity), particularly of endangered species, away from their natural habitat. It is done through establishment of 'gene-banks' which include

genetic resource centres, zoos, botanical gardens, culture collection, etc. Infact, we can say that ex-situ conservation is conservation in captivity under human-care.

8.7.4 Biodiversity Treaty

The Biodiversity Treaty was signed by 171 countries, including India, at the Earth Summit in Rio de Janeiro (Brazil) in June 1992. It came into effect in December 1993. Some of its salient features, whose importance the treaty recognises, are as under :

- Intrinsic value of biological diversity.
- Sovereign rights of states over their biological resources.
- Desirability of sharing equitably the benefits arising from the use of traditional knowledge, skills, innovations and practices.
- Facilitation of access to genetic resources on mutually agreed terms and with prior informed consent of the country providing these, with commitment on the recipient country to share in the benefits of utilizing the resource thus provided.
- Transfer of relevant technologies, including biotechnology, on fair and most favourable terms, from the developed to the developing nations, who are the main providers of genetic resources.

8.8 INDIA'S MEGA-DIVERSE BIODIVERSITY

Biodiversity has three aspects-ecosystem, species and genetics. India is recognised to be uniquely rich in all the three aspects. Clearly, it deserves the title of a megadiversity country. Here almost all the bio-geographic zones of the world are represented. It is estimated that over 75,000 species of fauna and 45,000 of flora are found here.

According to a recent classification done by the Wilf-life Institute of India, the country has ten biogeographic zones—Trans-Himalayas, Himalayas, Desert, Semi-arid, Western Ghats, Deccan, Gangetic Plain, North-East India, Islands and Coasts.

Trans-Himalayas region with its sparse vegetation has the richest wild sheep and goat community in the world. The snow leopard is found here, as is the migratory Blacknecked crane.

In the *North West Desert region* has extensive grasslands. The Great Indian Bustard, a highly endangered bird, is found here.

Adjoining the desert are the *semi-arid areas*, a transitional zone between the desert and the denser forests of the *Western Ghats*. Beyond the Ghats is *Decan Plateau*, a semi-arid region lying in the rain shadow of the Western Ghats.

In the North is the *Gangetic Plain* extending up to the Himalayan forthills. *North East India* is one of the richest flora regions in the country.

It has several species of orchids, bamboos, ferns and other plants. Here the wild relatives of cultivated plants such as banana, mango, citrus and pepper can be found.

The *Island forests* of Lakshwadeep in the Arabian Sea, and Andaman and Nicobar Islands in the Bay of Bengal have some of the best preserved evergreen forests of India. India has a coast line extending over 5,500 kms. Mangroves vegetation is characteristic of estuarine tracts along the coast for instance, at Pichavaram near Madras and Ratna Giri in Maharashtra.

8.8.1 Problems

All these ecosystem are under pressure. Agriculture has largely replaced natural vegetation in most of the Gangetic Plain and in extensive parts of the Deccan. Tea and coffee plantation has largely replaced the forest in the Western Ghats and the North-east. Shifting cultivation is another hazard in the North East region.

Besides agriculture, forests have been under pressure from hydro-electric projects, irrigation and mining. This pressure is particularly high as most mineral wealth and some of the best sites for water impoundment lie in areas which have high biodiversity. Natural forests being replaced by monoculture plantation of teak or eucalyptus have been a cause of biodiversity loss even where forest exist.

In the desert and semi-arid areas where vegetation is relatively sparse, the demand for fodder for livestock and of fuelwood have led to vegetative loss. While there is pressure on all ecosystems, the most fragile ones such as mangroves, wetlands and coral reefs are particularly vulnerable to human activity.

8.8.2 The Concept of Protected Areas

The creation of protected areas in recent times started with the establishment of a national park in 1936 in the foothills of Himalayas. With the setting up of the Indian Board of Wildlife in 1952, and the enactment of the Wildlife Protection Act in 1972, the number of national parks and wildlife sanctuaries grew rapidly. Today there are 69 national parks and 399 sanctuaries covering about 1,30,000 sq. kms or about four percent of India's land areas.

8.8.3 The Concept of Biosphere Reserves

The biosphere reserve concept which is being developed in 14 potential sites extends the conservation initiative beyond national parks and sanctuaries through developing an overall planning strategy for the area.

8.8.4 Management

National parks and sanctuaries are managed by the forest departments. However, the initiative for the creation of protected areas has also been taken by individuals and NGO's. The declaration of Silent Valley as a national park is an example of people's action leading to the declaration of an area as protected. The Wilf Life Fund (WWF) similarly played an important catalytic role in the establishment of 'Project Tiger', a project not only aimed at saving the tiger but doing so to protecting entire ecosystems which form its habitat.

Today there is widespread acceptance that in order to conserve ecosystems, alternatives will have to be found for the communities who live around the protected areas and who rely on the natural resources that are now protected. Buffer zone development programmes are being initiated by forest departments as well as NGO's.

8.8.5 Species Diversity

There are about 75,000 species of animals including 50,000 insects, 4,000 molluses, 2,000 fishes, 140 amphibians, 420 reptiles, 1,200 birds and 340 mammals, and other invertebrates. It is estimated that further exploration may increase the total to about 15,000 animal species. Thus India is home to about 2,00,000 species of living organisms.

Of there, several are endemic to India. Among the larger animals 79 species of mammals, 44 of birds, 15 of reptiles, and three species of amphibians are today endangered. In addition 1,500 plant species are considered endangered.

8.8.6 Strategy

The main strategy for the conservation of species is the protection of viable habitats in representative ecosystems.

Specific measures have been taken to prevent poaching and trade in wildlife products. Special steps to check illegal trade in ivory, rhinohorns, furs, skins, musk and peacock feathers have also been taken.

India is a signatory to the convention on International Trade in Endangered Species of Wild Fauna and Flora.

Certain special have been identified as needing a concerted and specifically directed protection effort. Projects such as Project Tiger, "Save the Barasingha" campaign, and more recently a Project on the Asiatic Elephant, have been embarked upon. These programmes, though focused on single species, are in fact much larger programmes that conserve habitats of a variety of species.

Ex-situ conservation is another thrust in this conservation effort. The Indian Botanical Garden in West Bengal is over 200 years old. While

the Zoological gardens have been looked upon essentially as centres for education, amusement and recreation, they have also played an important part in the conservation of specific species such as the Thamim deer.

8.8.7 Genetic Diversity

A great deal of work need to be done on the conservation of genetic diversity within wild species in India. The Asiatic Lion, for instance, has been saved by protecting the Gir habitat. But in a situation where the entire wild population of 240 lions is confined to one protected area, the genetic diversity will tend to decrease through interbreeding. Within a small population ways would have to be found to mix these with captive animals as well.

Sanctuaries and national parks are isolating populations and there are decreasing chances of one group breeding with another. Experiments at developing corridors between parks and integrating different parks into one larger protected zone are being tried.

India also has a long tradition of domestic animal breeds bred for specific qualities. These include cattle, goats and sheep as well as horses and pigeons for sport. With the focus on increasing milk yields through cross breeding some of the original cattle breeds are in danger of becoming extinct. A few programmes exist for the maintenance of such breeds but the efforts need to be considerably strengthened.

Compared to the animal breeds, much more work has been done on domesticated plants. Both "*in-situ*" and "*ex-situ*" programmes exist for their conservation. However, as in the case of cattle, hybrid varieties are rapidly replacing the domestic varieties. Out of an estimated 50,000 varieties of rice in India, the country may be dependent on just 300 in the next decade.

The replacement of numerous locally adapted varieties with a few high yielding strains in large contiguous areas presents the danger of the spread of serious diseases capable of wiping out entire crop, as happened prior to the Bengal rice famine in 1942.

Ex-situ collection and preservation of genetic resources is done through the National Bureau of Plant Genetic Resources (NBPGR), New Delhi. For wild relatives of crop plants ; the National Bureau of Animal Genetic Resources, Karnal, for domesticated animals, and the National Bureau of Fish Genetic Resources, Lucknow.

The NBPGR is the nodal agency for providing germplasm on request to scientific and research institutions both within and outside India. The department of Biotechnology, established by the Government of India in 1986, aims to guide, supervise and develop biotechnology programmes in the country and to establish infrastructural support for them.

8.8.8 The Mega Facts

Enemies of Ecosystem

(*a*) Expanding Agriculture.
(*b*) Tea and coffee plantation.
(*c*) Shifting cultivation.
(*d*) Hydroelectric projects.
(*e*) Irrigation.
(*f*) Mining.
(*g*) Mono culture plantation of teak and eucalyptus.
(*h*) Demand for fodder and fuel wood.

Steps to Save Ecosystem

- Started with a National Park in 1938 in the foothills of Himalaya.
- Indian Board of Wildlife 1952.
- Wildlife Protection Act 1972.
- At present 69 national park, 39 sanctuaries covering four percent of India's land area.
- Biosphere reserves 14.
- Initiative of private individual and NGO's.

Agencies for Genetic Resources

- Department of Biotechnology 1986 overall supervision.
- National Bureau of Plant-Genetic Resources (NBPGR), New Delhi for wild relative of crop plants ; also a nodal agency.
- The National Bureau of Animal Genetic Resources-Karnal for domesticated animals.
- National Bureau of Fish Genetic Resources, Lucknow.

Species Diversity

- The zoological survey of India, the Botanical Survey of India and the Forest Survey of India do it.
- 45,000 plant species—of it 15,000 species are of flowering plants and 75,000 species of animals—50,000 insect, 4000 mollusas, 2000 fishes, 140 amphibian, 420 reptiles, 1200 birds, 340 mammals.
- Further exploration may increase the number to about 1,50,000 animals species. So India is home to about 2,00,000 species of living organisms.

Endangered Species

- 44 birds.
- 79 mammals.
- 15 reptiles.

- 3 amphibians.
- 1,500 plants.

Steps to Save

- Protection of viable habitat.
- Prevention of Poaching and trade in wildlife products.
- Some target specific projects like "Project Tiger", "Save Barasingha", Project on Asiatic Elephant.
- Ex-situ conservation.
- Botanical Parks.

8.9 DEFORESTATION AND ITS EFFECTS

Deforestation is defined as the reckless felling of trees by human beings for its ulterior ends. Forests are burned or cut down for various reasons, like clearing of land for agriculture, harvesting of timber, expansion of cities, and many more ; but the aim behind all these reasons is 'economic gains'. But we forget that these economic gains are short lived, while the long term damaging effects of deforestation are disastrous and irreversible. At present, we are losing forests at the rate of 1.7 crores hectares annually worldwide.

Deforestation adversely and directly affects and damages the environment and humans both. Some of the ill-effects of deforestation are as under :

(*i*) **Soil erosion.** In the absence of forests/trees, especially on slopes, the soil gets washed away with rain water.

(*ii*) **Expansions of deserts.** Denuded land mass gradually gets converted into sand deserts due to the action of strong winds laden by fragmented rock dust. This effect is more pronounced in rain scared areas.

(*iii*) Migration of population from deserts to other fertile land in search of food, leaving behind vast tracks of sands only.

(*iv*) **Decrease in rainfall.** Forests bring rains due to high rate of transpiration and precipitation. In the absence of forests, rainfall declines considerably.

(*v*) **Loss of fertile land.** Less rainfall results into the loss of fertile land owing to less natural vegetational growth.

(*vi*) **Effect of climate.** The climate of a region is mainly controlled by the rainfall, snowfall, etc. Deforestation causes decrease in rainfall, which in turn increases the climatic temperature.

(*vii*) **Lowering of water table.** Decrease in rainfall results into a lowered water table due to lack of recharging of underground reservoirs.

(*viii*) **Economic losses.** Timber required for engineering purposes is lost for ever.

(*ix*) **Loss of flora and fauna.** Certain species of flora and fauna are getting extinct from the face of planet, mainly due to deforestation.

(*x*) **Loss of biodiversity.** Loss of flora and fauna has resulted into loss of biodiversity, leading to disturbances in ecological balance worldwide.

(*xi*) **Loss of medicinal plants.** There are many species of plants which have medicinal and other advantages, like Neem (Indian Margosa) which has been used in India for centuries as insecticide, fungicide, in medicine and in biofertilizers. Deforestation may lead to the extinction of these types of valuable plants.

(*xii*) **Environmental changes.** The air we breathe, is purified by forests. So, deforestation will lead to increase in carbondioxide and other air pollutants concentration. This will lead to global warming, which is a serious effect as well as threat.

8.10 EFFECT OF KILLING OF ANIMALS

There are about 1,50,000 species of fauna in the world, and India possessed about 75,000 species of animals. The illegal poaching and unauthorized hunting has harmed the fauna to such an extent that many species of animals have become extinct, and many are on the verge of extinction. The killing of animals has far reaching consequences. A few of the effects of killing of animals are as under :

(*i*) **Loss of biodiversity.** Killing of animals has resulted into loss of biodiversity of fauna. We have lost completely about 81 species of mammals, 38 species of birds and aves and 18 species of reptiles and nocturnals. And there are many species which are on the verge of extinction.

(*ii*) Ecological balance is disturbed, when the population of a particular species decreases substantially, or when it became extinct.

(*iii*) Economic loss sustainable harvesting of wild species for food and commercial products is useful, but it must be commercially grown and should not represent a serious threat to the species. Fish, prawn, etc. are useful source of food and oil.

(*iv*) There are many species whose skin, oil, venom, blood, etc. are used in various medicines. So, their killing/poaching can deprive mankind of many useful medicines.

(*v*) Aesthetic and cultural effect. The diversity of fauna life brings as many aesthetic and cultural benefits. Millions of people enjoy fishing, camping, wild-life watching, bird watching and other outdoor activities based on nature. The activities give psychological

and emotional satisfaction. Also, for many people, observing and protecting wild life has religious or moral significance.

(*vi*) Wild species provide a valuable but often unrecognized service in suppressing pests and disease carrying organisms, as they prey upon them or compete with them in some way. Snakes prey upon rodents and thus save tons of grain, earthworms make land fertile.

(*vii*) Reduced population or extinction of some species can free certain other species from their predators or competitors that normally keep their numbers in check. This can lead to their aggressive population growth, which might be considered a kind of ecological cancer that is dangerous to the survival of other species.

(*viii*) The fear of wild animals keeps away illegal cutting of trees by people from forests.