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BIODIVERSITY AND CONSERVATION

Large and diverse communities of biota have thus, occupied distinct climatic zone forming ecosystems. The concept of biodiversity first appeared in 1980. It is, in fact, the shortened form of two words – " biological" and " diversity". It was coined by W.G. Rosen in 1985. Biodiversity (G.K: bios= life, diversity = forms) or biological diversity can be defined as the vast array of species of micro-organisms, algae, fungi, plants, animals occurring on the earth either in the terrestrial or aquatic habitats and the ecological complexes of which they are a apart. It is so because environmental conditions of the area as well as the range of tolerance of the species determine whether or not a particular species can occur in that area.

MAGNITUDE OF BIODIVERSITY

India with about 45,000 species of plants and twice as many species of animals is one of the 12 mega diversity countries of the world. The major area where numerous species are believed to be unknown to science are tropics and coral reefs. Scientists estimate the number of species present in tropics by comparing species richness between tropics and temperate areas. For most groups of organisms, inventories are nearly complete for temperate areas

On this basis, scientists have calculated that the total number of species in the world is anywhere between 5.50 million. The most intriguing question of biodiversity is that more than 70% of all species are animals while plants accounts for only 22%. Amongst animals, insects are the most numerous (about 70%) with present estimate of 7 out of 10 animals. Further the knowledge about protists, archaebacteria and viruses is quite fragmentary.

LEVEL OF BIODIVERSITY

1. Genetic diversity
   - It is the diversity in the number and type of genes as well as chromosomes present in different species and the variations in the genes and their alleles in the same species. On average a bacteriophage has 100 genes, *Drosophila melanogaster* 13000 genes and *Homo sapiens* 30,000 – 40,000 genes.
   - Variation in the genes of a species increase with increase in size and environmental parameters of the habitat. Genetic diversity is useful in adaptation to changes in environmental conditions. It helps in speciation or evolution of new species. Lower genetic diversity within a species or variety may be useful for uniformity in yield as well as higher yield. However it is liable to undergo degradation and prone to mass scale destruction at the hands of fungal or insect attacks
2. Species diversity
   - It is the variety in the number and richness of the species of a region. The number of species per unit area is called species richness. Number

of individuals of different species represents species evenness or species equitability.

- Communities where species are represented more or less number of individual exhibit evenness. Others where one or more species have more individual than other show dominance or unevenness. Species diversity is the product of species richness or evenness or equitability odum et al (1960) calculate species diversity as number of species per thousand individuals while Menhinick (1964) calculates it as number of species in relation to square root of total number of individuals. Diversity index commonly used in ecological studies is Shannon index.

3. Community and Ecosystem diversity

It has three types

(i) Alpha diversity (within community diversity) It is a species diversity. α – diversity is dependent upon species richness and evenness. There is a lot of competition, adjustments and inter relationships amongst members of the same community. Variations are limited.

(ii) Beta diversity (Between communities diversity). It is diversity which appears in a along gradient of habitat within geographical area replacement of species with the change in communities due to different microhabitat, niches and difference in environmental condition.

(iii) Gamma diversity. It is diversity presents in ranges of communities as represented by diversity of habitats/ ecosystems over a total landscape geographical area.

Ecosystem diversity is the variety of forms in the ecosystem due to diversity of niches, tropic levels and ecological process like nutrient recycling, food webs, energy flow, role of dominant species and various biotic interactions. Diversity helps in producing more productive stable ecosystems which can tolerate various stresses like prolonged drought

INDIA AS MEGADIVERSITY REGION

- India has attained a unique distinction as it has been assigned the status of megadiversity nation.
- The country has 10 biogeographical regions namely, Trans Himalaya, Himalaya, Desert, Semi-arid, Western Ghats, Deccan peninsula, Gangetic Plain, Coasts, North-East and Islands.
- India has 89 national parks, 492 wild life sanctuaries, 14 biosphere reserves, 6 wetlands and 5 world heritage sites. The country has also 27 tiger reserves.
- The largest biogeographical region is Deccan peninsula and the most biodiversity rich region are Western ghat and north-east.

- 33% of flowering plants, 10% of mammals, 36% reptiles, 60% of amphibians and 53% fresh water fish are endemic. The richest regions are the Himalayas, Western Ghats. Indian Islands and North-Eastern Hills

PATTERNS OF BIODIVERSITY

LATITUDINAL AND ALTITUDINAL GRADIENTS

(i) Latitudinal gradient

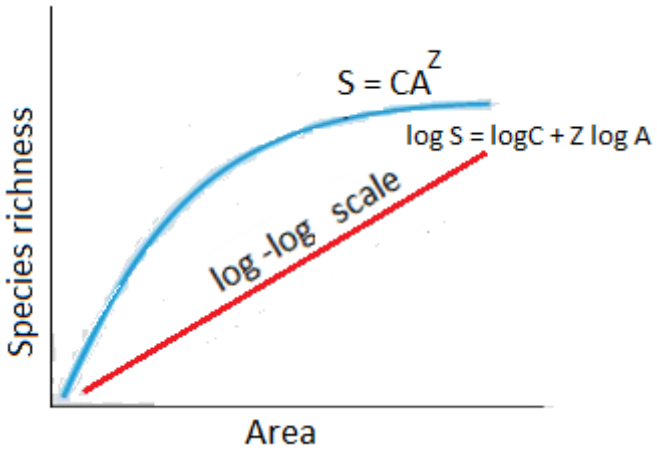
- There is little biodiversity at the poles. It increases in temperate areas but reaches the maximum in tropical rain forests. It is because the tropical rain forest have favourable, conditions with no catastrophes. Harsh conditions exist in temperate areas during the cold season only while very harsh conditions prevail for most of the year in arctic regions. Number of vascular species is 118-236/0.1 ha in tropical forests and 21-48 species 0.1 ha in temperate forests. Their number would 10/0.1 ha in arctic regions.

(ii) Altitudinal gradient

- A decrease in species diversity occurs as we ascend a high mountains due to drop in temperature and greater seasonal variability.

SPECIES - AREA RELATIONSHIP

German naturalist and geographer Alexander von Humboldt found that within a region the species richness increased with increasing area but upto a certain limit. The relationship between species richness and area turned out to be rectangular hyperbola for a wide variety of taxa whether they are birds, bats, fresh water fishes or flowering plants. On a logarithmic scale it is a straight line.



Here S is species richness, 2 is slope of line or regression coefficient, C is y-intercept while A is area.

Regression coefficient is generally 0.1-0.2, regardless of taxonomic group or region e.g. plants in Britain birds in California or mollusks in. New York. However, when the species area relationship is considered for a very large area

like whole continent, retrogression coefficient or slope of the line comes to have Z value of 0.6 – 1.2, e.g. frugivorous birds and mammals of tropical forests of different continents with a steeper line of 1.15.

IMPORTANCE OF BIODIVERSITY

1. Source of food
   There are over 3000 species of food plants, out of which only 150 species are commercialized, 85% of the food output is produced by less than 20 species. Two third of food is being produced by three carbohydrates rich crops-wheat, corn (maize) and Rice. Utilisation of more and more food plants has to be made.
2. Source of fats and oils
   The major plants are soyabean, coconut, cotton seed, peanut and sunflower besides a number of others like sesame, safflower, mustard and oil palm. Few species of oil are being investigated e.g. Bitter colocynth, jojoba seed yield high performance lubricants.
3. Fibres
   The major sources are cotton, flax, jute, hemp, sun hemp, rosella, agave and coir. Search for new superior fiber yielding plants is a continuing process
4. New varieties
   Domesticated commercial species are improved for various traits, especially disease resistance by crossing them with wild relatives. Rice was made resistant to four main diseases crossing it with wild species (*Oryza nivara*) from India. Similarly, Potato has been made resistant to late blight (trait from *Solanum demissum*) Potato Mosaic Virus Y (trait from *solanum stoloniferum*), Fusarium and five races of cyst nematodes (trait from *Solanum spegazzini*)
5. Drugs and medicines
   A number of drugs are based on plant products. Rosy periwinkle (charanthus roseus = Vinca rosea) yields alkaloids (Vicristine and vinblastine) which are useful for treatment of leukaemia. The same are now being synthesized chemically. Some other plant derived drugs are Morphine (*Papaver somniferum* for pains), quinine (from bark of cinchona ledgeriana for malaria), taxol (from bark of Yew; *Taxus brevifolia* and *Taxus baccata* for treating cancers), reserpine (from Rauvolfia serpentine for treating blood pressure and schizophrenia) etc. 25% of all drugs are currently being obtained from 120 species of plants. Traditional systems of medicine all over the world uses thousands of local/ wild plants for treating various maladies. Innumerable synthetic products can be manufactured from plant chemical. They are called botanochemicals.
6. Aesthetic value

Biodiversity has a lot of aesthetic and attraction value. Ecotourism, bird watching, wildlife, pet keeping and gardening are all rewards of aesthetic value of biodiversity.

7. Cultural benefits
   Historically people having linked themselves with certain specific plants and animals. Majority of the Indian homes have specimens of *Ocimun sanctum* (Tulsi) growning in pots. Trees of *Ficus religiosa* (Peepal) and *Prosopis cineraria* (Khejri) are held sacred. They are planed and worshipped. Many birds are considered sacred. Snakes are worshipped. Every country and state takes pride in recognizing a particular plant and particular animal as symbol of national and state pride and cultural heritage.
8. Ecosystem services
   Maintenance and sustainable utilization of useful products and services of various ecosystems as well as individual species require the presence of biodiversity. Forest and oceanic systems control climate and maintain gaseous composition of atmosphere. Amazon rain forest have been called lungs of planet earth since they give out 28% of total oxygen. Biodiversity is essential for natural pest control maintenance of populations of various species, pollination by insects and birds, nutrient cycling, conservation and purification of water, formation and protection of soil etc. The services are valued at 16-54 trillion dollars per year.

THREATS TO BIODIVERSITY

The world is facing accelerated rate of species extinction, largely due to human interference. There are four major causes the evil quartet

i) Habitat loss and fragmentation: Overpopulation, urbanisation and industrialization require additional land every year. It can come through destruction or fragmentation of natural habitat through filling wetlands, ploughing grasslands, cutting down trees, burning a forest and clearing some area of vegetation. Animals requiring large territories are badly affected. Migrating animals would go astray and get killed.

ii) Over –exploitation: Excessive exploitation of a species, whether a plant or animal reduces size of its population so that it becomes vulnerable to extinction. Dodo, passenger pigeon, three subspecies of Tiger and Stellar sea cow have become extinct in the last 500 years due to over-exploitation by humans. Many marine fish populations are declining around the world.

iii) Alien species invasions
   Non native or alien species are often introduced inadvertently for their economic and other uses. They often become invasive and drive away local species. Island ecosystems are most vulnerable due to small size and small number of species.

Water hyacinth (Eichhornia crassipes) was introduced in India waters to reduce pollution. It has clogged water bodies including wetlands at many places resulting in death of several aquatic plants and animals. Nile perch (a predator fish) was introduced in lake Victoria of South Africa. It killed and eliminated ecologically unique assemblage of over 200 native species of small Cichlid fish.

iv) Co-extinctions
Certain obligatory mutualistic relationship exist in nature e.g. Promuba yucca-selles and Yucca. Extinction of one will automatically cause extinction of other. If the host fish becomes extinct, all the parasites exclusively found on it will also become extinct.

WILDLIFE CONSERVATION

Wildlife conservation is necessary for lot of reasons

i) Balance of nature : There is a balance of nature in an ecosystem. The different living organisms live in equilibrium. The food web consists of an interlocking system of food chain, the destruction of any species of wildlife in an ecosystem can disrupt the entire balance of nature.

ii) Commercial value of wildlife: We have a rich variety of wild life. Government established national parks and sanctuaries attract many tourists from abroad. This is valuable source of foreign exchange. Surplus animals are exported to foreign zoos and parks, also earning foreign exchange.

iii) Biological studies : Naturalists and behavior biologists can study the ecology, physiology and behavior of wildlife in their natural habitats, thus contributing to our knowledge of biology

iv) Sport and recreation: The sport of hunting is now greatly restricted, because of the declining number of animals. Wildlife centers, however, provide good recreation in the form of camping and trekking.

CONSERVATION OF BIODIVERSITY

There are two types of conservation strategies – in situ (on site) and ex situ (off site)

IN SITU CONSERVATION

It is conservation and protection of the whole ecosystem and its biodiversity at all levels in order to protect the threatened species. However it is not economically feasible to conserve all biological wealth and all the existing ecosystems

Hot spots

They are areas with high density of biodiversity or megadiversity which are also the most threatened ones.

Ecologically hot spots are determine by four factors

(i) Number of species/ species diversity
(ii) Degree of endemism
(iii) Degree of threat to habitat due to its degradation and fragmentation
(iv) Degree of exploitation: Mayers (1988) initially identified 12 hot spots with 14% of plant species in an area of only 0.2%. 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 has three hot-spots : Indo Burma, Himalayas and Western ghats-srilanka. India is even otherwise a country of mega biodiversity with 2.4% of land area and having 8.1% of global diversity

Protected areas

They are ecological / biogeographical area as where biological diversity alongwith natural and cultural resources is protected, maintained and managed through legal or other effective measures. They are delimited on the basis of biological diversity e.g. cold desert (Thar), wetland (Assam) saline swampy area (sunderbans) etc. Protected areas include national parks, sanctuaries and biosphere reserves.

National park

They are areas maintained by government and reserved for betterment of wildlife cultivation, grazing, forestry and habitat manipulation are not allowed. There are 89 national parks in India occupying nearly 1.1% of geographical area

Sanctuaries

They 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, tilling of land etc are allowed.

Biosphere reserves

They are multipurpose protected areas 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 tribal and domesticated plant (animals genetic resources)

Creation of biosphere reserve was initiated in 1975 under MAB programme of UNESCO. Till 2002, 408 biosphere reserves had been established in 94 countries. In India, 17 biosphere reserve have been set up by now. Each biosphere reserve has

i) Core or Natural zone: No human activity is allowed. The area is undisturbed and legally protected ecosystem

ii) Buffer zone: It surrounds the core area. Limited human activity is allowed like resource use strategies research and education

iii) Transition zone: It is the outermost or peripheral part of biosphere reserve where an active cooperation is present between reserve management and local people for activities like settlements, cropping recreation, forestry and other economic uses without disturbing ecology. Transition zone has different parts like forestry, agriculture, tourism and restoration region. Restoration region is degraded area which is selected for restoration to near natural form.

Importance of biosphere reserves includes:

i) Restoration – Biosphere reserve help in restoration of degraded ecosystems and habitat

ii) Conservation – They are means of conserving genetic resources, species, ecosystems and landscapes without uprooting the local people.

iii) Development – They ensure culturally socially and ecologically sustainable economical development

iv) Monitoring- there is a regular monitoring of development and conservation progress

v) Education and Research – Each biosphere reserve supports education and research in various ecological aspects of the ecosystem / biome. There is also exchange of information about research, restoration, conservation and development aspects at the national and global levels.

MAB program

Man and biosphere program is an international biological programme of UNESCO which was started in 1971 but was introduced in India in 1986. MAB has studied human environment impact of human interference and pollution on abiotic and biotic components and conservation strategies for present as well as future.

EX SITU CONSERVATION

Offsite collections

They are live collections of wild and domesticated species in botanical gardens, zoos etc. Currently, they are more than 1500 botanical gardens and arboreta (gardens with trees and shrubs) laving more than 8000 species. Many of them have seed banks, tissue culture facilities and other ex-situ technologies. The number of zoological parks is more than 800. They have about 3000 species of mammals, birds, reptiles and amphibians. Most of them have well managed captive breeding programmes. Captive breeding is resorted to in those cases where the number of surviving individuals is so small that there is no realistic

chance of in situ survival. As the number of surviving increases, individual are selectively released in the wild.

Offsite collection can be used to restore depleted populations, reintroduce species in the wild and restore degraded habitats.

Gene Bank

They are institutes that maintain stocks of viable seeds (seed banks), live growing plants (orchid), tissue culture and frozen germplasm with the whole range of genetic variability.

(i) Seed banks: Seeds are of two types orthodox and recalcitrant.

- Orthodox seeds are those which can tolerate reduction in moisture content (up to 5%), anaerobic conditions and low temperature of -10^{o}C to -20^{o}C or even lower for prolonged periods e.g. cereals, legumes. At intervals seeds are allowed to germinate from plants and develop fresh seeds for storage
- Recalcitrant seeds are those seeds which get killed on reduction of moisture and exposure to lower temperature e.g. Tea, cocoa, jackfruit, coconut. They can be stored for shorter duration after treatment with fungicides in room having air and normal oxygen.

(ii) Orchards: Plants with recalcitrant seeds are grown in orchards where all possible strains and varieties are maintained e.g. Litchi, oil palm, rubber tree etc.

(iii) Tissue culture: It is carried out through callus formation, embryoids, pollen grain culture and shoot tip culture for those plants which are either seedless, have recalcitrant seed, variable seed progeny or where clone is to be maintained. The method is useful in maintaining a large number of genotypes in small area rapid multiplication of even endangered species and for hybrid rescue. Shoot tip culture maintains virus free plants. It is used for international exchange of germplasm in vegetatively multiplied cultures e.g. Banana, Potato.

(iv) Cryopreservation: Preservation at -196^{o}C (liquid nitrogen) can maintain tissue culture, embryos, animal cell/tissue, spermatozoa indefinitely. The cryopreserved material is revived through special technique when required

BIODIVERSITY ACT (2002)

For protection of India's rich biodiversity and associated knowledge against their use by foreign individuals and organizations without sharing the benefits arising out of such use and to check biopiracy.