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ECOLOGICAL LEVELS OF ORGANIZATION (ORGANISM TO BIOSPHERE)

There is definite ecological hierarhy starting from an individual to biosphere as a whole. Brief descriptions about the species population, community ecosystem and biomes are being given to introduce about the levels of organization. Biosphere, which includes all forms of life occuring in different geographical regions of the earth irrespective of their habit and habitat alongwith their physical environments is studied in ecology. It, thus, covers the basic and fundamental studies of hydrosphere, lithosphere and atmosphere, *i.e.*, the organisms found in water, on soil and in air and how they adjust themselves in their environment, how they interact with their physical environment for exchange of materials, utilization of available resources and energy and how they help in maintenance of a balanced ecosystem?

It is not easy to study biosphere as a whole, as it includes wide varieties of ecosystems and communities in various biomes.

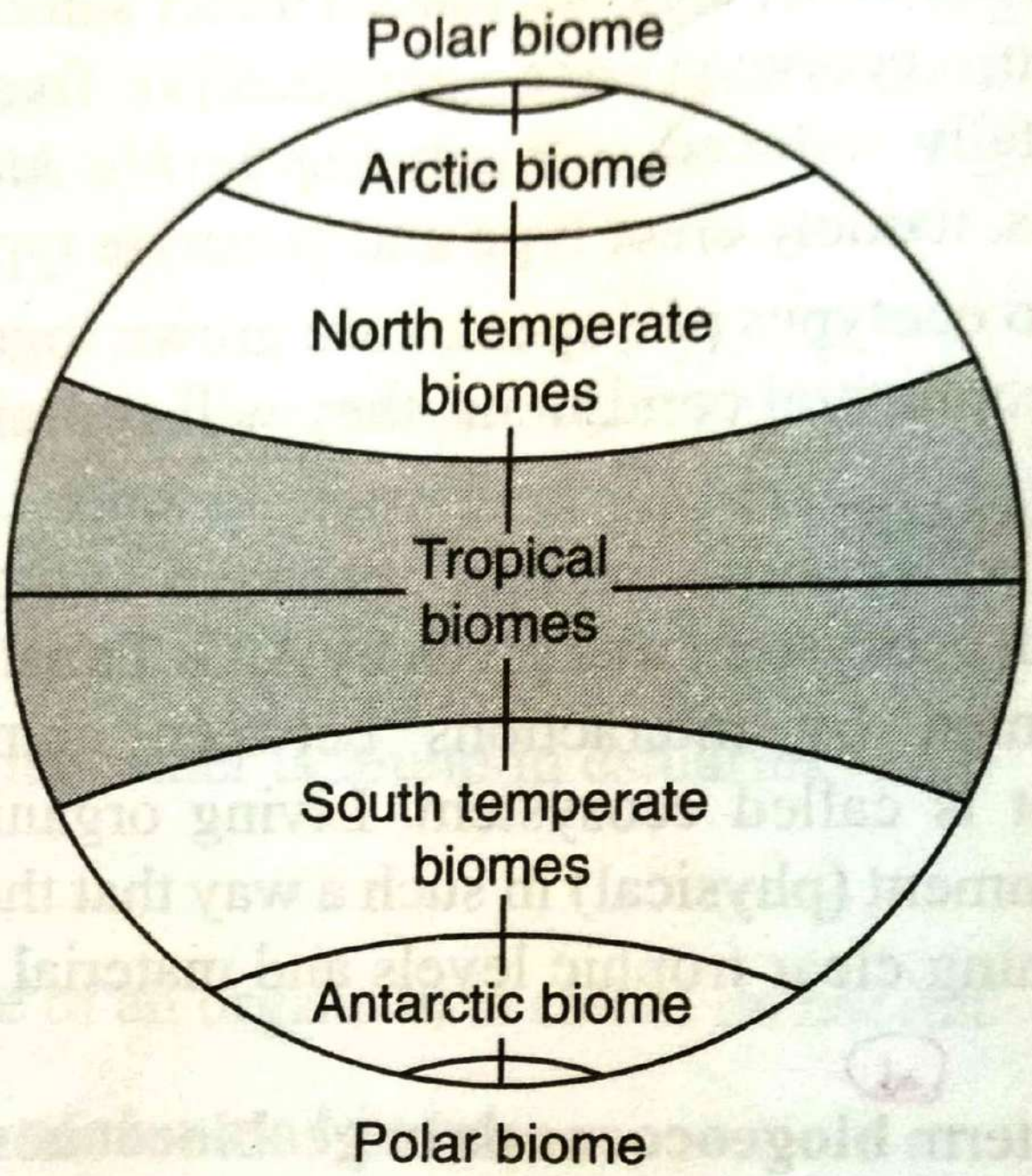

Fig. 26.1 Major Biomes of the Earth

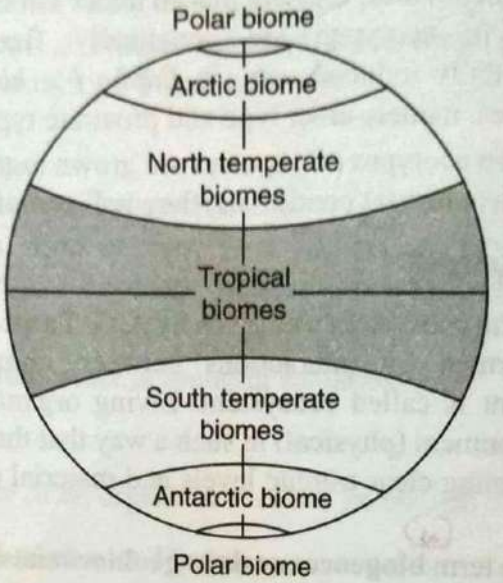

Fig. 26.1 Major Biomes of the Earth

In view of this, the biosphere has been subdivided into many biomes or major ecological categories formed by several ecosystems and their communities. If we proceed from the north pole towards south pole, we find **arctic region,** just below the north pole, then **north temperate region,** then **tropical region** covering the region of equator, then **south temperate region, antarctic region** and the south pole. All these geological zones or regions have been given the rank of **biomes.** All types of communities and ecosystems occurring in a specific biome are studied separately. Biome is an aggregate of several communities and their ecosystems. For examples, in the tropical region, we have forests, grasslands, deserts, fresh waters, marine environments, etc., each with their own ecosystem and own biotic communities. Even in forest, we have wide varieties, such as tropical wet and dry deciduous forests, tropical evergreen forests, tropical thorn forests, tropical littoral forests, etc., all with their own characteristic biotic communities. Step by step studies of different parameters (species, species composition, populations, communities, biomes and ecosystems) of biosphere should be carried out for better understanding of functional parameters such as exchange of materials, resource utilization, energy and minerals uptake, retention and release operating in different geological regions of the earth.

SPECIES

Individual organism or a species is the basic unit of ecological hierarchy. Each individual has a specific identity and specific genetic constitution which is inherited from generation to generation through sexual reproduction. Individuals may be **monoecious** (bisexual) or **dioecious** (unisexual). Monoecious individuals are very common in plant kingdom. Dioecious plants are rare in distribution. On the contrary, animals are usually dioecious and often showing sexual **dimorphism** (male and female individuals externally

dissimilar) or **polymorphism** (formation of different forms of individuals within the same organism or species) as in honey bees, termites, etc.

A population develops from aggregation of inbreeding individuals of a particular species in a given area at specific time and is characterized by its specific mode of dispersal, density, frequency, abundance, sex ratio, birth rate, death rate, reproductive ability, etc. Population growth is influenced by several external and internal factors. The environment has a natural check on population. Increase in density or frequency of an individual in a population ultimately results in severe intraspecific competition between the individuals for space, light, nutrition and water causing high rate of mortality of individuals (**Survival of the fittest** due to **struggle for existence**).

The individuals in a population has the potentiality to increase in number through interbreeding for producing fertile offsprings. The species may be monotypic or polytypic. In later case, the individuals have more varieties or subspecies or races. Polytypic forms of species can thus be divided as follows:

Races: Group of individuals within a species forming a permanent breed, *e.g.*, human beings where 7 different races have been recognized Negroid, Manggoloid, Caucasoid, Polynesian, lndo-americans, Red-indians, Australians and Bushman. Members of these races can breed freely.

Cline: It represents a transient population in between the two ecotypes or biotypes. Biotypes are individuals of a species carrying similar genotype.

Deme or Local Population: An assemblage of closely related interbreeding individuals of a species occurring in an area. They share a common gene pool.

Speciation: It represents the phenomenon of evolution of new species from the existing species through genetic drift or mutation or polyploidy or due to physical, geographical or reproductive barriers.

Allopatric Species: Species that occur in different geographical regions or are separated by spatial barriers are said to be allopatric species. It is very difficult to distinguish them due to their almost identical phenotype or look.

Sympatric Species: The species that occur in the same geographical area (but not necessarily the same niche) are said to be sympatric species. These species have marked external differences and can easily be separated by mere naked eyes

abrupt and is mainly due to crossing over, mutation, polyploidy of interspecific hybridization.

Sexual Dimorphism: A difference in the phenotype of male and female individuals of the same species, specially in external ornamentation, colouration and courtship behaviour refers to the phenomenon of sexual dimorphism. Such traits which distinguish sex over and above the primary sexual organs, are referred to as secondary sexual characters.

Sexual dimorphism can arise in three ways, *viz.*, (a) the dissimilar sexual functions of male and female individuals. Females produce larger female gametes or eggs, facundity is often directly related to body size. This may be the reason for larger body size of female individuals. Special nutritional requirements of females may lead females to use environment differently than the males. (b) sexual dimorphism may also develop in some males to contest with other males during courtship and thus they develop elaborate weapons for combat (Hornes of mountain sheep or antlers of deer). Males that win such contests are more likely to gain favour of females. (c) The third sexual dimorphism may arise through direct excercise of the choice of individuals of the opposite sex. The males have to compete among themselves for getting oppertunity to mate.

Sexual Polymorphism: In honey bees and termites, different types of individuals are found in a colony which differ in structure, function and sexual behaviour. The occurrence of several types of individuals within the same kind of organism is referred to as polymorphism. In colony of honey bee, queen, worker and drone are found for specific functions. Similarly, in the colony of *Physalia*, individuals of different kinds are found to perform the functions like feeding, protecting, reproductive and floating. Such polymorphism is also found in some flowers of wild individuals. Polymorphism is an adaptation for survival of the species.

Reproductive Isolation: The individuals of a species have the ability to interbreed with one another in nature but not with organisms of other species. This is due to reproductive isolation (inability to interbreed with other organism) and it helps in maintaining the genetic set up of individual of different species. In absence of reproductive isolation, the genetic stability of an individual can not be maintained. There shall be constant interspecific or inter-generic hybridization, resulting in origin of new species, mixing of characters of two different species, development of new characters in the individuals due to interaction of genes, etc.

Members of two different species may breed under laboratory conditions (*e.g.*, Formation of *Triticale* from intergeneric hybridization between *Triticum* and *Secale* or development of new world cotton through interspecific hybridization between the old world cotton and American upland cotton). Similarly, Mule was produced as a hybrid of donkey and horse.

In nature, interspecific or intergeneric hybridization is prevented by various biological or environmental barriers. However, inbreeding between the members of two different species or genera can occur if the isolating conditions are removed and more hospitable conditions are provided artificially. In plants, the embryo of rare hybrids does not grow properly in ovules but they can easily be grown in culture medium supplemented with desired hormones, amino acids, vitamins and minerals to provide most hospitable environment for proper growth, development and differentiation of embryo to form viable seedlings.

Origin of Species

Nature always prevent interbreeding just to maintain the phenotypic as well as genotypic identity of different species which help in their identification or recognition. New species usually originates by :

(a) Intergeneric hybridization (*e.g.*, *Triticale* produced by hybridization of *Triticum* and *Secale,* plumcot produced by hybridization of Apricot and Plum, *Raphanobrassica* produced by *Raphanus sativus* and *Brassica oleracea*, etc.)

(b) Interspecific hybridization (*e.g.*, new world cotton produced by old world cotton and upland cotton).

(c) Crossing over

(d) Polyploidy

(e) Mutation, etc.

In most of the cases, interbreeding is possible through manipulation of environment, removal of isolating factors, removal of natural barriers, providing more hospitable environment under laboratory conditions, etc.

Polyploidy can be induced using colchicine treatment. Spontaneous polyploidy also occurs in nature.

POPULATION

A population is defined as a group of individuals of a single species living in a given area. It is permanant group of interbreeding individuals in a given area. defined either by natural boundaries or arbitrarily for the purposes of ecoloical studies.

Population structure includes the spatial arrangement (spatial structure), genetic variation (genetic structure) and the dynamics (including natality, mortality, biotic potential, carrying capacity, etc.).

Population structure includes features such as density, abundance, spacing, movment of individuals in different age groups, genetic variations, etc. Special structure of a population reveals the spatial arrangement of individuals in a given habitat, the size of population and pattern of movement of individuals within and between populations (Emigration and immegration). Genetic structure reveals genetic variations and population size and how these variations developed in a

population. The dynamics reveals rate of birth, rate of death, vital index, biotic potential, growth rate, etc. It also includes emigration (movement out of a population) and immigration (movement into a population) of individuals continuously over time.

Within the geographical range of a species, individuals are not equally numerous in all regions. Individuals generally prefer areas of most suitable habitat in local population which is often called sub-population. Movement of organisms away from their place of birth or away from the areas of high population (to avoid competition) is referred to as dispersal. Dispersal of individuals within a population describes their spacing with respect to one another. Dispersion pattern may be clump type, random or evenly spaced type. In clump type distribution, individuals are found in discrete groups whereas in random type, distribution is random. Uniform and homogeneous distribution is seen in spaced type dispersion.

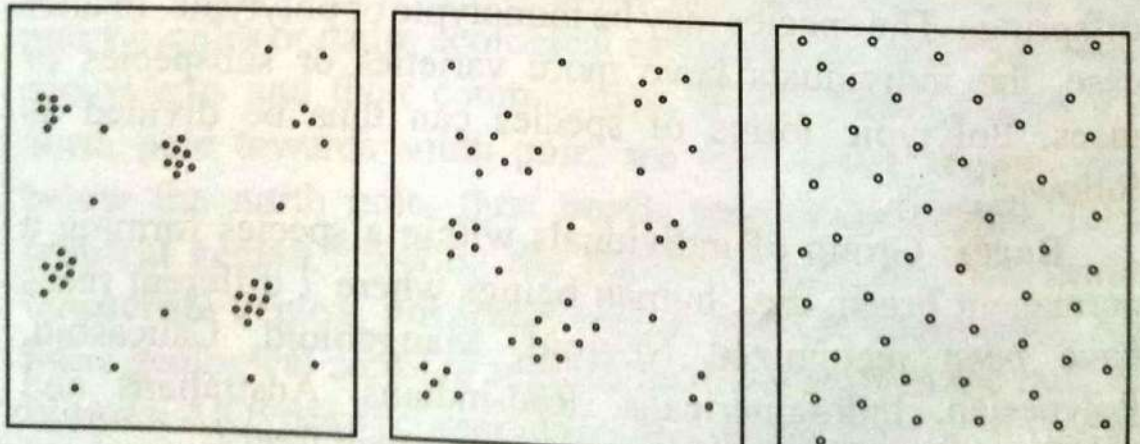

Fig. 26.2 Dispersion pattern of Individuals in a population