

VEGETATION SYSTEM

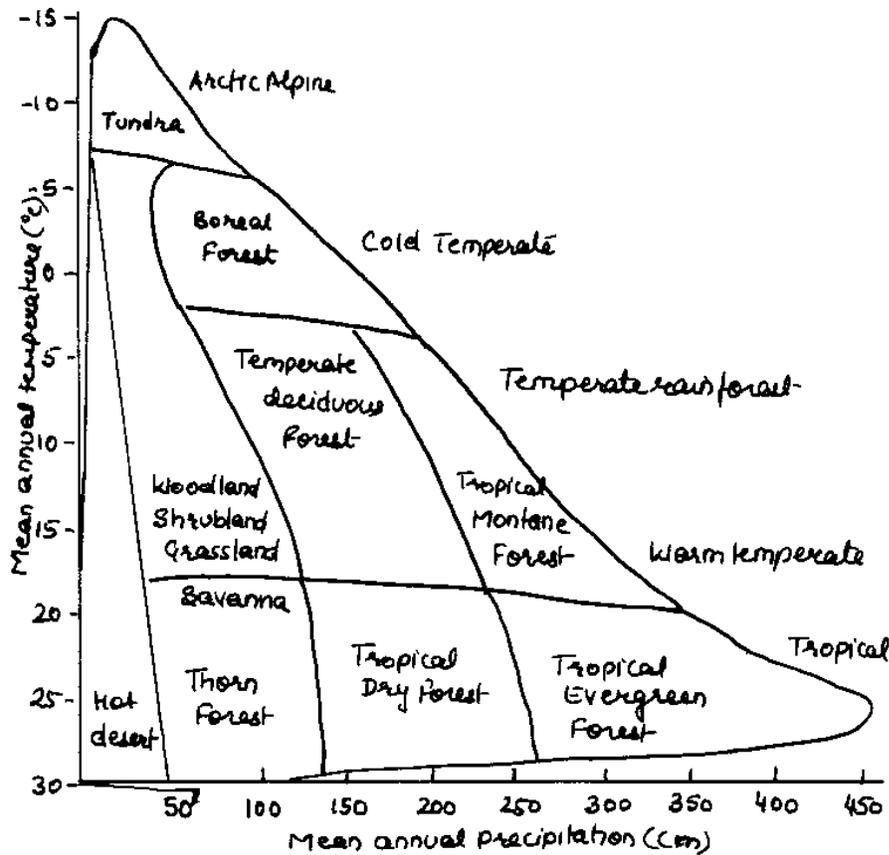
Ecosystems are communities of related organisms. A biome is a group of ecosystems with similar plant and animal species that exists under a similar climate. Terrestrial biomes are based on the dominant plant species while oceanic biomes are defined using the predominant animal species. *The major biomes based on natural vegetation are*

- Tundra
- Boreal/Taiga
- Temperate deciduous
- Temperate grassland
- Schlerophyll
- Desert
- Tropical rainforest
- Tropical deciduous
- Tropical savannah
- Complex highland vegetation.

Tundra – The Tundra biome develops under a climate with very low annual temperatures, long, bitterly cold and windy winters, extended periods of winter darkness and short cool summers. Annual precipitation is low, although the land remains snow bound for upto 8 months of year. Common plants are lichens, mosses, grasses and annual flowering plants and species adapted to little moisture and extreme temperatures. During the short summers, the upper layer of permafrost melts, creating a soggy landscape of shallow lakes, marshes, bogs and ponds. Hordes of mosquitoes, black flies provides food source for migratory birds that nests here during summers. Along the southern edge of tundra, stunted conifers survive in sheltered

hollow or river valleys. The low rate of organic decomposition, the shallow water logged soils and slow plant growth makes it one of the most fragile biomes.

Boreal – Also referred as taiga or coniferous, it develops under subarctic conditions with short summer growing seasons, long cold winters and moderate precipitation. These forests are dominated by a few species of coniferous evergreen trees, including pine, spruce, fir cedar and larch. Conifers are adapted to



survive cold climates and infertile, acidic poorly drained soils. Their short branches, waxy needles and resinous bark reduce the loss of moisture and warmth during winters. Long, shallow, root systems maximize the intake of nutrient from infertile soils. Tough, hard cones protect seed from harsh weather conditions and from animals and birds. Since the needles remain on

the trees throughout the year, they take maximum advantage of the short summers to produce enough food to survive the long winters. The close spacing of the trees means little sunlight penetrates to ground level and lower levels of vegetation are non-existent. The waxy, acidic nature of coniferous needles combined with slow rates of decay, results in thick mat of needles and forest litter covering the ground.

Temperate Deciduous – These are found where summers are relatively long, winters are mild and there is abundant moisture year round (750-2000 mm year round). The longer growing season allows time for the growth and development of leaves. Deciduous forests are dominated by a few species of tall, broad

leafed trees, including maple, oak, beech, walnut, hickory, poplar, chestnut. The ground under these forests is generally covered with leaf litter which breaks down into humus releasing basic nutrients for plant growth.

Temperate Grassland – In the interior and rain shadow areas of the continents, lower precipitation and higher evaporation rates results in the dominance of grasslands, rather than forests. Grasses are adapted to the semi arid and sub humid climates, growing quickly and producing seeds in the short, rainy periods. The seeds germinate and grow when spring moisture is available. Long roots reach deep into the soil to find moisture. The availability of grasses lie dormant during the cold winters is an important adaptation for survival. Growing conditions vary widely within the temperate grassland biome. As the trees thin on the margins of humid forests the open spaces are entirely covered by tall grasses upto one meter in height. As the climate become drier, the grasses becomes shorter and shorter and eventually is replaced by bunch grasses with areas of bare soil between. Along the margins of deserts, the spacing between the bunch grasses becomes greater.

Schlerophyll – This develops under Mediterranean climate. The areas fringing the Mediterranean sea contain the largest area of oak shrub grassland vegetation known as Schlerophyll forest biome. This biome includes trees such as cork oak, live oak, white oak, olive and various species of pine. In Australia and Africa, eucalyptus and acacia trees are common. Shrubs include the wild lilac, poison oak and mountain mahogany. The vegetation has adapted to a climate where precipitation occurs mainly during the cooler winter months and summers are hot, sunny and rainless. The adaptations to dry summers include long root system, thick bark on gnarled branches and trunks, leaves glossy and thick and are of small size. The tree cover is from 25-60% of the ground surface with the remainder covered by shrubs and grasses.

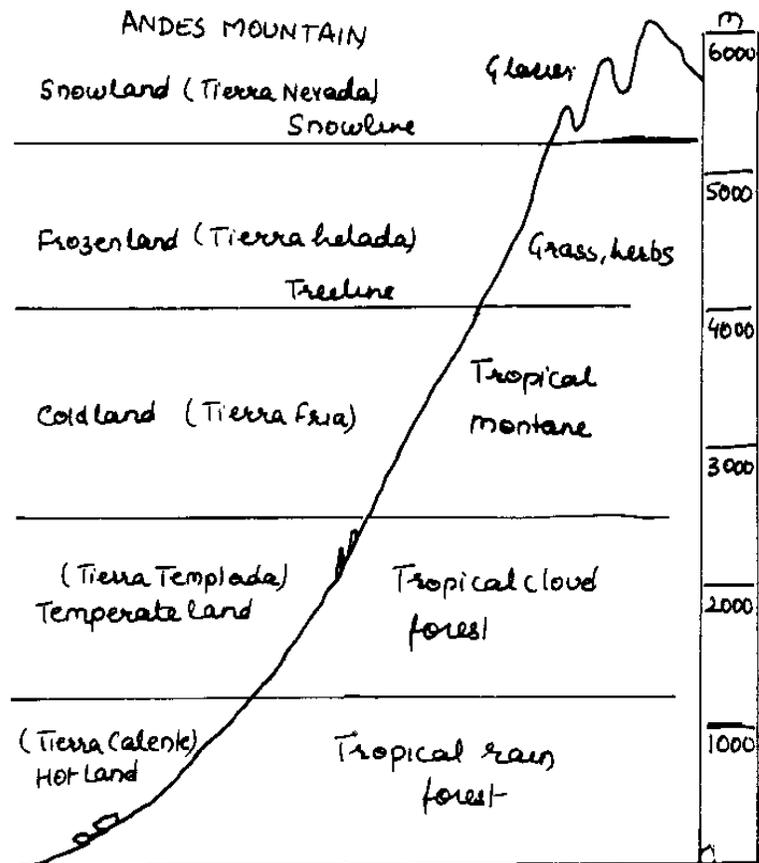
Desert – Desert vegetation must adapt to dry periods that can last several years. The term xerophyte is applied to such plants that have adapted to extreme dry climate. Adaptations include thick, waxy skins protecting large, pulpy interiors that store moisture long thin protective needles for leaves and wide spacing of plants competing for scarce moisture. Common shrubs such as sagebrush and creosote bushes and grasses have deep root systems and an ability to become dormant during long dry periods. When desert showers occurs plants make maximum of their moisture. The plant cover only a small percentage of ground surface less than any other biome except for the tundra.

Tropical rainforest – In these biomes (rainforest), precipitation is almost a daily event. The air is constantly humid and the warm temperatures scarcely change from day to night. Growing conditions are so favourable that these forests contain by far the largest number of plant, insect and animal species of any biome. The dominant species are tall, broad leaf evergreen trees. The tops of these trees form a continuous ‘canopy’ usually about 35-40 m above the ground that blocks most of the sunshine from reaching the ground below.

Shorter trees are able to survive in breaks in the canopy. Ferns grow in the dim light and abundant moisture at ground level, but the canopy blocks the sun so effectively that few species grow on the forest floor. Climbing vines use the trunks of tall trees as supports for growing upward into the sunlit areas of upper canopy. Upto 300 different species of trees may be found in one hectare of forest. The most valuable trees are the tropical hardwood including ebony, ironwood and mahogany. The leaves of the trees are large with leathery surface. The trees of the rainforest are never dormant because of the great competition among trees for sunlight and nutrients and the constant high temperatures and precipitation that enable growth to occur all year round. While forests are evergreen, trees lose their leaves in steady stream throughout the year. The leaf litter thus is typically concentrated in these forests.

Tropical Deciduous – In the tropical regions where rainfall is concentrated in a distinct wet season, tropical deciduous or monsoonal forests develops. Such forests must survive dry seasons where temperatures are high and evaporation greatly exceeds rainfall. These conditions causes deciduous open stand of vegetation. The trees are shorter (12-30 m in height), more widely spaced and less diverse. This reduces the competition for light and nutrients and allows dense thickets of shrubs or bamboo to grow at ground level.

Tropical savannah – Africa has the greatest extent of tropical savannah and grassland biome, which develops under climates with one or two wet seasons separated by long, dry periods. Temperature and evaporation rates are higher though the value of annual precipitation is considerably lower than monsoonal region. Widely spaced trees with tall tropical grasses are the characteristics. Thus the trees generally have flattened tops and thick, rough bark. Some are xerophytes



with small leaves and thorn such as acacia. Towards deserts, the trees paves way to short thorn bushes and bunch grasses.

Complex Highland vegetation – Vegetation within mountain region varies widely depending on climate, altitude and latitude. Changes in temperature and exposure give rise to a vertical zonation of vegetation biomes over short horizontal distances.

In the temperate regions, lower, windward slopes of mountains may be clothed in deciduous or coniferous forests. As elevation increases the temperature decreases, the tree size decreases and species may change from deciduous to coniferous. If the mountains are large enough, the climate may become too cold or windy for the survival of trees and mountain meadows with short flowering plants, mosses, lichens and bushes takes over. These meadows are similar to the tundra biomes of higher latitudes. High tropical mountains, such as the eastern Himalayas of Asia have vegetation zones that includes many of world's biome.

WILDLIFE

The geographical study of animals is called Zoo geography. Animals are more mobile than plants. Most of the plants are autotrophs, phototrophs and primary producers, whereas all animals are consumers, which are herbivores, carnivores and omnivores. *The following characteristics of animals differentiate from plants:*

1. Unlike plants, animals do not prepare their own food. They depend on plants for their food. Thus, animals are consumers and heterotrophs, whereas plants are producers and autotrophs.
2. Animals are mobile, whereas plants are mostly static in their places.
3. Every animal has a complete life-cycle.
4. Animals do not have cell vacuoles and rigid cell walls, while most of the plants have these features.
5. Animals are very much sensitive to external stimulating events and they response quickly to such events.

Classification of Animals

Animals are classified according to various criteria. However, their heirarchial classification is based on maximum similarity and mutual relationships. On the basis of their hierarchical orders, animals are divided into the following classes (from higher orders to lower orders):

Animal Kingdom – phyla – classes – orders – family – genera – species

The major phyla of the animals include the following:

1. **Protozoa:** It include single celled microscopic organisms. There are 30,000 known species of this group. They mainly live in aquatic habitats.

2. **Coelenterata:** These animals do not have stomach. There are 9600 known species of this group. These mostly live in saline water, while a few live in freshwater. These are carnivores, and include hydro, jelly fish, medusae, sea anemone, cereals, etc.
3. **Plathelminthes:** this group includes worms, flat worms, tapeworms, liver fluke etc. These are very long body animals and usually live in fresh water. There are 15,000 known species of these animals which represent a wide range of parasites.
4. **Annelida:** These are red blooded worms having a long and segmented body composed of several rings. There are 7,000 known species of this group. They live in different habitats, e.g. marine waters, fresh water, land, etc. several para sites like leeches are also included in this group.
5. **Arthropoda:** These animals also have segmented body, composed of several rings. There are 7,65,000 known species of this group. Crustacea, arachnids, peripatuses, millipedes, centipedes, insects, tardigrades etc. belong to this group. These animals live in a variety of habitats, e.g. marine, fresh water, soil, land etc. This group of animals is divided into three major classes:
 - (i)**Crustacea:** These animals have jointed legs with five or more pairs of joints in their legs. Most of them live in marine water. Lobster, crabs, crayfish, prawn etc. are the important members of their class.
 - (ii)**Insecta:** these animals have three pairs of walking legs, are usually winged in adult life, breathe air by means of tracheae, and undergo metamorphosis in their life span. They have the largest number of species. They are harmful to man as they spread disease. Most of these animals live in land habitats. Some of them, e.g. honeybees, butterflies are useful to human beings.
 - (iii)**Arachnida:** These animals have four pairs of walking legs, e.g. spiders, scorpions, mites, etc. They most live on land.
6. **Mollusca:** These animals have soft body and tender organs hidden under a strong outer shell like snails. Clam, aplysia, octopus, etc. are the other examples of this phylum. Most of them live in aquatic habitats. There are one lakh known species of this group.
7. **Echinodermata:** It includes vertebrates which have spines and body walls strengthened by calcareous plates. These animals usually move by tube feet and live in marine habitats. There are 5,700 species of this group.
8. **Chordata:** This group includes animals which have bones and spines. They are divided into two major groups: (i) Protochordates – which have notochord but no vertebral column, and (ii) Chordate – which are vertebrate animals. This phylum includes the largest animals of the animal kingdom, and has 45,000 known species. There are five major classes of this phylum:

- (i) **Pisces:** These include vertebrate cold blooded animals living in aquatic habitats. Fishes are the most important members of this group.
- (ii) **Amphibian:** These animals live in both aquatic and terrestrial habitats but lay their eggs only in water, e.g. frogs.
- (iii) **Reptilia:** This group consists of those animals which creep on the ground and some swim in water. They have scaly skins (e.g. snakes, crocodiles, lizards). Most of them live on the land, but some live in both aquatic and land habitats (e.g. crocodile, alligators).
- (iv) **Aves:** These are warm blooded animals which have legs, wings and feathers (e.g. birds). They live in land habitats.
- (v) **Mammalia:** These are warm blooded, hair-covered animals which breathe in oxygen. These animals have breasts and their females suckle the young ones. These animals live on land, trees, under the ground, in water and a few of them can fly. Man also belongs to this class. This group of animals is divided into three sub classes:
- (a) **Prototheria:** They lay their eggs, and have four chambered heart, hair-covered body and mammary glands, e.g. duck-billed platypus, echidna-ant eaters, etc.
- (b) **Metatheria (Marsupials):** The female has ‘pouch’ on the abdomen where it keeps the young one, e.g. kangaroo, opossum, koala, etc.
- (c) **Placental:** These include animals having placenta through which the foetus is attached to the mother’s womb. A wide range of animals, e.g. cats, dogs, cows, buffalo, ox, lion, tiger, elephant, bear, horse, whale, seal, etc. belong to this category. They live in a variety of habitats. Man is the most developed and intelligent animal of this class.

Origin and Evolution of Animals

Fossils preserved in the sedimentary rocks of different geological periods form the only sources of evidence of the origin of the oldest animals on the earth’s surface. However, such records provide only rough estimates about the origin of animals because fossils have also undergone modification and transformation. On the basis of fossil records the earliest microscopic organisms believably evolved some 4600 million years ago in Pre-Cambrian period in marine environment. However, these fossils are rarely traceable. According to **Clemmay** (1976), the oldest fossils (1000 million years old) are found in Zambia (Africa). These proto-organisms derived their food from detritus. Fossils of invertebrates (680-580 million year old) have been found in Africa, Europe and North America.

During the **Cambrian period** (600 million years ago), the climate of the earth was warmer than the pre-Cambrian period. Marine organisms such as protozoa, sponges, brachypods, sea urchins, sea cucumbers, starfish, molluscs etc. were evolved. Among animals, trilobites and brachypods were numerous.

During the **Ordovician period** (500 million years ago), the first vertebrates evolved in the fresh water environment. These animals had jawless bodies, and bony armour around their bodies. Snails, corals, sponges and squid-like animals evolved in the oceanic waters.

During the **Silurian period** (440 million years), the climate was dominated by a cooler phase. Towards the end of the period Caledonian orogeny took place. Algae was mainly evolved in inland seas. The first land plant in the form of clubmoss evolved in the surroundings of the inland seas. This period saw the first appearance of land invertebrate animals. Many armed mollusks were the most dominant animals of the period. The other important organisms included snails, brachiopods, graptolites, corals, jellyfish, sea-lillies, giant sea scorpions, etc.

During the **Devonian period** (400 million years ago), maximum development of primitive life occurred because of uniform climates, increased temperatures and aridity. The primitive fishes which earlier had bony gills, later-on developed jaws. The first amphibians and spiders were also evolved. Many land animals developed burrowing habits. Forests also became dense. In the growing arid environment, species and number of animals also increased. Several varieties of insects, and flies evolved during this period. A few special types of fishes and amphibians with tails were also evolved.

During the **Carboniferous period** (350 million years old), large scale glaciation occurred at the Gondwanaland, which brought in several changes in the plant and animal kingdoms. There was phenomenal increase in the number of insects. Amphibians and reptiles were also evolved. Giant dragonflies and spiders were also developed. The Great Ice Age of Carboniferous period resulted into large scale extinction of several animals. Only the strongest could survive. Amphibians still remained dominant. Reptiles increased in number.

During the **early Permian period** (270 million years ago), Gondwanaland was still covered with ice sheet. All the landmasses were joined together as Pangaea. The formation of the Appalachian mountains and their erosion, origin of deserts, advancement and retreat of ice sheet etc. were the major events during this period, which greatly affected the plants and animals. Only the strong species could survive. Amphibians were still dominant, some reptiles were greatly modified.

During the **Triassic period** (225 million years old), the broken Pangaea separated by Tethys Sea, was still linked by a few land bridges. Tropical and sub-tropical climate dominated. There was phenomenal increase in the number of invertebrate animals, especially 'arthropods'. First aquatic reptiles were evolved some of which later developed into birds.

During the **Jurassic period** (180 million years old), the climate was characterized by a warm phase. Pangaea's disruption and continental drift occurred, though at a small scale. The humid climate led to the

expansion of temperate forests. Insects became diverse. There was an abundance of first birds, spread of reptiles, appearance of primitive mammals, evolution of dinosaurs which could live in marine habitats, evolution of fresh lizards and crocodiles, etc.

During the **Cretaceous period** (135 million years ago), Gondwanaland finally got disrupted. Inland seas and swamps were formed. Flowering plants increased, while forests decreased. The number of reptiles was reduced while dinosaurs increased phenomenally. Mammals continued to evolve gradually. Insects were at their maximum development. Bony fishes were evolved in fresh water and marine water habitats. During the **Eocene period** (70 million years ago), the Alpine orogeny took place. Continents and oceans attained their present position due to large scale development and drift of continents and sea floor spreading. Climatic zones developed in early Eocene. Continental masses were largely denuded. It was followed by evolutionary explosion of mammals. Maximum diversity occurred in the placental animals. Primitive mammals in the seas or in the air also got evolved. Regional patterns of fauna were established.

During the **Oligocene period** (40 million years ago), climate became warm. Mountains gained in height. South American unique animals began to evolve due to isolation. Modern mammals were also evolved.

During the **Miocene period** (25 million years ago), climate became cool. Grasslands developed, while forests decreased. There was phenomenal increase in the number and special of mammals. Elephant like animals began to migrate from Asia to North America and South America.

During the **Pliocene period** (11 million years ago), Polar and temperate climate developed. There was increase in herbaceous plants, spread of grasslands, increase in mammals, appearance of Hominids and Pongids, etc.

During the **Quaternary epoch** (1 million years ago), there occurred widespread climatic changes. Most of North America and Eurasia were covered by continental glaciation. Cold climate and Pleistocene glaciation effected and modified the plants and animals on a large scale. According to the changing environment there were several phases of dispersal, distribution and redistribution of plants. Many large mammals were extinct. There was mass extinction of dinosaurs. Brisk walking and fast running animals could survive. Due to migration of animals new species were evolved.

The modern man evolved about 10,000 years ago, but the initial stage of evolution of man began in early Eocene of Paleocene period. Man like animals was evolved from Primate Prosimians during the late Eocene period. Shrews, tarsiers and lemurs were evolved from the Prosimians during Oligocene period. Monkeys of the Old World and the New World were gradually evolved from Anthropods of Eocene period, while Hominoidea, the third branch, developed from primate or primitive Prosimians, evolved during Oligocene period. Further two branches were developed from Hominoidea during Miocene period:

(i) apes and (ii) Ape man (early man). Gibbons, Orangs, Gorillas and Chimpanzee were evolved from Apes, during the late Pleistocene period, while the modern man evolved from Ape Man.

The central east Africa is considered as the origin place of Homo Sapiens where the early man evolved about 40,000 years ago. Some anthropologists like **Alan Thorne, Edmund Gill, John Sherwood** etc. believed southern Australia to be the homeland of Home Erectus, 60,000-85,000 years ago.

Dispersal of Animals Dispersal of animals may be defined as the spreading of animals from the places of their origin to other areas. Dispersal may be of the following types:

- (1.) **Gradual dispersal:** It involves longer period of time and very slow rate of migration. However, such dispersal covers large areas and results in widespread distribution of animals over time.
- (2.) **Rapid dispersal.** It involves mass exodus of animals from one area to another. Such dispersal may not be a permanent one as they may not be allowed by man or local environmental conditions to settle down in new habitats. Such dispersal involves certain animals only, e.g. locusts, lemmings, butterflies, moths, dragonflies, etc.
- (3.) **Seasonal dispersal:** It involves the migration of those animals which leave their habitat due to seasonal extreme weather conditions every year and migrate to areas of favourable weather conditions. These migratory animals and birds return to their native places when conditions become favourable. Migration of Arctic birds during winter to sub-tropical and tropical areas and the return to their native places next summer season proves this fact. Some of the Greenland wheatears birds fly directly to Spain covering a distance of 3200 km. Similarly, Blackpoll Warbler (a sparrow like small bird) flies from New England (USA) during winter to Venezuela (South America). Arctic terns cover the longest distance (over 35,000 km) each year. Like Volcanic eruptions, recurrent floods, forest fires, prolonged droughts, etc.
- (4.) **Forced dispersal:** It occurs when sudden events force the animals to leave their native places. In such conditions, scarcity of food leads to famine, and causes their migration. Serious forest fires in Siberia in 1915 caused many animals to migrate.
- (5.) **Anthropogenic dispersal:** Man has been a major factor in the dispersal of animals. He has introduced diversifications in the regional fauna and has caused several ecological problems. For example, the introduction of deers and rabbits in New Zealand by the Europeans caused large scale destruction of natural vegetation. It led to accelerated soil erosion.
- (6.) Sometimes due to phenomenal increase in the population of animals, they do not find sufficient breeding places and therefore tend to **migrate**.

Factors of Animal Dispersal

The spread and dispersal of animals is controlled by two factors:

- 1. Physical environment:** Distribution of land and water and topography affect the dispersal of animals to a great extent. Terrestrial animals cannot swim, as such, water poses a great barrier to their dispersal. Saline oceanic water is harmful for fresh water animals. High mountains, widespread deserts, swamps, deep valleys, etc. also obstruct the dispersal of animals. Unfavourable climate and distance factor also affect the dispersal of animals in a great way.
- 2. Innate ability:** Qualities of animals e.g. creeping, crawling, hopping, leaping, climbing, digging, borrowing, swimming, flying, etc. enable animals to move and migrate. These qualities of animals determine the type nature and rate of dispersal and migration. When animals become mobile and move out from their places motivated and stimulated by their innate qualities, the resultant dispersal is called “active dispersal”.

Mesosaurus (a Permian reptile), Glossopteris (Permian plant) and Cynognathus (a Late Triassic reptile) originated in South America, from where Cynognathus and Mesosaurus migrated to Africa, while Glossopteris plants migrated to Africa, Antarctica, India and Australia. Lystrosaurus (Late Triassic reptile) was originated in Africa from where it was dispersed to India and Australia.

Deer, saiga, sheep, bison, musk ox, mastodon, mammoths and man migrated from Asia to North America via Bering Bridge, while beavers, opossum, raccoon, horse, etc. migrated from North America to Asia (via the same bridge). Raccoons, cats, horses, tapirs, llamas, camels, etc. migrated from North America to South America via Central American Bridge, whereas capybaras, porcupines, armadillos, glyptodonts, ground sloths etc. were dispersed from South America to North America via Central American Bridge, Butterflies, moths, beetles, grasshoppers, locusts, bugs etc. were dispersed from Africa to Europe and Asia, whereas these animals were transported to South America by ships.

As said earlier, natural dispersal of animals is a slow and gradual process which covers major part of the world. The fresh water fishes and land invertebrates were originated in the tropical areas of the old world and they migrated to Europe, Africa and Siberia through land bridges. Sometimes the animal dispersal is effected by external carriers; it is called ‘passive dispersal’.

Passive dispersal occurs when animals are carried by man or by various means of transport (man made as well as natural). Such carriers are of four types:

- 1. Eolian Carriers:** e.g. air masses, air currents and winds, which transport micro-organisms from one place to another without the willingness of the organisms.

2. **Aquatic Carriers:** e.g. sea waves, tidal currents, and oceanic currents which can carry larger animals to distant places.
3. **Organismic Carriers:** Symbiotic animals (those dependent on each other and live together) also transport animals to distant places. It happens when small animals are attached and stuck to the bodies of the carrier animals and thus these are transported to various destinations. Birds also help in such dispersal. Parasitic organisms, such as virus are hidden in the stomach or mixed with blood, spatum and stool of animals, reach various destinations. Worms living in the stomach of man are also carried away to far off places when overseas journeys are under taken.
4. **Anthropogenic Carriers:** These are the most powerful and effective means of passive dispersal and migration of animals. It is caused by man deliberately or accidentally. For example, lions were transported from Africa to Great Britain and rabbits were introduced into Australia from Europe. European starling was brought to North America and African snails were transported to various parts of the world.

Dispersal of animals is not always positive. It becomes unsuccessful when the animals reaching new habitats are unable to adapt to new environmental conditions and ultimately perish.

Extinction of Species

Speciation and species extinction are the natural process of the evolution of animals. During the last 2000 years, about 200 species of mammals and birds have become extinct. According to Steenis (1969), the process of evolution of animals is faster than that of plants. Though there are several natural causes of species extinction, but the modern man has accelerated the pace of animal extinction.

Extinction of animals takes place in a number of ways, due to a variety of causes mentioned as under:

- I. Environmental conditions of any region change gradually or suddenly. When the environmental conditions change gradually, the animals living in the region try to adjust and adapt to new conditions. In case of rapid or sudden changes, the animals are unable to adapt to new conditions and as such, several species become extinct. The mass extinction of dinosaurs is believed to be effected due to sudden drop in temperature during the early Tertiary period.
- II. The sudden outbreak of disease and pest infection also causes species extinction.
- III. Sudden events like forest fires, volcanic eruptions, etc. cause species extinction.
- IV. Hunting and over killing of certain species by man causes 'selective mass extinction'.
- V. Some weaker species become extinct during the course of competition with powerful and strong species.

VI.. Man induced environmental changes also cause species extinction. Human activities alter the equilibrium of ecosystem which causes extinction of some species.

It is worth noting that extinction is a natural ecological process and there exists a natural balance between speciation, dispersal and extinction. But man-induced extinction upsets this balance which causes disastrous ecological problems.

Distribution of Animals

Animal distribution may be studied in a number of ways, the member of a species in a definite area. On this basis, the world is divided into a number of animal regions according to the dominance or abundance of animal species.

Factors Affecting Distribution of Animals

The present distribution of animals in the world is very complex. At times it becomes difficult to determine the area of a definite animal species, because animals are highly mobile. Some animals migrate seasonally and thus get distributed throughout the world. Besides human beings, fishes of cuprinid family, frogs of Rana genus, orders of birds living in trees, many types of rodents, colubrid snakes, etc. live in different types of environmental conditions. All these animals are cosmopolitan.

Usually, a species is concentrated in a distinct region, and a genus is found in several faunal regions. A family, which includes several genera, is developed in several continents. Nut the distribution pattern of animals constantly changes due to their migration. Consequently, the continuity of animal distribution is distributed.

Factors affecting distribution of animals are placed in two classes:

1. **Physical factor:** every animal lives in a definite type of habitat with distinct environmental conditions. Landforms, climate (temperature, humidity, water, sun light, air pressure, etc.), gravity, acidity alkalinity and salinity of water, ratio of gases in the atmosphere, soil, minerals, etc. affect the distribution of animals.
2. **Biological factors:** Aspects of population ecology, mutual interactions of animals with plants and their environment, and mobility, migration, dispersal etc. of animals affect the population of animals.

The important aspects of animal ecology which affect and control the distribution of animals in any region, include abundance of animal population, size of populations, regulation of population size and mutual interactions among the organisms and between the organisms and physical environments.

The following parameters affect the size and density of animals:

(a.) Primary: Natality, mortality, immigration, and emigration.

(b.) Secondary: Age distribution, genetic composition and dispersal.

In brief, density of population, growth, age distribution, fluctuations in population, biotic potential and mutual interactions affect the number population in an area.

The abundance of animals of a particular species is determined and controlled by the characteristics of the whole group and not of the individuals. For example, locusts normally do not live in clusters or groups. But when there is a sudden increase of hormones in their bodies, they start living in groups and form clusters at a particular place. This change in their habit compels them to resort to mass exodus in great migrating swarms. Such enormous locust swarms occasionally affect north-western India during July-August when Kharif crops are in growing stage.

Termites, ants and honeybees have also tendency to form clusters on sudden increase in their populations. Some animals like bison also form groups. Some birds and vertebrates also develop the tendency of social grouping which causes phenomenal increase in their populations.

Animal populations are closely related to food chain. Normally, in any habitat the herbivorous animals of trophic level two (primary consumer) are largest in number and derive their food from the green plants (primary producers) of trophic level one. With the increasing trophic levels, there is progressive decrease in the number of animals.

The abundance and distribution of animals also depend on their typical behaviour. For example, muskrats have high breeding rate, while raccoons have low production rate. The typical biological instinct or behaviour controls the dispersal and spread of animals.

The density of population of animals in an area increases when: (i) birth rate far exceeds death rates, (ii) major portion of the animal population consists of mature animals, (iii) immigration exceeds emigration, and (iv) dispersal of animals in the area is low.

There exists an automatic regulation of population size in a region. It is called '**self regulation**'. According to this law, when the number of animal populations of a given species in an area exceeds the critical limit, its size is naturally controlled in accordance with the supply of food resources. For example, when the population of insects in an area increases beyond optimum level due to favourable climate, the food supply falls short of the demand of the increased insect population. Due to competition among insects for food, many insects die of starvation and the insect population returns to its optimal size.

Interspecific interactions (interactions among the animals of the same species) and intra specific interactions (interactions among the animals of different species) also affect the pattern of distribution of animals. **Overcrowding** and **under-population** are caused by such interactions. Such interactions may be either negative or positive. Predation is an example of negative interaction which causes damage to one

group of animals by another. If all the prey animals are eliminated by the predators, the predators also perish because of scarcity of food.

Competition for the same food resource is another type of biological interactions which affect and control the distribution of animal population in the world. It causes negative effect on each species.

World Distribution of Land Animals

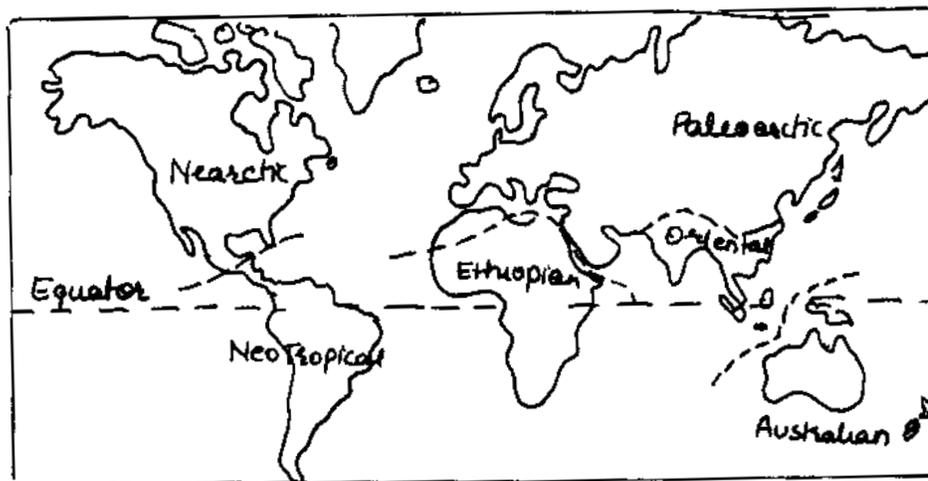
Zoo geography deals with the geographic distribution of animals. The world is divided into a number of zoo-geographic or faunal regions. According to **Wallace** (1876), the following zoo-geographic regions of the world may be observed:

- I. **Palaerctic region:** This largest region includes whole of Europe, northern China, Japan, Soviet Russia, northern part of Africa and Persia, etc. It is subdivided into Europeans, Mediterranean, Siberian and Manchurian sub regions. Fauna is represented by 135 families of terrestrial vertebrates (33 mammals, 68 of birds, 24 of reptiles, 10 of amphibians and fishes).
- II. **Ethiopian region:** This includes whole of Africa and Arabia, Madagascar and Mauritius. The fauna is much varied, resented by about 161 families of terres trial vertebrates; of which 30 are endemic to this region which include such mammals as aye-aye, golden moles, mole rates, jumping hares, African flying squirrels, giraffes etc. this region is divided into east African, west African, south African and Malagasy sub-regions.
- III. **Oriental region:** This region includes all the tropical parts of Asia, like India, Sri Lanka, south China, Malaysia and Malayan islands located to the western side of Wallace's line, i.e. Java, Sumatra, Philippines, Borneo, Bali, etc. Climatic conditions of this region are much varied being desert in the north of Indian sub-region, tropical in southern portion of India and Sri Lanka, and temperate in Bhutan and Yang-tse-kiang. Major part of the region is occupied by luxuriant forest vegetation. The terrestrial verte brates are represented by about 153 families of which 10 are peculiar to the region, which include four mammals, one bird and five reptiles.

Faunal characteristics: This region includes some interesting genera which are as follows:

- (a) **Fishes:** Freshwater fishes are more common, represented by about 13 families, including notopterids, silurids, anabantids, cyprinoids, nandidac etc.
- (b) **Amphibians:** Amphibians are represented by nine families of which interesting ones are caecilians, rhacophoids (tree frogs), true frogs and some salamanders

- (c) **Reptiles:** Reptiles are represented by 35 families of which important ones are true vipers, pit vipers, sea snakes, turtles, freshwater snakes, tree snakes, Pythonidae, crocodiles, gavialis, water lizards, geckos, some iguanas, etc.
- (d) **Aves:** Aves are represented by 71 families, of which important ones are babblers, sunbirds, king crows, passers, woodpeckers, barbets, cuckoos, kingfishers, pigeons, doves, fowls, peacocks, etc.
- (e) **Mammals:** These are represented by 35 families in which interesting ones are hedgehogs, shrews, flying lemurs, old world monkeys, cats, bear, dogs, elephants, rhinoceros, rodents, orangutans, etc. The gibbons, tarsiers and tree shrews are peculiar to this region.



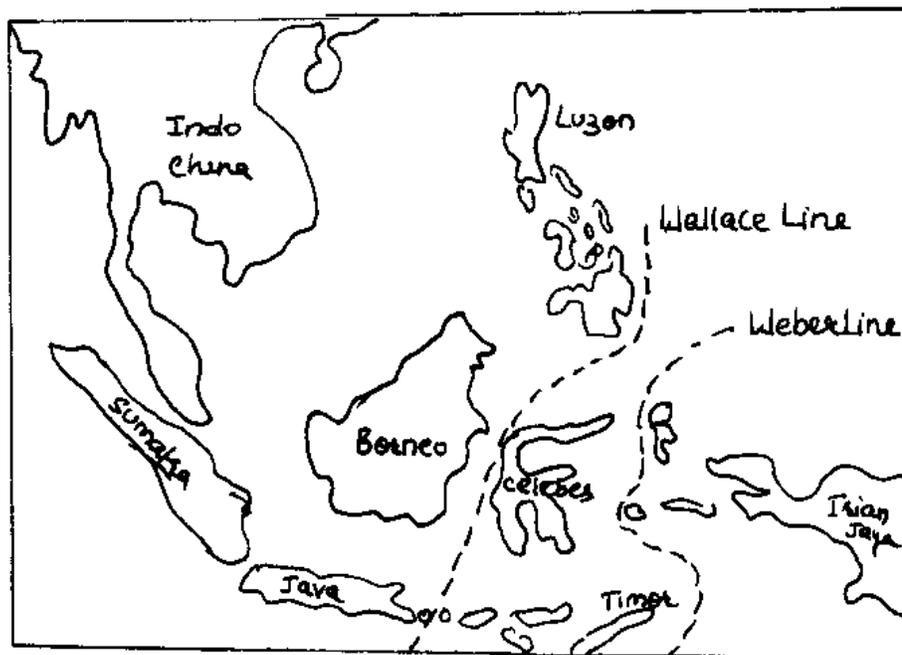
Oriental region is divided into the following four sub regions:

1. **Indian sub region:** It includes whole of India from the Himalayan slopes to Cape Comorin. The fauna is characterized by 123 families of terrestrial vertebrates. Elachistodontida with a single species of colubrine snake is peculiar. Mammalian forms as four-horned antelope, Indian or sloth-bear and shield-tails are characteristics of this region.
2. **Ceylonese sub region:** It comprises the island of Sri Lanka, whose physical characteristics are more or less similar to those of southern mountains of India. Characteristic fauna includes shield-tails, Loris, spiny rat, leaf insect, kalmia, mimetic butterflies, etc.
3. **Indo-Chinese region:** It includes China, south of Palaeartic boundary, Burma, Thailand and islands of Andaman, Formosa and Hainan. This region is comparatively richer and varied than the Indian and Ceylonese sub regions. There are about 138 families of animals, of which peculiar ones are ailurus, budocras, hapalomys, moles, gibbons, flying lemurs, tapir and rhinoceros, salamanders and disc-tongued frogs.

4. **Indo-Malayan sub region:** It includes the Malayan Peninsula and islands of Malayan Archipelago, i.e. Borneo, Java, Sumatra, Nicobar, etc. the fauna is represented by 132 families of which important ones are orangutan, proboscis monkey, Malayan badger, tree shrews, gibbons, broadbills, etc.

IV. **Australian region:** This includes the whole of Australian, New Zealand, New Guinea and adjoining islands, particularly those of Pacific Ocean. The oriental and Australian regions are separated from each other by an imaginary line, **Wallace's line**, that is supposed to run between the islands of Bali and Lombok. In various parts, the climate is of temperate as well as tropical type. The fauna is represented by 134 families of terrestrial vertebrates of which 30 are specific to the region including 8 families of mammals, 17 of birds, 3 of reptiles and 2 of amphibians. Among the mammals, all belong to Monotremata and marsupialia, placental ones being altogether absent.

Marsupialia includes kangaroos and related forms. Characteristic genera are kangaroos, wombats, bandicoots, phalanges, marsupial mole and dasyures. Among birds, peculiar ones are kiwis, emus, cassowaries, birds of paradise and tooth-billed pigeons. Reptilian genera include such



forms as sphenodon, or tuatara and scale-footed lizards, fly-river turtles and elapid snakes. This region is divided into Austro-Malayan, Australian, Polynesian and New Zealand sub region.

V. **Neotropical region:** It comprises southern Mexico, Central and South America, West Indies and Galapagos islands. It is a tropical region with luxuriant forests. The fauna is represented by 155 families of terrestrial vertebrates of which 39 are peculiar to the region. These include 10 mammals, 23 birds,

2 reptiles and 4 amphibians. This region is divided into Chilean, Brazilian, Mexican and Artillian sub regions.

VI. **Neoarctic region:** It comprises Greenland and North America up to the centre of Mexico.

In the west, there are many large lakes and island seas. The terrestrial vertebrates are about 120, or which 26 are mammals, 59 birds, 21 reptiles and amphibians. Of these, 5 are peculiar, such as Haplodontidae and prong-buck among mammals the wren-tits among birds. Anillidae among reptiles and the Siredidae among amphibians. This region is divided into Californian, Rocky Mountain, Alleghany and Canadian sub regions.

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