1

ECOSYSTEM

Ecosystem (*eco* – dwelling, *system* – composite whole) is a structural and functional unit of nature consisting of a community of living beings and their physical environment, both interacting and exchanging materials between them. The term was coined by Tansley (1935). An alternate term is **biogeocoenosis** (= geobiocoeonosis) employed by Sukhachev (1944). There are two aspects of ecosystem, structural and functional.

STRUCTURAL ASPECTS OF ECOSYSTEM

An ecosystem has two types of components, **biotic** and **abiotic**. Biotic components are living beings. They are of two types, autotrophs and heterotrophs. **Autotrophs** manufacture their own organic food. They are also known as producers. **Heterotrophs** obtain ready-made organic food from outside. They include consumers and decomposers. Abiotic components are organic debris, inorganic substances, climatic, topographic and soil factors.

BIOTIC COMPONENTS

1. Producers. They are green photosynthetic plants which trap solar energy and produce their own organic food from inorganic raw materials. The food is used for body building and liberation of energy for performing various activities by plants. All other organisms depend upon plants or producers for obtaining food and energy contained in it. Besides synthesis of organic food, the plants also maintain CO_2/O_2 balance of atmosphere by using CO_2 as raw material for photosynthesis and liberation of oxygen. Producers are also called **converters** (= transducers) as they convert radiant energy of sun into chemical energy of food. 99% of living mantle of earth is made of producers. Only 1% are consumers and decomposers.

2. Consumers. They are mostly animals which feed on other organisms or their parts. Consumers are of two types, herbivores and carnivores. **Herbivores** are **primary** or **first order consumers** which directly feed on plants, *e.g.*, Rabbit, Deer, Grasshopper, Cattle. **Carnivores** are predator animals which feed on other animals. **Primary carnivores** or **second order consumers** feed on herbivores, *e.g.* Frog (eating grasshopper), Wild Cat (eating squirrel), Fox, Jackal (eating rabbit). **Secondary carnivores** or **third order consumers** feed on primary carnivores, *e.g.*, Snake (eating frog), Wolf (preying upon fox). **Tertiary carnivores** or fourth order consumers prey upon secondary carnivores like Peacock feeding on snake. The carnivores which are not preyed upon by other animals are called **top carnivores**, *e.g.*, Lion.

Consumers are also called **secondary producers** since they resynthesise organic matter to build their bodies. A special category of consumers are **detrivores** (= scavengers). They feed on dead bodies of plants and animals, *e.g.*, Termites, Carrion Beetles. Another type of consumers are **parasites** which draw nourishment from living organisms, *e.g.*, Malarial Parasite, Cuscuta (vern. Amarbel).

3. Decomposers. They are **saprotrophs** (= osmotrophs) which feed on organic wastes and dead bodies through a process of external digestion by excreting digestive enzymes into outside medium. The digested organic matter is absorbed by decomposers. Some minerals trapped in organic matter are released in the process. The phenomenon is called **mineralisation**. Decomposers are also called **reducers** because they degrade organic remains. They are usually very small (*e.g.*, bacteria, fungi) and are, therefore, known as **microconsumers** (the consumers are then called macroconsumers).

ABIOTIC COMPONENTS

They include nonliving substances and factors like temperature, light, wind, humidity, rain, water bodies, background, topography, soil, organic detritus and mineral elements.

1. Temperature. Different parts of the earth have different temperature ranges. This has created four types of life zones – tropical, subtrophical, temperate and arctic/alpine. Arctic and alpine regions do not have trees. They possess hardy herbs, shrubs, mosses and lichens. Animals adapted to this area (low temperature) have thick coat of scales, hair, feathers and subcutaneous fat. During extreme cold they rest in warmer places like caves and inside soil (hibernation) or migrate to warmer areas, *e.g.*, Reindeer. Animals living in hotter areas rest in cool burrows during most of the day (aestivation). Plants growing in areas having low or high temperature show mucilage, high solute content, thick corky covering, hair, tannins and thick leaves.

2. Light. It is essential for photosynthesis. Light intensity is maximum at equator. It decreases towards poles (50 % at 50°N). Therefore, tropical forests are very dense and have higher productivity as compared to temperate forests. The minimum is in tundra. Light intensity controls pigmentation in animals and plants. Animals are active at particular period – **diurnal** (during day), **nocturnal** (during night), **auroral** (active at dawn) and **vesperal** (active at dusk). **Day length** or **photoperiod** controls leaf fall, appearance of new leaves, bird migration, flowering in many plants and breeding in several animals.

3. Wind. It determines weather conditions, transpiration, dispersal of seeds and pollination. Areas having high speed winds possess very few flight animals. Trees do not have branches on wind-ward side.

4. Humidity. It controls evaporation from land, water bodies, plants and animals, formation of clouds, fog and dew. Humid areas have luxuriant plant growth. Epiphytes grow only in humid areas. Organisms of dry areas have modifications to prevent desiccation. Kangaroo or Desert Rat seldom drinks water. It feeds on only dry seeds.

5. Rain. Amount and periodicity of rain determine the type of ecosystem of the area, *e.g.*, grassland, desert, forest.

6. Water Bodies. They have special types of plants and animals. In areas with strong water currents only attached plants, burrowing animals and strong swimmers are found. Fresh water aquatics have different adaptations as compared to marine organisms. Producers do not grow in sea below depth of 200 m due to insufficient light. Only consumers occur. Some of them are luminescent.

7. Background. Animals generally have a texture and colour similar to that of background, *e.g.*, green colour of Grasshopper, sand colour of Camel, bark colour of Elephant and white colour in snow dwellers.

8. Topography. Plain, slope, valley, north and south faces of a mountain have different types of organisms due to differences in light, humidity, rain and wind.

9. Soil. Texture of soil (sandy, clay, loam), its acidity or alkalinity influence vegetation and animals dependent on the same.

10. Organic Detritus. It is derived from organic wastes and dead bodies of organisms. Organic detritus forms humus required for maintenance of soil air, soil hydration and soil fertility. Decomposition of organic detritus releases minerals.

11. Mineral Elements. They are also called biogenic or biogenetic nutrients because they are required for proper growth and development of organisms. Both deficiency and excess are harmful. The nutrients keep on circulating in the ecosystem being picked up by producers, passed on to consumers and transferred back to environment by activity of decomposers.

FUNCTIONAL ASPECTS OF ECOSYSTEM

1. Nutrient Cycling. Green plants or producers obtain a number of inorganic nutrients from the environment, *e.g.*, carbon, nitrogen, phosphorus, magnesium, calcium, iron, etc. They become component of organic matter build up by producers through the process of photosynthesis. From producers the inorganic nutrients are passed on to consumers of different levels. Ultimately they become component of organic detritus from which the nutrients are released with the help of decomposers. Thus the inorganic nutrients circulate in the ecosystem between the biotic and abiotic components.

2. Flow of Energy. Ecosystem is sustained by flow of energy from outside. Energy comes from sun. Solar energy is picked up by green plants to perform photosynthesis (production of organic food from inorganic raw materials with the help of sun energy) in which radiant energy is changed to chemical energy trapped in food. Part of energy is consumed by producers or green plants for their own metabolic activities. The rest remains in plants as body building material. The latter is used by herbivores for their own activities and body building. From herbivores the energy is passed on to different types of consumers. Part of energy is lost at each step of its transfer from one organism to another. Energy does not circulate in the ecosystem. It flows unidirectionally and is ultimately dissipated. Therefore, a constant inflow of energy is required for sustaining ecosystem.

3. Controls or Limitations (Cybernetics). Ecosystem maintains a structural and functional balance or **homeostasis** through a system of controls. (*a*) **Carrying Capacity.** It is the maximum number of individuals of a type which can be supported in an ecosystem. (*b*) **Recycling of Wastes.** The capacity to recycle wastes determines the liberation of biogenic nutrients to support new growth. (*c*) **Self Regulation.** Certain populations have self regulatory mechanism whereby reproductive potential is inversely governed by density. (*d*) **Feedback System.** The density of one population controls the density of another population. For example, increase in producers will increase the number of herbivores which in turn will bring about increase in population of primary carnivores. On the other hand a temporary spurt in population of primary carnivores will decrease the number of herbivores. The latter will soon decrease the population of carnivores. Thus availability of food controls population densities.

4. Inter-Relations. Different components of an ecosystem are connected with one another in a complex three-dimensional inter-relationship. Food web is one such example. Plants provide food, shelter and oxygen to animals. Animals release CO_2 and perform pollination as well as seed dispersal.

TYPES OF ECOSYSTEM

Ecosystem can be natural or man-made, large or small, permanent or temporary, complete or incomplete. Each ecosystem has its own distinct community with a distinct environment.

Natural Ecosystem. It is an ecosystem developed under natural conditions without any appreciable human interference. Natural ecosystem can be terrestrial (*e.g.*, forest, grassland) or aquatic (*e.g.*, fresh water lake, river, sea).

Man-Made Ecosystem. It is an ecosystem which is created and maintained by human beings, *e.g.*, garden, orchard, crop land, aquarium, dam, village, town, city, etc. **Agroecosystem** is the single largest man-made ecosystem which has a large number of variations.

Mega-Ecosystem. A very large ecosystem such as marine ecosystem.

Macro-Ecosystem. A large ecosystem such as forest.

Micro-Ecosystem. A small specific part of a large ecosystem with its own specialisation, *e.g.*, sub-alpine ecosystem, valley ecosystem.

Nano-Ecosystem. A very small ecosystem such as wooden log.

Temporary Ecosystem. An ecosystem which persists for only a short duration like rain water pond.

Incomplete Ecosystem. It is an ecosystem which lacks one or the other component, *e.g.*, cave, sea bottom, city (all lack producers), rain water pond with bloom of toxic algae (lacks consumers).

IMPORTANCE OF ECOSYSTEM STUDY

1. Ecosystem study gives information about the amount of available solar energy in an area.
2. It gives data about the availability of mineral elements, their utilisation and recycling.
3. Inter-relationships between various types of organisms as well as between organisms and abiotic environment can be known.

4. Productivity of producers and consumers is known.
5. The maximum number of producers and consumers of various categories which can be supported in the ecosystem is known.
6. Information can be gathered about ways to increase productivity, shortage of inputs if any, effect of pollution, degree of exploitation alongwith conservation of resources.

2

FLOW OF ENERGY AND MATERIALS

FOOD CHAIN

It is a series of populations present in an ecosystem through which food and its contained energy passes with members of one population becoming food for members of the next higher level of population, *e.g.*, Grass ⟶ Insect ⟶ Frog ⟶ Snake ⟶ Peacock.

TROPHIC LEVELS

They are steps or divisions of a food chain which are characterised by the mode of obtaining food (Gk. *trophe* – nourishment). Each trophic level has a particular mode of nutrition, *e.g.*, photosynthesis, herbivory. A trophic level may have several subtypes called **guilds.** For example, herbivorous animals may be grazing, browsing, nectar feeding, frugivorous, etc.

Green plants or producers constitute the first trophic level called T_1. Herbivores or first order consumers belong to second trophic level or T_2. Primary carnivores or second order consumers form third trophic level or T_3, secondary carnivores T_4 while tertiary carnivores constitute T_5. Top carnivores may belong to T_4 or T_5 level. However, some organisms do not have fixed trophic level. Lion may belong to T_3, T_4 or T_5 level. Human beings are omnivores. They may fall under T_2 level of herbivores or any of the subsequent trophic level of carnivores. Parasites also do not belong to any fixed trophic level as they feed on all types of organisms. Decomposers form a separate trophic level called detritus trophic level. In a common food chain they are given a trophic level of T_6.

TYPES OF FOOD CHAINS

There are three types of food chains – predator, detritus and parasitic.

1. Predator Food Chain (Grazing Food Chain). It is a food chain characterised by predation (= preying or killing for feeding). Predator food chain consists of producers and consumers. (*i*) **Producers.** They are photosynthetic plants which manufacture organic food from inorganic raw materials in the presence of sunlight through the process of photosynthesis. During photosynthesis, chlorophyll converts radiant energy into chemical energy. Food manufactured by producers is passed on to other trophic levels of predator as well as other food chains. (*ii*) **Consumers.** (*a*) **Herbivores** are the first order consumers which feed on

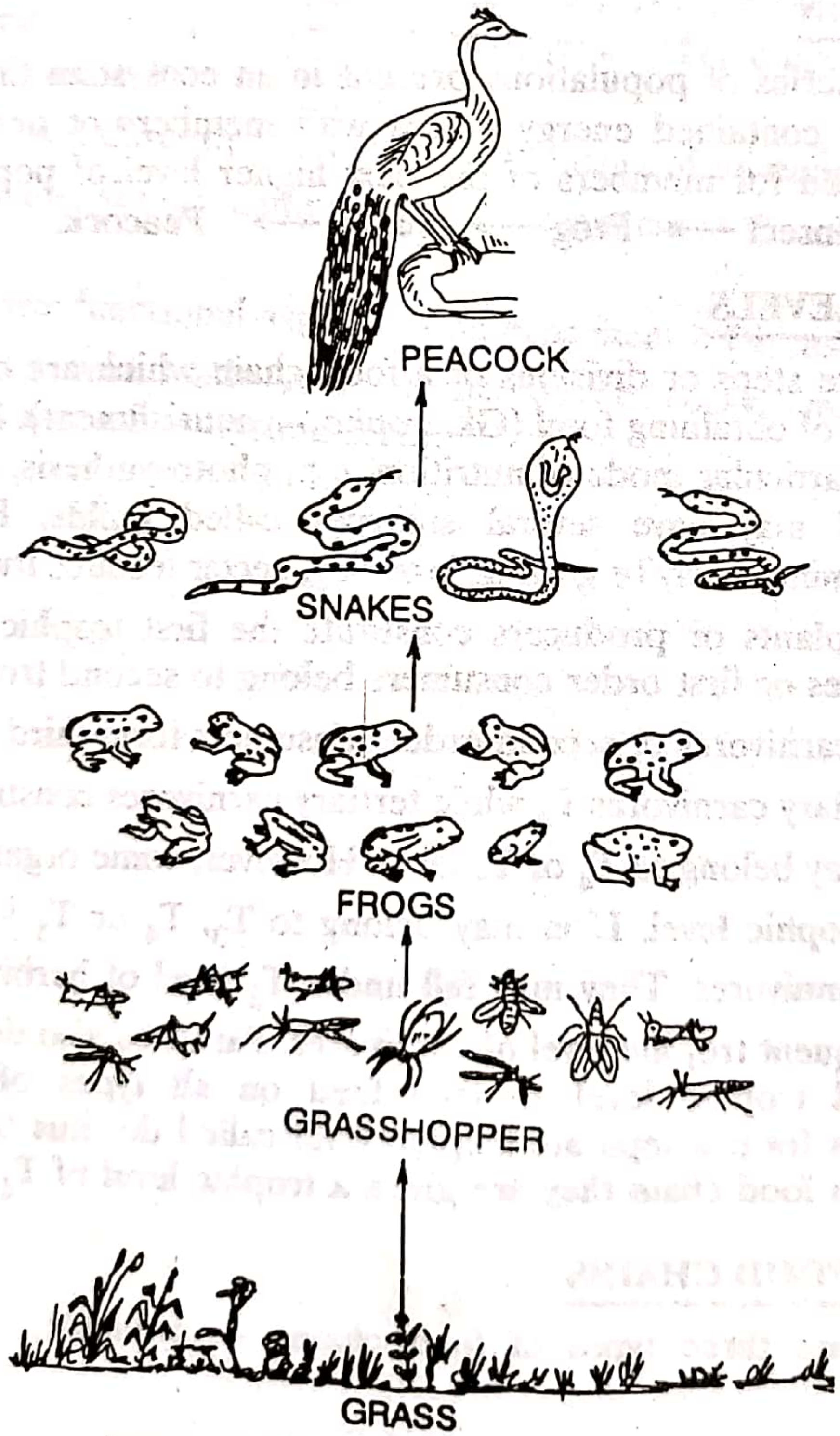

FIGURE. 2.1. A land food chain.

plants. Depending upon the ecosystem, they are of several types, *e.g.*, Grasshopper, Antelope, Deer, Rabbit, Elephant, Cow, Goat, Zooplankton, herbivorous fish. Herbivores are also called **key industry animals** (Elton, 1927) as they are able to convert plant matter into animal matter. (*b*) **Primary carnivores** or second order consumers are predator animals which prey upon herbivores, *e.g.*, Wild Cat, Fox, Frog, small carnivorous Fish, Spider. (*c*) **Secondary carnivores** or third order consumers are predator animals which prey upon primary carnivores, *e.g.*, Snake, Wolf. **Top carnivores** are those carnivores which are not preyed

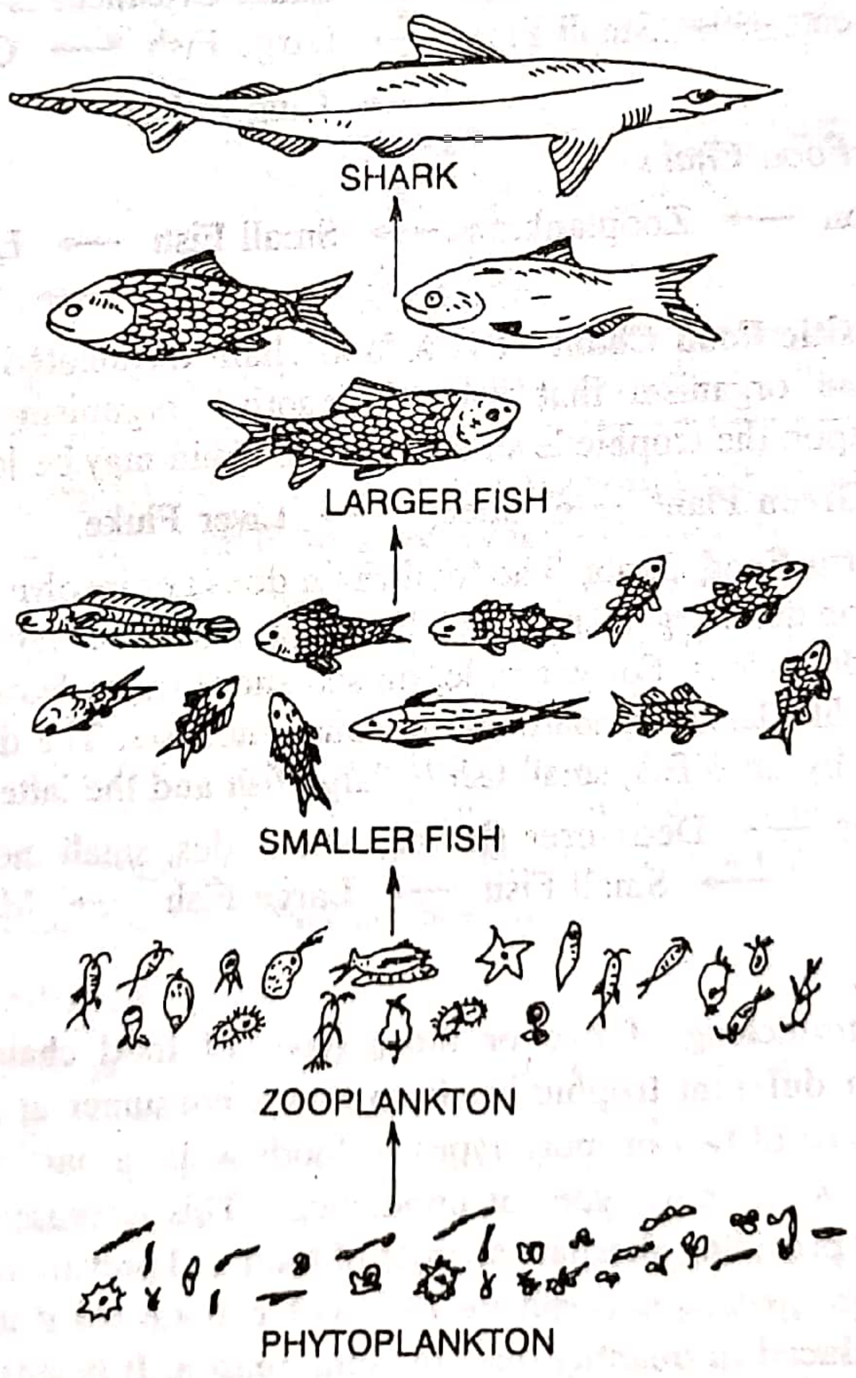

FIGURE. 2.2. A marine food chain.

upon by other animals, *e.g.* Lion, Tiger, Eagle. They terminate predator food chain. Some common predator food chains are

Land Food Chains

Vegetation ⟶ Grasshopper ⟶ Frog ⟶ Snake ⟶ Peacock/Falcon.

Vegetation ⟶ Butterfly ⟶ Dragonfly ⟶ Frog ⟶ Snake ⟶ Peacock/Falcon.

Vegetation ⟶ Rabbit ⟶ Fox ⟶ Wolf ⟶ Tiger.

Vegetation ⟶ Squirrel ⟶ Wild cat ⟶ Tiger.

Pond Food Chain

Phytoplankton ⟶ Zooplankton ⟶ Small Crustaceans ⟶ Predator Insects ⟶ Small Fish ⟶ Large Fish ⟶ Crocodile.
⟶ King Fisher

Marine Food Chain

Phytoplankton ⟶ Zooplankton ⟶ Small Fish ⟶ Large Fish ⟶ Shark.

2. Parasitic Food Chain. It is a food chain terminated by parasite. Parasite is an organism that lives on another organism called host. Depending upon the trophic level of host, the chain may be long or short.

Green Plant ⟶ Sheep ⟶ Liver Fluke.

3. Detritus Food Chain. The food chain does not involve green plants but is based on dead organisms and fallen plant parts. The latter constitute the food of detrivores. For example, on sea shore fallen leaves are eaten by detrivores like larvae, nematodes and small molluscs. The detrivores are in turn eaten by small fish, small fish by large fish and the latter by man.

Fallen Leaves ⟶ Detrivores (larvae, nematodes, small molluscs) ⟶ Small Fish ⟶ Large Fish ⟶ Man.

FOOD WEB

It is interlocking of two or more types of food chains involving interaction at different trophic levels so that a consumer at a particular level has choice of two or more types of foods while a particular food is available to two or more types of populations. This increases stability of ecosystem by providing alternate sources of food and preventing extinction of a palatable species. A carnivore does not get starved if its preferred species is reduced in quantity due to some reason. It begins to feed on alternate specirs. The preferred one gets chance to recover. Even if one

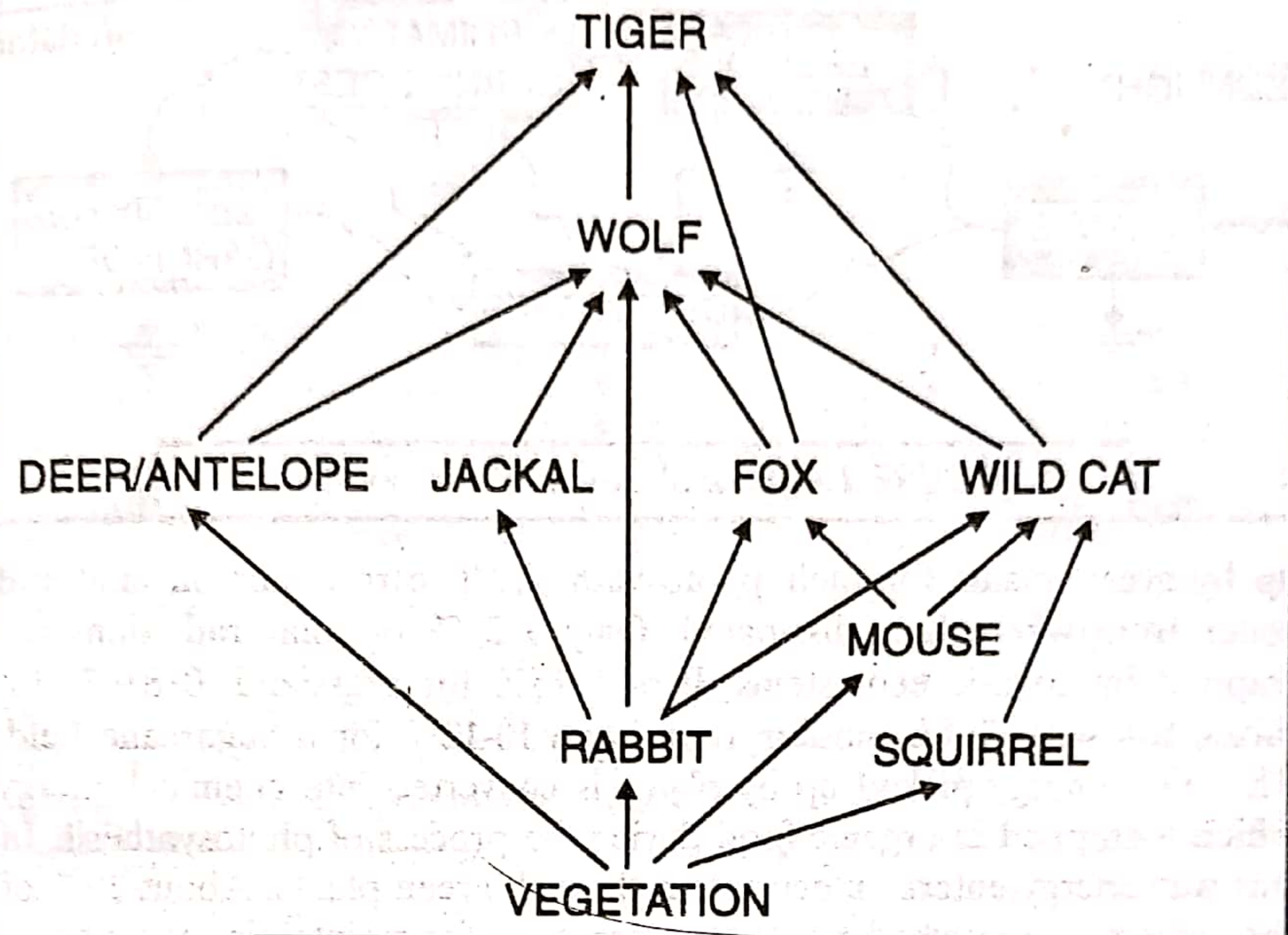

FIGURE 2.3. A terrestrial food web.

Sunderbans, tigers feed on fish and crabs because their natural preys do not occur in the area. Similarly, snakes feed on frogs, mice, shrews, etc. Wild Cat feeds on mice, squirrels, birds and rabbits. Wolf preys upon Deer, Fox and Rabbit. Rabbits begin to feed on alternate plant if their preferred species declines in number. This gives a chance to preferred species for recovery. Rabbits are preyed upon by Wild Cat, Wild Dog, Jackal and Fox. If their population declines in an area, the predators begin to feed on mice, squirrels and shrews. Meanwhile population of rabbits increases and the balance of nature is restored.

FLOW OF ENERGY

Energy does not circulate in the ecosystem. Instead, it passes through different trophic levels, dissipating at every step of its transfer. A lot of energy is used by organisms in maintaining their bodies and performing work. A constant supply of energy is essential for maintaining an ecosystem. Different ecosystems receive different amounts of solar radiations depending upon latitude and atmospheric conditions. The amount of solar energy received in Britain is 25000 cal/cm^2/yr while it is 75000 cal/cm^2/yr in Varanasi. Only a small amount of this energy is picked

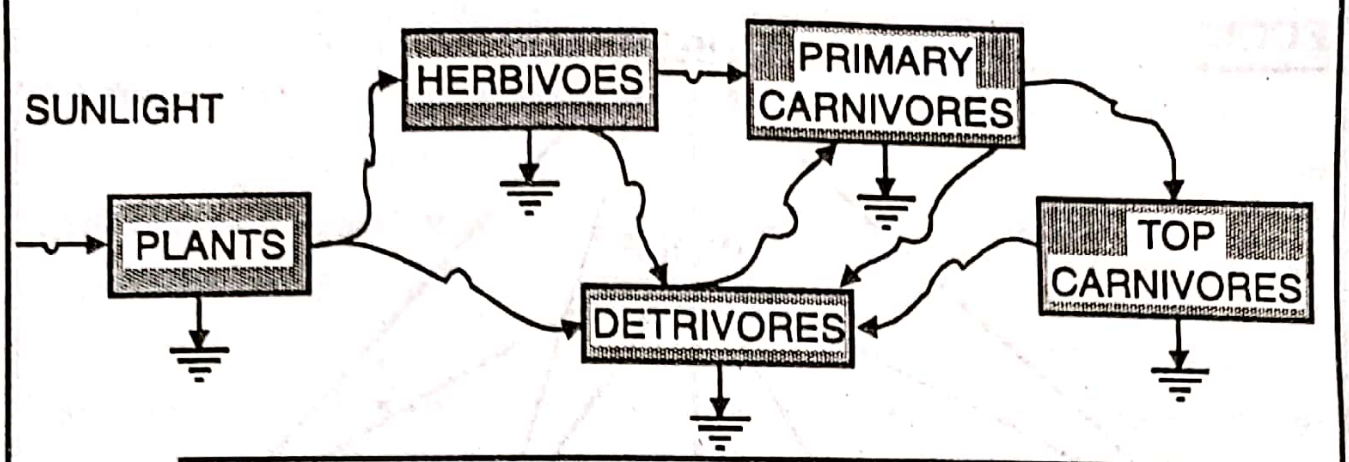

FIGURE 2.4. Flow of ENERGY IN AN ECOSYSTEM.

up by green plants for their photosynthesis. The rest falls on land and water from where it is dissipated. Only 0·2 % of solar radiations are trapped by aquatic ecosystems. It is 1·15% for grassland, 0·81 % for mixed forest, 5 % for modern crops, and 10-12% for a Sugarcane field. The solar energy picked up by plants is converted into chemical energy which is trapped in organic food during the process of photosynthesis. In this way energy enters an ecosystem through green plants. About 20% of this energy is consumed by plants themselves for maintaining their body. The rest is available to other constituents of ecosystem like herbivores and detrivores. During the transfer a part of the energy is dissipated. Herbivores and deterivores use the ingested food for two purposes : (*i*) Building up of their body and (*ii*) Metabolising it to release energy. It is estimated that respiratory consumption of energy is 30 % of the total in herbivores (as compared to 20 % in plants). From herbivores (and detrivores) the food energy is transferred to primary carnivores, from primary to secondary carnivores and ultimately to top carnivores. At every step part of the energy is dissipated during transfer. Carnivores consume upto 60% of the food energy in respiration. As a lot of energy is lost during transfer and maintenance of a trophic level, the number of individuals supported by an ecosystem decreases with the rise in trophic level so that top carnivores are very few in number.

BIOMASS

It is the amount of living matter present in an ecosystem or any of its components. Biomass is the index of **productivity** or rate of synthesis of energy containing organic matter. Rate of photosynthesis or total organic matter synthesised per unit area per unit time is called **gross primary productivity**. Rate of organic matter stored in producers per unit area per unit time is known as **net primary productivity**. Rate of biomass synthesis in consumers is called **secondary productivity**.

ECOLOGICAL PYRAMIDS (Eltonian Pyramids ; Elton, 1927)

An ecological pyramid is a graphic representation of a trophic structure or function at sucessive levels with producers forming the base, intermediate levels forming tiers with apex being represented by top carnivores. Ecological pyramids are expressed in terms of number, biomass, and energy.

1. Pyramid of Numbers. It is a graphic representation of number of individuals supported in a given ecosystem at successive trophic levels with producers forming the base, intermediate levels forming tiers and top carnivores placed at apex. Pyramid of numbers is generally upright with members of successive higher trophic level being fewer than the lower one. Producers have the maximum number. Herbivores are comparatively fewer, primary carnivores still fewer and so on. The top carnivores are very few in number. In terrestrial ecosystem, herbs and grass plants are very large in number. Grasshoppers feeding on them are fewer. The number of frogs feeding on grasshopers is smaller, the snakes feeding on frogs still fewer while peacocks or falcons preying on snakes are very few. A similar pyramid of numbers is met in case of pond ecosystem. Members of higher trophic level are fewer than the lower one due to (*i*) Wastage of food energy in transfer and (*ii*) Utilisation of food energy in respiration. However, pyramid of numbers can be spindle-shaped when a large sized producer like tree provides nourishment to several birds (herbivores) that are preyed upon by falcon (carnivore). It is inverted if we take into consideration that each bird has a number of parasites.

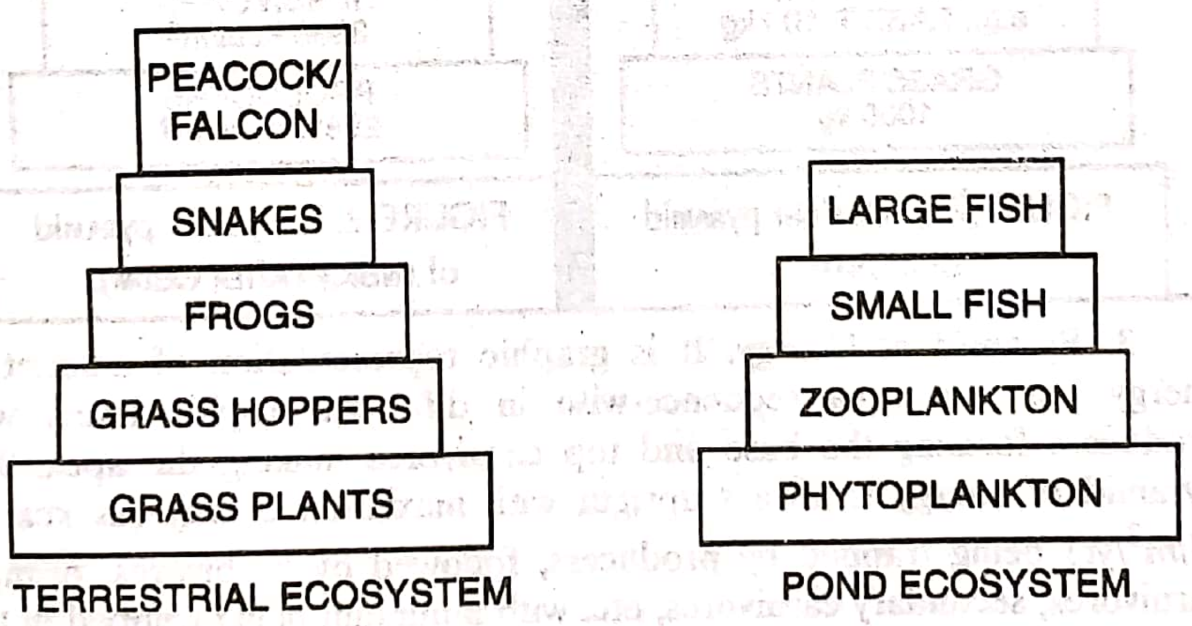

FIGURE 2.5. Upright pyramid of numbers.

2. Pyramid of Biomass. It is graphic representation of biomass or amount of living matter present in an area sequence-wise in different trophic levels with producers forming the base and top carnivores the apex. Maximum biomass occurs in producers followed by herbivores, primary carnivores, secondary carnivores and top carnivores. Therefore, pyramid of biomass is generally upright. It is found that 10-20% of biomass is formed in a higher trophic level as compared to lower trophic level. It is popularly called **10 % law** (Lindeman, 1942). The law is highly important in solving food problem of increasing human population. 100 kg of vegetable matter is consumed in raising 10 kg biomass in herbivore and 1·0 kg in primary carnivore. Therefore, more vegetarian population can be supported in a given area as compared to nonvegetarian population. Agriculture produce of Russia is almost double than that of India but population is less than half. Even then Russia imports grains from outside while India has become surplus. It is because Russians are nonvegetarians while Indians are mostly vegetarians.

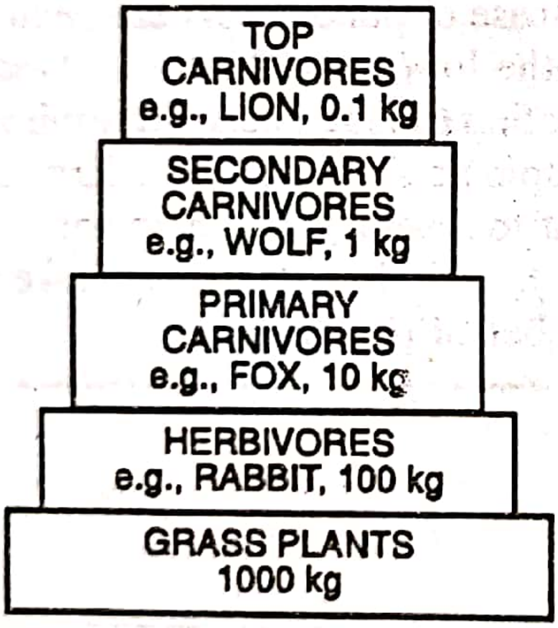

FIGURE 2.6. Upright pyramid of biomass.

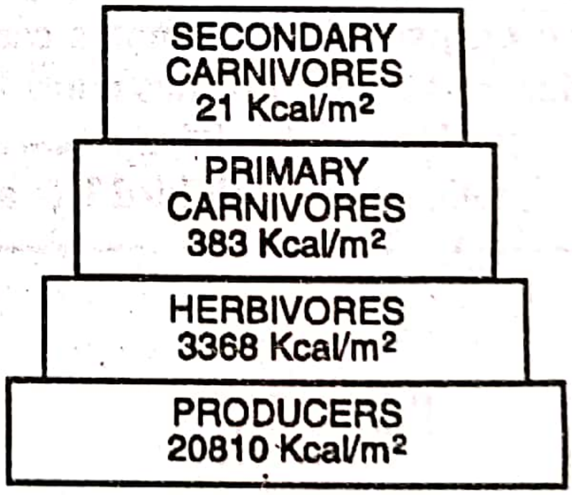

FIGURE 2.7. Upright pyramid of energy (After Odum).

3. Pyramid of Energy. It is graphic representation of amount of energy per unit area sequence-wise in different trophic levels with producers forming the base and top carnivores making the apex. The pyramid of energy is always upright with maximum energy (as kcal or $kJ/m^2/yr$) being trapped by producers, followed by herbivores, primary carnivores, secondary carnivores, etc. with minimum being trapped in top carnivores. Energy passes in the ecosystem from lower trophic level to higher trophic level alongwith food dissipating at every step as well as for performing different body activities.

Halophytes (*Gk. hals*—salt, *phyton*—plant). Halophytes grow in saline (vern. Kallar) soils and waters. The substratum contains large amount of salts, chiefly sodium and magnesium salts. The halophytes protect themselves against excessive salt content of the medium by (*i*) exclusion of salt, e.g., *Agropyron* (*ii*) excretion of salt, e.g., *Atriplex*, *Tamarix*, *Avicennia* and (*iii*) dilution of salts through succulence, *e.g.*, *Sueda maritima*.

Saline Soils. The saline soils are also called alkali soils. There may be white incrustation on the surface (white alkali, Solonchak) or blackish to reddish (black alkali, Solonetz) if humus is added to such soil.

The osmotic concentration of the plants growing in these environments is generally very high. It varies directly with the salinity of the water they absorb. Previously it was considered that the halophytes are faced with physiological drought. This may be possible for non-halophytes, but it is not applicable to halophytes. The halophytes have high transpiration rate. Many of the them secrete salts by guttation.

The plants of saline soils grow chiefly during rainy season when the concentration of salts is somewhat lower. The plants are, in general, shallow rooted probably due to the fact that most saline soils are water-logged. Some air is present only in the upper part of the soil.

A large proportion of halophytes are **succulents** (e.g., *Solicornia*, *Sueda*, Fig. 410). They store water and mucilage. The succulence was previously considered to be a fact pointing towards the xerophytic nature of these plants. It is now known that it is largely due to excess of chlorides.

Many halophytes show reduced, spiny or leathery leaves, reflecting or coated surface, thick cuticle, sunken stomata, greater development of palisade parenchyma and mechanical tissue. Leaves are absent in certain cases (e.g., *Salicornia*). These characters are typical of xerophytes. These adaptations are necessary in open and windy places where the halophytes grow.

Mangrove Plants. The halophytes growing in saline ponds near the sea-shore are called **mangrove plants.** The mangrove plants exhibit three characters—stilt roots, breathing roots and vivipary (Fig. 411). The **stilt roots** (*e.g., Rhizophora mucronata*) are found in trees and help in supporting plants in mud. Stilt roots may sometimes be replaced by **buttress** or **prop-roots.** The breathing roots or **pneumatophores** are derived from secondary roots. They possess extensive aerenchyma. The pneumatophores come out of water and bear breathing pores or pneumathodes at their tips, which communicate with the inner air cavities.

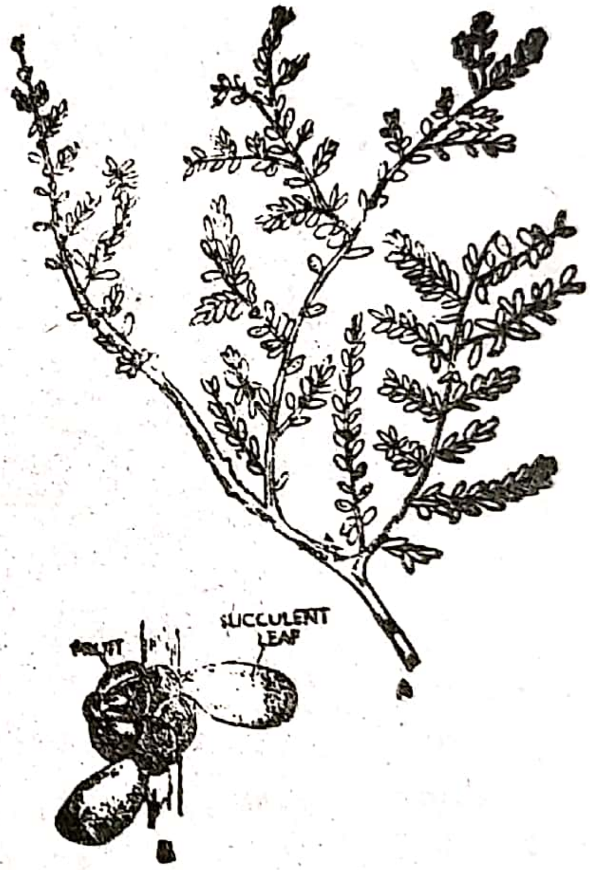

Fig. 410. *Sueda fruticosa*
A, branch. B, leaves and fruits.

The greatest difficulty faced by all halophytes is that of germination in higher concentration of salts present in water. This is perhaps the reason of thin population of plants in saline areas. Mangroves have solved this problem by **vivipary** (Joshi, 1933-34). Here the seeds germinate long before the fruits break from the plants. A large radicle comes out and the plumule slightly peeps out. On falling in the muddy water the radicle quickly gives out branches while the plumule, which does not dip in water, later on produces the shoot.

Some mangrove plants excrete salts of sodium and potassium (e.g., *Avicennia*).

Examples. *Saline Soils—Salsola* (*vern.* lusan), *Sueda fruticosa* (Fig. 410), *Chenopodium* species, *Tamarix* species (Salt Cedar Tree), *Salicornia, Atriplex, Acanthus ilicifolius*, etc.

Mangrove Plants—Rhizophora, Sonneratia, Heritiera, Avicennia, *Ceriops*, etc.

D. Alpine and Arctic Plants. These plants grow in cold areas of high altitudes and latitudes. High winds and strong illumination increase the rate of transpiration. The low temperature hinders root absorption. Consequently the growth is very stunted. The plants

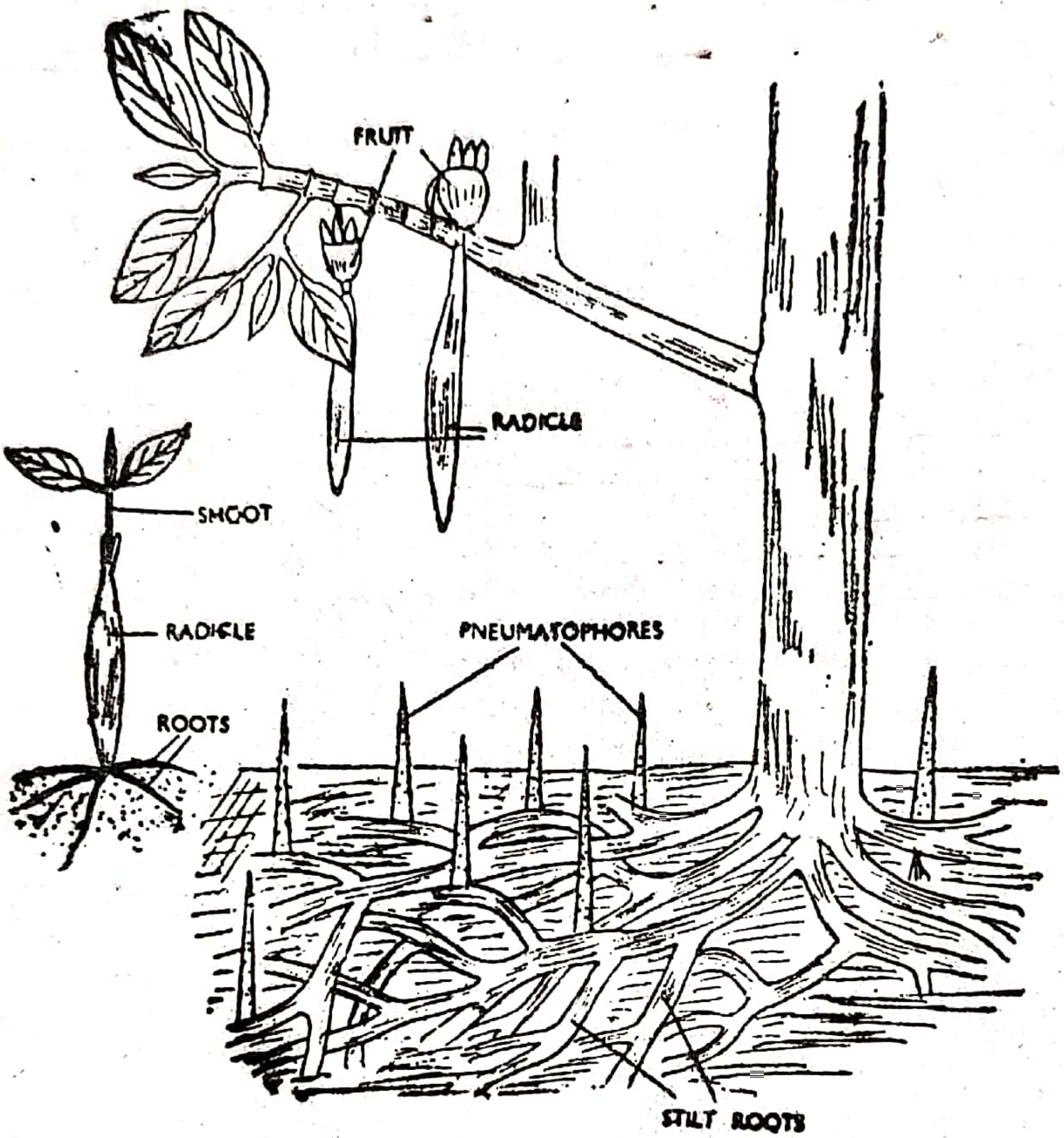

Fig. 411. A mangrove tree showing stilt roots, pneumatophores and vivipary.

are either low herbs or grow prostrate. The latter are often called **cushion plants.** In comparison to the top, the root system is more well developed. The alpine and arctic plants are highly frost resistant. They show several characters of typical xerophytes. All of them have a high osmotic pressure. The cells contain abundant free sugar. Both alpine and arctic plants have beautiful flowers. Some of the alpine plants of Indian Himalayas are *Primula*, *Potentilla*, *Saxifraga*, etc.

III. Mesophytes (Gk. *mesos*—intermediate, *phyton*—plant). Mesophytes are plants intermediate between xerophytes and hydrophytes. They live in moist habitats which are neither saline nor waterlogged. The temperature of such habitats is also moderate. Mesophytes can be herbs, shrubs or trees.

Mesophytes possess luxuriant growth of their root system. Shoot/root ratio is near unity. Root hairs are abundant. Root nodules and mycorrhizae are found in many plants.

Foliage shows maximum development. The leaves are broad, with a moderate thickness. They commonly have a deep green colour. Spines and thorns are very few or absent. Epidermis and cuticle are thin. Stomata occur on both the surfaces. They are seldom sunken. Chlorophyll is abundant and both palisade parenchyma and spongy parenchyma are well developed.

The mechanical and vascular tissues are highly elaborate. The osmotic pressure of the cells is low. If not provided with water the plants quickly wilt. They show temporary wilting during mid-day of summer. Plants faced with occasional drought or unfavourable season often possess subcoriaceous leaves (e.g., Mango) with stomata found only on the lower surface. Such plants are intermediate between mesophytes and xerophytes. They are called **tropophytes**. They may shed their leaves on the approach of dry or cold seasons.

These plants are abundant in moist climates where either rain is sufficiently high or water is supplied to soil constantly throughout the year. Such habitats are found in evergreen tropical forests and on the banks of rivers, canals and in irrigated fields and gardens.