UNIT-II

ECOSYSTEMS

Forests, grasslands, oceans, lakes, rivers, mountains, deserts, ponds, etc which support the life shows different variations and also derive (or) exchange energy from the surroundings. The interaction between them rEgarding energy, nutrients etc, are explained by the term „ECOLOGY" (coined by Earnest Hackel. Oikos- home + logos- study)

"The study of organisms in their natural home (or) habitat interacting with their surroundings is known as ecology". The total life supporting systems are classified into i) Biotic (living) & ii) Abiotic components (non-living) **Eg:** The study of an interaction of human being with other animals, plants, soil, water, etc is known as ecology. Basic unit of ecology is known as ecosystem.

„Ecosystem is a self rEgulating group of biotic communities interactions with one another & abiotic communities including their exchange of energy & matter". Simply study of ecosystems is known as ecology.

Key points of ecosystem:

1) An ecosystem is an intEgrated unit consisting of biotic & abiotic with the interaction of survival & maintenance.
2) It consists of number sub units, which may be linked directly (or) indirectly.
3) There are two types of ecosystems a) Open ecosystem (exchange energy freely with surrounding) b) closed (isolated, doesn"t exchanges)
4) The energy flows from the sun and continues through the chain of ecosystems, this sustains the life.
5) As a result of human activities, flow of energy & nutrients are disturbed.

Characteristics of ecosystem:

Inspite of large variations in size, structure, composition of ecosystem but they have some common i) structural and ii) functional features.

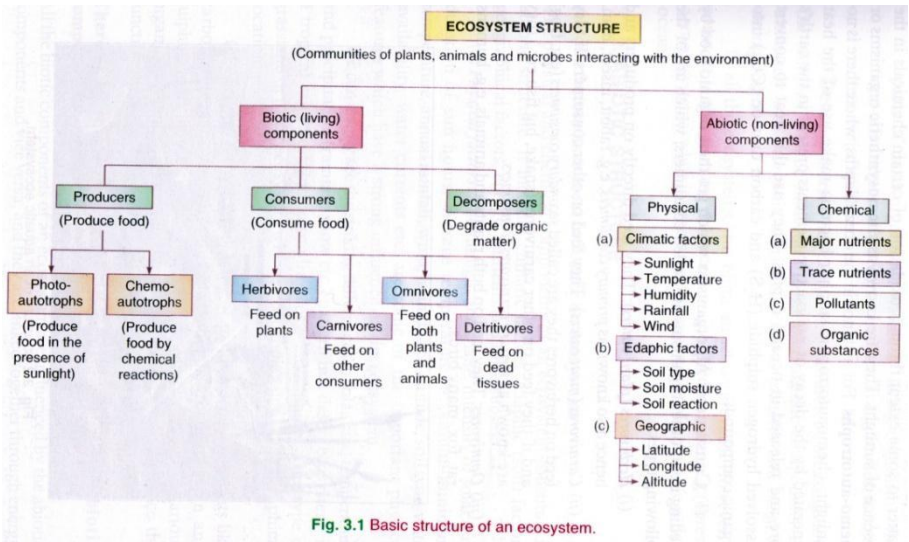

Fig. 3.1 Basic structure of an ecosystem.

Structural features of ecosystem:

As stated earlier ecosystem comprises of a) Biotic & b) Abiotic components.

I. Biotic component:

This comprises of plants, animals, micro organisms etc. Based on nutrition criteria, they are classified as follows:

i) Producers: These can synthesize food materials by own. They are also known as „photo autotrophs" (photo-light; autoself; trophs-food)

Eg: Green plants synthesise food materials with the help of (O_2, H_2O, Chlorophyll) in the presence of sunlight.

$$6\,CO_2 + 12\,H_2O \xrightarrow[\text{Cholorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6\,H_2O + 6O_2$$

Some microorganisms can also produce organic matter by the oxidation of some chemicals in the absence of sunlight and so known as chemosynthetic organisms (or) chemo-autotrophs.

Eg: Sulphur bacteria in deep oceans oxidise H_2S & CO_2 in the absence of sunlight with the help of heat into organic compounds.

ii) Consumers: These cannot synthesis food materials and depend on producers for food. They are of following types depending upon the level.

a) Herbivores (plant eaters)**:**

They are known as primary consumers or they feed directly on producers. Eg: rabbit, insect, man etc.

b) Carnivores (meat eaters):

These are known as secondary consumers as depend on herbivores for food materials. Eg: frog.

If they depend on other carnivores, they are known as tertiary consumers/secondary carnivores. Eg: snake, big fish, etc. **c) Omnivores:**

They feed on all of them (primary, secondary and tertiary consumers) Eg: man, rat, fox, birds, etc. **d) Detritivores:**

They feed on dead organisms, wastes of living organisms & their cast-off‟s and partially decomposed matter. Eg: beetles, crabs, earth worms, etc.

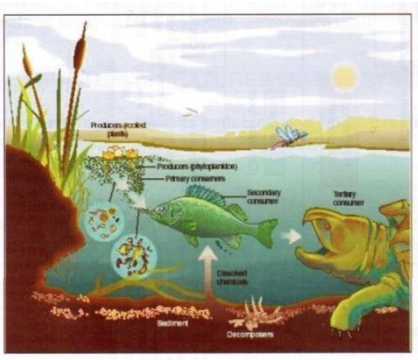

Fig. 3.2 Structure of an aquatic ecosystem.

iii) Decomposers:

These convert complex organic molecules into simple ones, finally to inorganic matter and derive the energy from them. Eg: bacteria, fungi, etc.

NOTE: In all types of ecosystems biotic components dominate over abiotic but within biotic component sometimes producers (forests), predominate and sometimes decomposers (deep ocean) predominates.

II) Abiotic component:

Ecosystems are driven by abiotic factors and play a key role. It includes physical & chemical components. They are climatic condition, soil conditions, energy, nutrients, geographical factor and toxic substances.

i) Physical factors:

Sunlight & shade, intensity of solar flux, duration of sunlight, average temperature from maximum & minimum, annual rainfall, wind, latitude, soil type, water availability, water currents etc.

Note: We can observe the fluctuations of solar flux, temperature, precipitation etc in different ecosystems (desert, tropical rainforest, tundra eco systems). Similarly there is a geographical difference in grassland and forest ecosystem.

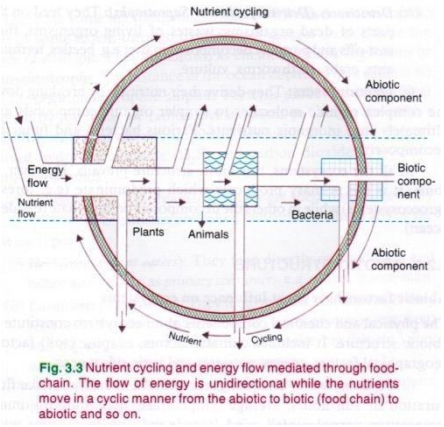

Fig. 3.3 Nutrient cycling and energy flow mediated through food-chain. The flow of energy is unidirectional while the nutrients move in a cyclic manner from the abiotic to biotic (food chain) to abiotic and so on.

ii) Chemical factors: They include major essential nutrients (C, H, O, P, K, N, S, Ca, Mg), salts, organic matter etc, influences eco system.

Both biotic and abiotic components are interlinked together with energy flow and shown below diagrammatically.

Functioning of ecosystems:

Under natural conditions, ecosystem performs in a systematic way. Flow of energy is undisturbed until on external force acts on it. Apart from energy, nutrients and water also required for life process in biotic components. The functional attributes are:

i. Trophical structure (food chain & food webs) ii. Flow of energy.
iii. Nutrient‟s cycle.
iv. Primary & secondary production.
v. Regulation & development of ecosystem.

i) Trophical structure: The producers and consumers are arranged in a definite order along with their interaction including population size are expressed together as trophic structure. Each food level is known as trophic level & amount of living matter in each level is known as standing biomass. **a) Food chains:**

The sequence of flow of energy (eating and being eaten) from producers to consumers in an ecosystem is called food chain.

Eg:1) Plant leaf ----→Catter pillar ------→Sparrow ---------→ (decomposes all dead organisms by decomposers)

2) Grass -----→ Grass hopper -------→ Frog ----→ Snake ---→Hawk (grassland ecosystem)
3) Phytoplankton ----→ Water fleas ---→ Small fish -----→ Tuna fish (pond ecosystem)
4) Liches ---→ Reinder ------→Man (artic tundra)

From the above fig. It is clear that each level of organisms depends on other for food material.

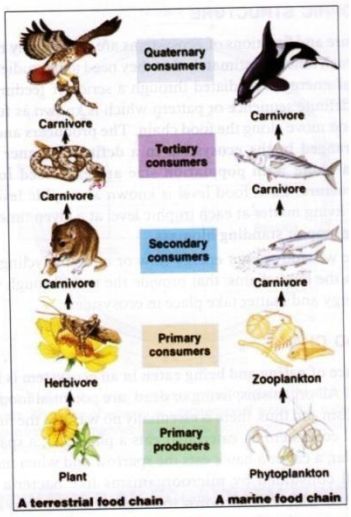

Fig. 3.4 Food chain in a terrestrial and marine ecosyster

Types of food chains: a) grazing food chain.
b) Detritus food chains.

a) Grazing food chain: It starts with primary producers (green plants) and ends with secondary (or) tertiary consumers (carnivores)

Eg: Phytoplankton -----→Zooplankton --------→Small fish ----→Large fish
(algae,diatoms)

Grass-----→Rabbit -----→Fox.

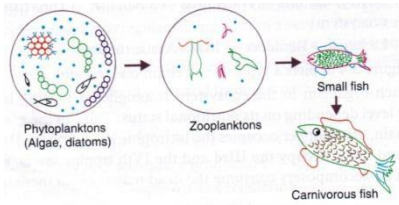

Fig. 3.5 A grazing food chain in a pond ecosystem.

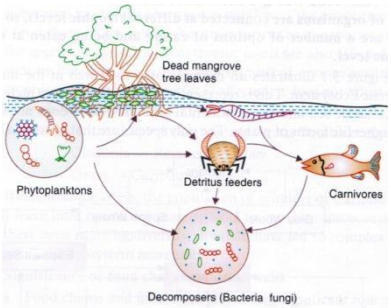

Fig. 3.6 A detritus food chain in an estuary based on dead leaves of mangrove trees.

b) Detritus food chain: It starts with death & decay matter, followed by detritivores and decomposers.

Eg: Phytoplankton ---→Detritus feeders ---→Carnivores.
\ /
Decomposers

Thus for grazing food chain energy is obtained from plants but for detritus, it is obtained from biomass of plants. Grazing food chain dominates over detritus.

c) Food web: Food chain has linear structure, but this has network structure. "The different organisms of different trophic levels are connected through a network in which there are multi-options for eating and being eaten is called food web".

In trophical ecosystems, the food webs are more complex due to rich in species diversity.

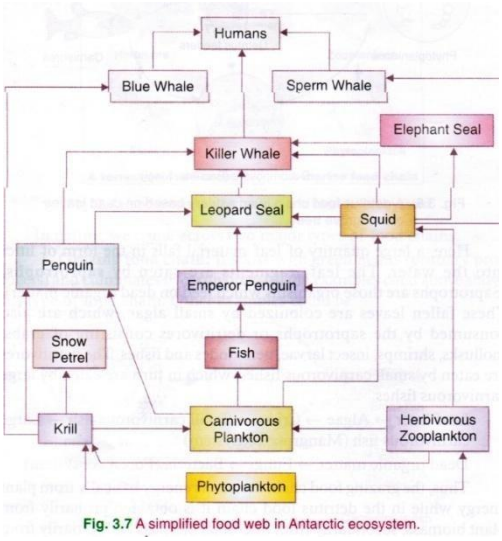

Fig. 3.7 A simplified food web in Antarctic ecosystem.

Reason for evolution of food web: In a linear food chain, if one species becomes extinct, then there will be no food for the preceding ones. So in search of food material, it diverted and which led to the evolution of food web. In a food web an organism has multiple options for consumption and also for being consumed.

Eg: Cladoria-----→Reindeer------→Man.
Grass-------→Caribou ------→Wolf.

If due to some reasons reindeer & caribou becomes endangered, the man (or) wolf finds food with other any trophic levels.

Significance of food chains & food web:

1) Both food chain & webs plays a key role in the flow of energy & nutrients in the ecosystem.
2) The ecological balance of population size of trophic level is maintained constantly by food chains.
3) Food chain shows a specific property known as "biomagnifications".

Bio magnification:

The increase in the concentration of pesticides, toxic chemicals, heavy metals from lower level of the food chain to the highest level is known as biomagnification.

Biomagnifications of DDT-case study: Some birds like osprey were found to have decrease in population due to hatching of young ones in a premature condition. The reason is having very high concentration of DDT. But when reaches to the next higher level, the concentration increases and the phenomenon is known as biomagnification.

Human beings are also affected more due to this biomagnifications of toxic chemicals and so pesticides & heavy metals should not be added to the plants in higher levels. **Ecological pyramids:**

"The graphical representation of trophic structure and function of an ecosystem starting with producers and followed by successive levels is known as ecological pyramids". There are three types:

1) Pyramid of numbers:

In this type, it indicates the number of individuals present in that particular trophic level. This may be upright (or) inverted. a) Upright pyramid – grass land ecosystem.

b) Inverted pyramid- parasitic food chain.

c) Broader in middle and narrow on sides- forest ecosystem.

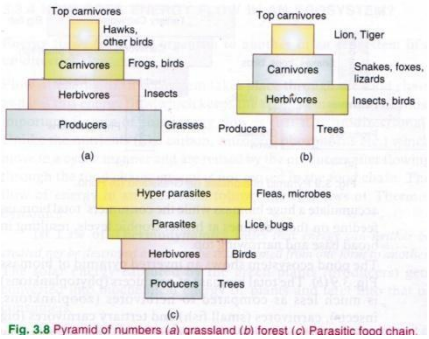

Fig. 3.8 Pyramid of numbers (a) grassland (b) forest (c) Parasitic food chain.

2) Pyramid of biomass:

In this type, it indicates the total biomass at each trophic level.

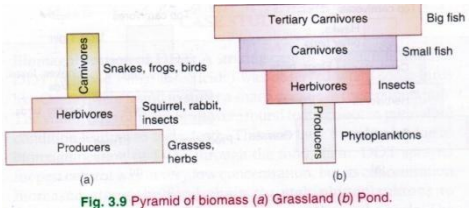

Fig. 3.9 Pyramid of biomass (a) Grassland (b) Pond.

This also may be upright (or) inverted. a) Forest ecosystem- upright.

b) Pond ecosystem – inverted.

3) Pyramid of energy:

In this type, it indicates the amount of energy associated in each trophic level and it is always upright because some amount of energy is **wasted** as it flows from one trophic level to the other. a) Pyramid of energy- upright.

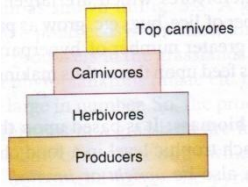

Fig. 3.10 Pyramid of energy.

ii) Energy flow in an ecosystem:

The energy flows is unidirectional as flows from one trophic level to the other in single direction. In contrast with this nutrients flows in cyclic path. The flow of energy obeys 1st &2nd law of **thermodynamics**.

1st law of thermodynamics:

It states that "energy can neither be created nor be destroyed but can be transformed from one form to another".

Eg: Plants capture solar energy and converts into biochemical energy and which are consumed by the successive levels.

2nd law of thermodynamics:

It states that "the energy is dissipated (on dispersed as it is used). In clear the energy is dispersed into less concentrated medium (from more concentrated ones).

Eg: At each trophic level 90% of the energy is wasted (for locomotion, respiration, etc) and the remaining only 10% of energy is transferred to successive trophic levels.

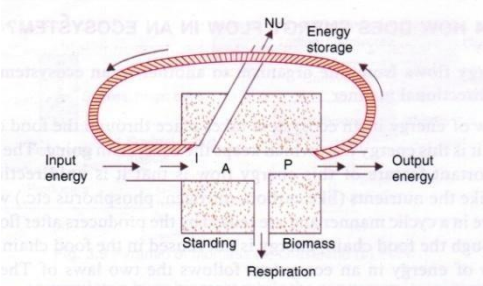

Fig. 3.11 Universal energy flow model applicable to all living components (I = Energy input; A = Assimilated energy ; P = Production ; NU = Energy not used.)

Energy flow – models:

To explain flow of energy, the following models are proposed.

a) Universal energy flow model: Normally, as energy flows from one form to other, some amount of energy is wasted. Similarly as the energy flows from one level to the other, some amount of energy is wasted and there is availability of less energy for the next level. The loss of energy is due to excretion, locomotion, respiration,

unutilization, etc. The only remaining energy is used for production. So the energy flow in the form of pipes becomes narrow & narrow as they move from higher trophic level to the lower ones. **b) Single energy channel flow model:**

In this model energy flows in a unidirectional way similar to that of food chain and not food web. As usual the energy is wasted as it moves from one level to another level. Flow of energy is from produces to carnivores.

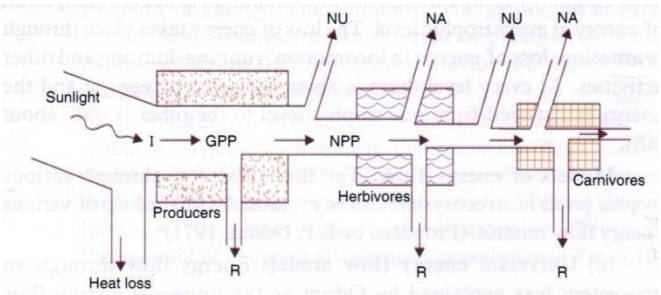

Fig. 3.12 One-way energy flow model showing unidirectional flow through primary producers, herbivores and carnivores in a grazing food chain. At each successive trophic level there is huge loss of energy (I = Solar energy input ; GPP = Gross primary production ; NPP = Net primary production ; NU = Energy not used ; NA = Energy not assimilated e.g. excretion ; R = Respiratory loss).

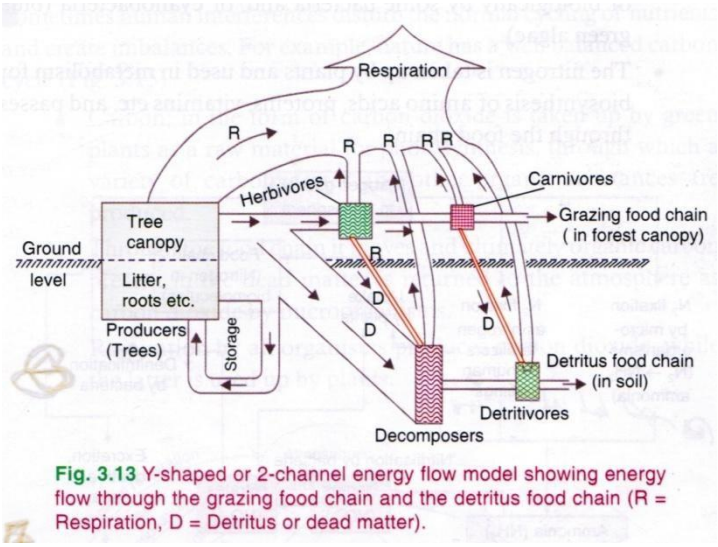

Fig. 3.13 Y-shaped or 2-channel energy flow model showing energy flow through the grazing food chain and the detritus food chain (R = Respiration, D = Detritus or dead matter).

c) Double channel (or) y-shaped energy model:

In nature, both grazing and detritus food chains operate together leading to the y-shaped energy model.

Eg: 1. Marine ecosystem- In this ecosystem major portion of the energy is deviated to grazing food chain and some portion to detritus food chain.

2. Forest ecosystem- In this ecosystem major is passed to detritus and little amount to grazing food chain.

iii) Nutrient's cycles:

Apart from energy flow, the nutrients also flows in the ecosystem, but their flow is in a cyclic way.

Eg: C, N, S, O, P, etc. (in hydrological cycle, the water moves in a cyclic path)

The nutrients flow from producers to carnivores and ultimately reach the detritus food chain and again they are converted into nutrients and continue the cycle. The different cycles are: **a) Nitrogen cycle:**

- Atmospheric air comprises of 78% N_2, but it is not utilised directly by the plants. The N_2 is fixed by physical (lightening) or biologically (some bacteria Eg:- cyanobacteria, rhizhobium etc)
- The N_2 utilised by the plants with the help of bacteria is used to synthesize amino acids, proteins, vitamins etc.
- This N_2 is passed into the successive trophic levels. Finally death of all organisms (plants and animals) takes place followed by the decomposition by ammonifying, nitrifying bacteria which convert them into NH_3, NO_3^-, NO_2^- etc which is again used by plants.
- Some bacteria converts NO_3^- into atmospheric N_2 & released back into the atmosphere, but a little amount of N_2 is lost into deep sediments of oceans.

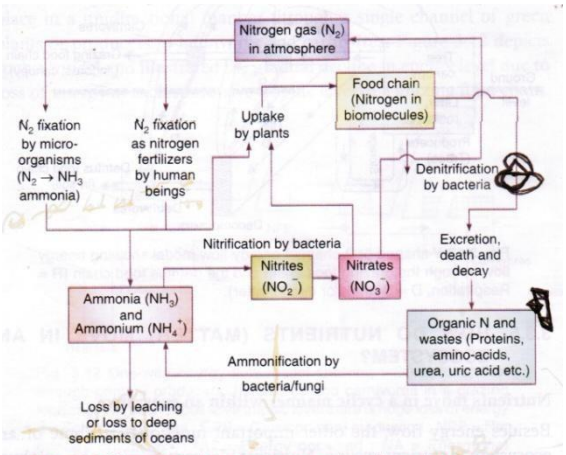

Fig. 3.14 Nitrogen cycle—a gaseous cycle with major reserve in atmosphere (N_2 : 78%). The boxes represent pools of Nitrogen in atmosphere/soil/water. Circulation occurs due to conversion of nitrogen from one form to another by microorganisms.

b) Carbon cycle:

Nature has a well balanced carbon cycle until they are interrupted by human activities.

- CO_2 present in the atmosphere is utilised by plants in the process of photosynthesis, by this it produces food materials (carbohydrates)

- These food materials are utilised by consumers and followed by detritivores. Decomposition of all death organisms by micro organisms leads to the formation of CO_2 which is released into atmosphere.
- In between these process, all the organisms releases CO_2 by respiration into atmosphere, which is utilised by plants.
- Now a days due to anthropogenic activities (man made activities) carbon cycle is disturbed. i.e., the levels of CO_2 are increased enormously in the atmosphere creating imbalance. Due to this world is facing serious problem (global warning)

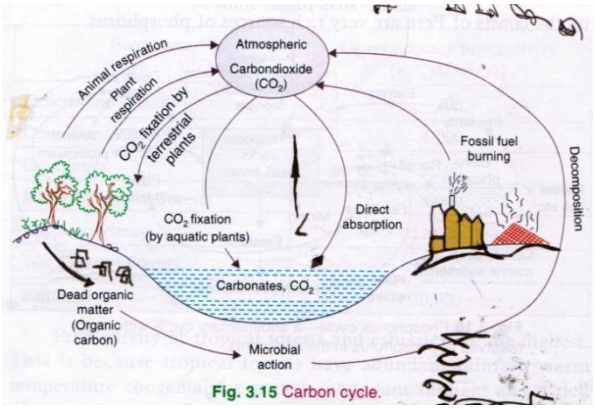

Fig. 3.15 Carbon cycle.

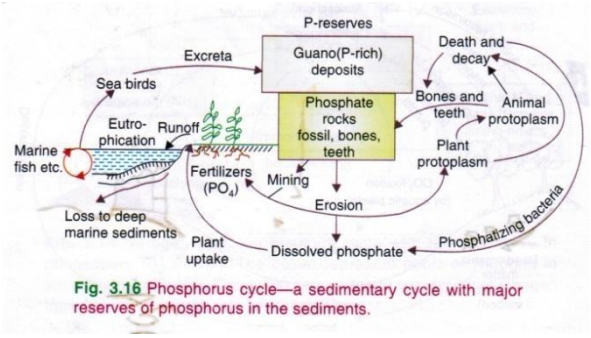

Fig. 3.16 Phosphorus cycle—a sedimentary cycle with major reserves of phosphorus in the sediments.

c) Phosphorus cycle:

It is an important cycle and the source of phosphorus is rocks, fossils etc. This cycle also shows in a slightly imbalanced way due to human activities (anthropogenic activities)

- Phosphorus is used by the plants in the form of fertilizers. The excess fertilizer is washed by the run-off, finally reaching into oceans (wasted in large amount), ponds, lakes (leading to eutrophication)
- Due to passage of phosphorus into oceans, the cycle is affected because it is not recycled. But any how some sea birds helps to recover some of it by a cycle (the sea birds eats fishes which posses phosphorus and excretes the wastes that contain phosphorus in the land)

Eg: Guano deposits on the coasts of Peru are very rich sources of „P". **iv)**

Productions:

a) Primary productions:

The rate at which radiant energy is converted into organic substances by photosynthesis (or) chemosynthesis by primary producers is known as primary production.

Table 3.1. Annual average of gross primary production of some major ecosystems

Ecosystem	Gross primary productivity (K Cal/m^2/yr)
Deserts and Tundra	200
Open Oceans	1,000
Grasslands	2,500
Moist Temperate Forests	8,000
Agro-ecosystems	12,000
Wet Tropical Forests	20,000
Estuaries	20,000

- Plants produce food material by photosynthesis, some part of it utilised for growth & respiration. So only some remaining part of the energy is available free, which is known as Net Primary Production (NPP)
- The total amount including energy utilised for growth & respiration produced by the plants is known as Gross Primary Production (GPP)

NPP = GPP - R (Respiration etc)

- But the primary production depends on the different factors like solar radiations, availability of water & nutrients, types of plants, chlorophyll content etc.
- Due to abundant rainfall, warm temperature, abundant sunlight and a rich of diversity in species etc, the productivity of tropical forests are very rich. The factors are all natural.
- On the other hand inspite of irrigation water supply, good quality seeds, fertilizers, pesticides, etc. the agriculture ecosystem has less productivity (12,000 kcal/m^2/year) than that of tropical rain forests (20000 kcal/m^2/year). The difference is due to natural & artificial conditions.
- Anyhow desert ecosystems have less production due to inadequate factors such as water etc. **b) Secondary production:**

The food materials synthesised by green plants are utilised by the consumers (herbivores, carnivores etc.) The food materials are converted into organic matter in the herbivores and this is available for the next trophic level (excluding the respiration loss).

"The energy stored at consumer level in the form of organic matter which is used for the next trophic level is known as secondary production".

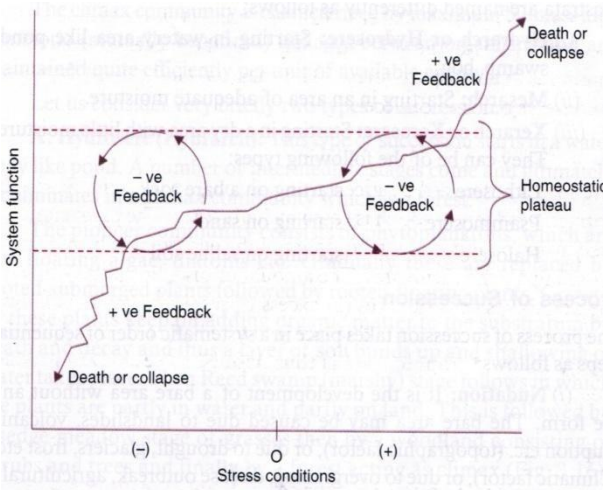

Fig. 3.17 Ecosystem regulation by homeostasis. On application of a stress, the negative feedback mechanisms start operating, trying to counter the stress to regulate the system. But beyond the homeostatic plateau, positive feedback starts which further accelerate the stress effects causing death or collapse of the organism/system.

v) Regulation and maintenance of ecosystem:

Ecosystem regulates themselves normally unless external stress (force) acts on it. Anyhow ecosystem itself has resist to change (stress) and maintain the equilibrium with a property known as homeostasis (homeostasis is the inherent property of all living systems to resist change).

- Ecosystem has resist to change with the maximum and minimum limits known as homeostatic plateau.
- If the stress is within the homeostatic plateau range, then the counteract is known as negative feedback mechanism.
- If the stress is out of range than the homeostatic plateau, then the counteract is known as positive feedback mechanism. If this pertains, it cause ecological imbalance.
- So man - made activities have to keep the ecosystem within the homeostatic plateau and should not go out of range to operate positive feedback mechanism.

Ecological succession:- change of ecosystem with time & environmental conditions

An ecosystem is not constant in nature and changes with time and other factors, and the change also can be predicted.

- During the course time one type of community is replaced by another community with several changes is known as ecological succession.
- Ecological succession is defined as "an orderly process of changes in the community structure and function with time and ultimately to higher point by modification in the physical environment resulting in stabilized ecosystem".
- The whole sequence of communities is known as several stages (or) serves and the first one is known as pioneer community.

Process of succession: The process of succession takes place in a systematic order.

1) Nudation: development of barren land.

Reasons: Landslides, volcanic eruption, drought conditions, glaciers, frost, over grazing, disease outbreak, agricultural, industrial activities, etc.

2) Invasion:

Successful establishment of one (or) more species in barren land through dispersal (or) migration. **Eg:** dispersal of seeds, spores etc by wind, a water, insects, birds, etc. (seeds, germinates and becomes pioneer species)

3) Competition and coaction:

Due to increase in the population, there arises completion between the species and also within the species for different reasons like water, space, nutrition etc. This influence such other in many ways known as coactions.

4) Reaction:

Due to influence of environmental factors such as water, nutrients etc, the organisms gets modified and this is known as reaction. The reaction may be favourable for new species and unfavourable for old species and which tends to replace it by which it deeds to seral communities.

5) Stabilisation:

The succession reaches to highest point of more (or) less stable community which is equilibrium with environment.

The climax community have maximum biomass and mutual benfit among the organism.

Let us consider some types of succession: a. Hrydrosere (hydrach):

This starts in watery area like pond swamp, bog etc. This consists of number of intermediate stages but ends with community in a forest.

At earlier stages the ecosystem comprises of phytoplankton (free floating algae diatoms etc) in water. But these are gradually replaced by rooted submerged plants, followed by rooted floated plants. The death and decay of all the organism imposes organic matter by which it builds up the soil by which it imparts shallowing of the water body. This leads to reed swamp marshy stage (which is partially on land and partially on water), followed by sedge meadow stage of grasses and then by woodland consisting of shrubs and trees, finally the climax is forest. **b. Xerosere (xerach):**

This starts on bare rock where there is less moisture and organic matter.

This succession starts with crustose and foliose lichens which produces weak acids that disintegrates the rock (weathering) Due to this organic matter, humans content and soil increases leading to the formation of mosses followed by shrubs and finally forests. So irrespective of the intial stages all are finally leading to the forest ecosystems as a climax.

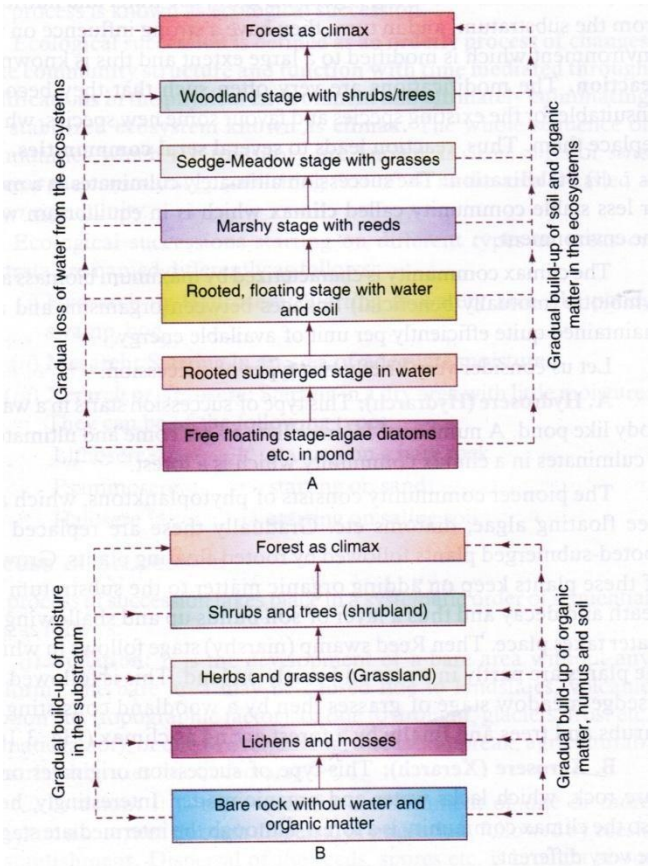

Fig. 3.18 Ecological succession: from lake to forest ecosystem – Hydrach (A); from bare rock to forest ecosystem – Xerach (B).

Major types of ecosystems: Some important ecosystems are discussed below: **a. Forest ecosystem:**

In this eco system it is characterised by more number of trees with more species like shrubs, herbs, climbers, lichens, algae, wild animals, birds, etc. Forests recieve moderate to high rainfall with stable climatic conditions and undisturbed environment.

Types of forests:

Based on climatic conditions forests are of following types.

1) Tropical rain forest: These are evergreen forests with broader leaves found near the equator. They receive high rainfall, temperature, humidity which favours the growth. They are rich in biodiversity with constant climate. The species confine to different areas based on conditions like food, sunlight, water, nutrient etc.

The silent valley in Kerala is the only tropical rain forest in India with wide variety of species.

These forests consist of different layers. **a.**

Emergent layer:

This is the top most layer with broad leaves of tall trees and receives much sunlight. **b.**

Canopy layer:

This is below emergent layer and leaves forms umbrella like shape and covers below layer. Most of the animals like bats, birds, insects occupies this layer.

c. Understory layer:

This is beneath canopy layer which consists of small trees. In this layer climbers and epiphytes are present. **i) Climbers:**

The plants that climb over the stem of the other plants.

ii) Epiphytes:

The plants that grows on the trunks of other tress. **Eg: O**rchids. Some epiphytes can stores nearly 4 litres of water and acts as mini pond, for which birds, insects, monkeys makes their habitats (home) in these area.

This layer receives less sunlight and so increases the chlorophyll content resulting in the dark color.

NOTE: 1. Animals like monkeys, snakes, chameleons etc, moves up & down in sunny and darker layer.


Fig. 3.19 Rafflesia—the biggest flower.

2. The flowers of forest are large, colourful, fragrant and attributive, which are helpful for pollination by birds, insects, bats etc.

Eg: Rafflesia: Biggest flower (7 kg) characterised by rotten egg smell by which it attracts the flies and beetles that helps for pollination.

d. Shrub layer: This layer is next to understory layer and receives very little amount of sunlight.

e. Ground layer: This is also known as forest floor and sunlight does not penetrate into it and so it is dark. It is characterised by warm temperature, moisture which facilitates decomposition of dropped leaves by which nutrients are produced. These nutrients are utilised by roots of tress. Termites, fungi, mushrooms, etc, grows on ground layer.

2. Tropical deciduous forests:

These are found little away from equator and are characterised by warm climate throughout the year. These forests receive rainfall in monsoon only and so remaining season will be leading to drying of leaves, finally falls. Different deciduous trees are found here.


Fig. 3.20 Tropical rain forest—Silent Valley, Kerala with dense vegetation.


Fig. 3.21 A tropical dry deciduous forest.

3. Sub-tropical forests:

These are found in areas having only season still higher than deciduous forests. This consists of small shrubs & deciduous trees.


Fig. 3.22 A sub-tropical forest biome.


Fig. 3.23 Boreal forest with evergreen coniferous trees.

4. Temperate rain forests:

They are found in temperate areas with moderate rainfall. They consists of coniferous trees like pines, firs, redwoods, etc.

5. Temperate deciduous forests:

These are found in areas with moderate temperature and characterised by long summer, abundant rainfall throughout the year and cold but no severe winter. These include trees like oak, hickory, poplar etc.

6. Evergreen coniferous forests (Boveal forests):

They are found in south of arctic tundra where winters are long, cold & sunlight is available for few hours only. Summer season is short with mild. They consist of pines, spruce, fis, cedar etc. The leaves are ting needle shaped with wax coated to with stand cold & drought conditions.

The soils get frozen during winter, due to which only particular species will survive. The forest floor also covered by leaves fall from trees. The soil is acidic in nature and species of diversity is less. **B. Grassland ecosystems:**

In this ecosystem grass species is predominated over the remaining species and at times it allows growing few trees & shrubs. It receives average rainfall, overgrazing is the phenomenon that affects the grassland ecosystem. Controlling of overgrazing yields more NPP or otherwise it is subjected to desertification. Three types of grasslands are discussed here.

1. **Tropical grasslands:** They occur near the borders of tropical rain forests which receives moderate to low rainfall and high average temperature.

In Africa, the tropical grasslands are known as savannas. This savanna consists of tall grasses with scattered shrubs and stunted trees, wide diversity of animals including zebra, giraffes, gazelle, antelopes etc. Fires are caught by these savannas during dry season. Termites gather the death matter known as mounds, on which the fungi are grown which releases CH_4 (green house gas). By fires of these groups also releases another major green house gas CO_2.

In these grasslands most of the captured carbon is transformed in the form of carbohydrates in bulbs, rhizomes and runners etc. These are fed upon by black, bulks, deer etc.

2) Temperature grasslands:

They are found on flat, gentle sloped hills. Here winters are very cold and summer is hot and dry due to which fires occurs and not allows shrubs (or) trees to grow.

In different areas they called by different names as follows:

USA & Canada - prairies.
South America - pampas.
Africa - velds.
Central Europe & Africa - steppes.

Here wind keeps blowing due to which evaporation rate is high followed by fires in summer. This is used for agriculture as soils are fertile.

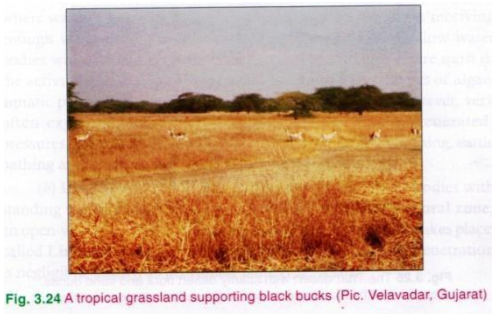

Fig. 3.24 A tropical grassland supporting black bucks (Pic. Velavadar, Gujarat)

3) Polar grassland (Arctic Tundra):

They are found in Arctic polar region. Here there is severe cold, frigid winds with ice and snow which does not allow trees to grow. The animals seen in these grass lands are arctic wolf, weasel, arctic fox, reindeer etc. Through the year a layer of ice present beneath soil known as permafrost, (in summer small annual plants grow) and also shallow lakes, bogs etc, and organisms like mosquitoes, migratory birds appear.

c) Desert ecosystems:

These type of ecosystem occur where evaporation exceeds rainfall, snow etc. The rainfall & snow fall is less than 25 cm per year. One-third of globe is covered by forests with less species diversity consists of drought resistant varieties. If it faces stress, it takes long time to recover due to water, slow growth rate, less number of species. Here temperature is dry and so acts as poor insulator due to which soil gets cooled up quickly and making nights cool. But deserts soil is rich in nutrients.

The desert plants & animals posses specific adaptations towards water conservation. They are a) scaly leaves, b) Succulent leaves, c) Waxy cuticle layer on leaves, d) Penetration of roots depper into ground for water, e) Modification of stem into leaf for photosynthesis, f) Thick outer covering for insects & reptiles.

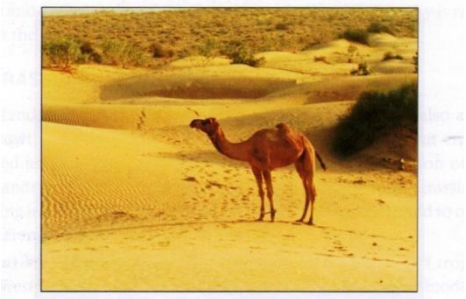

Fig. 3.25 The Thar desert with scanty desert flora and sand dunes. Camel is the best adapted animal to the extremely dry conditions.

There are three major types of deserts based on climatic conditions.
They are

1) Tropical deserts:

Deserts like Sahara & Namibia (Africa), Thar (Rajasthan, INDIA), come under this category. Here there is only few species and windblown, sand dunes are common.

2) Temperature deserts:

Deserts like Mojare (south California) comes under this category. Here day time, the temperature is hot in summer but cool in winter.

3) Cool deserts:

Gobi desert comes under this category these are characterised by cold winters and warm summer. **d) Aquatic ecosystems:**

Aquatic ecosystem includes water bodies and species present in it.
Water bodies may be a) fresh water, b) Marine

a) Fresh water bodies: The fresh water bodies are of two types. They are:

i) Lentic- stagnant: *They are:*

a) Pond ecosystem:

It is stagnant fresh water body usually shallow. The source is rain water and villages depend upon it for different activities. But due to this anthropogenic activities like washing, bathing, swimming, etc, the system gets polluted. The species includes algae, aquatic plants, insects, fishes, birds etc. **b) Lake ecosystem:**

It is a big fresh water body with stagnant. It is divided into different zones.

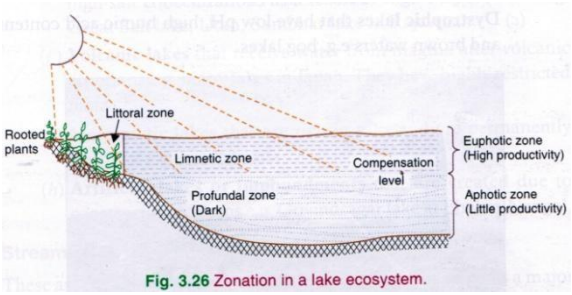

Fig. 3.26 Zonation in a lake ecosystem.

1) Littoral zone: Shallow zone with penetration of light.

2) Limnetic zone: Open zone with high penetration of light. **3) Prefunded zone:** Deep bottom zone with low penetration of light.

Eg: Dal lake (J & K), Naini lake (Uttarkhand), Loktak lake (Manipur)

Due to variation in the temperature of the lakes different strata (layers) are formed and the phenomenon is known as stratification.

The stratification is due to temperature difference i.e., top player warm up, on the other side bottom layer becomes colder. The layers are:

1. ***EPILIMNION*:** Warm, lighted and surface layer.
2. ***HYPOLIMNION*:** Cold, viscous and bottom layer.
3. ***THERMOCLINE*:** Middle layer connecting the above two layers. **Types of lakes:**

They are based on nutrients and different factors and they are:

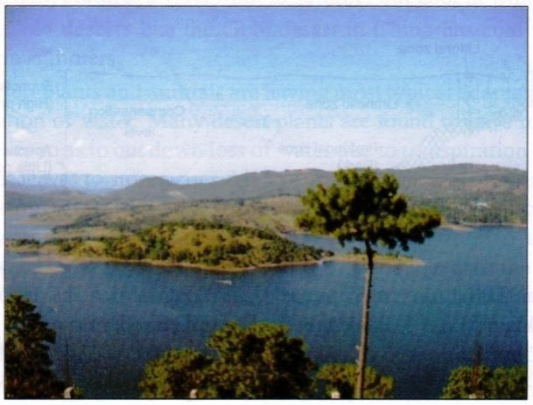
Fig. 3.27 An oligotrophic lake in the hillocks of Shillong.

1. **OLIGOTROPHIC LAKES:** These poses low nutrients.
2. **EUTROPHIC LAKES:** This poses high nutrients (N & P) and source is runoff water.

Eg: Dal lake.

3. **DYSTROPHIC LAKES:** These poses low P^H & high humic acid content. **Eg:** Bog lake
4. **ENDEMIC LAKES:** These are ancient, deep and posses only endemic fauna. **Eg:** Lake Baikal (Russia, deepest lake & threatened due to pollution)

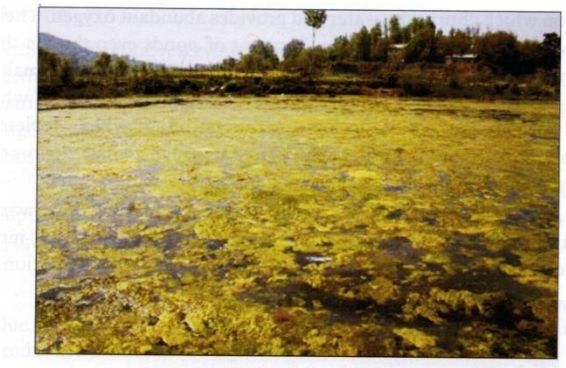
Fig. 3.28 Dal lake in Srinagar showing algal blooms due to entrophication

5. **DESERT SALT LAKES:** These occur in acid with high salt concentration due high evaporation. **Eg:** Great Salt Lake (Uttaranchal), Sambar lake (Rajasthan)
6. **VOLCANIC LAKES:** These are formed as a result of volcanic eruption and consist of magma. **Eg:** many lakes in Japan (no species are present)
7. **MEROMICTIC LAKES:** Rich in salts in the form of layers. **Eg:** Nevada.
8. **ARTIFICIAL LAKES:** These are produced due to dams construction. **Eg:** Govindsagar lake (bhakra-nangal) **Species in lakes:** These consist of several species.

1. **Planktons:** Float on surfaces. Eg: phytoplankton (algae), zooplankton (rotifers)
2. **Nektons:** These can swim. Eg: fishes.
3. **Neustons:** These will be at rest (or) swim.
4. **Benthos:** These are attached to bottom. Eg: snails.

5. **Periphytons:** Attached to other plants (or) clings on other surfaces. Eg: crustaceans. **ii) Lotic water bodies (streams):** These are the fresh water aquatic ecosystem with continuous flowing of water. The physical factors (O_2) & nutrients are uniformly distributed due to streaming. The organisms faces temperature and streaming problem severely compared to lotic systems. The species present in this have less tolerance towards O_2 deficiency as there is always abundant O_2 due to continuous streaming. If dissolved oxygen (DO) level is decreased due to pollution then these organisation are affected. **River ecosystem:** These flows across mountain highlands followed by plains & finally mix with sea. They show different conditions as follows:

Fig. 3.29 Bhagirathi river at Devprayag with clear and clean water.

1. MOUNTAIN HIGH LAND: Cold, clear water, high DO are characteristics. The species are periphytons (on rocks) fishes (consumes more DO Eg: Trotus)
2. SECOND PHASE: This is gentle slope area with male plants & fishes (need less DO)
3. THIRD PHASE: This is the delta phase and rich in bio diversity, nutrients etc.

b) Marine ecosystem (oceans):

It comprises of 70% of globe surface and posses 2,50,000 species and supply food for human & other organisms. Oceans provide us drugs, Fe, P, Mg, Oil, natural gas, sand & gravel. Ocean plays key role in maintaining biogeochemical cycle, hydrological cycle etc, and also acts as sink for CO_2. Oceans have two major life zones.

1. **COASTAL ZONE:** This is relatively warm, rich in nutrients, shallow due to which shows high NPP. They are rich in biodiversity.
2. **OPEN SEA:** It is the deeper part and divided into three regions based on penetration of sunlight.

I) *Euphotic Zone*: It receives abundant sunlight with more photosynthesis activity.

II) *Bathyal Zone*: It receives dim sun light & geologically active.

III) *Abyssal Zone*: It does not receive sunlight infact, it is dark zone due to which no primary production. It ranges from 2000 to 5000 meters. It is incomplete ecosystem.

Fig. 3.30 Coastal wetland is a habitat for various species of water birds (Pic. Ahmedabad)

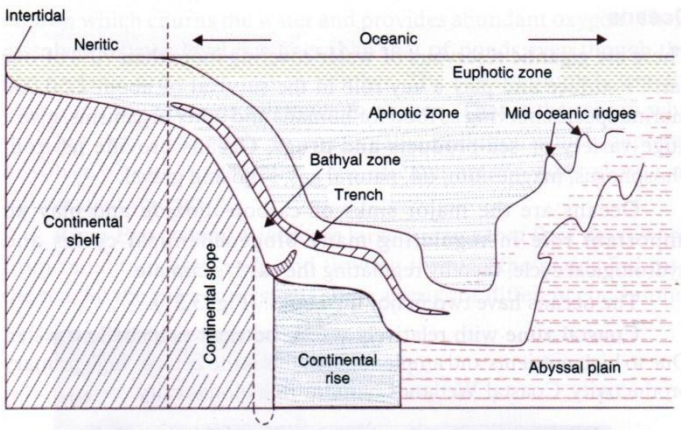

Fig. 3.31 Vertical and horizontal zonation of a marine ecosystem.

ESTUARIES:

It is a point where fresh water & salt water meet, i.e., connecting point between river & ocean. They are rich in nutrients and DO due to continuous streaming by which primary production is achieved greatly. These are affected by tidal current seasonally (diurhally, monthly). The species present in this area have wide range of tolerance towards temperature, salinity, streaming etc. The organisms are known as eurythermal and euryhaline. Eg: Coastal bays and tidal marshes.

Estuaries posses rich in species diversity and many of them are endemic. The migratory species like fishes (salmons) spends half life span in fresh & remaining half in marine, for them estuaries points provide resting place during migration. They are useful to human due to high productivity and reason for this is continuous streaming and tidal action. However these should be protected from pollution & maintain naturally.