CHAPTER- 14

ECOSYSTEM

Ecosystem is the functional unit of nature where living organisms interact among themselves and also with the surroundings physical environment.

Ecosystem- Structure and Functions

Ecosystem : There are two basic categories of ecosystem , namely the terrestrial and the aquatic.

Terrestrial ecosystem – forest, grassland , desert etc.

Aquatic ecosystem – ponds, lake, river estuary etc.

The biotic and abiotic factors of ecosystem work in integrated manner for flow of energy within the components of ecosystem. Interaction of biotic and abiotic components results in a physical structure that is characteristic for each type of ecosystem. The vertical distribution of different species occupying different levels is called stratification.For example, trees occupy top vertical strata or layer of a forest, shrubs the second and herbs and grasses occupy the bottom layers.

The components of ecosystem that are seen as functional unit are

(i) Productivity
(ii) Decomposition
(iii) Energy flow
(iv) Nutrient cycling.

· Productivity- Primary production is defined as the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in terms of weight (g –2) or energy (kcal m–2).The rate of biomass production is called productivity. It is expressed in terms of g –2 yr –1 or (kcal m–2) yr –1. It can be divided into gross primary productivity (GPP) and net primary productivity (NPP). GPP of an ecosystem is

the rate of production of organic matter during photosynthesis and NPP is the remaining biomass after respiration (R).

GPP –R = NPP

NPP is the available biomass for consumption to heterotrophs. Secondary productivity is defined as the rate of formation of new organic matter by consumers.

Decomposition- breakdown of complex organic matter into inorganic substances like carbon dioxide, water and nutrients is called decomposition. Dead plants remains like leaves, bark, flowers and dead remains of animals constitute detritus. Decomposition involves following steps- fragmentation, leaching, catabolism, humification and mineralization.

1. Fragmentation of Detritus: Detritivores feed on detritus ---breakdown --- increases the surface area of detritus particles for microbial action.
2. Leaching: Soluble inorganic nutrients dissolve in water –– percolate through the soil --- removed due to leaching action.
3. Catabolism: Decomposers (bacteria, fungi) release enzymes --- decompose detritus --- simpler inorganic compounds.
4. Humification: Simplified detritus--- converted to humus

- Humus is a Dark, Amorphous substance.
- Highly resistant to Microbial Action
- Undergoes Decomposition very Slowly.
- Reservoir of nutrients (due to colloidal nature)

5. Mineralisation: Humus is degraded – releases inorganic substances (CO_2, H_2O etc) and nutrients (Ca^{2+}, Mg^{2+},K^+ etc)

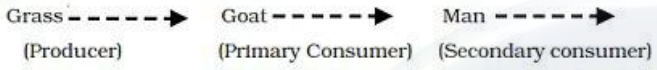
Factors affecting rate of Decomposition:

1. Chemical composition - decomposition rate will be slow when detritus is rich in lignin and chitin and rate increases when detritus is rich in nitrogen and water soluble substances like sugars.

2. Climatic conditions – warm and moist environment favour decomposition and low

temperature and anaerobiosis inhibit decomposition.

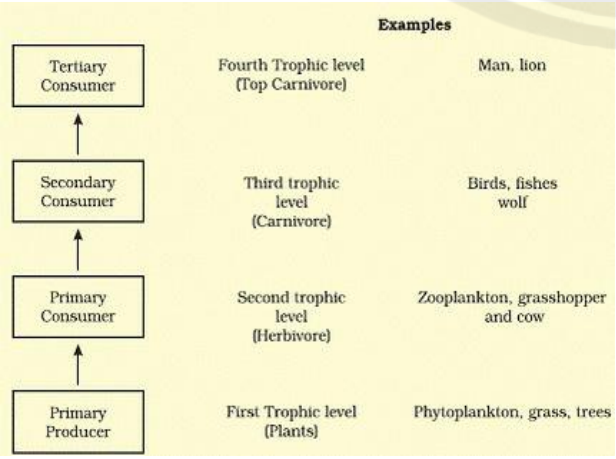
Energy Flow- All living organisms are dependent for their food on producers, directly or indirectly. There is a unidirectional flow of energy from the sun to producers and then to consumers. Photosynthetically active radiation (PAR) is responsible for synthesis of food by plants. Animals obtain their food from plants, so they are called consumers. The process of eating and being eaten is called food chain in which energy flow from producers to consumers. In Grazing food chain (GFC)-



The detritus food chain begins (DFC) begins with dead organic matter. It is made up of decomposers which are heterotrophic organisms (fungi and bacteria). These are also known as saprotrophs (sapro: to decompose). Decomposers secrete digestive enzymes that breakdown dead and waste materials into simple, inorganic materials, which are subsequently absorbed by them.Natural interconnection of food chain forms the food web.

Grazing food chain	Detritus food chain
Transfer of energy starts from producers.	Transfer of energy starts from detritus/decomposing organic matter.
Less energy flows through this.	More energy flows through this.
In aquatic ecosystem, it is the major conduit for energy transfer.	In terrestrial ecosystem, it is the major conduit for energy transfer.

Based on source of food, organism occupies a specific place in food chain that is known as trophic level.

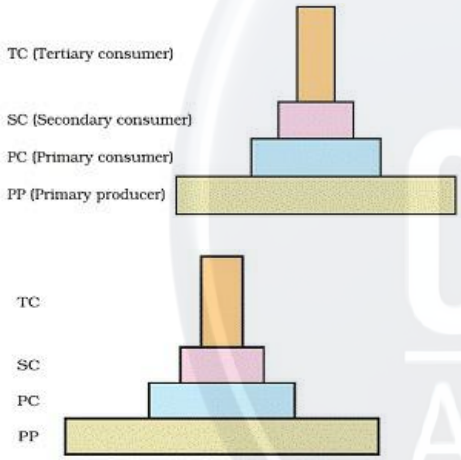


Each tropic level has a certain mass of living material at particular time called as standing crop. It is measured as biomass of living organism or number in unit area.

The number of trophic levels in the grazing food chain is limited as the transfer of energy follows 10 percent law that is only 10 percent of the energy is transferred to each trophic level from the lower trophic level. In GFC, following trophic levels are possible- producer, herbivore, primary carnivore, secondary carnivore.

Ecological Pyramids

Ecological pyramid is the graphical representation of an ecological parameter (number, biomass, energy) sequence wise in various trophic levels of a food chain with producers at the base and herbivores in the middle and carnivores at the top tiers. It can be upright, inverted, or spindle shaped.



Three common ecological pyramids are

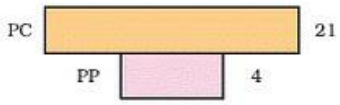
a) Pyramids of number- employs the number of individuals per unit area at various trophic levels with producer at base and various consumers at successively higher levels. It is generally upright.

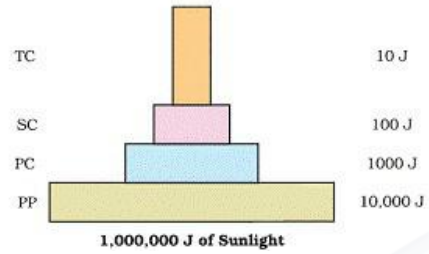
A pyramid of number in case of a big tree is generally inverted because number of insects feeding on that tree generally exceeds in number.

b) Pyramids of biomass- represent the biomass in various trophic levels. A pyramid of mass is upright except in aquatic food chain involving short lived plankton.

A pyramid of biomass in sea is generally inverted because biomass of fishes generally

exceeds that of phytoplankton.





c) Pyramids of energy- that give s graphic representation of amount of energy trapped by different trophic levels per unit area. Pyramid of energy is always upright, can never be inverted, because when energy flows from a particular trophic level to the next trophic level, some energy is always lost as heat at each step e.g in feeding, digestion, assimilation and respiration.

Ecological Succession

The gradual and fairly predictable change in species composition of a given area is called ecological succession. During succession some species colonise an area and their population becomes more numerous whereas population of other species decline and even disappear.

· Orderly and sequential change that leads to a community that is near equilibrium is called climax community.

· The entire sequence of communities that successively changes in a given area is called sere and individual transitional communities are termed seral stage or seral communities.

Ecoloical Succession : Primary sucsesion, Secondary Succession

· Primary succession starts where no organism are there. For example bare rocks, cooled volcano etc. Secondary succession occurs in the area where the living organisms have lost due to certain regions like forest fire. Earthquake etc.

Succession of Plants

On the basis of nature of habitat, succession of plants can be grouped as-

o Hydrach succession takes place in wetter area and the successional series progress from hydric to the mesic conditions.

o Xerarch succession takes place in dry areas and series progress from xeric to mesic conditions.

	Hydrarch Succession	Xerarch Succession
(i)	Ecological succession that starts in water bodies and proceeds to mesic condition called hydrarch succession	Ecological succession that starts with barsen rocks xeric condition and proceeds to mesic conditions, called xerarch succession.
(ii)	Phytoplankton stage → Submerged plant stage → Submerged free floating plant stage → Reed swamp stage → Marsh Meadow stage → Scrub stage → Forest (Climax community)	Bare rock → Lichen mass stage → Annual herb stage → Perennial herb stage → Scrub stage → Forest (Climax community)

· The species that invade a bare area are called pioneer species. In primary succession on rocks lichens are pioneer species that secrete acids to dissolve the rock for weathering to form soil.

· In primary succession in water, the pioneer species are the small phytoplanktons that are replaced by free floating angiosperms.

· Primary succession is slow process as soil is not available for pioneer species but secondary succession is comparatively faster due to availability of soil or other nutrients. A climax community is reached much faster in case of secondary succession.

Primary succession	Secondary succession
Initiates in area where organisms never existed, i.e. bare areas.	Initiate in areas where communities are recently destroyed.
The absence of the soil, humus and reproductive structures of organisms.	The presence of the soil, humus and reproductive structures from organisms of previous communities.
Takes a long time, i.e. several hundred to thousands of years to reach climax stage.	Takes comparatively lesstime (50-200 years) to reach climax or stable stage.

Nutrient Cycling

The movement of nutrients elements through the various components of an ecosystem is called nutrient cycling. It is also called as biogeochemical cycles. There are two types of nutrient cycles-

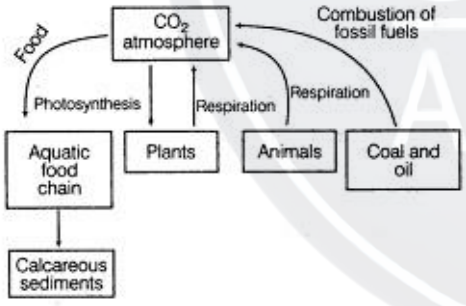
· Gaseous – exist in atmosphere.

· Sedimentary- exists in earth crust.

Environmental factors like soil, moisture, pH, temperature regulate the rate of release of nutrients into the atmosphere. The function of reservoir is to meet with the deficit which occurs due to imbalance in the rate fo influx and efflux.

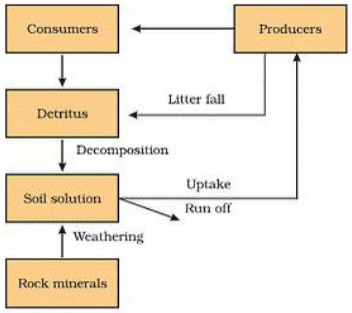
Carbon Cycle

Carbon cycling occurs through atmosphere, ocean and through living and dead organisms. Most of carbon is fixed by plants during the process of photosynthesis and returns to atmosphere in form of CO2 during respiration. Burning of wood, forest fire and combustion of organic matter, fossil fuel, and volcanic activity are other sources of releasing CO2 in the atmosphere.



Phosphorus Cycle

The natural reservoir of phosphorus is rock which contains phosphorus in the form of phosphates. On weathering, minute amount of phosphates dissolve in soil solution and absorbed by the roots of the plants. The waste products of dead organisms are decomposed by bacteria to release phosphorus. Gaseous exchange between organism and environment is negligible as compared to carbon.



Phosphorus Cycle

Ecosystem Services

The products of ecosystem processes are called ecosystem services. It includes-

· The healthy forest ecosystem purify air and water

· Mitigates floods and droughts

· Cycle nutrients

· Generate fertile soil

· Provide wildlife habitat

· Maintain biodiversity etc.

Researchers have put an average price tag of US $33 trillion a year on these fundamental ecosystems services which are taken granted because they are free although its value is twice the total global gross national product (GNP).