CHAPTER - 14

ECOSYSTEM

INTRODUCTION

Ecosystem is the interaction of living things among themselves and with their surrounding environment.
There are two basic ecosystems – terrestrial and aquatic.

STRUCTURE OF ECOSYSTEM

The interactions between the various biotic and abiotic factors of an ecosystem lead to the maintenance of the ecosystem.
Stratification is the vertical distribution of the different species occupying the different levels. For example, trees occur at a higher level then shrubs.
The various aspects taken into consideration to study the functioning of ecosystem are:
Productivity
Decomposition
Energy flow
Nutrient cycling

POND AS A ECOSYSTEM :

The complex interactions that exist in an aquatic ecosystem -pond.

All the above mentioned four basic components of an ecosystem are well exhiibited.

The abiotic component is the water with all the dissolved inorganic and organic substances and the rich soil deposit at the bottom of the pond.

The solar input the cycle of temperature.day-length and other climatic conditions regulate the rate of function of the entire pond. The autotrophic components include the phytoplankton. some algae and the floating. submerged and marginal plants round at the edges.

The consumers are represented by the phytoplankton the free swimming and bottom dwelling forms. The decomposers are the fungi, bacteria and flagellates especially abundant in the bottom of the pond.

Decomposition and mineralization of the dead matter to release them back for reuse by the autootrophs. These event are repeated over and over again.

PRODUCTIVITY

A constant supply of sunlight is required for the proper functioning of any ecosystem.
The amount of biomass produced per unit area over a time period by plants during photosynthesis is defined as the **primary productivity**.
It is expressed as weight (g^{-2}) or energy (Kcal m^{-2}).

Productivity can be mainly divided into gross primary productivity (GPP) and net primary productivity (NPP). GPP is the rate of production of organic matter during photosynthesis.

NPP = GPP − Respiratory losses (R)

Secondary productivity is defined as the rate of formation of new organic matter by consumers.

Primary productivity depends upon
type of plant species inhabiting a particular area
photosynthetic capacity of plants
nutrient availability

Annual net productivity for whole biosphere is about 170 b tons of organic matter.

DECOMPOSITION

It is the process of breakdown of complex organic matter into inorganic substances such as carbon dioxide, water, nutrients, etc.

Fragmentation − Breaking down of detritus (dead plant and animal remains, faecal matter) into smaller particles by detritivores (decomposers)

Leaching - Process by which these inorganic matters enter the soil

Catabolism − Process by which detritus is degraded into simpler inorganic substances by bacterial and fungal enzymes

Humification − Accumulation of humus in the soil. Humus is resistant to microbial action and decomposes at an extremely slow rate. It acts as a reservoir of nutrients.

Mineralization − Process by which humus further degrades to release minerals into the soil

It is an oxygen consuming process and is controlled by the chemical composition of detritus and climatic conditions.

ENERGY FLOW

Sun is the sole source of energy for all ecosystems on the earth.

Plants and other photosynthetic organisms utilize less than 50% of the solar radiation known as the **photosynthetically active radiation (PAR)**.

In an ecosystem, plants are called **producers** and all animals depend upon the plants directly or indirectly for their food. Hence, they are known as consumers or heterotrophs.

The consumers can be further divided into primary consumers (herbivores), secondary consumers (primary carnivores), and tertiary consumers (secondary carnivores).

Food chain − The energy flow among the various constituent animals is known as the food chain.

Food web − The interconnection of the various food chains is called the food web.

Trophic level − Every organism occupies a specific level in their food chain known as the trophic level.

Standing crop − Each trophic level contains a certain amount of living material at a certain time known as the standing crop.

The number of trophic levels in a food chain is restricted since the energy transfer follows the 10 percent law i.e., only 10% of the energy is transferred from a lower trophic level to a higher one.

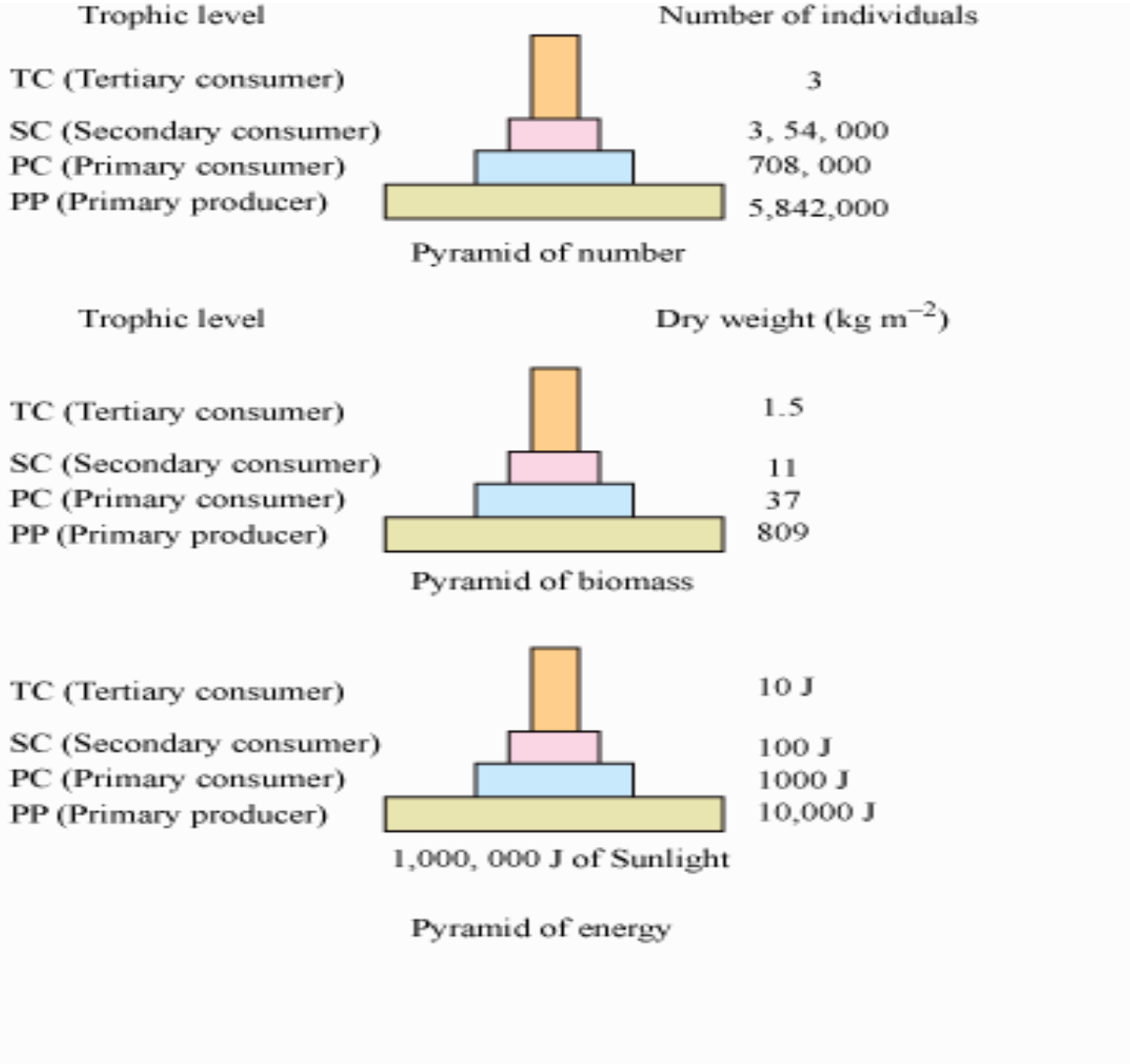
ECOLOGICAL PYRAMIDS

The energy relationship between the different trophic levels is represented by the ecological pyramids.
Their base represents the producers or the first trophic level while the apex represents the tertiary or top level consumer.
Ecological pyramids are of 3 types:

Pyramid of number

Pyramid of biomass

Pyramid of energy



In most ecosystems, the three pyramids are upright except in some cases:
The pyramid of biomass is inverted in an ocean ecosystem since a small standing crop of phytoplankton supports a large number of zooplankton.
The pyramid of number can be inverted when, say, a large tree is eaten by small insects.
However, the pyramid of energy is always upright.

A trophic level represents a functional level and not a single species as such. Also, a single species may become a part of more than one trophic level in the same ecosystem at the same time depending upon the role it plays in the ecosystem.

LIMITATIONS OF ECOLOGICAL PYRAMIDS:

The ecological pyramids do not take into account the same species belonging to more than one trophic level.
It assumes a simple food chain that almost never exists in nature. It does not explain food webs.
Saprophytes are not given a place in ecological pyramids even though they play a vital role in ecosystem.

ECOLOGICAL SUCCESSION

The composition of all ecosystems keeps on changing with change in their environment. These changes finally lead to the climax community.
Climax community – It is the community which is in equilibrium with its environment. Gradual and fairly predictable change in the species' composition of a given area is called ecological succession.
Sere(s) – It is the sequence of communities that successively change in a given environment. The transitional communities are called seral stages or seral communities.
Succession happens in areas where no life forms ever existed as in bare rocks, cool lava, etc. (**primary succession**), or in areas which have lost all life forms due to destructions and floods (**secondary succession**).
Primary succession takes hundreds to thousands of years as developing soil on bare rocks is a slow process. Secondary succession is faster than primary succession since the nature does not have to start from scratch.
During succession, any disturbances (natural/man-made) can convert a particular seral stage to an earlier one.
Hydrarch succession – It takes place in wet areas and converts hydric conditions to mesic.
Xerarch succession – It takes place in dry areas and converts xeric conditions to mesic.
Pioneer species – These are the species that first invade a bare area. On land, these could be lichens that secrete enzymes to dissolve the rock surfaces for soil formation while in water, pioneer species could be phytoplanktons.
The ultimate result of all successions is a climax community, a mesic.

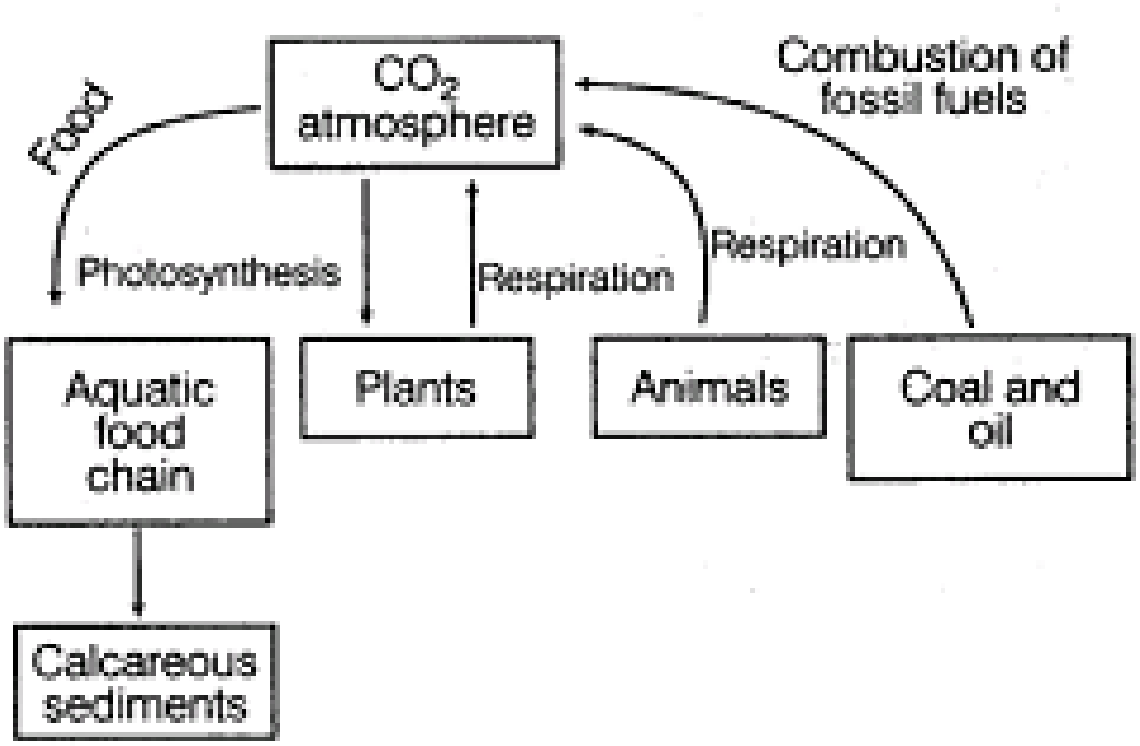
NUTRIENT CYCLING

The amount of nutrients present in the soil at a given time is known as the standing state.
Nutrients are never lost from the ecosystem. They are only recycled from one state to another.
The movement of nutrients through the various components of the ecosystem is called nutrient cycling or biogeochemical cycles. They are of two types:
Gaseous – Reservoir for these types of cycles exist in the atmosphere.
Sedimentary – Reservoir for these types of cycles exist in the earth's crust.

Carbon Cycle

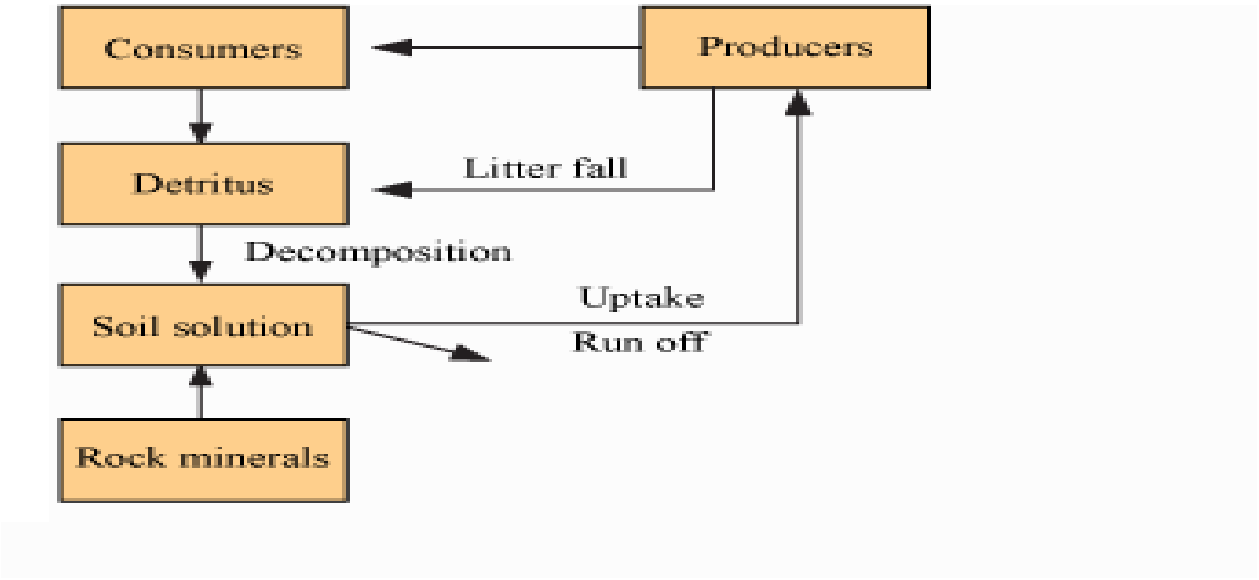
About 49% of the dry weight of living organisms is made up of carbon.
The ocean reserves and fossil fuels regulate the amount of CO_2 in the atmosphere.
Plants absorb CO_2 from the atmosphere for photosynthesis, of which a certain amount is released back through respiratory activities.

A major amount of CO_2 is contributed by the decomposers who contribute to the CO_2 pool by processing dead and decaying matter.
The amount of CO_2 in the atmosphere has been increased considerably by human activities such as burning of fossil fuels, deforestation.



Phosphorus Cycle

Phosphorus is an important constituent of cell membranes, nucleic acids, and cellular energy transfer systems.
Rocks contain phosphorus in the form of phosphate.
When rocks are weathered, some of the phosphate gets dissolved in the soil solution and is absorbed by plants.
The consumers get their phosphorus from the plants.
Phosphorus returns back to the soil by the action of phosphate-solubilising bacteria on dead organisms.



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.

Robert Constanza and his colleagues have very recently tried to put price tags on nature's life support services.

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).

IMPORTANT TERMS

sl No.	Terms	Explanation
1	Ecosystem	The unit which includes both biotic and abiotic components and their interaction.
2	Abiotic	Non living like temp,water,light,etc)
3	Biotic	Living organisms.
4	productivity	Rate of biomass production-expressed in terms of $g^{-2}\,yr^{-1}$ or($kcalm^{2})yr^{-1}$
5	Primary productivity	Amount of biomass or organic matter produced per area.
6	Secondary productivity	Rate formation of new organic matter by consumers.
7	GPP	Gross primary productivity
8	NPP	Net primary productivity
9	PAR	Photosynthetic active radiation
10	Food web	Interconnected food chains are known as food web. in food web one organism holds more than one position
11	Food chain	Transfer of energy from producer to top consumer through a series of organisms in from of a chain is called food chain.
12	Standing drop	Each tropic level with certain mass of living material at a particular time
13	Seral community	Individual transitional community
14	Pioneer	Species that invade a bare area.
15	Climax community	Community that is near equilibrium with the environment.
16	Carrying capacity	Maximum population f a particular species
17	Ecological pyramid	The relationship between producers and consumers in an ecosystem in graphically presented like pyramid.
18	10% law	At each step of food chain energy is transferred

		from one to next tropic level with only 10% of previous tropic level's energy.
19	Niche	Total way of life or role of species in an ecosystem
20	Keystone species	Species that play roles affecting many other organisms in an ecosystem.
21	Stratification	Vertical distribution of different species occupying different levels
22	Ecological succession	Sequential, gradual & predictable changes in the species composition in an area.