

CHAPTER 14

ECOSYSTEM

1)Ecosystem–Structure and Function. 2)Productivity. 3)Decomposition. 4)Energy Flow. 5)Ecological Pyramids. 6)Ecological Succession. 7)Nutrient Cycling. 8)Ecosystem Services.

1. ECOSYSTEM – STRUCTURE AND FUNCTION

An ecosystem can be visualized as a functional unit of nature, where living organisms interact among themselves and also with the surrounding physical environment.

The components of the ecosystem are seen to function as a unit for the following

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

2. PRODUCTIVITY

The rate of biomass production is called **productivity**. It is expressed in terms of $\text{g}^{-2} \text{yr}^{-1}$ or $(\text{kcal m}^{-2}) \text{yr}^{-1}$

Primary productivity 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 ($\text{g}^{-2} \text{yr}^{-1}$) or energy (kcal m^{-2}) yr^{-1} .

Gross primary productivity of an ecosystem is the rate of production of organic matter during photosynthesis.

Net primary productivity (NPP) - Gross primary productivity minus respiration losses (R), is the net primary productivity (NPP). Net primary productivity is the available biomass for the consumption to heterotrophs (herbivores and decomposers). $\text{GPP} - \text{R} = \text{NPP}$

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

3. DECOMPOSITION

Decomposition concerns with break down of complex organic matter into inorganic substances like carbon dioxide, water and nutrients.

Detritus -Dead plant remains such as leaves, bark, flowers and dead remains of animals, including fecal matter, constitute **detritus**, which is the raw material for decomposition.

Leaching is the process by which water-soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.

Humification leads to accumulation of a dark coloured amorphous substance called **humus** that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate.

Mineralization- The humus is further degraded by some microbes and release of inorganic nutrients occur by the process known as **mineralization**.

4. ENERGY FLOW

Except for the deep-sea hydro-thermal ecosystem, sun is the only source of energy for all ecosystems on Earth. Of the incident solar radiation less than 50 per cent of it is **photo synthetically active radiation (PAR)**. Plants capture only 2-10 per cent of the PAR.

Producers - Producers are the green plant in the ecosystem. Primary producers in an aquatic ecosystem are various species like phytoplankton, algae and higher plants.

Consumers - All animals depend on plants (directly or indirectly) for their food needs. They are hence called **consumers** and also heterotrophs. If they feed on the producers; the plants; they are called **primary consumers**, and if the animals eat other animals, which in turn eat; the plants (or their produce) are called **secondary consumers**.

Herbivores- The primary consumers are herbivores. Eg insects, birds and mammals in terrestrial ecosystem and molluscs in aquatic ecosystem.

Primary carnivores The consumers that feed on these herbivores are carnivores and are called **primary carnivores** (though secondary consumers).

Decomposers – Organisms, which are heterotrophs, mainly fungi and bacteria. They meet their energy and nutrient requirements by degrading dead organic matter or detritus. These are also known as **saprotrophs**.

Food web - The natural interconnection of food chains make it a **food web**.

Trophic level - Based on the source of their nutrition or food, organisms occupy a specific place in the food chain that is known as their **trophic level**.

Standing crop -Each trophic level has a certain mass of living material at a particular time called as the **standing crop**. The standing crop is measured as the mass of living organisms (**biomass**) or their number in a unit area. A simple **grazing food chain (GFC)** is depicted below: Grass ⊃ Goat ⊃ Man

(Producer) (Primary Consumer) (Secondary consumer)

Detritus food chain starts with dead organic matter, which is decomposed by heterotrophic organisms like fungi & bacteria to derive energy & nutrients.

10%Law- Only 10% of the energy is transferred to each trophic level from the lower trophic level that's why the number of trophic levels in a food chain is not more than 4 or 5.

5. ECOLOGICAL PYRAMIDS

The graphical representation of number, energy and biomass content in a food chain at different trophic level is called **Ecological Pyramid**.

Types of Ecological Pyramids:

(a) Pyramid of number; (b) Pyramid of biomass and (c) Pyramid of energy.

* Pyramid of energy is always upright, can never be inverted.

* Pyramid of Biomass and number are upright in most cases but can be inverted also. In case of tree-dominated ecosystems pyramid of number are inverted and in deep water body pyramid of biomass is inverted.

6. ECOLOGICAL SUCCESSION

In all communities the composition and structure constantly change in response to the changing environmental conditions over a period of time and is known as **ecological succession**.

- Succession occurring on previously unoccupied site is called **Primary succession**
- Succession occurring on previously occupied site is called **Secondary succession**

Steps or sere of succession:

- The plants that invade the land initially are called **Pioneer Community**.
- The entire sequence of communities that successively change in a given area are called **sere(s)**. The individual transitional communities are termed as **seral stages** or **seral communities**.
- These changes lead finally to a community that is in near equilibrium with the environment and that is called a **climax community**.

Types of succession in Plants

Hydrarch succession takes place in wetter areas and the successional series progress from hydric to the mesic conditions.

Xerarch succession takes place in dry areas and the series progress from xeric to mesic conditions. Hence, both hydrarch and xerarch successions lead to medium water conditions (mesic) – neither too dry (xeric) nor too wet (hydric).

Stages in Xerarch succession

Lichen stage ⊃ bryophyte stage ⊃ bigger plants ⊃ climax forest community

Xerophytic habitat gets converted into a mesophytic one.

Stages in Hydrarch succession

Phytoplanktons ⊃ free-floating angiosperms ⊃ rooted hydrophytes ⊃ sedges ⊃ grasses ⊃ trees (forest). With time the water body is converted into land. In secondary succession since soil is already there, the rate of succession is much faster hence, climax is also reached more quickly. Primary succession, is a very slow process, taking may be thousands of years. This change is orderly and sequential, parallel with the changes in the physical environment.

7. NUTRIENT CYCLING

The movement of nutrient elements through the various components of an ecosystem is called **nutrient cycling**. Nutrient cycles are of two types:

- Gaseous Cycle, 2.Sedimentary Cycles.

1.Ecosystem – Carbon Cycle- Gaseous cycle

* Carbon constitutes 49 per cent of dry weight of organisms and is next only to water.

- * 71 per cent carbon is found dissolved in oceans.
- * About 4×10^{13} kg of carbon is fixed in the biosphere through photosynthesis annually.
- * A considerable amount of carbon returns to the atmosphere as CO_2 through respiratory activities of the producers and consumers.
- * Human activities have significantly influenced the carbon cycle. Rapid deforestation and massive burning of fossil fuel for energy and transport have significantly increased the rate of release of carbon dioxide into the atmosphere

2.Ecosystem – Phosphorus Cycle- Sedimentary cycle

- * Phosphorus is a major constituent of biological membranes, nucleic acids and cellular energy transfer systems.
- * The natural reservoir of phosphorus is rock, which contains phosphorus in the form of phosphates.
- * The waste products and the dead organisms are decomposed by phosphate-solubilising bacteria releasing phosphorus.

8. ECOSYSTEM SERVICES

- * Healthy ecosystems are the base for a wide range of economic, environmental and aesthetic goods and services. The products of ecosystem processes are named as **ecosystem services**,
- * Healthy forest ecosystems purify air and water, mitigate droughts and floods, cycle nutrients, generate fertile soils, provide wildlife habitat, maintain biodiversity, pollinate crops, provide storage site for carbon and also provide aesthetic, cultural and spiritual values.
- * According to Robert Constanza and his colleagues an average price of US \$ 33 trillion a year of these fundamental ecosystems services are provided by nature, which are largely taken for granted because they are free.