

UNIT 3 LECTURE 1

CONCEPT OF ECOSYSTEM

Note: Italics means that text is given in slide

Slide 1

The ecosystem is the basic functional unit in ecology, since it includes both organisms and abiotic environment, each influencing the properties of the other and both necessary for maintenance of life as we have it on the earth.

Living organisms and their nonliving environment are in inseparably interrelated and interact upon each other. Any unit that includes all of the organisms in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles within the system is an **ecological system** or **ecosystem**.

*From the trophic stand point, an ecosystem has two components, an **autotrophic component**, in which fixation of light energy, use of simple inorganic substances, and build up of complex substances predominant; and the **heterotrophic component**, in which utilization, rearrangement, and decomposition of complex materials predominate.*

One of the universal features of all ecosystems, whether terrestrial, freshwater, or marine, or whether man-engineered or not, is the interaction of the autotrophic and heterotrophic component. Very frequently these functions and the organisms responsible for the processes are partially separated in space in that they are stratified one above the other with greatest autotrophic metabolism occurring in the upper “green belt” stratum in which light energy is available and the most intense heterotrophic metabolism taking place in the “brown belt” below in which organic matter accumulates in soils and sediments. The basic functions are partially separated in time in that there may be a considerable delay in the heterotrophic utilization of the products of autotrophic organisms.

Slide 2

For example, photosynthesis predominates in the canopy of the forest ecosystem. Only a part, of the photosynthate is immediately and directly used by the plant and by herbivores and parasites, which feed on foliage and new wood. Much of the synthesized material eventually reaches the litter and soil, which together constitute a well-defined heterotrophic system.

This space-time separation leads to a convenient classification of energy circuits into

- 1. A grazing circuit, in which the term grazing refers to the direct consumption of living plants or plant parts.*
- 2. An organic detritus circuit, which involves the accumulation and decomposition of dead materials.*

For descriptive purposes it is convenient to recognize the following components as comprising the ecosystem:

1. **Inorganic substances** (C, N, CO₂, H₂O, etc) involved in material cycles;
2. **Organic compounds** (proteins, carbohydrates, lipids, humic substances, etc.) that link biotic and abiotic;
3. **Climate regime** (temperature and other physical factors);
4. **Producers**, autotrophic organisms, largely green plants, which are able to manufacture food from simple inorganic substances;
5. **Macro-consumers** or phagotrophs, heterotrophic organisms, chiefly animals, which ingest other organisms or particulate organic matter;
6. **Micro-consumers**, saprotrophs, or osmotrophs, heterotrophic organisms, chiefly bacteria and fungi, which break down the complex compounds of dead protoplasm, absorb some of the decomposition products, and release inorganic nutrients that are usable by the producers together with inorganic substances, which may provide energy sources or which may be inhibitory or stimulatory to other biotic components of the ecosystem.

Items 1 through 3 comprise the abiotic components and 4 through 6 constitute the biomass.

Slide 3

The living and nonliving parts of the ecosystem are so inter-woven into the fabric of nature that it is difficult to separate them. Most of the vital elements and organic compounds are not only found both inside and outside of living organisms, but they are in a constant state of flux between the living and nonliving states. There are, however, some substances that appear to be unique to one or the other state. The high-energy storage material, ATP, for e.g., is found only inside living cells, whereas humic substances, which are resistant end products of decomposition, are never found inside cells yet are a major and characteristic component of all ecosystem. Other key biotic complexes, such as the genetic material DNA and the chlorophylls, occur both inside and outside organisms but become non functional when outside the cell.

The key living components (producers, phagotrophs, and saprotrophs) may be thought of as the three “functional kingdoms of nature” since they are based on the type of nutrition and the energy source used. Heterotrophic microorganisms (bacteria and fungi, etc.) are relatively immobile (usually embedded in the medium being decomposed) and are very small with high rates of metabolism and turnover. Macro-consumers obtain their energy by heterotrophic ingestion of particulate organic matter. These are largely the “animals” in the broad sense. They tend to be morphologically adapted for active food seeking or food gathering, with the development of complex sensory-neuromotor as well as digestive, respiratory, and circulatory systems in the higher forms. Earlier micro-consumers or saprotrophs were designated as decomposers, but recent work has shown that in some ecosystems animals are more important than bacteria or fungi in the decomposition of organic matter. Consequently, it seems preferable not to designate any

particular organisms as decomposers but rather to consider decomposition as a process involving all of the biotic and abiotic processes as well.

From the functional stand point an ecosystem may be conveniently analyzed in terms of the following:

- ❖ *Energy circuits,*
- ❖ *Food chains,*
- ❖ *Diversity patterns in time and space,*
- ❖ *Nutrient cycles,*
- ❖ *Development of evolution, and*
- ❖ *Control (cybernetics).*

Slide 4

Example of an ecosystem

The Pond – let us consider a pond as a whole as an ecosystem. Pond ecosystem may be reduced to the several basic units.

1. Abiotic substances are basic inorganic and organic compounds such as water, CO₂, O₂, Ca, N, P-salts, amino and humic acids etc. a small portion of the vital nutrients is in solution and immediately available to organisms, but a much larger portion is held in reserve in particulate matter, as well as in the organisms themselves. The rate of release of nutrients from the solids, the solar input, and the cycle of temperature, day length and other climatic regimes are the most important processes which regulate the rate of function of the entire ecosystem on a day-to-day basis.
2. Producer organisms – in a pond the producers may be of two main types:
 - (A) Rooted or large floating plants generally growing in shallow water only
 - (B) Minute floating plants, usually algae, called phytoplankton, distributed throughout the pond as deep as light penetrates.

The phytoplankton gives the water a greenish colour, otherwise, these producers are not visible to the casual observer. In large, deep ponds and lakes phytoplankton is much more important than is rooted vegetation in the production of basic food for the ecosystem.

3. Macro-consumer organisms are animals, such as insect larvae, crustacea, and fish. The primary macro-consumers fed directly on living plants or plant remains and are of two types, namely zooplankton and benthos, paralleling the two types of producers. The secondary consumers such as predaceous insects and game fish feed on the primary consumers or on other secondary consumers. Another important type of consumer is the detritivore, which subsists on the “rain” or organic detritus from autotrophic layers above.

4. Saprotrophic organisms – the aquatic bacteria, flagellates, and fungi are distributed throughout the pond, but they are especially abundant in the mud-water interface along the bottom where bodies of plants and animals accumulate. While a few of the bacteria and fungi are pathogenic in that they will attack living organisms and cause diseases, the great majority begin attack only after the organism dies. When temperature conditions are favourable, decomposition occurs rapidly in a body of water; dead organisms do not retain their identification for very long but are soon broken up into pieces, consumed by the combined action of detritus feeding animals and micro-organisms, and their nutrients released for reuse.

