INTRODUCTION, STRUCTURE AND FUNCTION OF AN ECOSYSTEM

Introduction

The term ecosystem is defined as the system resulting from the integration of all the living and non-living factors of the environment. The terms biocoenosis, microcosm, biocoenosis or geobiocoenosis, holocoen, biosystem, bioinert body and ecocosm, respectively are used to express similar ideas. However, the term ecosystem is most preferred, where eco refers the environment, and system implies an interacting and interdependent complex. The organisms of any community besides interacting among themselves always have functional relationship with the environment. This structural and functional system of communities and environment is called ecological system or ecosystem. It is the basic functional unit in ecology, since it includes both biotic and abiotic environment, influencing each other for maintenance of life.

An ecosystem may, in its simplest form, be defined as a self-sustained community of plants and animals existing in its own environment. An ecosystem may be as small as a drop of pond water (microecosystem) or as large as ocean. It can be of temporary nature, e.g., a fresh pool or a field of cultivated crops, or permanent e.g., a forest or an ocean. A balanced aquarium may be thought of as an artificially established self-sustained ecosystem.

Characteristics of Ecosystem

According to Smith (1966), the ecosystem has the following general characteristics:

It is a major structural and functional unit of ecology.

Its structure is related to its species diversity; the more complex ecosystems have high species diversity and vice versa.

Its function is related to energy flow and material cycling through and within the system.

The relative amount of energy needed to maintain an ecosystem depends on its structure. The more complex the structure, the lesser the energy it needs to maintain itself.

It matures by passing from fewer complexes to more complex states. Early stages of each succession have an excess of potential energy and a relatively high energy flow per unit biomass. Later (mature) stages have less energy accumulation and its flow through more diverse components.

Both the environment and the energy fixation in any given ecosystem are limited and cannot be exceeded without causing serious undesirable effects.

Alternations in the environment represent selective pressures upon the population to which it must adjust. Organisms which are unable to adjust to the changed environment must necessarily vanish.

Kinds of Ecosystems

Artificially ecosystems may be classified as follows:

Natural ecosystems

These operate under natural conditions without any major interference by man. On the basis of the type of habitat these may be further divided as:

a) Terrestrial

Forest, grassland, desert, etc.

b) Aquatic

Fresh water - which may be lotic (e.g., running water as spring, stream or rivers) or lentic (e.g., standing water as lake, pond, pools, puddles, ditch, swamp, etc.).

Marine - such deep bodies as ocean or shallow ones as seas or an estuary, etc.

Artificial (Man - engineered) ecosystems

These are maintained artificially by man whereby addition of energy and planned manipulation, natural balance is disturbed regularly, e.g. cropland ecosystem.

Structure of the Ecosystem

All ecosystems, whether terrestrial, fresh water, marine or man-engineered, consist of following major components:

Species components

Stratification

Trophic organisation—relationship of food between various layers

Nutrients—required for living organisms

Biotic (living) components

This comprises of all the living organisms. On the nourishment (or trophic) standpoint, they may be divided into two categories:

<u>The autotrophs (autotrophic = self-nourishing)</u>

These are green plants and certain photosynthetic or chemosynthetic bacteria which can convert the light energy of sun into potential chemical energy in the form of organic compounds needed by plants for their own growth and development. Oxygen is produced as a by-product of photosynthesis, needed by all living organisms for respiration. These green plants are also known as producers because they produce food for all the other organisms.

The heterotrophs (heterotrophic = other nourishing)

They are dependent directly or indirectly upon the autotrophs for their food. The organisms involved are also known as consumers because they consume the materials built up by producers. These may be subdivided into two kinds:

Macroconsumers (or Phagotrophs, Phago = to eat)

These are organisms which ingest food and digest it inside their bodies. They may be herbivores (plant eating), carnivores (= animal eating), or omnivores (= eating all kind of food). The herbivores are primary consumers. For example, insects like grass hopers, chew up stems and leaves, animals like goat, cow, deer and rabbit eat up entire aerial portion of green plants, and man eats up plant products, are all primary consumers. Frog, a carnivore, is a secondary consumer as it eats the herbivores, the snake that eats the frog is a tertiary consumer, there is also a class of top consumers, which are not killed and eaten by any other animals e.g. lion, tiger, leopard, vulture, etc.

Microconsumers (Saprotrophs, sapro = to decompose, or osmotrophs, osmo = to pass through a membrane)

These are the organisms which secrete digestive enzymes to breakdown food into simpler substances and then absorb the digested food. They are mostly parasitic and saprophytic bacteria, actinomycetes and fungi. They are also known as decomposers because of their role in decomposition of dead organic matter. However, the parasites are not decomposers and also some consumers (e.g. insects and such small animals) also which help in decomposition by breaking down the organisms into small bits. Keeping this in view, Wiegert and Owens (1970) suggested the classification of heterotrophs into two categories, biophages (= feeding on living organisms) and saprophages (= feeding on dead organic matter). Decomposers breakdown the complex compounds of dead or living protoplasm, absorb some of the decomposition products and release inorganic nutrients which are cycled back to the soil and the atmosphere from where they are once again made available to the primary producers.

Such a division of organisms based on the type of nutrition gives rise to the trophic structure of the ecosystem and the energy source used which is one kind of producer-consumer arrangement, where each food level is known as trophic level. The amount of living material in different trophic levels or in a component population is known as the standing crop, a term applicable to both, plants as well as animals. The standing crop may be expressed in terms of organism's mass, which can be measured as living weight, dry weight, ash-free dry weight or carbon weight or calories or any other convenient unit suitable for comparative purposes.

In nature simple food chains occur only rarely. There are several food chains linked together, and intersecting each other to form a network known as food web.

Abiotic components

Structurally abiotic components include -

Climate regime: Precipitation, temperature, light, and other physical factors.

Inorganic substances: Elements such as C, N, H, O, P, S, etc., involved in material cycles.

Organic Compounds: Carbohydrates, proteins, lipids and humic substances that link the abiotic components with the biotic components (for details see any elementary book on ecology).

The minerals and atmospheric gases keep on cycling. They enter into biotic systems and after the death and decay of organisms return to the soil and atmosphere. This is known as biogeochemical cycle. This circulation of materials involves trapping of the solar energy by the green plants which are ultimately lost by the organisms in several ways. The amount of abiotic materials present in an ecosystem is called standing stage.

Functions

The function of the ecosystem is to allow flow of energy and cycling of materials which ensures stability of the system and continuity of life. These two ecological processes including interaction between the abiotic environment and the communities. For the sake of convenience, the ecosystem dynamics may be analysed in terms of the following: (i) food chains, (ii) food pyramids, (iii) energy flow, (iv) nutrient cycles, (v) development and evolution of ecosystem, and (vi) homeostasis and stability of ecosystem.