Community Ecology

A naturally occurring group of different plant and animal populations living in common environment constitute a biotic community. Assemblage of plant populations in a biotic community is called plant community and that of animal populations is called animal community. The study of an organisms living together in an interrelated manner in a given environment is termed as community ecology or synecology.

Features

1. A community is a highly complex structure, dominant species are tree and shrubs.
2. The number of species in a community is determined by variation of environmental conditions.
3. If the conditions are adverse, the number of species present in a community is also less than average.
4. Closely related species normally do not occur at the same place, at same time, or in closely related niches.
5. Community vary in size and composition, smaller is called microcommunity e.g. water in a pitcher.
6. Two different kinds of community meet at a transition zone, called Ecotone.

Classification of Communities

1. Terrestrial (land)
2. Aquatic (water)

These two basic types of community contain eight smaller smaller units known as Biomes.

•Terrestrial Biomes: tundra, grassland, desert, taiga, temperate forest, tropical forest.

• Aquatic Biomes: marine, freshwater.

Autotrophic communities require only the energy from the sun to drive the process of photosynthesis, such as forests and grasslands.

Heterotrophic communities, such as organisms that inhabit a fallen log, depend on the autotrophic community for their energy source.

All communities communities have certain certain characteristics characteristics that define their biological and physical structure, but these characteristics vary in both SPACE and TIME.

A GUILD is a GROUP OF SPECIES within a community that interact MORE STRONGLY AMONG THEMSELVES than with others, utilizing HABITAT or FOOD resources in a SIMILAR MANNER.

Qualitative characteristics of Community

• Floristic composition
• Stratification
• Periodicity
• Vitality and vigor
• Growth forms
• Life forms
• Association of species
• Dominance

Quantitative Characteristics

1. Density
2. Cover
3. Abundance
4. Height, weight and volume
5. Frequency
6. Importance value index

TTRIBUTES OF THE PLANT COMMUNITIES

The attributes (characteristics) of a commit), are classified into three main groups: analytic. synthetic and physiognomic.

(a) Analytic characteristics

The characteristics which can ***be*** analyzed by quantitative or qualitative methods are called analytic characteristics. These may be qualitative or quantitative characteristics.

1. **Qualitative Characteristics**

The disruptive characteristic's which cannot be measured are called qualitative characteristics. These includes following characteristics.

(i) **Kinds of Species or Floristic Composition:** A complete list of species is called floristic composition. It is essential for the study of a stand.

(ii) **Stratification:** The plants occurring together with a similar ecology in definite strata are called stratification. The size and number of these strata depends on the type of life form. Stratification of the community causes differences in requirement of trees, shrubs and herbs. They require different light intensity, temperature, moisture condition and organic content of the soil. Most temperate forest communities are composed of 3 – 4 strata.

- **Over story tree:** The upper stratum consist of relatively large over storey trees.
- **Crown:** Below these taller trees, there is a stratum of the crown or secondary under storey trees.
- **Herbaceous plants:** Below the secondary trees there is one or more layers of herbaceous plants.
- **Mosses or lichens:** Mosses or lichens may be present in the low layer on the ground.

(iii) **Periodicity:** The rhythmic phenomena related to seasonal changes is called periodicity. These changes are growth. flowering, pollination, ripening of- fruit and seed. Periodicity is controlled by different environmental factors like light, temperature etc.

(iv) **Vitality:** The capacity of plants to complete its life cycle is called vitality. Some species have low vitality and die soon. Some have high vitality. They complete their life span.

(v) **Sociability:** The degree of aggregation of plants in nature is called sociability. Sociability depends on life form, mode of reproduction, habitat condition and competition.

2. **Quantitative characteristics**

The characteristics which can be measured are called quantitative characteristics. These include:

(i)**Density:** The number of individuals of a specie in a unit area is called density.

(ii) **Relative density:** The proportion of a density of a specie to a stand as a whole is called relative density.

(iii) **Abundance:** The. estimation of individuals of a specie is called abundance.

(iv) **Cover:** The ground covered or shaded by the above ground parts of plant is called cover. Cover also includes basal area. The ground actually covered by crown is called cover.

(v) **Relative cover:** The proportion of the cover of a species to sum of the all the plant of all the species is called relative cover.

(vi) **Frequency:** The degree of occurrence of individuals of a species within an area is called frequency.

(vii) **Relative frequency:** The proportion of the total frequency_ of specie to the sum of the frequency of all the species in the area is Called relative frequency.

(viii) **Frequency classes:** Dacron classes are formed on the basis of relative frequencies. There are live frequency classes.

(b) Synthetic characteristics

The generalization and integration of characteristics that derived from data of analytic qualities are called synthetic characteristics. In this case, data is arranged in tubular form. Then synthetic characteristics are studied. There are following synthetic characteristics:

(i) **Presence:** It is the uniformity of specie occurs in number of stands of the same type of community.

(ii) **Constancy**: A specie that occurs in 90% or more of the stand is called constant specie.

(iii) **Fidelity:** The relative occurrence of specie in an association or a group of related association is called fidelity.

(iv) Dominance: The species which have high number and large volume are called dominant species.

(c) Physiognomic characteristics

The general appearance or outlines of the stand or community are called physiognomic characteristics. It includes:

(I) Physiognomy: The appearance of stand is called physiognomy.

(ii) Pattern: The group of individuals with physiognomic contrast

(iii) Life-form: The vegetative appearance of the plant body and its longevity is called life-from. There are five principle life form classes.

- **Phanerophytes:** These plants include woody trees and shrubs. Their bud bearing shoots are elevated and exposed to the atmosphere. Example. Accaia sp.
- **Chamaeophytes:** They include wood or semi woody perennial under shrubs. The bud is above the ground but less than 25 cm high. Example Salvia sp.
- **Hemi-cryptophytes:** The perennating buds are half hidden in the surface of soil. Example cuphorbia.
- **Cryptophytes:** Their buds are ill soil or under water, e.g. Hydrilla.
- **Therophytes:** It includes all the annual plants. Their only perennating buds are present in seeds.

Community Ecology: 6 Characteristics of a Community Ecology

Some of the major characteristics of a community ecology are as follows: (a) Species Diversity (b) Growth From and structure (c) Dominance (d) Self reliance (e) Relative abundance (f) Trophic structure. Community ecology deals with the group of various kinds of population in the areas. A group of several species (plants/ animals) living together with mutual tolerance in a natural area is called as a community. A forest, a pond and a desert are natural communities. A community has its own structure, development history and behaviours.

The community has the following characteristics:

(a) Species Diversity:

Each community consists of different organisms like plants, animals, microbes etc. They differ taxonomically from each other. This species diversity may be regional or local.

(b) Growth From and structure:

Community can be analysed ‘ in terms of major growth forms like trees, shrubs, herbs etc. In each growth from as in trees, there may be different kinds of plants as-broad leave trees, evergreen trees etc. These different growth forms determine the structural pattern of a community.

(c) Dominance:

All species are not equally important in each community. The nature of the community is determined by a few species in a community. These limited species have control and dominating influence in the community.

(d) Self reliance:

Each community has a group of autotrophic plants as well as heterotrophic animals. The autotrophic plants are self dependent.

(e) Relative abundance:

Different populations in a community exist in relative proportions and this idea is called as relative abundance.

(f) Trophic structure:

Each community has a trophic structure that determines the flow of energy and material from plants to herbivores to carnivores.

Characteristics of Communities:

Communities, like populations, are characterised by a number of unique properties which are referred to as community structure and community function. Community structure comprises of species richness (types of species and their relative abundances) physical characteristics of the vegetation and the trophic relationships among the interacting populations in the community.

The characteristic features of a community are:

A. Species composition:

A community is a heterogeneous assemblage of plants, animals and microbes. In ecosystems, virtually every organisms of a community, including the most insignificant microbes, plays some role or the other

in determining its nature. The species in a community may be closely or distantly related but they are interdependent and are interacting with each other in several ways.

B. Species dominance:

All the species of a community are not equally important. There are a few overtopping or dominant species who, by their bulk and growth, modify the habitat. They also control the growth of other species of the community, thus forming a sort of nucleus in the community.

Some communities have a single dominant species and are thus named after that species, such as sphagnum bog community, deciduous forest community etc. Other communities may have more than one dominant species, for example, oak-hickory forest community.

1. Keystone Species:

There are species upon whom several species depend and whose removal would lead to a collapse of the structure and ultimate disappearance of these other species. Such species are referred to as keystone species, the term coined by Paine in 1966. These species may exert their keystone role in several ways. The beaver is one example whose ponds provide homes for many organisms from pond weeds to black ducks.

Paine through his classic experiments showed that predators and herbivores can manipulate relationships among species at lower trophic levels and, thereby, control the structure of the community. Such predator species are called Keystone predators as their removal can tumble the community. Paine's work on the star fish, Pisaster ochraceus, is a classical example of keystone predator that feeds primarily on barnacles and mussles (Mytitus).

After removal of this star fish from the experimental areas on the coast of Washington, Paine observed that the mussels spread very rapidly. They crowded other organisms out of the experimental plots, thereby reducing the diversity and complexity of local food webs.

Similarly, removal of the herbivore sea urchin, Strongylocentrotus, allowed a small number of competitive macroalgae to form healthy beds and crowding out limpets, chitons and other bottom-dwelling invertebrates.

2. Direct-Indirect Interactions:

In order to understand the structure of the community, one has to determine which possible interactions are the most important. When direct physical contact of one species with another is involved the interaction is said to be a direct interaction (Fig. 4.47) as in predation, herbivory and parasitism.

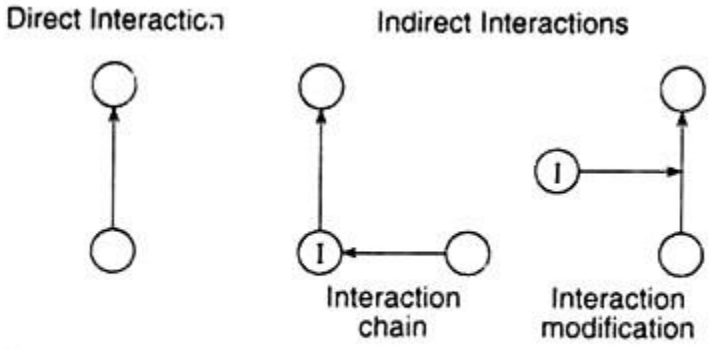

Fig. 4.47 : Direct-indirect interactions. Indirect interactions involve an intermediary species (I)

When the interaction of one species with another is affected by the intermediance of a third species, then this interaction is called indirect interaction (Fig. 4.47), and this third species is called intermediary species.

Depending on the role of the intermediary species, indirect interaction may result due to two mechanisms:

1. Any indirect effect resulting from a chain of direct effects known as interaction chain.
2. When interaction between two species is affected by the third species (I) is known as interaction modification.

Five simple types of indirect effects may be identified — interspecific competition, trophic cascade, apparent competition and indirect mutualism comprising of interference and exploitation types (Fig. 4.48). Indirect effects are often more complex than what is shown in Fig. 4.48. Even the simple effects are difficult to detect without extensive experimentation.

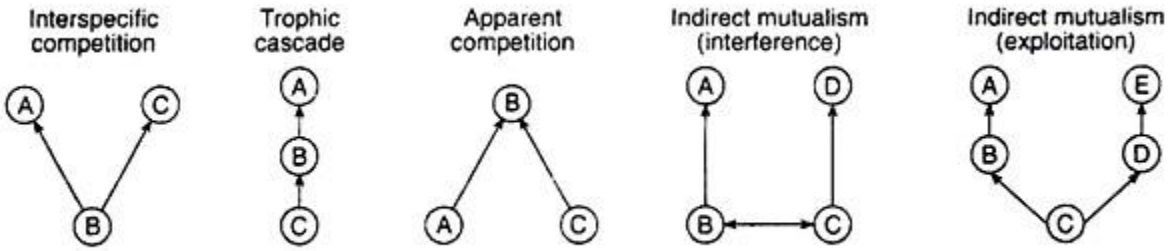

Fig. 4.48 : Various simple types of indirect effects

3. Chemical Interactions among Species:

In a number of cases, species relationships are based on chemical interactions. The study of the production and uptake or reception by organisms of chemical compounds having effects on the organisms is termed chemical ecology. Chemical ecology is not used to include simple relationships, Whittaker and Feeny (1971) put forward a classification based on inter-organismic chemical effects.

They are:

1. Allelochemic effect:

Chemical effects between different species and effects between individuals of the same species.

2. Pheromones:

These serve as chemical messengers between members of a species.

D. Spatial structure:

The members of a community exhibit a spatial structural pattern.

Structurally, communities may be divided into the following types:

1. Communities may be divided horizontally into sub-communities. They constitute the zonation in a community.

Examples:

(i) In deep ponds and lakes three zones (Fig. 4.49) may be recognised-upper littoral zone, middle limnetic zone, and a lower pro-fundal zone. Each zone constitutes different types of organisms. However, shallow ponds have very little zonation.

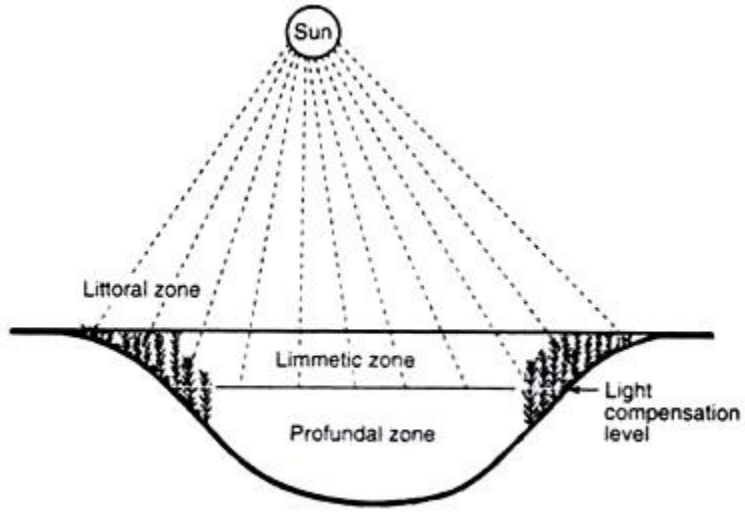

Fig. 4.49 : A fresh water body (lake) showing three major zones

(ii) Mountains show zonations of different distinct vegetational type. Altitudinal zonation in a mountain is due to climatic variations.

2. Another aspect of structure is stratification—which is very common. Ecosystems generally have noticeable vertical structure (strata).

Examples:

(i) Many ecosystems show two broad tropic strata – upper autotrophic and lower heterotrophic. In the upper part of the water of a lake, food production is restricted up to the part where light penetrates. The bottom of the lake comprises of heterotrophic organisms (animals and bacteria) that depend upon the autotrophs of the upper strata.

Similarly, in a forest ecosystem, food-making activities take place in the upper part where the leaves are concentrated, while consumption and decomposition occur on or beneath the forest floor.

(ii) Some community may comprise of more than two strata. Some forests-like a complex deciduous forest community-shows stratification where five vertical sub-divisions of different vegetational types are present. These vertical subdivisions are — sub-terranean, forest floor, herbs, shrubs, and trees.

(iii) Some communities may lack some of the above strata or may have other strata comprising of the same group of vegetation. Bog forests have two strata of herbs, a lower strata of plants like partridgeberry and gold thread and a higher strata of skunk cabbage leaves and ferns. Tropical rain forests may have three tree strata, while the herb and shrub layers are poorly developed.

3. Instead of occurring in zonation or strata, organisms may divide the habitat in a more complex manner by just occurring in layers.

Example:

In the Ponderosa pine forests of Colorado during winter, three different species of nuthatches live together. The familiar white-breasted nuthatch are generally seen scrambling in crevices in the bark of a tree in search of food A second slightly smaller species, the red-breasted nuthatch, obtains its food by foraging on large branches of the trees.

A third, much smaller species, the pigmy nuthatch, gets its food from small branches and clusters of pine needles. The above example shows division of resources as they occupy different ecological niches. This probably reduces interspecific competition.

4. In aquatic communities, temperature may cause thermal stratification.

Example:

Large lakes and oceans, depending on the temperature, are formed of three layers — upper epilimnion, a middle thermocline (Metalimnion), and a lower hypolimnion.

E. Community periodicity:

Periodicity refers to the rhythmic activity of an organism for food, shelter and reproduction. The periodicity of a community is related to seasonal changes, day and night, lunar rhythms, and the inherent property of the animals.

(a) Day-night changes:

The daily periodicity is due to the occurrence of day and night. Accordingly, organisms that are active in the daylight hours and inactive (sleep) in the night are diurnal, while those active at night and inactive at day are nocturnal. A few organisms are either active at dawn or dusk or at both the times — they are said to be crepuscular.

Most crepuscular animals like the whippoorwill, show increased activity mostly during bright moonlight. Some nocturnal animals like bats and moths are lunar phobic that is they become less active during bright moonlight.

There are other 24 hour cycles occurring in organisms such as daily patterns of physiological activity like production of new cells or the secretion of a particular enzyme. Many cycles like wakefulness, locomotion etc. persists even in environments with no alternation of light and dark.

Such daily cycles are called circadian rhythms. Why are organism nocturnal or diurnal? There is no single evolutionary answer. The evolving of nocturnal animals may be due to high humidity at night or evading diurnal predators or competitors.

(b) Seasonal changes:

Many communities show seasonal changes in structure, appearance and function, depending on the changes in seasons.

Example:

1. The most marked are the seasonal changes in temperate deciduous forests, where changes are seen during six recognisable seasons.
2. In many tropical and subtropical ecosystems, wet and dry conditions are more important than warm and cold seasonality. This is true in case of Sonora desert, monsoon forests etc.
3. Hot springs generally have constant temperature and salinity. They show changes during seasonal differences in sunlight.

F. Synusia and Guild:

Synusia, the term coined by DuRietz in 1930, denotes the subdivision of a plant community consisting of all the plants of the same life form. They also correspond to the layers of the community, like the canopy trees of a forest or the mosses of a bog. In a tropical rain forest, the larger epiphytes form a synusia and the epiphylls, that is the algae and lichens that grow on rain forest leaves, form another.

Guild, the term put forward by Root in 1967, presents a group of species that exploit the same classes of environmental resource in a similar way, or, in other words, they eat similar foods. The frugivores of a tropical rain forest feed on the fruits and are thus considered as guild.

Similarly, insects feeding on broad-leaved trees form one guild. Studies have shown constancy in the proportion of total species in certain guilds within a community. This is true in the case of the ratio between the predator species and prey species. This indicates that there might be certain common rules that govern community structure.

G. Eco-tone and Edge effect:

Communities generally have their boundaries well-defined. The intermediate zone lying between two adjacent communities are called eco-tones. The border between a forest and a grassland, the bank of a stream running through a meadow, an estuary (the junction where the river meets the sea), the transition between aquatic and terrestrial communities, between distinct soil types, are a few examples of eco-tone. Even the transition between north-facing and south-facing slopes of mountains is eco-tones where the transition between communities is abrupt and obvious. The eco-tone may be as broad as 100 kms or as narrow as 1 km. Species are distributed at random in respect to one another giving an open structure.

The environmental condition in an eco-tone is variable, intermediate between the two adjacent communities. Boundaries between grassland and scrubland or between grassland and forest have sharp changes in surface temperature, soil moisture, light intensity and fire frequency. This results in replacement of many species.

Grasses prevent the growth of shrub seedlings by reducing the moisture content of the surface layer of soil. Shrubs, on the other hand, depresses the growth of grass seedlings by shedding them. The edge between prairies and forests in mid-western United States is maintained by fire. Perennial grass resists fire damage to tree seedlings.

Eco-tone generally offers an abundance of food and shelter. It contains organisms from both the communities. As a rule, eco-tone contains more species and often a denser population than the two concerned communities. This is called edge effect. There are certain species which are entirely restricted iii the eco-tone and are called edge species.

However, it must be made clear at this point that the concept of eco-tone is not restricted to the interaction among communities, nor to the transition in the number of species. Eco-tone may be viewed as a surface forming common boundary between populations, or between ecosystems, as well as between communities. Eco-tone transitions will include fluxes of materials as well as transition in number of species.

H. Habitat and Ecological niche:

The word habitat is used to denote where an organism lives, or the place where one would go to find it. The word habitat is a Latin word which literally means ‘it inhabits’ or ‘it dwells’. It was first used in the eighteenth century to describe the natural place of growth or occurrence of a species. For example, the lowland gorilla (Gorilla gorilla) has as its habitat lowland tropical secondary forest.

Hericium abietis (fungus) habitats on coniferous logs and trees in the Pacific, northwest of USA. Some species, like the tiger (Panthera tigris), have several habitats. It includes tropical rain forest, snow-covered coniferous and deciduous forests and mangrove swamps.

The habitat of some smaller organisms is highly specialised. Certain species of leaf miners live only in the upper photosynthetic layer of leaves, while other species live in the lower cell layer in certain plant species.

Thus, the habitat of the two species is different and such divisions of the environment are called microhabitats. Any one environment is divided up into many possibly thousands of microhabitats. The specific environmental variables in the microhabitat of a population is called micro- environment or microclimate.

The term niche is used by ecologists to express the relationship of individuals or populations to all aspects of their environment. Niche, thus, is the ecological role of a species in the community. It represents the range of conditions and resource qualities within which an individual or species can survive and reproduce. Niche is multidimensional in nature.

Distinction between habitat and niche:

The words habitat and niche are often misunderstood. At this stage it is important to distinguish between the two terms in ecology. A habitat is a description of where an organism can be found, but its niche is a complete description of how the organism relates itself to its physical and biological environment.

For example, the habitat of the back swimmer (Notonecta) and the water boatman (Corixa) is the shallow area of ponds and lakes. They, thus, occupy the same habitat. However, the two species occupy very diversified trophic niches. The backswimmer is an active predator, whereas the water boatman feeds largely on decaying vegetation. Although species coexist they use different energy sources.

The habitat is the address of the organism, while niche is its ‘profession’, that is its trophic position in food webs, how it lives and interacts with the physical environment and with other organisms in its community. Habitat refers not only to organisms, but it also refers to the place occupied by an entire community.

The habitat of the sand sage grassland community occurs along the north sides of rivers in the Southern Great Plains of the United States. Thus, from the examples of the above, it can be said that the habitat of an organism or groups of organism (population) includes other organisms and the abiotic environment.