Community Ecology

All the species and their populations are always a part of an assemblage of different species population inhabiting that particular area. A group of several species (plants and/or animals) living together with mutual tolerance (adjustment) and beneficial interactions in a natural area is known as a community. In a community, organisms share the same habitat growing in an uniform environment. A forest, a grassland, a desert, or a pond are natural communities. By definition, a community must include only living entities of the area.

A community has its own structure, developmental history and behaviour. All these characteristics are in correlation with the environmental factors, just as population of same species and individual species. A community has following characteristics:

1. **Species Diversity.** Each community is made up of different species of plants, animals and microbes that differ taxonomically from each other. The number of species and population levels in community vary greatly. Of the total number of species in a trophic component, or in a community as a whole, a relatively small per cent are usually abundant and a large per cent are rare. While a few common species, or dominants, largely account for the energy

flow in each trophic group, it is the large number of rare species that largely determine the species diversity of trophic groups and whole community. Species diversity tends to be low in physically controlled ecosystems and high in biologically controlled ecosystems. In fact species diversity has a number of components which may respond differently to geographical, developmental, or physical factors. One major component is the species richness or variety component. There are a number of important ecological principles associated with diversity concepts. Higher diversity means longer food chains and more cases of symbiosis and greater possibilities of for negative feedback control which reduces oscillations and hence increases stability. Communities in stable environment as tropical rainforest have higher species diversities than communities subjected to seasonal periodic perturbations by man in nature. Species diversity is very much influenced by the functional relationship between trophic levels. For example, amount of grazing or predation greatly affects the diversity of the grazed or prey populations. During last few years there has been much concern in species diversity due to reduction in biodiversity of nature.

2. **Dominance.** This refers to the fact not all the species in the community are equally important in determining the nature of the community. Out of the hundred of species present in the community, relatively few exert a major controlling influence by virtue of their size, numbers and activities. Dominant species are those which are highly successful to a considerable extent of conditions under which the associated species must grow. In some communities these determinants may exert some influence on the other organisms. For example, in a forest, certain trees of the upper canopy influence the amount of light and moisture reaching the ground and the type of shelter offered to other plants and animals. They also affects the soil structure and its chemical composition. Which in turn affect the organisms that live in the forest soil.
3. **Growth form and Structure.** Community is described in terms of major growth forms as trees, shrubs, herbs, mosses, etc. These different growth forms determine the structural pattern of a community. The structure that results from the distribution of organisms in, and their interaction with, their environment has been called pattern. Several kinds of arrangements in the standing crop of organisms contribute to pattern diversity in the community. The pattern diversity in a community includes (*a*) stratification patterns (*b*) zonation patterns (*c*) activity patterns (*d*) Food-web patterns (*e*) reproductive patterns (*f*) Social patterns (*g*) coactive patterns (*h*) stochastic patterns. Besides composition and dominance, the communities exhibit a structure or recognizable pattern in the spatial arrangement of their members. Thus structurally, a community may be divided horizontally into subcommunities which are units of homogeneous life-form and ecological relation.
4. **Relative Abundance.** The idea of relative abundance is also closely related to the dominance idea but emphasize the relative proportions of different species in the community.
5. **Trophic Structure.** Who eat whom ? The feeding relation of the species in the community will determine the flow energy and materials from plants to herbivores and finally to carnivores.
6. **Stratification.** The word stratification, in broadest sense refers to vertical or horizontal layers of organisms and their activities upon the environment. The term stratification refers to vertical layering of organisms or environmental conditions within a biotic community.

7. **Succession.** Succession is a directional change in a community with time. It is the movement of gradual, orderly, predictable changes in the composition of communities towards the climax type. It begins with pioneer communities and terminates with climax communities. A primary succession takes place in an area from which previous community was removed.
8. **Community Periodicity.** It is the recurrence of daily and seasonal rhythmic changes occurring in nature. Birds signal the end of darkness and arrival of dawn. Animals set out in search of their food to distant places and retire to their home or resting places at dusk. When the light fades. But their place is taken over by nocturnal animals such as bat, owl, cockroaches, etc. Both environmental and physiological rhythms are responsible for such periodicities. Daily periodicities, seasonal periodicities and lunar periodicities constitute important community periodicity.
9. **Communal Interdependence.** Food, reproduction and protection are the three main factors which control the numerical balance of the community.

Food. Food is one of the most powerful factor in balancing the communal population. For example, green plants occupy the first trophic level, herbivores the second trophic level, carnivores, the third trophic level and perhaps even a fourth trophic level of the food chain indicate the natural link of the community.

Reproduction. The second important link among the members of the community. For example, if there is a over population of insects, and they have no proper shelter by plants, then the insects will become easier prey for birds and bats. This will also affect the plant population, because the major pollinating agents of plants may no longer be sufficiently effective. Moreover the community within a given area includes not only free living organisms, but also partly the parasites and other organism which live in symbiotic associations.

Protection. It is a third link among the members of the community. For example, if there is over population of insects, and they have no proper shelter by plants, then the insects will become easier prey for birds and bats. This will also affect the plant population, because the major pollinating agents of plants may no longer be sufficiently effective. Moreover the community within a given area includes not only free living organisms, but also partly the parasites and other organism which live in symbiotic associations.

Ecotypes

The locally adopted populations of a species with their own optimum and limits of tolerance adjusted to local conditions, such as light, temperature, moisture, etc. are termed as ecotypes. It has been observed that most of plants and animals can not survive outside their habitat range. Gote Turessor coined the term ecotype to designate the genetic varieties within the species. Ecotypes are generally interfertile, though they are genetically identical. For example, Jellyfish *Aurelia auriata*, can swim from northern population to high temperatures of southern populations. Both populations to some extent are independent of temperature variations in their particular environment.

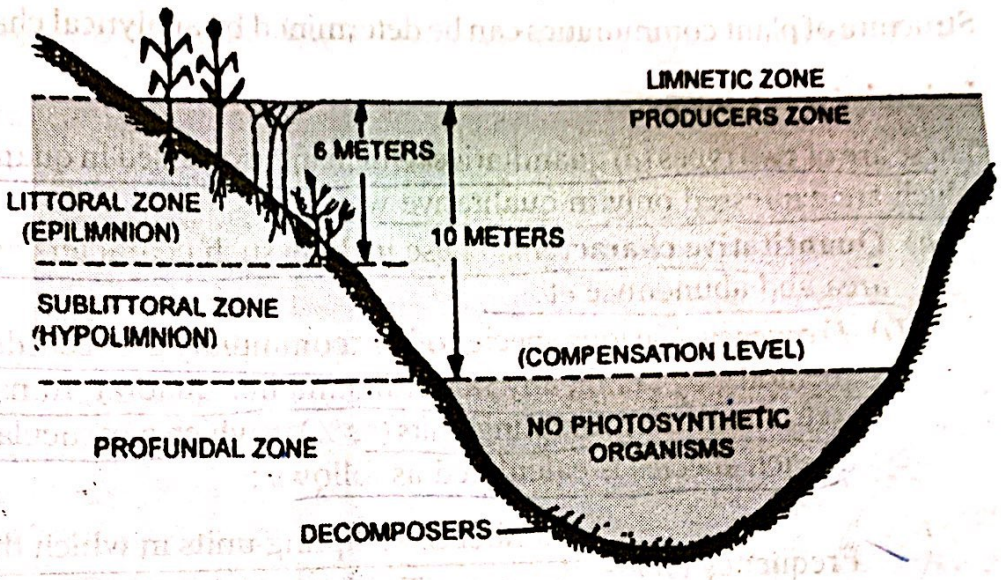
1. Composition

Communities may be large or small. Larger one extends over areas of several thousands of square kilometers, as forest. Others such as deserts, etc., are comparatively smaller, and still others such as meadows, ponds, rivers, etc., covering a very restricted area. Very small-sized communities are the groups of microorganisms in such microhabitats as leaf surface, fallen log, litter, soil, etc. The number of species and population abundance in communities vary greatly.

Among several species present in a community a few exert a major controlling influence on the growth of other species of the community. These are called as **ecological dominants or dominant species.**

2. Structure

The communities exhibit a structure of recognizable pattern in the spatial arrangement of members of the communities. Thus, structurally, a community may be divided horizontally into subcommunities', which are units of homogenous life forms and ecological relation. This horizontal division constitutes the zonation in the community. For example in deep ponds and lakes, there may be recognised three zones, viz, littoral zone, limnetic zone and profoundal zone. In each zone, organisms differ from each other.



Various zones of a deep fresh water lake.

Another aspect of structure that is more common, is **stratification** which involves vertical rather than horizontal changes within the community. Vertical gradients in environmental factors such as the availability of sunlight, the temperature and so on bring about a recognizable stratification in water bodies, particularly in **marine community.** The **oceanic region** (i.e., the region of open sea beyond continental shelf) comprises two zones: 1. **bathyal zone** (region of continental slope and rise) and 2. **abyssal region** (area of ocean "deeps"). In terms of light penetration, the ocean region is vertically also divided into an upper **euphotic zone** (= the light compensation zone) and a vast thicker permanently darker zone, the **aphotic zone** (including bathyal and abyssal zones). The oceanic region also includes two more vertical zones : the **benthic** (bottom) and the **pelagic** (whole body of water). The community of pelagic zones includes phytoplanktons, zooplanktons and nektons. **Benthos** are bottom dwellers of benthic environment. In **grassland communities**, there is a **subterranean floor**, containing basal portions of the vegetation such as rhizomes of grass covered by litter and debris of plants as well as animals, and **herbaceous substratum** consisting of upper parts of the grasses and herbs with a characteristic fauna. In a **forest community,** however, the stratification is most complicated and includes following five vertical subdivisions : 1. **subterranean subdivision** (2) **forest floor** (3) **herbaceous vegetation** (4) **shrubs** and (5) **trees.**

(3) Origin and Development

A community with its particular environment constitutes an entity which has its origin and development. Communities are never stable, but dynamic, changing more or less regularly over time and space. The occurrence of relatively definite sequence of communities over a period of time in the same area is known as ecological succession. A brief outline of succession is presented here. In a barren area there reach the seeds and propagules of the species which is known as

migration. These seeds or propagules after germination develop into the seedlings which then develop into adults. But only a few of these survive and are capable of successful growth, and this process of seedling establishment and successful growth is called **ecesis.** As a result of migration and subsequent ecesis, species colonise the new areas—colonization. By this time with the changing environment due to plants growth several other species of both plants and animals start colonising the area and sooner or later the area is colonised by a definite community.

Characters Used in Community Structure

Structure of plant communities can be determined by analytical characters and synthetic characters.

I. Analytical Characters

These are of two types (*a*) quantitative, which are expressed in quantitative terms, and (*b*) qualitative, which are expressed only in qualitative way.

(*a*) **Quantitative characters.** These include such characters as frequency, density, cover, basal area and abundance etc.

(*i*) ***Frequency.*** Various species of the community are recorded by different phytosociological methods, by taking any sampling unit like quadrat, transect, point centre, etc. Frequency is the number of sampling units (as %) in which a particular species occurs. Thus, frequency of each species is calculated as follows :

$$\text{Frequency (\%)} = \frac{\text{Number of sampling units in which the species occurred}}{\text{Total no. of sampling units studied}} \times 100$$

After determining the percentage frequency of each species, various species are distributed among **Raunkiaer's** (1934) five frequency classes depending upon their frequency values. as follows:

Frequency%	Frequency class.
0-20	A
21-40	B
41-60	C
61-80	D
81-100	E

(*ii*) ***Density.*** Density represents the numerical strength of a species in the community. The number of individuals of the species in any unit area is its **density.** Density gives an idea of degree of competition. It is calculated as follows.

$$\text{Density} = \frac{\text{Total no of individuals of the species in all the sampling units}}{\text{Total no. of sampling units identified}}$$

(iii) ***Cover and Basal area.*** The above ground parts (such as leaves, stems and inflorescence) cover a certain area – if this area is demarcated by vertical projections, the area of the ground covered by the plant canopy is called **foliage cover** or **herbage cover** or **canopy cover.** It is a good measure of herbage availability and is estimated by chart quadrat or point quadrat method. **Basal area** refers to the ground actually penetrated by the stems and is readily seen when the leaves and stems are clipped at the ground surface. It is one

of the chief characteristics to determine dominance. It is measured either 2.5 cm above the ground or actually on the ground level by callipers, line interception or point-centered quadrat method.

(iv) ***Abundance:*** This is the number of individuals of any species per sampling unit of occurrence. It is calculated as follows :

$$\text{Abundance} = \frac{\text{Total no. of individuals of the species in all the sampling units.}}{\text{No. of sampling units in which the species occurred.}}$$

But, abundance thus obtained in quantitative terms gives little idea of the distribution of the species.

(b) **Qualitative characters.** These include physiognomy, phenology, stratification, abundance, sociability, vitality and vigour, life form (growth form), etc.

(i) ***Physiognomy.*** This is the general appearance of vegetation as determined by the growth form of dominant species. Such a characteristic appearance can be expressed by single term. For example, on the basis of appearance of a community having trees and some shrubs as the dominants, it can be concluded that it is a forest.

(ii) ***Phenology.*** It is the scientific study of seasonal change i.e., the periodic phenomenon of organisms in relation to their climate. Different species have different periods of seed germination, vegetative growth, flowering and fruiting, leaf fall, seed and fruit dispersal, etc. Such data for individual species are recorded. A study of the date and time of these events is **phenology**. In other words phenology is the calender of events in the life history of the plant. Environmental factors tend to influence the phenological behaviour of a species population.

(iii) ***Stratification.*** Stratification of communities is the way in which plants of different species are arranged in different vertical layers in order to make full use of the available physical and physiological requirements.

(iv) ***Abundance.*** Plants are not found uniformly distributed in an area. They are found in smaller patches or groups, differing in number at each place. Abundance is divided in five arbitrary groups depending upon the number of plants. The groups are, **very rare, rare, common, frequent** and **very much frequent.**

(v) ***Sociability.*** Sociability or gregariousness expresses the degree of association between species. It denotes the proximity of plants to one another. **Braun-Blanquet** (1932) classified plants into the following five sociability groups :

S_1 – Plants found quite separately from each other, growing singly

S_2 – Plants growing in small groups (4 to 6 plants)

S_3 – Plants growing in small scattered patches.

S_4 – Several bigger groups of many plants at one place

S_5 – A large group occupying larger area.

(vi) ***Vitality.*** It is the capacity of normal growth and reproduction which are important for successful survival of species. In plants, stem height, root length, leaf area, leaf number, number and weight of flowers, fruits, seeds, etc., determine the vitality.

(vii) ***Life form*** *(growth form):* Ecologists generally use **Christen Raunkiaer's** classification (1934) of plant life forms. A life form is "the sum of the adaptation of the plant to climate".

On the basis of the position of perennating buds on plants and the degree of their protection during adverse conditions, **Raunkiaer** classified plants into five broad life-form categories which are as follows:

- **Phanerophytes**—Their buds are naked or covered with scale, and are situated high upon the plant. These life forms include trees, shrubs and climbers generally common in tropical climates.
- **Chamaephytes**—In these plants, the buds are situated close to the ground surface which gets protection from fallen leaves and snow cover. Chamaephytes commonly occur in high altitudes and latitudes, *e.g.*, **Trifolium repens.**
- **Hemicryptophytes**—These are mostly found in cold temperate zone. Their buds are hidden under soil surface protected by the soil itself. Their shoots generally die each year. Examples—most of the biennial and perennial herbs.
- **Cryptophytes or Geophytes**—In these plants, the buds are completely hidden in the soil as bulbs and rhizomes. Cryptophytes include the **hydrophytes** (buds remaining under water), **halophytes** (marshy plants with rhizomes under the soil) and **geophytes** (terrestrial plants with underground rhizomes or tubers).
- **Therophytes**—These are seasonal plants, completing their life cycle in a single favourable season, and remain dormant throughout the rest unfavourable period of year in the form of seeds. They are commonly found in dry, hot or cold environment (deserts).

Life-Forms of Animals

There have been several attempts to classify the life-forms of animals, but no definite system has resulted (**Remane,** 1952).

II. Synthetic Characters

These are determined after computing the data on the quantitative and qualitative characters of the community. For comparing the vegetation of different areas, community comparison needs the calculation of their synthetic characters. Synthetic characters are determined in terms of the following parameters:

(*i*) **Presence and constance.** It expresses the extent of occurrence of the individuals of a particular species in the community, *i.e.*, how uniformly a species occurs in a number of stands of the same type of community. The species on the basis of its percentage frequency may belong to any of following five presence classes that were first proposed by **Braun-Blanquet.**

(*a*) Rare—present in 1 to 20% of the sampling units.
(*b*) Seldom present—present in 21-40% of the sampling units.
(*c*) Often present—present in 41-60% of the sampling units.
(*d*) Mostly present—present in 61-80% of the sampling units.
(*e*) Constantly present—present in 81-100% of the sampling units.

(*ii*) **Fidelity.** Fidelity or "Faithfulness" is the degree with which a species is restricted in distribution to one kind of community. Such species are sometimes known as indicators.

The species have been grouped into five fidelity classes which were first formulated by **Braun Blanquet :**

(a) Fidelity 1 - Plants appearing accidentally (Strangers)

(b) Fidelity 2 - Indifferent plants, may occur in any community (Indifferents).

(c) Fidelity 3 - Species which occur in several kinds of communities but are predominant in one (Preferentials).

(d) Fidelity 4 - Specially present in one community but may occasionally occur in other communities as well (Selectives).

(e) Fidelity 5 - Occur only in one particular community and not in others (Exclusives).

(*iii*) **Dominance.** It is used as a synthetic as well as analytical characters (**Daubenmire,** 1959). The number of organisms sometimes may not give correct idea of the species. If one bases his conclusion on number, a single or few trees in a grassland, or few grasses in a forest should be of little value. But if he considers the species on the basis of area occupied or biomass, the situation may be different. Thus, cover is included as an important character in dominance. Relative dominance (cover; RDO) is calculated as follows :

$$\text{Relative Dominance (lover)} = \frac{\text{Dominance (cover) of the species}}{\text{Total dominance (cover) of all the species}} \times 100$$

(*iv*) **Importance Value Index (IVI).** This index is used to determine the overall importance of each species in the community structure. In calculating this index, the percentage values of the relative frequency, relative density and relative dominance are summed up together and this value is designated as IV or importance value index of the species. It provides the idea of the sociological structure of a species in its totality in the community, but does not indicate its position separately with regard to other aspects. For IV, values of relative density, relative frequency and relative dominance are obtained as follows :

$$\text{Relative Density} = \frac{\text{Density of the species}}{\text{Total density of all the species}} \times 100$$

$$\text{Relative Frequency} = \frac{\text{Frequency of the species}}{\text{Total Frequency of all the species}} \times 100$$

$$\text{Relative Dominance} = \frac{\text{Dominance (cover) of the species}}{\text{Total dominance (cover) of all the species}} \times 100$$

(*v*) **Other synthetic characters.** Besides the above mentioned ones, there have also been proposed some other characters which have been quite useful in comparative studies on communities. Such characters include, interspecific association and association index, index of similarity, dominance index, diversity index etc.