Community Structure and Characteristics:

Species Richness, Dominance, Diversity, Abundance, Vertical Stratification

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In areas such as forests, rivers, and mountains various species of living organisms co-exist. The species of plants, animals and microbes live together in an area and form an essential component of the community existing in that area. The group of species that occupy a particular area and interact with each other directly or indirectly is called as a biological community. Interrelationships between these organisms determine the functional attributes of an ecosystem such as energy flow or cycling of nutrients.

Community is an organized ecological unit in which organism interact through various associations such a predation, competition, mutualism and parasitism, linked to each other *via* feeding relationships and are adapted to prevailing physical environmental surroundings. These interactions, associations and adaptations by the organisms provide community its distinct structure and influence other characteristics such as growth and developments of the community, dominance and species diversity.

Structure of the community

The basic structure of the community is divided into physical and biological structure. The physical structure of community is defined by the growth forms and life forms.

Physical Structure: Growth forms and Life forms

The structure and form of vegetation defines the differences between different terrestrial communities. On the basis of the **growth forms** the vegetation of the community can be classified. Plant community may exhibit different growth forms such as short or tall plants, woody or herbaceous plants or deciduous or evergreen plants. The herbs, shrubs and trees are further sub-divided these categories into evergreen sclerophylls, needle-leafed evergreens, thorn trees, broad-leafed evergreen or broad-leafed deciduous trees, dwarf shrubs, shrubs, grasses, ferns, mosses, lichens and forbs.

The plants are also classified on the basis of **life forms** by Christen Raunkiaer (1903). He is a Danish botanist, who defined life forms on the basis of perennating tissue above ground or simply height of the plant. He suggested that in a given area, all the species are grouped into six principal classes of life forms, namely epiphytes, phanerophytes, chamaephytes, hemicryptophytes, cryptophytes and therophytes. A community consisting mostly of

phanerophytes are characterised by warm climate whereas when mostly comprised of hemicryptophytes and chamaephytes are characterised by cold climate.

Stratification

The ecological communities are arranged in different layer or strata forms, a phenomenon called **stratification**. For example in a natural forest community, as per the height of the plants the community is arranged into number of strata or layers such as herbaceous layer consisting of herbaceous plants followed by shrubs, smaller trees and tall trees. This fractionation in the community is caused by the gradations in the external environmental factors like water levels, temperature and light. Different strata or layer of forest community receives different degree of light intensity providing vertical stratification to the community structure. In a forest community generally three or more vertical layers or strata of plants are found including a herb layer, shrub, small tree layer followed by canopy tree layer. The canopy tree or other taller trees produces more foliage and interrupt the light to reach smaller plants on the ground. The gradients in the physical environment of the community cause horizontal layering or patterns among species. Differences in the amount of factors such as nutrients and water can significantly alter the distribution of plant and animal species over a region.

A community consists of different growth form determining the community structure such as herbs, shrubs, trees. A growth form also has variations such as a tree can be long leaved or broad leaved etc. Various growth form have different mode of arrangement classifying community into (a) **Horizontal Zonation and (b) Vertical stratification,** i.e. Populations assembled to form communities and these populations are dispersed into definite vertical or horizontal strata.

a. Horizontal Zonation

The spatial arrangement of community species exhibit patterns and based on these patterns the community is divided into sub-communities which are ecologically related. If the distribution pattern is horizontal it's called zonation layering in community. For example in lakes or deep ponds majorly three zones are recognised i.e. littoral, limnetic (Photic or open-water) and profondal zone (Aphotic or Deep-water). The organism varies in each zone of zonation pattern. Another example include mountain associated vegetation, altitudinal and latitudinal variations of vegetation in relation to climate of the existing region.

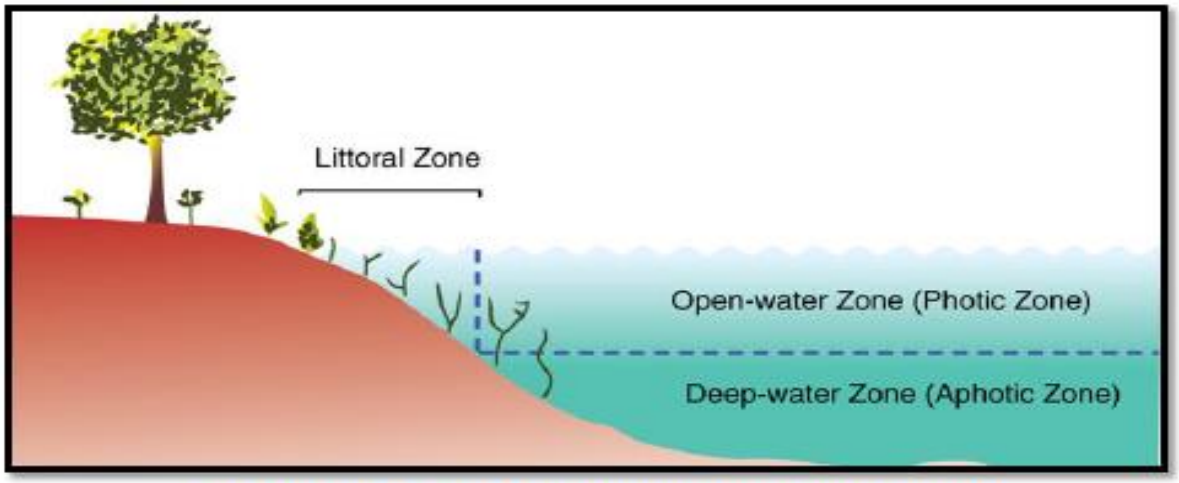


Figure 1: A deep lake depicting a Horizontal Zonation

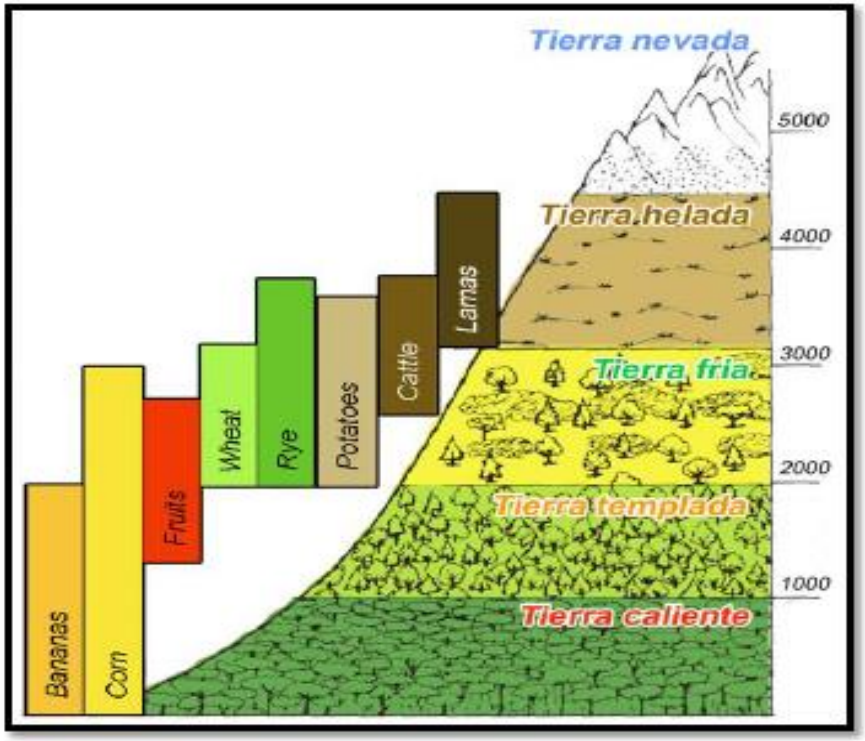


Figure 2: A mountain depicting a Horizontal Zonation

b. Vertical Stratification

Vertical change in the pattern of community structure is called stratification. Vertical Stratification is as simple as the horizontal zonation community of pond, where each zone has

different vertical storey, or complex stratification. For example in grassland communities distinct floor with different yet characteristics growth forms are exhibited. The lowest vertical sub-division is called (1) **Subterranean**-beneath the soil. Subterranean, which includes roots of plants, debris and living organisms like soil bacterium, protozoas or fungi etc.

(2) Herbaceous substratum: Above the soil with roots of growth forms, the herbaceous sub-stratum includes upper parts of growth forms. The forest community stratification is much more complex with five vertical layering including: The vertical stratification in the forest community mostly comprised of following strata's: Subterranean, **Forest floor**-with the upper parts of growth form along with the litters, fungi, bacteria etc., **Herbaceous vegetation, Shrubs and Forest Strata (canopy).** An additional stratum called emergent trees which are present in the tropical rain forest and these plants rises above the canopy of the forest.

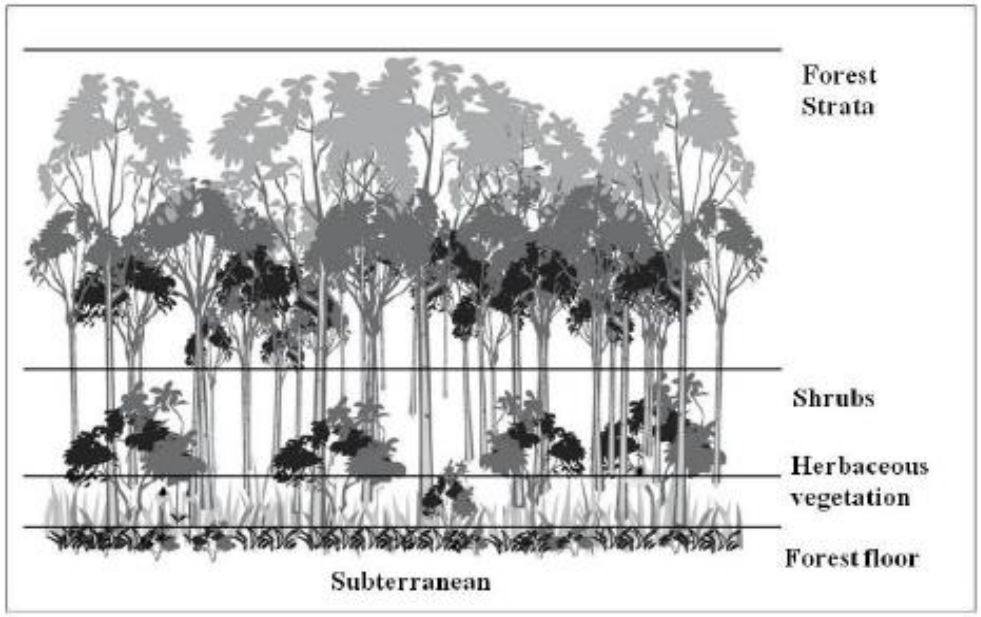


Figure 3: Vertical Stratification in a forest community

Biological Structure and Characteristics of a Community

A community has the following characteristics:

(a) Structure: By virtue of understanding the structure of the community, the frequency, density and abundance of different type of species are measured.

(b) Dominance: The community type is determined by the dominant species. These species of one or more type either occupy large space or occur in large number and called as dominant species.

(c) Diversity: The community show diversity which is composed of different species of plants and animals in different groups that may belong to different growth forms or life forms and are essentially prevailing in uniform environmental surroundings. Diverse communities are healthy and stable communities.

(d) Periodicity: The dominant species of the community are studied in various seasons of the year to determine various life processes such as reproduction, growth and respiration. Periodicity is defined as the expression and reoccurrence of various life processes annually at regular intervals in nature.

(e) Stratification: Within ecological communities, the habitat arrangement in form of layering (either vertical or horizontal) is called Stratification. The stratification of two different types of communities may differ such as the lake community represent horizontal stratification whereas mountain plant communities obey vertical stratification.

(f) Eco-tone and Edge-effect: Ecotones are easily recognisable marginal zones of vegetations separating two distinct types of communities. The species diversity is greater in the ecotone in comparison to the adjacent communities. This phenomenon of greater intensity and diversity at the common junction is defined as edge-effect.

(g) Ecological Niche: Ecological niche is defined as the role or function of species it plays in its ecosystem. In the ecological complex, different plants and animals of different species differ in their function and their combined interactions with other species in its environment are called its ecological niche. In other words, it can also be defined as the small habitat of single species within a large habitat in which it survives. E.P Odum defines and differentiate ecological niche and habitat by saying that ecological niche is the profession of the species within the ecosystem whereas the habitat is its address.

(h) Community Productivity: Community productivity is defined as the net storage of energy and production of biomass per unit time by the community.

(i) Biotic Stability: Biotic stability is the ability of a community to regain its equilibrium followed by disturbances causing population fluctuations. The stability of the community is directly dependent on the diversity of the community.

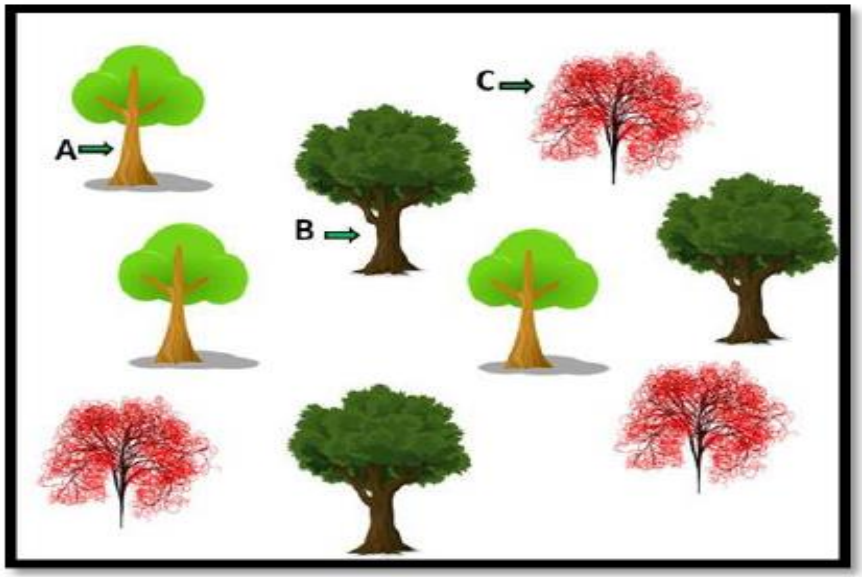
In 1994, Krebs characterized communities into five characteristics that can be studied, namely Growth forms and life forms (described earlier in section), species richness, dominance, relative abundance and trophic structure. Other major types of factors that constitute the structure of the community are as following:

a. Species Richness

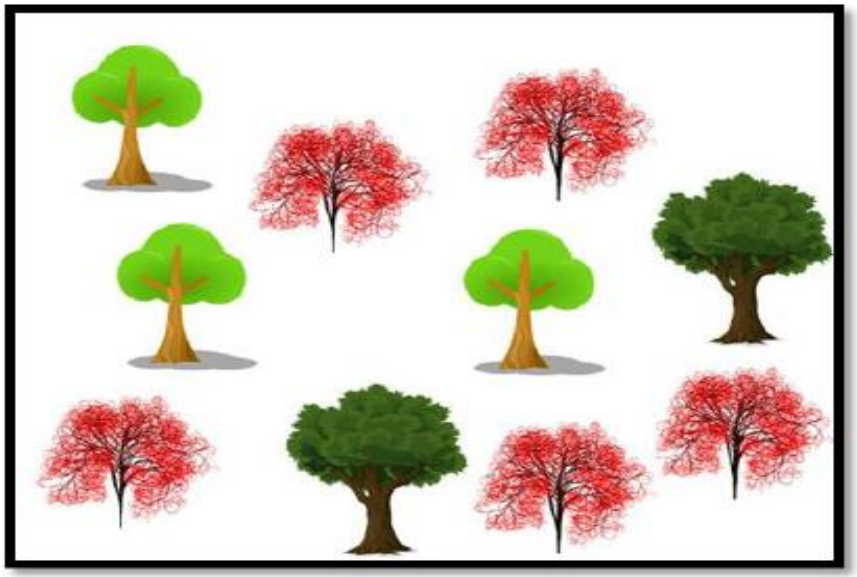
Species Richness is given as number of species in a community. In an ecological habitat, landscape or community the count of different species represents the species richness. It does not indicate about the species abundance or relative abundance of species. For example beetles counted from a pitfall trap etc. Sample heterogeneity and the number of species influence the species richness. If the samples are collected from different environment and habitats then the collected data is higher for species richness. Thus sampling should be performed on large areas as the more heterogeneous environment prevails and large size of population. Species richness helps in assessing the conservation values of landscapes or habitat by relative comparisons. Although it does not consider the type of species but areas with rare species have higher conservation values than same number of species which are commonly found.

b. Species Diversity

The major biodiversity measurements are species richness, Shannon Weiner Index and Simpson's Index. Species diversity comprised of two factors species evenness and species richness (number of species). Species evenness indicates the relative abundance of each species.



Community "1"



Community "2"

Both communities have three types of plant species depicting same species richness but relative abundance vary.

In community "1" species A, B and C are equal in proportion (three each) indicating higher species evenness thus revealed higher species diversity.

In community "2" species C is more in proportion indicating low species evenness and species diversity.

c. Dominance

In a community different species interacts among themselves and in some communities the interaction results into dominance by one species or by a prominent species in group. The organisms dominating others are referred to as **dominants**.

In ecology the proportion of biomass or abundance of one species or taxon than other interacting species or taxon in a community. It's the dominant species that defines the ecological community. For example *Alnus glutinosa* (Alder) is the tree dominating in the Western Europe woodland areas. They are used to classify or identify the type of ecology.

In a community we can consider a community as dominant on the basis of following:
Either they are occupying maximum space of community habitat or have highest biomass or play critical role in nutrient cycling, contribute maximum to energy flow or regulate other community organisms.

Sometimes numerically abundant (means more in number) makes organisms superior and dominant but not necessarily always. Microclimate within the community also effect and complicate this system by contributing more dominant species per microclimate.

Microclimates have local environment differences like nutrients levels, moisture, topographic location etc.

Its only how impactful and important functions a species play in shaping the structure and function of community which decides its dominance. Sometimes even the low density group of species or a single species can be dominant.

Keystone species: Dominant species (plants/animals) playing crucial and unique role and highly effect community structure and function in relative to its abundance are called Keystone species. These keystone species have very intense inter species associations thus, controls the number and types of other species in community. Therefore, if we remove keystone species the community will shift to new form dramatically and vary from its original structure and function.

A classic example of keystone species is *Pisaster ochraceus*, a starfish. This starfish is a keystone predator and the only natural predator for mussels, sea urchins and many other shellfishes. So, if we remove starfish, the mussels or urchin population will proliferate in an uncontrolled manner shifting the community.

This example indicates that dominant species directly control the community character but keystone species indirectly alter the community character.

Several approaches are used to determine the ecological dominance.
If a sample is collected from a large area than the individuals of a species found in large number represents the abundance of species and its distribution within ecosystem is called as **relative species abundances**.

a. **Relative abundance:** When the total abundance of all organisms is compared to numerically abundant one species it is called as species relative abundance. If a sample is collected from a large area than the individuals of a species found in large number represents the abundance of species and its distribution within ecosystem is called as relative species abundances.

b. **Relative dominance:** Dominance among same sized species can be measured by occupying by a species to the entire area of community.
c. **Relative frequency:** Among different sized species, the dominance is measured by the relative frequency.

All these three measurements summed up to provide an important value to each species. These values of species ranked them in a list and index species are the species with high level of important value.