■ 3.1. Biotic Community

A community is a local organization of several populations of different species. Communities are groups of interacting species that occur together at the same place and time that give communities their character and function. These interactions are *synergistic* i.e., they make communities into something more than the sum of their parts. Different ecologists define communities as-

I. Interacting collection of species found in a common environment or habitat is called community (Chapman and Riess, 1992).

II. An ecological community can be regarded as an assemblage of species populations that has the potential of interaction (Karmondy, 1996).

III. A community is a group of interacting organism or species populations living together in a particular place (Taylor *et al.*, 1997).

IV. The community is an assemblage of species populations that occur together in the same place at the same time (Mackenzie *et al.*, 1999).

V. An association of interacting populations, usually defined by the nature of their interaction or by the place in which they live (Ricklefs and Miller, 2000).

A biotic community is a naturally occurring, mutually sustaining and interacting assemblage of plants and animals living in the same environment, fixing, utilizing and transferring energy (R. L. Smith, 1980).

Organization of Biotic Community

Biotic community organization results from interdependence and interactions amongst populations of different species in a habitat. Large numbers of biotic communities are found in nature due to existence of diverse habitats with characteristic environmental conditions and co-occurrence of different species whose tolerance ranges overlap with the environmental conditions obtained in that habitat. Species whose tolerance ranges coincide with the environmental conditions found in that habitat. Each biotic community possesses ecological characteristics which differentiate it from other communities.

■ 3.3. Types of Community

1. Major community:

Major communities are those which are of sufficient size and completeness of organization. They need only to receive solar energy from the outside and are relatively independent of inputs and outputs from adjacent communities.For example a forest community.

2. Minor community:

Minor communities are those which are small in size and lack of completeness of organization. They are more or less dependent on neighboring communities or on the major communities for inputs and outputs.For example a fallen log, a root spring.

3. Pioneer community:

Biotic communities tend to maturity. Initial simple stage is called pioneer community.

4. Seral community:

After the pioneer community the successive stages in the development of climax community is called seral community.

5. Climax community:

The mature, stable and final stage of community is called climax community

6. Autotrophic community:

A community may be autotrophic when it includes photosynthetic plants and gains its energy from the sun.

7. Heterotrophic community:

They depend upon the input of fixed energy, such as organic material, from the outside.

8. Global community:

They have enormous mass of life, comprising all the plants and animals in the world.

9. Concrete community:

A concrete community can be defined as a specific area which can be observed directly and which is an assemblage of plants and animals that actually exists and from which some ecological data can be collected.

10. Hydrophytic community:

It is a community with predominantly aquatic habitats.

11. Mesophytic community:

It is a community with moderately moist soil.

12. Xerophytic community

It is a community with arid and dry conditions.

13. Closed community:

According to Clements (1936), each community has a definite boundary where the different species within community are intimately interrelated and each species has its own niche which is adjustable with the distribution of total community. This is called closed community. Ecotone is formed in this type of community.

14. Open community:

According to Gleason (1936) each species within a community remain independently and environmental adaptation they live in same habitat. This community does not have any definite boundary and are called open community. No ecotone is formed in this community.

3.7. Characters Used in Analysis of Community Structure

The structure of two communities may differ with respect to the density and diversity of species which can be analyzed by following methods:

b. Abundance.
c. Density.
d. Frequency.
e. Relative abundance.
f. Dominance.
g. Evenness.

1. **Abundance:**

I. Abundance is the commonness of a species.

II. It is the number of individuals of any species per sampling unit of occurrence.

III. It is calculated as ;

$A_i = n_i / x_i$

Where, A_i = abundance of 'i' species,

n_i = number of individuals of 'i' species

x_i = number of sample in which 'i' species occurred.

4. Relative abundance:

a. Abundance of a species in relation to all other species in the community expressed in percentage is called relative abundance.

b. It is calculated by the following formula – $RA = \frac{n_i}{N} \times 100$

Where, RA_i = relative abundance of 'i' species
n_i = number of individuals of i^{th} species
N = total number of individuals of all the species

5. Dominance:

Not all organisms in the community are equally important in determining the nature and function of the whole community. A relatively few species or species groups generally exert the major controlling influence by virtue of their number, size, production or biomass i.e., have high 'importance value'. Such species usually occupy more space (have greater frequency) and play important role in community dynamics. Within these groups when a single species or few species predominate within a community which largely control the energy flow and strongly affect the environment of all other species are known as **dominants**.

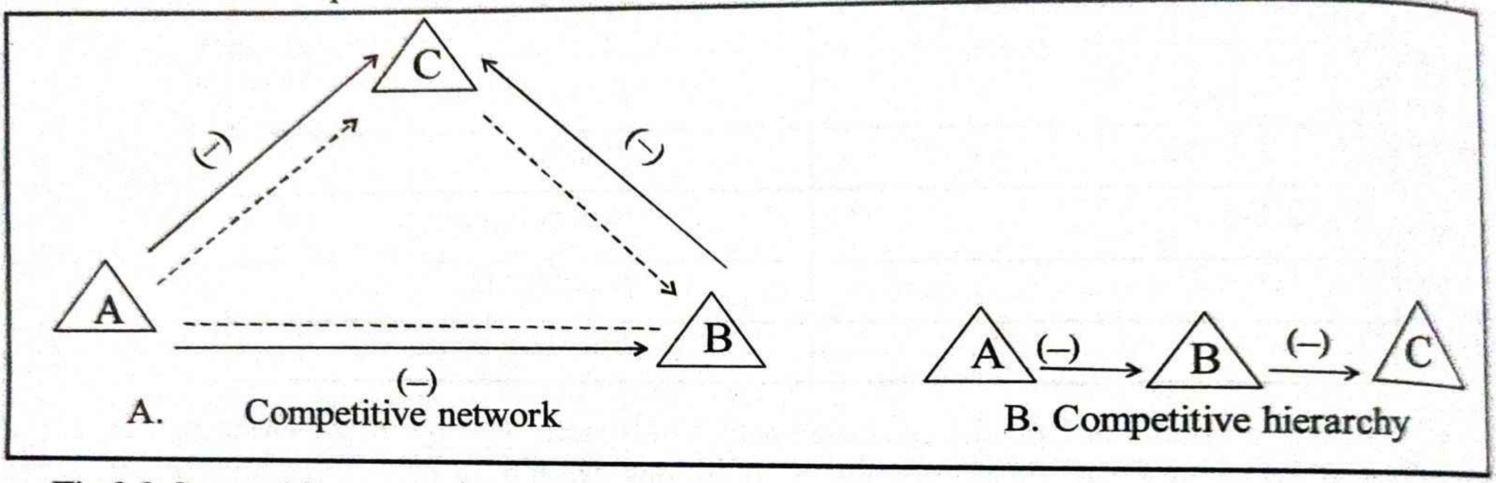

Fig 3.2 Competitive network versus competitive hierarchies. (A) In this circular network view, indirect species interactions buffer strong direct competition so that no one species dominates the interaction. (B) In this linear hierarchical view species A always dominates the interaction.

Cause of dominance:

- A species may become dominant due to prevailing climatic factors (such as rainfall, temperature, RH, pH etc.)
- A species may also become dominant as a result of coaction between two or more species.
- A species may become dominant due to biotic factors. Predators control the structure of the community so must be regarded as dominant and keystone species.

Keystone species: A species whose activities have significant role in determining the community structure are called keystone species (R. L. Smith, 1996). They function in a unique and significant manner through their activities and their effect on the community is disproportionate to their numerical abundance. Their removal initiates changes in community structure and often results in a significant loss of diversity. Their role in the community may be to create or modify habitats or to influence the interactions among the other species.

Example:

1. African elephant in the savanna communities of southern Africa.
2. Sea otters (*Enhydra lutris*) are a key stone predator in the kelp bed communities found in the coastal waters of the Pacific Northwest.
3. Tiger is a keystone species in forest ecosystem.

Example of dominance:

I. Korford (1958) had given a classical example of dominance. He observed that prairie dog (rabbit like rodent) is a herbivores. They can produce short grass community as these prefer to eat long grass due to in a mixed prairie grassland community.

II. The natural food tiger is chital (*Axis axis*), somber etc. tiger predates on both somber and chital. But when chital and somber both are present, tiger will predate on chital only in-stead of presence of somber. Here chital is dominant over somber.

Index of dominance:

Dominance indices are weighted toward the abundance of the commonest species. Common species influence estimates of diversity from dominance indices more heavily than do rare species.

A. Berger-Parker index:

Perhaps the simplest dominance index is that due to Berger and Parker (1970), who proposed the index.

$$D_{BP} = N_{max} / N$$

Where N_{max} is the total number of individuals in the most abundant species and N is the total number of all the individuals in all species.

■ 3.12. Species Diversity

Of the total number of species in a community as a whole, relatively small percent are usually abundant and a large percent are rare. While the few species are common or dominants. So, diversity occurs in the species. Species diversity tends to be low in physically controlled ecosystem (i.e., subjected to strong physiochemical limiting factors) and high in biologically controlled ecosystems.

Definition:

Species diversity is a ratio between number of species and 'importance values' (numbers, biomass, productivity etc.) of individuals in a community. In general it is the ratio or relationship between the number of species (S) and number of individuals (N) in a community and the species diversity = S/N ratio.

Explanation:

If a normal (undisturbed) environment is plotted in the graph that the number of species (S) in the Y-axis and the number of individuals per species (N/S) in the X-axis, the relationship will be a **concave** or **hollow curve.**

But if the environment is disturbed under any stress such as pollution, the relationship will be a flatten curve which shown by the dotted line. In this case most of the rare species are drastically disappear due to disturbance and abundant species will be low.

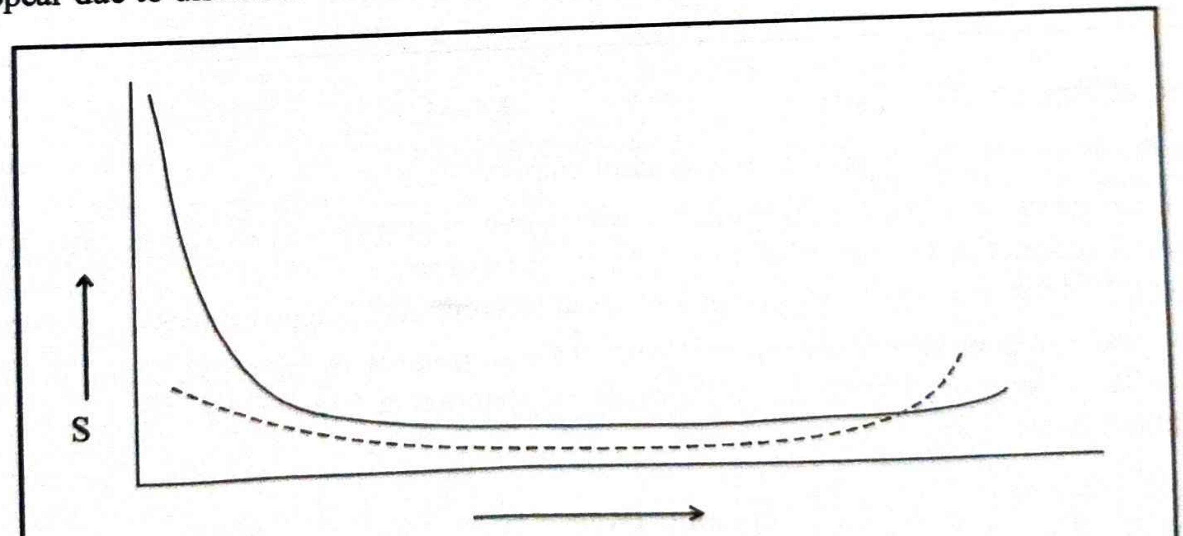

Fig 3.3. General relationship between the number of species (S) and the number of individuals per species (N/S). Most natural communities contain a few dominant species with large numbers of individuals and many rare species with few individuals. Rigorous physical environment, pollution, or other stresses will tend to flatten the curve as shown by dotted line.

Thus the most natural communities contain a few species with large numbers of individuals (the common or dominant species) and many species, each represented by a few individuals (the rare species). Rigorous physical environment, pollution, or other stresses will tend to flatten the curve, as shown by the dotted line.

Types of Species Diversity:

1. **Alpha diversity:** diversity of species within a small homogeneous habitat is called alpha diversity.
2. **Point diversity:** diversity of species within a habitat of very small samples is called point diversity.
3. **Beta diversity:** diversity of species between two habitats in the same geographical area is called beta diversity.
4. **Gamma diversity:** diversity of species between different geographical areas is called gamma diversity.

Species Diversity

A. Within Habitat	**B.Between Habitat**	**C. Regional**
1. Point diversity 2. á – diversity	1. β- diversity	1. γ- diversity

Component of Species Diversity

The species diversity may be divided into two main components:

1. **The richness or variety component**, which can be expressed as the number species per unit space. The total number of species per unit area (m^2 or hectare) and the Margalef diversity index are two simple equations used to compute species richness.
2. **The relative abundance or apportionment component** of individual species among the different species. The Shannon index, H> (Shannon & Weaver, 1949), and the Pielou evenness index, e (Pielou, 1966).

Species Diversity

A. Richness

1. Margelef ($D = S - 1 / \ln N$)
2. Species per area diversity (No. species / area)

B. Apportionment

1. Information theory($\bar{H} = -\Sigma p_i \ln p_i$)
2. Evenness ($e = \bar{H} / \ln S$.)

A community that contains a few individuals of many species will have a higher diversity than will a community containing the same number of individuals but with most of the individuals confined to a few species. In order to quantify species diversity different indices are used. The Shannon index (H') has probably been the most widely used index in community ecology. It is based on information theory of ***Shannon*** and ***Weaver*** (1949).

$$H' = \sum_{i=1}^{s}(p_i \ln p_i)$$

where, H' = diversity of species

S = total number of species in a community.

ln = natural logarithms.

p_i = proportion of individuals of the total sample belonging to the ith species,

$$\text{or, } \frac{n_i}{n} = \frac{\text{no. of individuals belonging to } i\text{th}}{\text{Total no. of individuals in sample}}$$

So, in practice, H′ is estimated from a sample as

$$H' = -\sum_{i=1}^{s}\left[\left(\frac{n_i}{n}\right)\ln\left(\frac{n_i}{n}\right)\right]$$

In oceans, species diversity increases from the continental shelf, where food is abundant but the environment is more changeable, to the deep, cold water where food is less abundant but the environment is stable. Likewise mountain areas in general support more species than do flatlands, and the peninsulas have fewer species than do adjoining continental areas. Small or remote islands have fewer species than do large islands and those nearer continents (*Smith*, 1977).

Species Richness

- Species richness (S) is a measure of the number of species found in a sample.
- Since the larger the sample, the more species we would expect to find, the number of species is divided by the square root of the number of individuals in the sample. This particular measure of species richness is known as D, the Menhinick's index.
- $D = s/\sqrt{N}$
- s = the # of different species
- N = total # of individuals

■ 3.10. Community Boundary

Community boundary is difficult to define. Although some communities may have a clearcut boundary between themselves (e.g., grassland and pond). Often two adjacent communities meet and blend into each other forming a transition zone called as 'edge' or 'ecotone'; a concept first stated by Leopold in 1933. Although previously regarded as similar the concept of ecotone and edge are now regarded as different (Smith, 1996).

Definition:

1. **Edge**: when community boundaries are sharp and abrupt, called edges.
2. **Ecotone:** when community boundary is diffused blending into each other forming a transient zone is called ecotone.

Types:

Types of edges:

1. **Inherent edge:** These are natural such as between terrestrial and aquatic systems formed du[=e to changes in topography and soil types.
2. **Induced edge:** These are arised due to natural disturbances like fire, floods or man made disturbances like agriculture, clearing, harvesting etc.

Types of ecotones:

1. **Simple & multiple ecotone:** When ecotone is formed by blending of two communities then it is called simple ecotone. When ecotone is formed by the advancement of more than two communities then known as multiple ecotone.
2. **Narrow & wide ecotone:** Narrow ecotone is formed due to advancement of one community into other. Wide ecotone is formed when both the communities blend into each other.

Examples:

Examples of edges:

The border between forest and grassland community

Examples of ecotones:

Estuary - a transient zone between river and sea.

Characteristics of ecotone or edge:

1. It is characterized by high density and diversity of organisms than the communities flanking it.
2. It is characterized by steep gradient of environmental factors (e.g., wind flow, turbulence, temperature, moisture, light etc.).

Edge effect & edge species:

In community boundary there is an overlapping of flora and fauna of either communities. In addition to this there may be species which are characteristic and often restricted to the ecotone. Thus both numbers of species as well as density of species are greater in the ecotone than in the community flanking it.

Definition: The tendency of increased diversity and density of some species at community junctions is known as edge effect.

Cause of edge effect:

I. Due to presence of species of both the communities.

II. Due to presence of edge species which are restricted to that region.

III. Due to presence of optimum different climatic condition. The moisture content is high in forest and low in grassland but the temperature is high in grassland and low in forest.

Edge species: The species which are restricted only at the community border are known as edge species.

Edge index (EI):

Name	Description	Effect
Competition	Organisms of two species use the same limited resource and have a negative impact on each other.	- / -
Predation	A member of one species, predator, eats all or part of the body of a member of another species, prey.	+ / -
Herbivory	A special case of predation in which the prey species is a plant	+ / -
Mutualism	A long-term, close association between two species in which both partners benefit	+ / +
Commensalism	A long-term, close association between two species in which one benefits and the other is unaffected	+ / 0
Parasitism	A long-term, close association between two species in which one benefits and the other is harmed	+ / -