Chaudhary Mahadeo Prasad Degree College

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E-learning
Course code BOT 507
Ecology and Phytogeography

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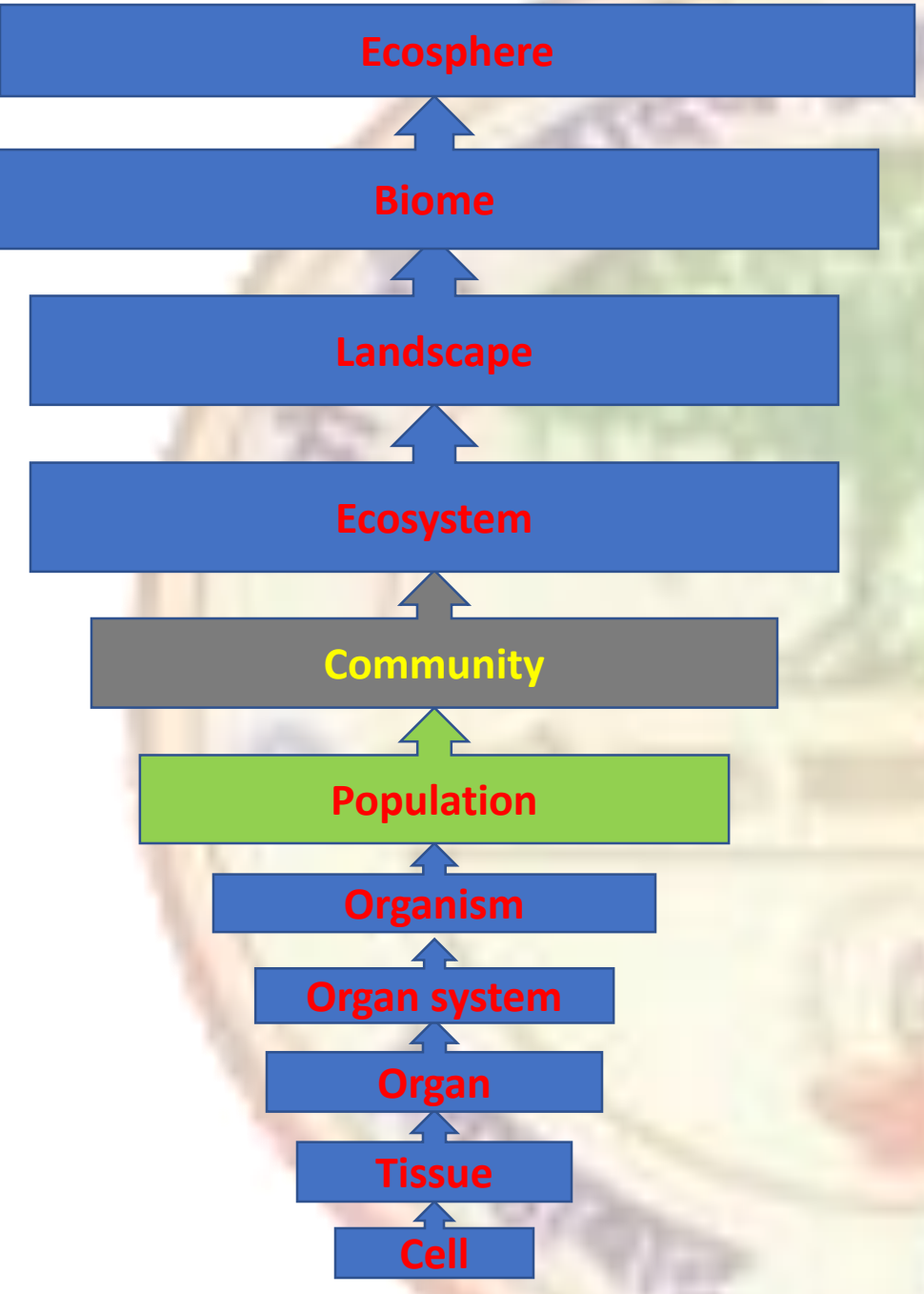
Community Ecology

Population Ecology



Community Ecology

- **Community ecology deals with the groups of different kinds of population in the area.**
- **Biotic community is an assemblage of population living in a prescribed area or physical habitat.**
- **Community comprises of the living systems of the ecosystems**
- **There is mutual tolerance and beneficial interactions so there is an integration within the group.**
- **Such a group of mutually adjusted plants and animals inhabiting in a natural area is known as community**

Range of communities on the basis of size

- **Community can be conceived in wide range of sizes:**
- **Major communities: these are sufficiently large communities and their organization is complete so that they are self sufficient and relatively independent of outputs and inputs from adjacent communities.**
- **Minor communities: these are the communities more or less dependent on neighboring aggregations.**
- **Community differ from place to place at the same place at different times.**

Characteristics of a community

- **Community have functional and compositional unity in their trophic levels and energy flow patterns.**

Tolerance range

- **Each species is not found at all places.**
- **The biological potentiality of each species determines a tolerance range towards environmental condition.**
- **This tolerance range includes the physical space where the species or ecological race can successfully grow.**
- **The range of environment that a taxa can tolerate is called its ecological amplitude.**

Community structure at a place depends on

- **Nature of plant community at a place is determined by the**
- **species content,**
- **their ecological amplitude,**
- **the climate,**
- **soil**
- **and biotic influences in the community.**

Species best suited are :

- **Ecological amplitude of several species usually overlap over a certain range.**
- **Depending on this degree of overlapping environment , the best suited species with higher ecological amplitude grows well.**
- **The are dominant in the community and some are less dominant**

Biotic community

- **In a community the organisms are orderly arranged and they have an association among each other.**
- **Plant as well animals show association with each other therefore we call it a Biotic community rather than Plant community or animal community.**

Victor E Shelford: concept of Biotic community

- **Biotic community is an assemblage with unity of taxonomic composition and of a relatively uniform appearance,**
- **And with a definite trophic organization and metabolic pattern.**

Characters of a community

- **Communities blend gradually into each other and there is no sharply defined boundaries.**
- **Community concept is important because it emphasizes that the community influences an organism and community maintains itself by adaptations.**

Landmarks

- **Carl Mobius: gave the concept of Biocenosis for the association of organisms in an oyester bed community.**
- **1902 Schroter and Kirchner introduced the term Synecology, referring to the plant species on the ocean bottoms as an association or community.**

Landmarks

- **Clements** emphasized the concept of succession
- **Tansely:** also gave the concept of ecological succession
- **Raunkiaer** emphasized the physiognomic methods of community studies.
- **Braun – Blanquet** developed phytosociological studies.

Community analysis

Intra community classification

- **It is an attempt to evaluate the actual importance of an organism in a community, i.e. whether it is dominant or rare species**
- **On the basis of dominance the trophic structure is formed in a community.**
- **Community has a basic trophic structure:**
- **Producer-macroconsumers-microconsumers and within these groups the group of species which controls the flow of energy and strongly affect the environment of all the other species are known a Ecological dominants.**

Index of Dominance

- **The degree to which dominance is concentrated in one, several or many species.**
- **The index of dominance sums up, each species importance in relation to the community as a whole.**
- **Generally dominant species are those which are either major producers or major consumers. And removal of dominant would affect the community as well as the physical environment.**
- **E.g. in land community spermatophytes are dominant autotrophs**

Degree of dominance: Simpson's index

- **Ecological dominants are the group which largely controls the energy flow and strongly affect the environment of all the other species.**
- **The degree of dominance is expressed by the index of dominance & it was given by Simpson 1949**
- **Simpson's index** $C = \sum \left(\frac{ni}{N}\right)^2$
- **Wheren $_{i}$ = importance value of a species in terms of number of its individuals, or biomass or productivity of each species over a unit area.**
- **N= total corresponding importance of value of all the component species in same area & period**

Indicators of dominance

- **Biomass**
- **Grass cover in grassland community**
- **Number**
- **Basal area cover (forest)**
- **Usually the plants are dominants in forest community. However some cases animals are also dominants in case where the size of the plants is small.**
- **Concept of dominance is not applicable to saprophytic community**

Species Diversity

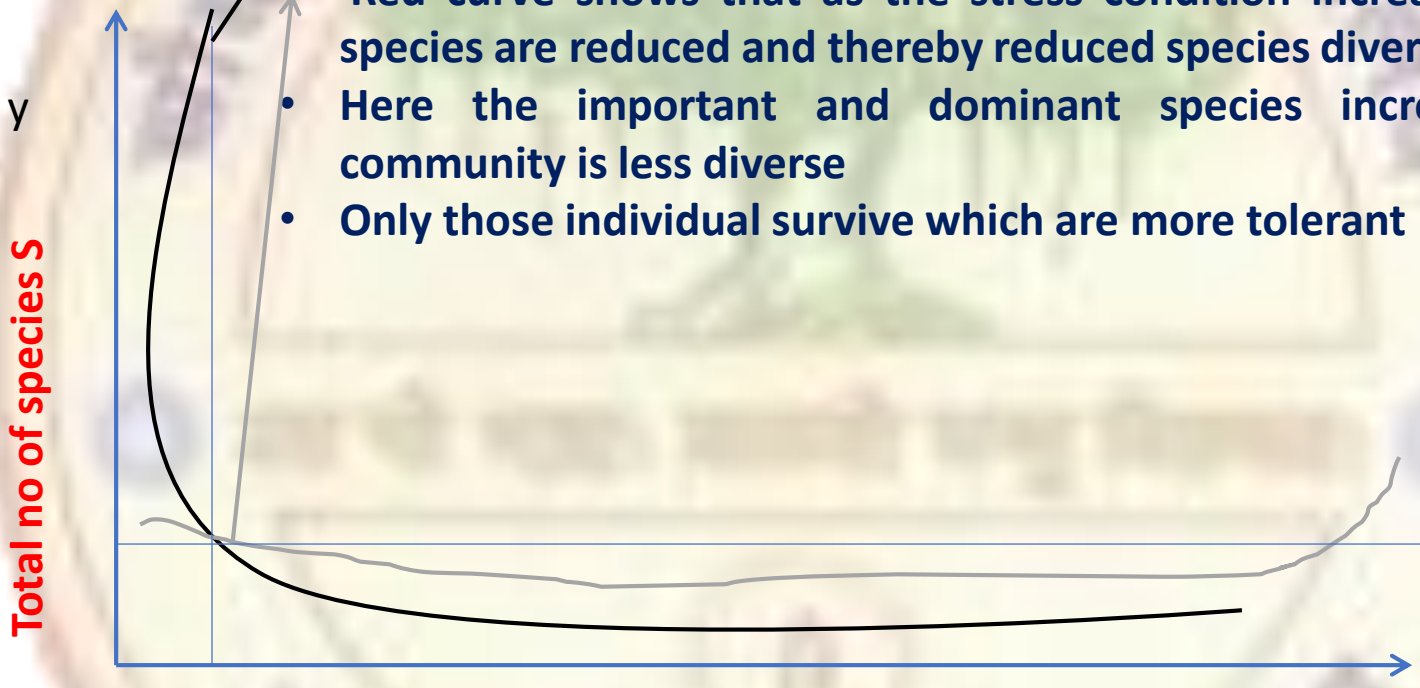
- **The large number of rare species in a community that determine the species diversity of trophic groups & whole community.**
- **The ratio between the number of species and important values (number, biomass, productivity) of individuals are called species diversity indices.**
- **Species diversity is low in physically controlled ecosystems (limiting factors are strong)**
- **Species diversity is high in biologically controlled ecosystems**
- **Diversity increases with a decrease in the ratio of anti thermal maintenance to biomass. i.e. R/B ratio or ecological turnover. (Schrodinger ratio)**

Diversity indices

- **Species richness (variety index) d of three different species.**
- **It is the ratio between the total species & total number of important values N.**
- $d1 = \frac{S-1}{LogN}$
- $d2 = \frac{S}{\sqrt{N}}$
- $d3 = {}^{S}/_{1000\ individuals}$
- **These can be used to compare one community or group of population with another, provided it is first determined that the**
- **S is a linear function of the log or square root of N**

Relationship between species &number (importance)

- Black concave curve shows more diversity
- Red curve shows that as the stress condition increases the rare species are reduced and thereby reduced species diversity.
- Here the important and dominant species increase & the community is less diverse
- Only those individual survive which are more tolerant



Role of species diversity in community regulation

- The more advanced system the more complex is the function due to increased number of individuals and availability of different niches mean more diversified flora and fauna.
- There are many producers which have varying degree of utilization of wavelength and intensity of light. Therefore a shift in spectral quality and quantity tends to affect some producers not all.
- Ecosystem is therefore able to continue with little disruption.
- The ability of climax community is related to its specific diversity and ageing phenomena of succession.

Species diversity in various systems

- **Development towards high diversity increases the productivity from poles to tropics.**
- **This is due to abiotic factors like in incident radiation but may also related to high diversity of species in tropics.**
- **Tropical rain forest> Deciduous forest>Tundra**

Evenness Index (e)

- **Evenness index or equilatibility index: it is the proportion of individuals among different species in a community**
- **E.g. 10 species & 100 individuals have same S/N index but they may differ in evenness**
- **91:1:1:1:1:1:1:1:1:1=not even**
- **10:10:10:10:10:10:10:10:10:10 (even)**
- $e = \frac{\bar{H}}{log\ S}$
- **Where $\overline{H}$ = Shannon's Index**
- **S= No of species**

$\overline{H}$ = Shannon's Index (index of general diversity)

- It combines the species variety and evenness therefore it is also called as overall index of diversity.
- It is independent of sample size and shows normal distribution
- e &$\overline{H} \propto \frac{1}{dominance}$
- Higher the evenness &Shannon's diversity lower the dominance of one individual
- $\overline{H} = -\sum\left(\frac{ni}{N}\right) log \frac{ni}{N}$
- Or $\sum Pi\ log\ Pi$
- Where N= total number of important values
- ni=importance of each species
- Pi= importance proportion of each species=$\frac{ni}{N}$

Species diversity indicate

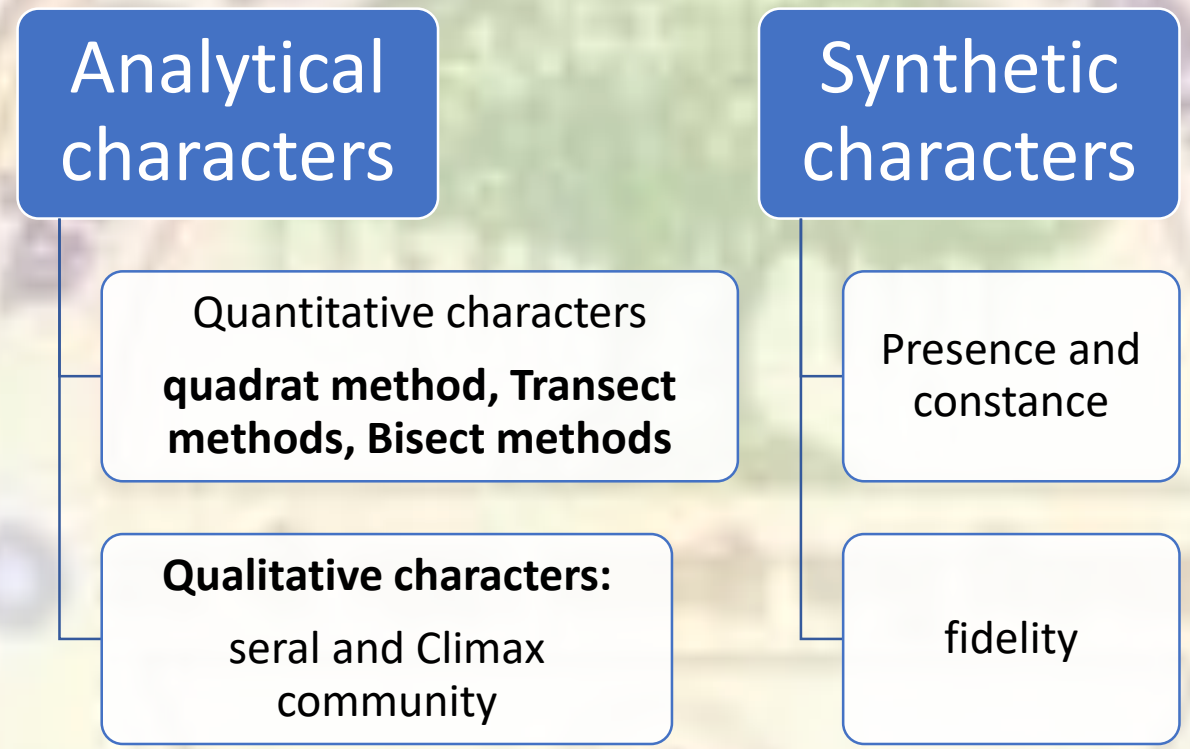
- **Longer food chain**
- **More interactions (+ve, -ve or symbiotic)**
- **Greater possibility of negative interactions i.e. feed back control which reduces oscillations and hence increases stability in community**
- **When antithermal maintenance cost imposed by physical environment are reduced i.e R.B ratio is low then more of the community ratio goes to the diversity.**
- ***Therefore the community in tropical rain forest is stable due to higher species diversity than those communities which are exposed to seasonal or periodic perturbation by man or nature***
- ***Diversity is high in older communities and low in newly established ones***

Factors affecting the species diversity

Community analysis

- Community study can be done by studying the :
- Major Structural features, such as dominant species, life forms, or indicators
- The physical habitat
- Functional attributes such as community metabolism.

Community analysis



Structural features of a community

- **There are two parameters:**
- **Analytical characters: two types**
- **A. Quantitative characters: frequency, density, abundance, cover and basal area**
- **The studies are basically carried out by means of sampling techniques like quadrat method, Transect methods, Bisect methods.**
- **B. Qualitative characters: there are certain units in a community: Clements 1916 recognized the fact that plant communities are not always same at a place and he classified communities into two parallel lines: Seral community: which is in a process of change**
- **Synthetic characters:**

Qualitative characters: Units in community

- **Clements 1916** recognized the fact that plant communities are not always same at a place and organised the communities on the basis of relative dominance of the species in the vegetation and he classified communities into two parallel lines:
- **Seral community**: which is in a process of change
- **Climax community**: which are stable communities
- Seral communities are suffixed with **"ies";** while climax community were suffixed with **"ation"**

COMMUNITY CHARACTERS	SERAL	CLIMAX
Dominant species with maximum canopy coverage of 2 or more species	*ASSOCIES*	*Association*
Community represented by single dominant species	CONSOCIES	Consociation
Some local variation in dominant and subdominant communities	LOCIES	Lociation
Community of sub-dominat species belonging to lower level of life forms than dominant	SOCIES	Society

Classification of community

- **According to Clements:**
- **There are following patterns in a community**
- **Plant formation**
- **The association**
- **Consociation**
- **Society**

Units of vegetation : Clememt's Scheme

Formation: (Dominant species belong to similar growth forms in uniform climate)

Association one or more dominant with subclimates different from general climate of formation

Consociations: Single species dominant with localk variations in soil, temprature, rainfall etc

Societies (Subdoominant species belonging to lower level life forms than the dominants)

Local variations

Faciations: Two or more species dominant, with differences in moisture conditions and temperature

Lociations: two or more species dominant, some subdominant species different from those in association)

Plant formation

- **It is the major unit of vegetation. Is the climax stage in the community.**
- **Plant formation denotes a geographically widespread**

Concept of Habitat, Ecological niche and Guild

Habitat/address

- **The place where an organism lives, Place where one should go and find a particular organism**
- **Eg. Habitat of Trillium plant is a moist shade situation in a mature deciduous forest,**
- **Different species of *Trillium* may occur in the same general habitat with small difference in their location (microhabitat)**
- **Habitat: of an organism or group of organism includes other organisms as well as abiotic environment**

Joseph Grinnel 1917 & 1928 used the word Niche: which is ultimate distributional units, within which a species is held by its structural and instinctive limitations

Niche concept

- **Different organisms fulfill different functions in the ecological complex where it inhabits. Role of each individual in ecosystem is spoken as its niche**

Ecological niche

- **Ecological niche of an organism depends on where it lives**
- **What it does?; i.e. how it transforms energy,**
- **how it behaves?**
- **responds to and modifies its physical & biotic environment**
- **How it is constrained by other species?.**

Study of ecological niche of an organism is useful in giving information about the:

- **organisms status in natural community, with regards**
- **to its activities,**
- **Nutrition & energy source.**
- **Its rate of growth**
- **ability of it to modify important operations in the ecosystems.**
- **As per Mc Arthur: Niche and phenotype are parallel things because both determines the difference between species and**

Ecological niche

- **The ecological niche covers three aspects of a species:**
- **Habitat niche (spatial niche): physical space occupied by an organism**
- **Trophic niche: its trophic position**
- **Multidimentional or hypervolume niche: its position in the environmental gradients of temperature, moisture, pH, soil and conditions of existence**

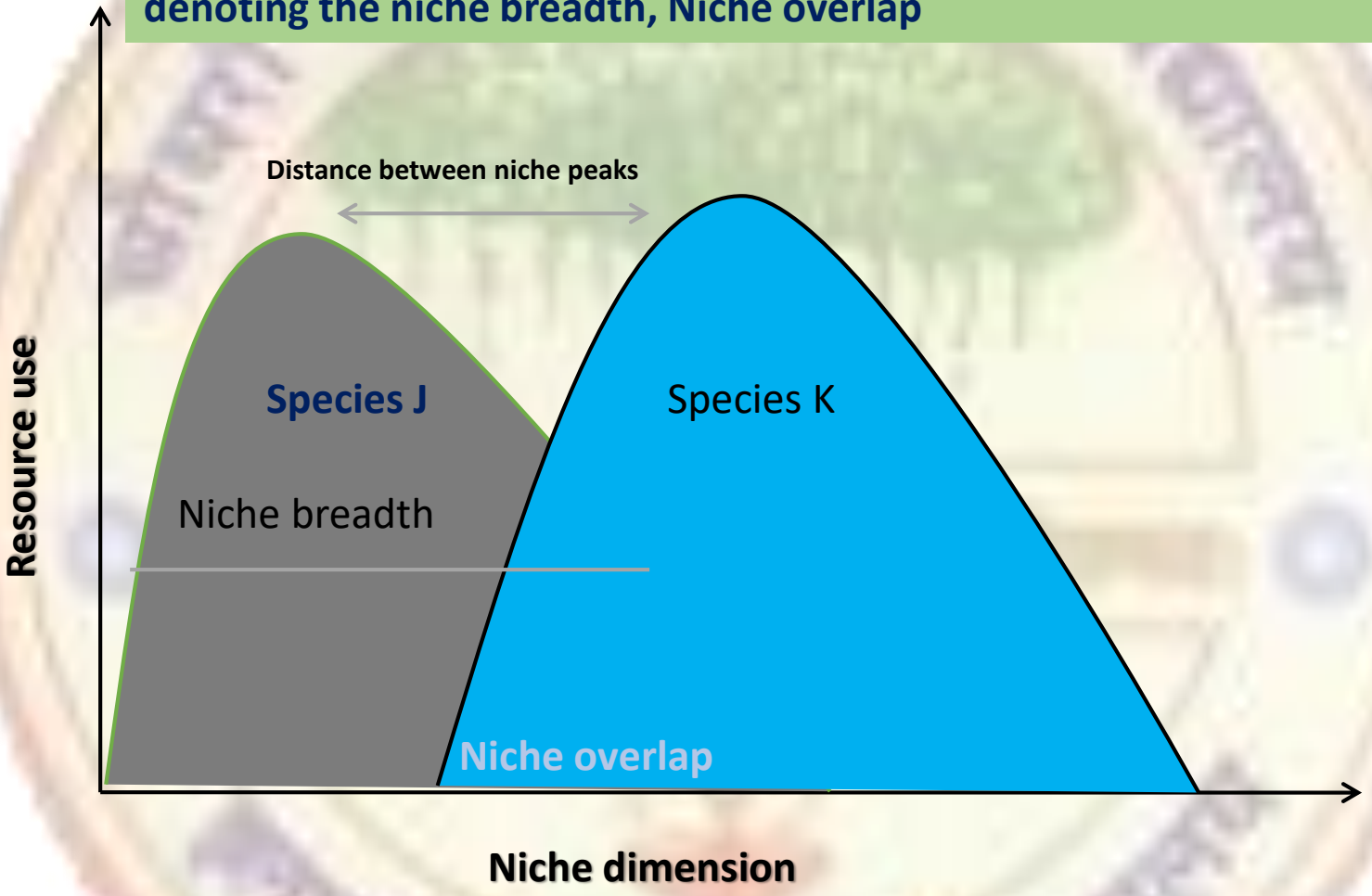
Spatial niche

- **No two species in same general category can occupy for long identically the same ecological niche, therefore a microhabitat can be considered as spatial niche**
- **Charles Elton: was first to use the term niche in the sense of the functional states of an organism in the community. He considered energy relations of the individuals (trophic niche)**
- **Hutchinson's concept: is called the multidimensional or hypervolume niche**

Fundamental niche/ Realized niche

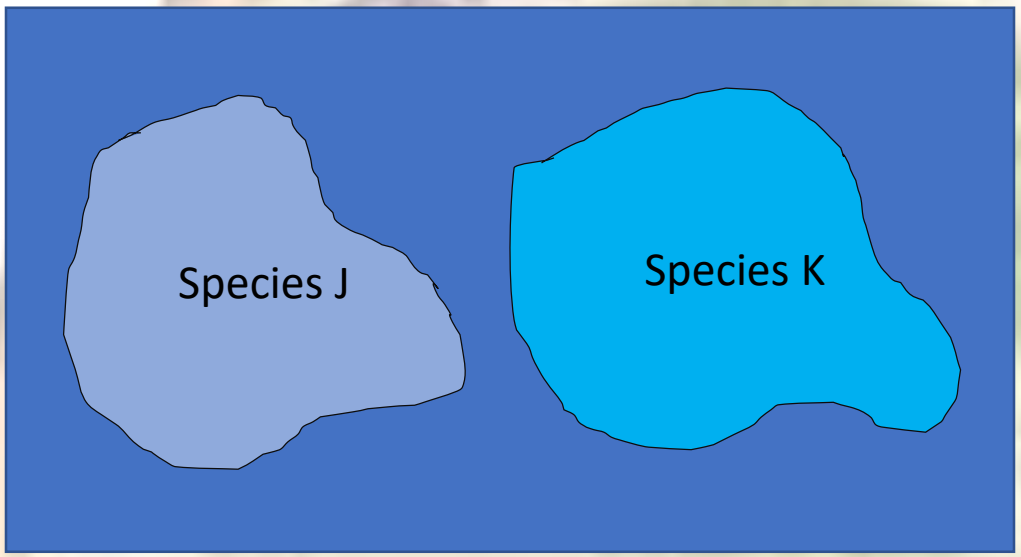
- **It is the maximum abstractly exhausted hyper volume when the species is not constrained by competition with other species. E.g. Pioneer species.**
- **Realized niche: it is a smaller hypervolume occupied under biotic constrains (Climax condition)**

Activity curves of two species J and K along a single resource dimension denoting the niche breadth, Niche overlap

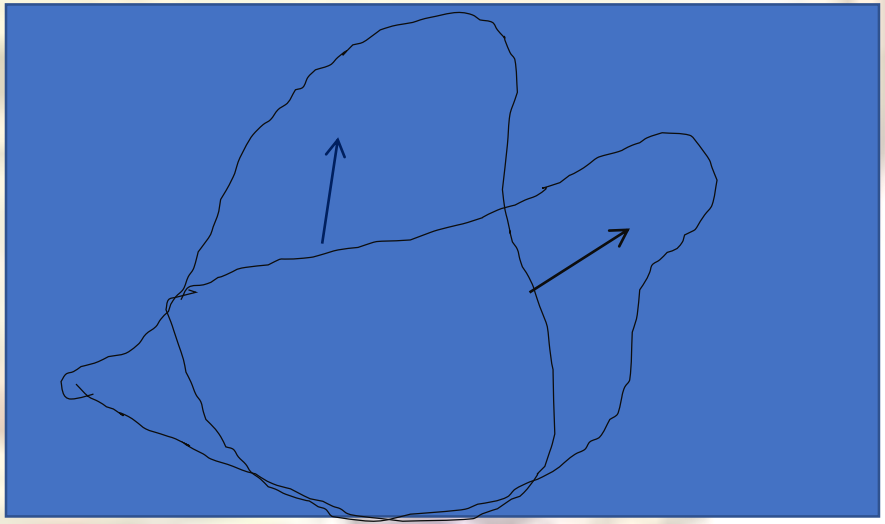


Types of Niches

- **Nonoverlapping Niches: forest birds have non overlapping niches.**
- **Overlapping Niches: Many population belonging to same basic trophic levels exhibit overlapping niches.**
- **The degree of overlapping of niches suggest the degree of competition among the species.**
- **Within the same species , competition is often reduced when different stages of life history have different niches: e.g. tadpole-herbivore; while frog is a carnivore**



Non overlapping niches



Overlapping of niches showing severe competition resulting in divergence of species in different directions shown by arrows

Guilds and Ecological equivalents

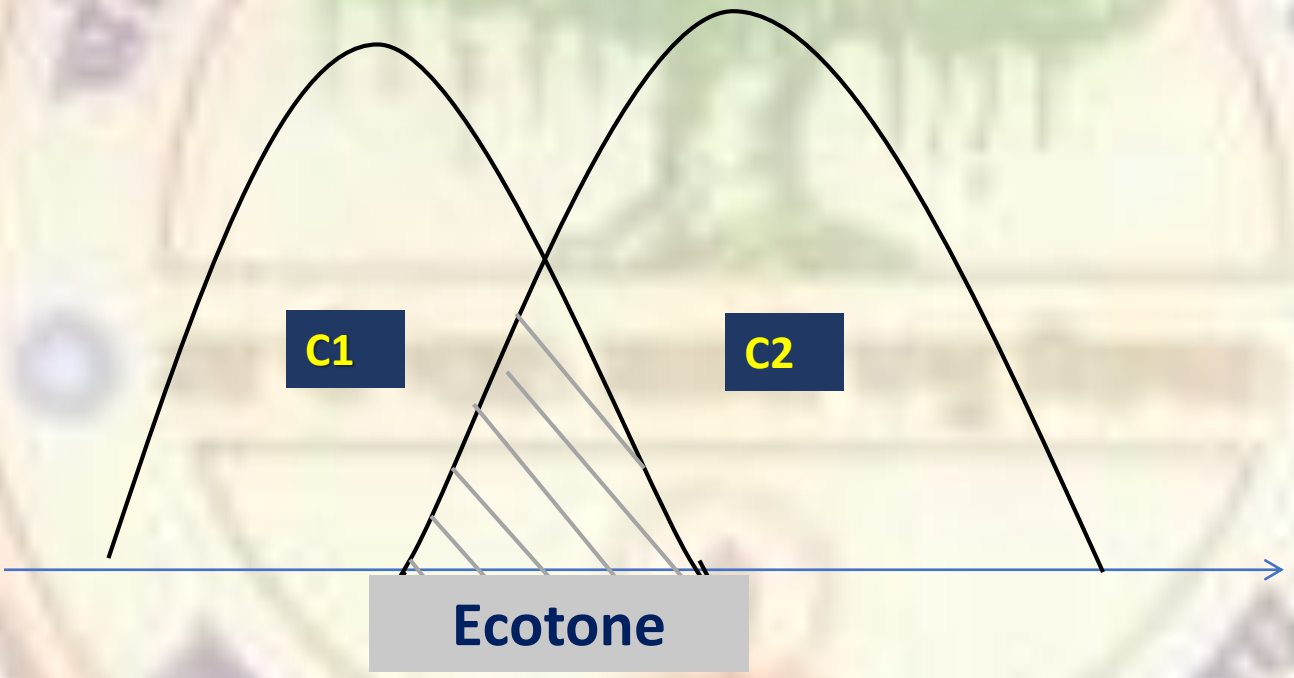
- **Groups of species with comparable roles and niche dimensions in a community are termed as GUILDS**
- **Species that occupy same niche in different geographical regions (continents and major oceans) are termed as ECOLOGICAL EQUIVALENTS**

Guild

- **Is a cluster of species that have similar or comparable role in the community. (Root 1967).**
- **E. g: Wasps parasitizing a herbivore population**
- **Nectar feeding insects**
- **Snails living in the forest floor**
- **Vines climbing into the canopy of tropical forests**

Ecotone and edge effect

- **An ecotone is a transition zone between two or more diverse communities as for e.g. forest and grassland**
- **Between soft bottom and hard bottom marine community.**
- **It is a junction zone or tension belt which have considerable linear extent but is narrower than**


C1
C2
Ecotone

Edge effect

- **The ecotonal community contain many of the organisms of each of the overlapping communities**
- **Also there are certain organisms which are restricted to the ecotonal zone.**
- **Often the no. of species in the ecotonal zone is greater than the flanking communities**
- **The tendency for increased diversity of at community junction is known as Edge effect**

Peculiarities of Ecotone

- **A well developed ecotonal community may contain organisms characteristic of each of the overlapping communities as well as species living only in the Ecotone region.**
- **The organisms which occur primarily or most abundant or spend most of their time in the junction zone are called as Edge species.**
- **Edge effect is not a universal phenomenon as some of the species show the reverse for e.g. the density of trees is obviously less in a forest edge than in the forest.**

Example:

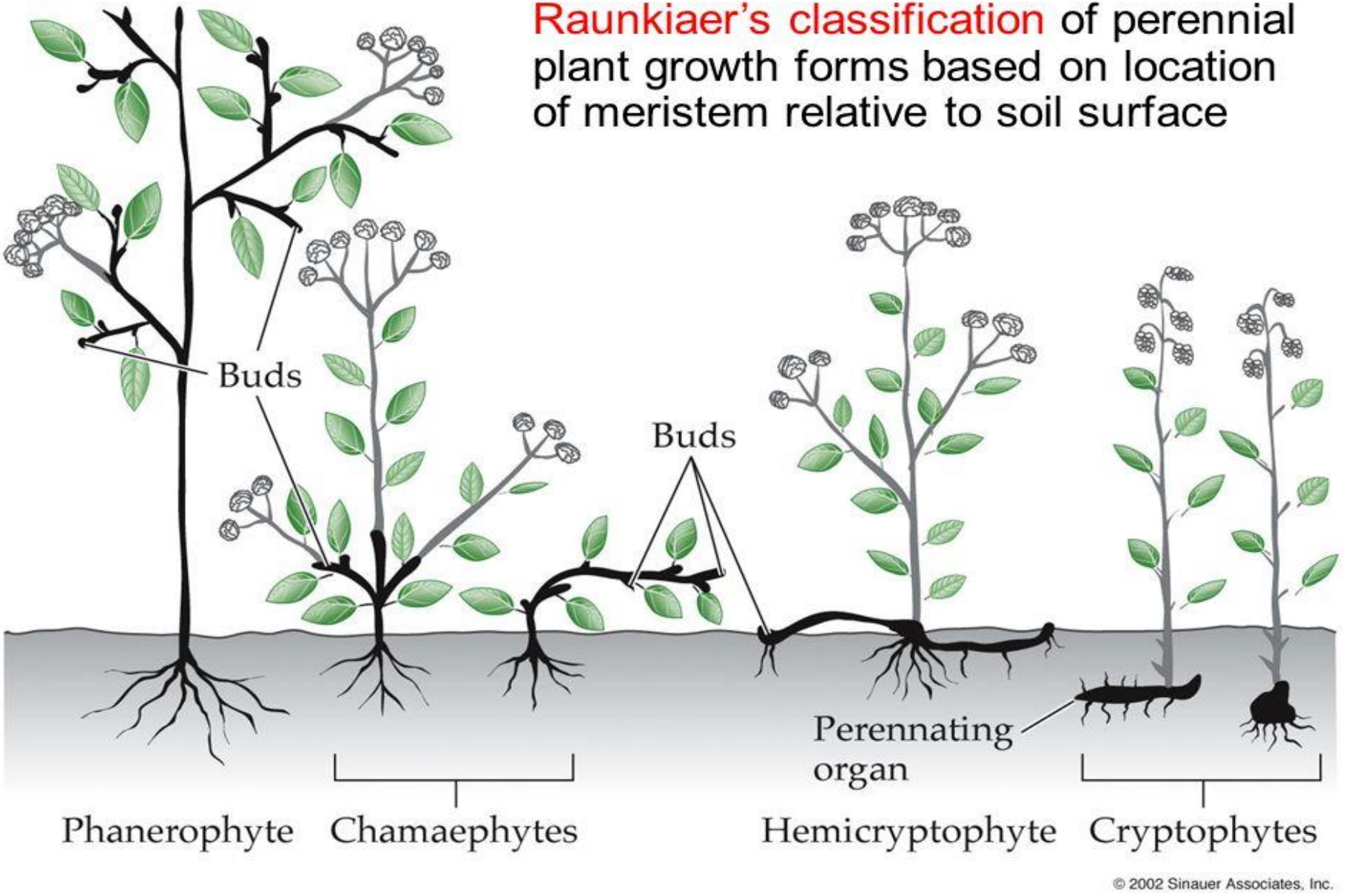
- **Forest edge. It is an edge between the forest and grassland or shrub land communities.**
- **Wherever Man settles he tends to maintain forest edge community in the vicinity of his habitations.**
- **Some of the original organisms of forest and plains are able to survive in the man made forest edge**
- **Those animals which are especially adapted to the forest edge, like many species of weeds, birds, mammals, often increase in number and expand their range as a result of creation by man of forest**

Life forms and Biological spectrums

- **Life forms: are the sum of the adaptations of plant to climate.**
- **According to Raunkiaer's 1934 : the way in which different species overcome the diverse environmental conditions determine the distribution of species.**
- **It is based on the location of the buds on the plant and the way the resting bud survives periods of adverse conditions – like cold or drought.**
- **It is a useful way to relate plant and environmental interactions.**

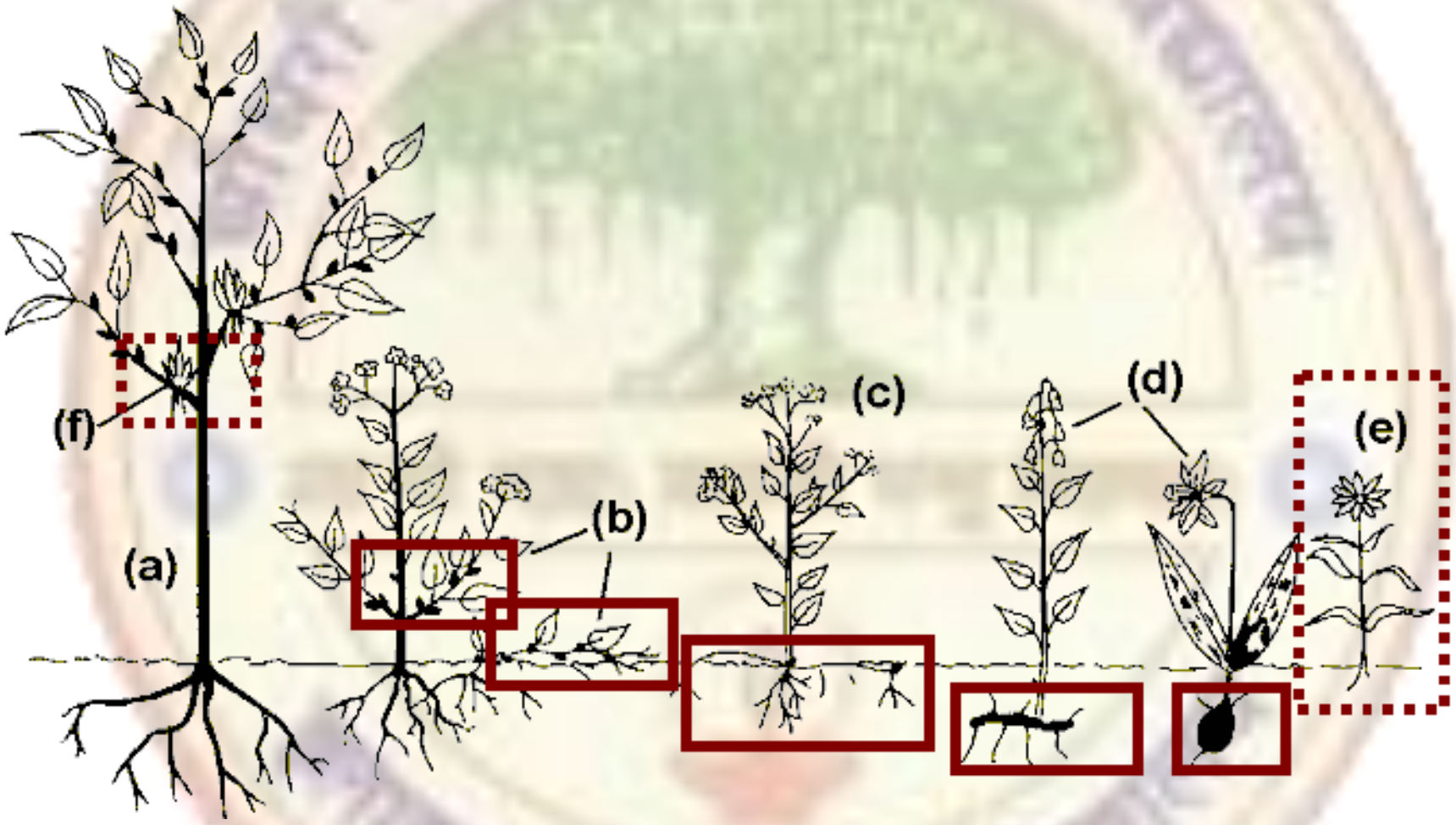
Classification of life forms

- **Degree and position of protection to parennating bud during adverse environmental conditions**
- **He classified 5 major life forms**
- **Phanerophytes (P)**
- **Chamaeophytes (Ch)**
- **Hemi cryptophytes (H)**
- **Cryptophytes (Cr)**
- **Threophytes (Th)**


Raunkiaer's classification of perennial plant growth forms based on location of meristem relative to soil surface
Buds
Buds
Perennating organ
Phanerophyte
Chamaephytes
Hemicryptophyte
Cryptophytes
© 2002 Sinauer Associates, Inc.

Modified classification

- **Phanerophyte**
- **Chamaephyte**
- **Hemicryptophyte**
- **Cryptophyte**
- **Geophyte**
- **Helophyte**
- **Hydrophyte**
- **Therophyte**
- **Epiphyte**
- **Aerophyte**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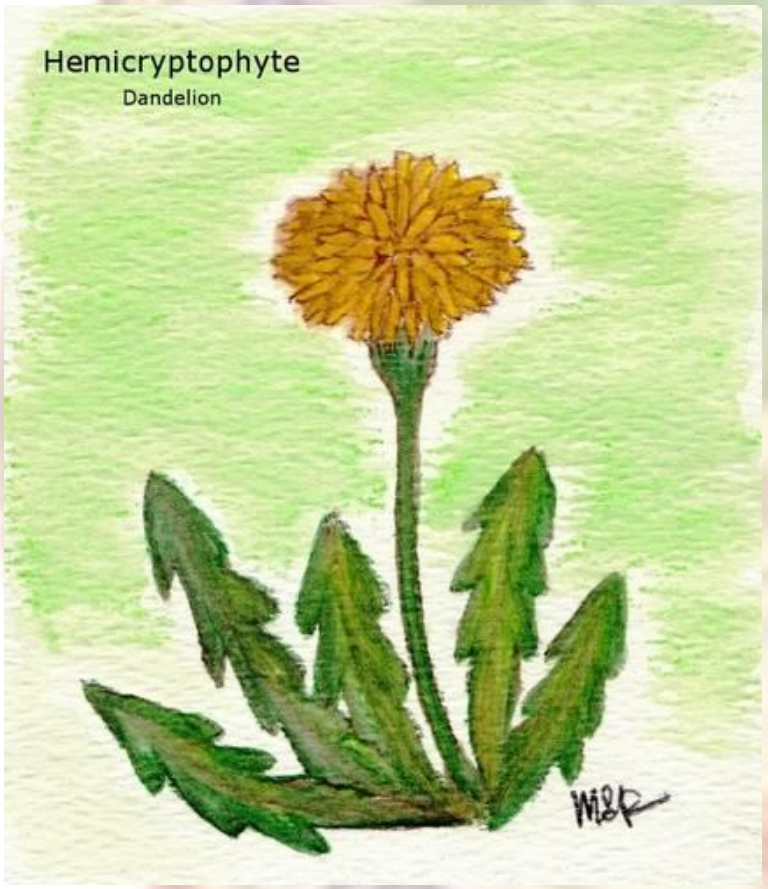
Phanerophytes

- **Phanerophytes are the woody perennials (trees and shrubs).**
- **The resting buds are > 0.5 m above ground.**
- **Phanerophytes have been further subdivided based on the size of the plants into:**
- **Megaphanerophytes: trees over 30 m tall**
- **Mesophanerophytes: 8-30 m**
- **Microphenerophytes : 2-8 m**
- **Nanophanerophytes. Below 2 m**

Chamaephytes: subshrubs

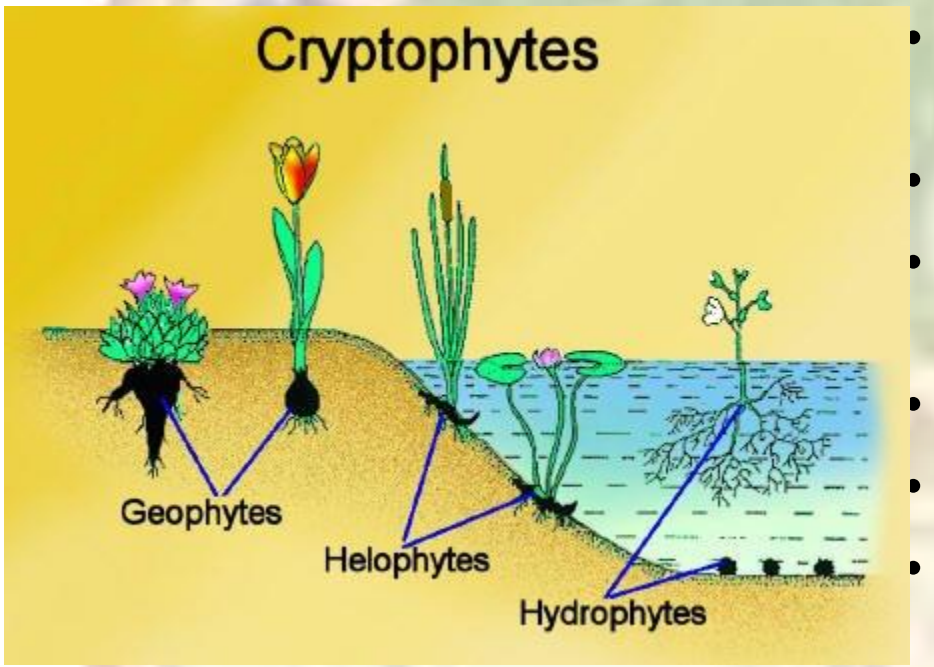
- **are woody perennials with the resting bud 25 cm above the ground.**
- **These include small shrubs.**
- **Found in cold region at high altitudes or high lattitudes**
- **E.g. *Trifolium repens*,**

Hemicryptophytes



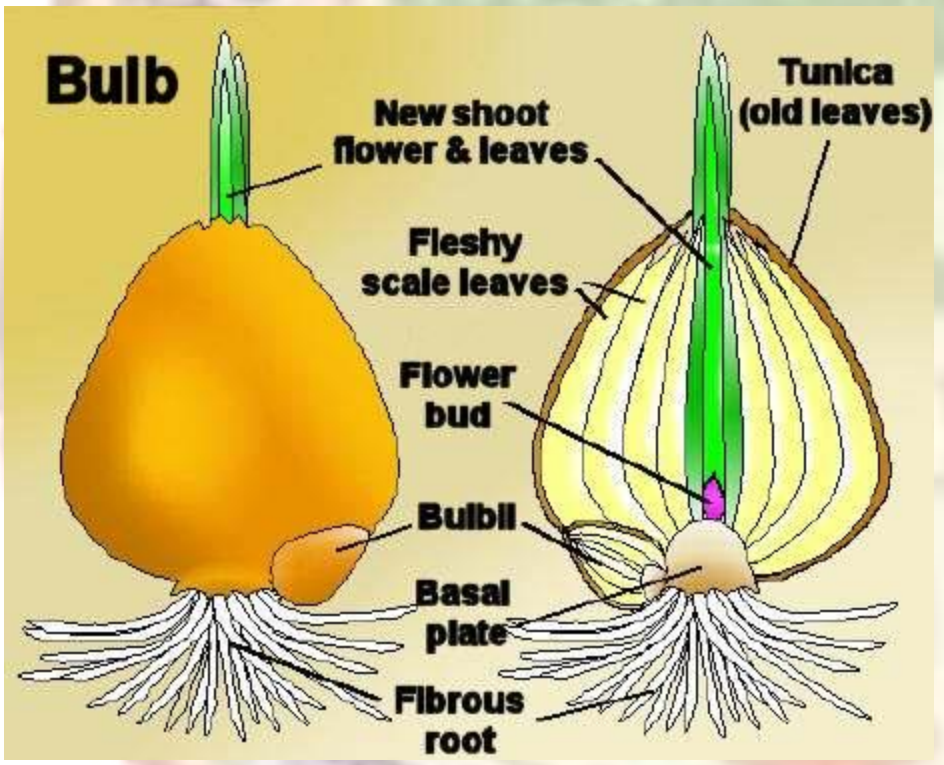
- **are herbaceous perennial plants with the resting bud at or near the soil line, hidden under the dead leaves and twigs**
- **These are mostly biennials or perennials**
- **Herbs whose vegetative growth & aerial parts are conspicuous in warm season only**

Cryptophytes



- perennial plants where the resting bud is below ground including those below water.
- These are able to withstand long period of adverse climate
- Store food in buds/rhizomes
- Cryptophytes can be further subdivided into
- geophytes,
- helophytes and
- hydrophytes.

Geophytes



- **have roots or shoots that are modified as storage organs.**
- **Geophytes include bulbs, corms, rhizomes, tubers, tuberous shoots, and tuberous roots.**

Helophytes

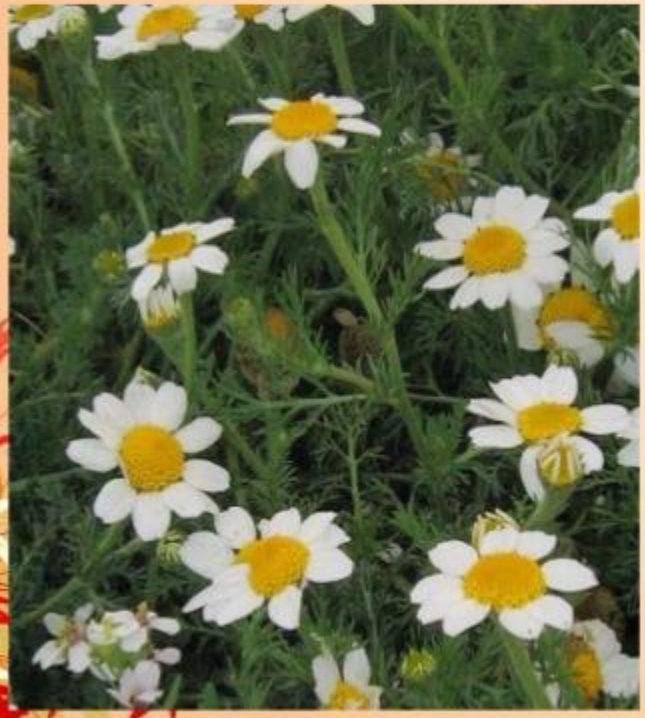
- **are those plants that grow in wet soils.**
- **The resting bud is below ground in the wet soil.**

Hydrophytes

- grow in water and resting bud over winters below the surface of the water often in the lake bed floor.

Therophytes

5. Therophytes- annual plants which survive the unfavorable season in the form of seeds



- **are those plants that survive adverse climatic conditions as seeds.**
- **These include all of the annual plants.**
- **They produce flower seeds in favorable conditions**
- **They are common in hot, dry, cold conditions**

An epiphyte

- **is a plant that grows on another plant,**
- **but does not derive water or nutrients from the association.**
- **Epiphytic vascular plants occur most often in the moist tropics and include ferns, aroids, orchids, bromeliads, peperomias, and cactus.**
- **Non-vascular epiphytes include mosses and lichens.**

Aerophytes

- **are epiphytes,**
- **but they have no functional roots and absorb moisture and nutrients through their leaves.**
- **A good example of this type of plant is spanish Moss: *Tillandsia*.**

Biological spectrum

- **Phytoclimatic spectrum: represents the % distribution of species among various life forms or**
- **it represents the % of total species in the community. It can be calculated**
- **Life forms are related to the environmental conditions :**
- **E.g. high % of threophytes indicate long dry seasons**
- **High % of chamaeophytes indicate extreemly cold climate.**
- **High % of hemicryptophytes indicate extensive grasslands**
- **Occurrence of similar biological spectrum indicates similar climatic conditions**

Raunkiaer's Biological spectrum

- **Normal biological spectrum as proposed by Raunkiaer:**
- **Phanerophytes: 46 %**
- **Chamaeophytes: 9 %**
- **Hemicryptophytes: 26%**
- **Cryptophytes: 6%**
- **Threophytes: 13 %**

Normal biological spectrum is a reference to the prevailing environmental conditions

- **In deserts the % of Threophytes was 42-50% (normal 13%)**
- **Temperate climate: % of Hemicryptophytes-49-51%(normal 26%)**
- **Tropical west Indies: Phanerophytes %- 74% (normal-46%)**

Limitations

- **One of the major drawback of Raunkiaer BS is that it doesn't considers other biotic disturbances.**
- **For e.g. Gangetic plains are favourable for forest development but in fact only threophytes are dominant due to agricultural practices. Thus besides the climate the biological spectrum is also altered by agricultural practices, grazing etc.**

Classification based on leaf size

- **Six leaf classes are there and the leaf size of each class is 9 times larger than the preceding one**

Class		size
1.	Leptophyll	25 sqmm
2.	Nanophyll	25x9=225 sqmm
3.	Microphyll	225x9=2025 sqmm
4.	Mesophyll	2025x9=18225 sqmm
5.	Macrophyll	18225x9=164025sqmm
6.	Megaphyll	larger than class 5

7. **Size of the leaf has been correlated with the climatic condition**