SNS COLLEGE OF TECHNOLOGY

Coimbatore-35.
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COURSE NAME : 19GET277 - Biology for Engineers

IV YEAR/ VII SEMESTER

UNIT – II - BIODIVERSITY

Topic: Plant System basic concepts of plant growth-nutrition

BIODIVERSITY

The word "biodiversity" is a contraction of "biological diversity".

The father of biodiversity Edward O. Wilson (an eminent entomologist) first coined this term in 1986.

Diversity is a vast concept refers to the range of variations or differences among some set of entities; biological diversity thus refers to varieties within the living world.

The term 'biodiversity' is generally considered as an 'Umbrella term' referring to organisms found within the living world.

It is commonly used to describe the number, variety of life and variability of living organisms.

BIODIVERSITY

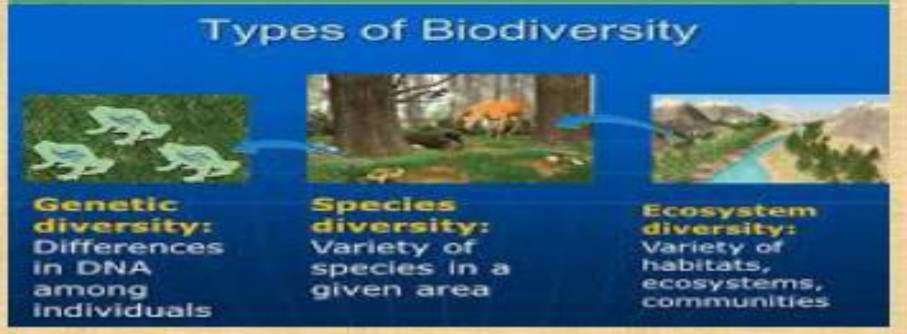
- **Bio-diversity:**

The variability among living organisms from all sources including, inter alia (among other things), terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Elements of bio-diversity

- **The predicted number of total species varies from 5 to 50 million and averages at 14 million.**
- **Out of the total known species, about 60 % are insects, about 16 % are higher plants and only about 0.3 % is mammals.**
- **The most unique feature of Earth is the existence of life and the most extraordinary feature of life is its diversity.**
- **Bio-diversity is normally treated in terms of genes, species and ecosystems in correspondence with three fundamental hierarchical levels of biological organization.**
- **The three diversities are referred as genetic, species and ecosystem diversity.**

- Sometimes **landscape** (is a heterogeneous land area composed of cluster of interacting ecosystems that is repeated in similar form throughout or **mosaic of heterogeneous land forms, vegetation types and land uses**) **or pattern diversity** is considered as **fourth** forum of bio-diversity.
- **Diversity:**
  - **Within the species is genetic diversity**
  - **Between species is species diversity or taxonomic diversity or organismal diversity**
  - **At ecological or habitat level is ecosystem or ecological diversity.**



Interaction is the principal intrinsic mechanism that shapes the characteristics and functions of biodiversity.

These interactions are a hierarchical nature.

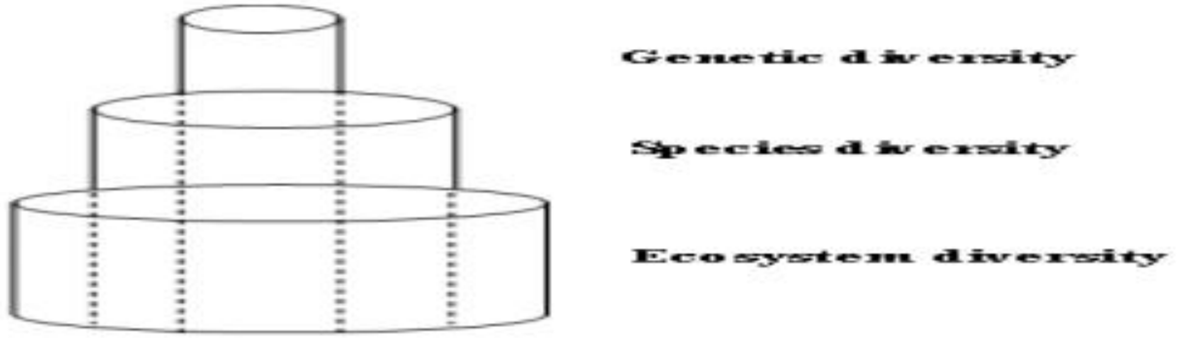


Fig.: Hierarchical levels of biodiversity and their interrelationship

Types of Biodiversity

- Biodiversity further classifies into three major types. They are:

1. Genetic Diversity
2. Species Diversity
3. Ecological Diversity

Genetic Diversity

- It is basically the variety of species expressed at the genetic level by each individual in a species. No two individuals belonging to the same species are exactly similar. For example, in the species of human beings, each human shows a lot of diversity in comparison to another human. People living in different regions show a great level of variation.

Species Diversity

- It is the biodiversity observed within a community. It stands for the number and distribution of species. The number of species in a region varies widely depending upon the varied environmental conditions. For example, it is usually observed that civilizations residing beside water bodies show more species than the one compared to the areas away from water bodies.

Ecological diversity

- It defines the diversity observed among the ecosystems in a particular region. Different ecosystems like mangroves, rainforests, deserts, etc., show a great variety of life forms residing in them.

3 types of Biodiversity

Scale of Organization

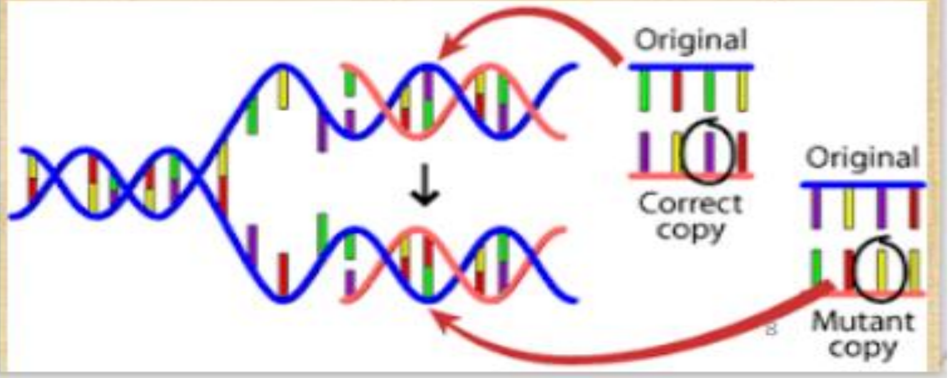
Levels of interaction

Genetic diversities	Species diversity	Ecological diversities
Community	Kingdom	Biosphere
Population	Phylum	Biome
Individual organism	Class	Ecosystem
Cell	Order	Patch
Molecule	Family	Habitat
	Genes	
	Species	
	Subspecies	

9/18/2022 The scale of organization and level of interaction of biodiversity 7

Genetic diversity

- **Referred as the diversity within the species or intra or infra species diversity.**
- **It encompasses the components of genetic coding that structures organisms (nucleotides, genes, chromosomes) and variation in the genetic make-up between individuals within a population and between populations.**
- **The variation could be in alleles (different variants of same genes), in entire genes (the traits determining particular characteristics) or in chromosomal structures.**
- **This enables a population to adapt to its environment and to respond to natural selection.**



- If a species has more genetic diversity, it can adapt better to the changed environmental conditions.
- Lower diversity in a species leads to uniformity and the amount of genetic variation is the basis of speciation (evolution of new species).
- It has a key role in the maintenance of diversity at species levels.
- Genetic diversity within a species often increases with environmental variability.
- It can be measured by the methods based on DNA marker like RFLP, PCR, RAPD, APPCR, PFGE, microsatellite primed PCR and others.

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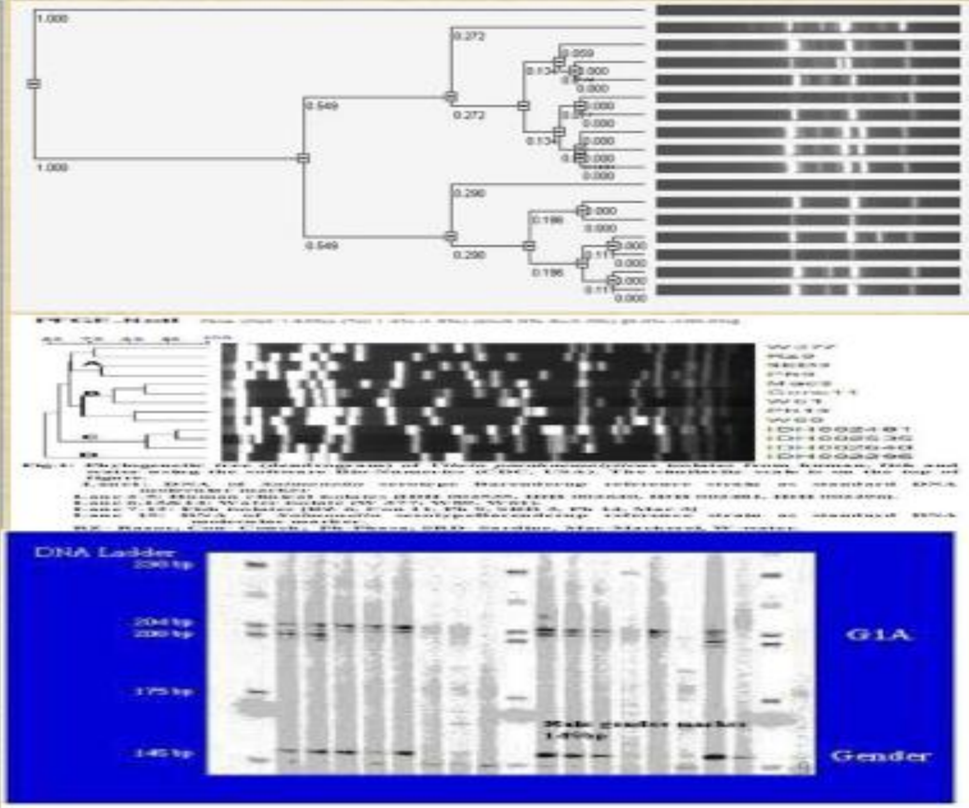
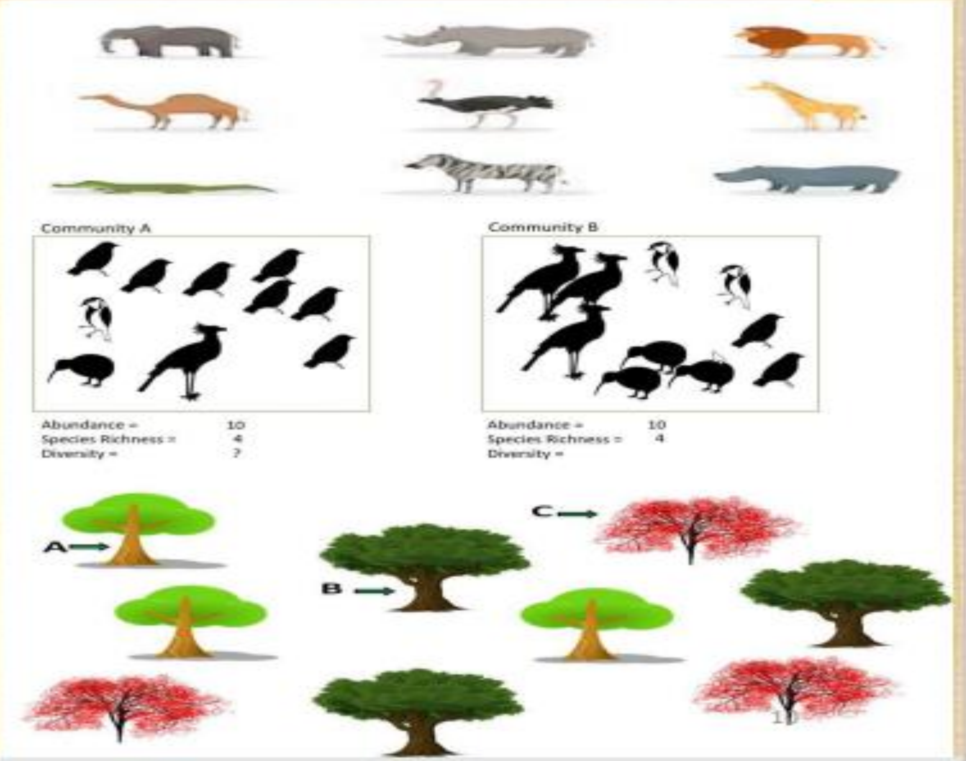


Species diversity

- Species are distinct units of diversity, each playing a specific role in an ecosystem.
- Therefore loss of species has consequences for the ecosystem as a whole.
- Refers to the **variety of living species within a geographic area**.
- It encompasses the taxonomic hierarchy and its components, from individuals upwards to species, genera and beyond.
- The **simplest measures of species diversity** (SR+SE) are:
  - **Species richness** (the number of species per unit area)
  - **Species evenness** (the evenness in number of individuals of each species in the area).
- Generally, **greater the species richness greater is the species diversity**.



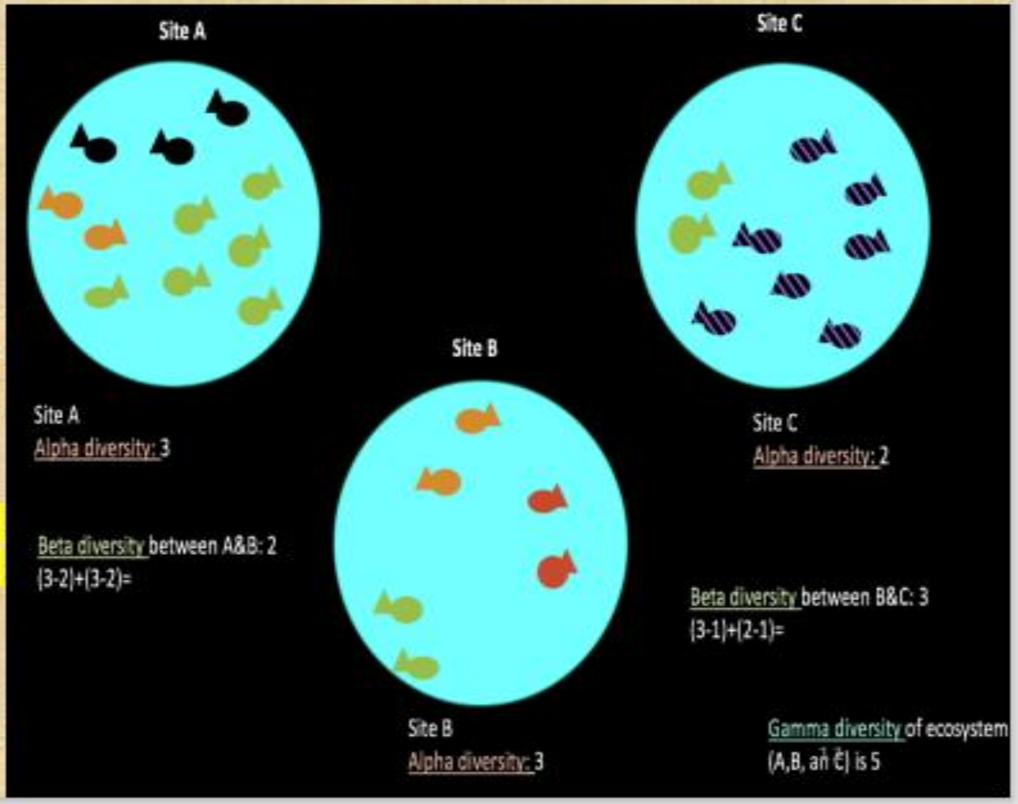
- ***Alpha diversity*** **refers to the average species diversity within a particular area, habitat, community or ecosystem.**

- **It is measured by counting the number of taxa (distinct groups of animals) within the ecosystem.**

- ***Beta diversity*** **is species diversity between ecosystems refers to the ratio between alpha diversity and regional diversity or comparison of taxa that are unique to each of the ecosystem.**

- **Beta diversity = (no. of sps. in Habitat 1- no. of common sps. Habitat 2 & 1)+(no. of sps. in H2- no. of common sps. Habitat 1&2)**

- ***Gamma diversity*** **is the overall diversity for different ecosystems within a region or total diversity over a large area or region.**



Ecological diversity

- Ecological diversity is the largest scale of biodiversity. On a global scale, ecological diversity would look into the variation in ecosystems such as deserts, grasslands, forests, oceans, and wetlands.
- Within each ecosystem, there is a great deal of both species and genetic diversity.
- Ecological diversity considers the variation in the complexity of a biological community, looking at the number of niches and trophic levels there.

plant nutrition

- Plants use inorganic minerals for nutrition. Complex interactions involving weathering of rock minerals, decaying organic matter, animals, and microbes take place to form inorganic minerals in soil.
- Roots absorb mineral nutrients as ions in soil water.
- Many factors influence nutrient uptake for plants.
- Ions can be readily available to roots or could be "tied up" by other elements or the soil itself. Soil too high in pH (alkaline) or too low (acid) makes minerals unavailable to plants.

Fertility or nutrition

- The term "fertility" refers to the inherent capacity of a soil to supply nutrients to plants in adequate amounts and in suitable proportions.
- The term "nutrition" refers to the interrelated steps by which a living organism assimilates food and uses it for growth and replacement of tissue.
- Previously, plant growth was thought of in terms of soil fertility or how much fertilizer should be added to increase soil levels of mineral elements.
- Plant nutrition is a term that takes into account the interrelationships of mineral elements in the soil or soilless solution as well as their role in plant growth.
- This interrelationship involves a complex balance of mineral elements essential and beneficial for optimum plant growth.

Essential Vs Beneficial

- The term essential mineral element (or mineral nutrient) was proposed by Arnon and Stout (1939).
- They concluded three criteria must be met for an element to be considered essential. These criteria are:

1. A plant must be unable to complete its life cycle in the absence of the mineral element.
2. The function of the element must not be replaceable by another mineral element.
3. The element must be directly involved in plant metabolism.

What are the mineral elements

- There are actually 20 mineral elements necessary or beneficial for plant growth.
- Carbon (C), hydrogen (H), and oxygen (O) are supplied by air and water.
- The six macronutrients, nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S) are required by plants in large amounts.
- The rest of the elements are required in trace amounts (micronutrients). Essential trace elements include boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), sodium (Na), zinc (Zn), molybdenum (Mo), and nickel (Ni). Beneficial mineral elements include silicon (Si) and cobalt (Co).

The elements of complete plant nutrition

Macronutrients

- **Nitrogen** is a major component of proteins, hormones, chlorophyll, vitamins and enzymes essential for plant life. Nitrogen metabolism is a major factor in stem and leaf growth (vegetative growth).
- Too much can delay flowering and fruiting.
- Deficiencies can reduce yields, cause yellowing of the leaves and stunt growth.
- **Phosphorus** is necessary for seed germination, photosynthesis, protein formation and almost all aspects of growth and metabolism in plants.
- It is essential for flower and fruit formation. Low pH (<4) results in phosphate being chemically locked up in organic soils. Deficiency symptoms are purple stems and leaves; maturity and growth are retarded.

- **Potassium** is necessary for formation of sugars, starches, carbohydrates, protein synthesis and cell division in roots and other parts of the plant. It helps to adjust water balance, improves stem rigidity and cold hardiness, enhances flavor and color on fruit and vegetable crops, increases the oil content of fruits and is important for leafy crops.
- **Sulfur** is a structural component of amino acids, proteins, vitamins and enzymes and is essential to produce chlorophyll. It imparts flavor to many vegetables.

- **Magnesium** is a critical structural component of the chlorophyll molecule and is necessary for functioning of plant enzymes to produce carbohydrates, sugars and fats. It is used for fruit and nut formation and essential for germination of seeds.
- **Calcium** activates enzymes, is a structural component of cell walls, influences water movement in cells and is necessary for cell growth and division. Some plants must have calcium to take up nitrogen and other minerals. Calcium is easily leached. Calcium, once deposited in plant tissue, is immobile (non-translocatable) so there must be a constant supply for growth.

Micronutrients

- **Iron** is necessary for many enzyme functions and as a catalyst for the synthesis of chlorophyll. It is essential for the young growing parts of plants. Deficiencies are pale leaf color of young leaves followed by yellowing of leaves and large veins. Iron is lost by leaching and is held in the lower portions of the soil structure.
- **Manganese** is involved in enzyme activity for photosynthesis, respiration, and nitrogen metabolism. Deficiency in young leaves may show a network of green veins on a light green background similar to an iron deficiency. In the advanced stages the light green parts become white, and leaves are shed. Brownish, black, or grayish spots may appear next to the veins. In neutral or alkaline soils plants often show deficiency symptoms. In highly acid soils, manganese may be available to the extent that it results in toxicity.

- **Boron** is necessary for cell wall formation, membrane integrity, calcium uptake and may aid in the translocation of sugars. Boron affects at least 16 functions in plants. These functions include flowering, pollen germination, fruiting, cell division, water relationships and the movement of hormones. Boron must be available throughout the life of the plant. It is not translocated and is easily leached from soils. Deficiencies kill terminal buds leaving a rosette effect on the plant.

- **Zinc** is a component of enzymes or a functional cofactor of a large number of enzymes including auxins (plant growth hormones). It is essential to carbohydrate metabolism, protein synthesis and internodal elongation (stem growth). Deficient plants have mottled leaves with irregular chlorotic areas. Zinc deficiency leads to iron deficiency causing similar symptoms. Deficiency occurs on eroded soils and is least available at a pH range of 5.5 - 7.0. Lowering the pH can render zinc more available to the point of toxicity.

- **Copper** is concentrated in roots of plants and plays a part in nitrogen metabolism. It is a component of several enzymes and may be part of the enzyme systems that use carbohydrates and proteins. Deficiencies cause die back of the shoot tips, and terminal leaves develop brown spots. Copper is bound tightly in organic matter and may be deficient in highly organic soils. It is not readily lost from soil but may often be unavailable. Too much copper can cause toxicity.

- **Molybdenum** is a structural component of the enzyme that reduces nitrates to ammonia. Without it, the synthesis of proteins is blocked and plant growth ceases. Root nodule (nitrogen fixing) bacteria also require it. Seeds may not form completely, and nitrogen deficiency may occur if plants are lacking molybdenum. Deficiency signs are pale green leaves with rolled or cupped margins.

- **Chlorine** is involved in osmosis (movement of water or solutes in cells), the ionic balance necessary for plants to take up mineral elements and in photosynthesis. Deficiency symptoms include wilting, stubby roots, chlorosis (yellowing) and bronzing. Odors in some plants may be decreased. Chloride, the ionic form of chlorine used by plants, is usually found in soluble forms and is lost by leaching. Some plants may show signs of toxicity if levels are too high.

- **Nickel** has just recently won the status as an essential trace element for plants according to the Agricultural Research Service Plant, Soil and Nutrition Laboratory in Ithaca, NY. It is required for the enzyme urease to break down urea to liberate the nitrogen into a usable form for plants. Nickel is required for iron absorption. Seeds need nickel in order to germinate. Plants grown without additional nickel will gradually reach a deficient level at about the time they mature and begin reproductive growth. If nickel is deficient plants may fail to produce viable seeds.

- **Sodium** is involved in osmotic (water movement) and ionic balance in plants.
- **Cobalt** is required for nitrogen fixation in legumes and in root nodules of nonlegumes. The demand for cobalt is much higher for nitrogen fixation than for ammonium nutrition. Deficient levels could result in nitrogen deficiency symptoms.
- **Silicon** is found as a component of cell walls. Plants with supplies of soluble silicon produce stronger, tougher cell walls making them a mechanical barrier to piercing and sucking insects.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