Chapter One

1. Introduction

1.1. The Meaning and Scope of Biogeography

How do you define Biogeography?

- Biogeography is the study of distribution of organisms both past and present.
- It is the science which attempts to describe and understand the innumerable patterns in the distribution of species and larger taxonomic groups.
- Biogeography in part is a historical science; from the study of fossils which provide valuable information on the history of life on earth.
- Biogeography asks the questions like;
    - ❖ Why a species confined to its present ranges?
    - ❖ What is its closest relative and where they found?
    - ❖ What roles do climate, topography and interactions with other organisms play in limiting the distribution?
    - ❖ How do we account for the replacement of species that we observe as we go up a mountain or move from a rock shore to a sandy beach nearby?
    - ❖ Why are so many species in the tropics than in the temperate or in the arctic latitudes?
    - ❖ How an island colonized and how is there always fewer species on the islands than on the same kinds of habitats on nearby continents?
    - ❖ Why are the animals and the plants of large isolated regions such as Australia, Madagascar are so distinctive?
    - ❖ How have geologic events such as continental drift and Pleistocene glaciations shaped this distribution?

Looking the past position of continents and oceans is important to understand the distribution of organisms.

- ❖ How do the number and kind of species vary from region to region over the surface of the earth and how can we account for this variation?

- Biogeography's questions are endless.
- Biogeographers have not yet answered all the questions.

Taxonomies of biogeography:

1. Phyto-geography(study of plants)
2. Zoo-geography(study of animals)

- Biogeography is a broad field of study which synthesizes a tremendous amount of information from historical biogeography which attempts to reconstruct the origin, dispersal and extinction of taxa and biotas.
- This approach contrasts with ecological biogeography, which accounts with the present distributions in terms of interactions between the organisms and their physical and biotic environments

Problems in the study of Biogeography

- Biogeography is a synthetic discipline relying heavily on data, principles and hypothesis which is made by others like ecology, population biology, systematic, evolutionary biology, the geosciences and natural history.
- Consequently we do not want to draw sharp line between biogeography and its related subjects.
- Most sciences follow standard way of addressing questions either deductively or inductively.
- Science usually devotes considerable space to distinguishing between inductive methods(reasoning from specific observations to general principles), and deductive methods (reasoning from general constructs to specific cases).

- *However, biogeography first identifies patterns then mechanistic explanation of pattern, then causes of pattern, then processes which result in pattern and finally deductive or inductive reasoning.*

- Pattern defined as non-random, repetitive organization
- Biogeography is purely a descriptive map making endeavor.
- It is an observational science, which does not use experimental methods in explaining patterns—no testing of theories

- In dealing with historical aspect of their science, most bio-geographers make one critical assumption that is usually impossible to test.

- They accept the principle of uniformitarianism or actualism.
- This principle says that the physical processes operating at the earth's surface have remained unchanged and are the result of the same fundamental laws that have acted throughout time.
- The principle of uniformitarianism is usually attributed to the British geologists Hutton (1795) and Lyell (1830)
- According to them, the surfaces of the earth were constantly changing as rocks were formed and weathered away and as mountains were uplifted and eroded down.

- In this same spirit, one of Darwin's great insights was the recognition that changes in domesticated plants and animals over historical time by selective breading represent the same process as changes in organisms over evolutionary time through the process of natural selection.

Simpson (1970a), acceptance of uniformitarianism has never been universal, because certain processes are now more or less intense in the past, some forces are more active in one part of the globe than the other, some forces are sudden not gradual where rates of change have not been constant over time.

- One must expect that intensity of forces varies from time to time and from place to place only, the nature of the processes themselves is timeless.

Simpson prefers to adopt the term Actualism conceptually similar to methodological uniformitarianism.

- Historical bio-geographers use this principle to account for present and past distributions, assuming that the processes of speciation, dispersal and extinction operated in the past in the same manner that they do today---*the present is the key to the past*.

Dear students in order to have deeper understanding about the problems in the study of the science biogeography it is better to study the historical development of the science.

1.2. **History of Biogeography**

Development in the early period

- 200 years ago biologists had described and attempted to classify only 1 percent of all the plants and animals species we know today.

- Therefore, biogeography really was founded and accelerated rapidly by world exploration and accompanying discovery of new kinds of organisms, which gained great momentum in the 1800s.

- One of the early explorer and naturalist was **Alexander von Humboldt**, who usually honored as the father of phyto-biogeography.

- He was the first to conceptualize and quantify the primary role of climate in the distribution and forms of plants around the world.

- The close relationship between climate and vegetation was as quickly as expanded by his contemporaries.
- For example, Adolphe Brongniart is regarded as the father of paleo-botany because he carried the theme of climate and vegetation into interpretations of the fossil record

- From his studies, the use of plants as indicators of past climates became the basis of new discipline, paleo-climatology.
- One of the great conceptual achievements of the early period was the law of the minimum, lucidly presented by Justus Liebig in 1840.
- Simply stated that, the distribution of an organism is restricted by one particular basic requirement for life that is critically limiting. e.g. a foodstuff, a mineral, water, light, or temperature.

- During this period, the study of animal distribution(Zoo-biogeography) lagged behind phyto-biogeography.

- Two important factors contributed for the delay:
  i. Because of the much greater number of animal species (about half of the 1.6 million described species are insects)--the task of describing and classifying animal life several times greater than for plants offering huge challenges for identifying the general pattern.
  ii. The relationships between animal distributions and climate are mostly indirect, in fact, distributions of animals more often closely associated with vegetation than with climate.

- Virtually all of the early bio-geographers had noted three basic patterns

1. All taxa are endemic or restricted to particular areas;

2. Certain kinds of organisms tend to occur together, providing a basis for dividing the earth into biotic regions or provinces; and

3. Similar kinds of plants and animals sometimes occur in widely separated areas.

The Darwinian period

- Four English scientists were responsible for revolutionizing concerning with the origin and distributions of species.

i. Charles Lyell initiated the stage for this drama in his publication of Principle of Geology in 1830.

- Lyell pictured the physical world as one gradually changing through the cons of time, responding to timeless and predictable physical processes.

ii. With a copy of this first volume, Charles Darwin set sail in 1831 on a five year surveying voyage aboard H.M.S Beagle as a scientist and gentleman companion for its captain, Robert Fitzroy.

- Darwin studied
  - ✓ geology,
  - ✓ native plants and animals,
  - ✓ indigenous peoples, and
  - ✓ domesticated animals during the journey in an attempt to understand the order of life.

- During the voyage of the Beagle, Darwin was intrigued and perplexed by the patterns he observed the fossils of the extinct beasts in Argentina, the presence of Scashells at high elevation in Andes, and the occurrence of unique forms of life on islands.

- The pattern of variability in the Galapagos Archipelago(in Equador), in which different species or races of tortoises and finches inhabit different islands, inspired him to the idea that geographic isolation facilitates inherited changes within and between populations.

- On his return to England, Darwin developed his theory of evolution, invoking natural selection as the primary mechanism by which new forms of life arose and are still arising today.

iii. But A.R. Wallace has been considered the father of zoogeography because he produced three massive works (1869, 1876, and 1880) that synthesize the basic concepts and tenets of zoogeography using the theory of natural selection.

- Wallace contributed immense knowledge on the biota of the East Indies and was the first person to analyze faunal realms based on the distribution of many groups of terrestrial animal.
- A distinctive original contribution was his observation of a sharp faunal gap between the islands of Bali and Lombok in the East Indies, where many species of Southeast Asia reach their distributional limit and are replaced forms from Australasia (Wallace, 1860).
- This break is called Wallace's line---a hypothetical boundary marking b/n these zoogeographical regions.

iv. A fourth great British contributor was Joseph Dalton Hooker, who was perhaps the world's most ambitious plant collector.

- At the age of 22, he became an assistant surgeon and botanist on an expedition to the Antarctic region led by Sir James Clark Ross(the discoverer of the Magnetic North pole).

- He developed the important concept of long distance dispersal to account for occurrence on remote islands of those plants with easily dispersed seeds and fruits, and it was with this philosophy in mind that Hooker interpreted the vegetation of the Galapagos Archipelago, mainly based on specimens collected by Darwin.

Biogeography since the early 1960s

During this period, four major areas of research have revitalized biogeography in the last 20 years;

1. acceptance of plate tectonics,
2. development of new phylo-genetic methods,
3. explorations of new ways of conducting research in ecological biogeography, and
4. investigations of the mechanisms limiting distributions.

- Plate tectonics and continental drift, first introduced by Alfred Wegener in1912, became widely accepted by bio-geographers in the late 1960s and early 1970s when evidence for the process became irrefutable.
- Thus, these evidences are revolutionized historical biogeography and require authors to rethink about many distributions of geographic patterns.
- Changes in the relative sizes and positions of landmasses and oceans have resulted in important movement of biota**.**
- This explanation must eventually be consistent with the geologic history of the earth's surface.

- Phylo-genetic research was transform from a discipline that discussed general similarities among taxa to one in which the degree of relationship of one species to another is carefully stated and quantified.
- In the mid 1800s, Asa Gray pioneered research on plant disjunctions, where two closely related species are widely separated spatially.

- With new phylo-genetic approaches in land,
  i. the study of disjunction of species, now called vicariantes, has taken a central position, particularly in zoological research, and
  ii. some of the older phylogenic and bio-geographic classifications are being tested and sometimes greatly revised.

- Up to the 1960s, emphasis in biogeography had been an evolutionary and historical one, emphasizing phylogeny of groups and their means of dispersing into and surviving in different areas and habitats.

1.3. Origin and Evolution of Life

Brainstorming

How is life originated on the surface of Earth?

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What is Life?

- Probably the best place to begin our discussion of the Earth's biogeography is to answer the following question.
- What is life?
- While the reply to this question may appear simple, scientists have actually spent considerable time pondering this problem.
- In fact, many scientists would suggest that we still do not have a clear definitive answer to this question.
- Part of this problem is related to the existence of viruses and other forms of microscopic things.
- Some scientists define viruses as very complex organic molecules, while others suggest they are the simplest form of life.
- Molecular biologist, Daniel E. Koshland Jr (March 22, 2002), in Science journal was asked to write a special essay where he would set out to define life.
- In this article, he suggested that something could be considered "alive" if it meets the following seven conditions.

1. Living things must have a program to make copies of them from generation to generation—reproduction.

    - In most living systems, the program of life is encoded in DNA(deoxyribonucleic acid which carries genetic information).

2. Life adapts and evolves in step with external changes in the environment.
    - This process is directly connected to life's program through mutation and natural selection.
    - This condition allows life-forms to be optimized for gradual changes in the environment.

3. Organisms tend to be complex, highly organized, and most importantly have compartmentalized structures (a separate section).

    - Chemicals found within their bodies are synthesized through metabolic processes into structures that have specific purposes.
    - Cells and their various organelles are examples of such structures.
    - Cells are also the basic functioning unit of life.
    - In multi-cellular organisms, cells are often organized into organs to create higher levels of complexity and function.

4.Living things have the ability to take energy from their environment and change it from one form to another.

What is the function of this energy?

- This energy is usually used to facilitate their growth and reproduction.
- We call the process that allows for this facilitation metabolism(the chemical processes that occur within a living organism to maintain life)

5. Organisms have regeneration systems that replace parts of themselves that are subject to wear and tear.
    - This regeneration can be partial or it can involve the complete replacement of the organism.
    - Complete replacement is necessary because partial replacements cannot stop the unavoidable decline in the functioning state of the entire living system over time.
    - In other words, all organisms degrade into a final non-functioning state; we call it death.

6. Living creatures respond to environmental stimuli through feedback mechanisms.

    - Cues from the environment can cause organisms to react through behavior, metabolism, and physiological change.
    - Further, responses to stimuli generally act to increase a creature's chance for day-to-day survival.

7. Organisms are able to maintain numerous metabolic reactions even in a single instance in time. Living things also keep each of these reactions separated from each other.

Organization of Life

- Scientists have recognized that life can be organized into several different levels of function and complexity.
- These functional levels are:
    i. species,
    ii. populations,

iii. communities, and

iv. ecosystems.

Species

- A species is a group of interbreeding organisms that do not ordinarily breed with members of other groups.
- If a species interbreeds freely with other species, it would no longer be a distinctive kind of organism.
- This definition works well with animals.
- However, in some plant species fertile crossings can take place among morphologically and physiologically different kinds of vegetation.
- In this situation, the definition of species given here is not appropriate.

Populations

- A population comprises all the individuals of a given species in a specific area or region at a certain time.
- Its significance is more than that of a number of individuals because not all individuals are identical.
- Populations contain genetic variation within themselves and between other populations.
- Even fundamental genetic characteristics such as hair color or size may differ slightly from individual to individual.
- More importantly, not all members of the population are equal in their ability to survive and reproduce.

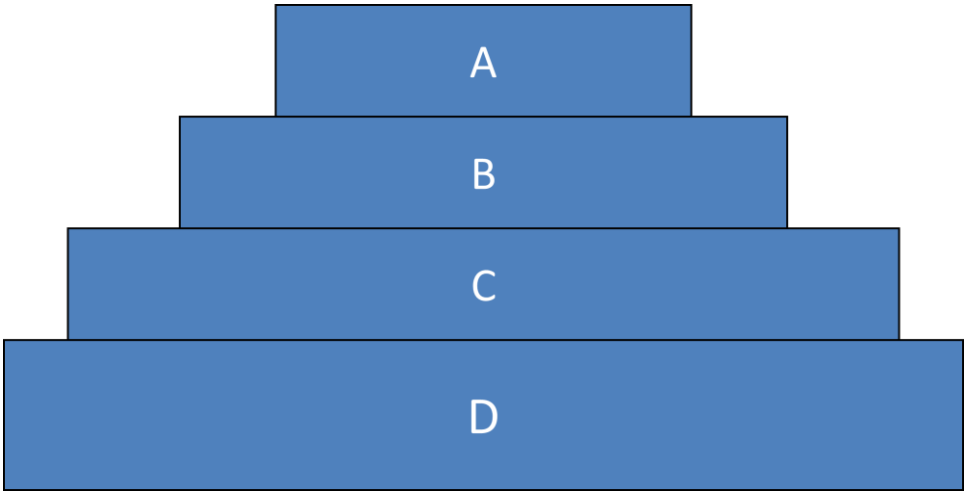
Communities

- Community refers to all the populations in a specific area or region at a certain time.
- Its structure involves many types of interactions among species.
- Some of these interactions involve:

i. the acquisition and use of food, space, or other environmental resources.

ii. nutrient cycling through all members of the community and

iii. mutual regulation of population sizes.



Level D = producers

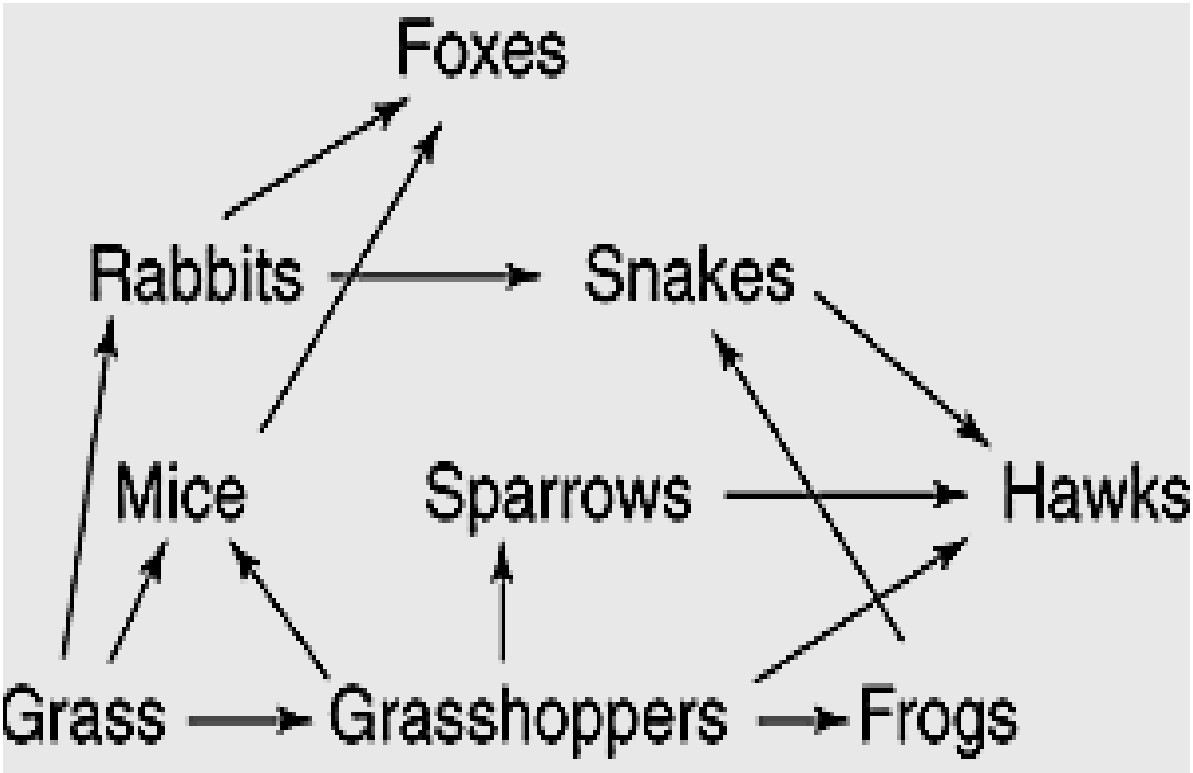
level C = primary consumers

level B= secondary consumers

level A = tertiary consumers.

- In all of these cases, the structured interactions of populations lead to situations in which individuals are thrown into life or death struggles.

- In general, ecologists believe that a community that has a high diversity is more complex and stable than a community that has a low diversity.
- This theory is founded on the observation that the food webs of communities of high diversity are more interconnected.
- Greater interconnectivity causes these systems to be more resilient to disturbance.
- If a species is removed, those species that relied on it for food have the option to switch to many other species that occupy a similar role in that ecosystem. In a low diversity ecosystem, possible substitutes for food may be non-existent or limited in abundance. For example, in the food web presented below, hawks would have many alternates than the others



Ecosystems

- Ecosystems are dynamic entities composed of the biological community and the abiotic environment.
- An ecosystem's abiotic and biotic composition and structure is determined by the state of a number of interrelated environmental factors--

  -nutrient availability,

  -temperature,

  -light intensity,

  -grazing intensity,

  -fire

  -population density.
- Changes in any of these factors will result in dynamic changes to the nature of these systems.
- For example, a fire in the temperate deciduous forest completely changes the structure of that system.
- it destroys large trees,
- most of the mosses, herbs, and shrubs that occupy the forest floor are also destroyed, and
- the nutrients that were stored in the biomass are quickly released into the soil, atmosphere and hydrologic system.
- After a short time of recovery, the community that was once large mature trees now becomes a community of grasses, herbaceous species, and tree seedlings.

Chapter Two

2. Energy Flow and Nutrient Recycling in Ecosystems

Introduction

- Energy "flows" through the ecosystem in the form of carbon-carbon bonds.
- When respiration occurs, the carbon- carbon bonds are broken and the carbon is combining with oxygen to form carbon dioxide.

- The breakdown of the carbon bond releases energy, which is either used by the organisms (to move the molecules, digest its food, excrete wastes, think, etc.) or the energy may be lost as heat.
- All the energy in ecosystem comes from the sun, and that the ultimate fate of all energy in ecosystem is to be lost as heat.
- Energy does not recycle; it flows.

- In terms of nutrients, the autotrophs obtain the inorganic nutrients (phosphorus, sulphur, etc.) from the inorganic nutrient pools, which is usually the soil or water
- These inorganic nutrients flow from organism to organism,(as an organism eats another organism).
  Eg. Soil/water---plants---grasshoppers
- Ultimately, all organisms die and become detritus, food for the decomposers.
- At this stage of the ecosystem, the last energy is extracted (and lost as heat) and the inorganic nutrients are return to the soil or water to be used up again.
- The inorganic nutrients are recycled, but the energy is not recycled.

2.1. What is Ecosystem?

Brainstorming

How do you define an ecosystem?

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- An ecosystem is a more or less independent part of the biosphere, for instance it includes forest, lake, river, grassland, and an ocean.

- Ecosystem has conveniently divided into two parts, which are
  i. the place (habitat) and
  ii. the living things (community).
- It is difficult to think of one without the other: e.g., an oak forest is an ecosystem, but if you take away the community of animals and plants, there would be no oak trees, so the habitat would not be the same.
- A habitat is a place in which you find living things(animals and plants).
- The kinds of animals and plant that can live in a habitat obviously depend upon what the habitat is looks like.
- Is it very hot or cold?
- Is it very wet or dry?
- Is the soil very acid or alkaline?
- These are the climatic and edaphic factors.
- It also depends upon what other animals and plants live there(biotic factors).
- Example, large trees like oak trees may provide shelter for animals against extremes of climate, but they could also prevent some plants from getting enough light for photosynthesis.

- Different animals and plants will affect each other by competition, predation, grazing, sheltering and so on.

- Therefore, the concept of ecosystem is interactions of organisms with each other.
- On the water, terrestrial organisms are depend on food; birds prey on fish and from some other communities.
- In other words, the basic central idea in ecosystem is the functioning that synthesis energy and the cycling of materials, i.e. organic materials are form due to photosynthesis- transfer in the form of energy from one group to the other.
- Synthesis began when plants (photosynthesis) began to build up organic material.
- The whole ecosystem concept lies on energy is bound and energy is released.

Explain briefly the central concept of ecosystem?_____

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2.2. The structure of ecosystem

Brainstorming

What is the structure of an ecosystem?

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- A type of organisms found in a particular ecosystem and the pattern of interrelationships among organisms make the structure of the ecosystem.
- It has two components:
  i. biotic and
  ii. abiotic.
- Abiotic components include;
  -energy,
  -water,
  -chemicals in the soil,
  -climate etc.
- Biotic involves three categories
  i. producers are those plants which synthesis organic materials
  ii. consumers are herbivores, carnivores and omnivores
  iii. Decomposers are also consumers but they consume on dead, routine, and decayed materials;
- They break down the bonds of the material and release nutrients, which is the most essential part of the ecosystem.
- There are certain bacteria, which have certain wavelength, which produce organic materials, are known as chemosynthetic bacteria.
- Generally, interacting species have a tremendous influence on the size of each other's populations.
- Biotic factors also regulate the size of populations more intensely.
- Finally, the influence of biotic interactions can occur at two different levels.
  i. Inter-specific effects are direct interactions between species, and
  ii. the intra-specific effects represent interactions of individuals within a single species.

Neutralism

- Neutralism is the most common type of inter-specific interaction.
- Neither population directly affects the other.

- An example of neutralism would be the interaction between rainbow trout and dandelions living in a mountain valley.

Competition

- When two or more organisms in the same community seek the same resource (e.g., food, water, nesting space, ground space), which is in limiting supply to the individuals seeking it, they compete with one another. *Competition: occurs when two different species or organisms living in the same environment (habitat) utilize the same limited resources, such as food, water, space, light, oxygen, and minerals*

If the competition is among members of the same species, it is called intra-specific.

- Competition among individuals of different species, it is referred to as inter-specific competition.
- Individuals in populations experience both types of competition to a greater or lesser degree.
- Competition may be the result of two different processes:
  i. exploitation or
  ii. interference.

- Competition by exploitation
  - The exclusion of one organism by another. If two different species compete for the same food source or reproductive sites, one species may be eliminated. This establishes one species per niche in a community—it is called competitive exclusion Principle
  - Resource exploitation, however, does not always cause the exclusion of a species from a community.
  - Competition by interference occurs when an individual directly prevents the physical establishment of another individual in a portion of a habitat.
  - Example, established plants can preempt the invasion and colonization of other individuals by way of dense root mats, peat and litter accumulation, and mechanical abrasion.

Amensalism

- Amensalism is an interaction where one species suffers and the other interacting species experiences no effect.
- One particular form of amensalism is allelopathy which occurs with plants.
- Allelopathy involves the production and release of chemical substances by one species that inhibit the growth of another.
- Allelopathic substances range from acids to bases to simple organic compounds.
- All of these substances are known under the general term: secondary substances.
- Secondary substances are chemicals produced by plants that seem to have no direct use in metabolism.
- A good example of a secondary substance is the antibiotic juglone which is secreted by Black Walnut (Juglans nigra) trees.
- This substance is known to inhibit the growth of trees, shrubs, grasses, and herbs found growing near Black Walnut trees.
- In the chaparral vegetation of California, certain species of shrubs, notably Salvia leucophylla (mint) and Artemisia californica (sagebrush) are known to produce allelopathic substances.
- Often these chemicals accumulate in the soil during the

dry season reducing the germination and growth of grasses and herbs in an area up to 1 to 2 meters from the secreting plants.

Mutualism

- Mutualism is the name given to associations between pairs of species that bring mutual benefit.
- The individuals in the populations of each mutualism species grow and/or survive and/or reproduce at a higher rate when in the presence of individuals of the other species.
- For example, most rooting plants have mutuality associations with fungal mycorrhizae.
- Mycorrhizae increase the capability of plant roots to absorb nutrients like nitrogen and phosphorus.
- In return, the roots of the host provide support and a constant supply of carbohydrates for consumption.
- Mutuality interactions between species can be of two types:
  i. symbiotic or
  ii. non-symbiotic.
- In a symbiotic mutualism, individuals interact physically and their relationship is biologically essential for survival.
- At least one member of the pair cannot live without close contact with the other.
- For example, the fungal-algal symbiosis that occurs in lichens.
- The morphological structure of a lichen is a mass of fungal hyphae that forms around a small colony of algae cells.
- In this mutualism, the alga produces carbohydrates and other food by products through photosynthesis and metabolism, while the fungus absorbs the required minerals and water to allow for these processes to occur.
- More common in nature is the non-symbiotic mutualism.
- In this interaction, the mutualisms live independent lives yet cannot survive without each other.

- Example of an interaction of this type is the relationship between flowering plants and their insect pollinators.
- In this interaction, the flower becomes pollinated by the insect, while the bee receives food in the form of pollen and nectar.

Predation, Parasitism, and Pathogens

- Pathogens, parasites, and predators obtain food at the expense of their hosts and prey.

- Predators tend to be larger than their prey and consume them from the outside.
- A parasite or pathogen is smaller than its host and consumes it either from the inside or from the outside of the organism.
- It is easy to believe that the predator-prey interaction is somehow detrimental(harmful) to the prey population.

- The population sizes of predator and prey species are inter-regulated by delicate feedback mechanisms that control the densities of both species.
- Sometimes predator species can drive their prey into localized extinction.
- In complex communities, this does not have particular harm to the predator if several other species exist as alternative prey.

List down the components of the structure of ecosystem?

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Forms of energy

- Nuclear energy(from uranium)
- Geothermal energy(from inside of the earth)
- Solar energy(from the sun)
- Fuel energy(from petroleum, coal and natural gas)
- Chemical energy(from food)

Sources of energy

- Fossil fuels(petroleum, coal, natural gas)
- Alternative energy sources(solar, nuclear, geothermal)

2.3. Energy Flow in Ecosystem

Brainstorming

How energy flows in an ecosystem?

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- The flow of energy through life is not an endless cycle.
- Energy flows from the sun to the plants to the plant eaters to the meat eaters.

- As energy moves up the food chain there is less and less amount of energy transfer to the higher animals along the food chain.

  Activity

  Describe what happens to the solar energy that reaches the earth from the sun?

- Most of the solar energy that falls on the earth is not used by plants.
- It bounces back to

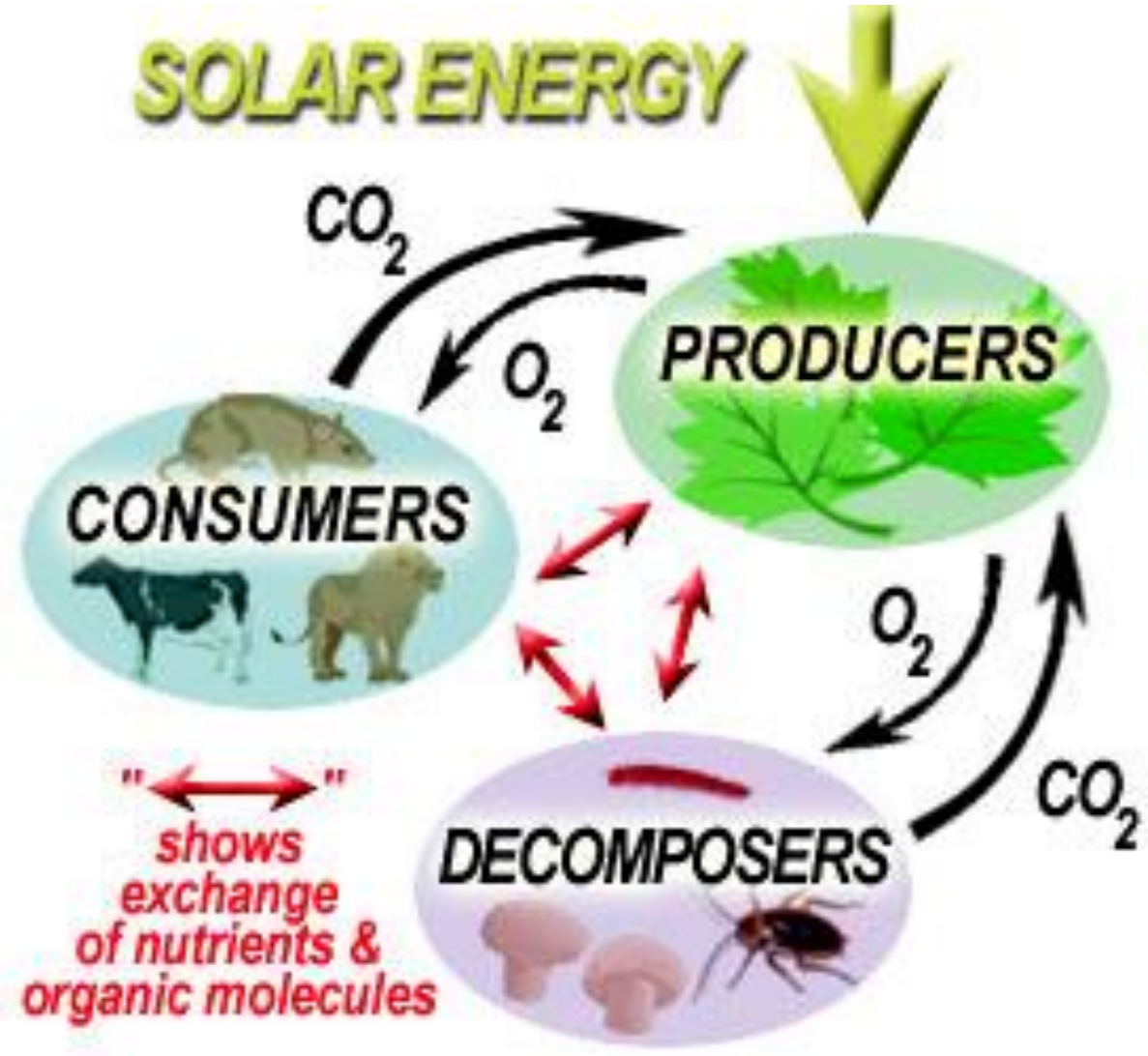
space or heats the air, oceans, and ground, and makes weather, among other things.

- Little bit of the solar energy that hits the earth is used by plants.
- The herbivores only get a little bit of the energy that hits the plants.
- The carnivores and decomposers only get a little bit of the energy that was eaten by the herbivores.
- Most of the plant energy that is consumed by herbivore is used by that herbivore to keep itself eating, breathing, walking, and staying warm.

- Only a little bit is left over for the carnivore or decomposer that eats the herbivore.

What would happen if the sun stops generating energy?

- We need fresh sunshine everyday and new plants have to keep growing.
- Otherwise the whole amazing system would quickly run out of energy and everything alive would come to a **"**dead**"** stop.



The flow of energy level

- The pathways of energy through the living components of an ecosystem are represented by food chains and food webs.

1) Primary Producers:

- Green plants and certain types of bacteria and algae are the primary producers because they are the ones that produce usable energy for the rest of the living organisms on earth.

- They use energy from the sun to make sucrose, glucose, and other compounds that other life forms can eat and "burn" for energy.
- In each of the sugar molecules a little bit of the sun's energy is stored in a form that we can call chemical energy.
- But it might better be called "potential energy" since it is a sort of "doing-nothing- for-now-waiting-to-happen" kind of energy

2) Herbivores

- Herbivores are the plant eaters.
- They have the ability to digest the plants they eat and release the energy stored in the plant cells for their own use.
- Some examples of animals in this group are deer, cows, elephants, rabbits, elks, zebras, most insects, and birds that eat fruit and seeds.
- Sometimes scientists call this level of the food chain the primary consumers (sounds like economics class)

3) Carnivores

- These guys are the meat eaters.
- Predators and scavengers are in this group.
- Sometimes this level in the food chain is referred to as the secondary consumers.
- They eat the guys that eat the plants and sometimes they eat each other.
- Most of these animals can't eat plants at all.

- They have got the glamour job but they are really pretty helpless without all the boring plants and herbivores.
- Cats and dogs, killer whales, sharks, spiders, snakes, wolves, vultures, hawks, eagles, crocodiles are in this group.

4) Decomposers - are the opposite of composers.

- They are the guys that eat up dead bodies - both plant and animal.
- This group of useful critters is mostly bacteria and fungus.
- Without them there would be a lot of dead bodies lying around.
- They're like carnivores and herbivores, because they also have to get their energy from the cells of animals or plants.
- The difference is they prefer their food dead - very dead.
- The stages of food transfer at each stage are called trophic level.
- At each stages of food transfer the chain or web potential energy is lost through digestion of organic material resulting to a continual diminishing of available energy.

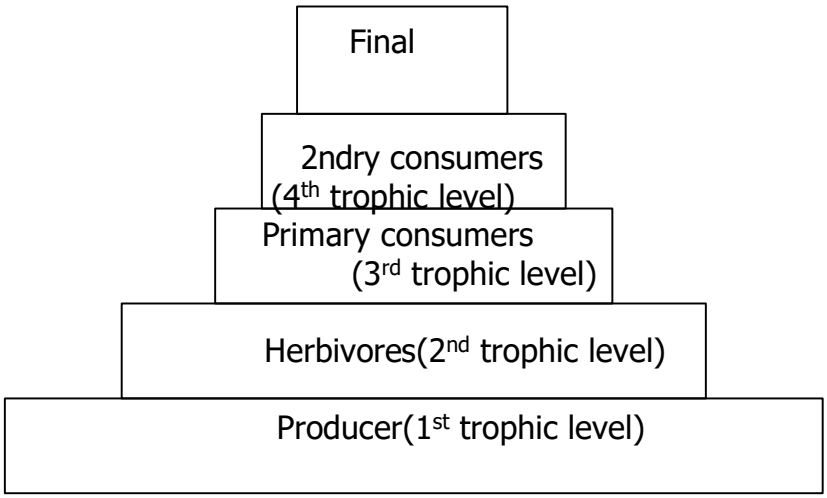


Fig. Normal Pyramid Number

- Pyramid number shows the decline of energy at every successive stage.
- This is called normal pyramid number.
- **The pyramid of biomass** tells as how much kilograms of energy stored on the primary organisms.
- Is the amount of energy stored in the bottom is greater than that of the top which shows the second law of energy.
- The amount of energy increases from the top to bottom.
- In the pyramid of energy we measure the amount of energy transferred between trophic levels.
- Or it measures the amount of energy utilized by different organisms over a sample area per a set of area example 1 meter square per one *year.*
-

Activity

Describe the flow of energy in ecosystem?

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- Flow of energy follows a down-hill process.
- Producers are linked with the consumers by the flow of energy.
- It is a uni-cyclical process which cannot be backed again but in the matter cycle which can be circulated.

*Explain in detail phrases such as trophic level, pyramid of biomass and pyramid of energy?*____

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_____

2.4. Biogeochemical Cycle

Brainstorming

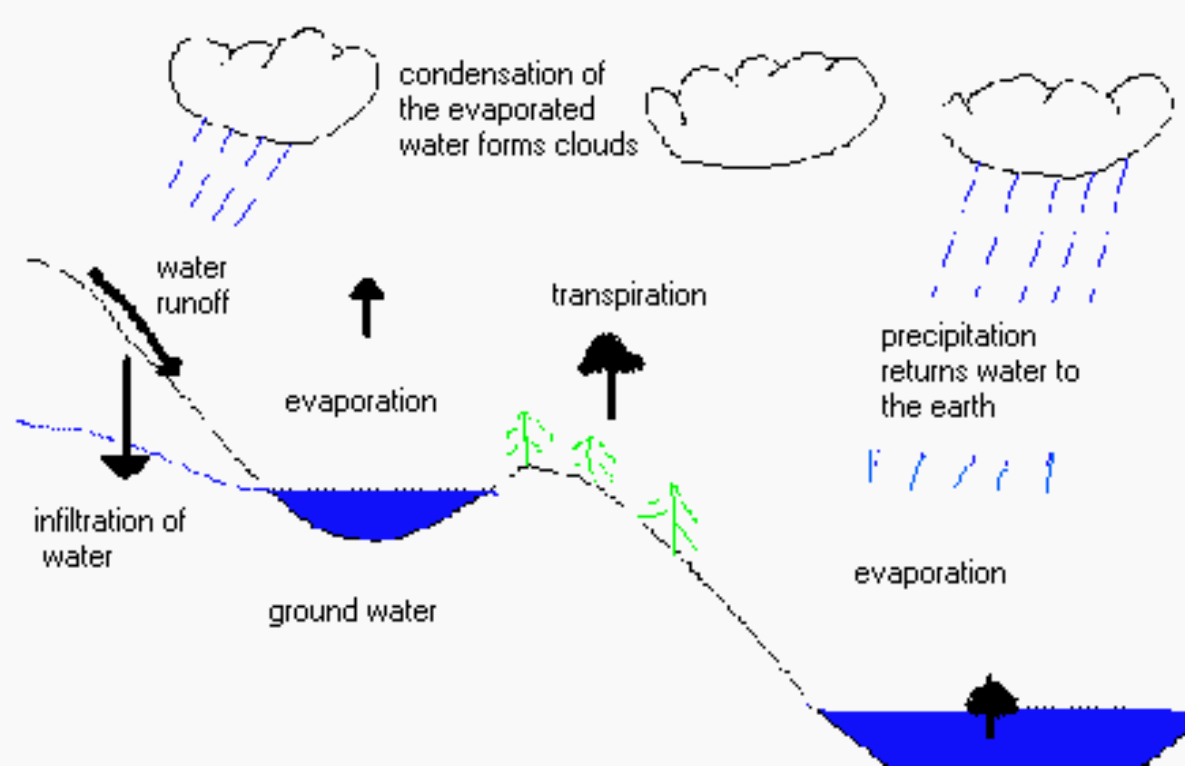
Write what you know about the biogeochemical cycle?

- We have already seen that while energy does not recycle through an ecosystem, chemicals do.
- Since the inorganic chemicals get recycled through both the biological and the geological world, we call the overall cycle's biogeochemical cycles.
- Each chemical has its own unique cycle, but all of the cycles do have something in common.
- Reservoirs are those parts of the cycle where the chemical is held in large quantities for long periods of time.
- In exchange pools the chemical is held for only short time.
- The length of time a chemical is held in an exchange pool or a reservoir is termed its residence time.
- The oceans are a reservoir for water, while a cloud is an exchange pool.
- Water may reside in an ocean for thousands of years, but in a cloud for a few days only.
- The biotic community includes all living organisms.
- This community may serve as an exchange pool and also serve to move chemicals from one stage of the cycle to another.
- For instance, the tree of the tropical rain forest brings water up from the forest floor to be evaporated into the atmosphere.
- The energy for most of the transportation of the chemicals from one place to another is provided either by the sun or by the heat released from the mantle and core of the Earth.
- While all inorganic nutrients have cycle, we will focus only on five of the most important cycles, i.e. water, carbon, oxygen, nitrogen and phosphorus.

The Water Cycle

- **involves the processes of photosynthesis, transpiration, evaporation and condensation, respiration, and excretion**

  - The various earths' water-sources get their supplies from precipitation, while the precipitation in itself is evaporation from these sources.
  - Water is lost to the atmosphere as vapor from the earth, which is then precipitated back in the form of rain, snow, hail, sleet or frost, etc. this precipitation and evaporation continues forever, and thereby a balance is maintained between the two.
  - This process is known as hydrologic cycle and shown in fig


condensation of
the evaporated
water forms clouds
water
runoff
transpiration
evaporation
precipitation
returns water to
the earth
infiltration of
water
ground water
evaporation

The Carbon Cycle

- All life is based on the element carbon.
- Carbon is the major chemical constituent of most organic matter, from fossil fuels to the complex molecules (DNA and RNA) that control genetic reproduction in organisms.
- *The RNA directs two processes—protein synthesis and replication (the process by which RNA copies itself). In cellular organisms, another type of genetic material, called deoxyribonucleic acid (DNA), carries the information that determines protein structure. But DNA cannot act alone and relies upon RNA to transfer this crucial information during protein synthesis*

- Yet by weight, carbon is not one of the most abundant elements within the Earth's crust.
- In fact, the lithosphere is only 0.032 % carbon by weight.
- The concentration of carbon in living matter (18%) is almost 100 times greater than its concentration in the earth (0.19%), i.e. living things exact carbon from their nonliving environment.
- For life to continue, this carbon must be recycled.
- From biological point of view, the key events in the carbon cycle are the complimentary reactions of respiration and photosynthesis.
- Respiration takes place carbon dioxide and water produces carbohydrate and oxygen.
- The outputs of respiration are inputs of photosynthesis, and the outputs of photosynthesis are the inputs of respiration.
- The reactions are also complimentary in the way they deal with energy.
- Photosynthesis takes energy from sun and stores it in carbon-carbon bonds of carbohydrates whereas respiration releases that energy.

- Both plants and animals carry on respirations, but only plants can carry on photosynthesis.
- The chief reservoirs for carbon dioxides are in the oceans and in rock.
- Carbon dioxide dissolves readily in water.

- Once there, it may precipitate as a solid rock known as calcium carbonate (limestone).
- Corals and algae encourage this reaction and build up limestone reefs in the process.
- On land and in the water, plants take up carbon dioxide and convert it into carbohydrates through photosynthesis.
- This carbon in the plants now has three possible fates.
  i. It can be librated to the atmosphere by the plant through respiration;
  ii. it can be eaten by an animal, or
  iii. it can be present in the plant when the plant dies.
- Animals obtain all their carbon through their food, and thus, all carbon in biological systems ultimately comes from plants (autotrophs).
- In the animal, the carbon also has the same three possible fates.
- Carbon from plants or animals that is released to the atmosphere through respiration will either be
  i. taken up by a plant in photosynthesis or
  ii. dissolved in the ocean.
- When an animal or plant dies, two things can happen to the carbon in it.
  i. It can either be respired by decomposers, or
  ii. it can be buried intact and ultimately form coal, oil, or natural gas.
- The fossil fuels can be mined and burned in the future; releasing carbon dioxide into the atmosphere.
- Otherwise, the carbon in the limestone or other sediments can only be released to the atmosphere when
  i. they are sub ducted and brought to volcanoes, or
  ii. pushed to the surface and slowly weathered away.

What will be the impact of humans on the carbon cycle?

- Humans have a great impact on the carbon cycle because when we burn fossil fuels more carbon dioxide goes into the oceans, and more is present in the atmosphere.
- The latter condition causes global warming, because this carbon dioxide in the atmosphere allows more energy to reach the Earth from the sun than it allows escaping from the Earth into space.

The Oxygen Cycle

- The carbon cycle explained earlier covers the oxygen cycle also because these atoms are often combined.
- Oxygen is present in the carbon dioxide, carbohydrates and water.
- Oxygen is released to the atmosphere by autotrophy during photosynthesis and takes up by both autotrophs and heterotrophs during respiration.
- All the oxygen in the atmosphere is biogenic, i.e. it was released from water through photosynthesis by autotrophs.
- It took about two billion years for autotrophs (mostly cyanobacteria) to raise the oxygen content of the atmosphere to the current 21 %.
- This opened the door for complex organisms such as multi-cellular animals, which need a lot of oxygen.
- This in turn enabled the evolution of complex organisms such as animals and human beings.
-

The Nitrogen Cycle

- It is another most important nutrient cycle found in terrestrial ecosystems.
- Nitrogen is used by living organisms to produce a number of complex organic molecules like amino acids, proteins, and nucleic acids.

  Major stores of nitrogen;

  i. atmosphere (largest reservoir)--it exists as a gas (mainly N_2).

- This storage is about one million times larger than the total nitrogen contained in living organisms.

  ii. It also stores as organic matter in the soil and the oceans.

- Despite its abundance in the atmosphere, nitrogen is often the most limiting nutrient for plant growth.

The nature of nitrogen cycle

- The nitrogen cycle is one of the most difficult of the cycles to learn, simply because there are so many important forms of nitrogen, and because organisms are responsible for each of the inter-conversions.

- It takes a lot of energy to get nitrogen gas to break up and combine with other things, such as oxygen.

Nitrogen fixation

- Nitrogen gas can be taken from the atmosphere in two basic ways.

  i. First, lightning provides enough energy to "burn" the nitrogen and fix it in the form of nitrate(NO_3) which is nitrogen.

- This process is duplicated in fertilizer factories to produce nitrogen fertilizers.

  ii. The other form of nitrogen fixation is by nitrogen fixing bacteria, which use special enzymes instead of the extreme amount of energy in lightning to fix nitrogen.

What are these nitrogen fixing bacteria?

- These nitrogen fixing bacteria come into three forms:

i. some are free living in the soil;

ii. some form symbiotic, mutualitstic associations with the roots of bean plants and other legumes (rhizobia bacteria); and

iii. photosynthetic cyanobacteria (blue green algae) which are found most commonly in water.

- All of these fix nitrogen, either in the form of nitrate or in the form of ammonia.
- Most plants can take up nitrate and convert it into amino acids.

How do animals acquire amino acids?

- Animals acquire all of their amino acids when they eat plants or other animals.

- *When plants or animals die or release waste the nitrogen is returned to the soil.*

  What is that waste called?

- The usual form of nitrogen returned to the soil in animal wastes or in the output of the decomposers, is ammonia.
- Ammonia is rather toxic, but there are nitrite bacteria in the soil and in the water which take up ammonia and convert it to nitrite.

However, nitrite is also toxic, but another type of bacteria, the nitrate bacteria, takes nitrite and converts it to nitrate, which can be taken up by plants to continue the cycle.

Short summary of nitrogen cycle

- Nitrates (used by plants)
- Build plant proteins
- Eaten by animals
- made into animal proteins
- Plants and animals die
- bacteria decay
- Ammonia (NH3)
- Nitrifying Bacteria
- Nitrates (used by plants)

Phosphorus Cycle

- In nature, phosphorus in the form of phosphate is present in rocks.
- When rock with phosphate is exposed to water (especially water with a little acid in it), the rock is weathered out and goes into solution.
- Autotrophs take this phosphorus up and use it in a *variety of ways.*
- *It is an important constituent of cell membranes, DNA, RNA and ATP*

- Heterotrophs (animals) obtain their phosphorus from the plants they eat.
- However, one type of heterotrophy, the fungi, excel at taking up phosphorus and may form mutualistic, symbiotic relationships with plant roots.
- These relationships are called mycorrhizae; plants get phosphate from the fungus and give the fungus sugar in return.
- Animals may also use phosphorus as components of bones, teeth and shells.
- When animals or plants die, the phosphate will be returned to the soil or water by the decomposers.
- There, it can be taken up by another plant and used it again

- Two types of animals play in the cycle of phosphorus.
  i. Humans
- Humans often mine rock rich in phosphorus; the phosphate is then used as fertilizer.
- This mining of phosphate and use of the phosphate as fertilizer greatly accelerates the phosphorus cycle and may cause local overabundance of phosphorus particularly in coastal regions, at the mouth of rivers, and any place where there is a lot of sewage released into the water.
  ii. The other animal that play a unique role in the phosphorus cycle are marine birds.
- The birds take phosphorus containing fish out of the ocean and return to land, where defecate, their guano contains high levels of phosphorus and in this way marine birds return phosphorus from *the ocean to the land.*

Define biogeochemical cycle? Elaborate the process of carbon cycle, water cycle, nitrogen cycle, phosphorus cycle and oxygen cycle?

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Summary

Ecosystems

Ecosystems are conveniently divided into two parts which are the place (habitat) and the living things (community).

A habitat is a place in which you find animals and plants. The kinds of animals and plants which can live in a habitat obviously depend upon what the habitat is looks like.

The community consists of all the animals and plants living in one habitat. Different animals and plants will affect each other by competition, predation, grazing, sheltering and so on.

The concept of ecosystem is interactions of organisms in the biophysical environment, i.e. the functioning in synthesis of energy and the cycling of materials

Structure of the ecosystem

A type of organisms found in a particular ecosystem and the pattern of inter relationships among organisms make the structure of the ecosystem. It has two components:

Biotic: producers ,decomposers and consumers

Abiotic: water, chemicals in the soil.

Flow of energy

The flow of energy through life is not an endless cycle. The energy doesn't go round and round getting used over and over again and never wearing out.

As energy moves up the food chain there is less and less amount of energy transfer to the higher animals along the food chain.

In the pyramid of energy we measure the amount of energy transferred between trophic levels.

Biogeochemical cycle

Biogeochemical cycle is the processes whereby in the ecosystem the biotic and abiotic environmental factors and their interaction between them are taking place.

Carbon dioxide is used by plants in photosynthesis to make carbohydrates. When animals eat plants, these carbohydrates are turned into animal carbohydrates e.g. glycogen. Eventually all animals and plants die and when bacteria or fungi decompose them, the carbon are returned to the atmosphere as carbon dioxide.

Nitrogen is also recycled by nature. Plants use nitrates from the soil to make proteins. Animals get their proteins by eating plants. Dead animals and plants release ammonia when they are decomposed. Nitrifying bacteria in the soil convert ammonium ions into Nitrate ions so completing the cycle

Chapter Three

3. Living organisms and the environment

Introduction

Individual, species, and populations both marine and terrestrial, tend to live in particular places. These places are called habitat. Each habitat is characterized by a specific set of environmental conditions- radiation light, temperature, moisture, wind fire frequency and intensity, gravity, salinity, currents, topography, soil, substrates, geomorphology, human disturbance, and so forth.

A place to live: habitats

Habitats come in all shapes and sizes, occupying the full sweep of geographical scales. They range from small (micro habitats), through medium (microhabitats) and large (mega habitats). Microhabitats are few square centimeters to a few meters in area. They include leaves, the soil, lake bottoms, sandy beaches, talus slopes, walls, river banks and

paths. Meso-habitats have areas up to about 10000 km^2 which is the size of Cheshire, England. Each main meso-habitat is influenced by the same regional climate, by similar features of geomorphology and soils, and by a similar set of disturbance regimes. Deciduous

woodland caves, and streams are examples. Macro-habitats have area up to about 1 million km^2 which is about the size of Ireland. Mega-habitats are regions more than in million km^2 extent. They include continents and the entire land surface of the Earth. Landscape

ecologists, who have an express interest in the geographical dimension of ecosystems, recognize three level of 'habitat'-region, landscape, and landscape element.

Landscape elements

*Landscape elements are similar to micro-habitats, but a little larger. They are fairly uniform pieces of land, no smaller than about 10 m, which form the building blocks of landscapes and regions. They are also called eco-topes, biotopes, geo-topes, faceis, sites, tesserae, landscape units, landscape cells, and landscape prisms. These terms are roughly equivalent to landscape element, but have they own special meanings. Landscape elements are made up of individual trees, shrubs, herbs and small buildings. There are three basic kinds of landscape element-**patches**, **corridors**, and **background matrixes**.*

1. *Patches are fairly uniform (homogenous) areas that differ from their surrounding.*

   Woods, fields, ponds, rock out crops, and houses are all patches.

2. *Corridors are strips of land that differ from the land to either side. They may interconnect to form networks. Road hedgerows and rivers are corridors.*

3. *Background matrixes are the background ecosystems or land use types in which patches and corridors are set. Examples are deciduous forest and areas of arable cultivation.*

Landscapes

Landscape elements combine to form landscapes. A landscape is mosaic, an assortment of patches and corridors set in a matrix, no bigger than about 10000km^2 it is

heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in similar form throughout.

Regions

Landscape combines to form regions, more than about 10000km^2 in area. They are collections of landscapes sharing the same microclimate.

Habitat Specialists

Habitat specialists have very precise living requirements. In southern England, the red ant, Myrmica subuleti, needs dry heath land with a warm south facing aspect that contains more than 50 percent grass species, and that has been disturbed within the previous decades. Other species are less pernickety and thrive over a wider range of environmental

conditions. The three toed woodpecker (Picoides tridactylus) lives in abroad swath of cool temperate forest encircling the Northern Hemisphere.

Habitate Generalists

A few species manage to eke out a living in a great array of environments. The human species (Homo sapiens) is the champion habitat generalist- the planet Earth is the human habitat. The plant kingdom, the broad leaved plantain (Plantago major), typically a species of grassland habitats, is found almost everywhere except Antarctica and the dry parts of North Africa and the Middle East

Activity

*Identify and explain briefly the three levels of habitat? Compare habitat specialist and habitat generalist?*_____
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3.1. Climatic Factors

Brainstorming

What are the climatic factors affecting the living organisms?

If you take a nice walk up a mountain there comes a point where it is too cold for broad leaf trees like the oak and you find yourself in coniferous forest.

Don't be surprised to find that the animals are also affected by the climate. The climate also has an effect on the soil: if rainfall is high the soil may become waterlogged.

Warm and wet climatic factors

Radiation and light

The sun is the primary source of radiation for the Earth. The visible portion (sunlight) is the effective bit for photosynthesis. It is also significant in heating the environment. Three aspects of solar radiation influence photosynthesis-the intensity, the quality, and the photo period (duration)

The intensity of solar radiation *is the amount that falls on a given area in a unit of time. Watts per square meter or kilo-Jules per hectare are units of measurement. The average annual solar radiation on a horizontal ground surface ranges from about 800 KJ/Ha over a subtropical deserts to less than 300 KJ/Ha in Polar Regions. Equatorial regions receive less radiation than the subtropics because they are cloudier a value of700KJ/Ha is tropical.*

Quality of solar radiation *is its wave length composition. This varies from place to place depending on the compositions of the atmosphere, different components of which filter out different type of the electromagnetic spectrum. In the tropics, about twice as much ultra violate light reaches the ground above 2500M than at sea level.*

Photoperiod *is seasonal variations in the length of day and night. This is immensely important ecologically because day-length, or more usually night length, stimulates the time of daily and seasonal rhythms (breading, migration, flowering, and so on) in many organisms. Short day plants flower when day length is below critical level. Long day plants are flower when day length is above a critical level. The strawberry tree flowers in*

the autumn as the night length increases. Day neutral plants flower after a period of vegetative growth, irrespective of the photoperiod.

In the high Arctic, plant growth is telescoped into a brief few months of warmth and light. Positive heliotropism (growing towards the sun) is one way that plants can cope with limited light.

Temperature

Broadly speaking annual temperatures are the highest at the equator and lowest at the poles. Temperature also decreases with increase elevation. The average annual temperature range is an important ecological factor. It is highest deep in high latitude continental interiors and lowest over oceans, especially tropical oceans. Many aspects of temperature affect organisms, including daily, monthly, and annual extreme and mean temperatures. Different aspects of temperature are relevant to different species and commonly vary with the time of year and the stage in an organism's life cycle. It may also affect competition with other organisms and susceptibility to predation, parasitism, and disease when the limits of temperature tolerance are approached. Many flowering plants are especially sensitive to low temperatures between germination and seedling growth.

Microbes and temperature

Heat-loving microbes (thermophiles) reproduce or grow readily in temperatures over 45^0C. hyperthermophiles, such as sulfalobus, acidocaldarius, prefer temperature above 80^0C, and some thrive above 100^0C. The most resistant hyperthermophile discovered to date is

phyrolobus fumarii, this microbes flourishes in the walls of 'smokers' in the deep-sea floor. It multiplies in temperature up to 113^{0}C.

Cold-loving microbes (psychrophiles) are common in Antarctic sea ice. These communities include photosynthetic algae and diatoms, and a variety of bacteria. Polarmonas vacuolata, a bacterium, grows best at about 4^{0}C, and stops reproducing above

12^{0}C. Lichens can photosynthesize at 30^{0}C, providing that they are not covered with snow.

The redish-colored snow algae, chlamydomonas nivalis, lives on ice and snow fields in the polar and nival zones, giving the landscape a pink tinge during the summer months.

Animals and temperature

In most animals, temperature is a critical limiting factor. Vital metabolic processes are geared to work optimally within a narrow temperature band. Cold blooded animals (poikilotherms) warm up and cool down with environmental temperature. They can assist the warming process a little by taking advantage of sunny spots or warm rocks. Most warm blooded animals (homeotherms) maintain a constant body temperature amidst varying ambient conditions. They simply regulate the production and dissipation of heat. Each homeothermic species has a characteristic thermal neutral zone, a band of temperature within which little energy is expanded in heat regulation. Above the upper critical temperature, animals living in hot environments can lose much heat. Evaporation helps heat lost, but has unwanted side-effect precious water is lost. Small animals can burrow to avoid high temperature at the ground surface.

Plants and temperature

Temperature affects many processes in plants, including photosynthesis, respiration, growth, reproduction, and transpiration. Plants vary enormously in their ability to tolerate either heat or cold. There are five broad categories of cold tolerance. Chilling sensitive plants, which are mostly tropical, are damaged by temperatures lower than 10^0C. Chilling

resistant (frost sensitive) plants can survive at temperature below 10^0C, but are damaged

when ice forms within their tissues. Frost resistant plants make physiological changes that enable them survive temperature as low as below -15^0C. Frost tolerant plants survive by withdrawing water from their cells, so preventing ice forming. Cold tolerant plants, which are mostly needle leaved, can survive any subzero temperature.

Moisture (water)

Protoplasm, the living matter of animals and plant cells, is about 90 percent water-without adequate moisture there can be no life. Water affects land animals and plants in many ways. Air humidity is important in controlling loss of water through the skin, lungs, and leaves. All animals need some form of water in their food or as drink to run their excretory systems. Vascular plants have an internal plumbing system-parallel tubes od dead tissue called xylem-that transfers water from root tips to leaves.

Plants cannot use all precipitation that falls. A substantial amount of the precipitation evaporates and returns to the atmosphere. For this reason, available moisture (roughly the precipitation less evaporation) is a better guide than precipitation to the useable water in a terrestrial ecosystem. Availability of moisture greatly determines soil water levels, which in turn greatly influence plant growth. Without the water, energy will merely heat and stress the plant. Similarly, for a plant to use water for growth, energy must be obtainable. Without an energy source, the water will run into the soil or runoff unused. For this reason, temperature (as a measure of energy) and moisture are master limiting factors that act in tandem. In tropical areas temperatures are always high enough for plant growth and precipitation is the limiting factor. In cold environments, water is usually available for plant growth for most of the year-low temperatures are the limiting factor.

Wet environments

Plants are very sensitive to water levels Hydrophytes are water plants and root in standing water. Helophytes at much plant. Meso-phytes are plants that live in normally moist but not wet conditions. Xerophytes are plants that live in dry conditions.

Dry environments

Plants are very sensitive to drought and aridity poses a problem of survival. Nonetheless species of algae grow in the extremely dry Gobi desert. Higher plants survive in arid conditions by xerophytic adaptations- dry lands support xerophytes.

Activity

List down the different climatic factors and explain each of them in detail?

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3.2. Topographic factors

Brainstorming

How the ups and downs of the surface of the earth affect living organisms?

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Topography *includes the physical features of the earth like altitude, slope, exposure, mountain chains, valleys, plains, etc.*

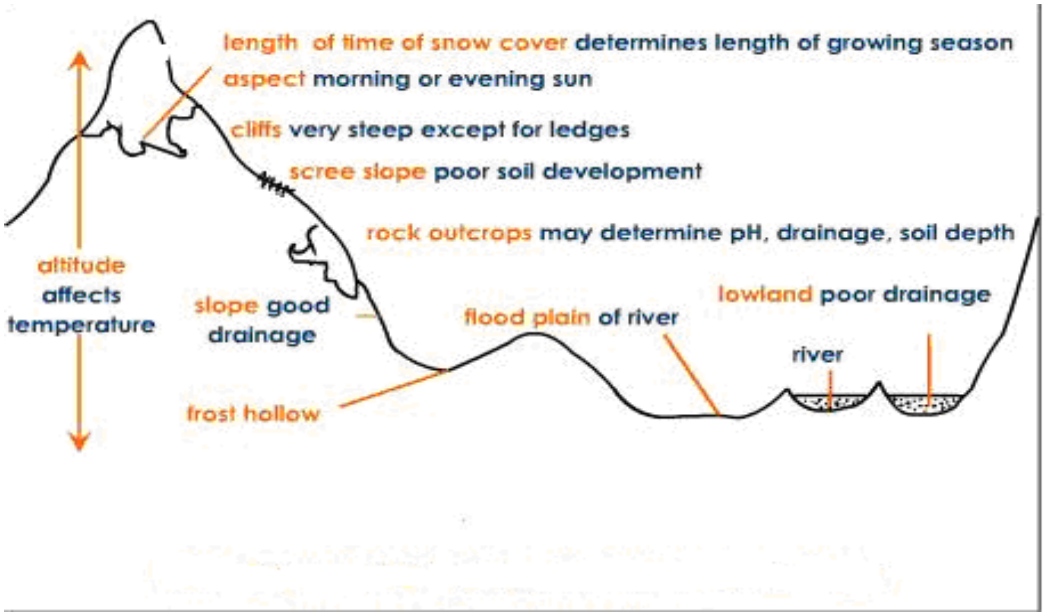

Fig.The topographic feature and their abiotic effects (www.tutorvista.com)

Marked variations of temperature at different altitudes result in the division of Earth's vegetation into different zones this are: - equatorial, tropical rain forests, desert, grasslands, deciduous forests, coniferous forests, and tundra.

Height above sea level forms the altitude. At high altitudes, the velocity of wind remains high, temperature and air pressure decrease, humidity as well as intensity of light increases. Due to these factors, vegetation at different altitudes is different showing distinct zonation.

The directions of mountain chains or ranges and high mountains act as wind barriers and affect the climate and rainfall and other factors which have a significant effect on the growth of vegetation and the distribution of animals. Slope is the characteristic feature of mountains. The steepness of a slope has a distinct effect on the climate of the area, namely the incidence of solar radiations, rainfall, wind velocity and the temperature of the region. Steepness of the slope decides the rapidity with which water flows away from the surface and determines the characteristic of the soil. A slope remains exposed to the sun and wind and this affects greatly the kind of plants growing there. Many topographic factors influence ecosystems. The most influential factors are altitude, aspect, inclinations, and insularity.

***Altitude** exerts a strong influence on animals and plants. The plant communities girdling the Earth as broad zonal belts are parallel in the plant communities encircling the mountain- Orobiomes. Individual's animals and plants species often occur within a*

particular elevational band, largely owing to climatic limits of tolerance. However, altitudinal ranges are influenced by a host of environmental factors, and not just climatic ones. For instance, tree lines are not always purely the result of climatic constraints on tree growth, but involve pedological and biotic interactions as well.

***Aspect** (compass direction) strongly affects the climate just above the ground and within the upper soil layers. For this reason virtually all landscapes display significant differences in soil and vegetation on adjacent north-facing (distal) and south facing (proximal) slopes*

and on the windward and leeward sides of hills and mountains. In the Northern hemisphere, south-facing slopes tend to be warmer, and so more prone to drought, than north-facing slopes.

Inclination (*Slope) is the inclination of the ground from the horizontal. It affects vegetation through its influence on soil moisture and on substrate stability. Slope commonly varies in a regular sequence undulating terrain-from summit, down hillside, to valley bottom- to form a geographic catena or topo-sequence. The geomorphic topo-sequence is mirrored in soil and vegetation topo-sequence. Topographic factors normally works in tandem with other factors.*

Insularity *is the relative isolation of an ecosystem. It has a significant influence on individuals and communities. True islands have abnormally high rates of extinction, house many endemic and relict species, favor the evolution of dwarf, giant, and flightless forms,*

and are often inhabited by good dispersers.

Activity

Identify and briefly explain the different forms of topographic factors?____
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3.3. Edaphic Factors

Brainstorming

What are edaphic factors?

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What is the soil like? It might be very acid, or neutral, or very acid. pH is very important for plants, some like acid soil, others like alkaline soil. If the soil is waterlogged, all the spaces between soil particles are full of water so there will be no oxygen; this makes it difficult for plants because their roots need oxygen to respire. So there must be enough water and enough oxygen for plants to grow successfully. Plants also need mineral salts like nitrates, sulphat, and phosphates. Plants remove these nutrients from the soil, and decomposers return them to the soil. Mineral salts are recycled in the ecosystem. Therefore, the edaphic factors include: Soil and substrate, minerals, pH, and soil.

***Soil and substrate**: - the word soil is derived from the Latin word solum meaning earthy material in which plants grow. A soil complex is formed of five categories of components namely mineral matter, organic matter or humus, soil water, soil air and living organisms. The quality of soil is differing due to its fertility, texture, structure, organic contents and air*

- water relationship.

***Soil profile**: -The vertical layered structure of soil is called the soil profile. There are 4 main horizons in a soil profile.*

***O** - Horizon is the organic layer composed of dead organic residues.*

***A** - Horizon is the top soil, the upper most layers which contains roots.*

B *- Horizon is the sub soil.*

C *- Horizon is the less weathered parent material.*

Soil helps in:

Providing water and minerals to the land plants

It acts as a substratum for a variety of organisms like bacteria, fungi, many kinds of animals and plants.

It is the site for decomposition of plants and animals.

It provides water, minerals and fossil fuels to man.

The type of soil (clayey, sand and loamy) and its water retention aeration and mineral contents determine the nature of plants and animals. On the basis of these characters of soil, the plants are divided into five ecological categories.

Halophytes - plants found on saline soil
Psammophytes - plants found on sandy soil
Lithophytes - plants found on rocky surface
Chasmophtyes - plants found in rock - crevices
Oxylophytes - Plants found on acid soils

The ground dwelling animals which may be cursorial (running) such as ostrich, rhea, ungulates, wolves, cats, bears, hyaenas etc, saltatory (jumping) such as rodents, rabbits, wallabies, kangaroos or graviportal (heavy) such as turtles armadillos, elephants etc exhibit different kinds of adaptations for different kinds of soil. For E.g., if the soil is firm and hard, the large animals inhabiting the ecosystem tend to have small hooves or paws. If the soil is wet and spongy, they tend to have broad hooves or paws.

Minerals: *- are also called as biogenic materials and are essential for the proper growth of organisms. So the type and distribution of plants and animals are determined by specific distribution of minerals. Deficiency or absence or excess of minerals results in abnormal growth or even death of organisms. To derive the required nutrients, organisms are adapted differently. Examples:*

a) Plants found in nitrogen - deficient bog soil have either nitrogen fixing bacteria or become insectivorous.

b) Snails occur in soils rich in calcium content to form their shell.

c) Halophytes and many marine animals have salt secreting glands

d) Leguminous plants like pea, gram methishow symbiosis with nitrogen fixing bacteria in their root nodules. High concentration of minerals generally limits the distribution of animals. Example: Dead Sea is devoid of vegetation because of high salt content.

***pH** is the relative acidity or alkalinity of medium. Every organism needs a specific pH called optimum pH for its optimum growth. Some organisms prefer alkaline medium (more than pH 7). For example, protozoan and mollusks, as some organisms prefer acidic (less than pH 7). For example euglena and other pyhto flagellates flourish in water having pH 2.8. Still other forms can survive in a wide range of pH. For example, the soil pH for*

tapeworm ranges from 4 to11).

***Activity** Explain edaphic factors? Elaborate the response of an organism to range environmental factors?*

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_____
_____

***Fire**: -Fire has important effects on the environment. Fire removes plant cover, burns litter on the soil surface and causes loss of nutrients. Due to forest fires a variety of animals groups die.*

***Range of tolerance:** -Plants and animals show a range of tolerance to environmental factors. The factor, which is present in least amount may become limiting. For example water availability limits plant growth in deserts. Minerals nutrients availability with the required amount, below or excess amount determines the growth and productivity of plants and animals.*

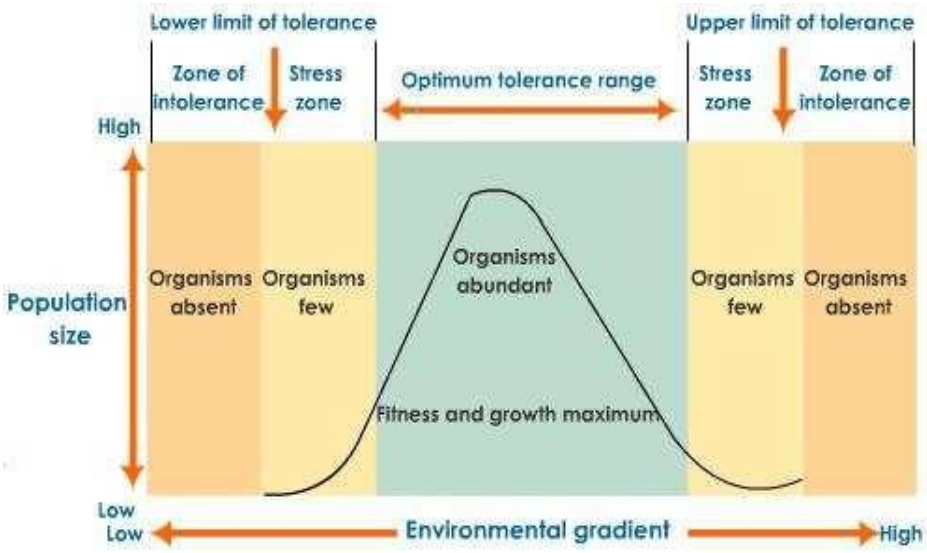

Figure 3.2. Relationships of organisms to a range an environmental factors (www. tutorvista.com)

The organisms are abundant in the central optimum range. In the zone of stress, only a few organisms survive and in the zone of intolerance, organisms are absent. If the organism has wide range of tolerance, it is usually distributed and if its tolerance range is narrow it is restricted. The gradual adjustment of an organism to slowly changing new environmental condition is called as acclimatization.

3.4. Biotic restrictions

Brainstorming

What do think about the limits of life (biotic)?

In an oak forest, the oak trees affect the soil by removing water and nutrients, they affect the climate inside the forest and shelter other things from extremes of temperature etc. and they are a source of food for insect, birds and squirrels. Living things all have an effect on each other but they also have effects on the climate and soil. The climate inside an oak forest is milder than outside because the oak trees provide shelter.

Fungi and bacteria in the soil are important because they return nutrients to the soil by decomposing dead plant and animal material.

Activity

Elaborate the biotic restrictions with an example?

3.5. Anthropogenic factors

Brainstorming

What do know about anthropogenic factors that affect living organisms?

Today biophysical resources have been exploited to a very large extent in order to satisfy human wants. These resources are divided into two; renewable resources and non-renewable resources. Renewable resources are also of two kinds: I) those that are not affected by human activities such as sun and II) are those that can be misused such as air, water and land (living things). Non-renewable resources such as natural gas, coal, oil and minerals are those resources that cannot be recycled and are finite. Curently, due to the huge increase in population these resources are depleting and will eventually run out if not utilized and conserve efficiently because these resources cannot be reproduced by humans

Natural resources have been over-exploited by humans and its growing population is causing a serious threat to the limited existence of these resources. Due to its excessive usage vegetation has been destroyed resulting in land degradation, soil erosion, drought, landslides, floods and unbalanced and disturbance of the ecosystems'.

The exploitation of natural resources has been degraded at a very rapid speed causing serious threat to the environment. Human greed is also one major reason for its degradation as they only think for today and not for their future. People living in developed countries are also responsible for the huge consumption of environmental resources as compared to people living in developing countries. They tend to spend more resources in order to maintain their standard of living.

Therefore, save the biophysical resources before it's too late. All individual needs to take proper care while utilizing these resources available to us. It might seems to be plenty in nature, but the fact is that it is depleting rapidly and if no attention is given to it , it will not take much time for us to run out of those biophysical resources and our future generation will have nothing to use.

Activity

*Briefly explain the human factors on the ecosystem?*_____
_____
_____
_____
_____

Summary

Types of habitat

Microhabitats (Landscape elements) are similar to micro-habitats, but a little larger.

They are fairly uniform pieces of land, no smaller than about few square centimeters to a few meters in are

Macro-habitats (landscape) is mosaic, an assortment of patches and corridors set in a matrix, no bigger than about 10000km^2 it is heterogeneous land area have area up to about 1 million km^2.

Mega-habitats landscape combines to form (regions), more than about more than in million km^2 extents. They are collections of landscapes sharing the same microclimate are regions.

Habitat specialists have very precise living requirements. Habitat generalist few species manage to eke out a living in a great variety of environments. The human species (Homo sapiens) is the champion habitat generalist.

Climatic factors

The climate (temperature, rainfall, humidity etc.) can have a profound effect upon the kinds of animals and plants which live in an ecosystem.

Three aspects of solar radiation influence photosynthesis-the intensity, the quality, and the photo period (duration).

Different aspects of temperature are relevant to different species and commonly vary with the time of year and the stage in an organism's life cycle.

Protoplasm, the living matter of animals and plant cells, is about 90 percent water-without adequate moisture there can be no life. Water affects land animals and plants in many ways.

Availability of moisture greatly determines soil water levels, which in turn greatly influence plant growth.

Ups and downs of the surface of the earth

- *Topography includes the physical features of the earth like altitude, slope, exposure, mountain chains, valleys, plains, etc.*

- *At high altitudes, the velocity of wind remains high, temperature and air pressure decrease, humidity as well as intensity of light increases. Due to these factors, vegetation at different altitudes is different showing distinct zonation.*

- *Insularity is the relative isolation of an ecosystem. It has a significant influence on individuals and communities*

Edaphic factors

- *Soil complex is formed of five categories of components namely mineral matter, organic matter or humus, soil water, soil air and living organisms.*
- *The quality of soil is differing due to its fertility, texture, structure, organic contents and air - water relationship.*
- *Soil helps in:*

  It acts as a substratum for a variety of organisms like bacteria, fungi, many kinds of

  animals and plants.

  providing water and minerals to the land plants

  It is the site for decomposition of plants and animals.
  It provides water, minerals and fossil fuels to man

- *Type of soil (clayey, sand and loamy) based on these characters of soil, the plants are divided into five ecological categories:*

- *Halophytes - plants found on saline soil*
- *Psammophytes - plants found on sandy soil*
- *Lithophytes - plants found on rocky surface*
- *Chasmophtyes - plants found in rock - crevices*
- *Oxylophytes - Plants found on acid soils*

Biotic factors

- *Biotic factors are the effects which the animals and plants have on each other and on the habitat itself, but they also have effects on the climate and soil.*

- *In an oak forest, the oak trees affect the soil by removing water and nutrients, they affect the climate inside the forest and shelter other things from extremes of*

  temperature etc. and they are a source of food for insect, birds and squirrels

Human factors

- *Now a day biophysical resources have been exploited to a very large extent in order to satisfy human wants.*
- *Due to its excessive usage vegetation has been destroyed resulting in land degradation, soil erosion, drought, landslides, floods and unbalanced and disturbance of the ecosystems'.*
- *Save the biophysical resources before it's too late. All individual needs to take*

  proper care while utilizing these resources available to us.

Summary questions

I. Write true if the given statement is correct and false if the statement is incorrect for the following questions

1. *Habitat specialists have the ability to live in a great array of environments.*
2. *The visible portion (sunlight) is the effective bit for photosynthesis.*
3. *Equatorial regions receive more radiation of the sun than the subtropics region.*

4. *Meso-phytes are plants that live in normally moist but not wet conditions whereas, xerophytes are plants that live in water conditions.*

5. *Soil is the site for decomposition of plants and animals.*

6. *The gradual adjustment of an organism to a slowly changing or new environmental condition is called as acclimatization.*

Instruction II

Choose the correct answer from the given alternatives

1. *Which one of the following is correct?*

A. *Chilling sensitive plants are surviving when the temperatures are lower than 10^0C*

B. *Chilling resistant (frost sensitive) plants can survive at temperature below 10^0C, but damaged when ice forms within their tissues.*

C. *Frost resistant plants do not make physiological changes but, can survive temperature as low as below -15^0C.*

D. *A and B only*

E. *B and C only*

2. *Which one of the following combination is incorrect?*

A. *Halophytes - plants found on acid soils*

B. *Psammophytes - plants found on sandy soil*

C. *Lithophytes - plants found on rocky surface*

D. *Chasmophtyes - plants found in rock – crevices*

E. *Oxylophytes - Plants found on acid soils*

3. *Which one is not false about the response of an organism to a range an environmental factors?*

A. *The organisms are abundant in the central optimum range*
B. *In the zone of stress, only a few capable organisms survive*
C. *In the zone of intolerance, organisms are absent*
D. *If the organism has wide range of tolerance, it is usually distributed in many areas*
E. *All of the above*

Instruction III Write short answer

1. *Explain how edaphic factors affect the living organisms?*

2. *How pH of a soil affect the living organisms? Briefly explain*

Chapter Four

4. Ecological Regimes

4.1. Bio-geographic realms

Brainstorming

What do you think about the bio-geographic realms?

_____
_____
_____
_____
_____
_____

Ecological communities can share characteristics for a number of reasons. Communities can also be classified into bio-geographical realms are based upon fundamental features of the plants and animals found in those regions as indicated in fig 4.1. and fig 4.2.(e.g,

Australasia, Antarctic, Afro-tropic, Indo-Malayan, Neartic, Neo-tropic, Oceania, Paleartic). Classifying communities into bio-geographic realms are attempts to highlight the importance of shared bio-geographic/evolutionary history in determining the composition of biological communities. It is important to recognize that many different biomes can be found in the same bio-geographic realm and that the same biome can be located in many different geographic realms.

The eco-region, a relatively large unit of land that contains geographically distinct assemblages of natural communities, is a subset of a biome found within a bio-geographic realm. The World Wildlife Fund has identified 825 terrestrial eco-regions, 450 freshwater eco-regions, and 229 marine eco-regions. Several distinct ecological communities may be found in a single eco-region. The main bio-geographic realms for animals and plants are based on genetic factors.

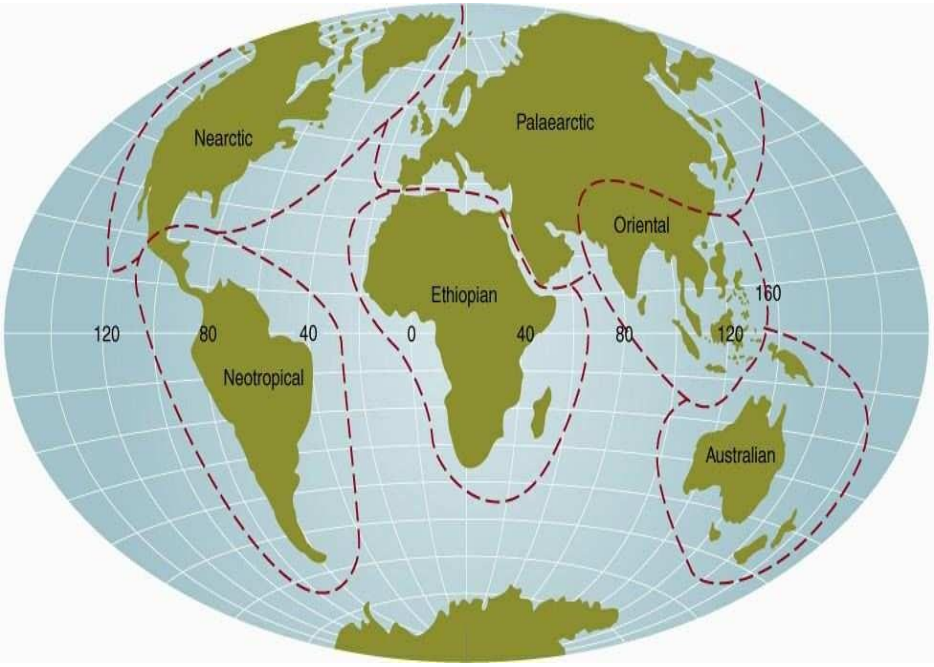

Figure 4.1. Bio-geographic realms of animals (www.eoearth.org/article/Biomes)

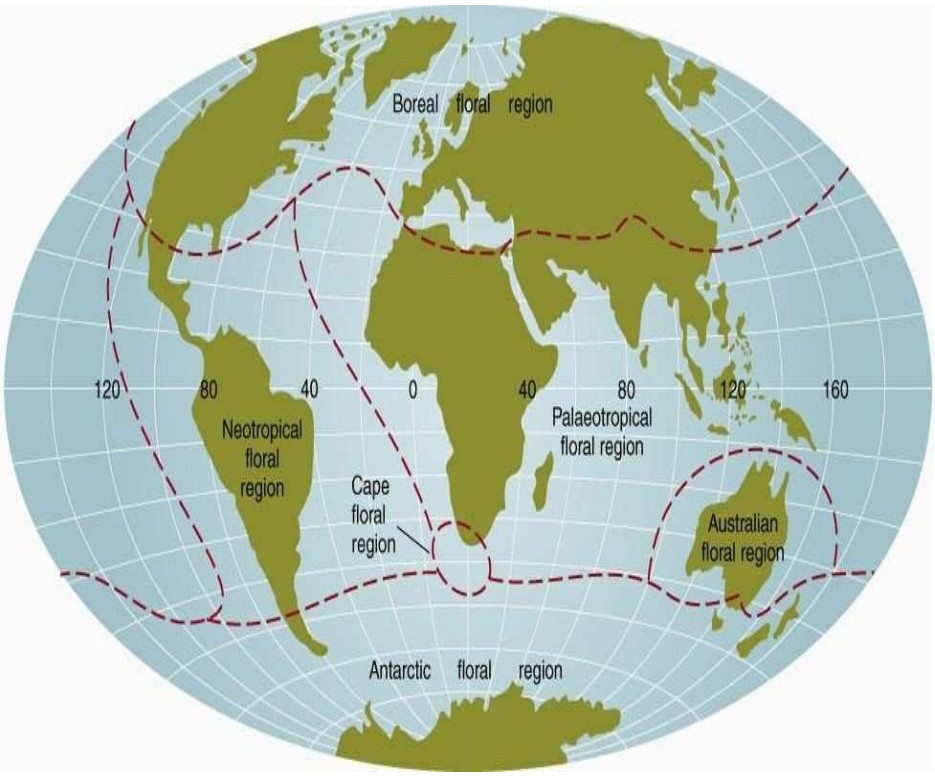

Figure 4.2. Bio-geographic realms for plants (www.eoearth.org/article/Biomes)

Activity

*Identify the major bio-geographic realms of plants and animals?*_____
_____
_____
_____
_____
_____
_____

Biomes organize the biological communities of the earth based on similarities in the dominant vegetation, climate, geographic location, and other characteristics. Aspects of the physical environment such as precipitation, temperature, and water depth, have a strong

influence on the traits of species living in that environment, and thus biological communities experiencing similar environmental conditions often contain species that have evolved similar characteristics. There is no single classification of biomes that is agreed upon by all scientists because different scientists wish to emphasize different characteristics by their definition. Historically however, biomes have been identified and mapped based on general differences in vegetation type associated with regional variations in climate and terrain.

Biologists have organized all the life on Earth into four levels of complexity and interaction. In this schema, species of organisms live in "communities" where they compete for food and habitat. At the next level, communities interact in an "ecosystem." The ecosystem includes weather and geology of the area in addition to plants and animals. For example a specific forest qualifies as an ecosystem. Then, taken together, those ecosystems that share major characteristics of terrain create a biome. A biome is united by temperature, precipitation, soil type, vegetation, latitude, and elevation. At the most macroscopic level reins the biosphere of our Earth that contains all the life we know exists in the universe.

Biomes are spread across the Earth's surface i.e., part of the Florida Everglades have more in common with India, in terms of ecosystems, than it does with Georgia right next door. Treating the world as a system of biomes allows biologists to study climate, geology, endangered species, agriculture, and many related subjects. Biomes were formed at different stages of Earth's evolution, depending on the presence of organic matter, water, plate tectonics, and where, in terms of latitude, the terrain lies. Since the Earth is tilted on its axis, and moves around the sun, latitude can tell us how much light hits the surface

4.2. Earth's major terrestrial and aquatic biomes

Brainstorming

What are the major terrestrial and aquatic biomes of the world?

_____
_____
_____
_____
_____
_____

Many places on Earth share similar climatic conditions despite being found in geographically different areas. As a result of natural selection, comparable ecosystems have developed in these separated areas. Scientists call these major ecosystem types biomes. The geographical distribution (and productivity) of the various biomes is controlled primarily by the climatic variables precipitation and temperature.

Most of the classified biomes are identified by the dominant plants found in their communities. For example, grasslands are dominated by a variety of annual and perennial species of grass, while deserts are occupied by plant species that require very little water for survival or by plants that have specific adaptations to conserve or acquire water.

The diversity of animal life and subdominant plant forms characteristic of each biome is generally controlled by abiotic environmental conditions and the productivity of the dominant vegetation. In general, species diversity becomes higher with increases in net

primary productivity, moisture availability, and temperature. Adaptation and niche specialization are nicely demonstrated in the biome concept. Organisms that fill similar niches in geographically separated but similar ecosystems usually are different species that have undergone similar adaptation independently, in response to similar environmental pressures. The vegetation of California, Chile, South Africa, South Australia, Southern Italy and Greece display similar morphological and physiological characteristics because

of convergent evolution. In these areas, the vegetation consists of drought-resistant, hard-leaved, low growing woody shrubs and trees like eucalyptus, olive, juniper, and mimosa.

Arctic and Alpine Tundra

Tundra means marshy plain. The geographical distribution of the tundra biome is largely pole ward of 60° North latitude. The tundra biome is characterized by an absence of trees, the presence of dwarf plants, and a ground surface that is wet, spongy, and hummocky. Soils of this biome are usually permanently frozen (permafrost) starting at a depth of a few centimeters to meter or more. The permafrost line is a physical barrier to plant root growth. Within this biome, temperature, precipitation, and evaporation all tend to be at a minimum. Most tundra locations have summer months with an average temperature below 10° Celsius. Precipitation in the wettest month is normally no higher those 25 millimeters. However, despite the low levels of precipitation the ground surface of the tundra biome is often waterlogged because of low rates of evapo-transpiration.

The species diversity of tundra vegetation is relatively small. Plant communities are usually composed of a few species of dwarf shrubs, a few grass species, sedges, and mosses. Perhaps the most characteristic arctic tundra plants are lichens like Reindeer Moss (Cladonia spp.). The principal herbivores in this biome include caribou, musk ox, arctic hare, voles, and lemmings. Most of the bird species of the tundra have the ability to migrate and live in warmer locations during the cold winter months. The herbivore species support a small number of carnivore species like the arctic fox, snow owl, polar bear, and wolves. Reptiles and amphibians are few or completely absent because of the extremely cold temperatures. Alpine tundra is quite similar to some arctic tundra but differs in the absence of permafrost and in the presence of better drainage.

Boreal Coniferous Forest

This moist-cool, transcontinental coniferous forest, or taiga lies largely between the 45th and 57th North latitudes. The climate of this biome is cool to cold with more precipitation than the tundra, occurring mainly in the summer because of mid-latitude cyclones. Th

predominant vegetation of boreal biome are needle-leaf evergreen variety tree species. Some common species include: White Spruce (Picea glauca) and Balsam Fir (Abies balsamea) east of the Rockies; Red Pine (Pinus resinosa), White Pine (Pinus strobus), and Hemlock (Tsuga canadensis) in the Great Lakes Region. In British Columbia, dominant boreal trees include: Black Spruce (Picea mariana), White Spruce (Picea glauca), Lodgepole Pine (Pinus contorta), Ponderosa Pine (Pinus pondersoa), Douglas Fir (Pseudotsuga menziesii), and Alpine Fir (Abies lasiocarpa). The understory is relatively limited as a result of the low light penetration even during the spring and fall months. Understory plants in the deciduous biome take advantage of the leafless condition of trees during these seasons concentrating their growth during this time period. Common understory species include orchids, shrubs like rose, blueberry, and cranberry. Mammals common to the boreal forest include moose, bear, deer, wolverine, marten, lynx, wolf, snowshoe hare, vole, chipmunks, shrews, and bats. Reptiles are rare, once again, because of cold temperatures. Boreal forest soils are characterized by a deep litter layer and slow decomposition. Soils of this biome are also acidic and mineral deficient because of the large movement of water vertically though the profile and subsequent leaching.

Temperate Deciduous Forest

As its name indicates, this biome is characterized by a moderate climate and deciduous trees. It once occupied much of the eastern half of the United States, central Europe, Korea, and China. This biome has been very extensively affected by human activity, and much of it has been converted into agricultural fields or urban developments. Dominant plants include trees like Maple (Acer spp.), Beech (Fagus spp.), Oak (Quercus spp.), Hickory (Carya spp.), Basswood (Tilia spp.), Cottonwood (Populus spp.), Elm (Ulmus spp.), and Willow (Salix spp.). The understory of shrubs and herbs in a mature deciduous forest is typically well developed and richly diversified. Many different types of herbivores and carnivores, and some reptiles and amphibians exist here. Brown

forest soils characterize temperate deciduous forest ecosystems. The surface litter layer in these soils is thin due to rapid decomposition

Grassland

In central North America are the grasslands, the tall grass prairie toward the east and the short grass prairie westward. In Europe and Asia some grassland are called Steppes. In South America, grasslands are known as Pampas. Prior to modern man, the tall grass prairie was dominated by species of Bluestem (Andropogon spp.). This particular species dominated much of the tall grass prairie forming dense covers 1.5 to 2.0 meters tall. In the western end of the prairie, where precipitation is less, Buffalo Grass (Buchloe dactyloides) and other grasses only a few inches above the soil surface are common in this habitat. Flowering herbs, including many kinds of composites and legumes, are common but much less important than grass species. Trees are limited to low lying areas and the narrow zone immediately adjacent to streams.

In the tall grass prairie organic rich and black chernozemic soils are common. Chernozems are among the richest in nutrients and consequently the most fertile in the world. In drier parts of prairies, soils can be influenced by salinization. As a result of their fertility, most grassland ecosystems have been modified by humans to grow grain and other dry land crops. Grassland mammals are dominated by smaller burrowing herbivores (prairie dogs, jack rabbits, ground squirrels, and gophers) and larger running herbivores such as bison, pronghorn antelope, and elk. Carnivores include badger, coyote, ferret, wolf, and cougar. The population size of many of these species has been drastically reduced because of habitat destruction. Some of these species are on the edge of extinction.

Desert

In its most typical form, the desert consists of shrub covered land where the plants are spatially quite dispersed. In general, the major desert biomes of the Earth are geographically found at between 25 to 40° North and South latitude, in the interiors of continents. Climatically, deserts are influenced by descending air currents which limit the formation of precipitation. Many desert areas have less than 250 millimeters of precipitation annually. Dominant plants include drought resistant shrubs like the Creosote Bush (Larrea divaricata) and Sagebrush (Artemisia tridentata), water storing succulent

like cactus and many species are short lived annuals that complete their life cycles during infrequent and short rainy periods. Desert habitats can be devoid of vegetation if precipitation is in very short supply. Cactus is a common type of drought resistant plant found in deserts.

Most desert mammals tend to be nocturnal to avoid the high temperatures. Desert habitats have a rich lizard and snake fauna because high temperatures promote the success of cold blooded life forms. Lizards are quite common in desert habitats. Because productivity is low, the litter layer is comparably limited and organic content of surface soil layers is very low. Also, evaporation tends to concentrate salts at the soil surface.

Chaparral

Chaparral has a very specific spatial distribution. It is found in a narrow zone between 32 and 40° latitude North and South on the west coasts of the continents. This area has a dry climate because of the dominance of the subtropical high pressure zone during the fall, summer, and spring months. Precipitation falls mainly in the winter months because of the seasonal movement of the polar front and its associated mid-latitude cyclone storms. Annual averages range from about 300 to 750 millimeters and most of this rain falls in a period between 2 to 4 months long. As a result of the climate, the vegetation that inhabits this biome exhibits a number of adaptations to withstand drought and fire. Trees and shrubs living in this zone tend to be small with hard evergreen leaves. Plants in the chaparral do not drop their leaves during the dry season because of the expense of replacement. The dry climate slows the rate of leaf decomposition in the soil. As a result, the plants growing in this biome do not have nutrients available for uptake to produce new leaves when the wet season begins. Instead, the plants of the chaparral develop leaves that can withstand arid conditions.

Representative species of the chaparral include cork oak (Quercus suber), olive (Olea europaea), eucalyptus, arbutus (Arbutus unedo), acacia, maritime pine (Pinus pinaster), shrub oak (Quercus dumosa), and live oak (Quercus agrifolia). Many of the plant species

have thorns to protect them from herbivore damage. This biome is sometimes also called ***Mediterranean Scrubland*** *or* ***sclerophyll forest****.*

Tropical Savanna

Tropical savannas are grasslands with scattered drought-resistant trees that generally do not exceed 10 meters in height. Tree and shrub species in the savanna usually shed their leaves during the dry season. This adaptation reduces water loss from the plants. New leaves appear several weeks before the start of the rain season. Scientists believe that savanna plant species may have developed this strategy to take advantage of the season variance of the start of the rains. Climatically, these biomes are characterized by distinct wet and dry seasons. Temperatures are hot all year long. Savanna vegetation is typical composed of a mixture of grass and trees. The savanna biome constitutes extensive areas in eastern Africa, South America, and Australia. Savannas also support the richest diversity of grazing mammals in the world. The grazing animals provide food for a great variety of predators. Giraffes are a common grazer on the African savanna. Savannas are also home to a number of predator species who prey on grazing animals. The soils are more nutrient rich than tropical forest soils. Some soils become extremely dry because of evaporation and form laterite layers.

Tropical Rainforest

Tropical rainforests occur in a broad zone outside the equator. Annual rainfall, which exceeds 2000 to 2250 millimeters, is generally evenly distributed throughout the year. Temperature and humidity are relatively high through the year. Flora is highly diverse: a square kilometer may contain as many as 100 different tree species as compared to 3 or 4 in the temperate zone. The various trees of the tropical rain forests are closely spaced together and form a thick continuous canopy some 25 to 35 meters tall. Every so

often this canopy is interrupted by the presence of very tall trees (up to 40 meters) that have wide buttressed bases for support. Epiphytic orchids and bromeliads, as well as vines (lianas), are very characteristic of the tropical rainforest biome. Some other common plants include ferns and palms. Most plants are evergreen with large, dark green, leathery leaves. *Tropical*

trees often have buttressed bases to help support their heavy above-ground biomass. The tropical rainforest is also home to a great variety of animals. Some scientists believe that

30 to 50% of all of the Earth's animal species may be found in this biome. The tropical rain forest is home to many different species of amphibians. Decomposition is rapid in the tropics because high temperatures and an abundance of moisture. Because of the frequent and heavy rains, tropical soils are subject to extreme chemical weathering and leaching.

These environmental conditions also make tropical soils acidic and nutrient poor.

Activity

*List down and discus the main terrestrial biome?*_____

_____

_____

_____

_____

The freshwater and marine biomes *are probably the most important of all the biomes. Their medium, water, is a major natural resource. Water is the basis of life, it supports life, and countless species live in it for all or part of their lives. Freshwater biomes supply us with our drinking water and water for crop irrigation. The world's oceans have an even greater effect on global climate than forests do. Water has a high capacity for heat, and because the Earth is mostly covered with water, the temperature of the atmosphere is kept fairly constant and able to support life. In addition to this climate-buffering capacity, the*

oceans contain several billion photosynthetic plankton is occurring on Earth. Without these, there might not be enough oxygen to support such a large world population and complex animal life.

1. ***Freshwater biomes*** *have suffered mainly from pollution. Runoff containing fertilizer and other wastes and industrial dumping enter into rivers, ponds, and*

lakes and tend to promote abnormally rapid algae growth. When these algae die, dead organic matter accumulates in the water. This makes the water unusable and it kills many of the organisms living in the habitat. Over fishing and pollution have threatened to make oceans into ecological disaster areas. Industrial pollutants that are dumped upstream of estuaries have rendered many marine habitats unsuitable for life. Again, tighter regulations have been used to prevent further destruction of the ocean biomes.

2. ***Marine biomes*** *are generally distinguished by the depth of the water and whether there is a substrate on which organisms can attach. Important marine biomes include oceans, coral reefs, and estuaries. The ocean biome, the largest of all of the earth's biomes, can be divided into several zones including the shore/intertidal zone, the pelagic zone, the benthic zone, and the abyssal zone.*

Anthropogenic biomes *humans have fundamentally altered global patterns of biodiversity and ecosystem processes. As a result, vegetation forms predicted by conventional biome systems are rarely observed across most of Earth's land surface. While not a replacement for existing biome systems, anthropogenic biomes provide an alternative view of the terrestrial biosphere based on global patterns of sustained direct human interaction with ecosystems, including agriculture, human settlements, urbanization, forestry and other uses of land. Anthropogenic biomes offer a new way forward in ecology and conservation by recognizing the irreversible coupling of human and ecological systems at global scales, and moving us toward an understanding how best to live in and manage our biosphere and the*

anthropogenic biomes we live in.

Activity

*Compare and contrast the main characteristics of freshwater and marine biomes?*_____
_____
_____
_____

Summary

Biogeographic realms

- *Based upon fundamental features of plants and animals found bio-geographic realms are identified like Australasia, Antarctic, Afro-tropic, Indo-Malayan, Neartic, Neo-tropic, Oceania, Paleartic.*
- *Biomes have been identified and mapped based on general differences in vegetation type associated with regional variations in climate and terrain.*
- *Biomes were formed at different stages of Earth's evolution, depending on the presence of organic matter, water, plate tectonics, and where, in terms of latitude, the terrain lies.*

Terrestrial biome

The major terrestrial biomes include the tundra biome, the forest biome, the grassland biome, and the desert biome.

The geographic distribution of terrestrial biomes is mostly influenced by climatic conditions such as rainfall and temperature.

Fresh water and marine biome

Freshwater biomes are generally distinguished by characteristics such as water depth and whether the water is moving or standing. Major freshwater biomes include ponds and lakes, streams and rivers, and wetlands.

Freshwater biomes are the basis of life; freshwater biomes supply us with our drinking water and water for crop irrigation.

Suffered mainly from pollution. Runoff containing fertilizer and other wastes and industrial dumping.

Marine biomes distinguished by the depth of the water and whether there is a substrate on which organisms can attach. Important marine biomes include oceans, coral reefs, and estuaries. The ocean biome, the largest of all of the earth's biome

Instruction I

<u>Write short answer for the following questions</u>

1. *According to the World Wildlife Fund the terrestrial biomes can be classified into:*

   A. _____

   _____

   B. _____

   _____

   C. _____

   _____

   D. _____

   _____

2. *Compare and contrast between freshwater and marine biome?*_____

   _____

   _____

   _____

   _____

   _____

*3. On the world map identify and locate the plant and animal bio-geographic realms?*_____

_____

_____

Chapter five

5. Important Bio-geographic Processes

5.1. Evolution and Speciation

Brainstorming

What do you know about evolution and speciation processes?

_____
_____
_____
_____
_____
_____

- Evolution, in biology, complex process by which the characteristics of living organisms change over many generations as traits are passed from one generation to the next.

Views regarding evolution

1. Species Evolution through Cladogenesis

- Cladogenesis is the splitting of one species into two clades, not only because of geographical isolation, but also because of reproductive isolation from clade ("branch") or group with common evolutionary ancestry.
- It is a branching of one species into two.

2. Darwinian or Phyletic Gradualism types of Evolution

- Is slow, step-by-step changes over time.
- Examples: From monkeys to apes; apes to hominines (e.g. Lucy); and from early hominines to modern Homo sapiens

3. Oscillating Selection types of Evolution

- Adaptive variation of speciation which is in response to environmental changes.
- Example: Medium and small ground finch lacked a bill strong enough to crack tough seeds.
- Occurrence of drought selected plants whose seeds had a tough exterior leads to survival of large, longer-billed finches.
- Smaller, shorter-billed finches returned after the climate returned to normal, shifting bill size and lengths reflected the oscillation of the environmental conditions.

4. Punctuated Equilibrium types of Evolution

- Species tend to remain stable over time, then, evolutionary changes occur suddenly (in terms of centuries or millennia).
- Populations may become fragmented and isolated, and from there new forms arise.
- Small, new populations may invade a region, and through the founder effect and better adaptation, create and spread a new species.
- Example: Archaeopteryx (ancient bird), a dinosaur with feathers: suddenly appears and may have created a new class known as Aves (birds).

5. Creationism

- Creationism is the belief in a literal biblical interpretation of the creation of earth in six days 6,000 to 10,000 years ago.

Generally, species is unit of evolution: evolutionary change is more random than progressive: speciation is the basic process of evolutionary

change: changes may be gradual or rapid; scientific: follow the evidence and evidence for evolution is overwhelming in the form of geological strata and fossil life forms.

Activity

Identify and explain the different views of evolution of species

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Causes of speciation

- There are two major **causes of speciation**, i.e. geographic isolation and reduction of gene flow (non-geographic).

1. Geographic Isolation

- In geographic speciation, initial isolation results from geographic separation of the populations.
- Scientists think that geographic isolation is a common way for the process of speciation to begin:
- Geographic barriers can include: rivers change course, mountains rise, continents drift, organisms migrate
- Unfavorable habitat between the two populations keeps them from mating with one another.
- Because of geographic isolation what was once a continuous population is divided into two or more smaller populations.

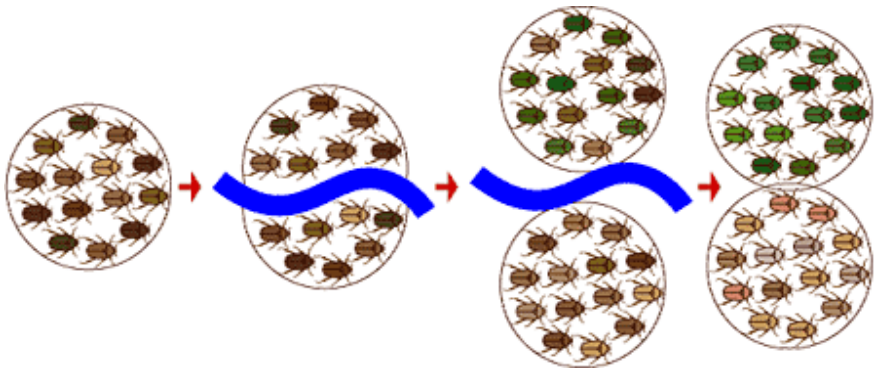

Figure 5.1. Speciation of insects by geographic isolation

(**http://evolution.berkeley.edu/evosite/evo101/VC1eSympatric.shtml**)

2. Reduction of Gene Flow

- In non-geographic speciation, initial isolation results from changes in behavior or genetics of part of a local population.
- Imagine a situation in which a population extends over a broad geographic range
- Individuals in the far west would have zero chance of mating with individuals in the far eastern end of the range as presented in figure 5.2. So we have reduced gene flow, but not total isolation.
- In the absence of a geographic barrier, reduced gene flow across a species' range can encourage speciation as indicated in the figure 5.2.
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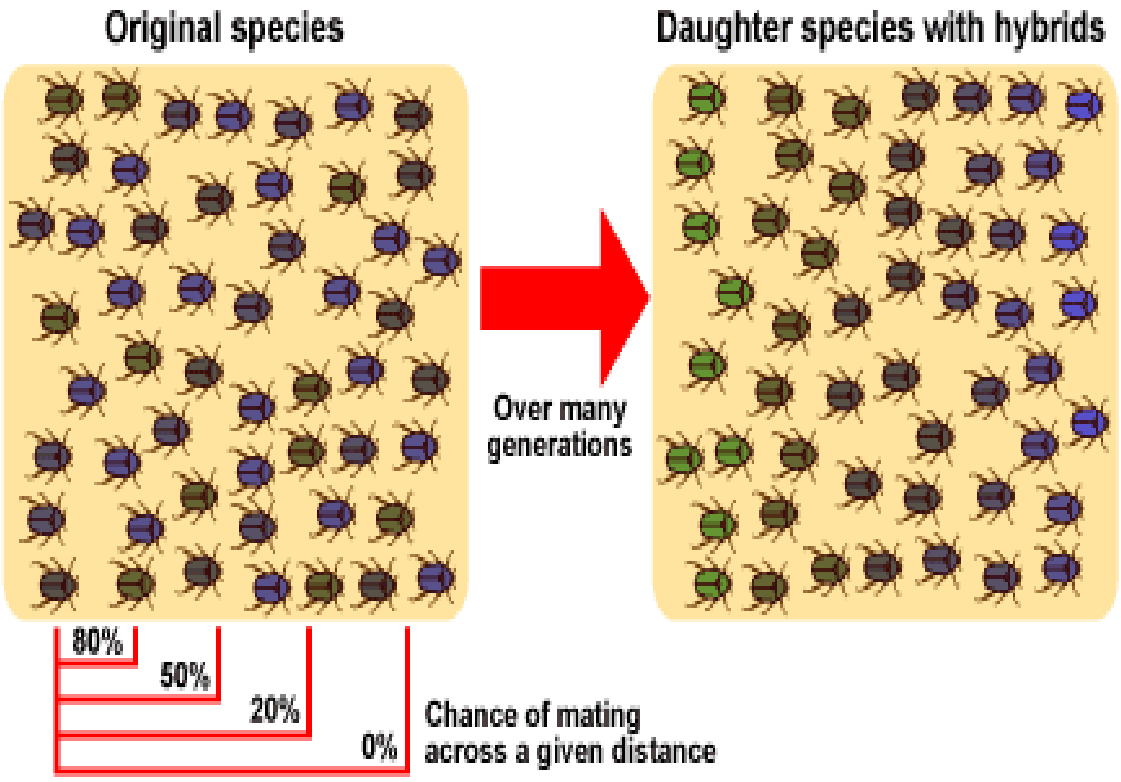


Figure 5.2. Speciation of insects by geographic isolation

(**http://evolution.berkeley.edu/evosite/evo101/VC1eSympatric.shtml**)

Activity

*List down the causes of speciation?*___

Modes of Speciation

- The key to speciation is the evolution of genetic differences between the incipient species.
- A small change in the timing, location, or rituals of mating could be enough (these need not be huge genetic differences).

- Modes of speciation are often classified according to how much the geographic separation of incipient species can contribute to reduced gene flow. The following table compares some of these speciation modes.

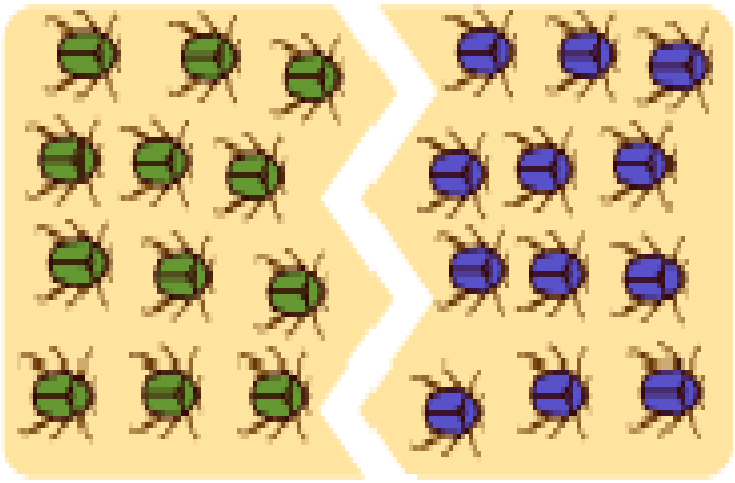
Table Comparison of Modes of Speciations

Modes of speciation	*New species formed*
Allopatric *(allo = other, patric = place)*	*Geographically isolated population*
Peripatric (peri, near Patric, place)	*A small population at the edge a larger population*
Parapatric Para, beside Patric, place)	*A continuously distributed population*
Sympatric(sym, same Patric, place)	*Within the range of ancestral population*

Allopatric Speciation: The Great Divide

- Allopatric speciation is a speciation by geographic isolation
- Something extrinsic to the organisms prevents two or more groups from mating with each other regularly.

- *Isolation might occur because of great distance or a physical barrier, such as a desert or river, etc*
- But it doesn't have to be reduced completely to zero.



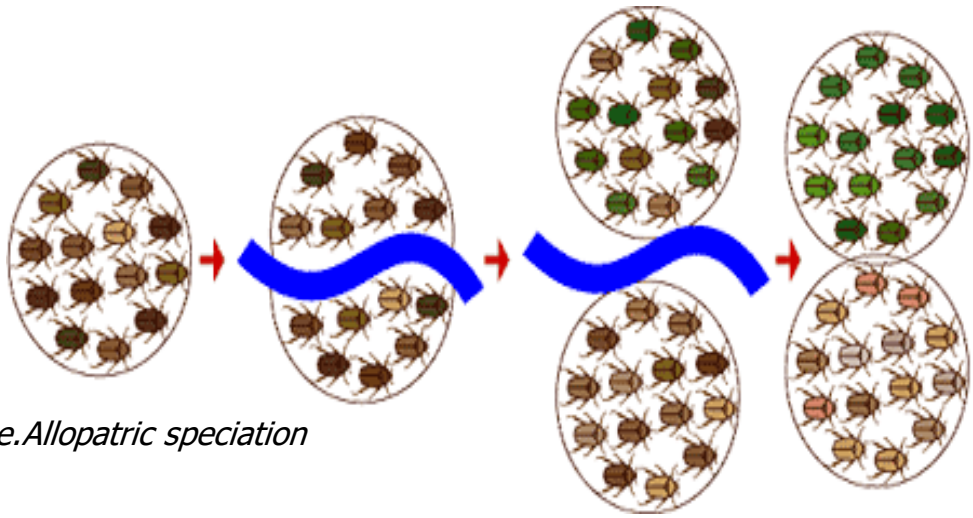
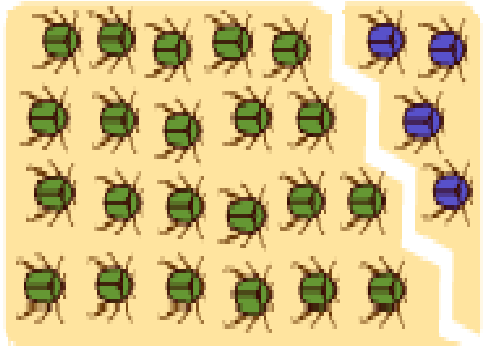


Figure.Allopatric speciation

Peripatric Speciation

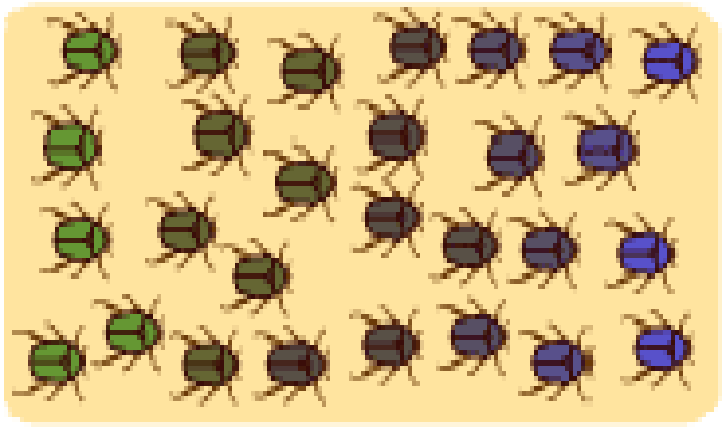
- *it* is a special version of the allopatric speciation mode.
- A population is split into two unequally-sized populations and they become separate species.



- It happens when one of the isolated populations has very few individuals.

Parapatric Speciation

- In this case, there is no specific extrinsic barrier to gene flow.
- The population is continuous but, the population does not mate randomly.
- *Individuals are more likely to mate with their geographic neighbors than with individuals in a different part of the populations range.*



- In this mode, divergence may happen because of reduced gene flow within the population and varying selection pressures across the populations range.

Sympatric Speciation

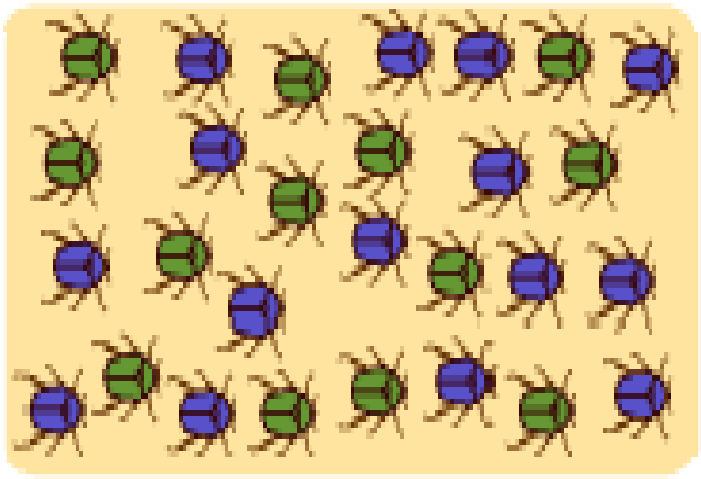
- Unlike the previous modes, this does not require large-scale geographic distance to reduce gene flow between parts of a population

How could a randomly mating population reduce gene flow and speciate?

- Merely exploiting a new niche may automatically reduce gene flow with individuals exploiting the other niche.
- This may occasionally happen when, for example, herbivorous insects tryout a new host plant.
- For example, 200 years ago, the ancestors of *apple maggot flies laid their eggs only on hawthorns*—but today, these flies lay eggs on hawthorns (which are native to America) and domestic apples (which were introduced to America by immigrants and bred).
- *Females generally choose to lay their eggs on the type of fruit they grew up in, and males tend to look for mates on the type of fruit they grew up in.*
- So hawthorn flies generally end up mating with other hawthorn flies and apple flies generally end up mating with other apple flies.
- This means that gene flow between parts of the population that mate on different types of fruit is reduced.

- This host shift from hawthorns to apples may be the first step toward sympatric speciation.

- Gene flow has been reduced between flies that feed on different food varieties, even though they both live in the same geographic area.



Activity

Briefly explain the different modes of speciation?____

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Cospeciation

- If the association between two species is very close, they may speciate in parallel.
- This is called cospeciation.
- It is especially likely to happen between parasites and their hosts.

Speciation in Plants

- In terms of reproduction, plants have a lot more options than animals do.
- Many plants can reproduce sexually, by fertilizing other individuals or themselves, and asexually, by creating clones of themselves through vegetative reproduction, while most animals only reproduce sexually.
- Similarly, in terms of speciation, plants have more options than animals do.
- Two modes of speciation are particularly common in plants:

1. Speciation by hybridization:

- For example, when Loren Rieseberg and coworkers reconstructed the phylogeny of several sunflower species, they found that several species had been formed by fertilizations between other species.

- Often the hybrid offspring of such

fertilizations are sterile, but occasionally they are fertile and are reproductively isolated from their "parent" species.

- In the latter case, a new species is formed.

2. Speciation by ploidy changes:

- In terms of plant speciation, a ploidy change generally means multiplying the number of chromosomes the species has by some number.
- Ploidy changes are common in plants and often produce a species that is reproductively isolated from the "parent" species.
- *For example, speciation in the anemones involved a ploidy change.*

Activity

Define plant speciation and the mechanisms of plant speciation?

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5.2. ***Dispersal and Extinction***

Brainstorming

what do you think about dispersal and extinction

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- There are four fundamental processes in biogeography:
  i. evolution,
  ii. speciation,
  iii. dispersal and
  iv. extinction.
- All the bio-geographic patterns that we study derive from the effect of these processes.
- Dispersalists (Darwin, Alfred Wallace, and Asa Gray) argued that species disjunctions can best be explained by long-distance dispersal across existing barriers.
- Their antagonist in this debate were the extensionists (Charles Lyell, Edward Forbs, and Joseph Hooker), who argued that disjunctionists were the result of movements along ancient corridors that subsequently disappeared.
- Evidence for the extensionists: a new mechanism of dispersal emerged in the early-twentieth century:i.e continental drift.
- No longer was it necessary to propose such rare and unlikely event as long distance dispersal to account for disjunctions.
- Species could simply ride on the continents as they split and migrated across the surface of the earth.
- This splitting of once continuous populations would serve as a vicariant event and promote divergence of the now isolated populations.

Point of contention has been transformed into: long-distance dispersal versus plate tectonics, orogeny, and other vicariant events in shaping bio-geographic patterns: in other words, did dispersal occur before or after barriers formed?

What is dispersal?

- All organisms have some capacity to move from their birth places to new sites.
- The movement of offspring away from their parents is a normal part of the life cycle of virtually all plants and animals.
- Often dispersal is confined to a particular stage of the life history.
- Higher plants and some aquatic animals are sessile as adults, but in their earlier developmental stages are capable of traveling along distances from their natal sites.
- But mobile animals can shift their location at any time during their lives

Dispersal vs Dispersion

- Dispersal should not be confused with dispersion, an ecological term referring to the spatial distribution of individual organisms within a local population.

Dispersal as an ecological process

- Plants and animals have evolved an incredibly diverse array of dispersal mechanisms.
- Yet in all cases dispersal is basically an ecological process that is an adaptive part of the life history of every species---Natural selection favors individuals that move a modest distance from their natal site.
- A new location is always likely to be more favorable than the individuals exact birth-place, in part because intra-specific competition between parents and offspring and among siblings is reduced, and in part because the environment, and hence the quality of the natal site is always changing.
- On the other hand, as distance from the natal site increases, habitats become more dissimilar and as a result, would be colonists are less likely to be well adapted to their new habitats.

Dispersal as a historical bio-geographic event

- Usually bio-geographers must look at dispersal as a historical process, and must infer the nature and timing of past long-distance movements from indirect evidence, such as the distribution of living and fossil forms.
- The distribution of every taxon reflects a history of local origin, dispersal and extinction.
- Patterns of endemism, provincialism and disjunction of geographic ranges indicate that the dispersal of some groups has been so limited that their histories are indeed reflected in the distribution of their living and fossil representatives

Dispersal and Range Expansion

- In order to expand its range, a species must be able to
  (1) travel to a new area,
  (2) withstand potentially unfavorable conditions during its passage, and
  (3) establish viable populations upon its arrival.
- Bio-geographers often distinguish three kinds of dispersal events (mechanisms of range expansion)
  i. jump dispersal,
  ii. diffusion, and
  iii. secular migration.

i. Jump Dispersal:

- It is also known as long- distance dispersal
- If you built up a pond at your backyard, you will be impressed by the rate at which populations of aquatic insects, snails, other invertebrates, vascular plants and algae become established there.
- The same process of colonization occurs on larger geographic scale.
- Long distance dispersal(jump dispersal) has at least three important consequences for bio-geographers.
  i. it can be used judiciously to explain the wide and often discontinuous of many taxa of animals, plants and microbes.
  ii. it accounts in part for both the similarities and the differences among biota inhabiting similar environments in different geographic areas.
  iii. Finally, it emphasizes the importance of the many changes that have occurred as expanding human civilizations have aided the long-distance travel of species to the most remote point of the globe.
- Not all kinds of organisms can successfully disperse due to barriers.

- However, because chance plays such an important role in the successful dispersal and establishment of colonists, there is a certain degree of taxonomic randomness (or stochasticity) in the compositions of biota.

ii. Diffusion:

- In comparison to jump dispersal, diffusion is a much slower form of range expansion that involves not just individuals, but populations.
- Whereas jump dispersal can be accomplished by just one or few individuals within a short period of their life span, diffusion typically is accomplished over generations by individuals gradually spreading out from the margins of species range.

Relationship between the two mechanisms

They are closely related, as diffusion often follows the jump dispersal of a species into a distant, but uncolonized region of hospitable habitat.

- Diffusion typically proceeds in three stages.
- Initially, invasion and range expansion may be very slow, and may require repeated dispersal events and adaptation to the characteristics of the ecosystem being invaded.
- Once an invasive species becomes established, however, its geographic range often expands at an exponential rate.
- Eventually, range expansion slows when the species encounters physical, climatic, or biological barriers.
- At this stage, geographic ranges may remain relatively stable unless environmental conditions become substantially altered or the species somehow crosses the barrier and reinitiates the invasion sequence.

iii. Secular Migration:

- This takes place so slowly-on the order of hundreds of generations-that species have ample opportunity to evolve on route.
- During the eighteenth century, Buffon hypothesized that most life forms originated in northern regions of the Old and New Worlds.
- From there, they migrated southward and once isolated, became modified—this is fanciful

Activity

Identify the mechanisms of dispersal of organisms?

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Mechanisms of Movement

1. Active dispersal:

- Organisms can disperse either
  - i. actively(moving under their own power) or
  - ii. passively (being carried by a physical agent, such as wind or water, or by other organisms).
- The term **vagility** and **pagility** are sometimes used to denote the ability of the organisms to disperse by active or passive means, respectively.

Which organisms can perform active dispersal or passive dispersal?

- Only few animals are capable to travel long distances under their own power---strong fliers(volant species), such as many birds, bats, and large insects have the greatest capability for long distance dispersal.
- Non-volant animals such as some of the large mammals, reptiles and fishes, are also able to disperse substantial distances by swimming or walking.
- Active dispersal by swimming or walking means is generally less effective than flight because the animals are forced to swim or walk through the unfavorable intervening habitats; whereas flying animals can simply vault barriers.

2. Passive Dispersal:

- The vast majority of the organisms disperse largely or solely by passive means.
- In any plant community, for we can simply observe the movement of diaspores (seeds, spores, fruits, etc.)are carried by wind, birds or mammals.
- The wind carries seeds and fruits by inflated processes.

- Birds and mammals consume fleshy and dry diaspores, scattering some of them during feeding and distributing others later with their feces.
- The seeds, fruits, and spores of some plants become attached to the feathers or fur of animals and ride as hitchhikes until they are dislodged accidentally or by grooming.

Biotic exchange and dispersal route

- Bio-geographers often distinguish three kinds of dispersal routes based on their effects on biotic exchange (listed in order of increasing resistance to biotic exchange), these include:
  i. corridors,
  ii. filters and
  iii. sweepstakes routes.
- **Corridor** refers to a dispersal route that permits the movement of many or more taxa from one region to another.
- A corridor therefore allows a taxonomically balanced assemblage of plants and animals to cross from one large source area to another, so that both areas obtain organisms that are representative of the other.

By definition, a corridor does not selectively discriminate against any form, and must therefore provide an environment similar to that of the two source areas.

- **Filters** as its name implies, a filter is a dispersal route that is more restrictive than a corridor.
- It selectively blocks the passage of certain forms while allowing those able to tolerate the conditions of the barrier to migrate freely.
- As a result, colonists tend to represent a biased subset of their respective species pools.
- For example, the Arabian subcontinent is a harsh filter that permits the dispersal of only a limited number of mammals, reptiles, non-passerine ground birds, invertebrates and xerophytic plants between Northern Africa and Central Asia.
- Filter may be produced by biotic or abiotic factors.
- Filter often forms a transition zone between two bio-geographic regions.
- **Sweepstakes route**, the term was coined by G.G. Simpson to describe rare, chance dispersal from one locality to another across a major barrier.
- In a sweepstakes, many individuals enter the contest, but only a handful of lucky one win prizes.
- Only those species or groups with features that permit long-distance jumps and tolerance of psychological hardships have any chance of arriving in a remote area.
- A severe barrier that results in this type of stochastic dispersal pattern is known as a sweepstakes route.

Activity

Explain the mechanisms of movement of organisms during dispersal?

Extinction

- Extinction can be defined as the end of existence of a group of organisms, caused by their inability to adapt to changing environmental conditions.
- The history of life on Earth is influenced by both
    i. Evolution (which allows organisms to adapt), and
    ii. extinction.
- Extinction affects individual species—that is, groups of interbreeding organisms as well as collections of related species, such as members of the same family, order, or class.
- Therefore, a species becomes extinct when the last existing member of that species dies.
- *A species may become functionally extinct when only a handful of individuals survive, which are unable to reproduce due to poor health, age, sparse distribution over a large range, a lack of individuals of both sexes (in sexually reproducing species), etc*
- The extinction of one species in wild population can have knock-on effects, causing further extinctions; these are called "chains of extinction".
- This is especially common with extinction of keystone species.
- Some species, called a keystone species, form a central supporting hub in the ecosystem.
- The loss of such a species(keystone species) results in a collapse in ecosystem function, as well as the loss of coexisting species.
- The importance of a keystone species was indicated as follows by the extinction of the Steller's Sea Cow (Hydrodamalis gigas) through its interaction with sea otters, sea urchins, and kelp.
- Kelp beds grow and form nurseries to shelter creatures that support the food chain.
- Sea urchins feed on kelp, while sea otters feed on sea urchins.

- With the rapid decline of sea otters due to overhunting, sea urchin populations grazed unrestricted on the kelp beds and the ecosystem collapsed.
- Left unchecked, the urchins destroyed the shallow water kelp communities that supported the Steller's Sea Cow's diet and hastened their demise.
- In this regard, the sea otter is a keystone species because the coexistence of many ecological associates in the kelp beds relied upon otters for their survival

Pseudo-extinction

- Descendants may or may not exist for extinct species.
- Extinction of a parent species where daughter species or subspecies are still alive is also called pseudoextinction.

Co-extinction
Is it similar to chains of extinction?

- Co-extinction refers to the loss of a species due to the extinction of another; for example, the extinction of parasitic insects following the loss of their hosts.
- Co-extinction can also occur when a species loses its pollinator, or to predators in a food chain who lose their prey.
- Species co-extinction is a manifestation of the interconnectedness of organisms in complex ecosystems.
- Co-extinction is especially common when a keystone species goes extinct.

Causes of extinction

- As long as species have been evolving, species have been going extinct.
- Any species that is unable to survive or reproduce in its environment, and unable to move to a new environment where it can do so, dies out and becomes extinct.
- Extinction of a species may come suddenly when an otherwise healthy species is wiped out completely, as when toxic pollution renders its entire habitat unliveable; or may occur gradually over thousands or millions of years, such as when a species gradually losses out in competition for food to better adapted competitors.
- Debate on genetic vs environmental(nature-nurture) causes.

- Humans can cause extinction of a species through overharvesting, pollution, habitat destruction, introduction of new predators and food competitors, overhunting, and other influences.
- Generally, the following are some of the main causes of extinctions of species

1. Genetics phemomena

- Natural selection acts to propagate beneficial genetic traits and eliminate weaknesses.
- Mutation---change in genetic material(it can be source of beneficial genetic variation, or it can be neutral or harmful in effect)

2. Genetic pollution

- Purebred wild species evolved to a specific ecology can be threatened with extinction through the process of genetic pollution, i.e., uncontrolled hybridization, introgression, genetic swamping which leads to homogenization, out-competition from the introduced, or hybrid species.
- Endemic populations can face such extinctions

3. Habitat degradation

- Habitat degradation is currently the main anthropogenic cause of species extinctions.
- The main cause of habitat degradation worldwide is agriculture, with urban sprawl, logging, mining and some fishing practices.
- The degradation of a species' habitat may alter the fitness landscape to such an extent that the species is no longer able to survive and becomes extinct.
- This may occur by direct effects, such as the environment becoming toxic, or indirectly, by limiting a species' ability to compete effectively for diminished resources or against new competitor species.
- Habitat degradation through toxicity can kill off a species very rapidly, by killing all living members through contamination or sterilizing them.

- It can also occur over longer periods at lower toxicity levels by affecting life span, reproductive capacity, or competitiveness.

- Habitat degradation can also take the form of a physical destruction of niche habitats.
- The widespread destruction of tropical rainforests and replacement with open pastureland is widely cited as an example of this; elimination of the dense forest eliminated the infrastructure needed by many species to survive.
- For example, a fern that depends on dense shade for protection from direct sunlight can no longer survive without forest to shelter it.
- Diminished resources or introduction of new competitor species also often accompanies habitat degradation.
- Sometimes these new competitors are predators and directly affect prey species, while at other times they may merely out-compete vulnerable species for limited resources.
- Moreover, vital resources including water and food can also be limited during habitat degradation, leading to extinction.

4. Predation, competition, and disease

5. Global warming

- Because of climate change, 15–37% of land species would be "committed to extinction" by 2050.
- The ecologically rich areas that would potentially suffer the heaviest losses include the Cape Floristic Region, and the Caribbean Basin.

These areas might see a doubling of present carbon dioxide levels and rising temperatures that could eliminate 56,000 plant and 3,700 animal species.

Mass extinctions

- It refers to any episode of multiple losses of species.
- However, the term is generally reserved for truly global extinction events in which extensive species loss occurs in all ecosystems on land and in the sea, affecting every part of the Earth's surface.
- Scientists recognize five such mass extinctions in the past 500 million years.
- The worst known mass extinction in history was not the one that ended the age of the dinosaurs 65 million years ago, but an even more devastating event about

250 million years ago that killed off roughly 90 percent of marine species and also wiped out most land animals.

- The most recent of these, the Cretaceous–Tertiary extinction event 65 million years ago at the end of the Cretaceous period, is the best known for having wiped out the non-avian dinosaurs, among many other species.

Elaborate the causes of extinction of an organisms?_____

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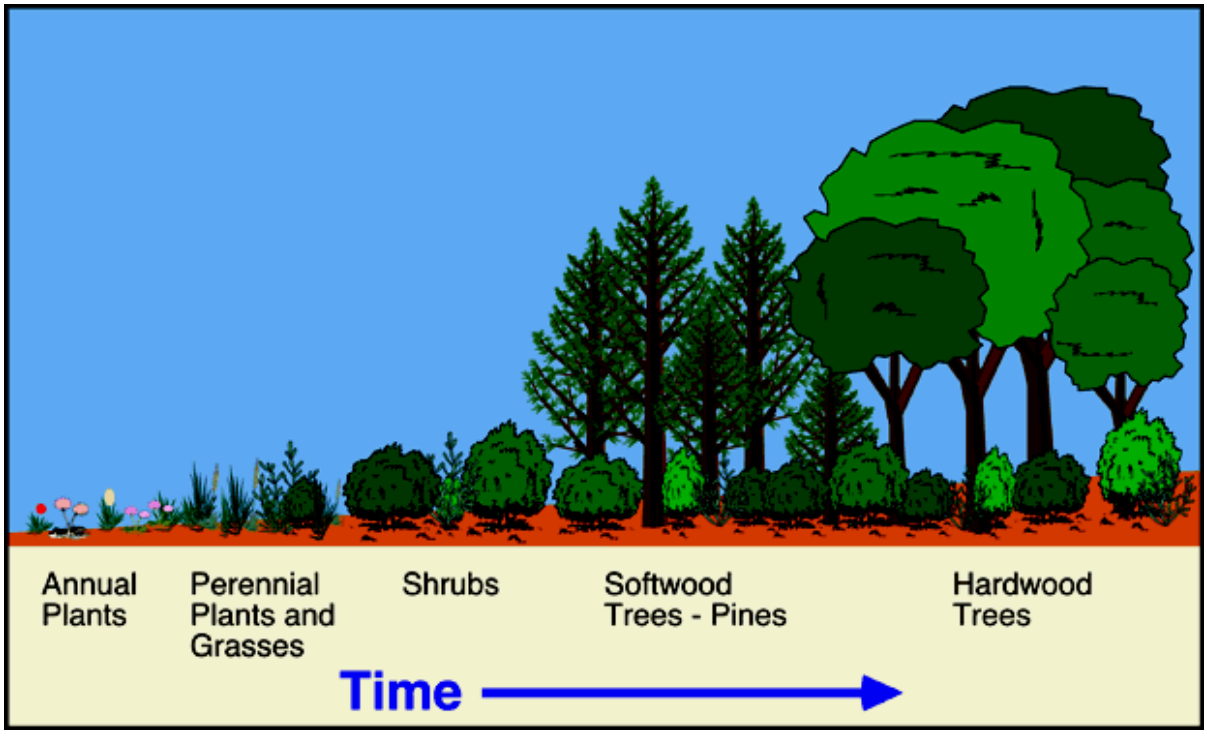
Ecological succession, stability, and biodiversity

- *Brainstorming*

What do you know ecological succession?

- Succession, a fundamental concept in ecology, refers to more or less predictable and orderly changes in the composition or structure of an ecological community.
- Or replacement of populations in habitat as it moves toward a stable state (determined by changes in plants)



- Succession may be initiated either by

i. formation of new, unoccupied habitat (e.g. a lava flow or a severe landslide) or

ii. some form of disturbance (e.g. fire, severe wind throw, logging) of an existing community.

Types of plant succession

i. Primary succession

- It begins in areas where initially no soil was present.

- *If the development begins on an area (such as a newly exposed rock or sand surface, a lava flow, glacial tills) that has not previously occupied or a newly formed lake, the process is known as primary succession*.

- In primary succession, everything has to develop a new community.

ii. Secondary succession

- begins in areas where soil is already present.

- *If the community development is proceeding in an area from which a community was removed, it is called secondary succession---when* original vegetation cover has been disturbed by humans or animals (an abandoned crop field or cut over forest, or natural forces such as water, windstorms, and floods)
- Shortly after the disturbance, the first wave of colonizing plants (pioneer community) establishes themselves.
- The pioneer community usually consists of various short-lived, small, but fast growing plant species.
- Secondary succession is usually more rapid as the area to be colonizing is rich in leftover soil, organic matter and seeds of the previous vegetation.

- Plant succession involves the processes of colonization, establishment, and extinction that act on the participating plant species.
    - Plant succession is a major limiting factor for animal succession.
    - <u>Animal Succession</u>- as the plant community changes so will the animals.

Climax community

- It is the final stage in the ecological succession of plant communities in an area
- Populations remain stable—it persists until a catastrophic change alters or destroys it.
- Plants become long-lived, larger, and slower growing---succession stops at this stage.
- *Ecological stability---point of stability that can last for hundreds or thousands of year*

Biodiversity

- *"Biodiversity" is "variation of life at all levels of biological organization".*
- *Biodiversity -- the differences in living things in an ecosystem*
- *Increased biodiversity increases the stability of an ecosystem.*
- *Increased biodiversity increases the chance that at least some living things will survive in the face of large changes in the environment*