Al- Azhar University
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LECTURES

IN

PLANT ECOLOGY

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Contents

Plant Ecology

The word " Ecology" is derived from Greek words, **Oikos** meaning Home and **Logos** meaning Science or study ; thus the word ecology was first proposed by a zoologist named Reiter in 1885, it means the study of living organisms, both plants and animals in their natural habitats or homes …. It can also be defined as the study of life in relation to environment (Shukla & Chandel , 1980) ; the environment being the aggregate of all external conditions and influences which affect the life and development of organisms at a given spot .

Ecology is the study of the reciprocal relationship between living organisms and their environments (Haeckel) or the study of the structure and the function of nature (Odum). So, the study of the reciprocal relationship between a plant (or plants) and its (or their) environment is called **plant Ecology** and has two aspects : autoecology and synecology. **Autecology** is concerned with the study of individual species and its environmental factors, while **synecology** (phytosociology) is the study of plant populations (communities) and their complex of ecological (or environmental) factors.

The plant ecologist must have deep knowledge about various branches not only of botany (e.g. taxonomy, morphology, physiology, anatomy, flora etc. but also of other branches of scinces that help him to understand and explain the ecological phenomena in the study area e.g. soil science, climatology, geomorphology etc.

Different fields of Ecology:

Different branches which are made to account for various specific and detailed aspects of ecology are as follows:

1- Habitat Ecology 2- Ecosystem Ecology

3- Conservation Ecology or Resource Ecology

4- Cytoeclogy 5- Paleoecology

6- Ecological energetics and Production Ecology.

Levels of Ecological inetration:

Plants, in nature, usually growing in group, not in isolated individuals. These groups may consist of plants of a single species , constituting a population, but if the group comprises individuals of several species, it constitutes a community are considered in the study of ecology and are the three principal kinds of ecological systems.

The individual is a genetically uniform cntity, normally, no part can live independent of the rest of the organism. The ecology of the individual is concerned with the way that a particular plant interact with environment.

This level of integration may be called physiological ecology , or Ecophysiology.

The Population : any relatively isolated, interbreeding groups of individuals is called a local population. A local population in a specific environment tends to become genetically adapted to that environment , by natural selection, by the survival of individuals with certain genes or gene combinations.

An individual plant is related to other organisms in two ways:

a) Genetically : with other members of its species.
b) Ecologically : to other plants of its biological community.

The community : individuals and populations do not live alone in nature but in a community with at least a fern, and usually a great many other plants.

These aggregations are not habhazard accumulation. On contrary, they are spatially orderd, machine- like organization which utilize energy and raw materials in their operations.

The Ecosystem represents the highest level of integration in ecological machine- like community of plants together with the environment that control them from an ecological complex or more briefly an ecosystem.

The basic unit of ecology is the community, and ecology in its broadest sense is the study of ecosystems i.e. the communities, their structure, operations, and environment .

Part I
THE ECOSYSTEM

Tansley (1935) first put the concept of ecosystem forth.
Ecosystem is the major ecological unit. It is the basic functional unit of organisms and their own components. An organism is always in the state of perfect balance with the environment (surroundings) .

The function of ecosystem is related to the fllow of energy and cycling of materials through structural components of the ecosystem. Ecosystem is a complex in which habitat, plants and animals are considered as one interesting unit . the materials and energy of one are passing in and out of the others (Clarke, 1954 ; Woodbutr, 1954).

All the ecosystem of the earth are connected to one another ; i.e. river ecosystems connected with the ecosystems of oceans, and a small ecosystem of dead logs in a part of large ecosystem of a forest .

Components of ecosystem:

According to odum, all ecosystems (terrestrial or aquatic) from the functional or trophic (nutrition) point of view have two basic components:

1) Autotrophic component, and
2) Heterotrophic component.

Various sizes, e.g., one square of grassland, a pool a large lake, a large trtact of forest, balanoed aquarium, a certain area of river and ocean. All the ecosystems of the earth are connected to one another, e.g., river ecosystem is connected with the ecosystem of oceans, and a small ecosystem of dead logs in a part of large ecosystem is rarely found in nature but situations approaching self- sufficiency may occur.

Components of ecosystem, According to odum, all ecosystem; terrestrial or aquatic, from a purely functional or trophic (nutriction) point of view have the following two basic components:

I) Autotrophic component, and
II) Heterotrphic component

" The autotrophic component fixes the radiant energy of sun and manufactures food from simple inorganic substances.

Rearranges it and finally decomposes the complex organic materials into simple inorganic forms.

In the ecosystem, the autotrophic and heterotrophic components are arranged in layers or strata. The autotrophic metabolism is greatest in the upper stratumwhere maximum light is available.

In the forest ecosystem, the autorophic metabolism is maximum in the canopy and the water ecosystem is in the surface water where mostly autotrophs are concentrated because of maximum availability of light.

The heterotrophic activity is maximum in the lower layer where organic matter accumulates. In the land ecosystems the heterotrophic stratum is the top layer of soil and in aquatic ecosystem it is the bottom sediments.

The ecosystem have structures also and they contain both non-living or abiotic substances such as water, soil, air and energy and living or biotic components such as pla-nts, animals and microbes. According to odum, ecosystems generally include four categories of basic structural com- ponents :

1) Non- living or Abiotic components.
2) Producers, mainly green plants.
3) Consumers, almost exclusively animals.
4) Demomposers, mainly bacteria and fungi.

Fundamental steps in the operation of Ecosystem:

The principal steps in the operation of ecosystem are as follows:

1) Reception of radiant energy energy of sun.
2) Manufacture of organic materials from inorganic ones by producers.
3) Consumpotion of producers by consumers and further elaboration of consumed materials.
4) After the death of producers and consumers, complex organic compounds are degraded and finally converted by decomposers and converters into such forms as are suitable for reutilization by producers.

The principal steps in the operation of ecosystem not only involve the production, growth and death of living components but also they influence the abiotic aspects of habitat.

Part II

THE ENVIRONMENT

The environment is the aggregate of an organism or a group of organisms and a set of conditions which directly or indirectly influence not only the life but also the communities at a particular place. So any external force, substance or condition affecting the organisms in any way is referred to as environmental factor. Environmental factors are classified as:

1. a- Conditions e.g. temperature, light etc.
   b- substances e.g water, carbon dioxide, oxygen , nutrients etc. and
   c- forces e.g wind, gravity etc.

or

II. a- Cilmatic factors which are related to atmospheric surroundings of the plant and include: precipitation, temperature, light, wind, evaporation, dew etc.
   b- Edaphic factors which are related to the subsurface part of the plants and include soil structure, soil texture, soil water , soil salinity etc.
   c- Biotic factors that include the biotic elements (man, animal, plant and microorganisms) affecting and are being affected by the aerial and subsurface parts of the plants, and
   d- Physiographic factors, which are related to the form and behaviour of the earth's surface and include also the exposure to sun, slopes, surface, altitude etc. (topography) and substratum.

Chapter 1
CLIMATIC FACTORS

Climate is one of the important natural factors, which controls the plant life. Its study is called climatology. The climate includes the following main factors:

1- light
2- temperature
3- precipitation and atmospheric humidity
4- winds

1- light

The radiant energy coming from the sun in the form of visible spectrum is called light or **luminous energy** Radiation that penetrates the earth atmosphere consists of electromagnetic waves of a wide range in wavelengths . A beam of light is pictured as a shower of particles called **photons** E ach photon carries a certain amount of energy called **quantum** when the visible sunlight is passed through a prism it is dispersed into a series of wavelengths exhibiting seven different colours (**VIBGYOR)** : Violet, indigo, blue, green, yellow, orange, and red (see fig 1) .

Light is usually measured by an electric instrument called light- meter or photometer which consists of light sensitive photoelectric cell the intensity of light is directly recorded on a dial of the photometer. It is measured in foot candle or lux.

In water meadium the intensity of light is reduced and this decreases progressivel with the invrease of water depth. About 10% of the sunlight falling on the water surface is reflected and 90% of that penetrates.

Phytoplankton, zooplankton and suspended particles either reflect or absorb the light rays. Submerged plants get weaker light than the on the surface of water get. It is so because a proportion of light falling on the water surfzce is reflected and the major portion of the penetrating light absorbed by upper proportion of rays of shorter wavelengths. i.e., violet, indigo, blue and green, are reflected and other lights are partly absorbed. This is the cause of the bluish green appearance of bodies in water.

Light weak at sunset in water and comparatively stronger during the midday hours. This periodical fluctuation in the intensities of light is due to the change in the angles of radiation reaching the earth. The skylight or diffused light available before sunrise and after sunset is of great ecological importance , Moon light sometimes atisfies light requirements of certain seeds, promotes starch hydolysis in the leaves, affects nocturnal leaf movement in legumes, and stimulates the sexuality in certain marine algae.

Light affects many physiological activities of the plants. It affects the following aspects of plants life:

1- PHOTOSYNTHESIS: Out of the total solar energy reaching to theearth, only about 2% is used in photosynthesis , and about 10% is used in other physiological activies. Red and blue green are the two maxima of absorption of light.

a. The green plants, the producers of ecosystem, synthesize their foor (carbohydrates) from water and CO_2 in precess, radiant energy by chloroghyll. The chemical energy stored in food is utilized in various other biochemical activities in the plants.
b. The rate of photosynthesis is greater in intermittent light than in the continuous light. The relationship of light intensity with photosynthesis in terrestrial as well as in aquatic plants follows the general pattern of linear increase up an optimum or saturation intensity follwed by a decrease. at high intensities.
c. Light plays important role in the development of plastids and pigments. It has marked effect on the number and position of chloroplasts. The upper part of leaf that receves full sunshine has a large number of chloroplasts which are arranged in line with the direction of light (fig. shows the leaf structwe)
d. At high intensity , the photooxidation of enzymes reduces not only the rate of carbohydrate synthesis but also that of protein synthesis. The protein synthesis is especially reduced by high intensity of light. High intensity of light, however, influences the formation of anthochanin pigment. It is for this reason, alpine plants have beautifully coloured flowers.

2- Respiration:

A- There is no direct effect of light on the respiratory activity in the plant body. Indirect effects much important because in presence of light, the respiratory substrates are synthesized.

B- In shde and under water, the light becomes a limiting factor and the photosynthesis is not sufficient for effective growth. Under such conditions, the rate of photosynthesis is just sufficient to meet the need of respiration.
This is called "compensation point". In many plants the respiratory rate increases with the increase in the light intensity.

C- Respiration rates, in some other plants, decreased slightly in intense light.
The rise and fall of respiration rate may be due to the effect of light on the permeability of plasma membrane, change in the viscosity of the protoplasm and photooxidation of enzymes. The permeability and viscosity increase with the increase in light intensity up to certain optimum. Light, however, has got very little effect in respiratory process of lower plants and thallophytes.

3- Opening and closing of stomata

a) The stomata remain opened in the light and closed in the dark.
b) Light brings about phosphorylation and conversion of starch into soluble sugars in the guard cells and thereby increases their osmotic pressure, which in turn causes inflow of water in the guard cells.
c) The increase in the turgidity of guard cells causes widening of gap between two guard cells.
d) The opening of stomata increase the gaseous exchange and also increases the rate of transpiration during day period.
e) Increase in the light intensity above the optimum shows detrimental effects.
f) The increase of transpiration in the intense light is injurious to plants.

4- Growth and flowering of plants:

A) Light shows many fold effects on the growth of the plants.
B) Growth of plants depends especially on the production of auxins or growth hormones and consequently it influences the shapes and sizes of plants.
C) Plants growth in darkness or insufficient light produce maximum amount of growth hormones as a result of which they are elongated with slender pale yellow stem and small leaves.
D) The plant growth is slow in the light of high intensity. Red light favours the growth. Lights of shorter wavelength, violet , are detrimental to plant growth.
E) Duration of light is also very important . the length of the day (photoperiod) is important factor in the growth and flowering oof wide variety of plants.

According to their response to the length of photoperiod, the plants have been classified into three well defined groups:

I) long clay plants: Plants which bloom when the light duration is more than 12 hours per day, as for example radish. Spinach, etc.
II) short day plants : plants which bloom when the light duration is less than 12 hours per day, as for example cereals, tobacco, etc.
III) Day netural plants:
IV) Plants which show little response to length of day light, as for example tomato plant.

2- Temperature

The most influential factors in the climate are temperature and moisture.

The temperature affects the vegetation either directly or indirectly. The direct effects apper in two ways:

- It determines which species can survive in a particular region.

a) The different species of plants show a wide variation as regards their tolerance to temperature range organisms can carry on their life activities over a relatively narrow temperature range extending from oc to 50 c°.
b) Every plant has a specific range of temperature requirement. This range differs from species to species. Plants do not thrive in places with higher or lower temperatures. Generally, at 40c the protoplasm undergoes such changes as minimal to plant life and it dies at temperatures above 90.
c) Some plants carry on their processes at high temperatures but at 70, plants rarely survive. At temperatures below freezing point, plants generally die because of rapid crystallization of protoplasmic water, which results in mechanical injury.
d) The general inability of protoplasm to endure high temperature can be due, in large pert, to the sensitivity of its enzymes to heat . catalytic proteins in nearly all cases are irreversibly inactivated by exposure to high temperature.
e) The optimum temperature for seed germination ranges between 0c° and 27c°. the absorption rate is retarded at low temperature.
f) Most of the algae require lower temperature range for photosynthesis than the higher plants. The photosynthesis continues even at 50c° in some desert plants.
g) The rate of respiration increases with the rise of temperature up to a certain level, but beyond the optimum limit the respiration rate shows marked qecrease. The rate of respiration becomes doubled at the increase of 10 c° above the optimum temperature provided other factors are favourable(Vant Hoff's law). High temperature generally favours the growth of plants. But for some crop plants, low temperature is beneficial.
h) Temperature in combination with humidity and factors helps in the spread of diseases in plants. Low temperatures.
i) Temperature in combination with humidity and other factors helps in the spread of diseases in plants. Low temperature and high humidity favour the rust attack, while low temperature, high humidity and cloudy weather favours the damping of seedling, blight and root rot diseases of cucurbits and tobacco. Temperature in combination with moisture determines the general distribution of vegetation.
j) Temperature varies from place to place and likewise the vegetations of different areas also differ considerably. Desert plants grow in extreme heat, aquatic plants grow in low temperature range, and grasses prefer to grow in the area of moderate temperature.

3- Precipitation and Atmospheric Humidity

Water is one of the most important climatic factors.

I) It affects the vital processes of all the living organisms.
II) It affects the morphology and physiology of the plants.
III) It, in combination with other factors, regulates the structure and distribution of plant communities.
IV) In nature. Water may be found in vapour, liquid and snow or ice states.

In the atmosphere, water is found in the form of vapour. The quantity of water retained in the atmosphere depends on temperature and wind. Vapour increases with the riseof temperature and the decreasing of ressure.

V) The precipitation is the condensation of vapour in the form of rain volume air at certain temperature

Absolute humidity is the amount of water required to saturate the same unit volume of air at certain termperature.

Relative humidity is the amount of water required to saturate the same unit volume of air under constant physical conditions.

Water of atmosphere reaches to the earth's suface though precipitation and from earth's suface. It reaches to the atmosphere through evaporation and trans[iration. Thus a continuous circulation of water from earth to atmosphere and vice versa is maintained in nature. This is called water cycle or hydrologic cycle (see Fig:)

According to precipitation- evaporation ratio, climate can be classified as follows:

1- **Arid** : It is characterized by the condition that evaporation is greater than precipitation.
2- **Arid- humid** : When evaporation is more or less equal to precipitation.
3- **Humid**: when evaporation is lesser than precipitation.

Sudden and heavy rains are not so beneficial because in the heavy rain a large amount of water is lost from the surtace of soil as run off and the soil is eroded.

- Rainfall is determined largely by geography and pattern of large air movements of weather systems. The amount of rainfall in different localities largely determines the nature of vegetation.
- The atmospheric humidity influences directly the form and structure of the plants. It directly affects the transpiration rate of the plants. In a dry atmosphere, transpiration rate increases and in the water content of the leaf tissues decreases and leaves with temporarily.

On the basis of their water requirements, the plants are grouped into there ecological groups:

a) Hydrophytes: Plants adapted to aquatic environment.
b) Xerophytes: plants adapted to grow in dry lands where water content is low .

c) Mesophytes : Plants living in the habitat that usually shows neither an excess nor a deficiency of water.

4- WIND

Air moves from high pressure to low pressure, causing wind,
The atmospheric of a number of glass particles and other constituents. The proportion of glass in atmospheric air is kept constant tofair degree:

Nitrogen	78%
Oxygen	21%
Carbon dixide	0,03 %
Argon and other gases	0,93%

The other constituents very depending upon habitat condition, microorganisms carried on these particales, pollen grains and spores etc.

The effects of wind on the vegetation are important. The wind exerts an influence upon both configuration and distribution of plants.
It commonly affects other ecological factors, as for example, the water content and temperature in a given area, through its effect on evaporation. It plays both positive and negative roles in the atmosphere, for instance, it has drying effect upon soil and may occasionally act in opposite direction bringing in moist air that reduces the transpiration and evaporation and may actually lead to the important effects of wind on vegetation:

I) Wind increases the water loss by constantly removing the air saturated with water vapour from the intercellular spaces of the leaves and bringing unsaturated air in contact with leaves and young shoots.

II) Mechanically, wind causes erosion of soil and abrasion of vegetation through removal of particles and physiologically, it decreases the growth of plants by way of reducing the moisture content of air and reducing the turgidity of plant parts on which it impinges.
Moist air promotes the growth of mesophytes.

III) In strong dry and hot winds, young parts of plants may become shriveled and killed in a few hours and the surface of soil may become dry.

IV) In open situations, e.g. sea shores and high mountain tops, where the strong winds blow all the year round in one direction, the trunks and branches are twisted chiefly the growth of buds becomes checked on windward side.

V) In strong wind, big trees are uprooted and small plants and grasses are affected but to a very little extent. By strong wind weak plants like wheat, maize, sugarcane, jwar, etc. are bent against the ground. These prostrated plants, if their stems are not too mature, may again become partially erect. This is due to differential growth at the meristematic lower nodes of these plants.

VI) Wind is an important agent for the dispersal of pollen grains, fruits, seeds the sand and seeds. Thus, it plays important role in local distribution of plant species or communities of plants, Some types are wind resistant but some my be totally dependent on wind for their dispersal. Many plants are unable to flourish or even exist in the exposed situations if they are brought to such placed by wind.

Strong wind causes injuries to plants growing at high altitudes. In desert, the storm results in big sand- dunes which cover the vegetation .

VII) In the areas subjected to strong winds, the leaves of plants become small and rolled. The transverse section of stem shows eccentrically developed secondary wood, i.e., the diameter of the trunks in the direction of wind becomes greater than that at right angle to it. The plants in such areas show extensive development of mechanical tissues which provide mechanical support and save the plants from wind injuries.

In India and many other countries of the world, unchecked winds have caused total disappearance of vegetation at certain places and rendered big areas deserted. Rajasthan desert in India is spreading eastward due to unchecked wind erosion.

Chapter 2
Edaphic or Soil Factors

Definition of soil:

The word soil in an ecological sense includes any part of the earth's surface in which plants are rooted:

The muddy bottoms of ponds, porous reck surfaces into which cryptogams send their rhizods, gravel ddeposited by glaeials, etc..

From a pedological sense, soil may be defined as the weathered upper layer of the earth's crust with which are mixed living organisms and products of their decay.

Typically, a soil is made up of perent material (the inorganic foundation or mineral framework) into which there has been incorporated an organic increments as well as living organisms, with the spaces remaining between the solid particles filled with water and gases.

The parent materials:

The basic formework of most soils consists of small fragments of mineral matter which have been derived from solid rock by mechanical or chemical types of weathering.

Mechanical disintegration of rock is brought about by temperature fluetuation, by growing roots, by the abrasive action of particles carried by running water and wind.

Chemical processes of weathering consist of hydrolysis oxidation, carbonation, and hydrolysis, by which certain minerals are converted into secondary minerals and solutes.

Chemical weathering also could happen as a result of carbonic acid secreted by plant roots, algae, bacteria and lichens that work their way into self-made cavities in rocks by dissolving away the less resistant minerals of which the rocks are composed.

Origin of soil:

The soil is the product of decomposition rocks and plant and animal residues. The rocks from which soil originate are divided into three categories:

1- Ingeous rocks:

Which result from the solidification of the molten magma. E.g. granite, basalt.

2- Sedimentary rocks:

Which result from the deposition and recementation of weathering products of rocks. E.g. sandstone, limestone.

3- Metamorphic rocks:

Those which have formed by the change in from of other rocks when subjected to pressure and high temperature.

Depending on the mode of origin, most parent materials can be classified as follows:

1- **residual parent as material.**
2- **Transported parent material.**
   a) Transported by gravity- colluvial.
   b) Transported by running water- alluvial
   c) Transported by glaciers- glacial
   d) Transported by wid- eolian
   e) Transported by other types.

1- residual parent materials resulted from the disintegration of rock in place. Since weathering with the atmosphere the most complete physical decomposition and chemical alteration. With increasing depth below the surface the mineral particles become larger and less altered chemically, until finally they integrate with bedrock.
2- Transported parent materials are compsosed of , or derived from mineral particles which have been brought from their place of origin by various agents. Their forms vary widely according to the agents of transport, and since most of the agents operate intermittently, the parent materials of this class usually occur in layers with abrupt transitions and do not integrate with the underlying bedrock as is characteristic of residual of material.

SOIL FORMATION (DEVELOPMENT)

Soil formation is basically a combination of destruction and synthesis. Rocks are first broken down into smaller rocks then into individual minerals of which they are composed. Simultaneously, rock fragments are attacked by weathering forces and are changed to new mineral either by minor modification (alteration) or by complete chemical changes.

These changes are accompanied by a continued decrease in particle size and by the release of soluble constituents.

Two basic processes are involved in soil development (rock weathering). These are:

1- mechanical (disintegration).
2- Chemical (decomposition) .

Disintegration results in a decrease in size of rock and mineral without affecting their composition. By decomposition, however, chemical changes take place, soluble materials are released, and new minerals are synthesized.

1) mechanical processes may be caused by temperature changes or water action.

A- Temperature changes:

In which different mineral constituents usually have different coefficients of expansion. It then a rock composed of different minerals (e.g. granite) is healed and cooled volume changes of the minerals. Changes in temperature also changes of the minerals. Changes in temperature also results in cracking or scaling off of the rock surface.

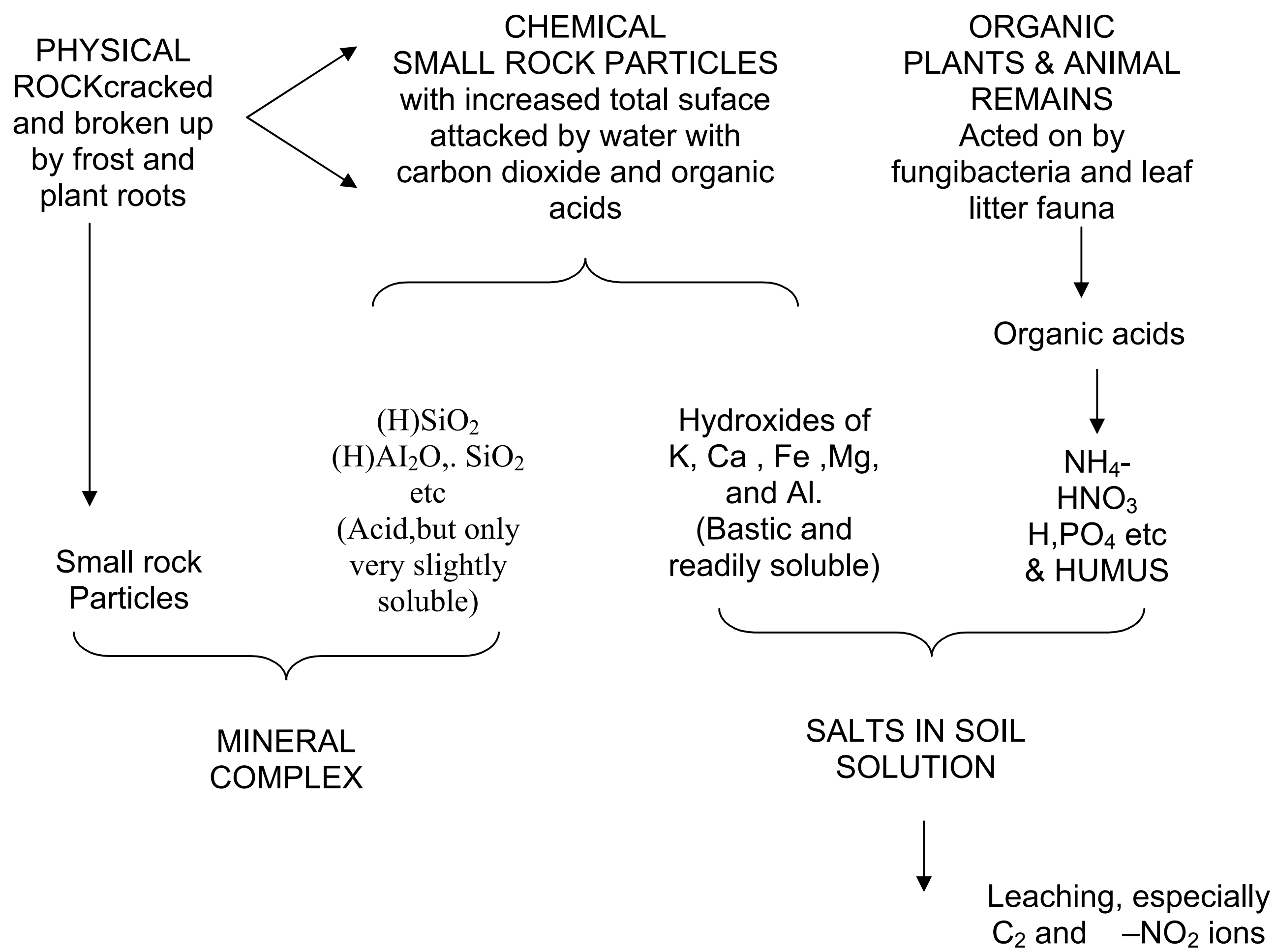
B- water action:

which upon freezing, on expansion a great force occurs. Accordingly water, accompanied by changes in temperature becomes an important agent in disintegrating soil material. When the water fills the crevices in rocks, freezes and thaws, the crevices enevices enlarged and cause the breakdown of rocks.

2) **Chemical processes of soil formation :**

<u>Hydrolysis</u>:

WEATHRING PROCESSES IN SOIL FORMATION



Outline scheme of the weathering processes in soil formation

Hydrolysis, which is a decomposition reaction, is important in weathering a wide range of minerals which contain strong bases., e.g.,

$Ca\ SiO_3 + 2\ HOH \longrightarrow H_2sio_3 + ca\ (OH)_2$

Calcium silicate   Silica acid

Hydration:

Hydration involves the attachment of H and OH ions to the compound being attacked. These ions become a part of the mineral structure. An example. An example of hydration is the hydration of iron oxide:

$2\ Fe_2O_3 + 3H_2\ O$ --------- $2\ Fe_2O_3.\ 3H_2\ O$

Hematitie (red)   Limonite (Yellow)

Carbonation:

Decomposition of organic matter and plant roots in the soil liberate large quantities of CO_2 into the soil. This gas combines with bases producing carbonates and bicarbonates.

$Ca\ (OH)_2 + 2\ CO_2$ --------- $Ca\ (HCo_3)_2$

$2\ KOH + CO_2$ --------- $K_2\ CO_3 + H_2\ O$

the carbonation is one of the most effective processes in decomposing soil minerals. As the bicarbonates of calcium and magnesium are fairly soluble, carbonation is the primary process in the aecumulation of residual soil material though decomposition of limestone.

Oxidation:

Oxidation is particularly noticeable in rocks carrying iron, an element which is easily oxidized. e.g. oxidation

$4\ FeO + O_2$ ----------- $2\ Fe_2\ O_3$

Reduction:

Occurs when the supply of oxygen is limited, It takens place particularly in deeper layers of the and in porrly aerated soils when O_2 is limited.

Solution :

The solvent action of water and the ions it carries as it moves throught rocks and minerals accelerate the weathering process.

3- **Biological activities and soil development**:

It is by the action of soil microorganisms that plant and animal remains are decayed, thus liberating the nutrients for the outrients for the use of the next plant generation and simulfaneously producing CO_2 and complex compounds which aid in mineral decomposition.

- Roots, particularly small ones, penetrate crevices in rock fragments, anlarying them and sometimes splitting the rock as growth continues. The porosity of the soil is also increased as result of root growth.

The continuous burrowing of worms and insects establish drainage channels in the soil. Earthworm pass large quantities of soil through their bodies, thus altering it both chemically and physically.

SOIL PROFILS

Examination of a vertical section a soil in the filed shows the presence of more or less distinct horizontal layers. Such a section is called a profile and the individual layers are regarded as horizons.
These horizons above the parent material are collectively referred as the solum, from the latin word meaning soil.

Soil Horizons:

The layering are horizon development is characteristic of mature soils. Each soil is characterized by a given sequence of these horizons. This sequence is termed a soil profile and is named and described as follows:

O- Horizon:

The o-horizon is on organic horizon which is formed above the mineral soil. It results. Oceurring commonly in forest areas, it is generally absent in granssland regions .

A- Horizon: (Zone of extraction)

It is the upper layer of a mature soil which is poor in soluble salts due to leaching, or washing `out. It consists colloidal clay. The granular structure is due to the greater humus content. In this grandlar layer roots penetrate easily and spread midely.

B-Horizon: (zone of concentration) :

It is the zone lying immediately below the a- horizon and into it are carried the soluble salts and the fine soil particles. Penetration of roots in this zone is more difficult and branching is pronounced.

C-Horizon:

In this zone neither extraction nor accumulation occurs.
The C-Horizon is composed of the some as the parent material from which the solum is formed. It is outside the zone of biological activities and is little affected by solum forming processes.
The depth of each horizon depends upon a vast complex of physical, biological, and chemical conditions within the region. The depth of the solum (true soil) is very important in governing the vegetation structure in any area. Where parent rock material is slightly weathered, only hardy plants (pioneer species, e.g. mosses and lichens) can endure these harch conditions. But deeper soil will support a varied and flourished vegetation.

SOIL TEXTURE

The soil is composed of particles of different sizes

The proportions of different- sized particles or soil texture has much to do with the physical and chemical properties of soil and hence with plant relationships.

The process of separation of the soil into groups of different sizes particles is know as mechanical analysis.

The international classification of particales according to their diameter is presented the following table: (Textural grades):

Nature of separates	**Particle Diameter (mm)**
Gravel	2 – 5 mm & more
Coarse sand	2 – 0,2 mm
Fine sand	0.2 – 0.02 mm
Sitl	0.02 – 0.002 mm
Clay	0.002 and less

The relative propotions of sand, silt, and clay in the soil determine what is called: Soil calss - texture, or textural grades . There is obviously an inifinite number of textural grades: e.g. silly-caly, silty- loam, etc.

<u>The Relation Between Soil texture and other soil properties:</u>

1- Water holding capacity :

Water is held in the soil in the form films around the particles, as weading in the angles between the particles and as moisture imbibed by the colloids.

The amount of water retained by fine- textured soil is greater than held by coarse-textured soil. This is due to the fact that the fine- textured doil has more aggregate surface, more angles and more colloidal material .

2- Infiltration of water:

When rain falls on a fine -textured soil it percolates rapidly, but in heavy soils the infiltration or rain water tekes place slowly resulting in loss of a considerable protion of water as run- off .

3- Rate of water Movement:

The movement of water in fine textured soil is slower than in coarse-textured ones due to presence of tiny interstitial spaces in the former type which offer considerable resistance to the mass movement of water.

4- Mechanical resistance of the soil :

The fine- textured soil, because of its finer particles and higher colloidal content has a greater mechanical resistance than the coars- textured one. For this reason, roots penetrate in sandy soils more easily than in clay soil.

5- Fertillity :

The colloidal content of the fine- textured soil is larger than of coarse – textured soil. Owing to the fact that the nutrient ions are held lossely by the colloids, the former type of soil is more fertile than the latter. For this reason, considerable amounts of fertilizers are to added to sandy soils.

6- Soil aeration:

In moderately coarse soils, as well as in heavy soils that are well aggregated, large interstitial spaces which facilitate the diffusion of gases.
As a result CO_2 produced in as soil by respiration of roots and organisms is able to escape easily, and the O_2 used up in this function diffuses into the soil easily
In heavy soils which are poolrly aggregated, the deficiency of O_2 and the toxicity of the excess CO_2 become limiting factor for plants.

SOIL PROSITY

The arrangement of the particles determines the amount and nature of the soil proes. Soil porosity may be defined as " the percentage of the soil volume which is not occupied by soil particles".

In a dry soil the total pore space will be filled with air. The pores of moist soil are filled with both air and water. The relative amounts of air and water percent will depend largely upon the size of the pores.

The porosity of the soil is calculated from the real and apparent specific granity.

The real specific gravity:

Is the weight of one Cm^3 of dry solid particles. The apparent specific gravity: is the weight of a given volume of soil in its natural structure. It represents the weight of one Cm^3 of soil and pore space. It is called" volume weight" of a soil.

The total porosity can be calculated by using the following formula:

$$\text{\% pore space} = 1 - \frac{\text{Apparent specific gravity}}{\text{real specific gravity}}$$

Clay soil possesses a large number of small pores which contribute to a high water- holding capacity and slow perme- ability. Sands, however, have a small number of large pores which are responsible for rapid drainge and a low moisture- holding capacity.

The pore spaces are differentiated into two classes:

1- the non- capillary pores :

It is the sum total of the large pores which will not held water by capillarity.

They are normally filled with air and responsible for aerastion and ready percolation of wither through the soil.

2- Capillary pores:

It is the sum total of the volume of the small pores which held water by capillarity.

The ideal soil should have the pore space equally divided between large and pores. Such a soil would have sufficient aeration, permeability and water- holding capacity.

SOIL WATER

A good soil contains, on a volume basis, on- half of solid material and one-half equally between water and air. Soil, as a porus medium, admits water, allows some to pass through, and retains the reminder.

Stares of water in the soil:

The ,moisture content of the soil is classified into four categories:

1- Gravitational water:

Any water that moves downward through a moist soil in response to gravity is caooed gravitational water.

It is available to plants only when showers follow one another rapidly, otherwise it percolates below the reach of roots within a short time. (Gravitational water fills the non-capillary poress of the soil. The presence of gravitational water interferes with aeration).

2- Capillary water:

As gravitational water drains out of the upper layers of a soil it leaves behind much moisture in the form of films coating each particle and droplets suspended in the angles of the larger pores or completely filling the capillary pores. This, the capillary water, is continuous from one particle to the next. It does not respond to gravitational force, and it is the source of almost all the water a plant absorbs from the soil. All the water refrained at field capacity is capillary water.

3- Hygroscopic water :

It is the water retained by air dry soil. It is held in the form of very thin around the soil particles by a great attractive force in the surface of the particles.

Hydroscopic water is not chemically or biologically active, i.e. not readily available for use.

4- Water vapor:

It is found in the soil atmosphere and moves along vapor pressure gradient, i.e. form regions with hight vapor pressure to regions with low vapor pressure. It probably is not used directly by the plants.

SOIL MOISTURE TERMINOLOGY

The literature dialing with soil moisture contains numerous terms or constants. Among these terms are the following:

1- **maximum water holding capacity :**

it is the amount of water that is held by a saturated soil before and after it has been immered in water for 24 to 48 hours.

2- **Field capacity: (capillary capacity) :**

It is the water retained by the soil after gravitational water drained awayand when the movement of the capillary water has become very slow. In other words, it is the capillary capacity of the soil.

3- **moisture equivalent:**

it is the water content of a saturated soil after it has been subjected for 30 minutes to centrifugal force of 1,000 fimes gravity. The moisture tension at the moisture equivalent of the soil is 1/3 atmosphere. The moisture equivalent of a soil is very close to its field capacity.

4- **Permanent wilting percentage:**

It is the moisture content of the soil at the time when the plants growing in the soil becomes permanently wilted. It is also called the wilting coefficient. The soil moisture tension at the permanent wilting percentage is approximately 15 atmospheres.

5- **Available soil water:**

This temr generally refers to the availability of soil water for plant growth, and is taken as the amount of water retained in the soil between the field capacity and the permanent wilting percentage. The available soil water is much greater in heavy soils than in light or course textured soils.

6- **Hygroscopic coefficient:**

It is the moisture retained by a soil at equilibrium with atmosphere of known relative humidity, usually a saturated one.

7- **Nonavailable soil water:**

This is the moisture content which is tightly held as thin films of water surrounding soil particles in association with the soil colloids (the hygroscopic water).

A soil which contains no more water than hygroscopic coefficient would not yield water to plants.

SOIL SALINITY

Origina and occurance of saline soils:

During the weathering of the rocks and minerals, large quantities of soluble salts are formed. In humid climates these salts are generally carried out of the soil into ground water and washed to the sea.

In arid or semiarid climates, the salts may be accumulated in the upper layers of the soils due to high rates of evaporation and low rainful. A fully and normally developed soil profile of an arid area, usually carried at some point is its profile (usually the C Horizon) a calcium carbonate accumaltion greater than that of its parent material. The lower the reinfall, the nearer the surface this layer will be.

Classification of saline soils:

There are three categories of saline soils:

1- saline soils:

these soils contain a concentration of neutral soluble salts suffecent to seriously interfere with the growth of most plants. The electrical conductivity of a saturated extract is greater than 4 mmhos/ Cm. Less than 15% of the cation exchange capacity if these soils is occupied by sodium ions and the PH is below 8.5. this is because the soluble salts present are mostly neutral, and because of their domination, only a small portion of exchangeable Na is present.

Such soils are sometimes called white alkali soils because a surface incrustation light in color may be present. The excess soluble salts, which are mostly chlordes and sulfates of sodium, calcium, and magnesium, can readily be leached out of these soils with no appreciable rise in PH. This is a very important practical consideration in management of these soils.

2- saline- Sodie Soils :

The saline-sodic soils contain appreciable amonts of netural soluble salts and enough adsorbed sodium ionsto seriodly affect most plants. Their repressive influence of the natural soluble salts, as in the saline soil.

More than 15% of the exchangeable capacity is occupied by sodium. The electrical conductivity of saturated extract is more than 4 mmhos/ Cm.

But unlike the salins soils, leaching will markedly raise the PH of the saline-sodic soils unless Ca and Mg salt concentrations are high in soil or in the irrigation water this is because the exchangeable Na, onoe the neutral salts are removed, readily hydrolizes and there by sharply increases the OH ion concentration of the soil solperse the mineral collsids. At the same Na toxicity to plants is increased.

3- Solic solis

Those soils do not contain great amounts of netural soluble salts the determintal effects on plants being , largely due to toxicityof the sodium as well as of the hydroxyl ions. The high pH is largely due to the hydrolysis of sodium as well as of the hydroxyl ions. The high pH is largeky due to the hydrolysis of sodium carbonate, which occurs as follows:

$2\ Na^+ + co_3^- + 2\ H_2\ O$ -------------------- $2\ Na^+ + 2\ OH^- + H_2\ co_3$

the resulting hydroxyl ions gives pH values of 10 and above also, the sodium complex undergoes hydrolysis as follows:

Na – micelle + HoH -------------- H – micelle + Na^+ + oH

The exchangeable Na; which occupies more than 15% of the total exchange capacity of these soils, is free to hydrolize because the concentration of netutral soluble salts is rather low. The electrical conductivity of a saturated extract is less than 4 mmhos/Cm. Owing to the deflocculating influence of the sodium, such soils are in unsatisfactory physical condition. As alteady stated, the unsatisfactory physical condition. As alteady stated, the leaching of a saline- sodic soil will change it to a characteristic sodic soil.

Because of the extreme alkalinity resulting from sodium carbonate present, the surface of sodic soils usually is discoloured by the dispersed humus carried upward by the capillary water- hence the name black alkali is frequently used .

Chapter 3
Biotic Factors

In fact all plants even the green ones are not indea pendent organisms. For example some green plants depend upon nectariferous insects for pollination and upon birds and other animal for seed and fruit dispersal. The amount of heat, light, moisture and nutrients available to one plant are all affected by the neighbourhood of other plants, or an animal which acts upon plants.

Relation Between Plants

There are two principal types of relation of plants: dependent unions and commensal unions .

Dependent Unions:

This type of relation means that one member depends on from other in any way. The degree of dependence varies greatly from complete dependence as in parasites to slight dependence as in lianas. Example of plants living dependently on other are the following:

1- **Parasites**:

When a parasite is dependent upon the host and the host only suffers harm, this type of life is known as onesided parasitism as in case of Cuscuta and Orobanche.

In case of Cuscata adventitions roots called haustoria emerge from the stem and penetrate the host stem where they become in contact with both xylem and phloem. In case of Orobanche the roots of seedling are connected to roots of host plants.

In another type of parasitism designated as mutual parasitism, each of the united organisms benefits from the other. Example of mutual parasitism are nodule becteria, mycorshiza and lichens.

2- Epiphytes:

Epiphytes depend upon larger plants for physical support only. They grow on trees and shrubs and depend for their water supply on rain water directly. The nutrient supply is composed of some substances dissolved in rain water. These nutritive substances are derived from accumulated win-borne particales and the decaying bark surface .

3- Lianas:

The vascular plants with roots fixed in the ground and stems held in a more or less erect position by using other plants or objects to get better light, are known as vines or lianas. The relation between plants here is very weak. Lianas can be divided into the following types arranged in ascending order according to their degree of specialization.

a) Leaners: these are plants having no special devices for holding into a support e.g. plumbago sp.
b) Thorn lianas: These are plants which have thorns or prickles for climbing e.g. bougainvillea and Rosa.
c) Twiners : The entire stem in these plants twines about the support . twiners are mostly herbaceous plants e.g.phaseolus and Ipomoea. Examples of woody twiners are celastrus and Lonicera.
d) Tendril lianas: these plants heve special organs for twining called tendrils. The tendrils may be modified leaflets e.g. Pisum and Vicia, leaf petiole e.g. clematis, stem e.g. vitis or roots e.g. cereus.

There are saprophytes which seam adapted to the utilization of specific organic plant wastes and therefore are dependent in this way upon certain plant species.

Commensal Unions :

The relation between commensal organisms rests upon the struggle for various life various life condition such as space , light , water and nutrients, the struggle for existence or competition is great between plants which have the same requirement called equal different nutrients and occupying unequal commensals.

RELATION BETWEEN ANTIMALS AND PLANTS:

Grazing and browing:

Grazing means feeding of animals on unharvested herbs. Browsing mans feeding on shrubs or trees.

Carnivorous plants:

These plants are provided with certain arrangements which enable them to and retain arrangements which enable them to capture and retain small Animals especially insects. They secrete enzymes which digest the insects and then absorb the resulting nitrogenous compounds.

Pollination : some insects and few firds carry on pollination. Animal – pollinated flowers have a conspicuous size and colour and produce an odour as well as nector.
These characteris serve to attract insects .

Dissemination:

The foor content of disseminules attract various animals which act as agents of dissemination. Usually succulent fruits have a bright colour and a pericapr which is partially or completely fleshy and edible. The seeds of such fruits are protected by a hard endocarp (in drupes) or a hard testa(in berries), so they can pass through the digestive tracts of animals without injury.

Chapter 4
Physiographic Factors

Physiographic factors are those which are introduced by the structure, conformity and behaviour of the earth's surface, by topographic features, such as elevation and slopes, by the geodynamic processes, such as silting and erosion and consequently by local geology. Mountains, hills, valleys etc. result from the irregularities in the carth's surface. These strong topographical reliefs tend to produce marked local clilmates or microclimates. The summits, for example, are different from the sides of mountains and narrow valleys are different from the open plains. At high altitude, the velocity of wind is high, temperature and air pressure decrease, humidity as well as intensity of light increases. Thus the extreme and rapid with increasing altitudes. Major topographic features influence the climate to a considerable locally and low rainfall in their lees.

It has been observed that in the northern hemisphere north facing slopes tend to be more adjusted to moist conditions than the south facing ones at be more adjusted to moist conditions than the south facing ones at similar altitudes. This is so, probably, because of the effects of the solar radiations on the air and soil temperatures and consequently on the relative humidity and evaporation and through them on the local water situation. The duration of sunlight on the south facing slope direct solar radiations. The slope of the soil surface affects the vegetation directly as well as indirectly.

The steepness of slope accelerates, the circulation of soil water. The steeper the slopes the more rapid is downward movement of surface water. The3 water moving over the slopes causes erosion of the top soil and as a result to this vegetations disappear from the areas. Erosion and geodynamic agencies are active in mountain regions and about the sea coasts causing many types of changes in the topography. Such activities often cause formation of new open habitats, both at the sites of erosion and at the places where eroded soil is deposited. Moving sand dune in deserts may be cited as example of geodynamic

source of physiographic change. The areas subjected to quick and continuous erosion are completely devoid of vegetation.

Part III
Plant Succession

Ecological succession refers to the orderly and progressive replacement of one community by another until a relatively stable community occupied by different plant communities, as vegetation develops. The whole series of communities, from grass to shrub to forest, that terminated in a final stable community in called a sere, and each of the changes that take place is a serial stage. Each seral stage is community.

The Nature of succession:

Succession is characterized by progressive changes in species composition, organic structure and energy flow.

It involves a gradual and continuous replacement of one kind of plant by another until the community itself is replaced by another that is more complex. It is brought about by a modification of the environment by the organisms themselves. As the environment is modified, the organisms make the habitat unfavourable for themselves. They are gradually replaced by different group of organisms more able to use the new environment.

A. Hydrosere (Aquatic Succession):

1. **Sumerged Stage:**

the earlies forms of life to colonize in lake are planktons, which may become so dense as to cloud the water. This plankton consists of microscopic algae and animal life, which upon depth setlle to the bottom of the lake.

The developing layer of head plankton creats a substrate for rooted aquatics, such as elodea and Potamogton. These species grow at different depths, mostly rooted in the bottom. These pioneer plants are called submerged because all the plants die their remains sink to the bottom forming a mass of humus which cements the muddy bottom making it firmer.

The result of these reactions brough about by the submergedplants is to shallow the water by building of the bottom of the lake. Obviously, this process is unfavourable to the submerged species and ultimately there are formed a suitable water depth and a rich substratum for invaders.

2. **Flcting stage :**

Where water in the lake is relatively shallow various species of floating plants begin to invade the area occupied by the pioneer, submerged plants. Among these floating species are Nymphoea and polygonum. All floating plants are rooted in the mud.

Nearly have rhizomes, or steme rooting at the nodes, and broad leves floating on the water surface.

A first the floating species are associated with the submerged species. But as the invaders increase in numbered species. But as the invaders increase in numbers, gradually spreading their leaves rear after year, their leaves occupy more of the water surface and the light for the submerged

speciesed is deoreased. And the floating species will out compete the submerged ones.
Because of the dense tangle of stems (of the floating species) much water-born soil is deposited in to the bottom, while the debris formed by the decay of these species rapidly build up the substratum. Usually the soil-building process goes on rapidly.

3- Reed- Swamp Stage:

With continued raising of the lakes bottom, invasion becomes possible for that root at the bottom and are parly submerged but their leaves is raised above the surface of the water e.g. *Typha* (Cattail), Phragmites (reed). Reed plants have large, much branched rhizomes. Again, as the floating species reduced the amount of sunlight which reach the submerged ones, now, the developing reed- swamp community with their taller and denser structure will exert a controlling influence. The result of competition (for light is obviously favoring the Swamp reed species.
Like the preceding plants, their structures and dense growth exert a controlling influence. Obviously, the floating plants are at a great disadvantage as regard light.
As the reed- swamp community develops, they disappear. Thus, the reaction of the reed- swamp plant is sheding the water surface and builing up the lake shores by retaining the sedimentary materials washed into the lake and by the very rapid accumulation of plant remains. Thus, the water depth is gradually decreased and become less for most species of the reed- swamp stage.

4- sedge- meadow stage :

the reed- swamp species develop less vigorously with a shallowing of the water depth, and other species invade their area. Favored by the increased amount of light , as the reed- swamp spices disappear, the esdgemeadow species develops. Examples of sedge meadow species include Carex, and junws . sedge- meadow plants are charactized by the tought, tangled rhizomes, copious roots sodlike must of vegetation. The soil gradually becomes too dry for plants of the preceeding community. The sedg - meadow plants react upon the habitat by binding water. As a result of these reactions, the marshy sedge meadow become too dry for these water-loving plants to grow. They are gradually replaced by species of another community. In dry climates, this may be grassland or some other xeric climax, but in more moist ones, wood- land .

5- Woodland stage:

Certain species of shrubs and trees may now appear in the nowland, where the soil is saturated perhaps only in spring and early summer. These species are characterized by their tolerance to the water- logged soil around their roots. Examples of such species:
Salix, Populus. These woody species react upon the habitat by producing shade and by lowering the water table (both by further building up the soil and by vigorous transpiration).

The drier, shaded soil is not favorable anymore for the sun- loving sedge-meadow species which gradually disappear. Sibultaneously, shade-enduring or tolerant herbs replace them, growing among the trees and shrubs.

Climax Forest:

As the humus accumulates and the moist soil becomes filled with bacteria and fungi which enrich it, many other tree species may invade the earea.

Mixed tree species with their accompanying characteristic shrubs and herbs may result. But as the trees become denser in the drier, better aeraled soil; many species, especially the pioneers, find difficulty in growing and reproducing their kind since their seedlings are intolerant, i.e. can not grow in shade.

The processes of reaction between the until no further change is possible. This is a stage of complete equilibrium between the vegetation and the habitat. This stage is known as the climax.

XEROSERE

1- Lichens stage:

On the surface of a bare rock some lichens are able to become established owing to the extreme deficiency of water and nutrients, great exposure to the sun, & extremes of temperature to which they are subjected . Crustose lickens alone are usually able to grow in such situations. They flourish during periods of wet weather and remain in state of desiccation for very long periods during drought. The fungus being parasitically living upon alagae secures its carbohydrates from the host which in turn, is producted by the crustlike fungs growth from extreme drought. Lichens are spong- like organisms, which enable them to absorb them to absorb water drops from rain or dew.

Carbon dixide produced from the respiration of lichens, combined with water will from carbonic acid. This acid will help in weathering and disintegration the rock surface. Thus, lickens help decompose the rock and by mixing the rock particles with their own remains make conditions possible for the growth of other group of plants.

2- Moss stage:

As soon as sufficient amount of soil have accumulated in the crevices and depressions in the rock, mosses begin to appear. Their rhizoids compete with those of the lichens for water and nutrients and the erect stems of mosses will prevent the sunlight from penetrating to the liches. As the time pass, there will be gradual increase in the mosses and gradual disappearance of the lichens.

The reaction of mosses upon the habitat will result in increasing the depth of the soil layer on the surface of the rock. These now conditions are more favorable for the growth of new invaders.

3- Herbaceous stage :

As a result of the more accumulation of soil layer, new seeds of various xerophytic herbs, especially short-lived annuals, are soon able to germinate and the plants to mature. The roots of the annual plants continue the process of decomposing the rock, and each year the humus from their decomposing remains enriches the soil.

Gradually, biennuals and perennials begin to invde.

The processes of rock disintegration and humus and nutrients accumulations are greatly accelerated as the tongled network of roots increases and the soil become shuded, humidity increased, and drought periods shortened.

Also, the bacterial and fungal populations of the soil increase and conditions gradually are less xeric.

The reactions brought about by the herbaceous community, especially the reduced light, are distinctly determintal to the musses and lichens which gradually become fewer in number.

4- shrub stage:

woody plants find conditions possible for growth on the soil thus prepared by the pioneer lichens, mosses, and herbs. Shrubs invade the area. The leafy branches from the underground tangle of rhizonmes overstop and shade the herbs, and when the shrub by growth becomes sufficiently dense, the former other speies find the habitat so modified that growth become almost impossible. The herbaceous species lagely disappear.

Among the numberous stems, the falling leaves finewind born soil particles accumulate. Massive networks of roots fill the soil. The deepest of these roots continually corods the rocks. Wind movement is retarded and humidity is higher above the deeaying litter covering the shaded soil from which surface evaporation is greatly reduced.

All these conditions associated with the enriched soil with its greater capacity for water, hurnised a good environment for tree seedlings, and trees may now start to appear.

5- Climax Forest:

The pioneer species of trees are relatively xeric.

The pioneers are widly spaced, and the hard condition of life are shown in their stunted growth. As the soil become more deeper, trees increase both in number and vigor. With increasing shade, the light demanding shrubs fail and other more tolerant and mesophytic ones replace them under the protection of the leafy tree canopy. A new herbecous a more humid atmosphere and a moister and richer soil than had before.

Many tree species will replace each other with each shift in the soil, light, moisture conditions in the forest. The process of communities sequential replacement will continues until a state of equilibrium is reached between the environmental factors in the forest and the tree species now establishing and growing in the forest.

Thus, in the xerosere as in the hydrosere, the habitat has changed from one of extreme to one of medium water relations , and the vegetation, at first adapted to xeric or hydric condition, respectively, has developed into a Mesophtic forest.