A. plant life or animal in such a

A. Hydrosere (Aquatic succession):

The development of a fresh-water body —lake, pool, or pond into a mesic forest can be observed in the limited area, often a freshly-built deep reservoir or a man-made pond. As the soil has been dug out from such a pond, there are very little or no nutrients in the substratum below the water and the water itself do not contain any nutrients due to this fact, this stage is characterized by a bottom barren of plant life or animal in such a new and virgin pond, aquatic succession or hydrosere starts with the colonization of some phytoplankton which forms the pioneer plant community, and finally terminates into a forest (the climax community). The complete process of aquatic succession includes the following stages: 1. Phytoplankton stage: During the pioneer stage of succession algal spores may be brought by wind along with soil particles and deposited on the water.

The unicellular and colonial photo- plank tonic forms such as bacteria, diatoms and microscopic unicellular algae are the first invaders and therefore this stage is called Phytoplankton stage in the presence of traces of phosphorus in the medium, large blooms of blue-green algae appear as they could utilized atmospheric nitrogen. Later on filamentous algae like Spirogyra and Oedogonium appear. Simultaneously, certain pioneer zooplanktons including protozoons like Amoeba, Paramecium, Euglena, etc.

, make their appearance. If the plankton growth becomes rich enough, the pond support other forms of animal life as bluegill fish, sunfish, large- mouth bass and small caddish flies which build cases of sand and feed on micro-organisms living on the bottom. All these organisms add large amount of

organic matter and nutrients due to their various life activities and upon their death, they settle to the pond-bottom to form a layer of muck. 2. Submerged stage: The developing layer of loose, oozy material (i.

e., mud) on the pond bottom creates a substrate for rooted submerged hydrophytes such as the branching green algae, Chara, Hydrilla, Myriophyllum, Elodea (water weed), Potamogeton (pond weed), Vallisneria (eel grass), Ceratophyllum (hornwort), Utricularia (bladder wort), etc. Their seeds and propagules are brought by birds and other animals which visit the water body frequently for food or other activities. These plants reproduce, increase in number and bind the loose bottom sediment into a firmer matrix and add materially to the deposition of the bottom organic matter. Organisms common to the barren pond bottom cannot exist in the changed conditions of the submerged vegetation stage. The caddis flies of the pioneering stage are replaced by other species able to creep over submerged vegetation and build cases from plant material. Dragonflies, mayflies and some small crustaceans like Asellas, Gammarus, Daphnia, Cypris, Cyclops, etc. inhabit the pond at this stage.

3. Floating stage: Accumulation of sediment washed into the pond from the surrounding watershed supplemented by the organic matter from plant and animal remains reduce water depth and provide nutrients for more demanding plants. Floating hydrophytes like Nelumbo, Nymphaea, Marsilea, Limnanthemum, Apono- geton, Trapa, Monochoria, etc., roots embedded in bottom sediments and leaves floating on the water’s surface invade the pond. Some species of free-floating plants such as Azolla, Lemna, Wolffia,

Pistia, Spirodella, Salvinia, Eichhornia, etc., also invade and colonize the water body.

Since these plants shut out the light from the pond’s depths, they tend to eliminate most of the submerged aquatic plants. However, certain shade-tolerant submerged hydrophytes like Vallisneria, Najas, Nitella, Chara, Potomogeton, Nechamadra, etc., thrive well at this stage.

In floating stage faunal living space is increased and diversified. Hydras, frogs, salamanders, gill-breathing snails, diving beetles (Dysticus) and host of new insects capable of utilizing the under surfaces of floating leaves appear. Some turtles and snakes also invade the pond. By now, the water level becomes very much decreased due to progressive build up of pond substratum and the pond becomes shallower.

As the water body is reduced in area, the marsh vegetation encroaches upon newly exposed shallow water areas and a reed-swamp stage is reached. 4. Reed-swamp stage: During this stage the hygrophilous emergent marshy plants such a Ranunculus, Saggittaria (grow head), Monochoria, Cyperus, Scirpus (bulrushes), Typha (cattail), Phragmites (reed grass), Rumex, etc., are firmly anchored in the bottom muck spreading their fibrous roots and rhizomes. Shoots of these Plants are partly or completely exposed to air. Lacking the buoyancy and protection of water, the weak and soft-tissued floating Plants fail to exist in the changing environment. Animals of the floating stage are also replaced by those that habit the vegetation of reed-swamp stage. Gill-breathing snails give way to lung-breathers like Lymnca, Physa, and Gyraulus.

Different species of mayflies (Ephemera) and dragonflies spend their nymphal stages on submerged stems and climb to the surface when they are ready to emerge as adults. Certain other insects such as water scorpion (Nepa), giant-water bug (Lithocercus, Belostoma) scavanger beetles (Hydrophilus), etc., are present at this stage. Red winged black birds, ducks, king fisher, great blue heron (Ardea), swamp sparrow, muskrats (Ondatra), beavers, etc., become common in the area. As the oxygen supply of the water decreases because of the increasing quantities removed through respiration by organisms of decay (reducers) breaking down the accumulated organic matter, only animals of low oxygen requirements can exist. Bullheads replace sunfish and annelid worms colonise the bottom muck. 5.

Sedge-meadow stage: Since the root system and the annual deposition of leaf growth add great quantities of organic matter to the bottom and entrap sediments, the substrate builds up rapidly after the emergents have appeared. Much of the old open water area is covered by species of Cypcraceae and Graminae, such as numerous species of sedges as Juncus (rushes), Carex (carices), Eleo- charis (spike rushes), Polygonum, etc., and many species of forbs like Mentha (mints), Colha (marsh marigold), Campanula (bell flower), etc., to form marsh or swamp. Further, as the bottom rises above the ground water level, the remnant of the open pond dries up in summer. It has now become a temporary pond drying in summer and freezing in winter. In a gradual manner as land builds higher, drainage improves, emergent’s disappear and the soil lies above the water table and organic matter exposed to the air decompose very rapidly. Meadow grasses

accompanied by land animals invade to form a marsh meadow in forest regions and a prairie in grass country.

With the approach of mesic conditions the herbs and woody plants invade the area. 6. Woodland stage: This stage is characterized by the plants that can tolerate water-logged soil around their roots. Some common plant species of this stage include Satix (shrubby willows), Cornus (dogwoods), Cephalanthus (button bush), Alnus (alders), Populus (cotton woods), tree willows, etc. The root systems of these plants spread horizontally instead of vertically in the soil due to high water table.

By this time there is much accumulation of humus with rich flora-fauna of micro-organisms. Thus, mineralization of soil favours the arrival of new tree species. 7.

Forest stage: This is the climax community. The woodland community is rapidly invaded by several trees. In tropical climates with heavy rainfall, there develop tropical rain forest, whereas in temperate regions, there develops mixed forests aspen, elm (Ulmus), red and silver maples, ash (Fraxinus), oak (Qucrcus), white pine, etc. In regions of moderate rainfall, there develops tropical deciduous forests. Moreover, as the forest floor becomes drier and the crown closes, seedlings of intolerant forest trees are unable to develop; but seedlings of sugar maple, beech, hemlock, spruce and cedar able to grow in low light intensities of a temperate forest and dominate the understory and subsequently replace the intolerant trees.

Since these trees tolerate the environmental conditions they create, the forest cover becomes stabilized.

B. Lithosere (Terrestrial succession):

Lithosere is a typical xerosere and it occurs on bare rocks. Lithosere includes following seral stages: 1.

Crustose-lichens stage: The rocks are dry and hard substrata which are characterized by full exposure to the sun, violent fluctuations in temperature and rapid changes in moisture conditions. The soil is absent for the penetration of roots and supply of nutrients. Thus, such a habitat is unsuitable for most plants but for blue-green algae and lichens, the pioneer species.

The blue green algae as Scytonema are found to adhere to the rock by their mucilaginous cell walls. These algae tolerate extremes of temperature and moisture contents and can utilize atmospheric nitrogen. However, in cooler climates (high altitudes, and temperate regions) crustose lichens like Rlizocarpon, Rinodina, and Lecanora are common pioneers. They produce some acids which bring about weathering of rocks. The dead organic matter of algae and lichens become mixed with the small particles of rocks to form the very thin layer of moist soil on the rocks.

The crustose lichens are then replaced by foliose type lichens. 2. Foliose-lichen stage: On the little soil which is accumulated on the rocks due to weathering effect of algae and crusiose lichens, there appear foliose and fruticose lichens like Dermato- earpon, Umbiiicaria, and Parmelia, etc., which have large leaf-like thalli. They can absorb and retain more moisture, are able to accumulate dust particles and produce more organic matter which helps in the further build up of the soil on the rock. 3. Moss stage: The

development of thin humus-rich soil layer on rock surface and in crevices and depressions in the rock, favours the growth of certain xerophytic mosses such as Grimmia (black moss), Tortula (twisted moss), Polytrichum (hair moss). Bryum, Barbula, Funaria, Weissia, Hypnum and Fissidcns.

These mosses grow, compete with the lichens and add more organic matter to the soil after their death and decay. The accumulated thick layer ^f soil retains great amount of water and provides suitable habitat ‘ or the invasion of herbs, grasses and ferns. 4. Herb stage: The herb stage is characterized by plant species like Aristida, Festuca, Poa. Sporobolus, Lindenbergia, Solidago, Adianlum, Asplenium, Cheilanthes, Actiniopteris, Justicia, Tridax, etc.

, Certain animals such as nematodes, insects and microarthropods, and other animals also invade the area. The weathering of the rocks by physical, chemical and biological means provides more soil and nutrients. Various bacteria and fungi decompose the accumulated organic matter. At this stage certain larger herbs and grasses such as Themeda, Heteropogon, Cymbopogon, Adathoda, etc., enter the community.

Herb stage is followed by shrub stage. 5. Shrub stage: The shrub stage is characterized by small and large shrubs such as Zizyphus, Capparis, Zygophyllum, Rhus, etc., in moderate climates and Rubus, Fragaria, Physocarpus, Sym- phoricarpos, etc., in cooler climates. The shrubs overshadow the herbaceous vegetation and produce more organic matter and thus increase the amount of humus and humidity in the soil.

The species diversity of flora and fauna is increased. The shrubs are finally replaced by trees which form the climax community. 6. Forest stage: Forest climax community commences by invasion of certain xerophytic plants and this is determined by climate of the region. In dry climates, due to slow weathering of rocks, comparatively thin layer of soil is formed which supports small trees like Acacia, Prosopis, Ealanites, Anogeissus, Boswellia, etc. All these plants require high rainfall to reach upto climax stage.

In moist and wet climates and also in temperate climates dense climax forest is developed. Like the hydrosere, the lithosere involves successive changes in animal life. The pioneer animals of the lichen stages are few species of mites, ants and spiders. These animals are exposed to harsh environment such as extreme fluctuations in temperature. During the moss stage, many new species of mites, small spiders, tardigrades and springtails invade the community. The herb stage is characterized by nematodes, mites, collembola, ants and various insect larvae. During the shrub and forest stages great qualitative and quantitative modifications occur in the fauna.

Thus, there occur numerous kinds of animals such as slugs, snails, wire worms, millipedes, centipedes, mites, ants, sow bugs, springtails, amphibians like salamanders, frogs, etc., reptiles such as turtles, skinks and other lizards, snakes, birds like flycatcher and grouse, and mammals like mole, mouse, shrews, squirrels, chipmunk and fox.

C. Psammosere (Terrestrial succession):

This kind of xerosere occurs on sand deposit (or sand dunes) existing on the banks of rivers, lakes and sea shores and also in the deserts. A product of

pulverized rocks, sand is deposited by wind (eolian sand) and water (alluvial sand). The sand dunes are rigorous environments for life to colonize them due to their various characteristics such as very unstable existence, extreme dryness due to poor holding capacity of moisture and high surface temperatures by day and cold temperatures by night.

Certain algae and grasses like Cenchrus, Armophila and Saccharum are the most successful pioneers and binding plants. When these and such associates as beach pea have stabilized the dunes various deep-rooted shrubs like Lcptadenia, Citrulus, Calligonum, Tephrosia, Balanites, Sericostoma, Zizyphus, Salvadora, Capparis and Calotropis invade the area and enrich the soil with moisture, nutrients and organic matter. Once the sand dunes become so stable, climax forest of deep-rooted perennial trees such as Acacia, Albizzia Anogeissus, and Casuarina.

Diospy and Prosopis is established in dry climates. Species of other trees and tall grasses like Calamus, Arundo, Phragmites, etc., are found to occur along river banks, in temperate regions, the shrub stage passes to become climax forest of oak.