Fundamental Concepts and Principles of Ecology

What we are going to cover

- Types of Ecology ✓
- Levels of Ecological Organisations ✓ Rev.
- Population ✓
  - Density ✓
  - Distribution ✓
  - Growth ✓
- Community ✓
  - Characteristics ✓
  - Interspecific Interactions ✓
  - Ecological Succession ✓

What we are going to cover - Cont.

- Ecosystem
  - Components
  - Functions
  - Ecological Pyramids
  - Ecosystem Productivity
- Biomes ✓
- Biosphere ✓
- Biogeochemical Cycles ✓

Types of Ecology

Synecology → Together → several sp.

- Global Ecology
  - Study of the Earth's ecosystems.
- Landscape Ecology
  - Distribution, patterns, and behaviors across geographical areas.
- Population Ecology
  - Rise and fall in the number of a species.
  - Also called Autecology.
- Microbial Ecology
  - Microbes and their relationships with each other and environment.

- ✓ Mycorrhiza — Beneficial fungi Plant roots.
- ✓ Rhizobium — friendly bacteria
  - ↓ Helps in Nitrogen Fixation
- ✓ PSB — Phosphate Solubilizing Bacteria

Types of Ecology - Cont.

- Community Ecology
  - Alteration in community structure and interspecific interactions.
  - Also called Synecology.
- Ecosystem Ecology
  - Interactions between biotic and abiotic elements.

Levels of Ecological Organisations

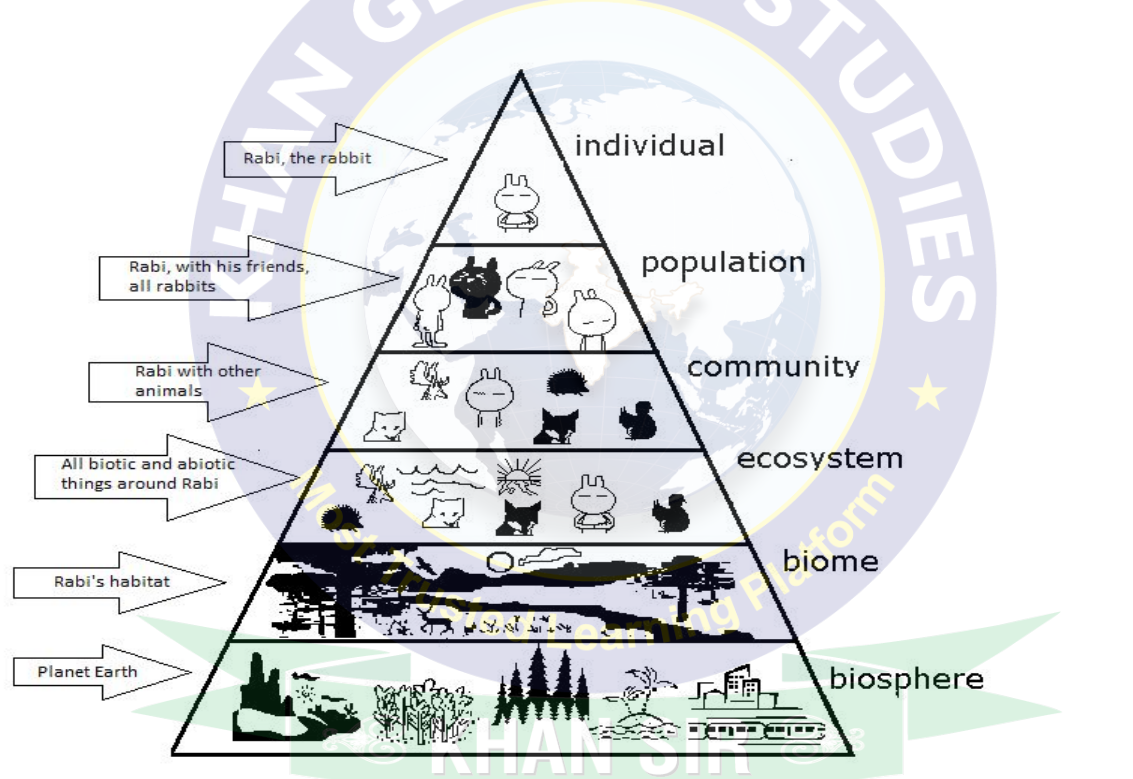


Figure.1. Levels of ecological organisations

Levels of Ecological Organisations - Cont.

- Individual
  - Act or function independently.
- Population
  - Same species living and interacting in a particular area.
  - Capable of interbreeding.
- Community
  - Types of population interacting at a particular area.
  - Two types: Major and Minor

Levels of Ecological Organisations - Cont.

- Ecosystem
  - Community of organisms and their physical environment interacting together.
- Biome
  - Major regional groupings of ecological systems.
- Biosphere
  - Global sum of all ecosystems.

Population

- Population Density
  - Number of individuals per unit geographic area.
- Population Distribution (P.T.O.)
  - Distribution of individuals throughout their habitat.
  - Can be uniform, random and clumped.
- Factors affecting Population Growth
  - Natality (Birth) ↑
  - Mortality (Death) ↓
  - Immigration ↑ inward migration
  - Emigration ↓ outward "

Population - Cont. : Dispersion

Uniform dispersion

Individuals are spaced more or less evenly

Example: Plants that secrete toxins to inhibit growth of nearby individuals—a phenomenon called **allelopathy**.
Animal species where individuals stake out and defend territories.

Random dispersion

individuals are distributed randomly

plants that have wind-dispersed seeds

environment is favorable

Clumped dispersion

individuals are clustered in groups

seen in plants that drop their seeds straight to the ground—such as oak trees—or animals that live in groups

also happen in habitats that are patchy, with only some patches suitable to live in

Population - Cont.

- Survivorship curve
  - Type I: High survival in early and middle life and rapid decline in later life.
  - Type II: Constant mortality rate regardless of age.
  - Type III: Greatest mortality in early life but low rates of death later.

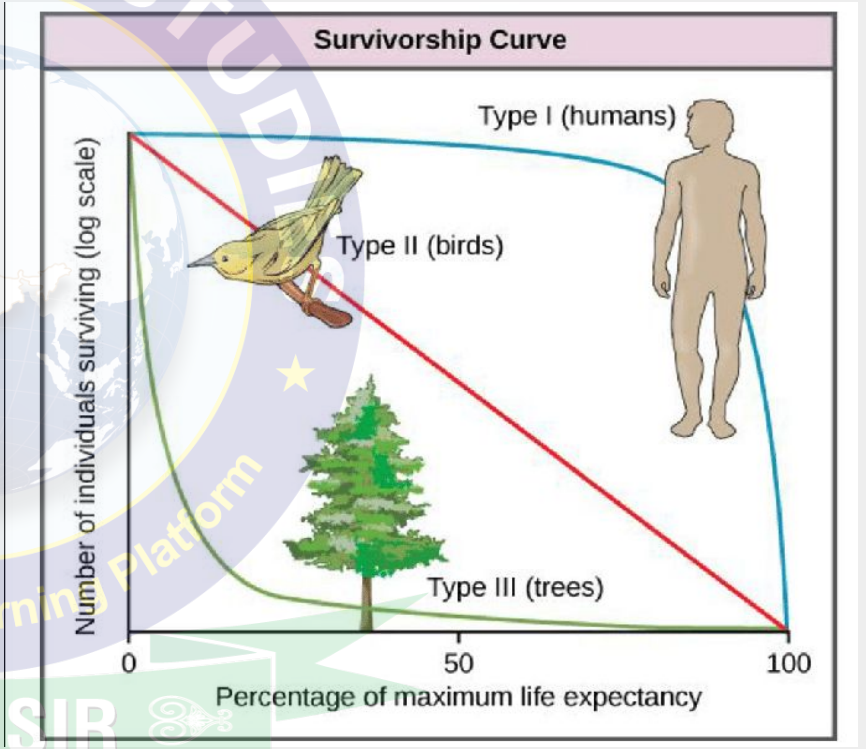
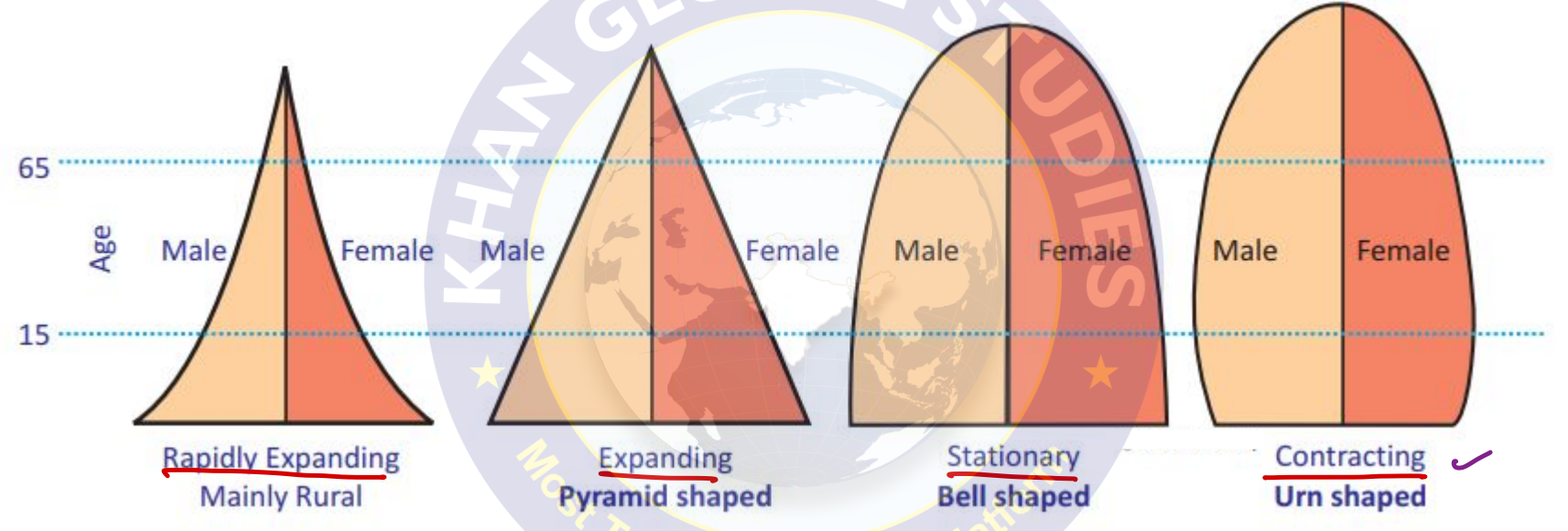


Figure.2. Survivorship curve

Age Structure Diagrams



Population - Cont.

Growth Pattern

- Exponential Growth (r-adapted growth)
  - No competition to place limits on rate of growth.
  - J-shaped curve.
- Logistical Growth (K-adapted growth)
  - A finite carrying capacity.
  - S-shaped curve.
  - Lag phase → Acceleration → Deceleration → Asymptote.

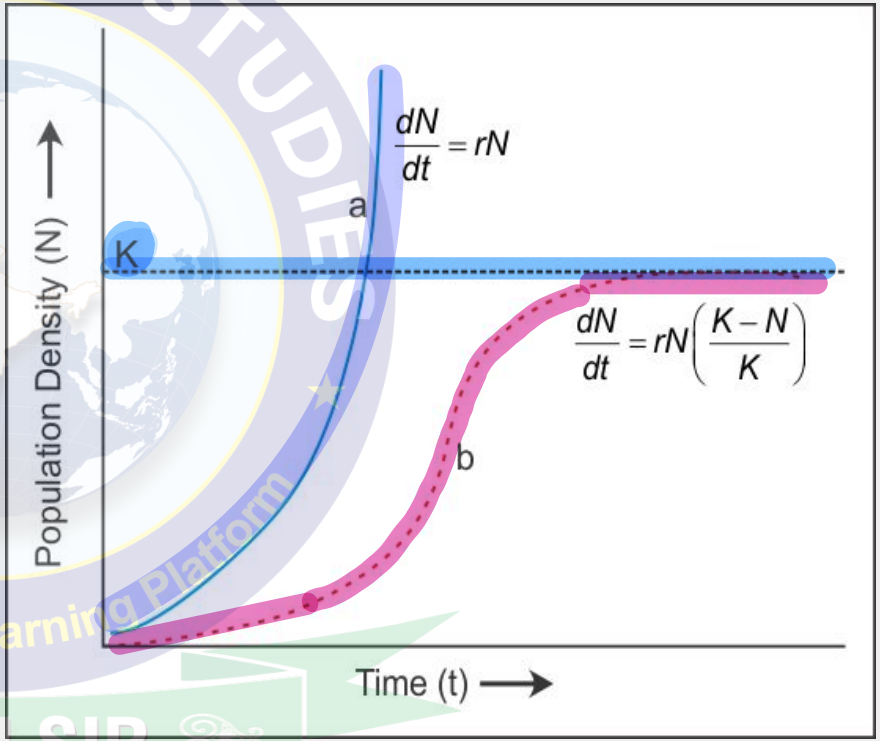


Figure.3. Growth pattern

Population - Cont.

- **Population Stabilization**
  - Stage when the size of the population remains unchanged.
  - Regulated by two factors: Density independent and Density dependent.
  - Density Independent Factors: Extrinsic factors.
    - E.g. food, space, weather, etc.
  - Density Dependent Factors: Intrinsic factors.
    - Include competition, predation, reproductivity, diseases, etc.

Community

- Species diversity
  - Product of species richness and species evenness.
  - Species richness: Number of species in a community.
  - Species evenness: Distribution of individuals among the species.
  - Three types: α-index, β-index and γ-index.
- Diversity Indices
  - Mathematical measure of species diversity in a community.
  - Calculated by various methods such as Simpson's index, Shannon Leaver index, etc.

Community- Cont.

- Dominance
  - One or few species play a dominant role in the community.
- Ecological Niche
  - Role of a species that it plays in its ecosystem.
- Ecotone and Edge effect
  - Ecotone: An area of transition between two or more diverse communities. E.g. Between forest and grassland
  - Edge effect: Along the boundary line, an area displaying a greater than usual diversity of species.
  - Edge species: Species that use edges for the purpose of reproduction or survival.

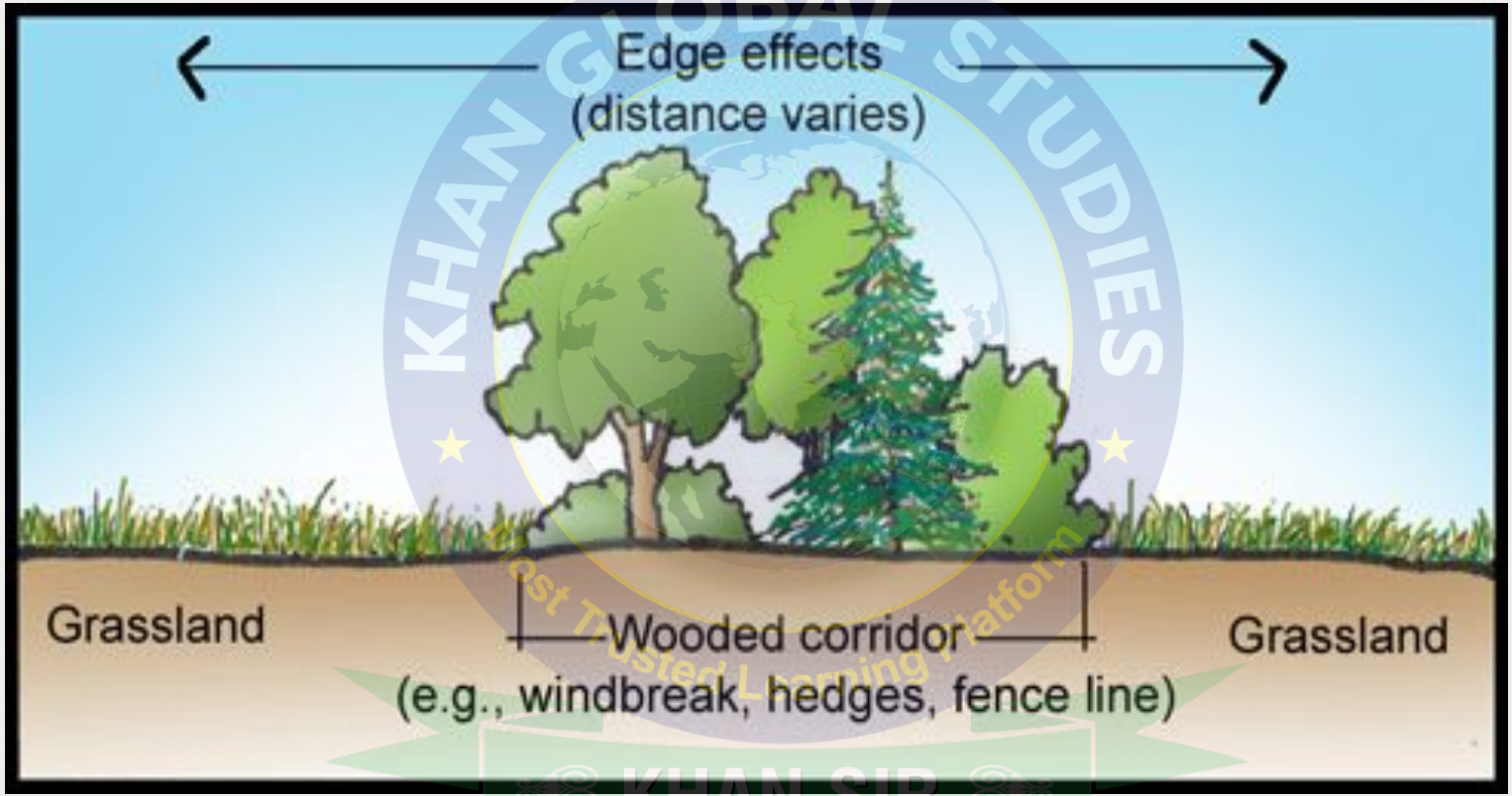


Figure.4. Ecotone and Edge effect

Community- Cont.

- Keystone Species
  - Has a disproportionate effect on its environment relative to its abundance.
  - E.g. Blue Jays (birds) in Oak forests.
- Interspecific Interactions in a Community
  - Neutralism: Neither population affects the other.
  - Competition, direct interference type: Direct inhibition of each species by the other.
  - Competition, resource use type: Indirect inhibition when common resource is in short supply.
  - Amensalism: Population 1 inhibited, 2 not affected

Community- Cont.

- Commensalism: Population 1 benefitted, 2 not affected
- Parasitism; and Predation: one population adversely affects the other
- Protocooperation: Interaction favourable to both but not obligatory.
- Mutualism: Interaction favourable to both and obligatory.

- Symbiosis
  - Two or more species living purposefully in direct contact with each other.
  - E.g. Symbiosis in lichens
  - Three major types: mutualism, commensalism and parasitism.

Community- Cont.

- Energy flow in a community
  - Photosynthesizing organisms use light energy and manufacture carbohydrates.
  - Stored energy is transferred to the second trophic level.
  - Organisms in each trophic level pass much less energy than they receive as biomass.
  - Energy flowing through the trophic levels is dissipated as heat.
  - Energy loses its capacity to do useful work and the process is called entropy.

Community- Cont.

- Ecological succession
  - Process by which the structure of a biological community evolves over time.
  - Sequential progression of species during succession is seral stages.
  - One seral stage is replaced by another seral stage till a climax community is established.
  - Two types: Primary succession and secondary succession.
  - Primary succession: Occurs in essentially lifeless areas.
  - Secondary succession: Occurs in areas where a community previously existed but has been removed.

Community- Cont.

Plant succession

- An orderly process of community change in a unit area.

Types of succession

- Based on origin
  - Primary succession: Formation of an ecosystem in a place where previous life does not exist.
  - Secondary succession: Formation of a new ecosystem after the disturbance of an existing ecosystem.

Community- Cont.

- Based upon factors responsible for environment changes
  - Autogenic succession: Organisms themselves bring change in the environment.
  - Allogenic succession: External environmental factors cause change in the environment.
- Based on habitat
  - Hydrosere: succession starts in aquatic environments.
  - Xerosere: succession occur in dry habitats.
  - Lithosere: succession occurs in the rocky area.
  - Psammosere: succession occurs in the sand.
  - Halosere: succession starting on saline soil or water.
  - Oxylosere: Succession on acidic soil.

Community- Cont.

Hydrosere: 7 stages

- Phytoplankton stage
- Submerged stage
- Floating stage
- Reed swamp stage
- Marsh meadow stage
- Woodland stage
- Climax

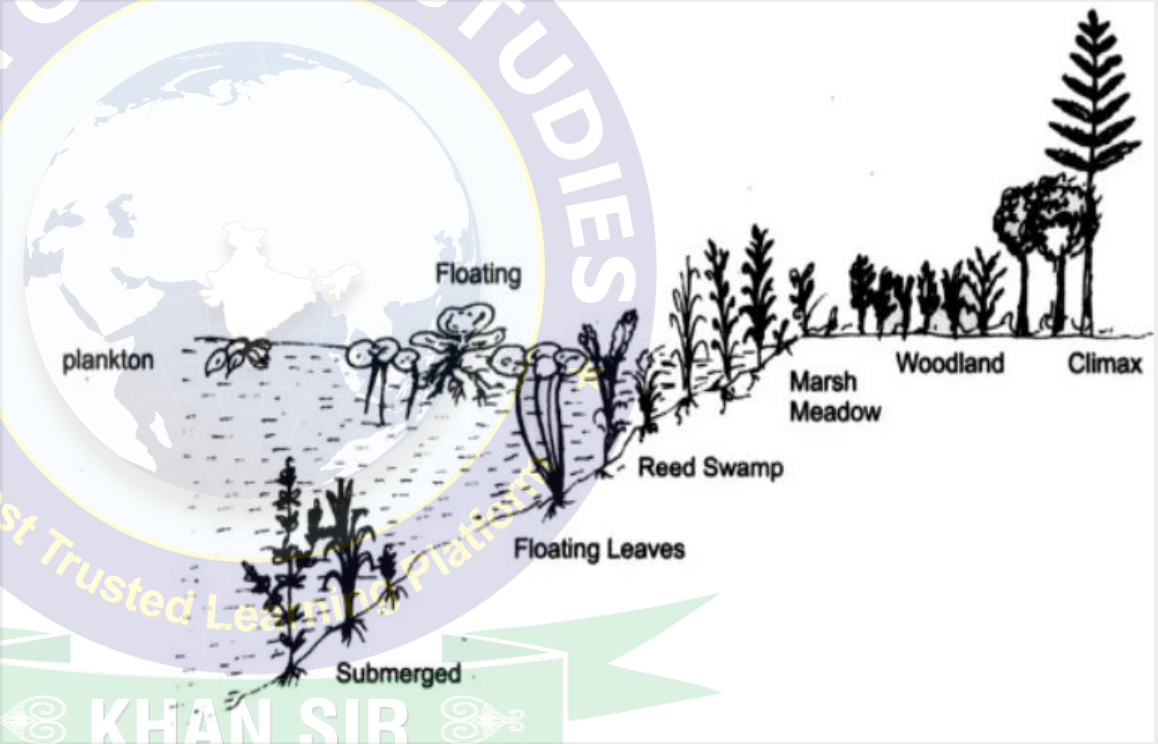


Figure.5. Stages in Hydrosere

Community- Cont.

Xerosere: 6 stages

- Crustose-lichen stage
- Foliose-lichens stage
- Mosses stage
- Herb stage
- Shrub stage
- Climax stage/vegetation

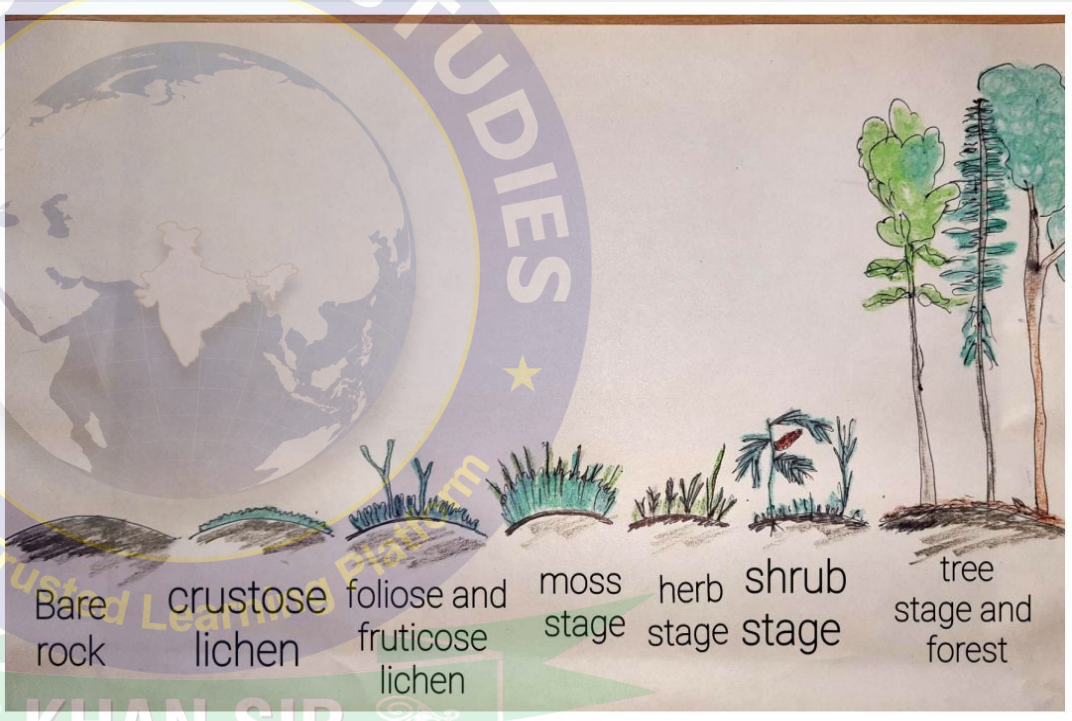


Figure.6. Stages in Xerosere