

Ecological Succession

1. Introduction

We have seen many landscapes with a complex, diverse community of plants and animals—such as a forest which were once a land with empty rocks. These are now supporting a rich ecological community consisting of populations of different species that live together and interact with one another. This change took many years.

Ecologists have a strong interest in understanding how communities form and change over time. In fact, they have spent a lot of time in observing how complex communities, like forests, have arisen from empty land or bare rock. They studied many sites such as where volcanic eruptions, glacier retreats, or wildfires have taken place, clearing land or exposing rock.

In studying these sites over time, ecologists have seen gradual processes of change in ecological communities. In many cases, a community arising in a disturbed area goes through a series of shifts in composition, often over the course of many years. These series of changes are called as ecological succession.

Ecological succession

Ecological succession means the natural development of a series of biotic communities, one after the other, in the same area, till a permanent climax community is established. The ecological succession is also called biotic succession.

The first community to inhabit an area is termed as the pioneer community; the succeeding ones are called transitional communities and the last one is called as the climax community. The entire series of communities is known as a sere and the individual transitional communities are known as seral stages. The pioneer community shows very little diversity and it takes the maximum time to alter the environment by which the environment becomes fit for the next community. The climax community is stable, shows considerable diversity and persists as long as no

disturbance occurs. The seral stages from the pioneer community to the climax community are called as xeroseres if the ecological succession starts on the terrestrial habitat for example a bare rock or land, and as hydroseres if it begins from open water. Xeroseres are of two types: lithoseres which start on a bare rock and psammoseres which begin on sand(G. psammos=sand). Ecological succession occurring in water is known as hydrach.

2. Characteristics of Ecological succession

Ecological succession shows certain characteristic features:-

- * It starts with small, short-lived plants and progresses toward large, long lived plants.
- * It leads from low to very high diversity of life.
- * It tends to progress toward a state of stability means complete adjustment with the environment.
- * It results in gradual increase in the biomass.
- * It involves considerable niche specialization.
- * It brings about gradual development of soil and its humus content.
- * It changes simple food chains to complex food webs.
- * Its seral stages are so regular and directional that an ecologist, by examining a particular seral community living in a given habitat, can often predict the sequences of future communities.
- * In successive seral stages, there is a change in the species of organisms and also an increase in the number of species.
- * Succession of plant and animal communities occurs side by side.

3. Types of Ecological succession

Ecological succession is of two types according to the condition of site where it occurs: Primary succession and Secondary succession.

Primary succession: The primary succession occurs in the barren, soilless, uninhabited regions, such as igneous rock emerged from the sea, a pile of rocks left when a mountain side caves in, area exposed by a retreating glacier or lake, sand dune, lava deposit, newly submerged area, etc. It takes a very long time, usually 1000 years or more.

Secondary succession: The secondary succession takes place in the previously inhabited but somehow distributed areas. It is easy and is completed quickly, because the area already has soil and some vegetation (for example underground stems). Secondary succession takes about 50 to 100 years for the regeneration of grassland and 100 to 200 years for a forest.

4. Process of Ecological succession

Primary autotrophic succession is completed through a number of sequential steps. These are:-

1. Nudation: The first step is the creation of bare area through any of the natural agencies such as wind, erosion, landscape, volcanic eruptions, floods, drought, storm, frost, fire, epidemic disease, human activities etc.

2. Invasion and Dispersion: The organisms settling for the first time on the bare area invade the said area through abiotic mode such as water and wind, or biotic mode for example along with the bodies of other animals. This transfer of seeds, spores or other propagules of the first settler species to the bare area is called migration.

3. Establishment or ecesis: The species invading the bare area must grow, establish and reproduce for successful succession. This largely depends on the characteristics of substratum, climatic and other environmental factors of the area. Those species

which are adjusted to this situation ultimately get established. As a result of ecesis, individuals of the species become established in the area.

4. Aggregation: After ecesis, the individuals of the species increase in number by reproduction and they come close to each other. This process is called aggregation.

5. Competition and coaction: Initially, many species invade the bare area simultaneously. But, those which find the environment favorable finally establish and get aggregated at the limited available area. This results in inter-specific and intraspecific competition for space and nutrition. Various kinds of inter-specific and intraspecific interactions affect the individuals of species in various ways which are called as coactions. The species which are unable to compete are ultimately discarded. Survival of the species is governed by a combination of various factors such as high reproductive ability, wide ecological amplitudes, small seed size and large number of seeds per plant as well as allelo-pathic properties of plants.

6. Reaction: The living organisms influence and get influenced by the environment, reciprocally. This is regarded as “reaction”. As a result of reaction, various changes takes place in soil, water, light conditions, temperature etc. of the area. Therefore, the environment of the area gets modified and becomes unsuitable for the community existing there. This community after some time gets replaced by another community which is known as seral community. This process goes on and various developing communities in that area are called seral communities or developmental stages.

7. Stabilization (Climax): The terminal stage in the process of succession is called as Climax. The final community becomes more or less stabilized for a longer period of time and it can maintain itself in perfect equilibrium with climatic and edaphic conditions of the area. This final community is called as the climax community and this stage is called as the climax stage.

5. Examples of Primary Succession & Secondary Succession

Biotic Succession on Bare Rock

Primary succession begins in barren areas, such as on bare rock exposed by a retreating glacier. This area lacks soil, water organic matter and plant life. It may have a small animal community consisting of some insects and birds. The insects feed on drift material and are fed upon by birds. Plants cannot grow on a rock due to lack of water and nutrients and high day temperature caused by the sun. Biotic succession proceeds on rocky beach in some steps:-

1. Lichen Stage: Lichens which are adapted to exposed conditions are the first to appear on a rocky beach. These lichens are resistant to desiccation and extreme conditions of temperature. Their propagules dropped by wind on a bare rock moistened by rain or dew develop attaching rhizoids and grow into lichens. The lichens produce organic acids which corrode the rock surface. This produces depressions and releases minerals which facilitate further growth of the lichens. The lichens hold the fine particles which are brought by wind in the depressions to initiate soil formation. Dead lichens contribute organic matter to the newly formed soil which becomes fertile.

Now larger lichens arrive. They increase soil and its organic matter, and kill the earlier small lichens by shading them.

2. Moss Stage: In the soil formed by lichens appears the first plant community. It consists of mosses that can gain a hold in even a thin layer of lichen remains and rock dust. Mosses are taller and gregarious, thus they kill the lichens with their shade and replace them. Mosses break up the rock further and add their own dead bodies to the soil, increasing its thickness, fertility and water-holding capacity.

3. Grass Stage: The seeds of small rooted plants can germinate and grow now. These soil binding grasses hold the rock particles in place. Their roots penetrate deeper, causing more weathering of rocks. Being larger the grasses now replaces the mosses. As the time passes, grasses die, adding more moisture- retaining humus to the soil. This changes the composition of the soil and gradually develops conditions

in which perennial grasses (*Cynodon*) can grow. These grasses rapidly spread by means of runners and rhizomes. They further enrich the soil in which annual herbs, then biennial and perennial herbs, can grow. All these plants, in turn add to the thickness and fertility of the soil.

4. Shurb Stage: This soil can now support the shrubs such as *Zizypus*, *Caparis*. The latter gradually replace the grasses and herbs. The roots of the shrubs go deeper and fragment more rock material, making the soil still thicker. Their dead and decaying leaves add organic matter that makes soil more fertile and moist.

5. Tree Stage: In the final stage the trees come in to replace the shrubs. By transpiration, the trees make the environment cool and moist. Their large size makes the environment shadier. The trees are not replaced and form the climax community. The type of climax community is determined by the climate of the region. Rain forests develop in the moist, warm, tropical zones and coniferous or deciduous forests grow in the cool temperate regions.

The plants of each community modify the soil by adding humus, thereby enabling the next community to grow. The plants of earlier communities in the succession can grow in full sunlight. The growth of trees causes shade formation which makes earlier plants unable to grow. Therefore, each seral community modifies the conditions in such a way that these are less favorable for itself and more favorable for the next community. In fact, each community acts to end itself.

Animal Communities: Succession of plant communities is accompanied by succession of animal communities. Each plant community in the sere is inhabited by a characteristic group of animals. The grass and shrub communities have spiders and grasshoppers. The forest community has ants, termites, earthworms, snails, centipedes, millipedes, birds, squirrels and many more.

Duration: The development of climax forests on bare rocks that is primary succession, takes at least 1,000 years.

Secondary Succession: Secondary succession is the succession of communities in previously inhabited areas which have been naturally or artificially disturbed and where soil and some organisms are already present. Natural phenomena, such as avalanches (massive snow-slides), landslides, volcanic eruptions, earthquakes floods, prolonged severe drought and forest fires set by lightening or human activity, destroy existing communities and pave the way for secondary succession. An abandoned field, heavily overgrazed pasture, deforested tract also provide an occasion for secondary succession of communities. Secondary succession is much faster than the primary succession because the soil and certain organisms are already present. Surviving seeds, underground stems, persisting and new invading species rapidly grow on the return of favorable conditions. This reestablishes the biotic community through necessary seral changes in due course of time.

In an abandoned field, grasses and annual weeds quickly move in and cover the soil with a carpet of low vegetation. Some taller perennial plants move in. These new plants shade the ground and their long roots monopolize the soil water. The seedlings of the pioneer species now find difficult to grow. The tall herbs are in turn, deprived of sunlight and water by the shrubs, which get the same treatment from the trees. Finally, a forest of climax species is established to persist till it is disturbed.

A destroyed grassland may take 50-100 years and a damaged forests over 200 years to recover fully. A cleared tropical rain forest invaded by the moss *Sphagnum* or an exotic weed such as *Lantena camara* fails to regenerate itself.

Fugitive Species: The species which occur in an area for a short period of time only during ecological succession are known as fugitive species.

Climax State: When a habitat is not disturbed, community does not change, succession stops and a steady state is reached between the environment and the plant and animal communities. This climax is reached probably because stable ones do not exist. The existing climax community can tolerate the conditions it has created for itself and continues permanently. Potentially, climax is determined by the climate of the region. If other limiting factors remain constant, all successions will attain the stable climax determined by the climate. Variation in soil or water condition may cause successions to end short of their goal.

6. Causes of Ecological Succession

Ecological succession is caused by two factors operating simultaneously: biotic and physiographic.

1. Biotic Factors: In these, the organisms themselves direct succession. The action of each seral community makes the area less favorable for the itself and more favorable for the next seral community in the succession. This continues until the stable climax community arrives. Thus, each community drives itself out of its habitat.

2. Physiographic Factors: These include climate and other physical factors, such as, erosion of hills, filling up of lakes and streams with silt, rise and fall of earth's surface, fire etc.

Reversing of Ecological Succession

Human actions, such as lumbering, grazing cattle, farming and urbanization may set ecological succession back.

7. Practical Importance of Ecological Succession

The practical importance of ecological succession lies in reforestation, range management and other human activities. Sometime efforts to restore fire – destroyed forests by planting dominant species of the climax community often fail due to strong sunlight, uncontrolled erosion and competition with weeds, rodents and shrubs which were favored in early stages of succession. Man should take necessary steps to save the water reservoirs used for irrigation and hydroelectric purposes from being filled up by biotic succession. A species can often be controlled more effectively by modifying the biotic community than by attempting to control it directly.

For instance, the best way to increase the quail population is not to raise and release quails or to destroy the predators but to manage the biotic community in a manner that ensures reproductive success of the quail species.

8. Advantages of the study of biological succession & Ecological Dominance

There are many advantages of studying the biotic succession:-

- * Grasses and herbs of a pasture can be maintained by halting the ecological succession through interference such as grazing or fire.
- * Water reservoirs can be saved by checking biotic succession and silting.
- * Reforestation and afforestation can be successfully done by following the proper sequence of ecological succession.
- * Growth of desired species can be ensured by preventing the next seral stage to invade the region.

Ecological Dominance

A succession stage in the sere is usually named after one or a few plant species which influence the entire community because of their size and numbers. These are called dominant species. Sal (*Shorea robusta*) trees dominate in a sal forest. Teak (*Tectona grandis*) trees dominate in a teak forest. Pine (*Pinus*) and oak (*Quecus*) trees are dominant species in temperate forests. The latter are distinguished as pine forest where pine trees dominate and as oak forest where oak trees abound. The tropical rain forests, as in the Andaman islands, have over a dozen dominant species because of milder conditions.

The dominant species are different for each successive stage in a sere. For example, on a bare rock, lichen dominate in the first stage, grasses in the second stage, followed in order by herbs, shrubs and trees.

GLOSSARY

Ecologist: One who study the interrelationships between organisms and their environments.

Ecological community: a group of actually or potentially interacting species living in the same place.

Ecological succession: The natural development of a series of biotic communities, one after the other, in the same area, till a permanent climax community is established.

Pioneer community: The first community to inhabit an area.

Transitional communities: The succeeding communities of an area.

Climax community: Last community to inhabit an area.

FAQs

Q-1 What is biotic succession?

Ans. Ecological succession means the natural development of a series of biotic communities, one after the other, in the same area, till a permanent climax community is established. The ecological succession is also called biotic succession.

Q-2 What are different communities in ecological succession?

Ans. The first community to inhabit an area is termed as the pioneer community; the succeeding ones are called transitional communities and the last one is called as the climax community.

Q-3 What are different types of Xeroseres?

Ans. Xeroseres are of two types: lithoseres which start on a bare rock and psammoseres which begin on sand (G. psammos=sand).

Q-4 What are different types of ecological succession?

Ans. Ecological succession is of two types according to the condition of site where it occurs: Primary succession and Secondary succession.

Q-5 Explain Aggregation.

Ans. After ecesis, the individuals of the species increase in number by reproduction and they come close to each other. This process is called aggregation.

Q-6 Explain Moss Stage of Biotic Succession on Bare Rock.

Ans. In the soil formed by lichens appears the first plant community. It consists of mosses that can gain a hold in even a thin layer of lichen remains and rock dust. Mosses are taller and gregarious, thus they kill the lichens with their shade and replace them. Mosses break up the rock further and add their own dead bodies to the soil, increasing its thickness, fertility and water-holding capacity.