

ECOLOGICAL SUCCESSION

Communities are never stable, but dynamic, changing more or less regularly over time and space. They are never found permanently in complete balance with their component species or with the physical environment. Variations in climatic and physiographic factors and the activities of the

species of the communities themselves bring about marked changes in the dominants of the existing community, which is thus sooner or later replaced by another community at the same place. This process continues and successive communities develop one after another over the same area, until the terminal final community again becomes more or less stable for a period of time. This occurrence of relatively definite sequence of communities over a period of time in the same area is known as ecological succession. Hult (1885) is said to have used for the first time the term succession for the orderly changes in communities. Clements (1916) while studying plant communities defined succession as the natural process by which the same locality becomes successively colonised by different groups or communities of plants. Odum (1971) preferred to call this orderly process as ecosystem development rather than the more often known ecological succession. He defined ecosystem development in terms of the following three parameters:

- (i) It is an orderly process of community development that involves changes in species structure and community processes with time, it is reasonably directional and therefore, predictable.
- (ii) It results from modification of the physical environment by the community, that is, succession is community controlled.
- (iii) It culminates in a stabilised ecosystem in which maximum biomass and symbiotic function between organisms are maintained per unit of "available energy flow."

Causes of Succession

Ecologists have recognized the following three primary causes of succession :

1. **Initial or Initiating causes.** These are climatic as well as biotic in nature. The climatic causes include factors such as erosion and deposits, wind, fire, etc., which are caused by lightening or volcanic activity. The biotic causes include various activities of organisms. All these causes produce the bare areas or, destroy the existing population in an area.
2. **Ecesis or Continuing causes.** These are processes as migration, ecesis, aggregation, competition, reaction, etc., which cause successive waves of populations as a result of changes, chiefly in the edaphic (soil) features of the area.
3. **Stabilising causes.** These include factors such as climate of the area which result in the stabilisation of the community.

Stages of Succession

The essential requirement in the process of succession is the migration of the plants and the animals from the surrounding area. These migrants are known as pioneers. They tend to react on the soil and also tend to gain equilibrium with the climatic condition. In the first stage of succession, the pioneers adjust itself to the environment and multiply later on. Thus, there sets a competition among the animals and plants for existence. The competition results in the gradual decrease in the number of pioneers. The changed environment becomes unsuitable for the growth and spread of existing organisms, so that these animals and plants dies due to arrival of fresh organisms. The environment now becomes suitable for the growth of next group of invaders. These are called seral communities which constitute the seral stage in succession. Again the changed environmental condition brings about the unsuitable condition for these organisms. In this way the development of communities progress and the number of new arrival at each stage goes on decreasing till the climax stage is reached. The hypothetical representation of the stages of secession is as follows:

Pioneers → Seral stage I → Seral stage II → Seral stage III ← Seral stage II ← Climax stage

Types of Succession

Some basic types of succession are as follows:

1. Primary Succession

In any environment, one type of succession is primary succession which starts from the primitive substratum, where there was no previously any sort of living matter. The first group of organisms establishing there are known as pioneers, primary community or primary colonisers.

2. Secondary Succession

It starts from previously built up substrata with already existing living matter. The action of any external force, as sudden change in climatic factors, biotic intervention, fire etc. causes the existing community to disappear. Thus, area becomes devoid of living matter but its substratum instead of primitive, is built up. Such successions are comparatively more rapid.

3. Autogenic Succession

After the succession has begun, in most of the cases, it is the community itself which, as a result of its reactions with the environment, modifies its own environment and thus causing its own replacement by new communities. This course of succession is known as autogenic succession.

4. Allogenic Succession

When the replacement of the existing community is caused largely by any other external condition and not by the existing organisms, the succession is known as allogenic succession. It may occur in a highly disturbed or eroded area or in ponds where nutrients and pollutants enter. From outside and modify the environment and in turn the communities.

5. Autotrophic Succession

It is characterised by early and continued dominance of autotrophic organisms like green plants. It begins in a predominantly inorganic environment and the energy flow is maintained indefinitely. There is gradual increase in the organic matter content supported by energy flow.

6. Heterotrophic Succession

It is characterised by early dominance of heterotrophs, such as bacteria, actinomycetes, fungi and animals. It begins in a predominantly organic environment, and there is progressive decline in the energy content.

There are still so many other kinds of succession depending upon the nature of environment, where the process has begun. For example, hydrosere or hydrarch *i.e.* starting in regions where water is in plenty, as ponds, lakes, streams, swamps, bog, etc.; mesarch *i.e.* where aquatic moisture conditions are present; xerosere or xerarch *i.e.* where moisture is present in minimal amounts, such as dry deserts, rocks, etc.; lithosere *i.e.* initiating on rocks; psammosere *i.e.* on sand and halosere *i.e.* in saline water or soil.

Process of Succession

The process of succession involves the following five steps:

I. Nudation

This is the development of a bare area with out any form of life. The area may develop due to several causes such as landslide, erosion, deposition, or other catastrophic agency.

The various causes of nudation are:

- (a) **Topographic.** Due to soil erosion by gravity, water or wind, the existing community may disappear. Other causes may be deposition of sand, etc. landslide, volcanic activity and other factors.
- (b) **Climatic.** Glaciers, dry period, hails and strom, frost, fire, etc. may also destroy the community.
- (c) **Biotic.** Man is the most important factor, responsible for destruction of forests, grasslands for industry, agriculture, housing, etc. Other factors are disease epidemics due to fungi, viruses, etc., which destroy the whole population.

II. Invasion

This is the successful establishment of a species in a barren area. The species is actually reaches this new site from any other area. The whole process is completed in the following stages:

- (a) **Migration.** The seeds, spores, or other propagules of the species reach the bare area. This process, known as migration, is generally brought about by air, water, etc.
- (b) **Ecesis.** After reaching to new area, the process of successful establishment of the species, as a result of adjustment with the conditions prevailing there, is known as ecesis. In plants, after migration, seeds or propagules germinate, seedlings grow, and adults starts to reproduce. Only a few of them are capable of doing this under primitive harsh conditions, and thus most of them disappear. Thus as a result of ecesis, the individuals of species become established in the area.
- (c) **Aggregation.** After ecesis, as a result of reproduction, the individuals of the species increase in number, and they come close to each other. This process is known as **aggregation**.

III. Competition and Coaction

After aggregation of a large number of individuals of the species at a limited place, there develops competition mainly for space and nutrition. Individuals of a species affects other's life in various ways and this is called **coaction**. The species, if unable to compete with other species, if present , would be discarded. To withstand competition, reproductive capacity, wide ecological amplitude, etc. are much help to the species.

IV. Reaction

The mechanism of the modification of the environment through the influence of living organisms on it is known as **reaction**. As a result of reactions, changes take place in soil, water, light conditions, temperature, etc. of the environment. Due to all these the environment is modified, becoming unsuitable for the existing community which sooner or later is replaced by another community. The whole sequence of communities that replaces one another in the given area is called a sere, and various communities constituting the sere, as seral communities, seral stages or developmental stages. The pioneers are likely to have low nutrient requirements, more dynamic and able to take minerals in comparatively more complex forms. They are small-sized and make less demand from environment.

Stabilization (Climax)

Finally, there occurs a stage in the process, when the final terminal community becomes more or less stabilised for longer period of time and it can maintain itself in equilibrium with the climate of the area. This final community is not replaced, and is known as climax community and the stage as climax stage.

Certain Recent Models of Succession

Connel and Slatyer (1977) have proposed the following three models to accommended different possible pathways of succession :

1. **Facilitation model.** It is based on the Clelments ideas of relay communities in which the seral community is believed to modify. According to this model each new community in course of time prepares suitable grounds to facilitate its own replacement by another better suited community. So each community like a 'relay process' delivers the habitat to next or higher status community. This model has not been supported by any proper evidence.
2. **Tolerance model.** This model is based on the concept of IFC or initial heretic composition which suggests that arrival of new invaders of higher life form types necessarily does not eliminate pioneers. According to this model, only such higher succession or climax species are able to join which can be tolerated by the early settlers. So, the tolerance model differs from Clement's relay succession model in the sense that as the succession proceeds, more and higher life form plants are tolerated to join and co-exist, then necessarily replacing the earlier component species. With the passage of time, species which mutually tolerate each other gain control over the habitat to form the climax vegetation.
3. **Inhibition model.** According to the model, the early arrived species (populations) on a new habitat may develop counter mechanism to normal replacement process. For example, the allolopathy may be the common counter acting adaptation to thwart or inhibit the entry of late arriving species. This kind of highly adaptated early stage communities may not be common on a wide range of habitats. In such a case, relay succession gains control only after the death of the allelopathic plants. Since inhibition model lacks university so it was also critised.