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## CHAPTER 8

# Ecological Succession Enriches Biodiversity Conservation

**Malviya Mamata Kashiramji**

Department of Zoology, Pratibha Niketan Mahavidyalaya, Nanded 431601 Maharashtra, India

*Corresponding author Email*: malviya1966@gmail.com

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**Abstract**

This chapter presents a review of ecological succession such as Xerarch, Hydrarch and Mesarch and also focuses on its significance, due to the fact that ecological succession produces a stable community despite the physical environment's fluctuations. The capacity to buffer and regulate physical forces like water, temperature, etc. is possessed by the stable or climax community. It is crucial to the gradual spread of animals. For scientists who wish to comprehend ecosystem dynamics and successfully preserve or rebuild natural communities, it is crucial. Increased biodiversity, more nutrients available in the soil, organic matter recycling, and an improved habitat for other creatures to live in lead to an increase in the number of those animals.

**Keywords:** *Ecological Succession, Xerarch, Hydrarch, Mesarch, Significance*

## Introduction

### Ecological Succession

Any area's communities are unstable. The totality of flora and fauna is known as the community. Occasionally, the communities transform into new types of communities. As a result, a community in a given area may be replaced by a group of communities or by another community. For instance, if a pond is gradually filled with sand and mud, it can become a marshy-land community. Depending on the climatic conditions that exist there, the marshy-land community may eventually give rise to a grassland community or a forest community. Ecological succession is the term used to describe this process of new communities emerging. It can be defined as "an orderly and progressive replacement of one community by another till the development of a stable community in that area" (SMITH, 1965).





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## 1. Characteristics of Ecological Succession

Ecological succession is characterized by the following way

a) It follows a path and is predictable.
b) The community's alteration of the physical surroundings is what leads to the succession.
c) Throughout succession, structural complexity rises.
d) Animal and plant species are constantly evolving through time.
e) Species diversity tends to rise with succession. On the other hand, the later stages of succession are when heterotrophic animals and microorganisms achieve their highest variety.
f) The biomass rises.
g) A large number of new habitat niches are produced as biomass rises.

## 2. Sere and Climax

One can liken the succession of a stable community to an organism's embryogenesis. A number of communities emerge during the process of creating a stable community, and they gradually replace one another until the stable community is achieved. A community's several stages of development are referred to as seral stages and each level is known as a seral stage. The term "climax community" refers to the last stable community.

## 3. Ideas Regarding Climax

Climax is the last phase of succession. Climax is a dependable neighborhood. It is balanced and self-sustaining. Regarding climax, there are three key ideas. They are

a) Monoclimax theory
b) Polyclimax theory and
c) Climax pattern theory

### Monoclimax Theory

This concept was proposed by CLEMANTS. According to this concept, each climatic or geographical region has only one climax community.

### Polyclimax Theory

It was TANSLEY who put out this theory. It states that numerous climax communities reside in each location. They are influenced by a number of variables, including soil nutrients and moisture. According to this view, there are various personalities, climate being just one of them. There are numerous established climax communities because to the various environmental variables.


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### 4. Climax Pattern Theory

It was WHITTAKER who put forth this notion in 1953. This hypothesis states that an area's peak community is defined by all of the environmental elements present in that location. He claims that there are nine main variables at play. These include each species' genetic makeup, the climate, soil, location, biotic variables, fire, wind, species availability, and dispersal probabilities.

### 5. Types of Succession

Ecological succession can be classified into two types, namely primary succession and secondary succession.

#### Primary Succession

Primary succession occurs when community development begins on a barren land that has never been home to a community before. The colonization of a recently exposed island serves as an example. The term "pioneer community" refers to the initial group of organisms that start ecological succession. One such illustration of primary succession is the emergence of a community on a rock. First, the pioneer communities, the lichens, take over the rock. Gradually, moss emerges, and is succeeded by herbs, shrubs, and eventually trees.

#### Secondary Succession

The term used to describe the process of community development that begins on land that was formerly home to established communities is secondary succession. The development of communities in cut-over forests, abandoned crop lands and ploughed fields are examples of secondary succession.

Further, based on the dominating species in the community, succession is classified into two types, namely autotrophic succession and heterotrophic succession.

#### Autotrophic Succession

It is characterized by early and continued dominance by autotrophic organisms. The succession begins predominantly in inorganic environments. The primary and secondary successions come under autotrophic succession.

#### Heterotrophic Succession

It is characterized by early and continued dominance heterotrophic organisms (animals). The succession begins in organic environments.

### 6. Patterns of Succession

Based on the place where succession occurs, three different patterns of succession can be recognised. They are:

a) Xerarch or xerosere
b) Hydrarch or hydrosere and
c) Mesarch or mesosere

### 7. Xerosere/ xerarch

The succession when starts in xeric or dry habitat having minimum amounts of moisture, such as dry deserts, bare rocks, etc. it is called xerosere. A temporary community in ecological succession dry and sterile habitat is called xerosere. It may be of 3 types.

Lithosere is Succession initiating on bare rocks.

Psammore is Succession initiating on sand.


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Halosere is Succession initiating on saline water / soil.

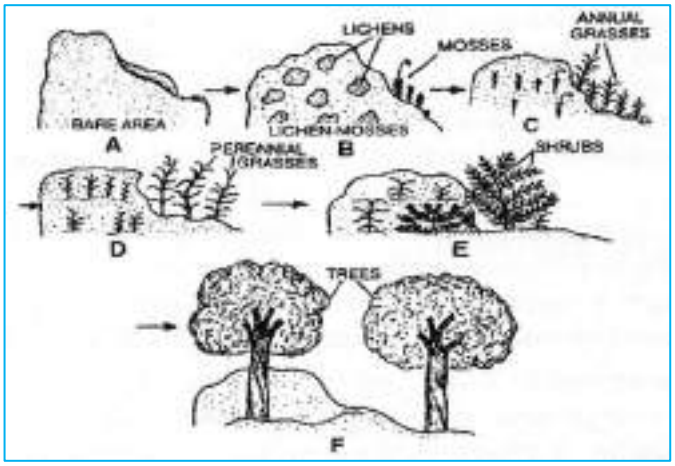


**Fig. Xerosere-stages of succession**

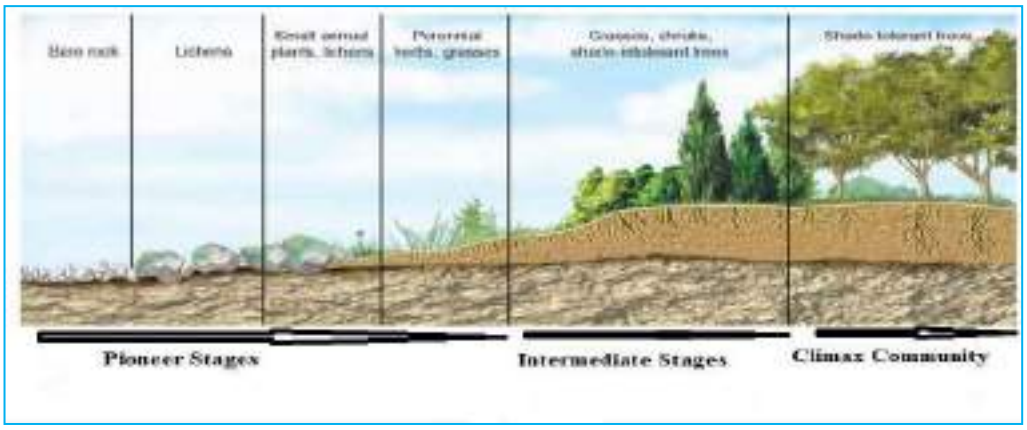


**Fig. Xerosere-stages of succession**

**Lithosere (Terrestrial succession)**

Typical xeroseres are lithoseres, which grow on bare (nacked) rocks. The primordial Substratum, which is bare rock, is devoid of biological stuff and has low water content. Only minerals exist in rock in its disintegrated, unweathered state. Crustose lichens make up the pioneer community that grows on rocks. After going through several progressively higher stages, succession ends in a forest climax community.

*Lithosere includes following seral stages:*

1. **Crustose Lichens stage**

Rocks are exposed to severe temperatures and are totally devoid of moisture and nutrients. A lichen's algal or fungal partners couldn't survive in such an environment for very long. As the fungus uses the algae as a source of sustenance. The fungus that resembles crust protects the algae from drying out. There is no dirt to allow roots to pierce through and provide nutrition. The pioneer species are lichens and blue-green algae. The mucilaginous cell walls of the blue-green algae, known as scytonema, are what allow them to cling to the rock. These algae are able to use ambient nitrogen and can withstand temperature and moisture extremes. However, crustose lichens like as Rhizocarpon, Rinodina, and Lecanora are common pioneers in milder conditions (high altitudes and temperate zones). They produce some carbonic acids which bring about weathering of rocks. The organic matter of Lichen becomes mixed with the small particles of rocks. This process is very slow. These lichens are relpaced by foliose type of Lichens.


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**2. Foliose-lichen stage**

Soil is formed on the bare rocks as a result of weathering and the decomposition of algae and crustose lichens. Large thalli resembling leaves begin to form on foliose and fruticose lichens such as Dermatocarpon, Umbilicaria, and Parmelia, among others. They contribute to the continued development of the soil on the rock by producing more organic matter, accumulating dust particles, and absorbing and holding onto more moisture. A thin layer of soil forms on top of the rough surface of the rocks as a result of weathering and the quick addition of humus. a significant shift in the environment.

**3. Moss stage**

Some xerophytic mosses thrive when a thin layer of humus-rich soil forms on the rock's surface as well as in its clefts and depressions. For example, wind-blown spores assist plants like Polytrichum (hair moss), Tortula (twisted moss), Grimmia (black moss), etc. to move. Following their demise and decomposition, these mosses develop, outcompete the lichens, and enrich the soil with additional organic matter. The layer of earth gets thicker. The soil layer holds a lot of water and gives grasses, ferns, and herbs a good place to flourish.

**4. Herb stage**

Because of its extreme compactness, the soil created during the moss stage allows herbaceous plants to flourish on the rocks. The decomposing remnants of the short-lived herbs also contribute to the soil's increasing humus content. Shallow-rooted grasses such as Aristida, Festuca, poa, and others along with Solidago, Potentilla, and others are what define the herb stage. More soil and nutrients are produced as a result of the physical, chemical, and biological weathering of the rocks. The accumulating organic matter is broken down by a variety of fungus and barteria. At this point, a few larger grasses and herbs, like Themeda, Heteropogon, and Adathoda, among others, join the community. The shrub stage comes after the herb stage. In the meantime, the soil's population of bacteria, fungus, and other organisms grows significantly.

**5. Shrub stage**

Enough soll is produced. in the period of herbaceous growth to facilitate the development of woody shrubs. With the aid of thizomes or seeds from the nearby regions, they travel. The innovator Rhus, Physocarpus, and Symphoricarpos are examples of shrubs. The herbaceous vegetation is overshadowed by them. This dense shrubby growth enriches the soil even more. The variety of plant and animal species grew. The peak community is finally formed by trees in place of the shrubs.

**6. Climax Forest Stage -**

Trees that are pioneer species called xerophytic. As additional rocks weather and the soil's humus content rises, more trees eventually appear and the vegetation eventually turns masophytic. Thus, a forest community eventually grows there.

**7. Animals dwelling**

Lithosere entails a series of alterations in animal existence. A few species of mites, ants, and spiders are the pioneer animals of the lichen phases. Numerous new species of mites, tiny spiders, tartigrades, and springtails appear during the moss stage. Insect larvae such as ants, mites, nematodes, and collembola are the hallmarks of the herb stage. The fauna undergoes significant qualitative and quantitative changes during the shrub and forest stages. Thus, a wide variety of animals can be found, including slugs, wireworms, millipedes, centipedes, mites, ants, sow bugs, and springtails; amphibians, including frogs and salamanders; reptiles, including turtles, skinks, and other lizards; birds, including grouse and flycatchers; and mammals, including moles, mice, shrews, squirrels, chipmunks, and foxes.


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**8. Hydrarch or Hydrosere**

When the succession starts in ponds, pools, lakes and marshes the Sere is called Hydrosere. This type of Succession occurs in the aquatic environment. Hydrosere can be studied the body in standing or running water.

*There are about seven stages in this sere:*

**1. Phytoplankton stage**

Algal spores are carried into the water by the wind together with soil particles during the first stage of succession. The first organisms to settle on water are the primitive forms of life, such as bacteria, algae, and numerous other aquatic plants and animals called phytoplankton and zooplankton. There are some diatoms, green algae, blue green algae, and green algae. They proliferate and expand for a while. Because of their varied life activities, all of these species contribute significantly to the amount of organic matter and nutrients in the pond. When they die, they settle to form a layer of muck at the bottom of the pond. Later on, filamentous algae such as oedogonium and spirogyra emerge. Amoeba, paramecium, and euglena are examples of zooplanktons. If the plankton growth becomes rich enough blue-gill fish, sunfish, largemouth bass and small caddish flies occurring.

**2. Rooted submerged stage**

Thus, the rooted submerged stage comes after the phytoplankton stage. The pond's water is often covered in a loose layer of mud at a depth of roughly ten feet. The dead and decomposing pioneer, phytoplankton, etc., make up the mud. This is an appropriate bottom for rooted submerged plant development. These comprise a few macroscopic organisms, such as flowering plants like Elodea, Potamogeton, Myriophyllum, Najas, Ceratophyllum, Hydrilla, Vallisnerio, and some types of algae like Chara and Nitella. Together, these plants create a tangled mass of vegetation that grows and covers more ground every year. These plants perish, and their remnants end up at the bottom. As a result, the water gets shallower and substratum accumulates. This new habitat now replaces by floating-leaved type Dragonflies, mayflies and some small cristaceans like Asellas, Gammarus, Daphnia, Cypris and cyclops etc. inhabit the pond at this stage.

**3. Rooted floating stage**

The water is now between two and eight feet deep. Floating species emerge as the submerged plants begin to fade. Although they are rooted plants, their branches reach almost to the top of the water or partially float on its surface. Nelumbo, Nymphaea, Limnanthemum, Aponogeton, Trapa, Monochoria, and other species are among them. Azolla, Lemna Wolffia, Pistia, Spirodella, Salvinia, and other free floating spp. associate with rooted plants due to the increased availability of organic materials and salts in the water. The water's surface is fully covered as a result of all of these. The large leaves floating on the water's surface serve as a barrier against light penetrating the water's deeper layers. Thus, direct sunlight cannot reach submerged plants. Most of the species thus die and eliminated and deposited their organic matter and ponds become shallow. Floating species disappear later on.

Hydras, frog, salamander, gill breathing Snails, diving beetles (Dysticus) appears. Some turtles, snake also occurs. When pond becomes shallow (1 to 3 ft) it is less suited to floating plants. They disappearing gradually and new amphibious species live successfully.

**4. Reed swamp stage (amphibious stage)**

The community's plants are rooted, but the majority of their shoots are still open to the air. The main plants at this stage are species of Phragmites (reed grass), Typha, Sagittaria, and Scirpus. Under these conditions, neither submerged nor floating plants can live because the foliage leaves of these plants are exposed to the water's surface and cover the submerged and floating plants. At the bottom, additional soil and plant detritus are deposited. The plants generate extremely dense vegetation and have well-developed rhizomes. As a result, it facilitates the accumulation of sedimentary sediments made of plant debris. The habitat becomes unsuitable for the majority of species' growth when the water depth is progressively reduced. Fauna found are Lymnea, Physa,


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Gyraulus. Drayonflies, may files, water scorpion, giant water bug, scavanger beetles are appeared at this Stage. Red winged black birds, duck, King Fisher, great blue heron, swamp sparrow, muskrat, and beavers become common in the area.

**5. Sedge-meadow stage (Marginal mats) / sedge Marsh stage**

The annual deposition of leaves and the root system provide significant amounts of organic matter to the bottom. At the end of the filling operation, the soil becomes marshy and may become too dry for the pre-existing plant life. The region is inhabited by Cyperaceae and Gramineae species, including Eleocharis, Carex, Juncus, and Cyperus. They use many branched rhizomes to build a mat-like vegetation that faces the center of the pond. Now that the mud is exposed to air, the sedge meadow stage plants gradually fade and give way to a mesophytic vegetation.

**6. Woodland stage**

With the exception of spring and early summer, the majority of the year, the soil is dry. The forest stage's pioneers are alien species that have invaded nearby terrestrial plants. They are able to withstand situations that are wet. There are certain tree and shrub species that emerge. Examples of woody plants are Poplus, Alnus, and Cephalanthus, whereas shrubs include Salix, Cornus, and Cephalanthus. A few shade-tolerant herbs can also be seen growing among the bushes and trees. A significant amount of humus, bacteria, fungi, and other creatures build up in the soil during the woodland stage. All of this encourages a large number of additional trees to reach the peak stage of the vegetation.

**7. Forest Stage (climax forest)**

The climax vegetation may eventually form as a result of the hydrosers. The habitat gets drier as soil levels rise above water levels due to humus and soil buildup. In this type of environment, woody plants grow. The wooland community, the community at the peak, is quickly overrun (supplanted) by several trees. In the climax vegetation, bacteria, fungi, and other creatures are more commonly found. The process moves quite slowly. Thousands of years could pass before the peak occurs. There are many kinds of flora in the climax forest. There are plants that like the shadow, mosses, bushes, and herbs. The majority organisms are trees, however there are also bacteria, fungus, and other microbes. They increase the amount of organic compounds in the soil. It is now clear whole sere is continuously but gradually changes.

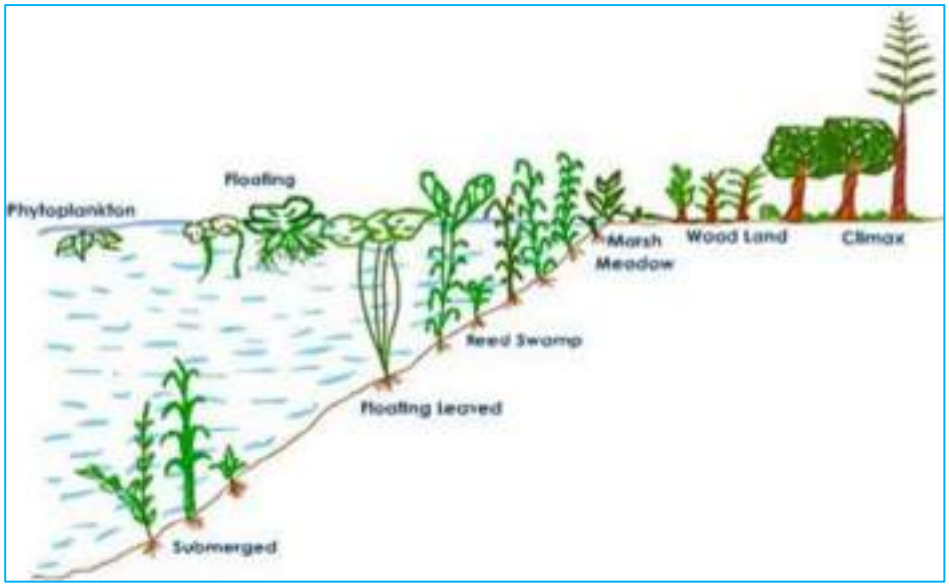


**Fig. Hydrosere-stages of succession**


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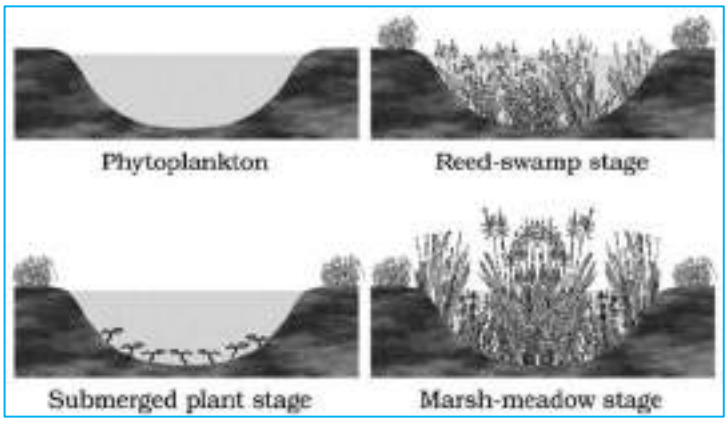


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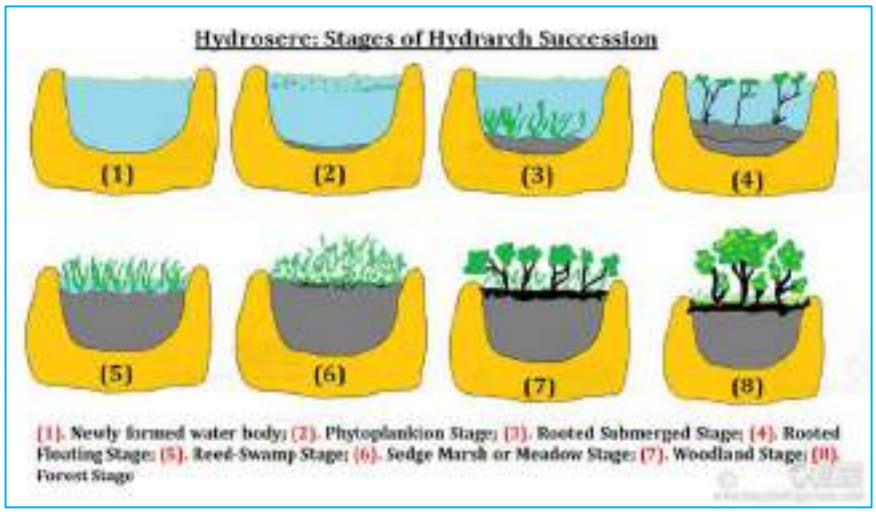


**Fig. Hydrosere-stages of succession**

**8. Mesarch or Mesosere**

Mesarch succession is intermediate between xerarch and hydrarch. This succession occurs in places with moisture. It occurs in the process of hydrarch or xerarch.

**9. Significance of Succession**

a. A stable community is created in the physically changing environment through ecological succession. The capacity to buffer and regulate physical forces like water, temperature, etc. is possessed by the stable or climax community.

b. It is crucial to the gradual spread of animals.

c. It is crucial for scientists to comprehend ecosystem dynamics and to successfully preserve or rebuild natural communities.

d. It enhances biodiversity, improves the amount of nutrients in the soil, recycles organic material, and creates a more hospitable environment for other creatures, which boosts their number.

**Conclusion**

Ecological succession is important to study and maintain focus on because it leads to increased biodiversity, nutrient availability in soil, recycling of organic material, and a more suitable habitat for other


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animals to inhabit, increasing their population size and aiding in the dispersal of animals and restoration of natural communities.

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