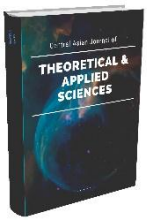

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Ecological Succession in Rajasthan with Special Reference to North-Eastern Areas

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Abstract: *Succession is the order of colonization of species in an ecosystem from a barren or destroyed area of land. Mosses and lichens are the first species that inhabit an area. They make the area suitable for the growth of larger species such as grasses, shrubs and finally trees . Sehima nervosum type on the hills and piedmont regions, Dichanthium annulatum type on older alluvial flat lands with sand clay loam to clay soils, Cenchrus type on well drained alluvial soils, Lasiurus sindicus type on loose sandy soils, Desmostachya bipinnata type on young alluvium, Sporobolus-Dichanthium annulatum type on low-lying heavy soils and Panicum turgidum type on sand dunes. Stable disclimax associations (grassland types) and seral communities within the associations are discussed in north eastern areas of Rajasthan.*

Keywords: *ecological, Rajasthan, succession, dessert, seral, communities, grasses, shrubs, trees.*

Introduction

Ecological succession is the steady and gradual change in a species of a given area with respect to the changing environment. It is a predictable change and is an inevitable process of nature as all the biotic components have to keep up with the changes in our environment.

The ultimate aim of this process is to reach equilibrium in the ecosystem. The community that achieves this aim is called a climax community. In an attempt to reach this equilibrium, some species increase in number while some others decrease.[1,2]

In an area, the sequence of communities that undergo changes is called sere. Thus, each community that changes is called a seral stage or seral community.

All the communities that we observe today around us have undergone succession over a period of time since their existence. Thus, we can say that evolution is a process that has taken place simultaneously with that of ecological succession. Also, the initiation of life on earth can be considered to be a result of this succession process.

If we consider an area where life starts from scratch through the process of succession, it is known as primary succession. However, if life starts at a place after the area has lost all the life forms existing there, the process is called secondary succession.[3,4]

It is obvious that primary succession is a rather slow process as life has to start from nothing whereas secondary succession is faster because it starts at a place which had already supported life before. Moreover, the first species that comes into existence during primary succession is known as the pioneer species.

Primary Succession

Primary succession is the succession that starts in lifeless areas such as the regions devoid of soil or the areas where the soil is unable to sustain life.

When the planet was first formed there was no soil on earth. The earth was only made up of rocks. These rocks were broken down by microorganisms and eroded to form soil. The soil then becomes the foundation of plant life. These plants help in the survival of different animals and progress from primary succession to the climax community.[5,6]

If this primary ecosystem is destroyed, secondary succession takes place.

Secondary Succession

Secondary succession occurs when the primary ecosystem gets destroyed. For eg., a climax community gets destroyed by fire. It gets recolonized after the destruction. This is known as secondary ecological succession. Small plants emerge first, followed by larger plants. The tall trees block the sunlight and change the structure of the organisms below the canopy. Finally, the climax community arrives.

Cyclic Succession

This is only the change in the structure of an ecosystem on a cyclic basis. Some plants remain dormant for the rest of the year and emerge all at once. This drastically changes the structure of an ecosystem.[7,8]

Seral Community

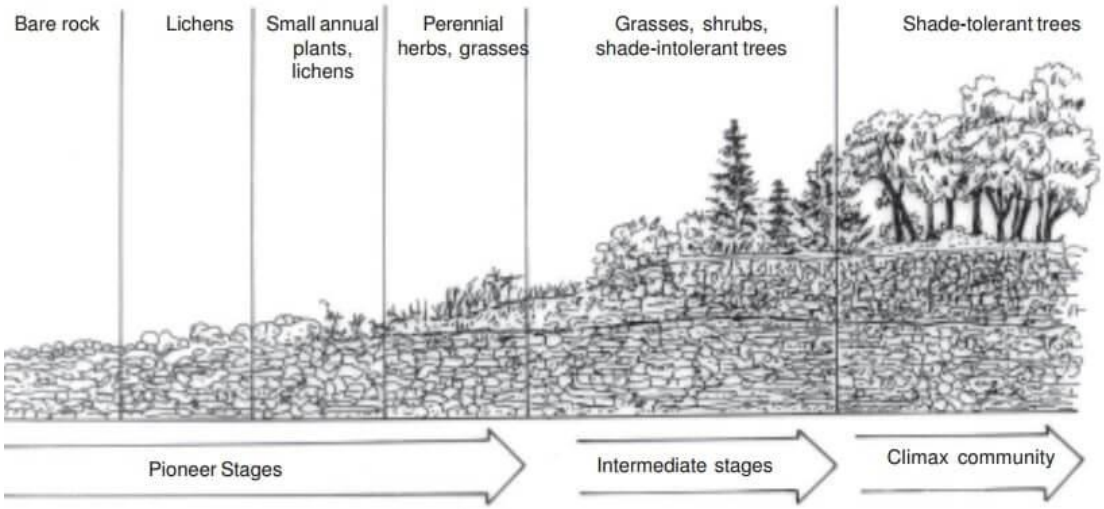
"A seral community is an intermediate stage of ecological succession advancing towards the climax community."

A seral community is replaced by the subsequent community. It consists of simple food webs and food chains. It exhibits a very low degree of diversity. The individuals are less in number and the nutrients are also less.

There are seven different types of seres:

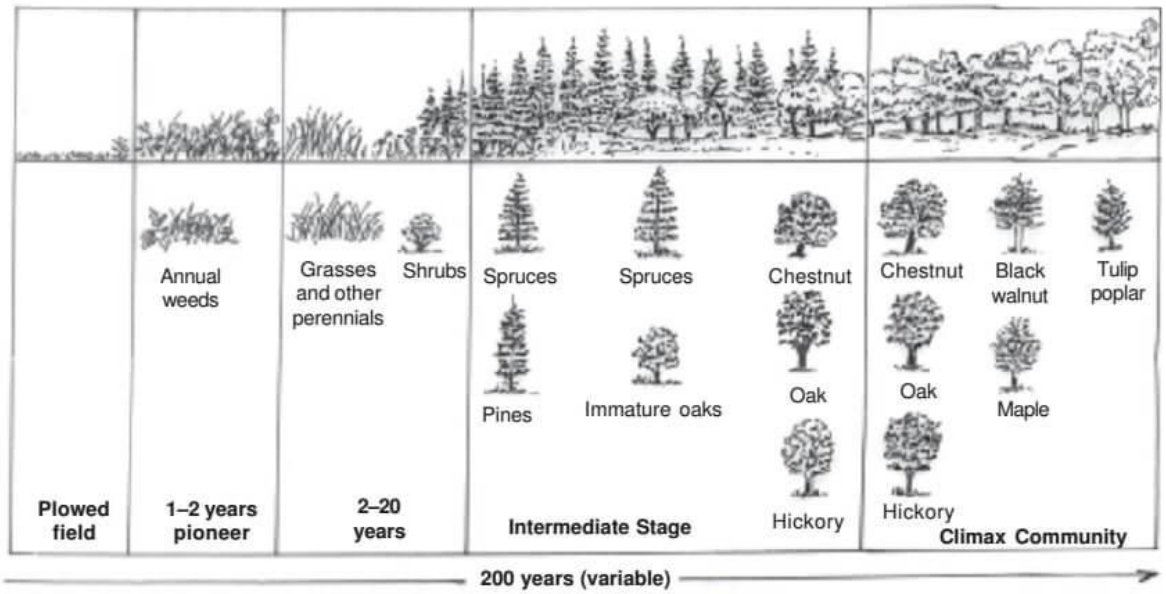
Types of Seres	Explanation
Hydrosere	Succession in aquatic habitat.
Xerosere	Succession in dry habitat.
Lithosere	Succession on a bare rock surface.
Psammosere	Succession initiating on sandy areas.
Halosere	Succession starting in saline soil or water.
Senile	Succession of microorganism on dead matter.
Eosere	Development of vegetation in an era.

In north east Rajasthan areas:-



Primary Succession

- The first plant to colonize an area is called the pioneer community.
- The final stage of succession is called the climax community.
- A climax community is stable, mature, more complex and long-lasting.
- The stage leading to the climax community is called successional stages or seres.
- Each transitional community that is formed and replaced during succession is called a stage in succession or a seral community.[9,10]
- Succession is characterized by the following: increased productivity, the shift of nutrients from the reservoirs, increased diversity of organisms, and a gradual increase in the complexity of food webs.
- Succession would occur faster in area existing in the middle of the large continent. This is because here seeds of plants belonging to the different seres would reach much faster.



Secondary succession

- ✓ A mature or intermediate community may be destroyed by natural events such as floods, droughts, fires, or storms or by human interventions such as deforestation, agriculture, overgrazing, etc.
- ✓ This abandoned land is first invaded by hardy species of grasses that can survive in bare, sun-baked soil.
- ✓ These grasses may be soon joined by tall grasses and herbaceous plants. These dominate the ecosystem for some years along with mice, rabbits, insects and seed-eating birds.
- ✓ Eventually, some trees come up in this area, seeds of which may be brought by wind or animals.
- ✓ And over the years, a forest community develops. Thus, an abandoned land over a period becomes dominated by trees and is transformed into a forest.[11,12]

Discussion

The 3,162 sq. km Desert National Park (DNP) is one of the largest protected areas in India. It represents all of the natural features of the Thar Desert in India. Since its establishment in the early 1980s, the wildlife population has increased, and now the Indian Gazelle, the Great Indian Bustard, the Desert Fox, etc., are easily seen in it. But although many core areas of 500 to 1,000 hectares each have been established, progress in the development of the Park is slow, and now the future of the Park itself is in jeopardy owing to a plan to construct a feeder canal of the main Indira Gandhi Nahar (canal) Project (IGNP), which would bisect the Park.[13,14] It is feared that such improvement in irrigation facilites would make it impossible to shift the villagers outside the Park boundary, as had been planned earlier—and moreover, it would attract settlers to the Park.

Water is the most precious substance on the earth. Life on the earth is not possible without water. Ponds have been a traditional source of water from ancient times for drinking purposes in villages. So, the present study is asses to quality of pond water of Similya Village Pond, District Kota, Rajasthan. The determinant of good water body is determined by physico-chemical characteristics. In the present study seasonal variation of physico-chemical characteristics were statically analyzed and graphically presented. The following ranges were obtained for the parameters evaluted atmospheric temperature 23.1- 34.6 ˚c, atmospheric relative humidity 40.9-78.9 %, water temperatre 22-29 ˚c, transparency 13.43-83.55 cm, electric conductivity 120.76-391.96 µmhos/cm, total dissolved solids 57.8-128.9 mg/l, pH 7.11-8.9, free carbon dioxide 0.50-4.86 mg/l, total alkalinity 86.44-155.87 mg/l, dissolved oxygen 6.46-9.57 mg/l, chloride 26.80-145.61 mg/l,total hardness 86.80-198.33 mg/l, phosphate 0.86-1.98 mg/l and nitrate 0.16-0.56 mg/l. The qualitative study of plankton was observed. Phytoplankton species were more diverse and dominant than zooplankton communities. These were found to be present in the ratio of 6.4:3.6 (64 % phytoplankton 36 % zooplankton). The study concluded that the water of the village pond similiya showed variation in the various physico-chemical parameters in all the three seasons. Therefore, urgent need to take the important step towards the quality management plans in order to eliminate water pollution.

As temperatures soar and water levels plummet, Rajasthan is running water trains and thousands of tankers to meet the needs of the population.[15,16] This is not the first time nor will it be the last.

Water has always been a precious commodity in Rajasthan, a desert state. As per the Central Ground Water Report for 2020, of the 295 blocks in the state, 203 are categorized as over-exploited, 23 are critical, 29 are semi-critical and only 37 blocks are safe. (Three blocks are saline).

Uday Singh is a farmer in Parmeshwarpura village of Kotdi block. He used to grow wheat in his five bighas of land. Wheat requires water five times during the crop cycle. Uday Singh does not have any

irrigation facility and he buys water from another person's borewell, paying Rs3000 per purchase. For the entire crop cycle, he has to pay Rs15,000 for water.

A few years back, Singh took part in a meeting by the NGO Foundation for Ecological Security (FES) that taught farmers about water management through games and discussions.

Singh says he became aware of saving water after playing the games. "I used to grow wheat on my land but after the FES facilitator told us about the water consumption, I decided to do mixed cropping to save water. Though there was some opposition from my family, I went ahead with my decision," he says.[17,18]

Now Singh grows wheat on 2 bighas of land and chana on 3 bighas of land. "Earlier I spent Rs15,000 for watering the crop. Now I spend Rs9500," he says.

Chana requires only two waterings. His production was 12 quintals of chana and 14 quintals of wheat, almost equal to the 25 quintal wheat he grew earlier. He used to sell the wheat crop for about Rs40,000. This time he sold the chana crop for Rs50,000 as the rates were between Rs4000-5500 per quintal.[19,20]

In his 60 years, Singh has seen 7-8 open wells in his village dry up and several borewells come up. He says the water table has gone down by 1-2 metres in his village. About 20,000 litres of water is required in one watering for the wheat crop. Five waterings amount to 5 lakh litres of water over five bighas of land. But now he is growing chana on 3 bighas of land. Chana requires only two waterings, so he's using 1.2 lakh litres of water for chana and 3.2 lakh litres for wheat and still saving 1.8 lakh litres of water. Roy says most governments and organisations work on the supply side, creating more and more structures to store water but there is no talk of water governance and demand management. With the water games and crop water budgeting, the starkest change has been the alteration in behaviour and attitude of the people who are beginning to think of water as a shared resource.

The water games are usually played before the Rabi season in August-September. The community groups assess the amount of water available and the demand. Based on the assessment, they have to decide what crops will be grown, If the water is not enough for domestic and irrigation use, then what strategy needs to be adopted. Groups of five players are made and they are given a particular amount of water. They have to choose between two types of crops – one that is water-intensive but fetches them a higher price in the market, and the second crop which demands less water but earns a lower price.[21,22]

There are 20 rounds. In the first 10 rounds, there is no communication between the players. The participants take individual decisions and cannot reveal their crop choice to others. The last 10 rounds are then played with communication. In this round, the participants reveal their crop choice. They can also discuss and takedecisions collectively after evaluating the water situation, discussing their problems and advocating solutions.

The game is followed by a debriefing session where the players and other community members hold discussions. The facilitator urges the players to reflect on the lessons from the game. The community deliberates upon the local water-related issues, irrigation strategies, and crop considerations. The game is supported by Crop Water Budgeting which is a community-centric tool to discuss balancing available water resources with the levels of consumption. It helps in creating a shared knowledge of the availability of water vis-à-vis the demand for water for various uses. It helps the farmers in developing strategies for more efficient and equitable water use.[23]

Kailash Balai, a trainer in Kotdi block says as individuals, the focus of the farmers is on earning maximum income from their crop. But as a group, they tend to have in-depth discussions on the water situation, the monsoon, mixed cropping, income generation and choose the agricultural activity based on the water availability.

Balai admits that changing the mindset of people is a challenge but the outcome of the interventions is visible. In some villages, the community members have prescribed rules and regulations to manage water resources, some are advocating water-sharing while others have banned borewells. The water games were developed jointly by the FES, International Food Policy Research Institute and Arizona State University. The water games draw from Game Theory which was developed by mathematician John von Neumann and economist Oskar Morgenstern in the 1940s. Game Theory is a theoretical framework to conceive social situations among competing players. Game theory is the science of strategy, or at least the optimal decision-making of independent and competing actors in a strategic setting.

The key to game theory is that one player's payoff is contingent on the strategy implemented by the other player. "Most watershed development projects focus is on building water harvesting structures. But just building structures and not engaging with the community to use the water efficiently and equitably will not have the desired impact of addressing the issue of the water crisis," says Pratiti.[24]

Results

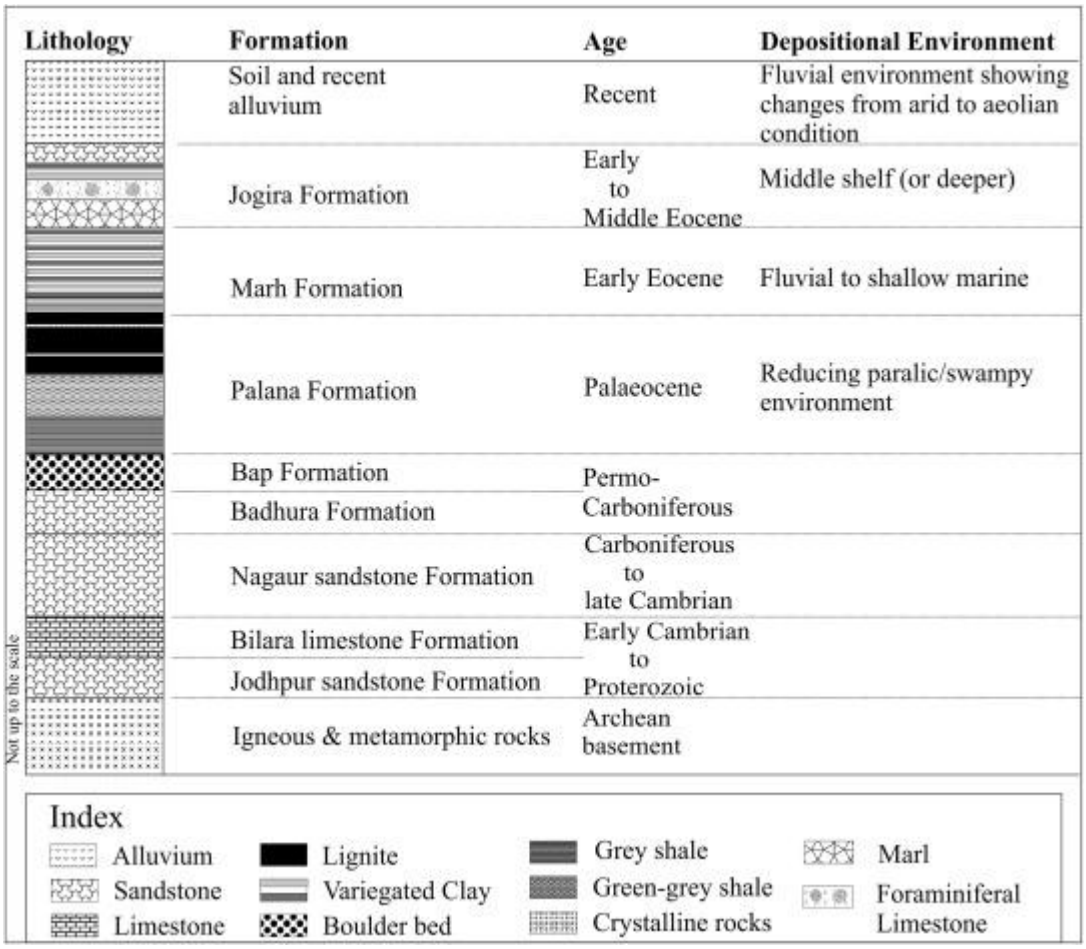
The sedimentary sequence containing lignite deposits in Gurha quarry of the Bikaner-Nagaur Basin (Rajasthan) has been investigated. The samples from lignite and allied shale horizons were evaluated for petrographical, palynological, palynofacies and organic geochemical inferences, to depict the source flora and to reconstruct the palaeodepositional conditions prevailed during the sedimentation. An assessment for the hydrocarbon generation potential of these deposits has also been made. The results revealed the dominance of huminite macerals and phytoclasts organic matter (OM) indicating the existence of forested vegetation in the vicinity of the depositional site. A relatively high terrigenous/aquatic ratio (TAR) and the carbon preference index (CPI) are also suggesting the contribution of higher plants in the peat formation. However, the *n*-alkane distributions, maximizing at *n*-C_{17} and *n*-C_{29}, showed inputs from the algal communities along with the higher plant derived organic matters. Recovered palynomorphs of the families Onagraceae, Meliaceae, Arecaceae, Rhizophoraceae, Rubiaceae, Ctenolophonaceae, etc. together with oleanene and ursane types of triterpenoids suggest the contribution from angiosperms source vegetation. Interestingly, the presence of Araucareaceae and Podocarpaceae pollen grains shows the existence of gymnosperms vegetation. Further, the presence of tetracyclic diterpanes; demethylated ent-beyerane, sandaracopimarane, pimarane, and Kaurane type of compounds confirms the contribution of conifers. The variation in the values of the coefficient of non-equality (H: 0.68%–7.56%), the standard deviation (δ: 0.04%–0.16%) and the coefficient of variability (V: 16.10%–46.47%), also shows the heterogeneity in the source organic matter.[25]

The various petrographical indices, palynological entities, and geochemical parameters indicate that the peat-forming vegetation was accumulated under a mixed environment and fluctuating hydrological settings. The interpretation of palynofacies data on APP (Amorphous organic matter-Phytoclast-Palynomorphs) diagram suggests that the accumulation of organic matter occurred in a dysoxic-suboxic condition in a proximal (to land) setting with the shift to an anoxic condition in distal setting towards the termination of sedimentation. The huminite (ulminite) reflectance (R_r) values (av. 0.28%) showed a good relationship with average T_{max} value (414 °C), suggesting the immaturity. The TOC content ranges of 13–59 wt.%, and HI values vary between 101 and 546 mg HC/g TOC in the studied samples. Collectively, the studied lignite and shale samples have the admixed kerogens (Type III–II) and exhibit the ability to generate the gaseous to oil hydrocarbons upon maturation.

Rajasthan State as a part of Indian shield consists of sedimentary records covering a time span from early Archaean to Holocene. The distinct basins viz. Bikaner-Nagaur, Barmer and Jaisalmer basins, developed as a result of the intracratonic sedimentation covering an area of about 120,000 $km^{2.}$ The basin (Neoproterozoic–early Palaeozoic) covers an area of 30,000 km^2 in the districts of Bikaner and Nagaur . It

(basin) comprised of Delhi metamorphites and MIS (Malani Igneous Suite) and is the largest of the basins in western Rajasthan.

Building upon and integrating these research results can lead to more confident reconstruction of the palaeovegetation and environment. Therefore, the present multidisciplinary investigation (on new set of samples) has been taken up for a better understanding of botanical origin, nature, composition and depositional settings of the Gurha lignites, besides attempting to estimate the hydrocarbon generation potential of these Palaeocene deposits. It is supplementary to the categorization of the DGH, MoPNG (India) that the Bikaner-Nagaur comes under the productive Basin-I category.[24]



Conclusions

The maceration technique given by Traverse (1988) for the palynological investigation, was followed. Briefly, the crushed samples were undergone to various acid (HCl, HF, and HNO_3) subsequent treatments. The acid-free sieved samples are also treated with a 10% KOH solution for the recovery of clean palynomorphs. The Leica DM 3000 microscope has been used for identification and counting (150–200 counts per sample) of the palynomorphs. For assessing the biomarker composition, the oven-dried powdered samples were first treated with the solution of dichloromethane: methanol (9:1), to obtain the soluble organic matter by ultrasonication for 30 min. The soluble (saturated and aromatic) fraction was analyzed on a gas chromatograph connected with a mass spectrometer. [25]

The ecological succession in north eastern areas of Rajasthan have been reviewed and discussed.

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