

Characteristics and scientific values of ecological succession in Danxia Landform of China

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Abstract: The characteristics and scientific values of ecological succession in Danxia Landform of China were discussed. It was known that research on vegetation succession was quite difficult for its long-term and intricate process. Space-time substitution is an important method to study the succession, while it needs intact spatial succession series. In Danxia Landform, there are such primary and secondary succession series. On the hilltops, there are typical low shrubberies and arboreal forests of primary succession. The surrounding slopes are subjected to seasonal rainfall erosion, weathering action, gravitational collapse and so on. The primary succession constantly starts from bare rocks, and then moss and herbal communities of early primary succession are formed. With further weathering of rocks and effects of moss and lichen, soil layers are getting thicker and thicker, which pushes primary succession ahead. New collapses are ceaselessly induced by the special geological geomorphological process, and then a new primary succession starts from bare rocks. Thus, different stages of primary succession are formed in Danxia Landform. In addition, the secondary succession series exist in Danxia Landform, including the pioneer forests, transitional forests and steady forests. Danxia Landform provides ideal sites for vegetation succession study. The relative studies would be helpful for the vegetation management and protection in this area. As ecological restoration reference, it is also meaningful for the vegetation restoration.

Key Words: Danxia Landform; succession series; scientific value

Succession is one of the oldest concepts in ecology^[1,2], and the most important characteristics of community dynamics. Research on succession has become one of the central issues of contemporary ecology. Succession has received wide concerns and continuous developments because it is the theoretical basis for restoration ecology to resolve the ecological crisis nowadays^[3-6]. However, the succession theory, short of a unified framework, is still far from being consummate^[7], and there are even a lot of serious controversies in its research methods^[8].

The community dynamic is a very complex process, so it is extremely difficult to study. In addition, it always takes a very long time to complete succession processes. The understanding of succession is still one of the most challenging subjects^[7]. Even if some theories were put forward, it also could not be validated in practice without communities at different succession stages, which would inevitably result in the slow development of the succession theories.

Some studies have been carried out on the speed and lasting time of the plant community succession. Generally speaking, in the cold climate it often takes longer time to reach the climax community than in the warm areas. It would take 5000 years to form the *Betula glaudulosa* + *Eriophorum vaginatum* community from fluvio-glacial deposit in the tundra of the Muldrow Glacier^[9], while it would take about 200 years to reach *Quercus-Carya* forests from *Pinus taeda* forests at the abandoned farmland in Piedmont, North Carolina^[10]. In the central of New England, 400 years is the minimum to establish the climax vegetation^[11]. It needs 800 years in the northern area of southern Ontario^[12].

To sum up, succession generally needs a very long time. It is reliable to study succession with long term fixed location observation, while it could be very hard to get some conclusions in a short time. Therefore, many scholars used the space-time substitution method to study the succession because it offers convenience of using contemporary spatial patterns to

infer long-term vegetation changes^[8].

The special Danxia Landform was formed for its hydro-thermal environment, soil characteristics and geological conditions, which gave birth to a complete succession series at the same time and space. Danxia Landform provides a unique ideal site for the succession studies. It will help to reveal the process and essential of succession. So the characteristics and scientific values of ecological succession in Danxia Landform were discussed in this paper.

1 Plant community succession in Danxia Landform

1.1 Primary succession

1.1.1 Generation of primary succession series

There are primary and secondary successions in Danxia Landform (Fig. 1). A special series of primary succession was exhibited here during its unique process of landform development. The primary short shrub and arbor forests appeared on the peak of typical Danxia Landform. The surrounding slopes were incessantly subjected to seasonal rainfall erosion, weathering, gravitational collapse, and the primary succession continually started from bare rocks to moss and herbal communities. The soil layers got thicker with further weathering,

and biotic effects of moss, lichen and other plants put the primary succession forward. Meanwhile, new collapse brought in bare rocks, and a new primary succession started from the rocks again. Therefore, different primary succession stages were formed.

1.1.2 Process of primary succession in Danxia Landform

(1) Early stage of primary succession

Primary succession has been performed on the cliffs, hill-tops and ridges in Danxia Landform. For instance in the *Selaginella tamariscina*-herbal community at Shaoshiding of Danxia Mountain (Shaoguan, Guangdong Province, China), the fern *S. tamariscina* with closed leaves turned yellow in drought condition, whereas it turned green and grew well once sufficient rainfall came down. Characteristics showed a good adaptation to the seasonal drought. For the vegetation establishment, *S. tamariscina* and many other bryophytes primarily settled down. It could help to improve the soil conditions for herb plants, and therefore other plants could expand around bare rocks (Fig. 2).

There are different types of succession on the sunny and shady sides of Danxia Landform. On the sunny side, small pieces of rocks fell from the bedrock and accumulated as a result of weathering. Moreover, this process could be en-

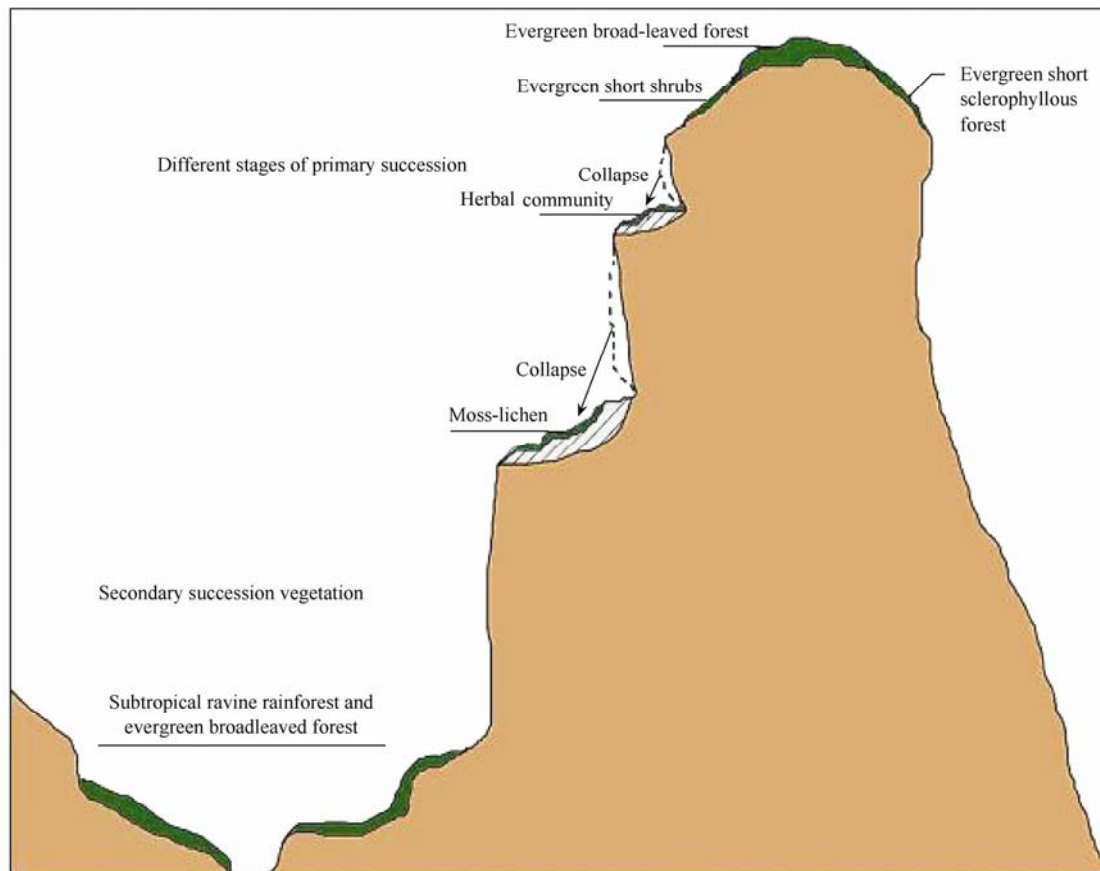


Fig. 1 Primary and secondary succession series of Danxia Landform

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