INTRODUCTION

Biodiversity has always been one of the important issues in the field of ecology (Gaston, 2000; Bandar et al., 2016; Willig, 2003). Species diversity is a manifestation of biodiversity at the species level. It is the most intuitive embodiment of biodiversity and the most basic structural and functional unit of biodiversity. The simplest indicator to measure species diversity is species richness. The elevational distribution pattern of species diversity has attracted much attention because it is more significant than its latitude distribution pattern (Barry, 2008; Zheng et al., 2014). The altitude gradient integrates various environmental factors, which is more obvious than the latitude gradient pattern. The change rate of temperature on the altitude gradient is 1000 times that of the latitude gradient. Therefore, it has become an important research object for ecologists to study the distribution of species richness. As early as the 19th century, Darwin, Wallace et al. observed the trend of species richness decreasing with the increase in altitude gradient (Lomolino, 2001), but until the 1990s, there were few studies on the spatial distribution pattern of species richness (Wu et al., 2013). The early research started from the basic species resources survey, mostly describing the distribution pattern of species richness, and rarely discussing the formation pattern of species richness combined with environmental factors (Nagorsen et al., 1981; Heidman et al., 1987; Stevens 1989, 1992). With the deepening of the research, the mechanism of species richness formation has been gradually explored, and the distribution pattern of species richness has been deeply analyzed combined with different environmental factors (Rahbek, 1995, 2005; Colwell et al., 2000; McCain, 2009; Wiens, 2011). In order to explain the formation mechanism of the spatial distribution pattern of species diversity, researchers have proposed hundreds of hypotheses (Rahbek et al., 2007), of which the two types of spatial influence mechanisms and climate influence mechanisms have received the most extensive attention (Colwell et al., 2004; Kluge et al., 2006).

Spatial Influence Mechanism

Species-area relationship

The effect of area on species richness is one of the earliest and most widely studied issues in ecology. It describes the law that the number of species in a habitat increases as the area of the habitat increases (Liu et al., 2017). Based on experimental data, Arrhenius (1921) found that species richness has a power-law species-area relationship with the sample area. Gleason (1922)
proposed logarithm species-area relationship. A large number of studies have been carried out in different regions and groups, trying to discuss and verify the species-area relationship model. However, apart from proposing a series of species-area relationship models, a unified conclusion has not been obtained (Tjørve, 2003; Merwe, 2011). At the same time, ecologists began to study the ecological mechanism behind the species-area relationship theory. MacArthur and Wilson (1967) proposed the theory of island biogeography balance, which tried to link the evolutionary process on islands with species richness, thereby explaining the power function relationship between species richness and island size. Subsequently, Hanski (1998), Harte et al. (1999), and Hubbell (2001) explained the species-area relationship from three different perspectives: metapopulation dynamics theory, self-similarity theory of species distribution, and neutral model. The species-area relationship theory contains complex ecological mechanisms, which are closely related to the ecological processes of species formation, extinction, migration and diffusion (Zurlini et al., 2002; Ricklefs and Bervinham, 2004).

**Mid domain effect**

The mid domain effect hypothesis is an important theoretical advancement in the study of biodiversity to explain the formation mechanism of the spatial distribution pattern of species richness (Colwell and Lees, 2000; Lees et al., 2010). Colwell and Hurtt (1994) found that, without considering the influence of any environmental and biological factors, only due to the limitation of the domain hard boundary on the species distribution, the random distribution of species in the space can produce a hump-shaped pattern with the highest species richness in the middle region and a smaller species richness at the two ends near the spatial boundary. Colwell and Lees (2000) first proposed and named the mid domain effect hypothesis. Since the mid domain effect hypothesis was proposed, it has caused great controversy in the academic field. The proponents believe that the mid domain effect not only affects the altitude and latitude patterns of species distribution, but also affects the environmental gradient patterns of abiotic factors such as water depth (Pineda et al., 1998; Connolly et al., 2003), time (Tiwari et al., 2005), and resources (Dunn et al., 2006). There are also some scholars who oppose it, believing that the mid domain effect hypothesis emphasizes the boundary restriction effect and weakens its biological significance (Hawkins et al. 2005; Hawkins, 2010). Some scholars believe that the basic premise that the distribution of species in this hypothesis is not affected by environmental factors is wrong and should be abandoned (Hawkins et al., 2002). Although there are still some controversies on the explanation of the distribution pattern of species diversity, the hypothesis of mid domain effect is still one of the important hypotheses to explain the distribution pattern of species richness.

**Hydrothermal Climate Influence Mechanism**

**Water-energy dynamic hypothesis**

The water-energy dynamic hypothesis was proposed by O’Brien (1993). When analyzing the geographical distribution pattern of woody plant species richness in South Africa, it was found that water and energy jointly determine the spatial distribution pattern of species richness. The relationship between water and species richness was linear, and that between water and energy was a quadratic power function. O’Brien (1998) suggested that the water-energy dynamic hypothesis is an interim general model for temporarily predicting the spatial distribution pattern of species richness. Field et al. (2005) extended the water-energy model. They thought that the water-energy dynamic model was only in one-dimensional space. Therefore, he added altitude variation (the difference between the highest altitude and the lowest altitude) to expand the model from one-dimensional space to two-dimensional space. O’Brien (2006) made an important explanation for the water-energy dynamics hypothesis in terms of biological characteristics. Water is the medium of metabolism of some organisms, and energy regulates the state of water. Some scholars believe that the influence of water and energy on the geographical pattern of animal species richness is indirectly realized through the influence on plant species richness (Gaston, 2000). This hypothesis was also used to study the geographic pattern of plant and animal richness in the world, Europe, North America, and Asia, and the results also support this hypothesis (Eiserhardt et al., 2011; Silva-Flores et al., 2014).

**Metabolism hypothesis of ecology**

The ecological metabolism hypothesis is based on the metabolic theory of ecology. Based on the relationship between metabolic rate, body size and environmental temperature, metabolic theory of ecology uses the law of conservation of energy to explain the change pattern of species richness along environmental temperature gradient, thus combining the ecological evolution process of species with metabolic rate (Wang et al., 2009a). Steen et al. (2009) explained the spatial gradient pattern of species richness using ecological metabolism hypothesis, and their basic view is that the logarithm of species richness is linearly related to the inverse of absolute temperature. Since the ecological metabolism hypothesis was put forward, it has attracted widespread attention and controversy among ecologists. Hawkins et al. (2007) suggested that the distribution pattern of species richness along the altitude gradient is more supportive of the ecological metabolism hypothesis than the pattern of the latitude gradient. The results of Michael et al. (2013) on the species richness gradient of adult microtubules in Switzerland also support this theory. However, there are some studies that do not support this hypothesis. Wang et al. (2009b) compared the spatial distribution patterns of woody plants in China and North America and found that the distribution of woody plants in China has a linear relationship with the reciprocal absolute temperature, but the slope varies with scale. It also proves that the theory has strong scale dependence.

**Productivity hypothesis**

The productivity hypothesis holds that increasing environmental energy can increase the net primary productivity of an area and ultimately determine the species diversity of the region (Gaston, 2000). The productivity hypothesis was first proposed by Brown (1981). When he studied the species richness of plants and birds in North America, he used the annual evapotranspiration to characterize the productivity, and revealed a significant positive correlation between species richness and productivity of plants and birds in North.
The research on the relationship between species richness and productivity mainly focuses on the pattern of species richness with productivity and the reasons for the formation of this pattern. The productivity hypothesis predicts that species diversity increases monotonously with the increase of productivity. However, more and more studies have shown that the single peak distribution pattern of species richness with the increase of productivity is a relatively common phenomenon (Weih et al., 1999; Mittelbach et al., 2001; Fraser et al., 2015). As the distribution pattern of species richness along the productivity gradient has not been determined, there is no consensus on the formation mechanism of the pattern (Liu et al., 2017). The formation mechanism of unimodal distribution pattern is the most studied. Tilman (1982) suggested that as the productivity increases to a certain degree, the environmental heterogeneity decreases, which leads to a decline in species richness. Abramsky et al. (1984) believed that while species richness increased with productivity, disturbance intensity also increased, thus forming a unimodal distribution pattern.

CONCLUSIONS

The elevational gradient integrates various environmental factors and is more obvious than the latitude gradient pattern. Therefore, it has become an important research object for ecologists to study the distribution of species richness. The elevational gradient pattern of species richness plays an extremely important role in studying the geographic distribution pattern of global species richness and its formation mechanism. In order to explain the formation mechanism of the spatial distribution pattern of species diversity, researchers have proposed hundreds of hypotheses, among which the spatial influence mechanism and climate influence mechanism have received the most widely concerned. Each hypothesis has its own advantages and disadvantages, but each hypothesis penetrates and complements each other to explain the altitude gradient pattern of species richness. The current research trend is that the vertical distribution pattern of species richness is caused by the comprehensive action of many factors. Therefore, in future research, a unified survey method should be adopted to improve and expand the species distribution information data, and to further carry out the mechanism research of the species richness elevational distribution pattern.

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