Plant Species Diversity along a Precipitation Gradient in Temperate Grasslands of China and Mongolia

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Introduction

Variations in species diversity can be linked to several ecological gradients (Huston 1994). Plant functional type is characterized by an adaption of plants to certain ecological conditions (Galan de Mera *et al.* 1999). In addition, patterns of species richness along an environmental gradient might be more interpretable by considering both species richness of different functional types and total species richness (Pausas and Austin 2001). Water availability generally signifies total precipitation available to support plant growth (Adler and Levine 2007), and its temporal distribution is the main driver of species composition and species diversity in arid and semi-arid environments (Shmida and Wilson 1985; Kutiel *et al.* 2000). Therefore, understanding how precipitation influences species diversity at a spatial scale will be critical for predicting the impacts of altered precipitation on vegetation patterns. This study aimed to examine the vegetation response to a spatial precipitation gradient in temperature grassland in China and Mongolia.

Methods

Study area and data collection

To compare species richness and diversity across a regional gradient of mean annual precipitation, we assembled census data for eleven widely scattered sites in central and southern Mongolia, north-eastern China and the Qinghai-Tibet Plateau. Mean annual precipitation at these sites ranges between 94mm in the bush desert-steppe and 603mm in the meadow steppe. Vegetation surveys were conducted during periods of peak vegetation cover (July-August), according to the phytosociological method of Braun-Blanquet (1964).

Data analysis

To investigate whether mean annual precipitation causes a regional trend in species richness despite within-site variability, we quantified the relationship between mean annual precipitation (recorded at the nearest meteorological station) and species richness by means of linear regression based on all data points. Two indices were chosen for estimation of diversity (Whittaker 1972):

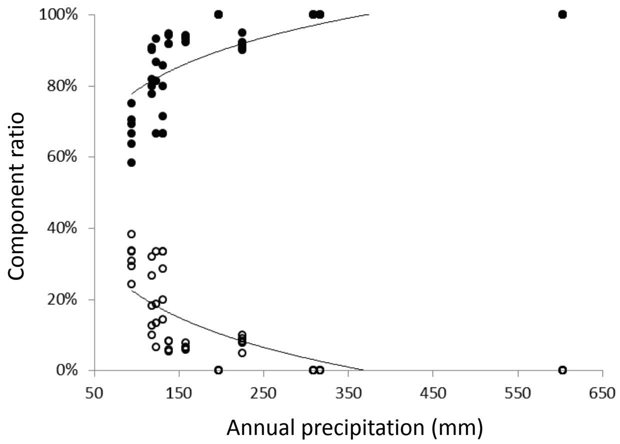

Figure 1. Changes in component ratio of functional type along a precipitation gradient in China and Mongolia temperature grassland region.○: Ratio of grass (perennial and annual) to total species in each plot (G/T); ●: Ratio of shrub to total species in each plot (S/T). Logarithmic relationship was found between the component ratio of functional type (G/T, S/T) and annual precipitation (P) across all sites (P = 0.16 ln(G/T)+0.04, R^2 = 0.55, P<0.001; P = -0.16 ln(S/T)+0.97, R^2 = 0.56, P<0.001).

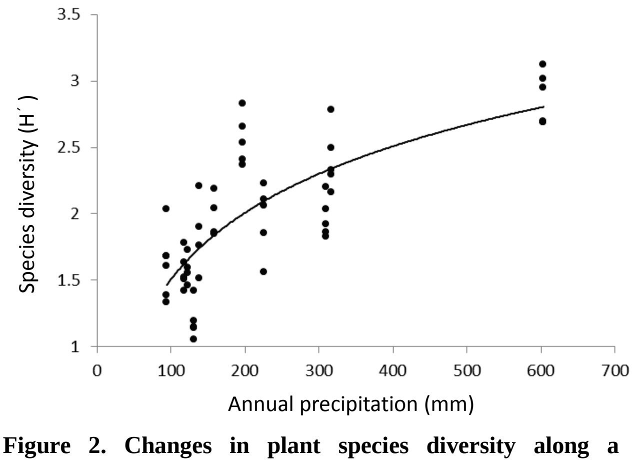

Figure 2. Changes in plant species diversity along a precipitation gradient in China and Mongolia temperature grassland region. Logarithmic relationship was found between the species diversity (H') and annual precipitation (P) across all sites (P = 0.72 ln(H')-1.81, R^2 = 0.60, P<0.001).

- Species richness S represented by number of vascular species recorded in each plot.
- 2) Shannon-Wiener's index of diversity

$$H' = -\Sigma P_i \log P_i$$

Where: $Pi = Ni/N$, Ni is the individuals of species i, and N is the total individuals of all species present.

Results

The regional gradient in annual precipitation showed positive and negative relationships with component ratio of grass ($R^2 = 0.55$, $P<0.001$) and shrub type ($R^2 = 0.56$, $P<0.001$), respectively, producing logarithmic relationships (Fig. 1). Shannon-Wiener diversity index of the communities had a positive relationship with mean annual precipitation ($R^2 = 0.60$, $P<0.001$), producing logarithmic relationships (Fig. 2).

Conclusion

Water was the key limiting resource in the present study areas, and a slight change in rainfall greatly affected the species composition and species diversity at the regional spatial scale. However, to predict the impacts of altered precipitation on vegetation patterns, it is important to understand the influence of rainfall on the proportion of each plant functional type, rather than on total species richness at the regional spatial scale.

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