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Changes and drivers of plant community in the natural broadleaved forests across geographic gradient

Jing Cong [a,b], Xiujiang Su [c], Xiao Liu [a], Yadong Xue [a], Guangliang Li [a], Diqiang Li [a], Yuguang Zhang [a,*]

[a] *Institute of Forestry Ecology, Environment and Protection, and The Key Laboratory of Forest Ecology and Environment of State Forestry Administration, The Chinese Academy of Forestry, Beijing 100091, China*
[b] *School of Minerals Processing and Bioengineering, Central South University, Changsha 410083, China*
[c] *Baiyunshan National Natural Reserve, Baojing 416500, China*

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ABSTRACT

Geographic variation can lead to the changes of local plant species, which play crucial roles in primary production and ecosystem structure. Therefore, understanding multiple scale distribution patterns of plant species is important for us to effectively monitor ecosystem changes due to climate changes and other modifications. Here, we mainly investigated the distribution pattern of wood vascular plants and key environmental controlling forces in natural broadleaved forest along the latitudinal gradient across 24 geographic regions of China continental territory. The results showed that the richness and diversity of plant community significantly decreased with the increasing latitude. The similarity of plant community also decreased with increasing latitudinal distance. The mean annual precipitation and mean annual temperature played the most important roles in the distribution of plant community across latitudinal gradient, followed by soil pH and soil moisture.

1. Introduction

Rapid climate changes are already influencing the physiology, distribution, and phenology of a broad variety of organisms [1], including of plant species [2]. Species distribution changes could influence the functioning of ecosystems, and condition the number and quality of ecological services [3]. Plant species are the primary drivers of ecosystem functioning, and also are influenced by other environmental factors [4]. Therefore, understanding environmental factors in controlling the distribution and abundance of plant species across terrestrial biome on a large scale was a pivotal topic.

Previous studies have explored plant species distribution and performance across geographic gradients [5,6]. Plant species diversity decreases with the increasing latitude, which is considered to be one old concept in ecology [7], except for some pine species [8]. The long scientific interest has spawned over numerous studies of plant species, however, continuous debate about the mechanisms that influence plant species distribution still remains [9]. One of the important sources of environmental variation, particularly on a large scale, is climate. Contemporary climate is an important predictor of plant species richness and diversity [10], reflected in vegetation zones, which follow the latitudinal pattern of prevailing environmental conditions [11]. On a large scale, the distribution variation of plant species is attributed to species-specific responses to temperature and precipitation [12]. Previous studies showed that mean annual temperature and mean annual precipitation had particularly high correlations with plant richness [10,13]. On a large scale, climatic conditions constrain vegetation diversity [14], and therefore, plant species interacting with environmental factors will change with global position [15].

The vascular plant species have been estimated to reach the number between 223,000 and 420,000 on Earth [16], which can be categorized into distinct biological realms and various functional types. China is one of the mega-diversity countries, crossing five climatic zones [17], which is worthy of studying the variation of vascular plant species and controlling factors. Here, we aimed at investigating our current knowledge of plant species distribution and mechanism, outlining the relevant factors controlling the spatial variability of plant species at the scale of China continental territory along the latitudinal gradient. We examined that the distribution pattern of plant species using an array of forest sites of varying soil and climatic conditions, explored the key environmental factors shaping plant species distribution.

2. Materials and methods

2.1. Field sampling and plant community investigation

Data collection was carried out from August to November in 2012, which spanned from warm temperate zone to subtropical zone, and about from 24.16° N to 40.83° N (Table 1). Total of twenty-four studying

* Corresponding author.
E-mail address: yugzhang@sina.com.cn (Y. Zhang).

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Table 1
The climatic and geographical characters of 24 sampling sites.

Sampling sites	Latitude, longitude/°	Geological substrate	Altitude/m	Mean annual temperature/°C	Mean annual precipitation/mm
DQS	40.83, 111.25	Alkaline	1677	1.50	381
LYS	38.71, 111.97	Acidic	1780	3.69	493
PQG	37.86, 111.47	Acidic	1888	3.10	536
HLS	35.70, 110.04	Acidic	1544	7.85	574
LS	35.42, 112.02	Acidic	1605	6.66	705
MH	35.26, 112.38	Acidic	1403	9.11	685
XQL	34.43, 110.50	Acidic	1771	7.60	799
LYW	33.67, 111.80	Acidic	1756	6.40	976
NZ	33.51, 111.96	Acidic	1245	9.20	905
BTM	33.49, 111.94	Acidic	1402	8.10	948
SWD	32.43, 110.75	Acidic	1108	10.67	1010
DHY	31.53, 110.01	Acidic	1798	9.00	1268
SNJ	31.49, 110.36	Acidic	1785	9.50	1234
HH	30.08, 110.55	Acidic	1568	11.18	1466
MLZ	30.06, 110.22	Acidic	1466	10.20	1515
BDGS	29.77, 110.07	Acidic	1453	11.56	1527
MYH	28.71, 108.20	Acidic	1133	12.88	1337
BYS	28.68, 109.32	Acidic	1068	14.28	1415
GWJ	28.66, 110.08	Acidic	927	14.10	1493
FJS	27.87, 108.74	Acidic	1046	14.24	1261
HS	26.39, 110.08	Acidic	1055	14.50	1485
MES	25.91, 110.47	Acidic	1248	12.56	1637
HP	25.56, 109.94	Acidic	1211	13.00	1646
DYS	24.16, 110.25	Acidic	1514	14.20	1648

sites, including DQS, LYS, PQG, HLS, LS, MH, XQL, LYW, NZ, BTM, SWD, DHY, SNJ, HH, MLZ, BDGS, MYH, BYS, GWJ, FJS, HS, MES, HP, and DYS, were selected in typical natural broadleaved forest of the national nature reserves from the north to the south along the latitudinal gradient (Fig. 1). In each studying site, we set up 10 (20 m × 20 m) sampling plots for plant community research, and total of 240 plots were sampled. We only focused on wood vascular plants due to their important roles in maintaining ecosystem functioning [18]. The properties of plant communities were recorded in the sampling process, including plant (tree and shrub) species, diameter at breast height (DBH) or ground diameter, plant height and number. Plots were characterized by soil type, geological substrate (alkaline vs acidic substrate), climate (cold/rainy vs warm/dry), geography (altitude, latitude and longitude). Climate data were obtained from the WorldClim-Global Climate Data

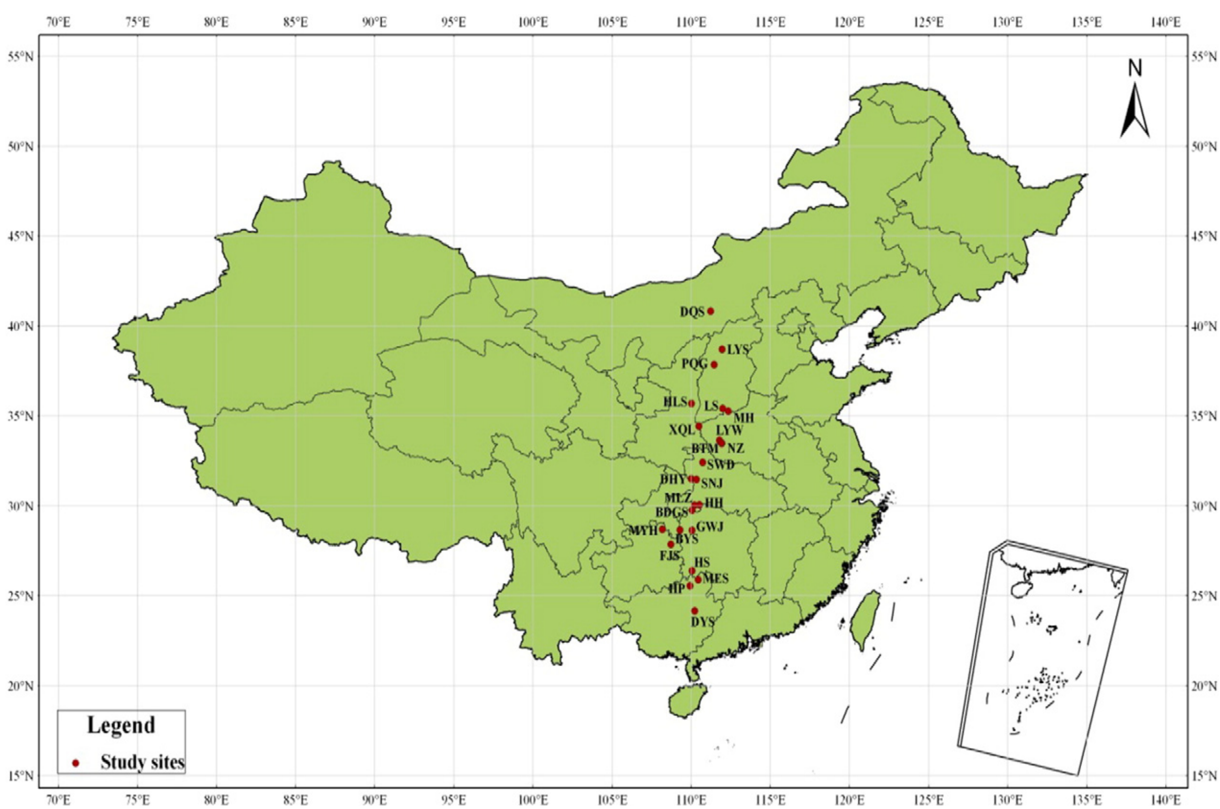

Fig. 1. Location of 24 sampling sites in this study.