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Biomass Quantity and Structure Distribution in Pinus Massoniana Forest

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Pinus massoniana forest is an important tree species for protection forest. In this paper, we take the Pinus massoniana forest in Luotian County as the study object, and adopt the plot sampling method to study the vegetation composition, vegetation biomass and vegetation diversity in horizontal and vertical spaces in pinus massoniana forest with different percentages. The results from the analysis show that, in pinus massoniana forest, the total biomass has a correlation with the community vegetation diversity, that is, it is positively correlated to the shrub layer biomass and negatively correlated to the herb layer biomass; the total biomass in the forest, the biomass n every layer of the vertical space are both negatively proportional to soil bulk density, positively proportional to soil porosity, and has a significantly positive correlation with soil organic matter and available phosphorus content; other chemical indicators such as PH, total nitrogen, and total potassium, etc, show an insignificant correlation with it. These fruits provide a reference for the ecological structure and ecological assessment of the forest area.

1. Introduction

Pinus massoniana can survive in poor and harsh environments. As a shelter forest species, it can improve the ecological environment and increase the sustainable utilization of forest lands (Xiang et al., 2011; Parker 1982). Vegetation organisms in the forest can not only improve soil, water retention and make biodiversity abundant, but also make up an ecological protection space echelon with pinus massoniana to steer the forest to a good ecology environment.

Up to now, the studies have always focused on the spatial distribution of biomass in pinus massoniana forest. (Justine et al., 2015; Chen et al., 2016) Justine and Chen et al. only analyzed the spatial structure of forest biomass, (Zhang et al., 2012) Zhang et al. studied the distribution characteristics and ecological benefits of pinus massoniana in the field. These studies have turned out that the biomass in the arborous layer is the maximum; (Zhang et al., 2006) Zhang et al. investigated the productivity of various organic components in the forest and worked out the orders of biomass and productivity for each organic component. (Wang et al., 2013) Wang et al. used biomass prediction model to estimate forest biomass. (Tateno et al., 2010). Tateno et al. analyzed the evolution of pinus massoniana vegetation over 10 years. The results show that the vegetation community increases uniformly with better diversity.

Available literature rarely involves the relationship between pinus massoniana biomass and vegetation diversity. In order to fill in the gap of the study and improve the ecological benefits of vegetation in the forest, the paper traces down to the biomass, structure distribution and vegetation of pinus massoniana, for example, in Luotian County, thus providing a reference for ecological structure and ecological assessment in forests.

2. Biomass and diversity in forests

2.1 Biomass community characteristics

Pinus massoniana forest lies in Luotian County, Hubei Province, at the southern foot of the Dabie Mountains, for the general situation of sampling site, see Table 1. Its climate zone is subtropical monsoon climate with the average annual sunshine duration of 2047 h, the average annual temperature of 16.4 □C, and the average

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annual precipitation of 1330 mm (Chen et al., 2013). The staple vegetation type of pinus massoniana in the county is evergreen deciduous broad-leaved forest.

Table 1: General condition of the survey sample

Sample	Proportion	Altitude	Slope gradient	Slope position	Density (tree · hm^{-2})	Height (m)	DBH (cm)
1		163	23	medium	151	8.1	15.9
2	0-20	171	19	superior	76	7.1	17.6
3		86	21	inferior	173	6	11.8
4		103	24	medium	451	8.4	16.7
5	20-40	91	16	inferior	376	9	13.8
6		160	10	medium	220	8.5	14.9
7		118	11	inferior	276	8.7	17.2
8	40-60	101	15	medium	200	9.3	15.9
9		90	16	inferior	422	8.3	16
10		176	18	inferior	623	7.9	10.8
11	60-80	168	21	medium	603	9.6	12.9
12		155	15	medium	955	6.9	17.0
13		169	22	superior	710	9.0	13.9
14	80-100	158	25	medium	1521	8.6	11
15		182	21	superior	1206	7.3	17

2.2 Forest biomass determination

With reference to previous studies (Webb et al., 2010; Apigian et al., 2006; Grodnitskaya and Sorokin, 2018), the paper chooses three parameters, i.e. richness, evenness, and species diversity, to describe the vegetation diversity in forest zones. The meaning of the indicators is shown in Table 2 below.

Table 2: Forest vegetation diversity index

Parameter	Meaning	Parameterization
Species richness	The number of species in a community or habitat	D_M
Evenness	The distribution of the total number of individuals in a community or habitat	E
Species Diversity	The combination of richness and uniformity	H'

The formulae for the three indicator parameters are given below:
$D_M=(S-1)/\ln N$; $H'=-\Sigma P_i \ln P_i$; $E=H'/\ln S$
Where, S - vegetation types (shrub layer or herb layer) in the forest; N - vegetation individuals (shrub layer or herb layer) in the forest; Pi- species *i* individuals Ni/N.
The important parameter IVi of plant species is used to express the composition of the vegetation in the forest by the formula below, reflecting the advantages and disadvantages of various plants in the community (Planas et al., 2013):
$$\mathrm{IV}_i = \mathrm{RD}_i + \mathrm{RP}_i + \mathrm{RF}_i$$
Where, $\mathrm{RD}_i -$ relative density; RP_i - relative saliency; RF_i – relative frequency.
The quadrat harvest method is used to calculate the fresh and dry weights of different tree species by the formula below:
$$\mathrm{W}_u = \frac{\Sigma \mathrm{W}_{ui}}{a \times n \times 10000}$$
Where, W_u—biomass / 1 hectare; W_{ui}—biomass / 1 quadrat; a—quadrat area; n—quadrat size.

2.3 Relationship between Forest Biomass and Structure Distribution

Factor analysis is used to analyze the relationship between pinus massoniana vegetation characteristics and soil and other parameters.
Calculate the cumulative importance value of shrub layer at different ratios, as shown in Fig. 1. We can see from Figure 1 that The plant species within the community reflect their competition relationship in the environment, which has an important impact on the species and composition of the understory vegetation.

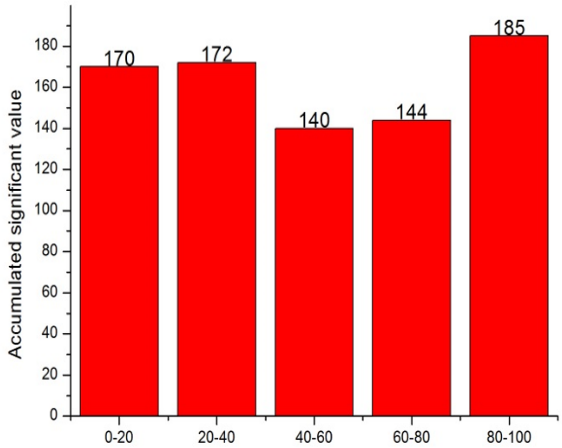

Figure 1: Accumulated important value of shrub layer in different proportion

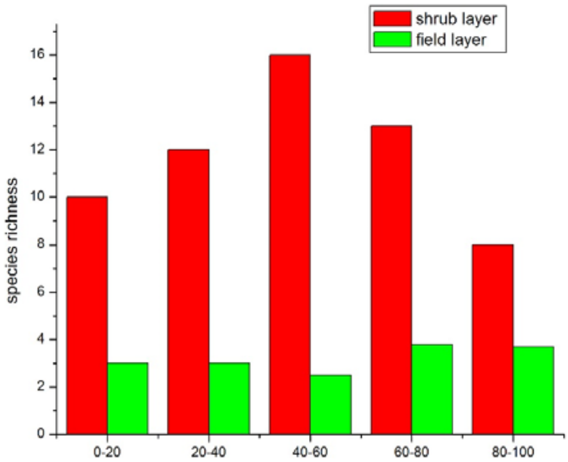

Figure 2: Species richness of undergrowth vegetation

The understory vegetation richness of pinus massoniana forest is shown in Fig. 2. It can be seen that the maximum difference in species richness in the shrub layer appears in 40-60 % of the stands, quite distinctive from that in the herb layer. There are two main reasons for this situation: First, the light factor, the leaf type of the pinus massoniana is small at the young age, with the decrease of the proportion of the Pinus massoniana, the light weakens, and the plants with tolerance of the shade grow well; Second, the soil conditions, pinus massoniana can improve soil conditions to a certain extent. When the proportion of pinus massoniana increases, shrub species are reduced accordingly.
The vegetation distribution on the vertical space can be characterized by the parameter vegetation height; as can be seen from Fig. 3, the stratification of vegetation in vertical space is obvious, the shrub layer height is between 70-110cm, and both shrub layer and herb layer heights decrease with the increase of proportion of Pinus massoniana.

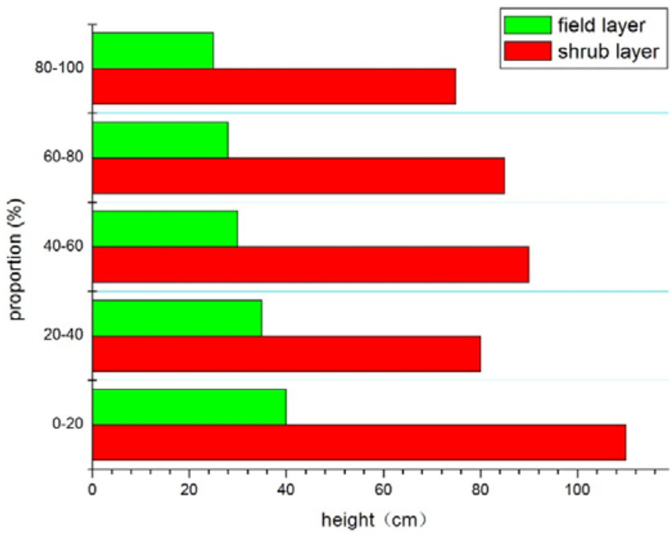

Figure 3: Height of vegetation under forest

The vegetation distribution in horizontal space can be characterized by the parameter vegetation coverage (Recio-Vazquez et al., 2014; Wei, 2005); as can be seen from Fig. 4, with the increase of the proportion of pinus massoniana, the herb layer coverage is basically unchanged, shrub layer coverage gradually decreases.

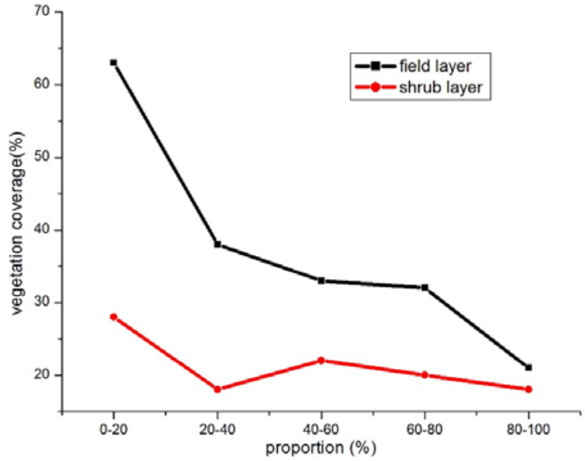

Figure 4: Vegetation coverage under the forest

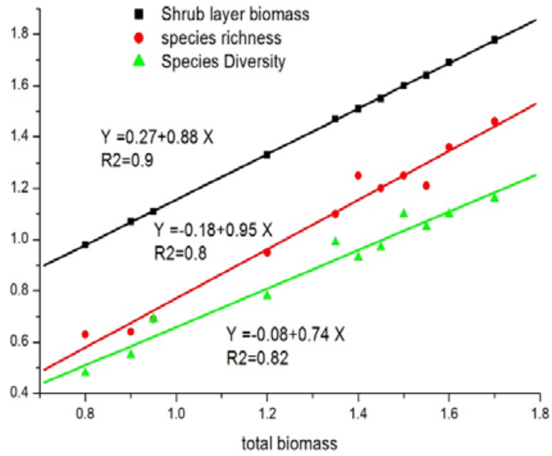

Figure 5: The relationship between shrub layer biomass and plant diversity in various layers

The curve of biomass in different layers as a function of plant diversity in each layer is shown in Fig. 5, we can see that: (1) With the increase of shrub layer biomass, the total biomass increases, and the correlation goes higher; (2) Herb layer biomass is positively correlated with its abundance and diversity, and herbaceous vegetation can also increase biomass to some extent; (3) Due to competition between shrub layer and herb layer organisms. the quantities of the two are negatively correlated to each other.

3. Forest Area biomass and physical and chemical properties of soil

3.1 Determination of soil physicochemical properties in forest areas

Table 3: Soil property parameters and calculation methods of forest land

	Indicators	Methods	Computational formula
Physical properties	volume-weight	cutting-ring method	
	porosity	1- volume-weight/ soil density	soil density=2.6$g \cdot cm^{-3}$
	soil moisture content	1- Dry soil weight/ Wet soil weight	
Chemical properties	PH	acidometer titration	Water: soil=2.5:1
	soil total nitrogen	Full Ntrogen System	
	soil total phosphorus	spectrophotometer	
	Soil Available Phosphorus	spectrophotometer	
	total potassium	Flame photometer	
	soil organic matter	dichromate titration	
	soil available kalium	ammonium chloride extracted	
Environment Specifications	Illuminance	illuminometer	The measurement is 150cm from the ground at 10am

The physical parameters and calculation methods of forest soil are shown in Table 3, in which the soil bulk density is measured by the ring shear method. When determining the theoretical properties of the soil in the forest, the soil stratification method is used to obtain soil samples within a depth of 10cm, choose five points in each sample area to determine soil pH and contents of total nitrogen, total phosphorus, total potassium, and rapidly available phosphorus and available potassium.

Use the method described in the above table to determine the physical properties of Pinus massoniana soil, as shown in Table 4. With the deepening of the soil layer, the soil bulk density gradually increases, and the soil porosity and moisture content decrease.

Table 4: Soil physical properties of forest woodland mixed with masson pine

Proportion (%)	Soil layer (cm)	V Volume-weight ($g \cdot cm^{-3}$)	Porosity (%)	Soil moisture content ($g \cdot g^{-1}$)
	0-10	1.1	58.54	0.27
0-20	10-20	1.19	55.09	0.20
	20-30	1.23	53.78	0.16
	0-10	1.2	58.24	0.18
20-40	10-20	1.18	55.26	0.21
	20-30	1.22	55.03	0.93
	0-10	1.08	58.93	0.2
40-60	10-20	1.14	54.98	0.19
	20-30	1.19	54.25	0.18
	0-10	1.21	55.75	0.19
60-80	10-20	1.25	53,12	0.18
	20-30	1.29	51.99	0.13
	0-10	1.27	52.75	0.16
80-100	10-20	1.35	49,12	0.13
	20-30	1.39	47.99	0.11

3.2 Forest biomass and soil physical and chemical properties

The soil properties of vegetation communities can reflect the physical and nutritional environment where the vegetation grows (Valbuena et al., 2016). It is deduced from analysis that there are coefficients of correlation between physical and chemical properties of soil and biomass are shown in Table 5.

Table 5: The correlation between plant diversity and soil physicochemical properties in mixed forest of tail pine

Coefficient of association	Volume-weight	Porosity	Organic matter	Total P	Total K	Total N	Available P
Total biomass	0.3	0.38	0.5	0.29	0.1	0.13	0.20
Total biomass	0.32	0.3	0.54	0.34	0.13	0.18	0.23
Herb layer biomass	0.33	0.31	0.52	0.33	0.15	0.2	0.18

Organic matter is a key factor that promotes vegetation growth and has a positive correlation with biomass; available phosphorus as a nutrient component that the soil easily absorbs in vegetation has a positive correlation with biomass in different vertical spaces. The coefficients of correlation between other four chemical indicators and vegetation biomass are all lower.

4. Conclusions

The paper explores the composition of pinus massoniana vegetation, the characteristics of vegetation biomass, and its biological diversity with field sampling and laboratory analysis. The main conclusions drawn from the study are as follows:

With the increase of proportion of pinus massoniana, the biomass of the shrub layer vegetation gradually increases. When it reaches 60% of the total biomass, the vegetation biomass decreases; the herb layer biomass gradually increases, when it reaches 80%, vegetation biomass has a downward trend;

There is a relationship between total biomass of pinus massoniana and community vegetation diversity: the total biomass of pinus massoniana is positively correlated with the shrub layer biomass, and negatively correlated with the biomass of the herb layer biomass; both shrub layer biomass, herb layer biomass has significantly positive correlation with richness and diversity indexes;

There is a relationship between total biomass of pinus massoniana and the theoretical properties of the community vegetation soil: the total biomass in the forest and the biomass in every layer in the vertical space are negatively proportional to the soil bulk density, and positively proportional to the soil porosity, and have a significantly positive correlation with the soil organic matter and the available phosphorus content; other chemical indicators such as PH, total nitrogen, and total potassium are not significantly correlated to each other.

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