Study on Diversity and Protection Countermeasures of Zhongshan Park in Wuhan City

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Abstract. Park green space is an important part of garden green space, concentrated expression of the diversity of urban plants. In order to explore the diversity of plants in the park, a typical site in Zhongshan Park in Wuhan was selected for this survey. The species importance, richness index, diversity index and evenness index were used to analyze the characteristics of plant diversity. There are a total of 184 plants of 114 genera and 64 families in Wuhan Zhongshan Park. Among them, there are 86 species of plants of 40 families and 64 genera, 60 species of plants of 26 families and 38 genera, and 26 species of herbs, 11 families and 15 genera. The richness was herb layer > tree layer > shrub layer. Pielou uniformity was herb layer > tree layer > shrub layer; Shannon-wiener diversity was herb layer > tree layer > shrub layer. Simpson diversity was herb layer > tree layer > shrub layer. The diversity of herbaceous plants in the park is high, and the index of shrub layer is generally low, with few species. Plants in the park grow well, some plants are not evenly distributed.

1 preface

Plant diversity is the basis of urban ecosystem, and the protection of plant diversity is the key point of urban biodiversity protection, and plant diversity is also an important index for the evaluation of China's national ecological garden cities[1]. The improvement of the stability and healthy development of urban ecosystem functions are often closely related to urban plant diversity[2]. Therefore, with the gradual improvement of urbanization level and the rapid increase of population, ecological problems, especially the plant diversity under the influence of urbanization, have become a hot issue for people to study[3]. As an important part of urban green space system, park green space has large patch area, rich species, complex plant community structure and good landscaping effect, which are the main manifestations of urban plant diversity[4]. This paper analyzes the plant diversity and discusses its garden plant configuration characteristics, and puts forward corresponding suggestions for the diversity protection and green space construction of the park as well as the effective protection and sustainable utilization of plant landscape resources.

2 Overview and methods of research

2.1 Research Site Overview

Wuhan is located in the east of Jiangnan plain, the Yangtze river middle reaches. Wuhan has a typical subtropical monsoon climate, cold in winter and hot in summer, with

plenty of rainfall and sunshine. Zhongshan Park in Wuhan is a famous historical park, formally established in 1928, which is a national key park. It is a comprehensive park with many service functions, and the annual visitor volume is as high as 10 million person-times.

2.2 The research methods

2.2.1 Survey method

The diversity of Zhongshan Park in Wuhan was investigated, and representative typical places were selected in the park. Each sample plot was 20m×20m, and the species, name, DBH, plant height, crown width, canopy density and growth status of the trees in the sample plot were recorded. A 5m×5m shrub quadrat was set in each plot, and the species name, plant height, number of plants, coverage and growth status of the shrub were recorded by the quadrat method. Meanwhile, a 1m×1m herb quadrat was also set to record the species name, coverage and growth status of the herb.

2.2.2 Data calculation

Importance value of trees and shrubs = (relative density + relative coverage + relative frequency) / 3.

Herb importance value = (relative coverage + relative frequency) / 2 [5].

Shannon-wiener diversity index is calculated as formula (1); Simpson index of diversity is calculated as formula (2); Pielou uniformity index is calculated as formula (3); Margalef richness index is calculated as

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formula (4):

$$H = -\sum P_i \ln P_i \quad (1)$$

$$D = 1 - \sum P_i^2 \quad (2)$$

$$E = H / \ln S \quad (3)$$

$$R = (S-1) / \ln N \quad (4)$$

In the formula, N_i is number of individuals of the i th species; N is Total number of individuals of all species, S is Number of plant species in sample plot.

3 Results and analysis

3.1 Park plant species composition

According to the survey, there are 184 species of plants in 114 genera and 64 families in Zhongshan Park in Wuhan, among which 86 species of trees in 40 families and 64 genera account for 46.74% of the plant species in the park (Table 1). There are 60 kinds of shrubs, 26 families and 38 genera in the park, accounting for 32.61% of the whole plant species in the park. There are 26 herbaceous species, 11 families and 15 genera in the park, accounting for 14.13% of the plant species in the park. The ratio of arbor to shrub species in the garden was about 1.43:1, and the appropriate ratio of arbor to shrub was 1 (1-1.5) [6], indicating that the arbor and shrub ratio planning in Zhongshan Park was reasonable. There are 48 native species in the park and 136 alien species, accounting for 73.91% of the plant species in the park. In Wuhan zhongshan park which contains the advantage of more than 8 kinds of tree species have two kinds, the first is rosaceae have 11 genera and 13 species, the second is a oleaceae has 9 kinds of 8 genera.

Table1. Composition of plant community in Zhongshan Park

Life-type	Families	Genus	Species
Trees	40	64	86
Shrubs	26	38	60
The herb	11	15	26
In total	64	114	184

3.2 Diversity analysis of plants in the park

3.2.1 Species significance analysis

The important value is a comprehensive quantitative index of the status and function of a species in a population, which can reflect the degree of dominance of each species. Among the 8 quadrates selected from Zhongshan Park in Wuhan, there are 45 species of plants, 30 families and 45 genera. There were 17 species, 15 families and 17 genera of Joe, 9 species, 8 families and 9 genera of Irrigation, and 19 species, 11 families and 19 genera of herb. In the arbor layer, *Magnolia grandiflora*, *Lagerstroemia indica*, *Cinnamomum bodinieri*, *Fraxinus chinensis*, *Taxodium ascendens* important value is relatively high (Table 2). *Lagerstroemia indica*, *Cinnamomum bodinieri*, *Fraxinus chinensis*, *Taxodium ascendens* are all native species, *Magnolia grandiflora* for foreign species.

Table2. Ranking of important values of arbor layers in Zhongshan Park, Wuhan (top 5)

Number	Plant	Important value
1	<i>Taxodium ascendens</i>	0.0846
2	<i>Fraxinus chinensis</i>	0.0719
3	<i>Cinnamomum bodinieri</i>	0.0482
4	<i>Lagerstroemia indica</i>	0.0447
5	<i>Magnolia grandiflora</i>	0.0236

In the shrub layer, the most important value in the top five are *Osmanthus fragrans*, *Loropetalum chinense*, *Mahonia fortune*, *Hypericum monogynum*, *Aucuba chinensis* (Table 3). Among them *Osmanthus fragrans*, *Mahonia fortune*, *Aucuba chinensis* are native tree species, and *Loropetalum chinense*, *Hypericum monogynum* are alien tree species. All indexes of *Osmanthus fragrans* rank the first. As a native plant in Wuhan, *Osmanthus fragrans* has a good growth and a wide planting area. Meanwhile, as an evergreen shrub, *Osmanthus fragrans* has a good landscape effect. *Loropetalum chinense* is often arranged as a low shrub, although the frequency of the garden is not high, but planted in pieces, forming a good landscape. *Mahonia fortune*, which is in the middle of the index, grows well as a native species. The indexes of *Hypericum monogynum* and *Aucuba chinensis* are relatively low, and the planting in the garden is sparse, with general growth condition and poor landscape effect. From the overall index of the shrub layer, the garden shrub planting range is small, few varieties, uneven distribution, and landscape effect is relatively general.

Table3. Ranking of important values of shrub layer in Zhongshan Park, Wuhan (top 5)

Number	Plant	Important value
1	<i>Osmanthus fragrans</i>	0.0657
2	<i>Loropetalum chinense</i>	0.0294
3	<i>Mahonia fortune</i>	0.0226
4	<i>Hypericum monogynum</i>	0.0158
5	<i>Aucuba chinensis</i>	0.0151

In the ranking of important values for the herb layer (Table 4), the top five values are *Ophiopogon bodinieri*, *Duchesnea indica*, *Cynodon dactylon*, *Petunia hybrida*, *Eleusine indica*. Among them, *Duchesnea indica*, *Cynodon dactylon*, *Eleusine indica* are native species, and *Ophiopogon bodinieri*, *Petunia hybrida* are alien species. *Ophiopogon bodinieri* is among the best in all the indexes. It has strong adaptability and can endure heat and cold as well as humidity. Its root system is well developed, and although it is an alien species, it has good covering effect and is a common ground cover plant. The indexes of *Duchesnea indica* and *Cynodon dactylon* are similar. As common native plants, they spread fast, grow well and have good landscape effect. *Petunia hybrida*, as an ornamental plant, is rich in landscaping and frequently appears in the garden. However, *Petunia hybrida* prefers warm environment and is not resistant to frost and waterlogging. As an alien species, its relative coverage is not high.

Table4. Ranking of important values of herb layer in Zhongshan Park, Wuhan (top 5)

Number	Plant	Important value
1	<i>Ophiopogon bodinieri</i>	0.1667
2	<i>Duchesnea indica</i>	0.0883
3	<i>Cynodon dactylon</i>	0.0832
4	<i>Petunia hybrida</i>	0.0772
5	<i>Eleusine indica</i>	0.0624

3.2.2 Species richness index analysis

The richness of species can measure the richness of garden plants in the garden green space, reflecting the adaptability of species to the environment and the utilization of resources. The more abundant the plants, the higher the value will be[7]. It can be seen that the Margalef richness index of arbor and shrub is arranged as: herb layer > tree layer > shrub layer (Table 5) . The herbaceous layer in the sample land is the most abundant, because of the human disturbance, through the fence and other obstacles to visitors to trample herbaceous plants, so that all kinds of herbaceous plants can grow naturally.

Table5. Measurement results of plant diversity index in park

Level	Richness	Uniformity	Shannon-Wiener	Simpson
Tree Layer	0.7072	1.0301	1.1645	0.4712
shrub Layer	0.5403	0.7219	0.5701	0.4720
Herb Layer	1.5702	1.4425	2.3567	0.8007

Species richness is a measure of the richness of garden plants in the garden green space. The more uniform the population distribution in the plant community, the higher the community uniformity index. On the contrary, the more concentrated the population distribution, the lower the community evenness index[8].The Pielou evenness index of arbor and shrub was arranged in the order of herb layer > tree layer > shrub layer. Compared with shrub layer, the uniformity index of tree layer and herb layer is higher. In the park, the distribution of tree layer and herb layer is more uniform, with low ecological dominance, while the distribution of shrub layer is not uniform, with high ecological dominance.

Species diversity is an important index to measure the richness and evenness of community structure. The higher the plant diversity in the community, the more complex the structure and function will be[9]. Shannon-winner diversity index is used to reflect the degree of individual disorder and uncertainty of community species. The diversity index of shannon-winner in the overall layout of the park is arranged as herb layer > tree layer > shrub layer (Table 5) . At some of the landscape nodes of the park, the management has constructed a landscape layer with high coverage and rich colors, with native species as the main structure for good landscape effect. Among all the plots, shrub layer has the simplest structure and the worst ecological function. Only a few shrub species such as

Osmanthus fragrans, *Loropetalum chinense* and *Mahonia fortune* are widely used in the garden, while others are planted sparsely and have a single ecological function. Herbaceous layer shannon-Winner diversity index was almost greater than 2, herbaceous layer species richness was high. The extensive management of herbaceous plants by the park managers shows that many wild herbaceous plants can grow naturally, resulting in high diversity of herbaceous layers.

Simpson diversity index refers to the probability that two individuals belonging to the same species are randomly selected from a community[10].The Simpson diversity index was the herb layer > shrub layer > tree layer (Table 5) .On the whole, the vegetation in the tree layer and herb layer is more abundant, and the landscape effect is better than that in the shrub layer.

4 Discussion and Suggestions

4.1 Discuss

The selection and arrangement of plant species is often an important factor that determines the style of garden plant landscape and affects garden art and environmental greening level [11].Through this survey, it is found that WuHan ZhongShan Park green space is relatively rich, a total of 64 families, 114 genera and 184 species of plants.Among them, there are 48 native plants, accounting for 26.09% of the total plant species in the garden. It can be seen that the proportion of native species planted in the garden is relatively low, and most of them are imported species.The reasonable collocation of native species and alien species should be paid attention to when plant configuration is carried out in the park. The herbaceous plants in the park are abundant, and the shrub species are the least, among which the species of *Rosaceae* and *Luteaceae* are more dominant, which are outstanding in the greening of the park. It was found that some areas of the garden had unreasonable arrangement of greening, relatively simple plant community and relatively simple plant arrangement. In the park as a whole, the richness index, diversity index and evenness index of the tree layer, shrub layer and herb layer in wuhan zhongshan park were mostly as follows: herb layer > tree layer > shrub layer. The stability of had strong stability, while shrub layer had the weakest stability.

4.2 Suggest

The diversity of garden plants is an important part of the urban green space system, and native plants are in a key position among garden plants[12]. Add native plants appropriately in the garden, and use native species to build urban landscapes with obvious regional characteristics.Native species are those with low cost, high survival rate and quick effect, with lax requirements on conservation and management[13].It is suggested to enrich the variety of garden plants, a variety of evergreen plants and an appropriate amount of some excellent native plants to view flowers and leaves, so as to adorn the color

of the park in four seasons. We suggest designers to optimize the structure of shrub layer, increase the variety and quantity of shrub, and enrich the plant species. We need to combine the ornamental value and function through different landscape features, which can not only achieve good landscape effect, but also increase the stability of the park green space system. At the same time we should pay attention to increase the variety and number of shrubs. Due to the low shrub diversity in the park, we should try our best to choose some evergreen shrubs. At the same time, we should also pay attention to the arrangement of some flower viewing, leaf viewing or fruit viewing shrubs in the park to increase the seasonal variation of the park landscape. For example, *Cycas revoluta*, *Sabina procumbens*, *Distylium chinense*, *Fatsia japonica* and other evergreen native shrubs can be planted in the garden, and then some flowers such as *Gardenia jasminoides*, *Malus halliana*, *Michelia figo*, *Serissa japonica* as shrubs. There are many lawns in Zhongshan Park in Wuhan, and the herb planting in some areas is relatively simple, so some plants can be added for flower viewing.

When we construct the plant community in the park, we should try to form a multi-layered plant community. The plant community should be dominated by trees, supplemented by shrub layer and herb layer, which can enrich the diversity of landscape structure. [14]. Secondly, we should make full use of the limited space and combine different planting forms to improve the number of garden plant varieties, green rate of parks and plant landscape quantity .

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