Spermatophyte Flora of Liangzi Lake Wetland Nature Reserve

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Abstract. Based on route and sample-plot survey, plant resources of Liangzi Lake Wetland Nature Reserve were investigated. The result showed that there were 503 species of spermatophyte belonging to 296 genera of 86 families. There were 5 species under national first and second level protection. The dominant families of spermatophyte contained 20 species and above. The dominant genera of spermatophyte contained 4 species and below. The 86 families of spermatophyte can be divided into 7 distribution types and 4 variants. Tropic distribution type was dominant, accounting for 70.83% in total (excluding cosmopolitans). The 296 genera of spermatophyte can be divided into 14 distribution types and 9 variants. Temperate elements were a little more than tropical elements, accounting for 50.84% and 49.16% in total (excluding cosmopolitans) respectively. Reserve had 3 Chinese endemic genera, reflecting certain ancient and relict. The purpose of the research is to provide background information and scientific basis for the protection, construction, management and rational utilization of plant resources in the reserve.

1 Preface

Flora refers to the sum of all plant species in a certain region or country. It is the result of the development and evolution of the plant kingdom under certain natural and geographical conditions, especially under the comprehensive effect of natural and historical conditions. With the development of Botany, the researches of flora have been carried out continuously. The basic characteristics and division framework of Chinese flora have been basically completed in the efforts of several generations of botanists. New distribution information can be obtained through systematic and in-depth floristic investigation and collection. For example, some plants have been extinct in the origin, but may be found in other regions. As a great biodiversity country, China has accumulated rich data on the basic characteristics, division and resources of flora. This provides an important theoretical basis and practical guidance for biodiversity conservation [1].

2 Research area and method

2.1 General situation of research area

Liangzi Lake Wetland Nature Reserve is located in the southeast of Hubei Province, on the south bank of the middle reaches of the Yangtze River. It borders Daye in the east, Xianning in the south and Jiangxia in the west. It is located between 114°31′19″~114°42′52″E and 30°04′55″~ 30°20′26″N. The total area is 37946.3 hectares, including 31000 hectares of water area.

The Reserve belongs to subtropical monsoon climate area, with obvious monsoon climate. The annual average temperature is 17℃, the annual average rainfall is 1663mm, the average sunshine hour is 2061 hours, and the frost free period is 270 days. The rain bearing area is 208500 hectares, and the annual average water level is 17.81m. The lowest water level is 16.69m in March and the highest is 18.78m in August. The soil can be divided into four types and 11 sub types: red soil, purple soil, tidal soil and paddy soil. Among them, there are 3 soil types and 6 subclasses in dry land soil, 1 soil type and 5 subclasses in paddy soil [2-3].

2.2 Field investigation method

The plant resources of Liangzi Lake Wetland Nature Reserve were investigated by using the methods of route and sample-plot. The survey sites were Wangdian, Chenmujiang, Liujiabao, Xinguohuang, Zhongxiaowan, Zhangjiacun, Banzuidiu, Dashanchen, Xiabianwan, Hetouzui, Zhoujiaqiao, Laowuxia, Dongbianfang, Xiajiacun, Dazuiwan, Daluhu, Xiaojiazui, Dingluo, Caiyucun, Dawenzui, Qiaotouxu, Xiaoxu, Dajiang, Kuangshuai, Xiamincun, etc.

For areas with rich vegetation diversity, the route survey method was mainly used. The ecological sample-plot method was used to investigate the community in the area with less vegetation damage. Recorded the name of the plant, collected the plant samples, and taken photos [4]. After the field survey, the collected plant specimens were sorted out and identified by referring to Flora of China, Atlas of Higher Plants of China and Flora of Hubei. Combined with the relevant literature, the list of plants in the reserve was finally determined, and the floras of spermatophyte in the reserve were analyzed.

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3 Results and analysis

3.1 Basic composition

There were 503 species of spermatophyte in Liangzi Lake Wetland Nature Reserve belonging to 296 genera and 86 families. Among them, there were 354 species of dicotyledons in 69 families and 213 genera, 149 species of monocotyledons in 17 families and 83 genera (Table 1). Dicotyledons accounted for 80.23%, 71.96% and 70.38% of the total families, genera and species in reserve, while monocotyledons accounted for 19.77%, 28.04% and 29.62% of the total families, genera and species in reserve. Among them, herbs accounted for a large proportion of dicotyledons, shrubs and arbors were relatively scarce, and wetland plants were more in monocotyledons.

Table 1. Species composition of spermatophyte in Liangzi Lake Wetland Nature Reserve

Item	Monocotyledonous plant	Dicotyledonous plant	Total
Number of families	17	69	86
Number of genera	83	213	296
Number of species	149	354	503

3.2 Composition of families

There were 86 families of spermatophyte in Liangzi Lake Wetland Nature Reserve. According to the number of species in the family, they were divided into five grades (Table 2): large family (more than 50 species), larger family (20-49 species), medium family (10-19 species), oligarchic family (2-9 species) and single family (1 species).

According to the statistical results, there were 2 families in the large family, accounting for 2.32% of the total families in reserve, including 121 species, accounting for 24.06% of the total species in reserve. There were 3 families in the larger family, accounting for 3.49% of the total families in reserve, including 92 species, accounting for 18.29% of the total species in reserve. It can be seen that although there were only 5 families in large family and larger family, the number of species in them accounted for 42.35% of the total species, closed to half of the total number of species, which were the dominant families in reserve. They were Gramineae, Compositae, Cyperaceae, Leguminosae and Polygonaceae.

Table 2. Statistics of family size of spermatophyte in Liangzi Lake Wetland Nature Reserve

Item	Family	Genus	Species
Large family	2	77	121
Larger family	3	32	92
Medium family	7	56	98
Oligarchic family	45	102	163
Single family	29	29	29
Total	86	296	503

3.3 Composition of genera

There were 296 genera of spermatophyte in Liangzi Lake Wetland Nature Reserve, which were divided into four grades (Table 3): large genus (more than 10 species), medium genus (5-9 species), oligarchic genus (2-4 species) and single genus (1 species).

The results showed that there were only 3 genera in the large genus, accounting for 1.01% of the total genera in reserve. They were *Polygonum*, *Artemisia* and *Cyperus*. There were 13 genera in medium genus, accounting for 4.39% of the total genera in reserve, such as *Fimbristylis*, *Carex*, *Scirpus*, *Veronica*, *Eleocharis*, *Euphorbia*, *Ranunculus*, etc. There were 75 genera and 205 genera in oligarchic genus and single genus respectively. They contained 395 species, accounting for 78.53% of the total species, which was an important part of the genera in reserve and the reason for the diversity of the genera.

Table 3. Statistics of genera size of spermatophyte in Liangzi Lake Wetland Nature Reserve

Item	Genus	Species
Large genus	3	36
Medium genus	13	72
Oligarchic genus	75	190
Single genus	205	205
Total	296	503

3.4 Distribution types of families

According to the distribution type system of the world spermatophyte family of Z. Y. Wu [5], 86 families in the reserve were divided into 7 distribution types and 4 variants (Table 4). They can be divided into 3 types: cosmopolitan (Type 1), tropical distribution (Type 2-7) and temperate distribution (Type 8-10).

Table 4. Statistics of distribution types of spermatophyte families in Liangzi Lake Wetland Nature Reserve

Type code	Distribution types	Numbers of family	Percentage (%)
1	Cosmopolitan	38	44.19
2	Pantropic	26	30.23
2-2	Tropical Asia, Africa & South America disjuncted	1	1.16
2S	Tropical Asia, Africa & South America disjuncted	3	3.49
3	Tropical Asia & Tropical America disjuncted	2	2.33
4	Old World Tropics	1	1.16
7d	New Geainea	1	1.16
8	North Temperate	3	3.49
8-4	North Temperate & South Temperate disjuncted	9	10.47
9	East Asia & North Ameira disjuncted	1	1.16
10	Old World Temperate	1	1.16
Total		86	100.00

3.4.1 Cosmopolitan families

There were 38 cosmopolitan families in Liangzi Lake Wetland Nature Reserve, accounting for 44.19% of the total families in reserve. Families with more species including: Gramineae, Compositae, Cyperaceae, Leguminosae, Polygonaceae, Scrophulariaceae, Labiatae, Rosaceae, Cruciferae, Umbelliferae, etc.

It can be seen that although the cosmopolitan families accounted for a large proportion in the total families of the reserve, they were not enough to reflect the characteristics of the flora of the reserve. Because the cosmopolitan families were distributed all over the world, they just play an important role in enriching the plant diversity of the reserve.

3.4.2 Tropical distribution families

There were 34 tropical distribution families in Liangzi Lake Wetland Nature Reserve, accounting for 39.53% of the total families. The distribution types with the most families were pantropical distribution family and its variants, which had 30 families, accounting for 34.88% of the total families in reserve. For example, Euphorbiaceae, Viticeae, Tetrandriaceae, Araceae, Sapindaceae, Cucurbitaceae, Malvaceae, Tiliaceae, etc.

The second was tropical Asia, Africa and South America disjuncted distribution family, which had 2 families, accounting for 2.33% of the total families in reserve, respectively Verbenaceae and Lardizabalaceae.

It can be seen that the main component of the tropical distribution family were the pantropic distribution family and its variants, and the tropical distribution family played a significant role in the whole flora.

3.4.3 Temperate distribution families

The temperate distribution families in Liangzi Lake Wetland Nature Reserve were 14 families, accounting for 16.28% of the total families. The distribution types with the most families were north temperate distribution family and its variant, which had 12 families, accounting for 13.95% of the total families in reserve. They were the main distribution types of temperate distribution families. For example, Liliaceae, Juncaceae, Fagaceae, Salicaceae, Caprifoliaceae, Juglandaceae, Papaveraceae, etc.

In addition, East Asia and North Ameira disjuncted distribution family and old world temperate distribution family each contained 1 family, each accounting for 2.33% of the total families in reserve. They were Saururaceae and Trapaceae respectively.

3.5 Distribution types of genera

According to the distribution types of spermatophyte genera in China of Z. Y. Wu [6], 296 genera in the reserve were divided into 14 distribution types and 9 variants (Table 5). They can be divided into 4 types: cosmopolitan (Type 1), tropical distribution (Type 2-7), temperate distribution (Type 8-14) and endemic to China distribution (Type 15).

Table 5. Statistics of distribution types of spermatophyte genera in Liangzi Lake Wetland Nature Reserve

Type code	Distribution types	Numbers of genus	Percentage (%)
1	Cosmopolitan	58	19.59
2	Pantropic	72	24.32
2-1	Tropical Asia, Australasia & South America disjuncted	2	0.68
2-2	Tropical Asia, Africa & South America disjuncted	1	0.34
3	Tropical Asia & Tropical America disjuncted	5	1.69
4	Old World Tropics	18	6.08
4-1	Tropical Asia, Africa and Australasia	2	0.68
5	Tropical Asia to Tropical Australasia	6	2.03
6	Tropical Asia to Tropical Africa	1	0.34
7	Tropical Asia (Indo-Malesia)	9	3.04
7d	New Geainea	1	0.34
8	North Temperate	21	7.09
8-4	North Temperate & South Temperate disjuncted	27	9.12
8-5	Eurasia & Temperate South America disjuncted	3	1.01
9	East Asia & North Ameira disjuncted	12	4.05
10	Old World Temperate	17	5.74
10-1	Mediterranea, West Asia (or Central Asia) & West Asia disjuncted	3	1.01
10-3	Eurasia & South Africa (sometimes also Australasia) disjuncted	6	2.03
11	Temperate Asia	6	2.03
12	Mediterranea, West Asia to Central Asia	1	0.34
14	East Asia	11	3.72
14SJ	Sino-Japan	11	3.72
15	Endemic to China	3	1.01
Total		296	100.00

3.5.1 Cosmopolitan genera

There were 58 cosmopolitan genera in Liangzi Lake Wetland Nature Reserve, accounting for 19.59% of the total genera. Genus with 3 species and above including: *Artemisia*, *Cyperus*, *Carex*, *Scirpus*, *Euphorbia*, *Ranunculus*, *Rumex*, *Viola*, *Rubus, Heleocharis, Juncus*, *Galium*, *Cardamine*, *Lysimachia*, *Bidens*, *Rorippa*, *Chenopodium*, *Solanum*, *Amaranthus*, *Physalis* and *Nymphoides*.

3.5.2 Tropical distribution genera

There were 117 tropical distribution genera in Liangzi Lake Wetland Nature Reserve, accounting for 39.53% of the total genera. The distribution types with the most genera were pantropical distribution genus and its variants, which had 75 genera, accounting for 64.1% of the tropical distribution genera in reserve. Genus with 3

species and above including: *Rotala*, *Fimbristylis*, *Veronica*, *Echinochloa*, *Eragrostis*, *Phyllanthus*, *Smilax*, *Ipomoea*, *Kyllinga*, *Conyza*, *Ludwigia* and *Setaria.*

The second was old world tropical distribution genus, which had 20 genera, accounting for 17.09% of the tropical distribution genera in reserve. They were *Hemarthria*, *Achyranthes*, *Stephania*, *Themeda*, *Rostellularia*, *Hydrocharis*, *Grewia*, *Osbeckia*, *Arthraxon*, *Melia*, *Limnophila*, *Murdannia*, *Asparagus*, *Cayratia*, *Capillipedium*, *Striga*, *Mallotus*, *Monochoria*, *Gardenia* and *Rottboellia.*

3.5.3 Temperate distribution genera

The temperate distribution genera in Liangzi Lake Wetland Nature Reserve were 121 genera, accounting for 40.88% of the total genera. The distribution types with the most genera were north temperate distribution genus and its variants, which had 51 genera, accounting for 42.15% of the temperate distribution genera in reserve. For example, *Polygonum*, *Vicia*, *Potentilla*, *Oenanthe*, *Lonicera*, *Clinopodium*, *Cirsium*, *Vitis*, *Aster*, *Corydalis,* etc.

The second was old world temperate distribution genus, which had 26 genera, accounting for 21.49% of the temperate distribution genera in reserve. For example, *Trapa*, *Sonchus*, *Medicago*, *Torilis*, *Ajuga*, *Avena*, *Melilotus*, etc.

3.5.4 Endemic to China distribution genera

There were 3 endemic to China distribution genera in Liangzi Lake Wetland Nature Reserve, accounting for 1.01% of the total genera. They were *Koelreuteria*, *Poncirus* and *Indocalamus*.

4 Conclusion and discussion

There were 503 species of spermatophyte in Liangzi Lake Wetland Nature Reserve belonging to 296 genera and 86 families. Five families were dominant in the reserve, which were Gramineae, Compositae, Cyperaceae, Leguminosae and Polygonaceae. The oligarchic and single genus contained 280 genera, which were the reason for the genera diversity. The *Brasenia schreberi* and *Nelumbo nucifera* in the reserve belong to the national first level protection. *Glycine soja*, *Trapa incisa* and *Zelkova chneideriana* belong to the national second level protection. In addition, Liangzi Lake Wetland Nature Reserve was the only habitat of *Nymphaea stellata*, which was a rare aquatic plant species in Asia.

The 86 families of spermatophyte can be divided into 7 distribution types and 4 variants. Tropic distribution type was dominant, accounting for 70.83% in total (excluding cosmopolitans). The proportion of tropical distribution family to temperate distribution family was about 2.4:1. In addition, the cosmopolitan families also reflects certain temperate attributes. The results showed that tropical components were dominant in this flora at family level.

The 296 genera of spermatophyte can be divided into 14 distribution types and 9 variants. Temperate elements were a little more than tropical elements, accounting for 50.84% and 49.16% in total (excluding cosmopolitans) respectively. In tropical distribution types, pantropic distribution genus and its variants were dominant. While in temperate distribution types, north temperate distribution genus and its variants were dominant. It can be seen that the transition between temperate and tropical elements was obvious.

In addition, the reserve contained 3 genera of the genus endemic to China, including 4 species. They were *Koelreuteria paniculata*, *Koelreuteria bipinnata*, *Poncirus trifoliata* and *Indocalamus tesellatus*, reflecting certain ancient relic.

Liangzi Lake Wetland Nature Reserve was rich in plant resources. It is suggested to regularly investigate the vegetation in the reserve, record its growth, file the data, establish a detailed database, and provide data support for the management and scientific research of the reserve [7]. Moreover, the protection measures for the reserve should be scientific and effective. We should take the endangered plants as the key protected objects, formulate clear protection measures, and reasonably develop and utilize the plant resources in the reserve. We need to increase efforts to publicize the ecological environment in the reserve and popularize the knowledge of ecological protection.

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