Examination of Woody Flora on University Campus: A Case Study of Anhui Xinhua University

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Abstract The investigation and analysis of woody plants on the campus of Anhui Xinhua University reveals the presence of 103 species distributed across 43 families and 78 genera. Notably, depauperate families and monotypic genera are found to be the most numerous. Among the families, Rosaceae is identified as the most diverse, encompassing a total of 21 species, while *Prunus* is found to contain the highest number of species, totaling 5. The geographic component of the plant flora is intricate and encompasses a wide range of distribution types, with a predominance of both tropic and temperate plants.

Keywords Flora, Woody plant, University campus

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Flora refers to the collective array of plant species within a specific region or country. It is the outcome of the development and evolution of the plant kingdom, shaped by particular natural geographic conditions, especially the interplay of historical natural factors. Understanding flora is essential for identifying the properties of regional vegetation, as well as for the zoning, management, and utilization of these vegetative resources[1]. Woody plants constitute a significant component of the plant flora. In the context of seed plant evolution, woody plants are considered primitive, and their flora and development possess a lengthy historical trajectory. Therefore, the study of woody flora is of considerable importance[2]. Research on the composition of woody flora on university campuses can offer valuable insights for campus greening construction, and serve as teaching materials and scientific research resources for disciplines such as landscape architecture and related fields. Consequently, this study investigates and analyzes the woody flora present at Anhui Xinhua University.

1 Overview of the study area

Hefei City is situated between the Yangtze River and the Huai River, in a region characterized by the convergence of warm temperate deciduous broadleaf forests and northern subtropic evergreen broadleaf forests. The city experiences a mild climate with four distinct seasons, moderate rainfall, ample sunlight, a prolonged frost-free period, and a brief freezing period. This area falls within the climatic transition from the warm temperate zone to the subtropic zone, specifically classified as a subtropic humid monsoon climate. Anhui Xinhua University is situated in the High-tech Industrial Development Zone of Shushan District, Hefei City, which serves as the capital of Anhui Province. The geographic coordinates of the university are 117°20' E and 31°80' N. The university encompasses a total teaching area of 100 hm^2. Additionally, the university is in proximity to the national scenic area of Shushan Forest Park, characterized by its picturesque natural landscapes and abundant plant resources.

2 Research methods

The research concentrated on all woody plant species located within the campus of Anhui Xinhua University. Upon completion of the survey, the identified plant specimens were classified with reference to the *Flora of Anhui*[3] and the *Flora of China*[4]. For classification purposes, gymnosperms were categorized according to the Zheng Wanjun system, while angiosperms were classified based on the Engler system. Meantime, to conduct the flora analysis, this study integrated information from *The Areal-types of the World Families of Seed Plants*[5], *Floraistics of Seed Plants from China*[6], and *The Areal-types of Chinese Genera of Seed Plants*[7] edited by Wu Zhengyi et al.

3 Results and analysis

3.1 Composition characteristics of woody plants on campus

3.1.1 Overview of the composition of woody plants. The examination of floral composition can offer a scientific foundation for the selection of plant species in campus gardens, thereby informing campus planning and the development of green spaces. Additionally, this study can enhance the diversity and richness of the plant flora. The field survey has identified a total of 103 species of woody plants distributed across 43 families and 78 genera on the campus. This includes 11 species of gymnosperms belonging to 5 families and 10 genera (according to the Zheng Wanjun system, 1978), and 92 species of angiosperms classified within 39 families and 68 genera (based on the Engler system, 1964). Notably, angiosperms constitute the predominant component of the woody plants on the campus. Out of a total of 103 woody plant species, 36 are classified as evergreen, representing approximately 34.9% of the total, while 66 species are deciduous, accounting for about 65.1%. This results in a ratio of approximately 1 : 2. The campus exhibits a lower proportion of evergreen woody plants, which may adversely affect the aesthetic and functional quality of the winter landscape. The classification of plant life form reveals the presence of 53 species of trees, which constitute 51.4% of the total; 45 species of shrubs, representing 43.7% of the total; and 5 species of lianas, accounting for 4.9% of the total. The ratio of these three categories is approximately 12 : 9 : 1.

3.1.2 Diversity analysis of families. In the classification of plants, the family represents the largest natural unit, and each family possesses unique structural characteristics. Families can be categorized into three classes based on the number of species they encompass: multiple-species families ($\geqslant$ 10 species), depauperate

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families (2−9 species), and monotypic families (consisting of a single species). The specifics of this classification are presented in Table 1. Within the category of multiple-species families, there are 21 species of woody plants, which constitute 20.4% of the total number of woody plant species. Conversely, the number of families classified as multiple-species families is limited to one, representing only 2.3% of all families. The depauperate family comprises 59 woody plant species, representing the highest number of woody plant species within this classification, which constitutes 57.2% of the total woody plant species. Additionally, this class includes 19 distinct families, accounting for 44.2% of all families. Within the monotypic families, there are 23 species of woody plants, which represent 22.4% of the total number of woody plant species. Additionally, the number of families within this classification is also 23, constituting 53.5% of all families. The data presented above indicate that, with respect to the family statistics of woody plants at Anhui Xinhua University, monotypic families represent the highest quantity, whereas depauperate families encompass the greatest number of woody plant species. This finding highlights that depauperate families constitute a significant component of the woody plant population on campus.

3.1.3 Diversity analysis of genera. In systematic taxonomy, species that belong to the same genus typically share a common origin and exhibit similar evolutionary trends. Consequently, they are more closely related in terms of their taxonomic and ecological characteristics than families[8]. Based on the statistical analysis of the number of woody plant species within each genus, the genera are classified into three categories: multiple-species genera ($\geqslant$ 5 species), depauperate genera (2−4 species), and monotypic genera. Among these categories, multiple-species genera comprise 5 species of woody plants, representing 4.9% of the total species, and include only one genus, which account for 1.3% of the total genera. In contrast, depauperate genera contain 36 species of woody plants, constituting 35.3% of the total species, and encompass 15 genera, accounting for 19.2% of the total genera. Monotypic genera, on the other hand, include 62 species of woody plants, the highest number among the categories, representing 59.8% of the total species, and comprise 62 genera, which account for 79.5% of the total genera. The analysis of the aforementioned data indicates that the woody flora of Anhui Xinhua University exhibits a significant degree of genus diversity. Notably, monotypic and depauperate genera are predominant, encompassing the highest number of plant species, whereas the quantity of multiple-species genera is comparatively limited.

3.2 Flora composition of woody plants on campus

3.2.1 Flora composition of families. In plant taxonomy, the family represents a higher classification unit, characterized by similar gene expression among its members. These genes

Table 1 Statistics on the composition of woody plant families on campus

Level (number of species)	Family	Number of genera	Number of species	Proportion of families//%	Level (number of species)	Family	Number of genera	Number of species	Proportion of families//%
Multiple-species families ($\geqslant$ 10 species)	Rosaceae	9	21	2.3	Depauperate families (2−9 species, with a total of 19 families)	Rubiaceae	1	2	44.2
Depauperate families (2−9 species, with a total of 19 families)	Cupressaceae	4	5	44.2		Caprifoliaceae	5	6	
	Labiatae	3	3			Taxodiaceae	2	2	
	Euphorbiaceae	2	2			Pinaceae	2	2	
	Aquifoliaceae	1	3			Myrtaceae	2	2	
	Leguminosae	4	4			Sapindaceae	2	2	
	Magnoliaceae	4	5			Hydrangeaceae	1	2	
	Oleaceae	4	7			Salicaceae	2	3	
	Anacardiaceae	2	2			Ulmaceae	2	2	
	Aceraceae	1	3		Monotypic families (with a total of 23 families, 23 genera and 23 species)	−	−	−	53.5
	Lythraceae	2	2						

Table 2 Distribution types of woody plant families on campus

Component type	Distribution type	Family name	Number of plant families on campus	Proportion//%
Cosmopolitan	Cosmopolitan	Leguminosae, Oleaceae, Lythraceae, Ericaceae, Hydrangeaceae, Rosaceae, Rubiaceae, Ulmaceae	8	18.7
Tropic	Pantropic	Euphorbiaceae, Malvaceae, Apocynaceae, Podocarpaceae, Meliaceae, Anacardiaceae, Ebenaceae, Clusiaceae, Celastraceae, Sapindaceae, Lauraceae, Bignoniaceae, Arecaceae	13	30.4
	East Asia and tropic South America disjuncted	Araliaceae, Buddlejaceae, Aquifoliaceae	3	6.9
	Tropic Asia to tropic Australasia Oceania	Myrtaceae	1	2.3
	Total		17	39.6
Temperate	North temperate	Cupressaceae, Hamamelidaceae, Caprifoliaceae, Cornaceae, Aceraceae, Taxodiaceae, Paeoniaceae, Pinaceae, Berberidaceae, Salicaceae, Platanaceae	11	25.6
	East Asia and South America disjuncted	Calycanthaceae, Magnoliaceae, Nyssaceae	3	6.9
	Total		14	32.5
Ancient Mediterranea	Mediterranea to West Asia and Central Asia	Lamiaceae, Punicaceae	2	4.6
East Asian	East Asia variant	Pittosporaceae	1	2.3
	Endemic to China	Ginkgoaceae	1	2.3
	Total		2	4.6
Total			43	100

play a crucial role in determining the climate tolerance of plants, thereby making the family as a common unit for classifying the distribution areas of various plant species[9]. Based on Wu Zhengyi's classification of seed plant families, the 43 families of woody plants present on the campus of Anhui Xinhua University can be categorized into 5 major components and 9 distinct types of distribution areas.

As illustrated in Table 2, there are 17 families of tropic components at the family level, which represent 39.6% of the total number of plant families on the campus. Families of temperate components constitute the second largest group, accounting for 32.5% of the total. The third largest category comprises families with a cosmopolitan distribution, totaling 8 families and representing 18.7% of the overall plant families on campus. The remaining distribution types account for a negligible proportion, comprising only 9.2% of the total number of plant families. Thus, tropic and temperate families form the predominant categories of woody plant families at Anhui Xinhua University.

3.2.2 Flora composition of genera. The taxonomic characteristics of genera exhibit a degree of stability, and their regional distribution tends to be consistent. Species within the same genus typically share a common origin and possess a similar evolutionary history. Consequently, the flora composition of genera is more intricate than that of families, thereby providing a more relevant and effective representation of the flora characteristics of the plants. As illustrated in Table 3, the woody plants belonging to 78 genera at Anhui Xinhua University were classified into 4 primary component types and 10 distribution types, utilizing the same method applied to families.

The cosmopolitan distribution of woody plants on campus is characterized by the presence of angiosperms, comprising 3 genera and a total of 3 species, predominantly represented by shrubs. Notably, there is only one genus of trees, specifically *Platanus* × *acerifolia*. This particular distribution type constitutes a relatively minor component of the overall woody plant population on campus. To enhance the campus's botanical landscape, it is recommended that this type of plants be considered for future introduction and cultivation.

Among the tropic components, the campus is home to 27 genera and 33 species of woody plants, which represent 34.6% of the total number of genera and 31.9% of the total number of species, respectively. This proportion is the second highest among the various component types and constitutes a significant segment of the woody plant population on campus. The pantropic component comprises a total of 21 genera and 24 species of plants, representing the most extensive distribution type among tropic components. Within this component, the genus *Ilex* includes 3 species, while the genus *Gardenia* encompasses 2 species. The remaining genera, such as *Cupressus*, *Triadica*, and *Bischofia*, are all monotypic. Tropic Asia to tropic Australasia Oceania distribution encompasses 4 genera and 7 species, representing the second category of distribution types within the tropic component. The genus *Osmanthus* comprises 4 species, while the remaining 3 genera are monotypic. Additionally, East Asia (tropic and subtropic) and tropic South America disjunctions and tropic Asian distributions are minimal within the tropic component, each represented by one genus and one species.

Among the temperate components, the woody plant category on the campus comprises a total of 32 genera and 48 species. This represents 41.1% of the total genera and 46.7% of the total species, making it the predominant component type. Consequently, it constitutes a significant aspect of the campus's botanical landscape, contributing to its unique characteristics. North temperate distribution represents the most extensive distribution type for temperate components, encompassing a total of 15 genera and 28 species of woody plants. Among these, the genus *Prunus* is the most diverse, comprising 5 species. This is followed by the genera *Acer*, *Rosa*, and *Spiraea*, each containing 3 species. The genera *Salix*, *Malus*, and *Lonicera include* 2 species each, while the remaining genera, such as *Paeonia*, *Pinus*, and *Armeniaca*, are monotypic. The second distribution type within the temperate component is characterized as the East Asian and North American disjunction, which encompasses a total of 10 genera and 12 species of plants. The majority of plants in this distribution type are monotypic genera, with a limited number of depauperate genera. Additionally, the Old World temperate distribution comprises 7 genera and 8 species of plants, with only one genus containing 2 species.

The East Asian component comprises 16 genera and 19 species of plants. The predominant distribution type within this component is the East Asian distribution type, which includes 14 genera and 17 species, predominantly consisting of monotypic genera. In contrast, the plants endemic to China represent a relatively minor proportion, encompassing 2 genera and 2 species, specifically *Ginkgo* and *Camptotheca*. The primary vegetation of the campus consists of both tropic and temperate component plants. This diversity suggests that the campus is situated in an area characterized by favorable climatic transitions and geographic connectivity, which facilitates the coexistence of these two

Table 3 Distribution types of woody plant genera on campus

Component type	Distribution type	Number of genera	Proportion of the total genera//%	Number of species	Proportion of the total species//%
Cosmopolitan	Cosmopolitan	3	3.8	3	2.9
Tropic	Pantropic	21	26.9	24	23.3
	East Asia (tropic and subtropic) and tropic South America disjuncted	1	1.3	1	0.9
	Tropic Asia to tropic Australasia Oceania	4	5.1	7	6.8
	Tropic Asia	1	1.3	1	0.9
	Subtotal	27	34.6	33	31.9
Temperate	North temperate	15	19.3	28	27.2
	East Asia and North America disjuncted	10	12.8	12	11.7
	Old World temperate	7	9	8	7.8
	Subtotal	32	41.1	48	46.7
East Asia	East Asia	14	17.9	17	16.6
	Endemic to China	2	2.6	2	1.9
	Subtotal	16	20.5	19	18.5
Total		78	100.0	103	100.0

plant types.

4 Conclusions and discussion

The statistical analysis of woody plants conducted at Anhui Xinhua University reveals several notable characteristics regarding the flora composition of woody plants on the campus.

The campus of Anhui Xinhua University exhibits a diverse array of woody plant species, comprising 103 species across 43 families and 78 genera. The flora is predominantly characterized by angiosperms, while gymnosperms are represented in lesser numbers. Additionally, the prevalence of deciduous plants significantly exceeds that of evergreen plants, with an approximate ratio of 2 : 1. The campus is particularly rich in both tree and shrub species, which are present in comparable quantities, whereas lianas are less frequently encountered. The aforementioned analysis suggests that an increase in the number of evergreen plants on campus would enhance the otherwise monotonous winter landscape. Additionally, the introduction of lianas could address the deficiency in vertical landscaping, thereby contributing to the creation of a distinctive campus environment.

The campus is characterized by a significant presence of depauperate families and monotypic genera. The depauperate family, comprising 59 woody plant species, represents the largest proportion of plant species, accounting for 57.2% of the total species observed. Additionally, it encompasses 19 families, which constitute 44.2% of all families recorded. In contrast, the monotypic genus includes 62 plant species, accounting for 59.8% of the total species, and comprises 62 genera, representing 79.5% of all genera identified. From the standpoint of family and genus composition in plant taxonomy, the campus exhibits a significant prevalence of depauperate families and monotypic genera. This phenomenon contributes to a rich diversity of plant species on the campus, resulting in a varied and dynamic plant landscape.

The geographical composition of the plant flora is intricate. At both the family and genus levels, tropic and temperate components are predominant. This observation suggests that Anhui Xinhua University is situated in a transitional zone between the tropic and temperate regions, facilitating the growth of plant species characteristic of both tropic and temperate climates, thereby exhibiting a significant transitional nature. The climate of the location where the campus is situated exhibits a transitional and complex nature, incorporating characteristics of both tropic and temperate climates. This unique climate provides a conducive living environment for a diverse range of plant species with varying climate adaptability. Consequently, in future planning of campus green spaces, it is advisable to introduce and cultivate plant species that are well-suited to the local climate. This approach is expected to enhance the survival rate of the plants and improve the overall landscape of the campus.

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