Vegetation and vascular plant diversity of Huzhou Island, Huizhou, China

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Abstract. Human activities have an increasingly severe impact on uninhabited islands. It is beneficial to monitor and protect the vegetation diversity of uninhabited islands to master the species composition and diversity of plant communities. The vascular plants and plant communities of Huzhou Island were investigated by sample plot method. The plant species diversity was analyzed. The results showed that there were 98 species of vascular plants belonging to 88 genera and 49 families in the island. Among them, tropical and subtropical families were dominant the island. The genera floristic distribution of vascular plants was mainly pantropic distribution and secondly old word tropic distribution. The vegetation in the island could be classified into 1 vegetation type (monsoon evergreen broad-leaved forest vegetation), 1 alliance (coastal hilly monsoon evergreen broad-leaved forest) and 2 associations (Ficus microcarpa and Eucalyptus urophylla - Myrtle). The change trend of community richness, evenness and diversity was consistent. This study can provide scientific data for resource protection and development of uninhabited island.

1. Introduction

Island is a unique and fragile ecosystem type on earth. There were serious degradation phenomena in China's coastal islands, such as the decrease of island area, the decrease of island vegetation, the decrease of biodiversity and the fragmentation of island landscape [1]. The research on island vegetation in China involved Island plant diversity, vegetation succession and restoration, etc. [2-4]. Vegetation was an important resource and the basis of regional ecosystem function and stability. The types and characteristics of vegetation could reflect the natural conditions of the region. The objective characteristics of species richness and structural diversity were revealed by studying the composition and diversity of island plant communities. It is of great significance to protect the diversity of island vegetation community and monitor the self restoration of island vegetation. Based on the investigation of vegetation resources in Huzhou island in Huizhou city, this study would analyze the species composition and diversity characteristics of island plant communities. It could provide a scientific basis for the formulation of vegetation protection measures, the selection and optimal allocation of restoration species and the sustainable utilization of island vegetation.

Huzhou island is located about 22° 46’ 26” N and 114° 40 12” E. It is 0.16 km near north of the mainland at Xiayong port in Huizhou city. The uninhabited island area is 2.3 km². The topographic feature is a low hill island landform type. It is long in shape, northeast southwest trend. The highest place is 40 m above sea level. The island is composed of bedrock and sandy soil on the surface. There are sandbanks along the northern coast connecting with the mainland. The rest of the coast is rocky
beach. The climate type of this area is south subtropical monsoon marine climate with abundant hydrothermal conditions. The annual average temperature is 22.1 °C with the average temperature in the hottest month (July) 28.5 °C and in the coldest month (January) 14.1 °C. There is no frost in the whole year. The average annual rainfall is 1734.9 mm, but the distribution is uneven. The rainy season is from April to September every year, with thunderstorms and typhoon, accounting for more than 80% of the annual rainfall. The island is an offshore island with a long history of social and economic activities, which has caused great damage to the zonal vegetation. The primary vegetation has been basically destroyed, and the current vegetation is mainly plantation.

2. Methods
On the basis of comprehensive investigation, 15 sample plots were randomly selected to investigate the plant community, including 3 arbor plots, 4 shrub plots and 8 grass plots. The size of arbor plot was 10 m × 10 m. Up arbor layer, the number, height, DBH and coverage of all species with DBH ≥ 3 cm were recorded. Shrub plot size was 5 m × 5 m. All shrub species in the plots were investigated. Species name, quantity and coverage were recorded. Herb plot size was 1 m × 1 m. Species name of herbs in the plots, quantity and coverage were recorded.

In this study, α diversity was measured by richness index, evenness index and diversity index [5]. Community richness index was the total number of species in the community. Shannon index was used as diversity index. Pielou index was used as evenness index. Calculation of important value: arbor important value = (relative abundance + relative frequency + relative dominance) / 3; shrub and grass important value = (relative abundance + relative frequency + relative coverage) / 3.

3. Results and discussions
3.1. Species composition of vascular plants in the Island
According to the survey, there were 98 species of vascular plants belonging to 88 genera and 49 families in the island (Table 1). There were 5 families, 5 genera and 5 species of pteridophytes, 44 families, 83 genera and 93 species of angiosperms (Table 1). Dicotyledons were dominant in the vascular flora, with families, genera and species accounting for 77.55%, 81.72% and 82.83% of the total flora respectively. Families, genera and species of monocotyledons accounted for 12.24%, 13.64% and 12.24% of the total flora respectively. Families, genera and species of pteridophytes accounted for 10.20%, 5.68% and 5.10% of the total flora respectively. There were no gymnosperms on the island (Table 1). Huzhou island were dominated by shrubs, among which *Rhodomyrtus tomentosa*, *Litsea glutinosa*, *Embelia ribes Burm. f.*, *Ilex asprella* were the most high frequent species. The species of trees were few, mainly *Eucalyptus urophylla* and *Ficus microcarpa*. *Pteridium aquilinum var. latiusculum*, *Liriope spicata* and *Lygodium japonicum* were the most common herbs in the island. According to the growth type, there were 11 tree species (including 10 evergreen trees, 1 deciduous tree), 45 shrub species, 22 species of herbs (including ferns) and 21 species of lianas.

| Taxa          | Family | Genera | species |
|---------------|--------|--------|---------|
| Pteridophytes | 5      | 5      | 5       |
| Gymnosperms   | 0      | 0      | 0       |
| Monocotyledon | 6      | 12     | 12      |
| Dicotyledon   | 38     | 71     | 81      |
| Total         | 49     | 88     | 98      |
3.2. Characteristics of the vascular plants flora in the Island

There were 6 families with more than 5 species in the flora, accounting for 12.24% of the total families. The 6 families included 35 species, accounting for 35.35% of the total species. Therefore, it was an important family in the flora, mainly Lauraceae (5 species), Euphorbiaceae (9 species), Papilionaceae (5 species), Rubiaceae (5 species), Verbenaceae (5 species), Poaceae (6 species) (Table 2). 30 families only contain one species which accounting for 61.22% of the total families (Table 2). It indicated the secondary nature of the flora. No Rare and endangered plant species had been found on this island.

| Family              | G. | S. | Family              | G. | S.          |
|---------------------|----|----|---------------------|----|-------------|
| Gleicheniaceae      | 1  | 1  | Celastraceae        | 2  | 2           |
| Lygodiaceae         | 1  | 1  | Rhamnaceae          | 1  | 1           |
| Pteridaceae         | 1  | 1  | Elaeagnaceae        | 1  | 1           |
| Blechnaceae         | 1  | 1  | Rutaceae            | 2  | 2           |
| Nephrolepidae       | 1  | 1  | Simaroubaceae       | 1  | 1           |
| Lauraceae           | 4  | 5  | Meliaceae           | 1  | 1           |
| Menispermacae       | 2  | 2  | Sapindaceae         | 2  | 2           |
| Portulacaceae       | 1  | 1  | Anacardiaceae       | 2  | 2           |
| Amaranthaceae       | 1  | 1  | Alangiaceae         | 1  | 1           |
| Thymelaeaceae       | 1  | 1  | Araliaceae          | 2  | 2           |
| Flacourtiaceae      | 1  | 1  | Myrsinaceae         | 1  | 1           |
| Theaceae            | 1  | 1  | Loganiaceae         | 1  | 1           |
| Myrtaceae           | 2  | 3  | Apocynaceae         | 3  | 3           |
| Melastomataceae     | 1  | 1  | Asclepiadaceae      | 2  | 2           |
| Hypericaceae        | 1  | 1  | Rubiaceae           | 3  | 4           |
| Sterculiaceae       | 3  | 3  | Asteraceae          | 4  | 4           |
| Malvaceae           | 1  | 1  | Solanaceae          | 1  | 1           |
| Euphorbiaceae       | 7  | 9  | Scrophulariaceae    | 1  | 1           |
| Daphniphyllaceae    | 1  | 1  | Verbenaceae         | 4  | 5           |
| Rosaceae            | 1  | 1  | Commeliniaceae      | 1  | 1           |
| Mimosaceae          | 1  | 1  | Liliaceae           | 2  | 2           |
| Fabaceae            | 4  | 5  | Smilacaceae         | 1  | 1           |
| Ulmaceae            | 2  | 2  | Arecaceae           | 1  | 1           |
| Moraceae            | 1  | 3  | Cyperaceae          | 1  | 1           |
| Aquifoliaceae       | 1  | 1  |                     |    |             |

G. stands for genera; S. stands for species
Referring to Wu's distribution types of seed plants and their origin and differentiation [6], Flora of China [7] and families and genera of pteridophytes in China [8]. The study on the distribution characteristics of the flora showed that most of the families were tropical and subtropical families, while a few, such as Gramineae, Papilionaceae, Cyperaceae, Euphorbiaceae, were world distribution families. Most of the genera in this flora were tropical. Among them, the genera in pantropic distribution account for the largest proportion (38.64%), followed by old world tropical distribution (17.05%) and tropical Asia & tropical Australasia (12.50%) (Table 3). Only a few were temperate distribution (Table 3). It fully showed that the flora was still tropical. The genera rate endemic to China was 1.14% (Table 3). It reflected that the differentiation history of flora in this area was relatively short.

### Table 3  Areal-type of vascular plant genera in the island.

| Areal types                              | Genera | Percentage |
|------------------------------------------|--------|------------|
| 1 Cosmopolitan                           | 3      | 3.41       |
| 2 Pantropic                              | 34     | 38.64      |
| 3 Trop. Asia & Trop. Amer. disjuncted     | 6      | 6.82       |
| 4 Old World Tropics                      | 15     | 17.05      |
| 5 Trop. Asia & Trop. Australasia         | 11     | 12.50      |
| 6 Trop. Asia to Trop. Africa             | 3      | 3.41       |
| 7 Trop. Asia                             | 7      | 7.95       |
| 8 North Temperate                        | 2      | 2.27       |
| 9 E. Asia & N. Amer. disjuncted          | 3      | 3.41       |
| 10 Old World Temperate                   | 1      | 1.14       |
| 11 Temp. Asia                            | 0      | 0.00       |
| 12 Mediterranea, W. Asia to C. Asia      | 0      | 0.00       |
| 13 C. Asia                               | 0      | 0.00       |
| 14 E. Asia                               | 2      | 2.27       |
| 15 Endemic to China                      | 1      | 1.14       |
| **Total**                                | 88     | **100.00** |

3.3. **Characteristics of plant community structure in the Island**

Based on the investigation of island route and sample plots in typical section and according to the classification principle and classification system of vegetation in China [9], the current vegetation in the island could be classified into 1 vegetation type, 1 alliance and 2 associations. They were monsoon evergreen broad-leaved forest vegetation type, coastal hilly monsoon evergreen broad-leaved forest alliance, Ficus microcarpa association and Eucalyptus urophylla - Myrtle association.
3.3.1. *Ficus microcarpa* arbor forest

*Ficus microcarpa* arbor forest distributed in the southeast of the island in a small area with a small species composition. It belonged to natural secondary vegetation. It could be divided into two layers: arbor layer and herb layer. The height of arbor layer was generally 4 - 10 m, the canopy density was about 0.95 and the diameter at breast height was 4 - 29 cm. There were trees as *Ficus microcarpa*, *Ficus tinctorius*, etc. The shrub was rare under the forest with the coverage less than 5%. There were shrubs such as *Sterculia lanceolata*, *Celtis philippensis var. wightii*, etc. The coverage of undergrowth herbs was high up to 40%. The main species in this layer were *Blechnum orientale*, *Lygodium japonicum*, *Indocalamus tessellatus*, etc.

3.3.2. *Eucalyptus urophylla* - *Rhodomyrtus tomentosa* arbor forest

It was the main vegetation covering the island which accounting for more than 70% of the island area. *Eucalyptus urophylla* was the main species which belonged to plantation. The plantation in most of the area could be divided into three layers: arbor layer, shrub layer and herb layer. The height of *Eucalyptus urophylla* in tree layer could reach 5 - 17 m. The canopy density was about 0.9 and the DBH was about 2-12 cm. There were also a few *Acacia confusa* and *Litsea glutinosa* in the tree layer.

The clump-forming shrubs generally had 2-10 ramets. The height of the shrub was about 1.3m and the coverage was about 90%. The shrub layer is mainly dominated by *Rhodomyrtus tomentosa*. There were also *Ilex asprella*, *Litsea glutinosa*, *Acacia confusa*, *Eucalyptus urophylla* and other shrubs. Lianas were *Embelia ribes*, *Psychotria serpens* and *Cassytha filiformis*.

The herb layer under the forest was sparse with the main species such as *Liriope spicata*, *Dianella ensifolia*, *Achyranthes bidentata* and so on. There were many *Dicranopteris pedata* under *Eucalyptus urophylla* forest in the west central part of the island.

3.4. Vascular plant species diversity in the Island

Shannon Wiener diversity index was a concentrated reflection of species diversity. Shannon Wiener diversity index of the two vegetation types in Huzhou Island was 2.03 (*Ficus microcarpa* community) and 3.18 (*Eucalyptus urophylla* - *Rhodomyrtus tomentosa* community) (Table 4). This was mainly because the first community was located in the position with poor soil and affected by the tide which not suitable for growth of plant. The order of species richness and community evenness index was basically consistent with that of Shannon Wiener diversity index, indicating that the more abundant species, the higher evenness, the higher diversity index.

| Sample plots                  | Species richness | Shannon index | Evenness index |
|-------------------------------|------------------|---------------|----------------|
| *Ficus microcarpa*            | 10               | 2.03          | 2.03           |
| *Eucalyptus urophylla* - *Rhodomyrtus tomentosa* | 20               | 3.18          | 2.45           |

4. Conclusion

Huzhou island was a bedrock island with few plant species. There were 98 species of vascular plants belonging to 88 genera and 49 families in the island. The dominant families were Euphorbiaceae, Poaceae, Lauraceae, Papilionaceae, Rubiaceae and Verbenaceae. According to the growth type, there were 11 tree species, 45 shrub species, 22 species of herbs and 21 species of lianas. The vegetation in the island could be classified into 1 vegetation type, 1 alliance and 2 associations. They were monsoon evergreen broad-leaved forest vegetation type, coastal hilly monsoon evergreen broad-leaved forest alliance, *Ficus microcarpa* association and *Eucalyptus urophylla* - *Myrtle* association. Most of the vascular plants in the island belonged to tropical and subtropical families. The genera floristic distribution of vascular plants in Huzhou island was mainly pantropic distribution and old world tropic distribution. The change trend of community richness, evenness and diversity was consistent. The
human traces in the islands were obvious, which damage the vegetation composition and diversity. The investigation of vegetation in island was of great significance to the protection and monitoring of vegetation diversity and the study of ecological diversity.

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