A study on vegetation community and plant species diversity of Yeli Island, Zhuhai, China

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Abstract. The vegetation of Yeli Island is of great importance to biological and cultural diversity and to the ecosystem services of Zhuhai. To understand the vegetation ecology, vegetation development process and vegetation structure of Yeli Island, a detailed vegetation investigation was conducted on the Yeli Island through line survey and sampling survey methods. Analysis of woody plant population structure and plant species diversity were conducted. Vegetation on this island was relatively simple since it had been once destroyed. It was mainly covered by artificial *Acacia confusa*. The upper layer was filled with *Acacia confusa* and the lower was filled with small trees, shrubs and a few herbs. The dominant population of *Acacia confusa* was gradually degraded, and a series of newer secondary communities had been formed in the lower layer. The index of biodiversity was low. The vegetation quality was not high. Positive measures should be taken to promote the recovery of this community.

1. Introduction
Natural vegetation is seriously affected by various factors such as land degradation, deforestation, agricultural expansion, settlement and invasive species [1]. The reduction of vegetation cover is one of the most serious challenges facing humanity today [1]. Island vegetation plays an important role in the study of global vegetation and diversity [2]. The island ecosystem is mainly affected and modulated by maritime climate [3]. Most islands are rich in biodiversity and grow various plant communities similar to terrestrial vegetation [3]. Studying island plant communities and plant diversity has important theoretical value and practical management significance for understanding the plant community construction process and species coexistence mechanism under sea-land interaction.

Yeli Island is located in the northwest of Zhuhai City, Guangdong Province. It is the closest island to the urban area of Zhuhai. It belongs to the low hilly landform of the island. The soil layer is shallow and the organic matter content is low. The climate type of this area is the south subtropical monsoon maritime climate with abundant hydrothermal conditions. According to the vegetation division principle of “China Vegetation”, this area belongs to the tropical monsoon rain forest and the rainforest area of the northern tropical semi-evergreen rain forest and humid rain forest [4]. It is a semi-evergreen seasonal rain forest area in the coastal hilly area of southeastern Guangdong [4]. The composition belongs to tropical and subtropical species. The social and economic activities of Yeli Island have a long history, which destroys the zonal vegetation greatly. The primary vegetation has been destroyed. The current vegetation is mainly artificial vegetation and secondary vegetation. The results of the study were expected to provide baseline information for further research on Yeli Island.
2. Methods

2.1. Vegetation survey methods
Vegetation surveys were mainly carried out by a combination of route surveys and typical sample surveys for a comprehensive investigation and record of the island's plants. On the basis of the route census, a typical location was selected for a plot survey. Two tree quadrats were set up with an area of 10 m x 10 m and 16 shrub quadrats were set up with an area of 5 m x 5 m. No quadrats of herbaceous plants were set up because there were few herbs under the forest. Only the species and quantity of herbaceous plants were recorded. The species name, tree height (shrub height), breast diameter (shrub base diameter), crown width (shrub cover) and other indicators of plants in each sample were investigated. The species, quantity, density, coverage and frequency of plants in each sample were counted.

2.2. Data processing
Important values were calculated by Bosun Wang and Shixiao Yu [5].

\[ IV = RA + RF + RD \]  

In the formula \( IV \) was the important value, \( RA \) was the relative density, \( RF \) was the relative frequency, \( RD \) was the relative dominance. Among them, the dominance of trees was measured by breast height section, while the dominance of shrubs and herbs was calculated by crown width.

Formula for estimating tree biomass [5]:

\[ Bmf = 0.00003396D^2H \]  

\( Bmf \) was the biomass of forest community (t. dry weight), \( D \) was DBH (diameter breast height, cm), \( H \) was tree height (m).

Formula of woody layer production (growth) [5]:

\[ Bg = 0.00010246(D^2H)^{0.625} \]  

In the formula, \( Bg \) was production (growth) (t), \( D \) was DBH (cm), \( H \) was tree height (m).

The biomass of shrub and herb layers was calculated by quadrate harvesting method.

Formula for determining Shannon-Wiener diversity index [5]:

\[ SW = 3.3219 (\lg N - \sum \frac{n_i \lg n_i}{N}) \]  

In the formula, \( SW \) was Shannon-Wiener diversity index, \( N \) was the total number of individuals in the plot, \( n_i \) was the number of individuals in the first species, and \( S \) was the number of species.

3. Results and discussions

3.1. Analysis of plant community composition
According to the data of this survey, there were 157 species of vascular plants belonging to 131 genera and 68 families in the island (Table 1). There were 145 angiosperms, accounting for 92.4% of the total species, mainly dicotyledons, accounting for 83.4% of angiosperms. The original ferns and gymnosperms were relatively poor, accounting for 5.7% and 1.9% of the total species. According to the traits, the vascular plants in the region were dominated by woody plants, accounting for 67.5% of the total, followed by herbaceous plants, accounting for 23.6% of the total species, and fewer vines, with 14 species, accounting for 8.9% (Table 1).

Studies on the distribution characteristics of this fauna showed that most of the families were tropical and subtropical distribution families, and a few such as Gramineae, Compositae, and Papilionaceae were world distribution families. The floristic composition had a higher genus system with a genus ratio of 1:1.2. These characteristics of the composition indicated that the vegetation in
this area was seriously affected by human disturbance, and the plant composition showed obvious secondary characteristics. The flora consisted of 7 families with more than 5 species, accounting for 1.0% of the total families. It consisted of 54 species, accounting for 34.4% of the total species. Therefore, they were seven important families of the flora, mainly Moraceae (11 species), Compositae (10 species), Poaceae (8 species), Euphorbiaceae (7 species), Apocynaceae (7 species), Palmae (6 species) and Myrtaceae (5 species). The rest were less than 5 families, of which 39 families contained only 1 species, accounting for 57.4% of the total number of subjects which further indicated the secondary nature of this district.

Table 1. Statistics of vascular plants.

| Groups            | Composition statistics | Trait statistics |
|-------------------|------------------------|-----------------|
|                   | Families | Genera | Species | Woody | Vines | Herbs |
| Pteridophytes     | 7        | 8      | 0       | 2     | 7     |
| Gymnosperms       | 3        | 3      | 3       | 3     |       |
| Angiosperms       |          |        |         |       |       |
| Dicotyledons      | 48       | 98     | 121     | 96    | 10    | 15   |
| Monocotyledons    | 10       | 21     | 24      | 7     | 2     | 15   |
| Total             | 68       | 131    | 157     | 106   | 14    | 37   |

3.2. Analysis of Vegetation Community Structure

The vegetation composition in the island was relatively simple. The main vegetation of the island was the Taiwan acacia plantation. The road around the island had ornamental trees such as Leucaena leucocephala, Lagerstroemia indica, Prunus cerasifera f. atropupurea, Ficus microcarpa, Ficus altissima and artificial turf. The communities of Acacia confusa, Microcos paniculata. Mallotus paniculatus, Psychotria rubra were distributed throughout the island except the roundabout road. The species composition was relatively simple. The community presented a state of arbor forest. Most parts could be divided into three layers: arbor layer, shrub layer and herb layer. The arbor layer could be divided into two secondary layers. The upper level was the layer of Taiwan acacia. The dominant population of Taiwan acacia was gradually degraded, and a series of new secondary communities were formed in the lower layer. The secondary community was a layer of Microcos paniculata Linn and Mallotus paniculatus. The herbaceous plants under forest were sparse.

Table 2. Statistics of important values of tree layer in community.

| Species name        | Number of plants | Relative density (%) | Frequency (%) | Relative frequency (%) | Chest height section (cm²) | Relative dominance (%) | Important value (%) |
|---------------------|------------------|----------------------|---------------|------------------------|---------------------------|------------------------|-------------------|
| Acacia confusa      | 5                | 8.77                 | 50            | 16.67                  | 2389.44                   | 56.56                  | 82.00             |
| Microcos paniculata | 22               | 38.60                | 25            | 8.33                   | 924.68                    | 21.89                  | 68.82             |
| Mallotus paniculatus| 11               | 19.30                | 75            | 25.00                  | 732.97                    | 17.35                  | 61.65             |
| Psychotria rubra    | 7                | 12.28                | 50            | 16.67                  | 47.78                     | 1.13                   | 30.08             |
| Ilex asprella       | 9                | 15.79                | 25            | 8.33                   | 48.01                     | 1.14                   | 25.26             |
| Evodia meliaefolia  | 1                | 1.75                 | 25            | 8.33                   | 74.55                     | 1.76                   | 11.85             |
| Uvaria microcarpa   | 1                | 1.75                 | 25            | 8.33                   | 4.97                      | 0.12                   | 10.21             |
| Schefflera heptaphylla | 1       | 1.75                 | 25            | 8.33                   | 2.07                      | 0.05                   | 10.14             |

The Taiwan acacia trees in the upper layer were generally 6-18 m in height, 0.9 cm in canopy density, 8-32 cm in DBH. Trees in the lower layer were 8-9 m in height and 1-12 cm in DBH.
Common species of lower arbor were Microcos paniculata, Mallotus paniculatus, Psychotria rubra, Ilex asprella, Schefflera heptaphylla and Evodia meliaefolia (Table 2). Shrubs generally had a cluster with 2 to 8 trunks, about 2 to 4 meters high, covering 90%, evergreen. The shrub layer was composed of Ilex asprella, Schefflera heptaphylla, Desmos chinensis, Ardisia lindleyana and so on. The understory herb was sparse. The main species were Lygodium japonium, Pteris dispar, Adiantum flabellulatum, Liriope spicata, etc.

3.3. Analysis of plant biomass and growth in vegetation communities

Biomass and productivity were important indicators to measure the function of an ecosystem. Biomass referred to the total dry matter weight of living organisms in a given period of time, while productivity referred to the amount of organic matter produced by organisms in a community through photosynthesis combined with solar energy. According to the measurement method, the results of calculating the biomass and growth of different vegetation types on the island were shown in Table 3. Because the herbs were scarce, no statistics were taken. It showed that the biomass of the island arbor layer was higher, the growth was lower (Table 3). The biomass and growth of the shrub layer were both low. It was consistent with the appearance and structure of the vegetation community on the island. The proportion of the upper arbor of the island vegetation was larger. The shrub layer had a small proportion. In general, the community had high biomass and low growth.

| Tree layer biomass (kg/m²) | Tree layer biomass (kg/m²) | Growth (kg/m².y) |
|---------------------------|---------------------------|-----------------|
| Tree layer                | Overground part           | Underground part| Tree layer | Total growth |
| 33.11                     | 0.41                      | 0.17            | 0.46       | 1.04         |

3.4. Analysis of plant species diversity in vegetation communities

Biodiversity represented the structural aspects of ecosystems, which provided people and society with various benefits such as support services, supply services, regulatory services and cultural services [6]. Species diversity was an important part of biodiversity. Species diversity was also an important indicator reflecting the complexity and stability of community structure. The level of species diversity was directly related to the succession stage of the community and the degree of human disturbance. Generally, the stability of communities with high species diversity was more stable. Therefore, the level of diversity was also an important indicator of the quality of the environment. The diversity analysis of the island plant community showed that the arbor layer had a higher diversity index (2.4), followed by the herb layer (1.93), and the shrub layer had the smallest diversity (1.89). Compared with the local semi-evergreen rainforest (4.0), the difference was large, which fully reflected the secondary nature of each vegetation type.

4. Conclusions and suggestions

Yeli Island was an offshore island in the Gulf. It was damaged by long-term human activities and its native vegetation had been destroyed. The biodiversity index of all levels of vegetation types in the island was low. The plant species were mostly common plant species in the region. They were mainly composed of drought-tolerant plants such as Microcos paniculata, Mallotus paniculatus, Psychotria rubra, Ilex asprella and so on. The dominant population of Taiwan acacia had gradually degraded, and the lower layer had formed a series of renewed secondary communities, which were Mallotus paniculatus, Psychotria rubra, etc. The understory herbaceous plants were sparse. The overall ecological level of vegetation in this island was above medium level. The protection of vegetation should be strengthened to make it better.

Afforestation should mainly choose wind-resistant, salt-tolerant, fast-growing tree species, large caves, base fertilizers and community planting methods. In the selection of tree species, attention should also be paid to the combination of fast-growing and middle-growing, tree and vine shrub, nitrogen fixation and barren-tolerant tree species.
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