Diversity and Growth Characteristics of *Eupatorium odoratum* and Local Plants in Invasive Communities

Jiangfei Qian[a], Jingtian Xu[b], Simengyu Li[c], NengQin Li[d] and Ruifang Wang*[e]

Pu'er University, Pu'er, Yunnan Province 665000, China

Keywords: Invasion, *Eupatorium odoratum*, Diversity.

Abstract: The invasion *Eupatorium odoratum* has become a key research in ecological protection and deployment. Puer located in the south of Yunnan in China, is bordered by Burma, Vietnam and Laos, and located at the frontier of the invasion *E. odoratum*. In Puer, *E. odoratum* can be found in abandoned land, wasteland edge, freeway, tea garden and many other places, threaten the biodiversity of border cities. In this study, the biomass, the specific leaf area, the diversity index and the species richness of *E. odoratum* and the local plants were measured. It is found that the invasive community mostly a single dominant community with only one species, *E. odoratum*. The local plants are difficult to survive. The main reason is that its higher biomass, larger leaf area than native species of *E. odoratum*, which leads to the difficulty of the growth of native plants. In this study, the growth difference between *E. odoratum* and native plants provided a theoretical basis for the control of *E. odoratum* and other invasive plants.

1 INTRODUCTION

Eupatorium odoratum, is a perennial, tufted herb or subshrub of the genus *Eupatorium* in the Compositae family. The whole plant of *E. odoratum* has a certain toxicity, very strong reproductive ability, rapid growth, and a wide range of ecological adaptability, small seeds. E. odoratum spreads easily through a variety of ways and scramble for water, fertilizer and other ecological resources with native plants. In addition, allelochemicals can be produced to inhibit the growth of native new plants, resulting in the weakening or even loss of biodiversity in a large area of the invasive area (Liu 2007, Hu 2007). E. odoratum in China have caused serious harm to agriculture, forestry, animal husbandry, as well as human and animal health (Jia 2020, Xue 2010). *E. odoratum* has the common characteristics of invasive alien plants. It competes and occupies the ecological niche of native species, affects the survival of native species, reduces species diversity, and makes great use of local water and soil nutrients, which is very detrimental to soil and water conservation. It destroys the nature and integrity of the landscape and affects the genetic diversity. After successful invasion, *E. odoratum* will grow wildly, which is difficult to control, resulting in serious biological pollution and serious damage to the ecosystem, and this damage is lasting andirreversible.

Although there are many researches on the biological characteristics and control measures of *E. odoratum* in China and abroad, the harm of *E. odoratum* has not been fundamentally solved (Zhang 2009). In addition to studying the biological characteristics of *E. odoratum*, the differences in growth characteristics between *E. odoratum* and native plants in invasive communities are also worth studying. Through the investigation and analysis of the plant community structure and the characteristics of plant species in the invasive sites of *E. odoratum*, the differences of growth characteristics between *E. odoratum* and other species were obtained, which provided a certain theoretical basis for better analysis of the mechanical research and control of *E. odoratum* invasion.

[a] https://orcid.org/0000-0002-7173-2132
[b] https://orcid.org/0000-0002-0013-2973
[c] https://orcid.org/0000-0002-4623-9178
[d] https://orcid.org/0000-0002-9399-2648
[e] https://orcid.org/0000-0003-4715-6240

Qian, J., Xu, J., Li, S., Li, N. and Wang, R.
Diversity and Growth Characteristics of Eupatorium odoratum and Local Plants in Invasive Communities.
DOI: 10.5220/0011186000003444
In *Proceedings of the 2nd Conference on Artificial Intelligence and Healthcare (CAIH 2021)*, pages 86-90
ISBN: 978-989-758-594-4

2 MATERIALS AND METHODS

2.1 Sample Plot Survey

Puer is located in the southwest border of Yunnan Guizhou Plateau and the south of Yunnan Province. The climatic conditions of Puer are favorable for the growth and reproduction of *E. odoratum*. This experiment, the choice pot is near downtown in puer tea college tea tree in the back empty abandoned farmland, wasteland, Buddha lotus hill road, plum lake forest edges, wash the landmark wetland wasteland, tourism circle near the desert, Ninger Jinbao Mountain, the sequence numbers for sample areI-VIII.

2.2 Sample Plot Setup and Sampling Method

The invasive areas with high distribution of *E. odoratum* were divided into three types: mild (*E. odoratum* coverage <5%), moderate (*E. odoratum* coverage 30%-40%) and severe (*E. odoratum* coverage over 90%).

Leaf area was calculated by paper pattern weighing.

Plant biomass is the amount of matter accumulated by plants per unit area (dry weight: g/m2).

Relative biomass = species/organ biomass/total biomass.

2.3 Simpson Diversity Index (D)

The Simpson diversity index is the probability that two randomly sampled individuals belong to different species, and its value is equal to 1 minus the probability that two randomly sampled individuals belong to the same species.

$$D = 1 - \sum_{i=1}^{s} P_i^{\,2}, \quad P_i = \frac{n_i}{N} \tag{1}$$

Where D is Simpson index, ni is the number of individuals of the ith species, the lowest value of Simpson index is 0, and the highest value is (1-1/S).

2.4 Shannon Wiener Diversity Index (Zhang 2006, Liu 1994)

$$H = -\sum_{I=1}^{S} P_i \log(Pi) \tag{2}$$

Where, Pi= Ni /N, represents the relative abundance of the ith species, N is the sum of the number of all species in the community, ni is the number of individuals of the ith species, and is the species trees in the community.

2.5 Pielou Evenness Index (Zhang 2006, Liu 1994, Liu 2006)

$$J_{sw} = H / H_{\max} \tag{3}$$

Pielou evenness index (Pielou evenness Index) reflects the evenness of species composition to a certain extent. It is the distribution of individual numbers of all species in a community or habitat.

2.6 Margale Species Richness Index (Liu 2006, Huang 2006)

$$D_{MA} = (s-1) / LnN \tag{4}$$

The Margale species richness index represents the number of species in a quadrat of a given size, ignoring the number of interspecific individuals

2.7 Community Similarity Coefficient (Liu 2006)

$$C = 2j / (a+b) \tag{5}$$

Where, C represents the community similarity coefficient, J represents the number of species in both communities, and A and B respectively represent the total number of species in the two communities.

2.8 Life Forms of Plants

According to the Danish ecologist Raunkaer C's life type classification standards. Species of a life form in the community/total species of plants in the community ´100%= percentage of a life form of a plant.

2.9 Biomass Allocation

Leaf weight fraction (LMF, leaf weight /aboveground plant weight); Specific leaf area (SLA, total leaf area / total leaf weight); Mean average leaf area (MLA, total leaf area / leaf number).

2.10 The Data Analysis

SPSS (23.0) software was used to analyze the differences among species diversity in invasive communities of *E. odoratum* and native local plants. Regression analysis and correlation analysis were performed for community biomass, evenness index and species richness index. Before the data analysis, the normal distribution test is carried out for all kinds of data.

3 RESULTS AND ANALYSIS

3.1 Species Composition of the Invasive Community

Human disturbance and light condition are two important factors to determine the composition of *E. odoratum* community. In the investigated plots, there were 5 species of plants, including *E. odoratum, Biden spilosa* L.*, Eupatorium adenophora* Spreng.*, Pantropical weeds* and *Camellia sinensis* (L.) O. Ktze*,* belonging to 3 families and 3 genera. *E. odoratum* was the main species, and was the only species in the 4th and 6th plots. Jia Guikang *et al*. found that after the successful invasion of *E. odoratum* (Jia 2010). It is easy to "overgrow" into dense forests, occupy the appropriate ecological niche, develop into a single optimal community, and compete for the limited living environment and soil nutrients of the surrounding local plants. The greater the coverage of *E. odoratum*, the lower the species richness. Some low-lying light- loving plants in the community did not grow well or even failed to grow due to the low utilization rate of light.

3.2 Diversity of Community Species

The species richness of the invasive community of *E. odoratum* was low, as the invasive community of *E. odoratum* caused serious damage to the species diversity of the community. The number of species in the quadrats was not more than 5, and the number of other species in the quadrats was not more than 4, except for *E. odoratum*. The number of species within each sample site was low, with the most being sample site 5 with four species, the species richness index did not consider the evenness of the distribution of species in the community, so the largest richness index was plot 2 (0.87), richness index of plot 4 and plot 6 was 0, and there was only one species, *E. odoratum*, in both plots. At the same time, the evenness index of both plots was the maximum infinity.

Table 1: Plant species diversity and evenness indices.

SP	S	R	S_1	SW	E
I	2	0.36	0.30	0.21	0.30
II	3	0.87	0.56	0.41	0.38
III	2	0.43	0.42	0.27	0.38
IV	1	0.00	0.99	0.10	∞
V	4	0.17	0.70	0.50	0.40
VI	1	0.00	0.98	0.12	∞
VII	3	0.59	0.47	0.36	0.32

(SP: Sampling plot, S: Species number, R: Richness index, S_1: Simpson index Simpson, SW: Shannon-Wiener index Shannon-Wiener, E: Evenness index)

In terms of the life pattern of *E. odoratum* invasive communities, the proportion of highbudding plants was the largest. Except for plot 7, the proportion of highbudding plants in other plots was as high as 100%, and the proportion of highbudding plants in plot 7 was as high as 87%. In the rest, only the proportion of groundbudding plants was 13%. The composition of community life patterns reflected the characteristics of warm and wet growing season in the area where *E. odoratum* invasion communities were located. In addition, it also reflected the degree of disturbance in the community to a certain extent. The larger the proportion of highbud plants, the lower the degree of disturbance.

3.3 Similarity Coefficient

The community similarity coefficient as a measure of similarity between different habitats (table 2), the results showed that *E. odoratum* invasion community similarity is higher, the sample area 6 to 4 with the sample up to 1, the two pieces in the sample area are only *E. odoratum* a species, the lowest also reached 0.33, *E. odoratum* founded after the invasion of community, the species composition and more focused, less The species composition of communities in different plots was similar to each other.

Table 2: Similarity coefficients.

SP	1	2	3	4	5	6	7
I		0.40	0.50	0.67	0.33	0.67	0.40
II			0.80	0.50	0.86	0.50	0.33
III				0.67	0.67	0.67	0.40
IV					0.40	1.00	0.50
V						0.40	0.29
VI							0.50

3.4 Biomass Allocation

Previous studies have shown that the higher the total leaf area of exotic species is, the more carbon it can capture through assimilation under the same light and radiation conditions, and the more favorable it will be for plant morphogenesis and biomass accumulation. According to table 3, in terms of total leaf area, average single leaf area and average specific leaf area of various plots, plot 5 had the largest total leaf area, but smaller mean single leaf area and specific leaf area compared to other plots.

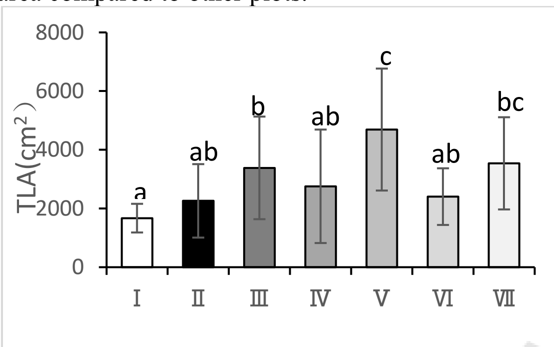

Figure 1: Total leaf area (TLA) of seven sampling plots.

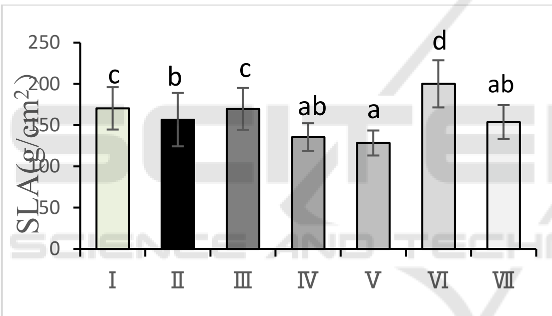

Figure 2: Specific leaf area (SLA) of seven sampling plots.

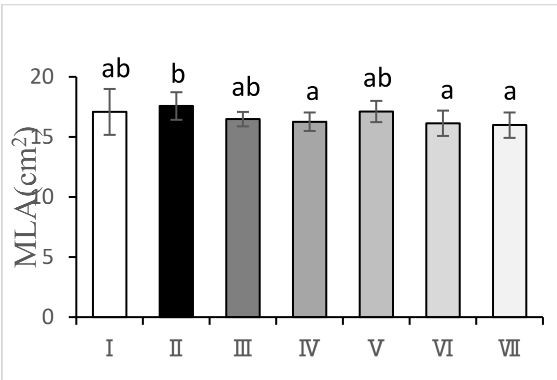

Figure 3: Mean single leaf area (MLA) of seven sampling plots.

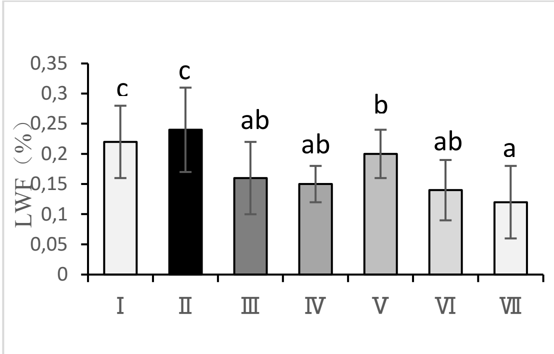

Figure 4: Leaf weight fraction (LWF) of seven sampling plots.

Generally, within the same community or individual, the greater the SLA the greater the photosynthetically capacity. One-way ANOVA data (Figure 2) showed that the greatest difference in SLA was between sample plot 5 and sample plot 6, mainly because sample plot 5 was a wetland edge heathland with significantly better soil fertility and moisture content than sample plot 6 forest edge heathland, which provided a better growing environment for *E. odoratum*. Leaf area is closely related to plant photosynthesis. The greatest difference in TLA was between sample plot 1 and sample plot 5, with little difference in MLA, the smallest being sample plot 7 and the largest being sample plot 2. The LMF values between 0.12 to 0.24 for seven sample plots.

4 DISCUSSION AND CONCLUSION

The invasion of exotic plants can affect the local ecosystem. They compete with native plants for limited living space, water and fertiliser, light and air, threatening the survival and distribution of local plants, and changing the species composition and climatic conditions of the original local plants, thus causing a sudden reduction in local biodiversity. This impact and damage are lasting and prolonged. Currently, *E. odoratum* has occupied most of the area near the urban areas of Puer, mainly in fields, ground, abandoned wasteland and other land types, where the renewal and growth of forest trees are affected.

In this study, the communities invaded by *E. odoratum* were mainly composed of compositae, among which there was only one species of *E. odoratum* in two sample plots, forming a patch of *E. odoratum* community, with a large number of individual *E. odoratum*, large projection area, large biomass and strong survival ability. When *E. odoratum* plants were taller than or equal to 15cm, they could inhibit the growth of other herbs in the community through shading, which seriously damaged the local biodiversity. In addition, the allelopathic effects of *E. odoratum* make it impossible for local plants to survive in the invaded areas.

There have been many reports on the morphological characteristics, biomass allocation and photosynthetic characteristics of *E. odoratum* in response to light, water, phosphorus and nitrogen nutrition. However, there are few reports on the community invasiability. Therefore, the effects of comprehensive environmental factors on community invasibility should be considered in the further studies.

ACKNOWLEDGEMENTS

This work was supported by the National Natural Science Foundation of China (31660170) and Outstanding Young Teacher program (2020GGJS006).

REFERENCES

Jia Guikang, Xue Yuegui. The damage and control of invasive plant plane grass on the ecosystem[J]. Weed Science,2010(4):12-15.

Liu J, Hu ZQ. Species composition and diversity of molluscs in the middle reaches of the Xiangjiang River [J]. Journal of Ecology, 2007, 27(3):1153-1160.

Liu JH, Huang BZ, Luo FC. Introduction to the hazards and control measures of plane grass [J]. Grassland Science, 2006.

Liu Qiufeng, Kang Muyi, Liu Quanru. Quantitative classification and environmental interpretation of forest tree species in the mixed gorge region of Zhongtiao Mountains [J]. Journal of Plant Ecology, 2006, 30(3):383-391.

Mark P., Liu Y. M. Methods for measuring the diversity of biological communities: Methods for measuring diversity (below) [J]. Biodiversity, 1994, 2(4):231-239.

National Ming, Zhang Jiaen, Xu Huaqin, Mao Danjuan, Xie Junfang. Biological characteristics and control strategies of the invasive alien plant plantain [N]. Chinese Agronomy Bulletin, 2009, 25(09):236-243.

Zhang Jiaen. Common experimental research methods and techniques in ecology [M]. Chemical Industry Press, 2006.