The Diversity and Natural Enemies of *Eupatorium adenophorum* and Native Plants

Jiangfei Qian[1][a], Tianyu Li[1][b], Lidan Mu[1][c], Yuankai Xia[1][d], Qing Ji[1,2,*][e] and Ruifang Wang[1,2,*][f]

[1]*College of Agriculture and Forestry, Puer University, Puer, Yunnan, 665000, China*

[2]*Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Mengla 6663, China*

Keywords: *Eupatorium adenophorum*, Diversity, Biocontrol.

Abstract: The diversity and natural enemies of invasive *Eupatorium adenophorum* in invaded areas were investigated in border city in Yunnan Province. The results showed that *E. adenophorum* affected the growth of accompanying plants through shading. Because the plant richness was greater in Menghai and Ninger in dry season, thus the inhibitory effect of *E. adenophorum* on native plants was lower, while opposite in Baoshan. Aphids can feed on *E. adenophorum*. Therefore, it is hopeful to find biocontrol organisms in Yunnan.

1 INTRODUCTION

Eupatorium adenophorum is an ornamental plant, native to Mexico and Costa Rica in Central America. It has been introduced as an ornamental plant to Europe, Oceania and Asia, and is widely distributed in more than 30 countries and regions in the tropical, subtropical and temperate regions. In the early 1950s, *E. adenophorum* was introduced into southern Yunnan Province from the border between China and Myanmar, and has caused serious harms (Yang 2003). A large number of studies have shown that E. adenophorum has a high allelopathic potential, and its allelopathic effect has a great influence on most plants to achieve the purpose of invasion (Liu 2018). In this study, the community composition and natural enemies of E. adenophorum in invaded border cities in Yunnan Province were investigated. We try to learn more about the invasive mechanisms and look forward to find biocontrol organisms of E. adenophorumin Yunnan.

Biological control, can be broadly divided into three categories: insect, bird and bacteria control. It is a way to reduce the population density of pests such as weeds and pests. Biological control is a pollution-free, low-cost, non-resistant, long-lasting prevention and control methods. Using biological control methods is hopeful (animals, plants and microorganisms, etc.), such as native generalist enemies, to control the population density of *E. adenophorum* under the level of ecological and economic hazards of the anti-removal method.

The control of *E.adenophorum* has been under much research since 2003, when it was listed as the first invasive alien species in China, published by the State Environmental Protection Administration and the Chinese Academy of Sciences. There are some good prevention and control methods, but it is difficult to achieve large area control. So until now, *E.adenophorum* has not been well controlled.

Procecidochares utilis is a special predatory predator of *E.adenophorum* that can hinder the growth and reproduction of *E.adenophorum*, which has been studied both at home and abroad. China introduced P. utilis from the 1980s. P. utilis crossed the Himalayas into Tibet, and then from Tibet into Yunnan and gradually spread to Sichuan, Guizhou and other places. Although its natural enemy P. utilis

[a] https://orcid.org/0000-0002-7173-2132
[b] https://orcid.org/0000-0002-2807-1172
[c] https://orcid.org/0000-0002-4334-698X
[d] https://orcid.org/0000-0002-5137-0242
[e] https://orcid.org/0000-0002-4126-7137
[f] https://orcid.org/0000-0003-4715-6240

Qian, J., Li, T., Mu, L., Xia, Y., Ji, Q. and Wang, R.
The Diversity and Natural Enemies of Eupatorium adenophorum and Native Plants.
DOI: 10.5220/0011280900003443
In *Proceedings of the 4th International Conference on Biomedical Engineering and Bioinformatics (ICBEB 2022)*, pages 729-733
ISBN: 978-989-758-595-1

have been introduced to prevent and control *E. adenophorum*, the *E. adenophorum* population has not been effectively controlled.

The adaptability and competitiveness of *E. adenophorum* make it possible to quickly form a single-advantaged community and spread wildly in south China, bringing harm to native plants, animals and even humans, and causing great losses to agriculture, ecology and economy (Wan 2011). Facing the increasingly serious problem of *E. adenophorum*, the current control method is inefficient and expensive, how to use effective means to control the expansion of *E. adenophorum* should be the main topic of future research. According to Wang Yongda et al., there are mainly ecological engineering methods, biological control methods, chemical control methods and mechanical control methods (Zhou 2009). For example, it can be developed other values, use it as feeding through fermentation and detoxification, and make use of it to manufacture fiberboard and biogas. Artificial, mechanical and chemical control methods,
combined with ecological control measures, should be used to prevent the invasion of *E.adenophorum*, so as to achieve the purpose of replacing economic plants. Not only that, there are many uses of *E.adenophorum*, which is not a few research. For example, it can kill animal parasites, be developed as raw material for animal feed, and have analgesic effect on wounds caused by acetic acid, etc.

E.adenophorum can be damaged by manual or mechanical means . Although this method is simple, but it costs labor and time, and the terrain is difficult to implement. It is advisable to the local area with light harm and the newly introduced area, but not feasible to the area with serious harm. This method is hard to be applied in a wide range because of its high labor intensity and low labor efficiency. After elimination in this way, the initiation of soil residual roots and the colonization of new seedlings make the success rate not high. Due to the complexity of its habitats, where *E.adenophorum* occurs, such as steep slopes, sporadic edges, arable land and under open forest, etc., it is mechanically controlled are very limited (Liu 1985).

Numerous studies have shown that the plant has a high allelopathic potential, and its allelopathic effects affect most plants such as Eucalyptus robusta Smith, Pinus yunnanensis Cunninghamia lanceolata, etc. Thus the extracts had strong fumigation activity against four kinds of stored grain pests, such as rice weasels, maize weasels, mung bean weasels and vata bean weasels. After being fumigated at 44.44 mg/L for 48 h, the mortality rate of each adult insect reached 100%. The results of fumigation showed that the LC50 of *E.adenophorum* extract against the four kinds of adults were 14.65, 12.80, 25.07 and 12.20 mg/L for 24 h, and the semi-lethal dose for 48 h were 11.79, 9.67, 13.29 and 9.76 mg/L, respectively.

Although several natural enemies have been found and damaged on *E. adenophorum* in invaded areas (Zhao 1989, Xiang 1991, Wang 2002), such as Dihammus argentatusye, which can eat *E.adenophorum*, has also been found locally in Wales, Australia, and aphids have also been found to be able to pick up purple stalks, and microbially, Cercospora is also a candidate for the control of *E.adenophorum*, we we don't know is there any natural enemy that can control this plant in the bio rich Yunnan.

The purpose of our survey was to prepare for the search of natural enemies of *E.adenophorum*, mainly by investigating the diseases and insect pests of *E.adenophorum* in different habitats in Yunnan province. Through the investigation of the habitat, diseases and insect pests of *E.adenophorum*, a better foundation is laid for the control of *E.adenophorum*, so as to control its expansion as soon as possible, prevent *E.adenophorum* from seizing the living space of other species, destroying ecological balance and destroying biodiversity .

2 MATERIALS AND METHODS

2.1 Sample Site and Survey Method

The selection was made at four different locations in Yunnan Province: Ninger, Jiangcheng, Menghai and Baoshan. Ninger, Jiangcheng in Pu'er City (between 22°02′～24°50′ N, 99°09′～102°19′ E) belongs to the subtropical monsoon climate, the average annual temperature in 10℃～13℃, the average monthly temperature between 18℃～25℃, the light and heat conditions are good, year-round frost-free, winter without cold, summer without heat. The altitude is between 376 and 3306 meters, with annual rainfall of 1100～2780 mm. With mountain, hilly, valley, basin and other types of landscape, it is an important area of biodiversity protection in China. Menghai is located in Xishuangbanna, Xishuangbanna is located in the southernmost tip of Yunnan Province, the China, located at about 21°10′ north latitude, 99°55′ ～101°50′ east longitude, is a tropical humid area south of the Northern Regression Line. Baoshan, Yunnan Province, located in the southwest of Yunnan Province, 98°25′～100°02′ east longitude and 24°08′

～25°51′ north latitude, is a low-latitude mountain subtropical monsoon climate, due to its location in the low-latitude plateau, the terrain is complex. Climate types are North Tropical, South Asia Tropical, Central Asian Tropical, North Subtropical, Southern Temperate, Mid temperate and Plateau climate a total of 7 climate types. Because of its border with Myanmar, it was considered to be the only way that *E. adenophorum* invaded.

Sampling survey was carried out in four different sites in Yunnan Province, and 3-4 were selected from 3-4 directions in each place to investigate *E. adenophorum* and native accompanying in the respectively. Then 5 plants were randomly selected from *E. adenophorum* and 10 leaves were selected from the second functional leaf to measure their damaged area. The same method was used for each accompanying to select 5 leaves from each plant to measure its damaged area.

2.2 Plant Diversity

2.2.1 Species Richness Index (Yu 2005)

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

Species richness index indicates the number of species in a certain size, ignoring the number of individuals between species.

2.2.2 Simpson Diversity Index (D)

Simpson's diversity index is the probability that two sampled at random belong to different species, which is equal to 1 minus the probability that two sampled at random belong to the same species.

$$D = 1 - \sum_{i=1}^{s} P_i^2 \ , \ \ \mathrm{P_i} = \mathrm{n_i}/\mathrm{N}$$

In the formula, 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).

2.2.3 Shannon-Wiener Diversity Index (Yu 2005, Zhang 2006)

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

In the form, Pi-ni/N represents the proportion of individuals belonging to the ith species in the sample, N is the sum of the number of all species, ni is the number of individuals in the ith species, and S is the number of species in the community.

Table 1: Species diversity in dry season.

SN	Jiang cheng	Ning er	Bao shan	Meng hai
SN_1	14.7±3.8	5.3±0.9	4.0±0.6	7.3±0.7
RI	0.0±0.0	0.0±0.0	0	0.0±0.0
SI	0.8±0.4	0.7±0.2	0.8±0.0	0.0±0.0
SW	2.9±0.4	2.1±0.0	2.4±0.2	2.7±0.2
EI	1.1±0.1	1.4±0.2	1.8±0.1	1.4±0.1

(SN: Sample name, SN1: Species number, RI: Richness Index, SI: Simpson index, SW: Shannon Wiener, EI: Evenness index,the same as below.)

Table 2: Species diversity in rainy season.

SN	Jiang cheng	Ning er	Bao shan	Meng hai
SN_1	15.7±1.5	14.0±1.2	11.0±2.1	14.0±1.5
RI	0.9±0.0	0.9±0.0	0.9±0.0	0.9±0.0
SI	0.9±0.0	0.9±0.0	0.9±0.0	0.9±0.0
SW	3.6±0.6	3.6±0.1	3.8±0.1	3.7±0.1
EI	1.3±0.1	1.9±0.1	1.6±0.1	1.4±0.1

Table 3: The plant height and damaged ratio.

S	Sample name	Plant	Height (cm)	Damage ratio (%)
DS	Baoshan	1 (N=3)	103.05±5.76	7.72±0.88
		2(n=9)	68.70±36.67	13.13±2.84
	Menghai	1 (N=3)	138.85±8.02	6.46±1.16
		2(n=10)	115.44±21.48	16.81±4.02
	Ninger	1 (N=4)	86.9±6.26	8.36±2.16
		2 (n=13)	71.29±12.66	9.14±2.22
RS	Baoshan	1(N=3)	122.93±11.57	11.45±1.83
		2 (n=4)	52.35±27.67	13.18±5.67
	Menghai	1(N=3)	126.33±9.23	6.54±1.63
		2 (n=5)	122.13±37.43	4.11±3.59
	Ninger	1(N=4)	118.00±5.78	8.4±1.26
		2 (n=5)	106.50±14.40	8.06±7.61

(SE: standard error, 1: *E. adenophorum*, 2: Native paints, S: season,DS: dry season, RS: rainy season)
(N represents the number of repeat value in the sample plot of *E. adenophorum*, and n represents the number of repeat value in the sample plot of native plants.)

2.2.4 Pielou Evenness Index (Liu 1994)

$$J_{sw} = H / H_{\max} \ H_{\max} = Ln(s)$$

The Pielou Uniformity Index, which partly reflects the uniformity of genus composition, is the distribution of the number of individuals of all species in a community or habitat.

2.3 Results and Analysis

Independent sample T-test was carried out on the comparison between invasive *E. adenophorum* and its native accompanying plants in the richness, uniformity, Simpson index, plant height and damaged ratio.

3 RESULTS AND ANALYSIS

3.1 Species Diversity

Table 4: Representative native plants.

The Latin name	Familia	Genus	Number
Bidens pilosa L	Asteracea	Bidens	614
Ageratum conyzoides	Asteracea	Ageratum	259
Eupatorium odratum L	Asteracea	Eupatorium	205
Oplismentls undulatifolius folius	Gramineae	*Oplismentls*	473
Armgrass	Gramineae	*Oplismenus*	469
Digitaria sanguinalis (L.) Scop.	Gramineae	*Digitaria*	379
Desmodium racemosum Thunb	*Leguminosae sp.*	*Desmodium* Desv	166
Lespedeza cuneata (Dum.Cours.) *G.Don.*	*Leguminosae sp.*	*Lespedeza* Michx.	40
Indigofera spicata Forssk	*Leguminosae sp.*	*Indigofera* L	31

(In this table, we selected three representative plants of Compositae, Gramineae and Legume that have the largest number of associated plants in *E.adenophorum*. orchid community)

The accompanying plants most in three families: Compositae, Gramineae and Legume, while there were only 3-5 species in other families. According to the survey, Bidens pilosa L has the largest number. The second is Ageratum conyzoides, which has a strong growth capacity and has a large density in the sample. There are 16 accompanying species of Gramineae. The most abundant are O undulatifolius folius, Armgrass, Digitaria sanguinalis (L.) Scop and Imperata cylindrica (Linn.) Beauv.

Species richness of *E. adenophorum* was very low, and species diversity of *E. adenophorum* was relatively uniform. It has an inhibitory effect on the growth of other plants and seriously damages the biodiversity of the community. Jiangcheng had the highest number of species. Overall, there are more plant species in the rainy season than in the dry season and plants species richness is uniform.

3.2 The Plant Height and Damaged Ratio

In the dry season, the plant height of *E. adenophorum* in Baoshan was higher than that of the native plants, and the damage was lower than that of the native plants. There was no significant difference between *E. adenophorum* and native plants in Menghai and Ninger. Therefore, it is expected to find the natural enemies of *E. adenophorum* in Menghai and Ninger.

During the rainy season, there was no significant difference in the damage of *E. adenophorum* and native plants. By comparing the difference of the damage in the dry season with that in the rainy season, the insects in the rainy season had a certain selectivity to the plant feeding of *E. adenophorum* community.

3.3 Natural Enemies

Figure 1. *E. adenophorum* and enemies.

Brevicoryne brassicae feeding on *E. adenophorum* and can survive. In addition, other natural enemies, such as Psychomyiidae, Fruticicolidae were all found herbivory on *E. adenophorum.*

4 DISCUSSION AND CONCIUSIONS

The three most abundant accompanyingin *E. adenophorum* community are compositae, legumes and gramineae. *E. adenophorum* crowded out the plants through severe shading especially in rainy season.

As the history of *E. adenophorum* invasion lengthened, native insects began feeding on *E. adenophorum* Studies have shown that there are 168 species of local insects in the invasive community of *E. adenophorum*, which play a certain role in resisting the invasion of *E. adenophorum*. In this study, several natural enemies were found to feed on *E. adenophorum*. It is possible to find biocontrol organisms in Yunnan Provinces.

ACKNOWLEDGEMENTS

This work was supported by the National Natural Science Foundation of China (31660170), Yunnan Fundamental Research Projects (grant NO. 202101AU070030) and Outstanding Young Teacher program (2020GGJS006).

REFERENCES

He Yongfu, Yu Li, Lu Deqing, etc. The current situation of prevention and control research in purple stem Zelan[J]. Guizhou Agricultural Science, 2005, (S1): 50 - 52.

Liu Jiming, Chen Jingzhong, Sun Yungang etc. Effects of water extracts from leaves of E. adenophorum. On seedling growth and chlorophyll allelopathology of seven native plants [J/OL]. Botany of Guangxi: 1-11 [2018-10-18].

Liu Lunhui, Xie Shouchang, Zhang Jianhua. A study on the distribution, damage and control strategy of E. adenophorum in China [J]. Ecology, 1985,5 (1): 1-6. (in Chinese)

Ma Keping, Liu Yuming. Biodiversity Science, 1994, 2 (4): 231-239.

Wang Jinfeng. Geographical distribution and harm of E.adenophorum and its related varieties [J]. Sichuan Grassland, 2002, (2): 49-60. (in Chinese)

Wan Fanghao, Liu Wanxue, Guo Jianying, et c. Research progress on invasion mechanism and control strategy of alien plant Eupperm adenophorum [J]. Scientia Sinica Life Sciences, 2011,41 (01): 13-21. (in Chinese)

Xiang Yexun. Distribution, damage and control of E. adenophorum [J]. Weed Science, 1991, (4): 10-11. (in Chinese)

Yang Rongxi. A serious invasive alien plant -- Eupperm adenophorum [J]. Chinese Journal of Biology, 2003, 38 (1): 20-21.

Zhou Zhongkui. Control and utilization of Euphorum adenophorum [J]. China Forestry, 2009, (15): 53.

Zhao Guojing, Ma Yunxiang. Investigation on the distribution and damage of E.adenophorum in Yunnan Province [J]. Chin J Weed Sci, 1989,3 (2): 37-40. (in Chinese

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