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Research Article

# The Interspecific Interaction Mechanism of Plant Diversity Affecting Alien Species Invasion

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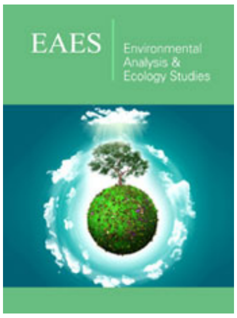


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## Abstract

Interspecies interaction is the basis link among different plants. However, plant interaction has not been pay more attention in many studies of plant diversity-invasibility relationship. In this study, artificial plant communities with different diversity gradients (1, 2, 4 and 8) were established. Two comparative experimental blocks were established with changing the distribution of invasive plants and native plants, i.e., the staggered and non-staggered distribution. The results showed that species richness and functional group richness were significantly negatively correlated with the biomass of *S. Canadensis* under staggered distribution, while there was no significant relationships under non-staggered distribution. The interspecific competition intensity of *S. Canadensis* under the staggered distribution was significantly stronger than that under the non-staggered distribution. The results showed that the distribution pattern of native and invasive plants may be an important factor affecting the resistance of plant diversity to invasion of alien plants.

**Keywords:** Species richness; Functional groups; Solidago canadensis; Invasion; Interspecific interaction

## Introduction

Due to serious threat of biological invasion to ecosystem functioning and human health [1,2], Community invasibility has received more and more attentions [3]. Competition is considered to be the main interspecific interaction between native and invasive plants [4]. Effect of plant diversity on invader through interspecific interaction between native and invasive plants at neighborhood scale [5-7]. Therefore, the small-scale spatial structure of species will certainly affect interspecific interaction. Bufford et al. [8] found that the resource competition of native plants around invasive plants had an important impact on the growth and reproduction of invader in the Hawaiian lowland community. Stoll & Prati [9] found that the aggregation of of same species can reduce the pressure of interspecific competition, and lead to the survival of less competitive species. Therefore, the different distribution patterns of plant species may change the impact of native plant communities on invasive plants.

In this study, we construct native plant communities with different species richness and control competition intensity between native plants and invasive plants by change species distribution patterns.

We address two questions:

A. Does change of species distribution pattern change intensity of interspecific competition between native plants and invasive plants?

B. Whether change of interspecific competition intensity change the richness-invasibility relationship?

## Materials and Methods

Eight native species grow in area around Taizhou city (*Plantago asiatica L., Solanum nigrum L., Cirsium setosum (Willd.) MB., Kalimeris indica L., Lysimachia fortunei Maxim., Inula japonica Thunb., Polygonum caespitosum BL. and Viola japonica Thunb*) were selected, and *Solidago canadensis L.* were selected as invader. Pots (40cm diameter and 28cm height) with different species richness (1, 2, 4 and 8) were established by randomly selected from eight native species. Sixteen native plants were set in each plot, and the number of each species was divided equally according to the species richness to ensure the cross distribution of different species. Weeding and watering were carried out regularly to maintain original composition. According to the above experimental design, two blocks (control and invasion) were established. In the invasion block, the staggered (Figure 1B) and non-staggered (Figure 1A) distribution treatments of *S. canadensis* (four plants) were constructed. In September 2017, plant biomass was harvested, separated by species, dried at 80 °C for 48h, and weighed. During the experiment, plant height and coverage of each plant in each pots were measured four times.

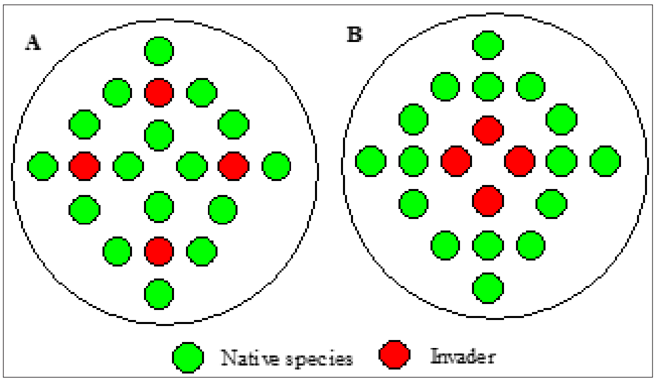


**Figure 1:** Distribution of native and invasive plants.
A: Staggered distribution
B: Non-staggered distribution

### Data analysis

Growth index of *S. canadensis* was reflected by the product of plant height and coverage. Interspecific competition index (ICI) was calculated by the following formula:

$$\text{ICI} = \left(B_W - B_0\right)/\left(B_W + B_0\right)$$

$B_0$: plant biomass in monoculture; $B_W$: plant biomass in mixture.

The average value of interspecific competition index of all species in community represents interspecific competition intensity of the community.

Linear regression was used to analyze the effects of species richness on the biomass and growth potential of S. canadensis. Paired sample t-test was used to analyze the difference of interspecific competition intensity between staggered and non-staggered distribution treatments. Spss20.0 software was used for data analysis.

## Result

Biomass of invader was negatively correlated to the species richness in staggered treatment (Figure 1) (r = -0.399, n = 51, P = 0.005) but had no significant relationship (r = - 0.153, n = 35, P = 0.358) (Figure 2).

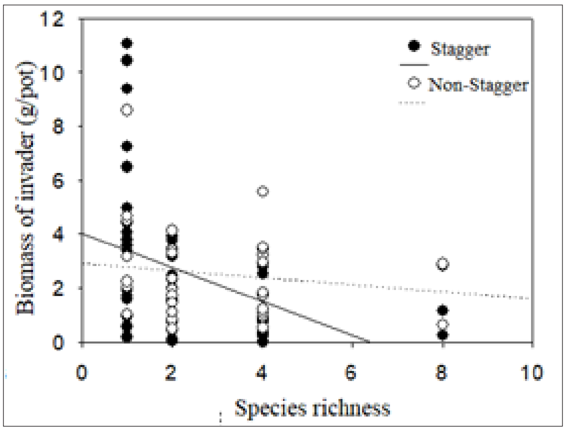


**Figure 2:** Effects of species richness on biomass of invader under different distributions.

Growth index of *S. Canadensis* under staggered distribution was significantly lower than that in non staggered distribution (Figure 3, in all four times P <0.05). Moreover, at the third time (r = -0.280, n = 51, P = 0.047) and fourth time (r = -0.376, n = 51, P = 0.007), species richness was negatively correlated to the growth index of *S. Canadensis* under stagger distribution.

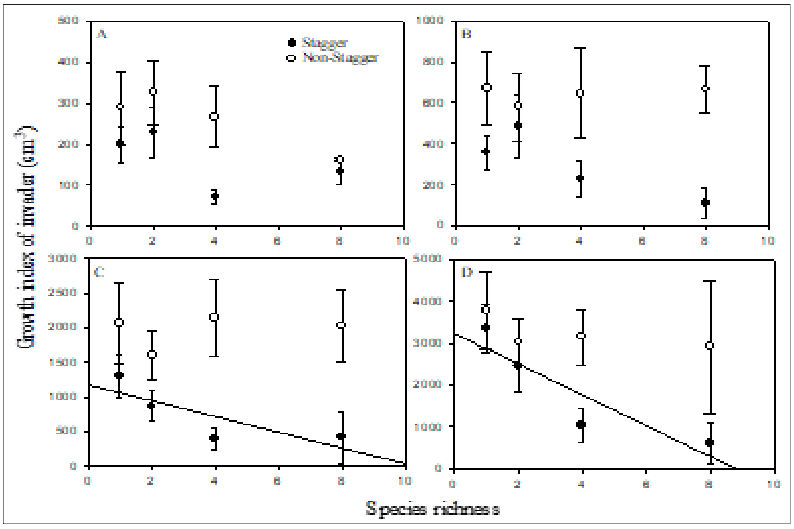


**Figure 3:** Growth index of S. Canadensis under different distributions.

There was no significant difference in the competition coefficient between staggered and non-staggered communities in the control group (t = 0.979, n = 51, P = 0.332). However, in the invasion group, the competition coefficient of staggered distribution was significantly lower than that of non-staggered distribution (Figure 4) (t = -5.051, n = 51, P < 0.001). There was no significant difference in interspecific competition coefficient between species richness and functional groups (P > 0.05).

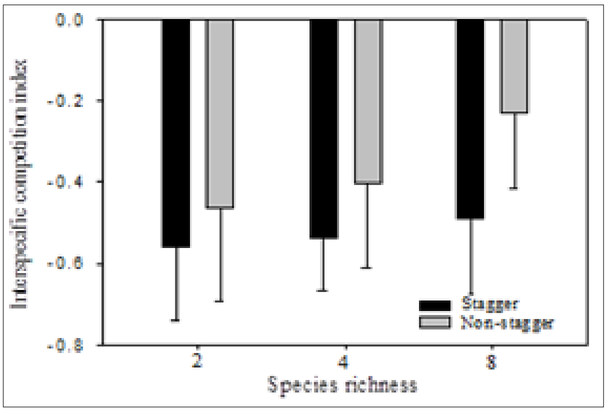


**Figure 4:** Interspecies competition index under different distributions.

## Discussion

Results showed that distribution pattern of *S. canadensis* changed the species richness-invasibility relationship, which indicate that species distribution pattern may be a potential factor that affects species richness-invasibility relationship. Consistent with the results of Stoll & Prati [9], interspecific competition intensity between S. canadensis and native plants under staggered distribution was significantly lower than that under non-staggered distribution. Effect of plant diversity express through the interspecific interaction [6,7]. When *S. canadensis* was staggered distribution, competition effect of plant diversity cannot be expressed through neighbor interspecific interactions, and lead to no significant relationship. Consistent with the result of Bufford et al. [8], the growth inhibition of native plants on *S. canadensis* was stronger under staggered distribution but had no significant effect under non-staggered distribution.

Moreover, we also found, under the non-staggered distribution, the inhibition of species diversity on invasion was more obvious with the extension of time. Therefore, we speculate that the inconsistent species richness-invasibility relationships of prior studies may be due to the different distribution patterns of invader, which affect competition intensity of native plants. This study provides an theoretical explanation for the debate of species richness-invasibility relationship.

## Acknowledgement

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