Is sap thicker than water? Examining the effects of relatedness on competition

CHICAGO BOTANIC GARDEN
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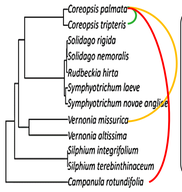
Introduction

- Since 1830, there has been a decline in tallgrass prairie ecosystems. Less than 1% of the Illinois land area previously covered by prairie remains today[1]. Prairie restoration has therefore become a priority to preserve this endangered ecosystem and dependent species
- One consideration when planning prairie restorations is *phylogenetic diversity* (PD)[2]. The more distantly related the individuals in a community are, the higher a community's PD. High PD is desirable because it has been linked to increased biomass[3] and resistance to invasion[4].
- High PD is linked to these ecosystem functions because more closely related species are more likely to share similar *functional traits*[5], which help determine a species' niche. Distantly related species in a high PD prairie may conversely lead to niche complementarity and facilitation. Here, we investigate this relationship to ultimately improve restoration planning[2].

Hypotheses

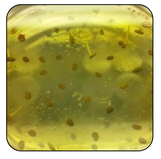
1. More closely related prairie plant species will experience greater competition than more distantly related species.
2. Plants grown in more stressful (sand) conditions will compete more heavily for resources than plants grown in benign (soil) conditions.

Methods



Experimental Design

- We tested prairie plant competitive interactions directly in a greenhouse experiment.
- We measured the growth success of 16 focal species when grown alone, with itself, or with a closely, intermediately, or distantly related species in soil and sand over a period of 7 weeks.



Plating

- The seeds were cold stratified as needed.
- We plated 50 seeds per petri dish.
- We then incubated the seeds in warmer temperatures until germination.

Planting

- Once germinated, we planted the seeds according to their phylogenetic and soil type treatment.
- We put the seedlings in the greenhouse at CBG.

Measurements

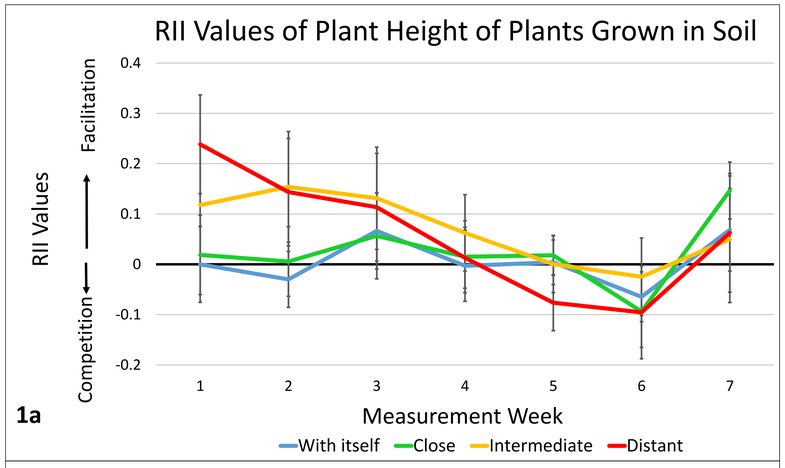
- We measured the height, number of leaves, and length and width of the largest leaf of every plant on a weekly basis.
- We used these measurements to calculate a competition index, Relative Intensity of Interaction (RII).

Analysis

- We quantified competition by comparing the growth of the phylogenetic relatedness treatments to the growth of the plants grown alone using RII.
- We compared these data between soil types.
- We used t-tests and ANOVAs to determine significance.

Results

- We found no significant difference in competition between levels of relatedness for height, number of leaves, and length and width of the largest leaf in either soil or sand during all measurement weeks (Fig. 1a and b, ANOVA $p>0.14$).
- We found a significant difference in competition between benign and stressful conditions for height and number of leaves in the second week (t-test $p<0.031$).
- Although plants in the stressful environment were significantly smaller (t-test, $p<0.017$), all other analyses that tested the degree of competition between soil and sand in a single week were not significant (t-test, $p>0.08$)



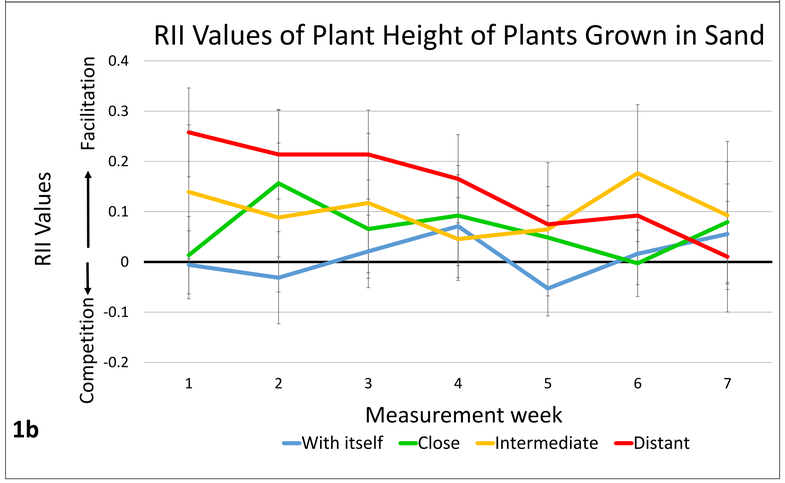


Figure 1: a) RII values for height of plants grown in soil. **B**) RII values for height of plants grown in sand. More closely related species did not experience more competition than more distantly related species. There were no significant differences between data points. Error bars are standard error.

Discussion

- The lack of significant differences indicates that relatedness does not have an effect on competition between prairie plant species.
- The significant differences found between benign and stressful conditions are not part of a larger trend, and so there is no significant effect on competitive interactions. This indicates that our stress treatment did not lead to stronger competitive interactions than benign conditions.
- These findings are in contrast to previous literature, which found that phylogenetic diversity impacted competitive interactions[5].
- Non-significant results could be due to the following:
  - Our study used relative measures of phylogenetic diversity instead of absolute distance between species, which may be a better predictor of competition.
  - Above-ground measurements do not quantify the likely important competitive interactions below ground.
  - Our ultimate metric will be above- and below-ground biomass, which may be important to measuring competitive interactions.
- Though phylogenetic diversity is important in successful communities, our results do not show that this is due to the level of competitive interactions that occur between more closely related species. There may be other processes involved, such as niche complementarity, that explain why phylogenetic diversity is important in successful communities.
- Further research is necessary to determine if absolute phylogenetic distances more accurately predict competitive interactions and to determine if competition is more intense below ground.

Conclusion

1. The level of relatedness of prairie plant species does not have an effect on the intensity of the competition they experience.
2. Plants grown together in stressful conditions do not compete more heavily for resources than plants that are grown together in benign conditions.

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