Competitive Exclusion Between *Echinacea angustifolia* and *Echinacea purpurea*

Nina Denne, Illinois Mathematics and Science Academy

Advisor: Dr. Stuart Wagenius, Chicago Botanic Garden

How does competitive exclusion affect *Echinacea angustifolia* and *Echinacea purpurea*?

The potential impacts of future invasive species in habitat restorations and preservations can be better understood through examining the effects of a non-native species in a remnant prairie plant community. This study will accomplish this through testing the competitive exclusion principle, creating an environment where *Echinacea purpurea* and *Echinacea angustifolia*, a non-native species and a native species, are competing directly for resources, and will measure the height of the seedlings of these two species when they are grown together. Over the course of the investigation, *E. angustifolia* and *E. purpurea* seedlings were planted in three levels of treatment: individual *E. angustifolia* seedlings, individual *E. purpurea* seedlings, and *E. purpurea* and *E. angustifolia.* There were also varying density levels of these species. Based on preliminary data, *E. purpurea* seems to grow shorter in mixed treatments, while *E. angustifolia* seems to grow taller in mixed treatments. Currently, 259 total seedlings across 189 pots are being measured, 206 of which are *E. angustifolia* and 53 of which are *E. purpurea*. This study seeks to test the competitive exclusion principle between *E. angustifolia* and *E. purpurea*, which will provide insight into their behavior in other competitive settings.

Echinacea

- This genus is commonly known as the purple coneflowers
- Part of the daisy family, and this genus is found only in North America
- *Echinacea angustifolia* native to Minnesota, while *Echinacea purpurea* considered non-native
- This study seeks to test the competitive exclusion principle, which states that one species will naturally outcompete another.
- There are 259 individual seedlings in this experiment, across 189 pots. Their growth and mortality rate was measured over the course of 5 weeks.

Figure 1. Right: After undergoing germination treatment, seedlings began to sprout cotyledons in the petri dishes.

Methods

- Achenes were weighed to assess fullness, and to determine the amount of seeds to germinate. Seeds entered standard pre-germination treatment and a germination treatment.
- Once the seeds germinated, they were planted into conetainers. The conetainers either contain only individuals of a single species, or individuals of both species. The density of seedlings varies from 2 to 12 seedlings in each conetainer. The height (mm) and mortality of the seedlings was assessed weekly over 5 weeks.

Figure 2. Two conetainers. The conetainer on the left contains both species, while the container on the right contains only *E. angustifolia.* These plants have a single true leaf and two cotyledons at their base.

Figure 3. The conetainer on the left feautures both species together: *E. angustifolia* has lance shaped leaves while *E. purpurea* has more oval shaped leaves. These sprouts are approximately 2 weeks old.

Results and Conclusion

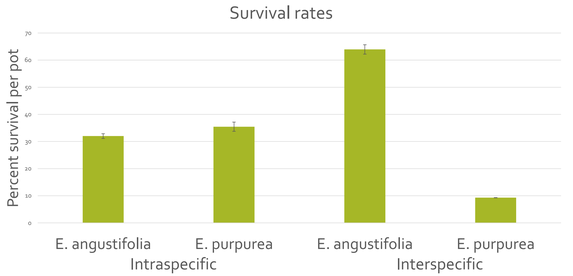

Figure 4. Percent survival of both species when grown in competition versus when grown individually. Error bars represent standard error.

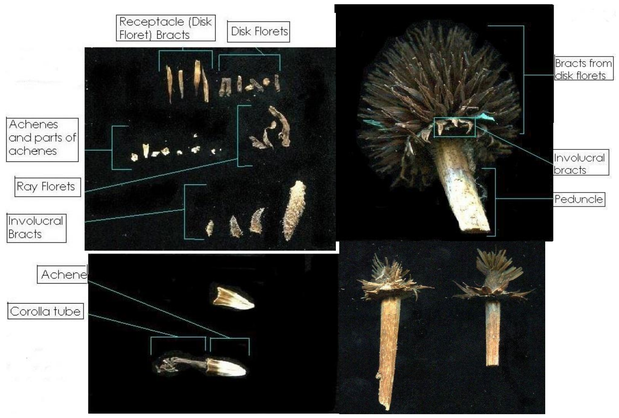

Figure 3. Top left: an array of the parts of an Echinacea seed head once removed from the head. Top right: the Echinacea seed head, which has been cleaned of the achenes, but the bracts are still present. Bottom left: an achene with and without its corolla. Bottom right: a seed head where the bracts were deciduous.

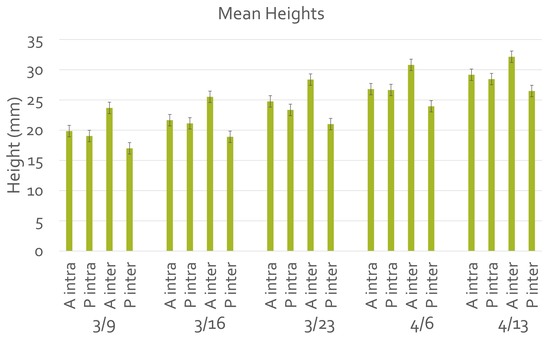

Fig 5. Mean heights of seedlings from March 9 through 23, grouped by species and treatment level. Error bars represent standard error.

Mean heights of E. purpurea and E. angustifolia when grown with intraspecific competition are about the same, but when grown in interspecific competition, ($p = 0.008$, $df = 178$).

The percent survival follows the same trend; when the species are grown individually, percent survival is approximately the same, but when grown in competition, *E. angustifolia* survives more ($p < 0.001$, $df=706$). Pots with no survival of either species were excluded from this analysis.

Selected Bibliography

Feghahati, J., & Reese, N. (1994). Ethylene-, Light-, and Prechill-enhanced Germination of Echinacea angustifolia Seeds. Journal of the American Society for Horticultural Science, 119(4), 853–858-853–858.

Wagenius, S., A. B. Dykstra, C. E. Ridley, and R. G. Shaw. (2012). Seedling recruitment in the long-lived perennial, Echinacea angustifolia: a 10-year experiment. Restoration Ecology 20: 352-359.

Wagenius, S., and S. P. Lyon. (2010). Reproduction of Echinacea angustifolia in fragmented prairie is pollen-limited but not pollinator-limited. Ecology 91:733-742.

Acknowledgments

I wish to thank lab managers Amy Waananen and Danny Hanson for supporting me throughout my project and my parents for providing transportation.