Echinacea Project Research Project Proposal
Shona Sanford-Long
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The potential for and effects of hybridization between *Echinacea angustifolia* and *Echinacea pallida*

Background

Echinacea angustifolia is native to the prairies of Minnesota; however, in many attempts at prairie restoration *Echinacea pallida* has been planted in place of *E. angustifolia*. This happens for a variety of reasons; some restorers do not know that it is a non-native species, and seed for *E. pallida* may be cheaper and easier to find than seed for *E. angustifolia* (Stuart Wagenius, personal communication). The introduction of *E. pallida* into Minnesota prairie could have a negative impact upon the population of native *E. angustifolia.*

E. angustifolia is a self-incompatible species (Wagenius et al.,2007). Although it is possible that *E. pallida* is self-compatible as many polyploids are (Goldsmith unpublished), the degree to which *E. pallida* is self-compatible has not been well studied. Goldsmith (unpublished) found that *E. pallida* pollen was compatible with *E. angustifolia* plants and *E. angustifolia* pollen was compatible with *E. pallida* plants. General measurements of compatibility for these three groups indicate that there may be different levels of compatibility within and between species. If mean compatibility between species is higher than the mean compatibility within species it seems likely that cross pollination would occur more frequently than pollination within species, which could lead to hybridization, or pollen limitation if crosses are unfertile. If one species shows higher mean compatibility than the other, or than crosses, it could indicate that that species would be less likely to suffer from pollen limitation, and/or that it would be less prone to hybridization. A better understanding of the compatibility of these three cross-types would provide insight into the potential effects of the introduction of *E. pallida* into habitats containing native *E. angustifolia.*

Seed set was not recorded in *E. pallida* florets pollinated by *E. angustifolia,* however *E. pallida* pollen led to seed set in *E. angustifolia,* and hybrid seeds were successfully germinated (unpublished data). This indicates that hybridization between the two species is likely to some degree. However little is known about the resulting progeny. By studying the morphology of hybrid offspring I will be able to infer possible implications for later populations, and the impact upon individual species.

Questions

What are the possibilities and ramifications of hybridization between *Echinacea angustifolia* and *E. pallida*?

1. Is there a difference in the mean self-compatibility of *E. pallida,* self-compatibility of *E. angustifolia,* and compatibility between *E. pallida* and *E. angustifolia*
2. Are morphological characteristics of hybrids more similar to one parent? Does it matter which is the pollen donor? This summer I will only be able to observe progeny with *E. angustifolia* as the maternal plant.

Methods

Compatibility

I will select a population of flowering *E. angustifolia* and a population of flowering *E. pallida.* The population of *E. pallida* will be from the Hegg Lake Wildlife Management Area (HLWMA) where *E. pallida* was planted in a restoration project in the past five or ten years. We found six flowering *E. pallida* at this site on June 18, 2012 and one that was flowering but had lost its head. I have chosen to use *E. angustifolia* from a native population in a different section of HLWMA. This site was chosen because it is a native population that is in close proximity to the introduced *E. pallida,* and the interactions shown in this study will be directly applicable to the future of this site. From an initial observation there appear to be more than six flowering *E. angustifolia* in this population so pollen donors will be chosen based on flowering synchrony with *E. pallida*.

Using the style persistence measurement method as described by Wagenius (2004) I will pollinate plants in each group with pollen from the same species and pollen from the other species and observe style shriveling. I will perform reciprocal crosses to determine whether there is any difference in compatibility based on which species is maternal and which is paternal.

Each flowering head will receive pollen from six donors, as shown in Figure 1. On the first day or two of pollination, when there are more florets, I will pollinate a few florets of each head with pollen from that head as a control for self-incompatibility. At the beginning and end of the project there will be some crosses that do not fit into the crossing pattern because of lack of complete flowering synchrony.

		E. pallida paternal (where each ID starts with PAL)						*E. angustifolia* paternal					
		1002	1003	1005	1004	1013	1014	17167	17168	17169	17164	17165	17170
E. pallida Maternal (where each ID starts with PAL)	1002	Yel			Aqu	Pnk	Wht				Grn	Ind	Vlt
	1003		Yel		Aqu	Pnk	Wht				Grn	Ind	Vlt
	1005			Yel	Aqu	Pnk	Wht				Grn	Ind	Vlt
	1004	Aqu	Pnk	Wht	Yel			Grn	Ind	Vlt			
	1013	Aqu	Pnk	Wht		Yel		Grn	Ind	Vlt			
	1014	Aqu	Pnk	Wht			Yel	Grn	Ind	Vlt			
E. angustifolia maternal	17167				Aqu	Pnk	Wht	Yel			Grn	Ind	Vlt
	17168				Aqu	Pnk	Wht		Yel		Grn	Ind	Vlt
	17169				Aqu	Pnk	Wht			Yel	Grn	Ind	Vlt
	17164	Aqu	Pnk	Wht				Grn	Ind	Vlt	Yel		
	17165	Aqu	Pnk	Wht				Grn	Ind	Vlt		Yel	
	17170	Aqu	Pnk	Wht				Grn	Ind	Vlt			Yel

Figure 1. Yellow spaces show self pollination, shaded spaces are the crosses that will be made, and different colors differentiate between the three cross types, where there are

crosses with each species as maternal and paternal donors. The color that bracts will be painted is indicated with abbreviations in each cell.

If possible at the end of the summer I will return to the plants to observe seed set, or have someone else collect seed heads to observe fertilization and germination rates.

Hybrid characteristics

To determine hybrid trait similarity to parental traits I will develop measurements of a set of characteristics of each parent variety, and then measure those same characteristics on the hybrid seedlings.

Possible characteristics to quantify could include: pubescence on leaf and petiole, ratio of leaf width to length, color of leaves (may be hard to quantify), angle of leaf tip, size and persistence of cotyledons, plant growth rate, petiole length (in relation to leaf length), and apparentness of veins.

Next steps

I will be going out to Hegg lake every morning until plants finish flowering to paint, cross, and observe styles.

The less pressing part of my project is to develop a protocol for measurements of characteristics.

Literature Cited

Wagenius, S. 2004. Style persistence, pollen limitation, and seed set in the common prairie plant *Echinacea angustifolia* (Asteraceae). *International Journal of Plant Science*. 165(4): 595-603.

Wagenius, S., E. Lonsdorf, C. Neuhauser. 2007. Patch aging and the s-Allee effect: breeding system effects on the demographic response of plants to habitat fragmentation. *The American Naturalist*. 163(3): 383-397.