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Research Proposal: Pollinator Efficiency
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Primary Focus

I am interested in continuing the project started by Katie Koch in 2010, investigating which native bees visit *Echinacea angustifolia*, and the extent to which each of these contributes to *Echinacea* reproduction through successful pollination.

Background Information and Implications

At least 26 species of bees have been observed visiting *Echinacea*, each of which potentially contributing to the movement of pollen between individuals (Wagenius 2010). These Bees play a fundamental role in *Echinacea* reproduction because it is self-incompatible and thus produces no seed set unless cross-pollination occurs. It is important that *Echinacea* experiences sufficient pollination activity considering that pollen limitation can affect individual and population mean fitness (Wagenius 2004). Pollen limitation is only one of several aspects of reproduction, but previous research has found that it has a far greater effect on *Echinacea*'s reproductive output than other factors such as resource limitation (Wagenius 2004).

The Style-Persistence method of examining pollen limitation provides a clear dichotomous response: either a pollinator succeeds in depositing a compatible pollen grain on each respective floret, or it does not. The former case is indicated by the style shriveling into the corolla within 24 hours, and the latter case, by the style remaining turgid and receptive to pollen, not presenting with a morphological change in this period of time, unless disturbed by a confounding factor such as insect herbivory (Wagenius 2004).

The results of this study could have broad implications, since *Echinacea* serves as a model organism for many prairie plants including others that are self-incompatible, pollinated by generalist insects, and reproduce only via seeds (Wagenius 2004).

Hypothesis

The various species of bees that visit *Echinacea* contribute to its reproductive success differentially based on the frequency with which they visit, and their efficiency, or the number of floret stamen they successfully pollinate with a compatible pollen grain per visit. Multiple factors contribute to the efficiency of a particular species, including average duration of visit, pollinator anatomy, and behavioral factors. I will quantify the efficiency of each species that I observe and expect to find results consistent with Katie's from 2010.

Methods

Since this investigation is not purely observational, but rather requires manipulation of *Echinacea* with pollinator exclusion bags, it will be conducted in the Common Garden (C1). I chose the plants that I will be observing by inspecting the flowering plants in the 1996 and '97 gardens, and selected ones that would likely produce an observable flowering head within my desired observation window of June 29 through July 15, the dates during which

Katie collected data in 2010. In order to ensure consistency with the previous research on this topic, I will follow the field methods outlined by Katie. The virgin inflorescences of the selected individuals will be bagged, ensuring that no insects contact the stamens or anthers prior to the controlled observation. Two rows of untouched styles will be allowed to mature on each plant before it is allowed exposure to pollinators. Emerged styles will be observed at the base, middle, and top of the head. Acrylic paint will be used to mark ray florets (helping to denote the location on a head where the pollinator landed) as well as the bracts of florets with anthers on the day an exclusion bag is placed. Four colors will be used on the ray florets, each corresponding to a specific cardinal direction, and a fifth will be used on the bracts. I will record each pollinator visit with a video camera as well as using a stopwatch to measure the duration of the visit. I will use a net or aspirator to collect as many of the observed pollinator specimens as possible. Collecting the insects will allow me to determine the species of pollinator as well as note physiological differences between specimens. Approximately 24 hours after each observed pollinator visit, the number of persistent and shriveled 1 and 2-day-old styles will be counted.

Materials:

pollinator exclusion bags, net, Insect collection aspirator, jars with lids, clipboard, measuring tapes, flags, stop watch, acrylic paint, video camera, tripod, insect mounting materials, pollinator identification guide

Possible Expansion

Investigating the effects of local weather and climatic events may also provide insight into how pollinators interact with Echinacea. I plan to monitor the weather closely, recording data on temperature, precipitation, wind, and sunlight. I am not certain yet how these might relate to my pollinator data, but perhaps they will correspond to pollinator behavior, a key aspect of Echinacea's reproductive paradigm.