Pollinating bees of *Echinacea angustifolia*: who gets the job done?

Andrew Kaul, Departments of Biology and Environmental Studies, St. Olaf College
andrewdkaul@gmail.com

CHICAGO BOTANIC GARDEN

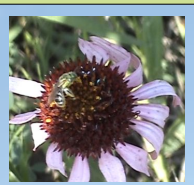
Introduction

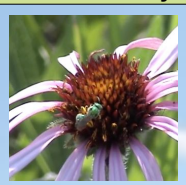
Purple coneflower, *Echinacea angustifolia* is native to the tallgrass prairie that spanned from Texas to southern Canada before European settlement (Sampson and Knopf, 1994). This biome has been fragmented and drastically reduced in size due to the conversion of prairie to cropland. Echinacea serves as model organism for long-lived herbaceous, prairie forbs, and an understanding of its ecology and population dynamics could lead to better-informed conservation and restoration strategies.

Bees play a fundamental role in Echinacea reproduction because it is self-incompatible, and thus produces no seeds unless cross-pollination occurs. At least 26 species of bees have been observed visiting Echinacea, each of which potentially contributes to the movement of pollen between plants (Wagenius 2010). Pollen limitation can affect individual and population mean fitness and has a far greater effect on Echinacea's reproductive output than other factors such as resource limitation (Wagenius 2004).

The purpose of this study is to investigate which native bees visit Echinacea angustifolia, and to what extent each of these contributes to Echinacea reproduction through successful pollination.

Study Species


Agopostemon viresscens


Augochlorella Striata


Halictus sp.


Lasioglossum sp.


Ceratina sp.


Melissodes sp. female


Melissodes sp. male


Echinacea angustifolia

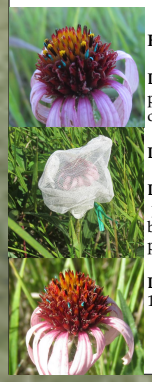
Methods

Study Site

- Experiment was conducted in a 24 x 44m area of the 46 x 123m Echinacea Project common garden plot (CG1) in Douglass Co, MN
- CG1 contains E. angustifolia planted as seeds originating from prairie remnants within 10 km

Field Methods

Style-Persistence: The result of a pollinator visit can be evaluated for each floret. If a compatible pollen grain is deposited on a style, that style will shrivel into its corolla within a day, and if not it will persist unchanged.



Four-day observation protocol:

Day 1: bracts subtending florets that are producing anthers are painted; head is covered with a mesh bag

Day 2: second row of anthers emerge

Day 3: bag is removed and a single pollinator visit is recorded on video; bracts of anther producing florets are painted; bag is replaced

Day 4: assess persistence and shriveling of 1 and 2 day old styles

Results

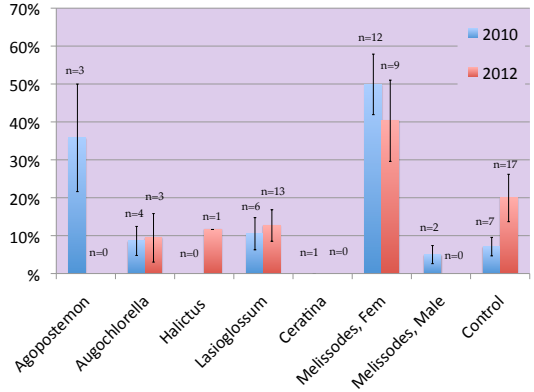


Fig. 1 efficiency of pollinators observed in a 2010 study and in 2012 as a measure of style persistence; bars notate standard error

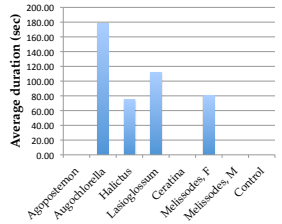


Fig 2. duration of pollinator visits in 2012

Taxa	Observed 2010	Observed 2012	Proportion shriveled 2010	Proportion shriveled 2012
Agopostemon viresscens	3	0	35.8	0.00
Augochlorella striata	4	3	8.6	9.43
Halictus sp.	0	1	0	11.63
Lasioglossum sp.	6	13	10.5	12.68
Ceratina sp.	1	0	0	0.00
Melissodes, Female	12	9	49.9	40.31
Melissodes, Male	2	0	5	0.00
Control	7	17	7.1	19.94

Table 1. sample sizes and efficiency by year and taxonomy

Results Continued

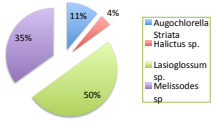


Fig. 2 taxonomy of 2012 pollinators

- Augochlorella and Halictus had the longest and shortest average visit durations respectively. Augochlorella has a low efficiency with respect to visit duration and Melissodes has a respectively high efficiency (Fig 2).
- Pollinator efficiency differed between female Melissodes and Lasioglossum species ($p = 0.0001$) and their efficiency did not differ between years ($p = 0.64$) according to a generalized linear model with a binomial response (Fig1).
- Sample sizes for other taxa were not large enough to test for statistical analysis.

Discussion

- Melissodes has significantly higher pollination efficiency than Lasioglossum with 40.31% and 12.68% respectively
- Half of the pollinators observed were Lasioglossum (13), and along with Melissodes, they account for 85% of the observations
- No significant difference in efficiency from 2010 to 2012
- The control group had the second largest efficiency; this could be due to several confounding factors including failed exclusion bags, pollination by ants, climatic effects, and damage to styles from herbivory by caterpillars
- The data indicate that Mellissodes may be the most efficient pollinator
- Additional research could examine the affect of behavioral and physical characteristics on pollination efficiency
- behavioral characteristics could include direction of approach to an anther and degree of movement on the flower head
- physical characteristics could include the presence/location of a pollen basket, size of pollinator, and prevalence of hairs on body

Literature Cited

•Samson and Knopf. 1994. Prairie Conservation In North America. Bioscience.
•Wagenius, S. 2004. Style persistence, pollen limitation, and seed set in the common prairie plant *Echinacea angustifolia* (Asteraceae). International Journal of Plant Sciences 165:595-603.
•Wagenius, Stuart, and Stephanie Pimm Lyon. 2010. Reproduction of Echinacea angustifolia in fragmented prairie is pollen- limited but not pollinator-limited. Ecology. 91:733-742

Acknowledgements

I would like to acknowledge Katie Koch for starting the pollinator efficiency experiment and outlining the field methods. I would like to thank Stuart Wagenius and the Echinacea Project for providing the supplies, guidance, and facilities necessary for this study. I thank Lydia Kan, Kelly Kapsar, and Shona Sanford-Long for assistance in the field, and the Chicago Botanic Garden for funding my research. The Echinacea project is supported by the National Science Foundation (grants 1051791 & 1052165).