Temporal variation in pollinator behavior on a common prairie plant

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Introduction

Tallgrass prairie used to cover a vast portion of North America but has since been reduced to less than 0.01% of its original area (Samson and Knopf, 1994). Studies have found that bee abundance decreases with a decrease in flower density (Totland and Matthews, 1998), and that there is a considerable decline in bee species diversity, especially among solitary bees, in smaller fragments (Alfert et al., 2001). A partner study (Feng, Rosenthal, and Ison unpublished data) investigates how pollination rates may be affected by spatial and temporal isolation of *Echinacea angustifolia*. It is necessary to understand basic pollinator behavioral trends in order to know how fragmentation may affect plant-pollinator interactions. This study investigates how these behavioral trends may vary among species and change over the course of the flowering season.

Research Question

How do pollinator behavior and pollinator abundance change over the course of the flowering season in an experimental plot of *E. angustifolia*?

Pollinators

9 genera of native, solitary, generalist bees were recorded

Family	Taxa	Number of sightings
Halictidae	*Agapostemon virescens*	93
Anthophoridae	*Melissodes* sp.	87
Anthophoridae	*Ceratina calcarata*	81
Halictidae	*Halictus rubicundus*	21
Megachilidae	*Megachile latimanus*	19
Halictidae	*Augochlorella striata*	16
Apidae	*Apis mellifera*	6
Andrenidae	*Pterosaurus albitarsis*	3
Halictidae	*Dialictus* sp.	3

Figure 1: *A. virescens* with aqua marking, *Melissodes* sp. with white marking, and unmarked *C. calcarata*, left to right

Methods

- Observations were conducted in western Minnesota in a Common Garden of *Echinacea angustifolia*, a self-incompatible model prairie species
- Observations began at the start of flowering and continued for 11 days
- Bees on *E. angustifolia* plants were caught with nets and placed in glass vials in a cooler
- Once cool, the thorax was marked with a dot of colored acrylic paint and the bee was released on the plant where it was caught
- Visits to subsequent plants were recorded until bee lost
- Flights of unmarked bees and of previously painted bees were also recorded
- All data were analyzed and maps created using R 2.6.0 (2007 CRAN)

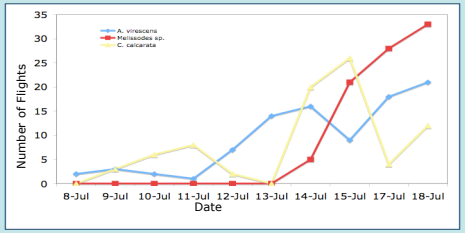

Figure 2: Number of sightings recorded per day for each major pollinator. Significant for *A. virescens* (p=0.004, AIC=56.665) and *Melissodes* sp. (p<0.001, AIC=70.148). Not significant for *C. calcarata* (p=0.168, AIC=74.242).

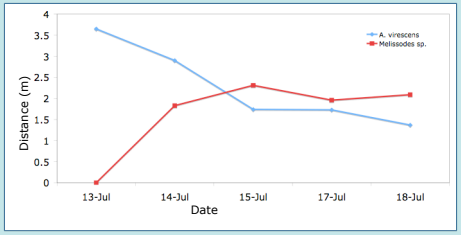

Figure 3: Mean distance traveled between two *Echinacea* plants. Significant for *A. virescens* (p=0.036, AIC=10.223). Not significant for *Melissodes* sp. (p=0.228, AIC=15.549). *C. calcarata* is not included due to difficulties in tracking their flights.

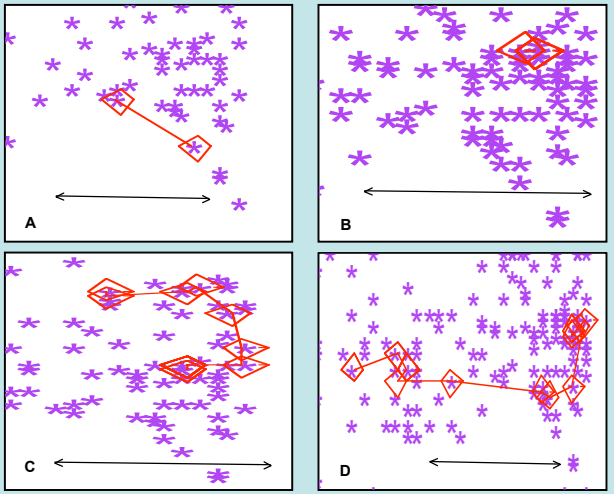

Figure 4: Flight paths of selected *A. virescens* (A,B) and *Melissodes* sp. (C,D) on July 14th (A,C) and July 18th (B,D). Purple "*" represent flowering plants, red indicates the flight path taken with stops circled, and the black arrow is scaled to 10m. *A. virescens* flight distances decreased with time while *Melissodes* sp. flight distances increased with time.

Data Analysis and Results

- Data fitted to 3 generalized linear models (GLM) with date as the predictor
- July 16th and 19th were not included due to inclement weather conditions
- Response: Number of flights per day (fig. 2)
- Response: Mean flight distance between plants (fig. 3)
- Response: Percent of daily flowering plants visited
  - Not significant for *A. virescens* (p=0.902, AIC=78.083) and *C. calcarata* (p=0.804, AIC=83.799)
  - Significant, increasing, for *Melissodes* sp. (p<0.001, AIC=83.799)

Discussion

- No bees observed flying from *Echinacea* to a flower of another species, so *Echinacea* is highly appealing to the pollinators we observed

***Melissodes* sp.**

- No *Melissodes* were sighted until July 14th, so there may be a threshold number of flowering plants before which *Echinacea* is not attractive enough to draw *Melissodes*
- 2 new species of *Melissodes* were observed during the last third of the observation period, indicating that *Echinacea* may become more appealing to a variety of *Melissodes* species as more plants flower
- *Melissodes* flew farther between plants as the number of flowering plants increased (a longer observation period may prove this trend statistically significant) (fig. 3,4)
  - Perhaps flying farther in search of plants with more or higher quality pollen

A. virescens

- *A. virescens* flew longer distances between plants earlier in the season, indicating that they find *Echinacea* appealing earlier in the season than do *Melissodes* (fig. 3,4)
  - Complements the pollinating behavior of *Melissodes* by moving pollen farther earlier in the season
  - Early flowering *Echinacea* are not harmed by interspecific competition for pollinators
  - Early flowering plants may benefit from gene flow, as supported by another study at the same site (Feng, Rosenthal, and Ison unpublished results)

Implications

- Potential impacts of fragmentation:
  - Smaller plots may mean that *Echincea* never reaches the threshold for *Melissodes* to appear or reaches it much later in the season
  - A decline in either bee species would adversely affect *Echinacea* due to the different pollination niches filled by each species

Acknowledgements and References

Alfert T., I. Steffan-Dewenter, and T. Tschantke. 2001. As seen in Waser N. and J. Ollerton, 2006. *Plant-pollinator interactions: From specialization to generalization*. U. Chicago. 390-2.

Comprehensive R Archive Network. 2008. R 2.7.1. <www.r-project.org>

Samson & Knopf (1994) Prairie conservation in North America. BioScience.

Totland O. and I. Matthews. 1998. *Acta oecologica*, v19 n2. 155-165. "Determinants of pollinator activity and flower preference in the early spring blooming *Crocus vernus*"

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