Insect Size and Foraging Distances for Insects Visiting *Eryngium yuccifolium*

Final Report to Litzsinger Road Ecology Center

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Abstract

The success of tall grass prairie restorations depends not only on the survival of plantings but on many factors, including the presence of a healthy population of pollen-carrying insects (Taron, 1997). The distance these insects can travel, and thus the distance between patches of one plant species where there is a chance of successful cross-pollination, has not yet been determined for any specific plant populations at the Litzsinger Road Ecology Center (hereafter LREC) in St. Louis, Missouri. I sought to determine whether any flower-visiting insects visit forbs in more than one of the three patches of *Eryngium yuccifolium* at LREC. Specimens were collected from each of the patches at LREC on five separate occasions, and Chi-Squared tests were used to determine if the size of an insect makes a significant difference in its propensity to travel from patch to patch. The results indicate that flower-visiting insects over 10mm long have a greater propensity to move between two of the three patches of *E. yuccifolium* at LREC. There was no data indicating that any insects visited all three patches, nor that the most isolated patch was visited by insects from the other two. The study provides both useful information on potential methods for pollination studies and promising preliminary data for a number of potential research topics related to pollination at LREC.

Introduction:

Attempts at tall grass prairie restoration often focus on plant diversity with the assumption or even hope that the native insects will return on their own over time. This is a dangerous assumption, as many wildflowers require pollination by insects for successful reproduction (Michener, 2000). While some plants that are insect-pollinated can self-pollinate if necessary, this often results in a decrease in genetic diversity (Michener, 2000). Hence the presence of pollen-carrying insects is crucial for the health of the ecosystem (Taron, 1997).

The Litzsinger Road Ecology Center of St. Louis, MO has three areas of restored tall grass prairie as well as a woodland area. Restoration attempts began in 1988 and have largely been successful (Davit, 2000). Historically, restoration efforts have focused on increasing plant diversity, while evaluation of the presence of insects has been more recent (Davit, 2000). In general, methods for managing restoration insect populations have not been tested nearly as thoroughly as methods for managing plant restorations (Taron, 1997).

Plant distribution within a population tends to be patchy (Kwak and Vervoot, 2000), and therefore the distance that potential pollen-carriers can travel is one factor in determining whether they are able to visit different patches of a population (and thus potentially cross-pollinate). Flower-visiting insect mobility also plays an obvious role in whether insects are able to disperse to a newly-restored area from outside the site.

Eryngium yuccifolium, or Rattlesnake Master, grows in three different patches at LREC (see schematic on final page of this report—not to scale). It is highly conservative and dominant, and it blooms from July to mid-August, the ideal time for the proposed study to occur (Clinebell, 2001; Denison, 1993; Hauser and Packard, 2005; Robertson, 1929). While *E. yuccifolium* is somewhat self-compatible, bagged inflorescences failed to produce fruit or seed in previous

studies, suggesting a need for cross-pollination if successful reproduction is to occur (Molano-Flores, 2001). Individual *E. yuccifolium* plants also do not go through pistallate and staminate phases concurrently, thus minimizing geitonogamous pollination and increasing the chance of out-crossing, also suggesting a need for cross-pollination (Molano-Flores, 2001). The third and final reason *Eryngium yuccifolium* was chosen is that it has an unusually diverse pollinator guild (Clinebell, 2001), as it is visited by bumblebees, wasps, flies, small bees, moths, and butterflies (Molano-Flores, 2001). These factors combined make it an ideal subject for the proposed study, which seeks to examine the propensity of visiting insects of any species to travel from one patch of LREC's *Eryngium yuccifolium* population to another. It is hypothesized that larger insects (over 10mm) will visit both Area 1 and 3 while smaller insects (10mm and under) will not make this jump. It is also hypothesized that no insects will be found to have visited Area 2 in addition to either Area 1 or Area 3, as Area 2 is much farther away.

Materials and Methods:

Of the *E. yuccifolium* patches in question, Area 1 is by far the largest area, with over two hundred flowering plants. Area 2 is the smallest of the patches, having only seven inflorescences. Area 3 consists of about 50 flowering plants and is located approximately 50 meters away from Area 1. Area 2 is located over 400m from both Areas 1 and 3 and only about 25m from Litzsinger Road. It is also separated from the other two patches by a woodland area.

DayGlo powders AX-11-5 (Aurora Pink), AX-18 (Signal Green), and AX-19 (Horizon Blue) (obtained from Day-Glo Color Corporation in Cleveland, Ohio) were used in the study. The pink fluorescent powder was painted onto to a given sample group of the flowers in Area 1, and blue fluorescent powder to a similar sample group in Area 3. Due to the extremely small size of Area 2, green fluorescent powder was applied to all the inflorescences in the patch, seven in

total. On five separate occasions over the course of three weeks, visiting insects were collected from each area using a sweep net.

The specimens were examined under a microscope with both natural light and black light to see if they carried any of the three fluorescent colored powders. A specimen carrying more than one color powder was known to have visited multiple patches. Likewise, a specimen carrying only one color of powder but not the color assigned to the patch in which it was collected was also known to have visited multiple patches. Collected specimens were also measured and grouped into two groups by length, those over 10mm long and those 10mm and under. These groupings were chosen because previous studies on LREC's *E. yuccifolium* population concluded that the population was visited mainly by very small bees and by wasps over 10mm long (Clinebell, 2001). Previous studies have also shown positive correlations between bee size and foraging distance and between bee size and dispersal ability, indicating that larger size may be a factor in greater mobility (Gathmann and Tscharntke, 2002; Gathmann, Greilier, and Tscharntke, 1994).

Chi-Squared tests were performed with MiniTab software (MiniTab V.14, MiniTab, Inc.) to determine if the size of the insects made a significant difference in their propensity to travel from patch to patch. Two p-values were found, one based on all the specimens collected and the other taking into consideration only those specimens that carried at least one color powder.

Results:

I did not seek to identify individual visiting insects by species. Rather, I grouped the collected specimens by size in order to gather data about whether size may be a potential factor in the propensity of flower-visiting insects to travel from one patch of the *E. yuccifolium* population to another. The study also deals only with one plant species within one summer. It

should also be noted that all three patches are on edges of LREC's prairies, and there may be edge effects on the insect-visitation to any or all of the patches. The possibility of these effects could not be eliminated while still conducting the study at LREC.

All Specimens--Observed

Length (mm)	Travel	Don't Travel	Totals
10+	9	26	35
10 and 10-	0	55	55
Totals	9	81	90

Powder-Carrying Specimens--Observed

Length (mm)	Travel	Don't Travel	Totals
10+	9	12	21
10 and 10-	0	13	13
Totals	9	25	34

There were significant differences between observed and expected values for all insects ($p<0.001$), and there were also significant differences between the observed and expected values for powder-carrying specimens ($p = 0.006$). The data was tested two ways because over half of the specimens collected carried no colored powder at all, even that of the patch from which they were collected. Thus, there it is not known whether these insects visited any of the other patches or not. Tomentose insects (members of the *Bombus* genus, in particular) picked up the colored powders very well, and it was clear under black light, and often under only natural light, which colors of powder they were carrying. However, glabrous insects did not pick up sufficient colored powder to detect, if they picked up any at all. Thus this method would be better suited to future studies of tomentose species than to studies of wasps or beetles, which tend to be glabrous (Dyer, 2006). That said, tomentose insects frequently carry more pollen than glabrous insects (Clinebell, unpublished data), and their greater propensity to pick up the florescent powders is thus unsurprising.

The data was thus calculated twice in order to minimize the effects of the problems with the method, once with all specimens and once only taking into account those that carried at least one color powder. Both analyses produce extremely low p-values, and thus I reject the null

hypothesis that insect size and tendency to visit multiple patches are independent of each other. Rather, the data indicate a definite correlation between larger insect size (over 10mm long) and propensity to visit multiple patches of the *E. yuccifolium* population at LREC.

Discussion:

I did not take into account how oligolectic the insects collected on *E. yuccifolium* were, if they were at all oligolectic, and thus I can make no conjectures about whether specimens may have visited other species of plants in between visiting two *E. yuccifolium* patches, hindering the chance of *Eryngium* cross-pollination. This compounding variable could not be avoided without performing a genetic study on the *E. yuccifolium* population and thus could not be eliminated within this study. I make no claims to have established that cross-pollination has occurred or that it does occur with the insects that do travel from one patch to another. Rather, I conclude that forb-visiting insects over 10mm long showed a greater propensity to move from one patch of LREC's *E. yuccifolium* population to another. Indeed, there is no data indicating that insects measuring 10mm or less ever visit more than one patch.

The data indicate that specimens traveled from Area 1 to Area 3 and vice-versa. The data does not provide evidence that any insects travel between Area 2 and either Area 1 or Area 3. There are a number of possible explanations for this. Area 2 may simply have been too far away from the other two patches for it to be worth the insects traveling that far, even if they are capable of doing so. For example, honeybees have been known to forage up to 12km away from their nest, but only when such extremes are necessary (Ratnieks, 2000). Insects consume vast amounts of energy in flight (Dyer, 2006). Thus, if acceptable areas are available closer to the nest, it would be logical that the insects would visit these areas first and with greater frequency.

Solitary bees in particular have small foraging ranges (150-600m), and therefore often nest relatively close to their preferred food source (Gathmann and Tscharntke, 2002).

Another potential impediment to travel between Area 1 or 3 and Area 2 is the presence of the large woodland between the two prairie areas at LREC. Insects nesting near Areas 1 or 3 may not be aware that another prairie exists on the other side of the woodland, even if they would be capable of crossing it. A small corridor of prairie plants either through or along the edge of the woodland could potentially help induce insects to travel between the two prairies, as habitat corridors have been shown to increase travel between different patches of plant populations (Beier and Noss, 1998; Kwak and Vervoot, 2000). Another option could be to maintain the woodland habitat entirely as such but increase native plant diversity within it by replacing the extensive amounts of various invasive species currently present with native woodland forbs.

One implication of the data that is extremely interesting but only peripherally related to this project is the presence of bumble bees on LREC's *E. yuccifolium* population. Although some studies indicate that *E. yuccifolium* is visited by bumblebees (Molano-Flores, 2001), a study from the same year specifically at LREC finds that *E. yuccifolium* did not attract bumblebees at all and that it was pollinated largely by sand and sphecid wasps and by very small *Hylaeus* bees (Clinebell, 2001). Given the presence of specimens of various Bombus species on each day of collection and sightings of *Bombus* on all three patches, it is clear that Clinebell's findings are no longer the case at LREC. Pollen-carrying insect activity for LREC's *E. yuccifolium* population has changed since the publication of Clinebell's report to be consistent with pollination patterns of *E. yuccifolium* elsewhere, suggesting that LREC has achieved some success in managing its insect populations and also highlighting the need for further pollination research at LREC.

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Litzsinger Road Ecology Center Schematic with *Eryngium yuccifolium* Detail (not to scale)