Ecotypic variation in flowering phenology: Investigating pollinator response to altered flowering times

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Introduction

Climate change is expected to alter many natural processes. Unlike more mobile organisms, plants are particularly vulnerable to changes in climate as they are unable to migrate in response to environmental stimuli. One way in which plants will respond is through changes in the timing of seasonal events, also known as phenology. Studies have found that as temperatures increase, some plants have begun flowering earlier. This has potential to disrupt plant-pollinator interactions through a phenomenon called plant-pollinator mismatch, which is essentially mismatched timing between flowering and pollinator emergence that could cause a reduction in fitness in both plant and pollinator. Investigating the relationship between flowering time and pollination is important to understanding how not just individual species, but plant-pollinator relationships, will respond to changes in climate.

Questions

- **Do local and non-local populations differ in flowering time?**
- **Does variation in flowering time affect pollination?**

Methods

Common milkweed (*Asclepias syriaca*) is a widespread perennial forb. It is a valuable nectar source and host plant for many specialized insects, perhaps most commonly known as the obligate host plant for the imperiled monarch butterfly larvae. In 2013, seeds were sourced from northern, local, and southern populations in the Midwest, and planted in a common garden at the Chicago Botanic Garden. The overall aim of the project is to evaluate variation among populations from different source climates.

Phenology

Thirty plants in each population, 90 total, were monitored biweekly for phenology. Individuals were identified by a pre-determined ID number and followed throughout the flowering season. A phenophase of vegetative, buds (1), first flower (2), early flower (3), full flower (4), post flower (5), and early fruit were recorded.

Phenology observations from 2016 showed an earlier but shorter flowering window, 14 ± 4 days, in the northern population starting on 6/20/16 ± 4, as compared to 20 ± 8 days in the southern population that began on 7/2/16 ± 8. The local population demonstrated an intermediate flowering schedule lasting 18 ± 6 days, beginning on 6/27/16 ± 7.

Figure 1. Milkweed phenophases.

Results

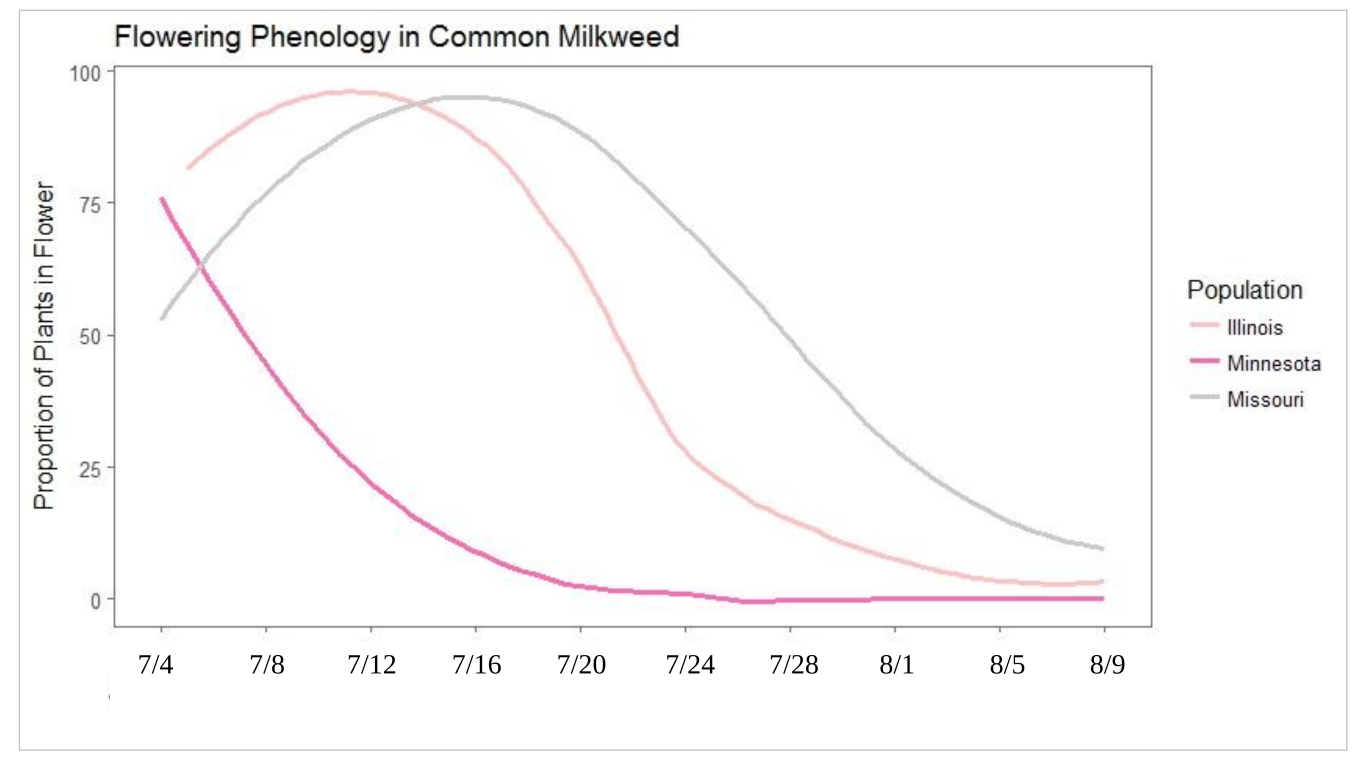

Figure 2. Flowering phenology for summer 2017. Southern and local (Missouri and Illinois, respectively) populations began to flower around the same time, however Minnesota, the northern population, entered the end of its flowering season just as both local and southern began.

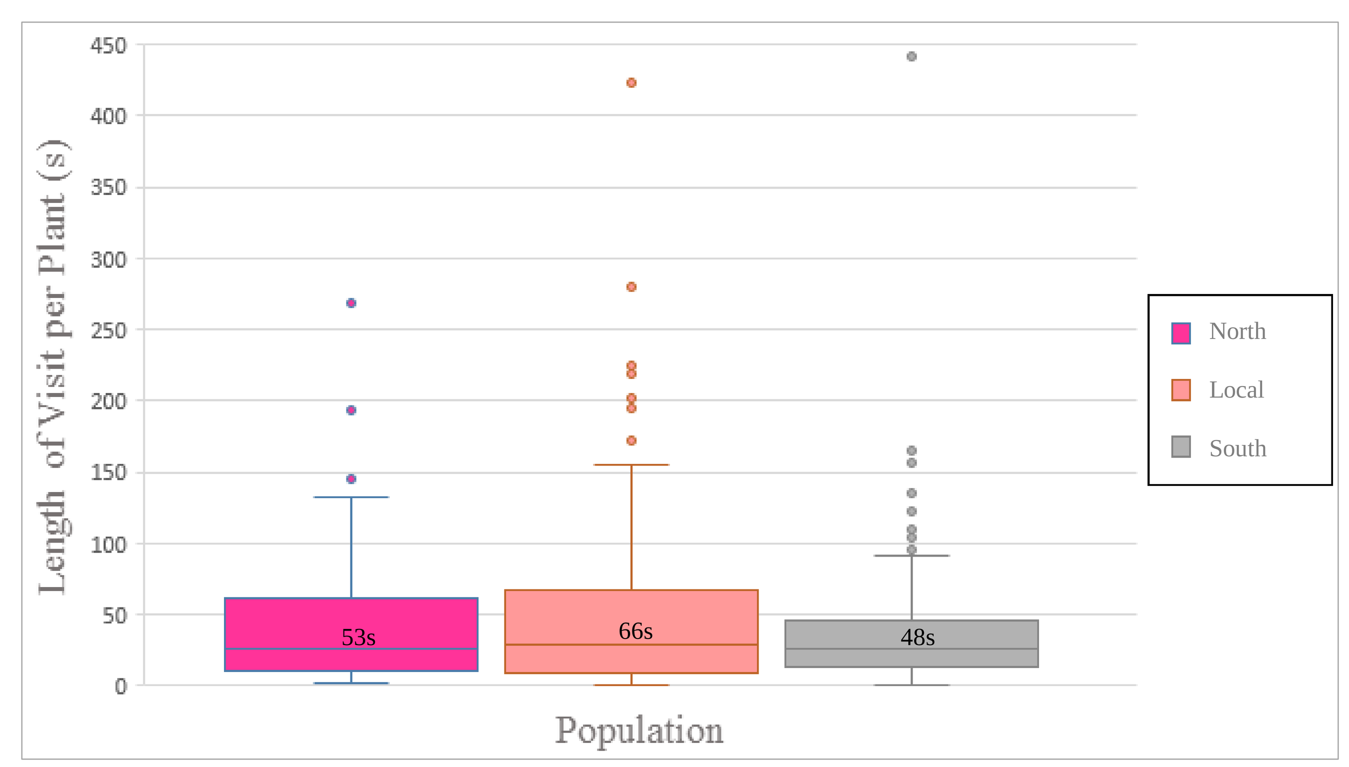

Figure 3. Displays length of insect visits per plant; average length of visit per population shown on box plot. Length of pollinator visit per plant did not significantly differ among populations according to a one-way ANOVA [$F(2, 289) = 2.66$, $p = 0.07$].

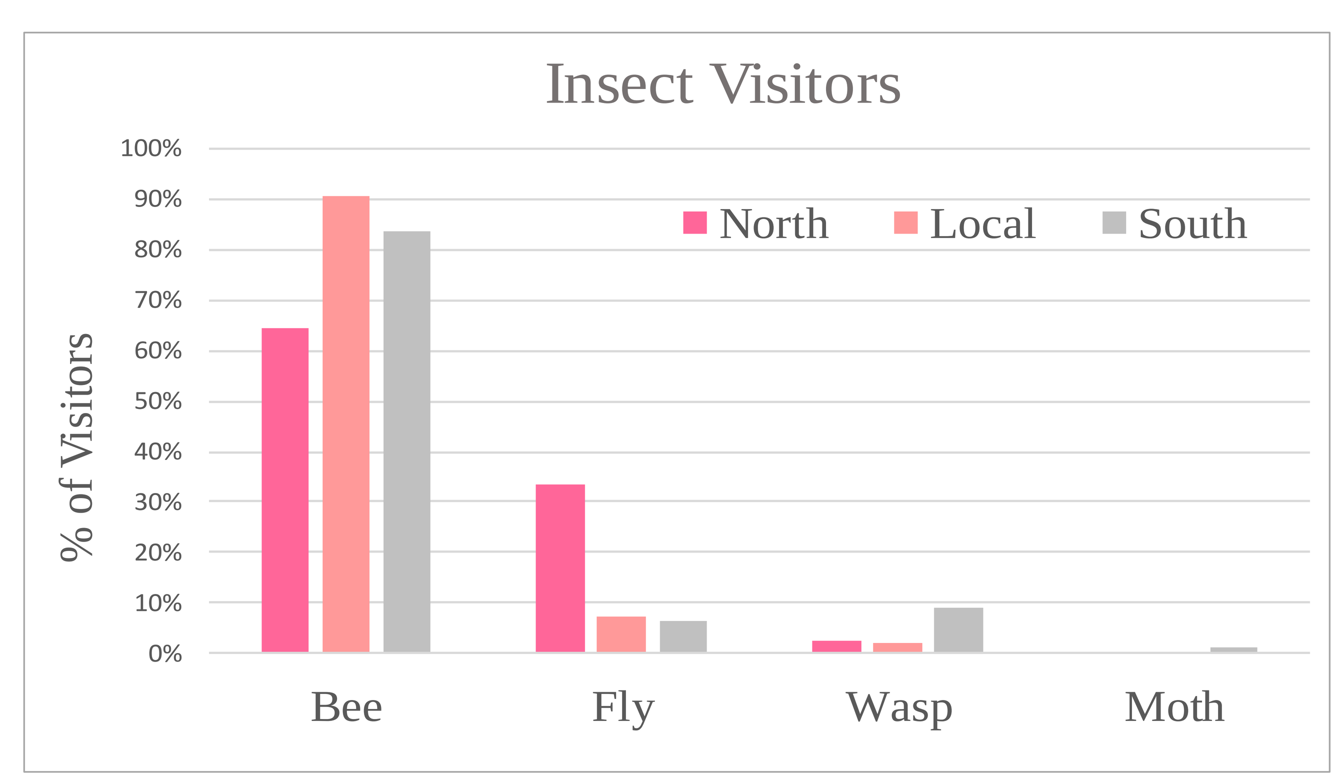

Figure 4. Illustrates proportion of visitor types seen between populations throughout flowering season. Highest proportion of insect visitors that visited all three populations were bees, with some variation in flies and wasps between populations

Methods Cont'd.

Pollination Observations

Observations were conducted 2-3 times per week during morning (10-12am) and afternoon (1-3pm) sessions. During each session a random 2mx2m plot in each population was monitored for one 15-minute interval. Plots were randomly selected within each population along transects running north to south along the east and west sides of the garden (see map of garden). To ensure visitation was not confounded by time of day, morning and afternoon sessions alternated between east and west transects. Length of pollinator visitation, the number of plants visited, and the phenology of both plant and umbel being pollinated were recorded.

Figure 5. Pollinators seen throughout the flowering season: monarch butterfly (*Danaus plexippus*, left), honey bee (*Apis mellifera*, center), carpenter bee (*Xylocopa* species, right).

Discussion

Trends in flowering phenology were consistent between 2016 and 2017. Although onset and peak flowering in the northern population wasn't captured in the 2017 dataset, we can infer that the pattern of an early, short flowering schedule persisted. Variation in flowering schedule adhered to expectations based on source climate. As source latitude increased, flowering time occurred earlier. However, flowering period lengthened as source latitude decreased. Flowering periods for local and southern populations were largely overlapping. Average insect visitation length was slightly longer in the local population (+24-37%), although this trend was marginally significant (p=0.07). Increased sampling may provide greater evidence supporting the relationship between population, flowering phenology, and length of visit. The highest proportion of visitors seen among all three populations were bees, with declining abundance throughout the summer. Given the later flowering period of the local and southern ecotypes, decreased bee abundance may result in reduced reproductive fitness for these populations. This fall, fruit and seed set will be quantified for each population, to quantify reproductive fitness.

Acknowledgements: I would like to thank my mentor, Jessamine Finch, for all her guidance throughout this program. This project would not have been possible without support from Dr. Kay Havens, the NSF-REU grant DBI-1461007, and my College First student, Maximillian Lloyd.