Surviving the City:
The Effects of Urbanization on Common Milkweed

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Introduction

Monarch butterflies (*Danaus plexippus*) migrate from all parts of North America to Mexico every winter in order to breed. This long journey makes them a potentially important agent of pollen transfer, likely carrying pollen from otherwise isolated communities of plants and allowing for gene flow. Monarchs lay their eggs exclusively on plants of the Ascelpias genus. More people are migrating to cities, causing the expansion of urban environments. The dense building development characteristic of cities can serve as a barrier for the monarchs, thus inhibiting gene flow between plant populations in and around cities. This is especially relevant for Chicago, which lies within the monarch migration corridor. Ascelpias syriaca, however, is a resilient plant and is able to survive in urban areas, an environment characterized by elevated temperatures (urban heat island effect; UHI), enhanced precipitation, elevated carbon dioxide (CO_2 domes), and high levels of impervious surfaces, which alter urban hydrology, exacerbating drought and flooding conditions. Within urban areas, milkweeds persist in isolated populations due to sparse and fragmented urban green space. Their separation from rural populations, and the unique environmental pressures of the city, could potentially lead to the development of an urban ecotype more adept at urban living.

Objectives and Hypotheses

The objective of this research project was to determine if an urban ecotype of common milkweed is developing within the city of Chicago based on a comparison of the physical characteristics of plants raised from populations within the city versus plants raised from populations outside of the city. It was hypothesized that plants from within the city would be taller but have similar leaf count and leaf area, and therefore a lower overall leaf density, as compared to plants without the city, indeed pointing to the development of an urban ecotype.

Method Overview

Seed from eight populations of milkweed in and around Chicago was collected in the fall of 2014. The sites were classified as either rural or urban based on percent impervious surface cover data provided by the National Land Cover Database; 50% or greater was considered urban, and less than 50% was considered rural (Fig. 1).

Urban populations	Abbr.	Rural populations	Abbr.
Avondale and Ogallah, Edison Park	EP	Buffalo Grove Prairie	BG
Ashland and Kinzie	AK	Heller Nature Center	HN
45th and Howard	45H	Midewin Natural Tallgrass Prairie	MTP
Chicago and Howard	CH	Morton Arboretum	MA

The seeds from the populations were then reared in the greenhouses of the Chicago Botanic Garden under constant conditions. Height of 60 seedlings from each of the eight populations was measured from the base of the seedling to the tip of the highest leaf of the plant in late May 2015. The number of leaves and the length and width of the largest leaf were recorded for each seedling. These metrics were used to approximate leaf area. The data from the eight populations was then compared using a series of ANOVA tests. An ANOVA test was done on each three plant characteristics individually. First the four urban populations and the four rural populations were grouped together and compared, then the eight populations were all compared separately. A post-hoc Tukey HSD test was used to determine significant differences between individual populations.

Study Species: Common milkweed, *Asclepias syriaca*

- **Family:** Apocynaceae
- **Habitat:** Southern Canada and throughout the United States east of the Rocky Mountains in prairies and along roadside, and are found growing spontaneously in urban environments.
- **Characteristics:** perennial, herbaceous, possessing short rhizomes, often with multiple stems per plant. They contain toxins in their tissues called cardenolides. Some arthropods have adapted to eat milkweeds, often reappropriating the toxin for their own defense. The Asclepias genus is the obligate food source for the imperiled monarch butterfly's caterpillars. Asclepias syriaca also acts as an important nectar resource for many types of arthropods. Because of these qualities, highly diverse and specialized insect communities have evolved around Asclepias syriaca, highlighting their importance in conservation efforts.

Map of Sites

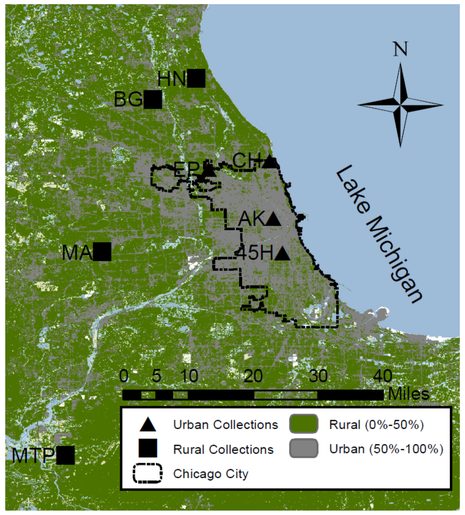

Figure 1. A map of Chicago and the surrounding areas, with the eight sites from which seed was collected in the fall of 2014 labeled with the corresponding abbreviations.

Urban vs. rural plant characteristics

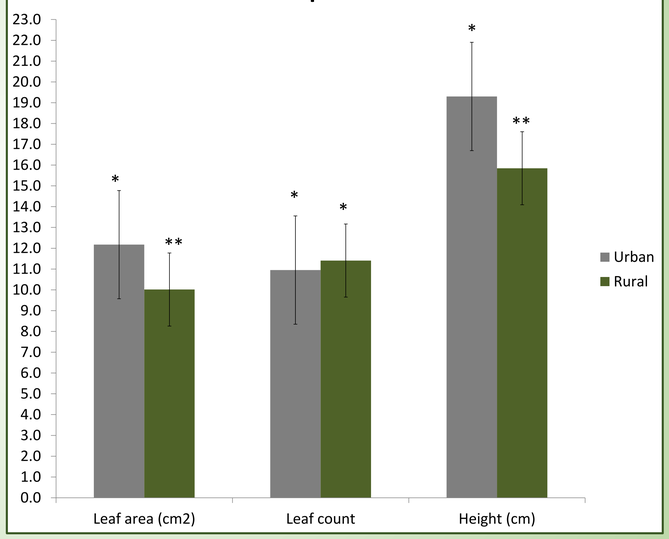

Figure 2. A graph comparing the mean values of the three characteristics measured for urban versus rural populations, including error bars of 2SE.

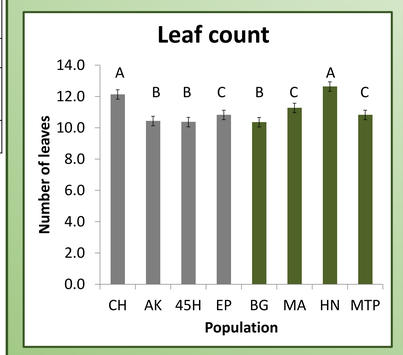

Figure 3

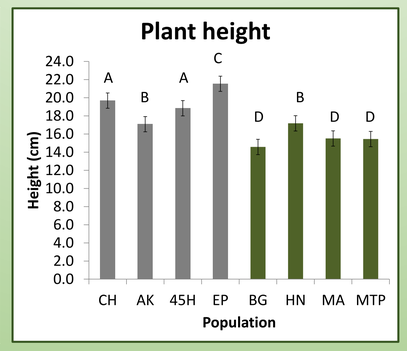

Figure 4

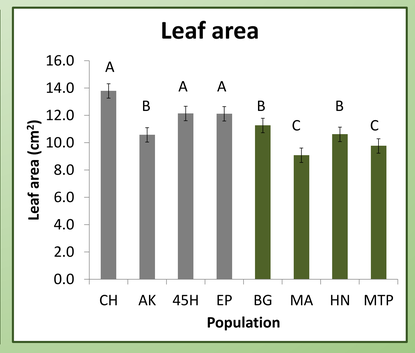

Figure 5

Figures 3-5. Individual graphs of the three characteristics measured for all eight populations, with error bars of 2SE. The populations are identified by their abbreviations, and urban and rural populations are color-coded. Populations with significant differences have different letters above them (Tukey HSD, $p < 0.05$).

Results

- Plants from urban populations were significantly taller (19.3 cm ± 0.36 vs. 15.8 cm ± 0.38 $p < 0.0001$) and had significantly greater leaf area (12.2 cm2 ± 0.42 vs. 10.0 cm2 ± 0.39, $p < 0.0001$) than plants from rural populations. Leaf count did not differ significantly between the urban and rural populations (Fig. 2).
- Plants from Chicago/Howard (urban) and Heller Nature Center (rural) had the highest leaf count, 12.1 ± 0.22 and 12.6 ± 0.28 respectively (Fig. 3).
- The Edison Park (urban) population was significantly taller than all other populations (21.5 cm ± 0.41, $p< 0.006$), both urban and rural (Fig. 4). Despite significant variation in plant height among urban and rural populations, only one rural and urban population failed to significantly differ, Morton Arboretum and Ashland/Kinzie (17.2 cm ± 0.34 vs. 17.1 cm ± 0.34, Fig. 4).
- The greatest leaf area was seen in Chicago/Howard (13.8 cm2 ± 0.48; urban) and 45th/Halsted (12.2 cm2 ± 0.43; urban). Lowest leaf area was observed in plants from Morton Arboretum (9.1 cm2 ± 0.38; rural) and Midewin National Tallgrass Prairie (9.8 cm2 ± 0.34; rural) (Fig.5).

Conclusions

The results demonstrate that urban and rural populations of common milkweed significantly differ in early life history characteristics, which points to a potential genetic divergence and the development of an urban ecotype. The use of native plants in urban green space is essential for creating pathways for pollinators through the city, allowing gene flow through an area that would normally act as a barrier. Specifically, the use of milkweed species is vital for supporting the monarch butterfly migration. Urban plant ecotypes may prove particularly essential to this end, as they are uniquely adapted to succeed in stressful urban conditions. As cities continue to expand, integrating common milkweed, an important food source for a wide variety of organisms, is increasingly important for developing spaces in cities that can support insect pollinators and other wildlife. The maintenance and growth of urban pollinator communities is likewise key to the success of urban farming, an increasingly common practice. Pollinator-friendly spaces in cities, which would likely include common milkweed, have the potential to support diminishing local pollinator communities and aid in the recovery of an iconic butterfly species.

Future research

The results of this study indicate the effects of urbanization on common milkweed has led to population divergence, but as it was conducted in a greenhouse setting, fails to speak to how these differences play out in the field. This May a reciprocal transplant study was initiated to further investigate the potential of an urban ecotype. Plants from all eight study populations were planted at both a rural (Midewin National Tallgrass Prairie) and urban (Rodeo Farm, Chicago, IL) field site. Plants are monitored monthly for the same growth parameters outlined above, and for reproductive success starting in year 2. If urban populations outperform rural populations at the urban field site, this would demonstrate home-site advantage and indicate milkweed plants from urban populations are uniquely adapted to persist in the urban environment.

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