Defining Germination Tolerance Ranges for Three Milkweeds *(Asclepias spp)*

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Introduction

Change in Climate: By the end of the century, the Midwestern United States is projected to experience a rise in temperature and precipitation, potentially impacting plant performance (Table 1). Each life stage has an environmental tolerance range (TR) bounded by maximum and minimum values for factors such as temperature and moisture. The breadth of this TR dictates how sensitive taxa will be to changes in climate.

Early life stages: Dormancy break and germination are predicted to have a more narrow TR than adult plants, suggesting a large potential bottleneck to plant recruitment under climate change.

Restoration Relevant: Decline in the monarch overwintering population has been linked to the highly successful eradication of milkweed plants from agricultural settings.

Seed Sourcing: Monarch conservation efforts have led to a heightened demand for genetically appropriate milkweed, yet little is known about how early life stages differ at both the species and population level. Understanding how TR varies is critical to sourcing optimal seed for habitat creation.

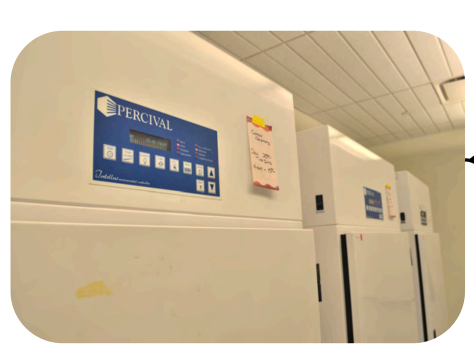
Objective: Investigating tolerance range for dormancy break and germination for three species of milkweed (*Asclepias spp.)* collected along a latitudinal gradient

Season	Year	Temperature	Precipitation
Winter	2030	↑ 1.6-2.2°C	↑ 0 to 15%
	2095	↑ 3.8-7.2°C	↑ 0 to 20%
Summer	2030	↑ 2.2-4.4°C	↓ -5 to 0%
	2095	↑ 5-9.4°C	↓ -15 to 0 %

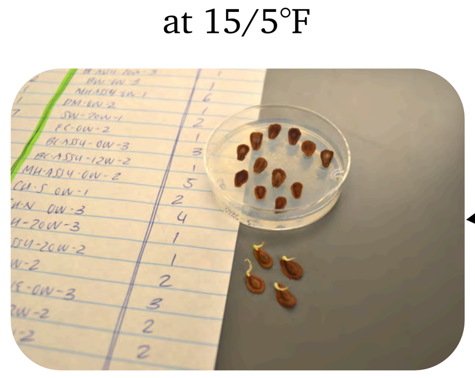
Table 1: Projected temperature and precipitation[2]

Methods

After surface sterilization in 8% bleach solution, 16 seeds are placed in petri dishes on agar (1.5%) medium, and cold stratified for 0,4,8,16 or 20 weeks

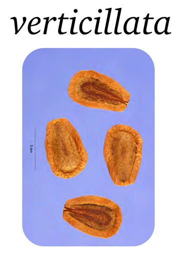


Seed dishes are placed in two temperature controlled incubators for 32 days at 25/15°F or 36 days at 15/5°F

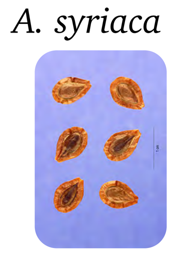


Germination scored every 48 hours

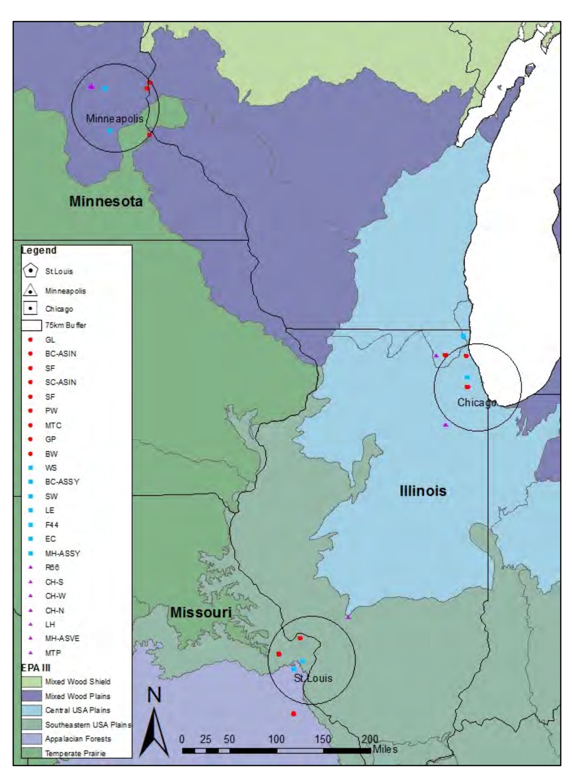
A. verticillata



A. syriaca



A. incarnata



Seed Collections were made from 9 populations of each milkweed species (*Asclepias syriaca, A. incarnata, A.verticallata*) within a focus of 75 km radius from Minneapolis, MN, Chicago, IL and St.Louis, MO.

Viability testing was conducted to check for dormant (A) or dead seeds (B)

Results

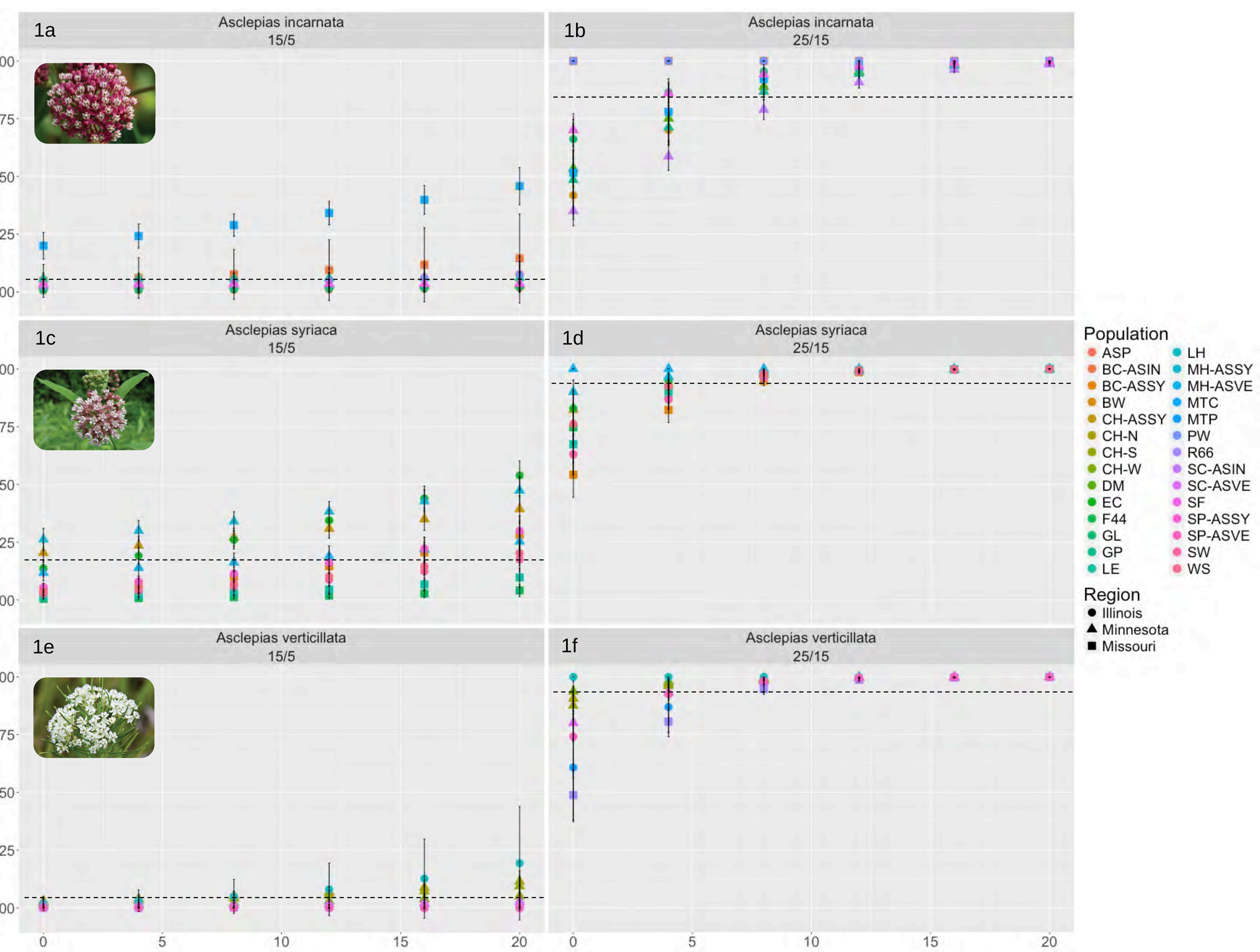


Figure 1. Proportion of germinated seeds by population for each cold stratification (3°C) treatment length. Dotted lines mark mean germination value for each species at each temperature regime. Both population samples experienced a positive correlation with cold stratification length and proportion germinated (1a - 1f). Highest proportion of germinated seeds for *A. verticillata, A. syriaca, and A. incarnata* were collected from Illinois, Minnesota, and Missouri respectively.

2a	Mean ± SE		
	15/5°F	25/15°F	Overall
A. verticillata	3.12% ± 2.5	95.0% ± 2.54	49.06% ± 2.50
0	1.14% ± 0.93	79.47% ± 9.49	40.30% ± 5.20
4	1.59% ± 1.23	93.0% ± 4.04	47.34% ± 2.64
8	2.24% ± 1.70	98.12% ± 1.25	50.18% ± 1.47
12	3.15% ± 2.40	99.52% ± 0.36	51.33% ± 1.38
16	4.43% ± 3.46	99.87% ± 0.10	52.15% ± 1.78
20	6.18% ± 4.98	99.99% ± 0.02	53.07% ± 2.50

2b	Mean ± SE		
	15/5°F	25/15°F	Overall
A. syriaca	17.04% ± 3.41	94.0% ± 2.0	55.47% ± 2.68
0	9.02% ± 2.32	75.37% ± 7.09	42.19% ± 4.71
4	11.31% ± 2.51	91.45% ± 3.09	51.38% ± 2.80
8	14.22% ± 2.80	97.53% ± 1.05	55.89% ± 1.92
12	12.84% ± 3.30	99.33% ± 0.33	58.60% ± 1.81
16	22.28% ± 4.15	99.82% ± 0.10	61.05% ± 2.13
20	27.55% ± 5.40	99.99% ± 0.03	63.76% ± 2.50

2c	Mean ± SE		
	15/5°F	25/15°F	Overall
A. incarnata	6.87% ± 3.63	88.20% ± 3.0	47.53% ± 3.3
0	4.62% ± 2.64	62.0% ± 7.60	33.26% ± 5.14
4	5.36% ± 2.84	80.3% ± 5.33	42.86% ± 4.0
8	6.2% ± 3.14	91.6% ± 2.71	48.93% ± 2.92
12	7.19% ± 3.61	96.9% ± 1.21	52.0% ± 2.42
16	8.30% ± 4.32	98.9% ± 0.52	53.60% ± 2.42
20	9.58% ± 5.24	99.5% ± 0.22	54.60% ± 2.73

Table 2. All three species experienced optimal germination conditions for samples cold stratified for 20 weeks, at 25/15°C (highlighted in tables 2a, 2b,2c). *A.verticillata* is the species with the highest average germination rate at both temperatures.

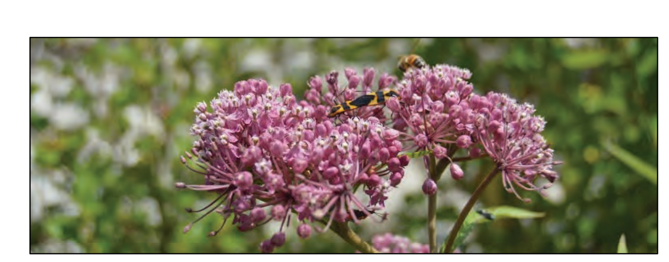


Figure 2: Milkweed pollinator garden

Study Genus

Three highly restoration relevant forbs supporting many specialist herbivores, are an important resource for nectarine pollinators, and are the obligate host plant to the monarch butterfly (Figure 2). This genus also has wind dispersed seeds and is characterized by its white latex sap containing cardenolide compounds, contributing to its toxicity.

Asclepias incarnata (Swamp Milkweed)
- Mostly self-compatible but self-incompatibility found occasionally
- Pollinated by large bees, butterflies and wasps

Asclepias syriaca (Common Milkweed)
- Mostly self-incompatible
- Pollinated by large bees, and butterflies

Asclepias verticillata (Whorled Milkweed)
- Primarily Self Incompatible
- Pollinated by small bees, and wasps

Discussion

Inter- and Intraspecific Variation: Our results identified significant differences in milkweed germination among species, regions, and populations throughout the Midwest U.S. Current seed sourcing guidelines for milkweed exist only at the genus level. Increased understanding of inter- and intraspecific variation in early life stages of milkweed is critical to efficient propagation and the success and longevity of restoration efforts.

Monarch Migration: The predicted increase of spring temperatures will cause milkweed germination to occur earlier. These changes of phenology upon a single species holds potential to alter ecosystem efficiency. The monarch migration may change as a result, as they time their northward migration to the emergence of milkweed.

Seed Sourcing: Marked impact upon seed germination in response to simulated winter length and spring temperature changes were found between species and populations. These findings have the potential to inform best practices in seed sourcing for restoration. Implementing optimal milkweed ecotypes decreases management time and cost, two major limiting factors in restoration. More so, given rapid anthropogenic climate change, local genotypes may no longer be the best suited for restoration, and sourcing seeds from southern climates may assure greater survival.

Acknowledgments

Sincere *thank you* to my mentor Jessamine Finch, for guiding me towards success, Tia Chung and my College First intern for additional help, as well as the NSF for funding my research through the Chicago Botanic Garden (2016 Research Experience, *Plant Biology & Conservation Research Experiences for Undergraduates - From Genes to Ecosystems* (DBI-1461007).

CHICAGO BOTANIC GARDEN

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