Milkweed Phenology Across Environmental Gradients: Ecological Risks and Restoration Guidance

UC SANTA BARBARA
Marine Science Institute

Kaitlin B. Crane and Adam M. Lambert
University of California, Santa Barbara

INTRODUCTION

Western monarch butterfly (*Danaus plexippus*) populations have declined sharply in recent decades, largely due to habitat loss and degradation[1,2]. Monarchs are iconic pollinators and serve as indicators of ecosystem health. This species relies exclusively on milkweeds (Asclepias spp.) during their breeding cycle. Climate change, anthropogenic disturbance and non-native plant introductions are altering these habitats[1].

Non-native tropical milkweed (*A. curassavica*) is the most readily available species available to the public, but likely acts as an ecological sink, as its evergreen growth disrupts cues for overwintering. Planting non-native milkweeds, especially near overwintering sites, should be avoided, as they can disrupt local ecology and monarch life cycles. Native milkweeds are a better alternative for homeowners and restoration projects because they typically senesce seasonally, signaling migration and the formation of the "super generation" critical for population sustainability.

Concerns exist that native milkweeds in mild coastal climates may also fail to enter dormancy, potentially creating risks similar to tropical milkweed. Consequently, planting native milkweeds near coastal overwintering grounds has been discouraged. However, it remains unclear whether coastal native milkweeds enter winter dormancy and how this affects monarch overwintering behavior.

OBJECTIVES

To inform selection of native milkweed species as alternatives to planting non-native tropical milkweed by evaluating native milkweed phenology and monarch caterpillar use in coastal vs. inland habitats.

Guiding Questions

1. Does native milkweed growing along the coast have reduced dormancy or shifts in phenology relative to inland populations?
2. What are the ecological implications of winter breeding behavior in monarchs associated with year-round host plant availability?

METHODS

Study Sites

Two common gardens were established along an environmental gradient in California:

- **Coastal site:** Goleta, CA – mild maritime climate
- **Inland site:** Fillmore, CA – greater temperature and precipitation extremes

Each garden contained 109 *Asclepias fascicularis* (Narrowleaf milkweed) plants planted in a randomized design. Plants were grown from seed collected from six source populations spanning a coastal/longitudinal gradient from Los Alamos, CA to San Diego, CA.

Surveys & Measurements

- **Phenology and Reproductive Phases:** Bolting, flowering, fruiting, senescence, dormancy
- **Monarch use:** Counts of caterpillars and chrysalides
- **Insect activity:** Associated arthropod abundance per plant

Statistical Analyses

We are currently analyzing data in R using Generalized Linear Models (GLMs) and Generalized Additive Models (GAMs) to improve the predictive capacity of plant growth responses across environmental gradients.

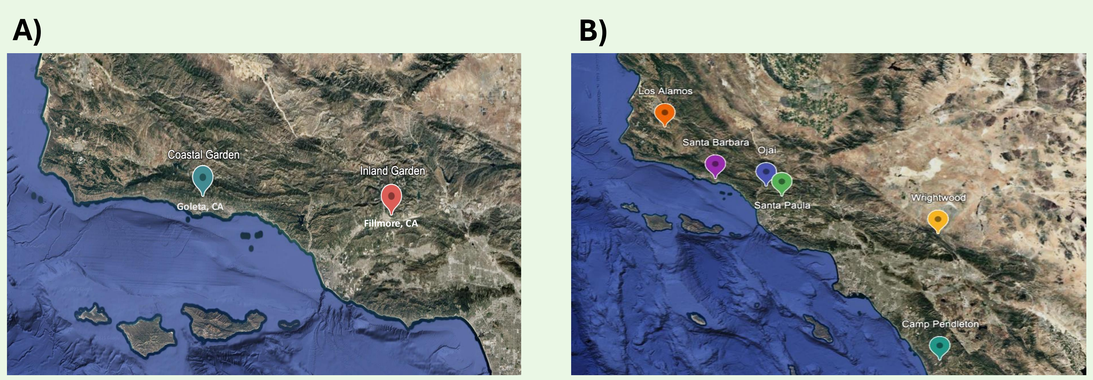

Fig. 1. A) Geographic locations of the study sites. **B)** Source locations of the milkweed plants used at each site.

PRELIMINARY RESULTS

Fig. 2. *Seasonal patterns of milkweed growth, use, and reproduction, and monarch migration.* **A)** Average monthly vegetative volume per plant. **B)** Proportion of plants with caterpillars. **C)** Coastal flowering phenology (shaded = dormancy). **D)** Inland flowering phenology (shaded = dormancy). **E)** Monarch migration cycle illustration.

DISCUSSION

Preliminary Observations

Clear differences in phenology, caterpillar abundance, and vegetative volume were observed between inland and coastal sites.

- Coastal milkweed: partial growth continues through winter; monarch caterpillars present.
- Inland milkweed: full dormancy in winter; no caterpillars observed.

Ecological Implications

- Continued winter plant growth in coastal areas may preclude full dormancy, facilitating limited off-season breeding.
- Findings align with research showing evergreen milkweed can facilitate winter oviposition and caterpillar activity.
- Slight potential for ecological sink and altered adult behavior, however it remains unclear if there is sufficient biomass available during the winter to impact monarchs on a biologically relevant scale.

RESEARCH & MANAGEMENT IMPLICATIONS

- Further studies are needed to determine to what extent available biomass influences overwintering behavior
- Establish monarch habitat using milkweeds sourced from regionally appropriate populations to align with local climate and ecological dynamics.
- Prioritize planting a diversity of native Asclepias spp., as monarchs may show limited preference for *A. fascicularis*, especially compared to tropical milkweed
- If tropical milkweed is present, cut back in winter to mimic natural dormancy and reduce potential ecological disruption.

FUTURE WORK

- Assess how genetic and environmental variation influence phenology to guide native plant sourcing for restoration.
- Investigate ecological and biological consequences of winter monarch breeding on fitness and migration.
- Examine how climatic patterns and fine-scale microclimate variation influence dormancy thresholds and long-term phenological trends.

REFERENCES

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ACKNOWLEDGMENTS

We thank Dr. Steven Hollstien, Ron Mercord, and Tom Landis for their assistance and support throughout this project, and the staff of Lambert Lab and Santa Clara River Conservancy for their assistance in fieldwork and data collection.