

# The evolution of novel traits:

## Measurements of selection on floral traits in two species of milkweed

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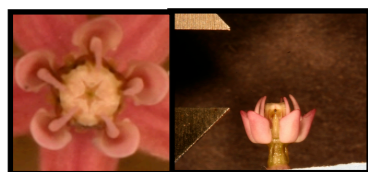
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### Introduction

- Previous studies on novel traits have focused on development and genetics. We lack studies that address the adaptive value of novel traits in the field.
- Members of the genus *Asclepias* (Apocynaceae) have an entirely novel floral structure. Each flower has an attracting “corona,” which consists of five cup-shaped hoods that hold the nectar reward, a curved horn within each hood, all arranged around the cylindrical gynostegium formed by the fused male and female whorls.
- These basic floral components are conserved across the 140 species of *Asclepias*; however, the species differ in floral color, size, and relative proportions of these traits.
- Looking for trends in selection in multiple *Asclepias* species will improve our understanding of the adaptiveness of the floral traits.
- The species in this study are visited by an array of pollinators that include both native and non-native insect species, namely butterflies, bumblebees, and honeybees.
- Honeybees are a relatively recent addition to the New World, so they are a new selective agent.

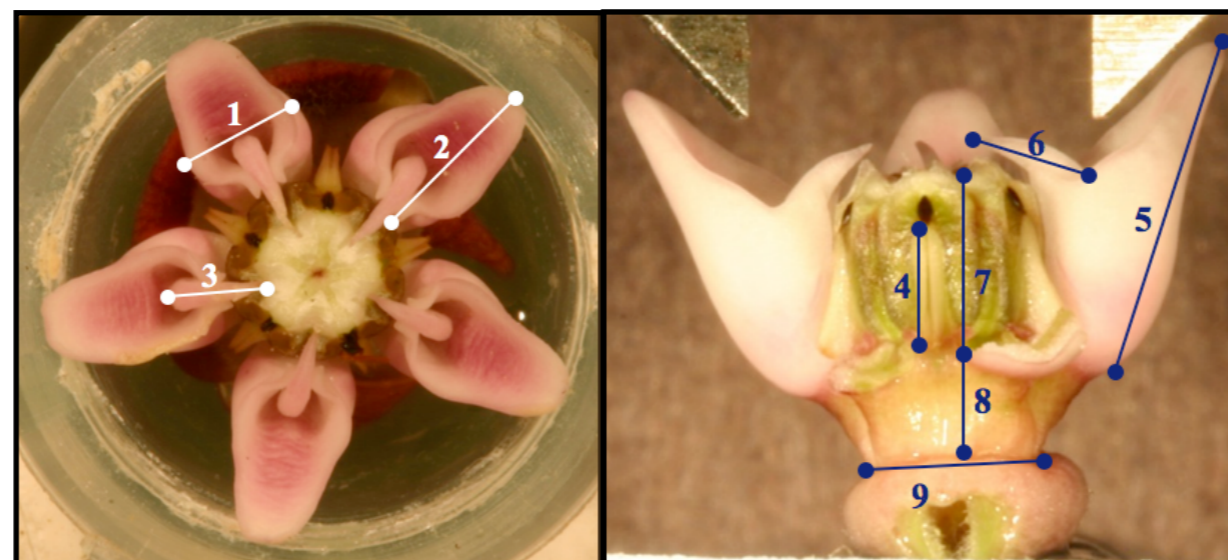
- What floral traits are adaptive?
- Is present-day selection reinforcing the differences between species?



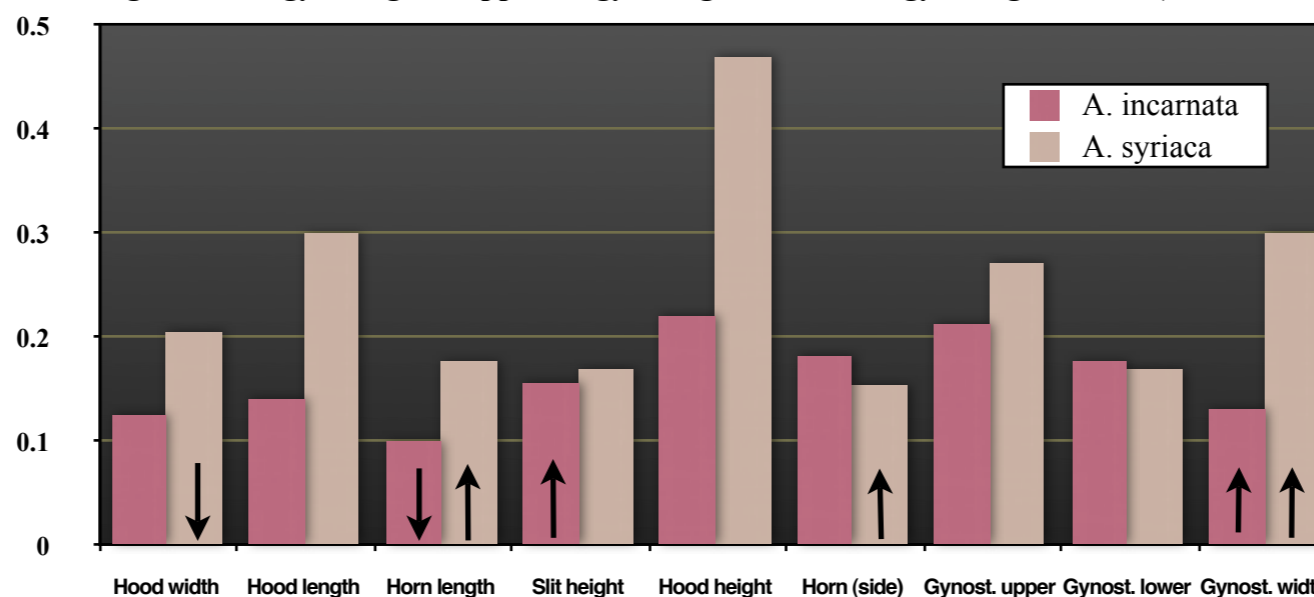
### Materials and Methods

- System
  - 2 plant species
    - Asclepias incarnata* (50 plants)
    - Asclepias syriaca* (34 plants)
  - Perennials
  - Pollination generalists
- Selection measurements
  - Measure 9 floral traits (Fig. 1)
  - Estimate fitness
    - Pollinia removal (male)
    - Pollinia insertions (female)
    - Fruit set (female)
  - Estimate selection gradients ( $\beta$ ) to determine direct selection on each trait

$$\text{Fitness} = \beta_1 \text{trait}_1 + \beta_2 \text{trait}_2 + \dots + \beta_n \text{trait}_n + e$$



**Figure 1. Top and side views of the corona and the landmarks of the nine floral traits (1, hood width; 2, hood length; 3, horn length; 4, slit height; 5, hood height; 6, horn length side; 7, gynostegium upper; 8, gynostegium lower; 9, gynostegium width).**



**Figure 2. Mean trait sizes (cm) of *A. incarnata* (pink) and *A. syriaca* (off white). Arrows indicate the direction of selection ( $p < 0.05$ , Table 1).**

**Table 1. Traits with significant selection gradients ( $\beta$ ); p-values are in parentheses.**

Species/Trait	Hood Width	Horn Length	Slit Height	Horn Length (Side)	Gynostegium Width
<i>A. incarnata</i>		-0.08 (0.019)	0.18 (0.019)		0.08 (0.018)
<i>A. syriaca</i>	-0.21 (0.041)	0.39 (0.046)		0.23 (0.034)	0.34 (0.004)

### Future Plans

- Frame-by-frame video analysis of pollinator visits to better understand how the unusual floral traits function
- Note differences between pollinator species in visitation and efficiency
- Use natural variation or manipulate the presence of honeybees to determine the selection they exert
- Add populations and increase sample size; estimate quadratic selection
- Are honeybees exerting complementary or conflicting selective pressures compared to native pollinators of *Asclepias*?

### Results

- Asclepias syriaca* is larger than *A. incarnata* for all traits except for the length of horn that protrudes from the hood (Trait 6 on Fig. 1; Fig. 2).
- There is evidence that at least five of the nine traits are adaptive (Table 1).
- Selection is positive for nearly all the traits that show significant directional selection.
- Selection for decreased hood width in *A. syriaca* means less overlap between the hood and the stigmatic slit region, possibly increasing insect contact and thus successful pollination.
- Horn length is the only trait that has selection to reinforce the size difference between the species (Fig 2).
- The rest of the traits do not show this reinforcement and instead just show a trend for larger/longer traits, with the exception of hood width in *A. syriaca*.

### Discussion

- There is selection to increase the size of several floral traits in *A. syriaca* and *A. incarnata*.
- It is unknown which pollinators are most effective on these species and what selection they exert.
- If honeybees are effective pollinators, as they are for *A. tuberosa* (Fishbein 1996), then plants might currently be adapting to this new selective agent.
- Since there appears to be no consistent trend to reinforce the size differences in these two species, it may be that honeybees are acting to reduce the trait differences by being major visitors to both species.

### Citations

Fishbein, M., D. L. Venable. 1996. Diversity and Temporal Change in the Effective Pollinators of *Asclepias Tuberosa*. *Ecology*. 77:1061-1073.

### Acknowledgements

Thank you to the Field Ecology and Evolution class at KBS for sharing their data.