Genetic correlation between flowering time and pollen to ovule ratio in *Clarkia*

Deanna Duffy, Dr. Leah Dudley, Dr. Susan Mazer

Biological Sciences, Santa Barbara City College & Ecology, Evolution , and Marine Biology at UC Santa Barbara

Clarkia xantiana ssp xantinana

We test whether a genetic correlation exists between life history and sexual allocation traits. More specifically through a greenhouse selection experiment, we determine if date of first flower and the ratio of pollen to ovules (P:O) within a flower are genetically correlated. Across taxa, P:O ratio tends to be lower in those that flower early. We use a California native, wild herbaceous, flowering plant, *C. xantiana ssp xantiana*. In a greenhouse selection experiment, we selectively bred for early flowering from field collected (population H99) maternal families of *C. xantiana ssp xantiana*. We then compared the P:O ratio between maternal families of the early flowering line and a control line (randomly mated). Based on across taxon comparisons, we predict that there is a genetic correlation between flowering time and P:O ratio. If this is the case, then the P:O ratio will be lower for early flowering lines when compared to the controls. A contrasting prediction (i.e. no genetic correlation between the two traits) that would not conflict with cross-taxon comparisons would show no difference in P:O ratio between the early flowering and control lines, indicating that the two traits must evolve independently.

Commonly known as Gunsight fairyfan Clarkia

Introduction

Sexual Allocation

Pollen: ovule ratio is a measure of sexual allocation. Sexual allocation is the amount of resources a plant allocates to male versus female function. This has a direct effect on a plant's reproductive success.

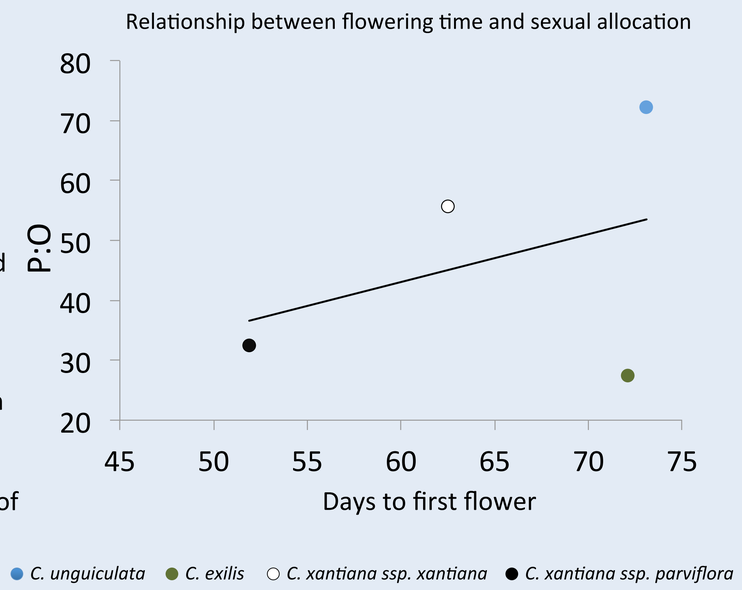
Flowering Time

This has a major affect on a plant's success. A plant needs to flower when their pollinators are available and when the seasonal conditions are optimal.

Genetic Correlation

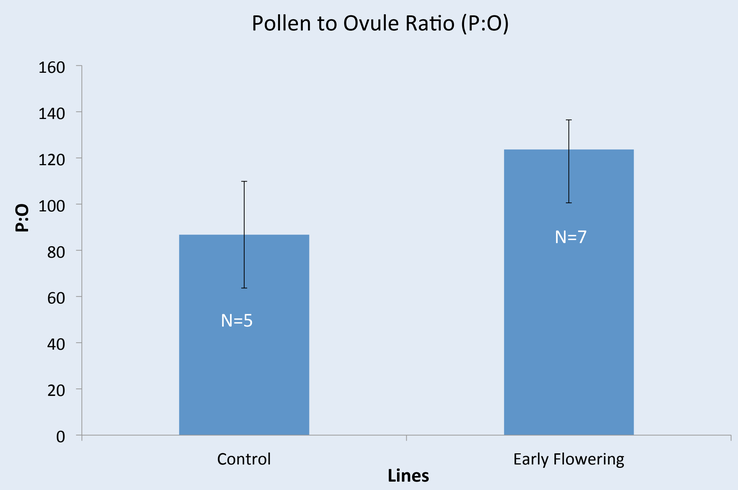
This may be caused by pleiotropy where a single gene effects more than one phenotypic trait or Linkage when traits are controlled by genes located on the same chromosome.

A positive correlation may occur if an increased value of one trait is always paired with an increased value in another trait; a negative correlation occurs when an increase in one trait corresponds to a decrease in the other.



Observed positive correlation between flower time and P:O ratio across taxa

Results



The average P:O ratios for maternal families of the control and early flowering lines. The average P:O ratio is higher in early flowering plants, although preliminary analysis shows there is no statistical difference between the two. Data suggest that these traits are not genetically correlated.

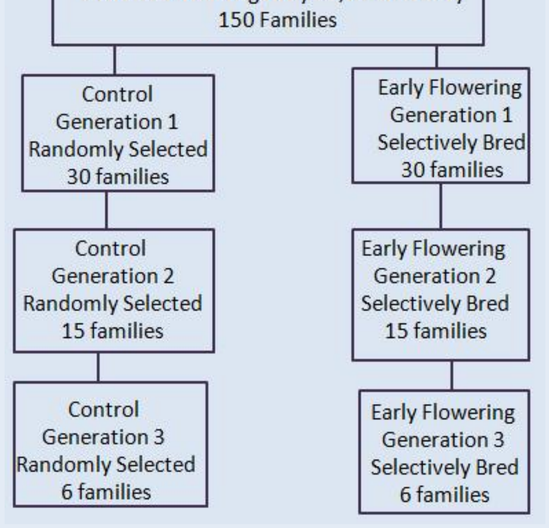
Methods

Collection Site

Clarkia xantiana is found in the southern regions of the Sierra Nevada Mountains, just east of Bakersfield. The population I'm focusing on was collected from Kern County near Lake Isabella in 2007.

Greenhouse Selection Experiment

I am comparing the P:O ratio between two selection lines: one selected randomly and one selected for early flowering.



Selection experiment design. Data is from generation 3.

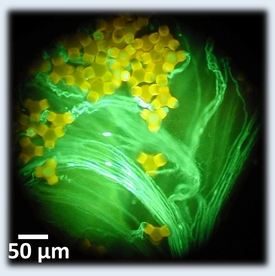
First Flower Date and Bud Collections

As a plant grows it matures from the bottom up. Flower buds lower on the stem will open first. For each plant, the first flower date was recorded after the 1st bud opened. Then we collected the next available bud. The bud contains the anthers, where pollen is made and stored. Ovaries were removed from the buds and stored in the freezer until they could be dissected. The ovules are made and stored within the ovary. The buds were then opened, the anthers removed and stored in a micro-centrifuge tube until they could be prepped to count.

Clarkia bud with inferior ovary

Pollen Counts

The anthers were placed into 1000 µl of solution and cut up in order to release the pollen. Three slides for each flower are made using 20 µl of solution per slide, giving a dilution factor of 50. Every slide is double-counted using a dissecting microscope and the average of these counts is multiplied by 50 in order to estimate the total number of pollen grains per flower.



Clarkia pollen grains

Ovule Counts

Ovaries are dissected under a dissecting microscope and each ovule is counted.

Dissected *Clarkia* ovary with ovules

C. xantiana ssp xantiana growing in the greenhouse on the UCSB campus

Conclusion

If sex allocation and flower time are selected for independently, there must be a selective advantage in order for both of these traits to evolve together. Future studies should consider these two traits separately in trying to understand the evolutionary advantages/ disadvantages of life history and sexual allocation.

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Works Cited

Mazer, Susan J.; Dudley, Leah S.; Delesalle, Veronique A.; Paz, Horacio; Galusky, Preston."Stability of pollen-ovule ratios in pollinator-dependent versus autogamous *Clarkia* sister taxa: testing evolutionary predictions" *New Phytologists* 183 (2009): 630-648.

Dudley, L. S.; Mazer, S. J., Gulusky,P. "The joint evolution of mating system, floral traits and life history in *Clarkia* (Onagraceae): genetic contraints vs. independent evolution" *Journal of Evolutionary Biology* 20:6 (2007): 2200-2218