Pollinator type and offspring fitness

Ashley Burgos[1,2], Zoe Diaz-Martin[2], Krissa Skogen[2], Kathleen Kay[3], Jeremie Fant[2]

[1] Roosevelt University, [2] Negaunee Institute for Plant Conservation Science and Action, Chicago Botanic Garden, Glencoe, IL, [3] Department of Ecology and Evolutionary Biology, University of California, Santa Cruz, 130 McAllister Way, Santa Cruz, CA

CHICAGO BOTANIC GARDEN
2021 Research Experiences for Undergraduates Program
REU Site: *Plant Biology & Conservation Research Experiences for Undergraduates - From Genes to Ecosystems* (Supported by NSF award DBI-0353752).

Introduction:

- Larger bodied pollinators are typically more mobile and travel further distances compared to smaller pollinators.
- Highly mobile pollinators are more likely to visit more flowers across a larger area compared to pollinators that forage locally.
- The farther a pollinator is able to travel, the likelihood of collecting pollen from unrelated plants increases.
- Plants fertilized by un-related pollen sources will produce offspring with higher fitness[1].

Objective: Determine how pollinator type influences offspring fitness

Prediction 1 : For *Clarkia breweri*, plants pollinated by larger hawkmoths (*Hyles lineata*) would have higher seed viability, germination rates, flower number and lower offspring mortality.

Prediction 2 : For *Clarkia concinna*, plants pollinated by the larger Carpenter bee (*Xylocarpa sp.*) would have higher seed viability, germination rates, flower number and lower offspring mortality.

Study system: *Clarkia concinna and C. breweri*

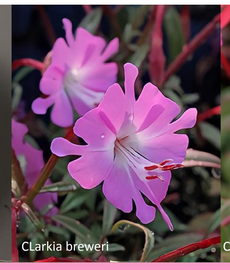
- *C. concinna* extends from central to northern CA and grows in the understorey of woodlands and evergreen forests
- *C. breweri* has a limited range extending to southern CA, growing in steep, rocky exposed hillsides.

Methods:

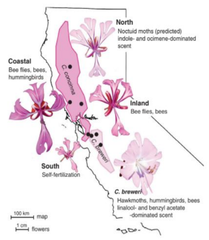
- In 2004 plants were grown in a greenhouse, planted outdoors, and observed. Each plant was covered after it was visited by a single pollinator.
- The seeds were then harvested and sown on agar in petri dishes.
- Seeds that germinated were sown in soil and placed in a greenhouse.
- After approx. 2 months, we counted the total number of flowers produced.


Plant trays

Seeds sown on agar


CLarkia breweri


CLarkia concinna

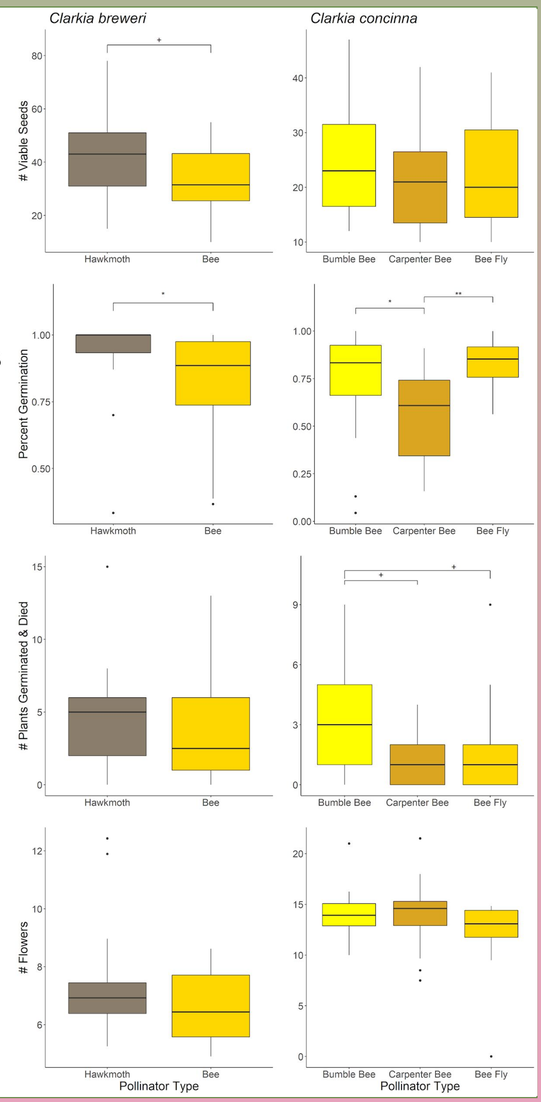


Acknowledgements: I want to thank my mentor Zoe Diaz-Martin, and my mentee Xuan An Nguyen. Also, everyone who helped work on this project; Kat, Andrew, and Alyssa. Lastly, the chicago botanic garden, the NSF for funding and the biodiversity grant.

References: [1]Breed, M. F., Marklund, M. H., Ottewell, K. M., Gardner, M. G., Harris, J. B. C., & Lowe, A. J. (2012). Pollen diversity matters: revealing the neglected effect of pollen diversity on fitness in fragmented landscapes. Molecular Ecology, 21(24), 5955-5968.
[2]Kay, K. M., Zepeda, A. M., & Raguso, R. A. (2019). Experimental sympatry reveals geographic variation in floral isolation by hawkmoths. Annals of botany, 123(2), 405-413.
[3]Miller, T. J., Raguso, R. A., & Kay, K. M. (2014). Novel adaptation to hawkmoth pollinators in Clarkia reduces efficiency, not attraction of diurnal visitors. Annals of botany, 113(2), 317-329.
[4]U.S. Forest Service. (n.d.). Retrieved from https://www.fs.fed.us/wildflowers/pollinators/pollinator-of-the-month/bee_flies.shtml
[5]Wessinger, C. A. (2021). From pollen dispersal to plant diversification: genetic consequences of pollination mode. New Phytologist, 229(6), 3125-3132.

Results:

- Plants pollinated by hawkmoths tended to produce more viable seeds than those pollinated by bees (F-value = 2.95 0.096).
- Seeds pollinated by hawkmoths had significantly higher germination rates compared to those pollinated by bees (chi-squared = 11.58, p = 0.033).
- Seeds pollinated by bumble bees and bee flies had significantly higher germination rates compared to those pollinated by carpenter bees (p = 0.030 and p = 0.002, respectively).
- Plants pollinated by carpenter bees and bee flies tended to have fewer plants that germinated and died compared to bumble bees (p = 0.087, both).
- There was no significant difference in the number of viable seeds or number of flowers produced in offspring pollinated by hawkmoths or bees, nor by bumble bees, carpenter bees, and bee flies (p > 0.05).
- There was no difference in the number of offspring that germinated and died for plants pollinated by hawkmoths and bees (p > 0.05)



Discussion:

- Our research suggests that hawkmoths are more effective pollinators for *C. breweri* than are bee species. The difference in effectiveness between hawkmoths and bees is probably due to the different sizes of the pollinators. Hawkmoths and *C. breweri* over time have developed a close evolutionary relationship which allows effective pollination[2]. Their large size allows them to contact the stigma and anthers of the *C. breweri* when pollinating, compared to small bees that rarely contact the stigma[3]. In addition, hawkmoths travel farther than bees when foraging.
- This work highlights bee flies as potentially the most effective pollinators of *C. concinna*, followed by bumble bees. These associations might be due to the pollinator's physical characteristics[5]. Carpenter bees have a smooth abdomen, while bumble bees have hairs on their bodies which allows pollen to attach to their bodies easier. Bee flies have been found to be the most effective pollinator for other annual plant species due to their frequent visits and hair-covered bodies[4].