Activity: Mason Bees as Pollinators

Pollinator Limitation— Data Analysis

We tend to think of pollination of flowers as either "yes - the flower is pollinated," or "no - the flower is not pollinated," but the process isn't quite so clear-cut. Pollinator limitation is where a plant may not be able to maximize fruit size or seed number if too little pollen is transferred to it by pollinators. Pollinator limitation may reduce agricultural productivity and also plant reproductive success.

In this activity, we will explore the importance of bee diversity in watermelon pollination by analyzing the results of a 2018 publication by Campbell et al. and then explore pollination limitation in store bought apples with help from Garratt et al.'s 2014 study on the topic.

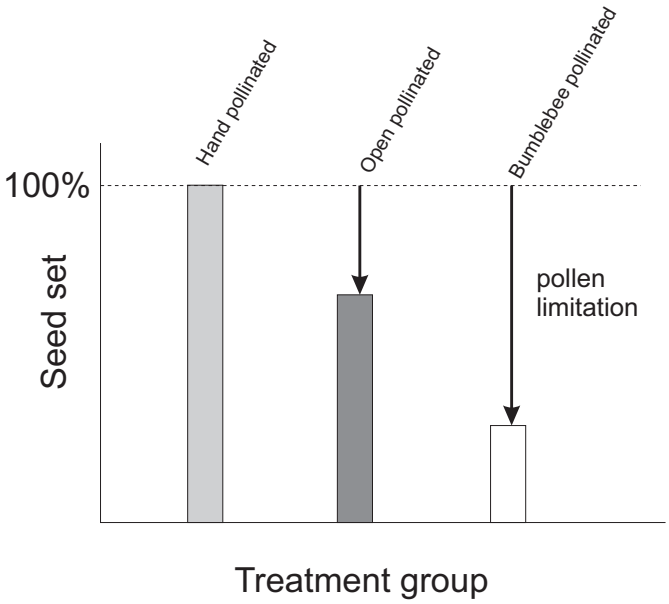

Figure 1. Pollinator limitation results in lower seed set. Plants which are fully pollinated such as hand pollinated plants have the highest seed set, followed by flowers which are able to be pollinated by many different bees species. Finally, flowers that are only pollinated by one species (in this case bumble bees) have the lowest seed set.

Part 1: Watermelon Pollination

Background

Watermelons are pollinated by a number of bee species. Managed bumblebees species such as *Bombus impatiens* are often used to help pollinate commercially grown watermelons. In their study, Campbell et al. explored how melon weight and fruit set are affected by pollinator availability. They used three treatments:

1. A bumble bee cage where all pollinators except *B. impatiens* were excluded,
2. A pollinator excursion cage where all pollinators were excluded, and
3. An open area or field where bumblebees, honeybees, and wild bees can all pollinate the flowers.

Using the figures below study how each of the trials affects melon weight and percent fruit set per flower and answer the following discussion questions.

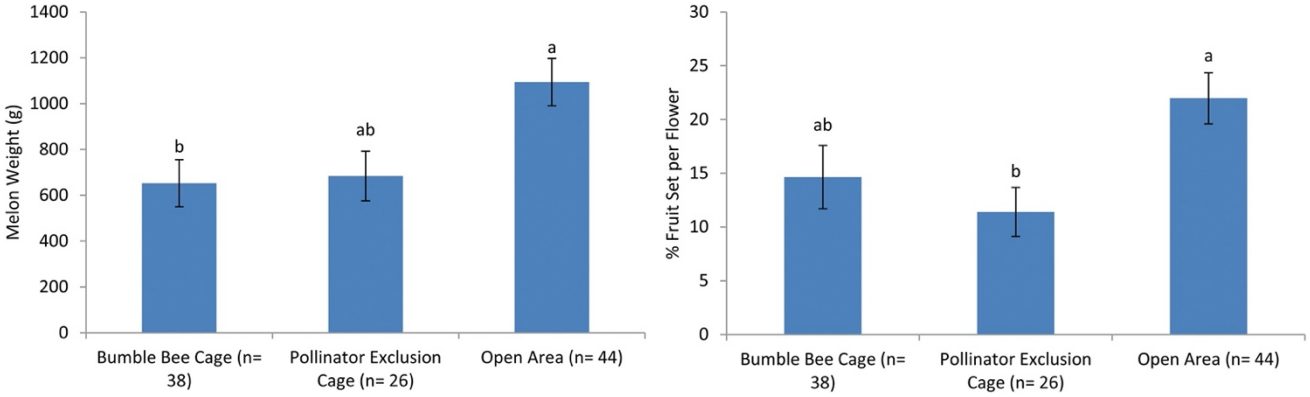

Figure 2. Left: The mean melon weight (g) for each treatment. Right: Percent fruit set per flower. The error bars represent the Standard error and different letters show a statistically significant difference (Figures from Campbell et al. 2018).

Discussion Questions

1. Describe the general relationship between each treatment. Which trial has the least pollinator limitation? Which has the greatest? Are any of the trials statistically similar?

2. If you were a watermelon farmer, how might this information inform your farming practices?

3. What other information might you want to know before making a decision?

Part 2: A hands on look at pollinator limitation in apples

Background

Fruit quality is measured using many variables including width, weight, sugar content, and number of seeds. Using these metrics, Garratt et al. evaluated how pollinator limitation may affect fruit quality in two varieties of apples. They summarized their results in the figure 3.

Note: Hand pollination is when researchers or farmers act as the pollinator and transfer pollen from one flower to another themselves, often using a small brush.

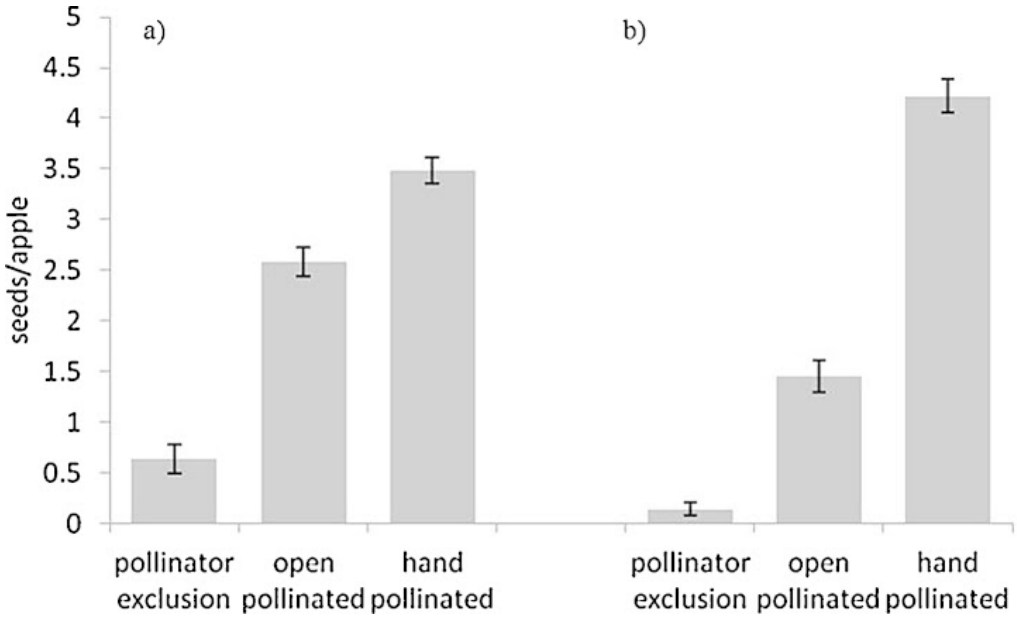

Figure 3. The number of seeds per apple in each treatment group for two varieties of apples a) cox and b) gala (Figure: Garratt et al. 2014)

A) Discuss the results: Which treatment resulted in the most seeds/apple? The least? Why might we see this relationship? Are these trends consistent between both apple varieties?

B) Hands on: Now that we have a better understanding of how pollinator limitation can affect the number of seeds per apple let us look at some apples of our own.

Supplies:

1. Apples (One per student or small group)
2. Knife
3. Balance
4. Rulers

Data collection:

1. Create a table with columns for apple width, weight, and number of seeds.
2. Apple size: Weigh each apple individually. Carefully cut the apple in half and measure the width at the widest point. Record the values.
3. Count the number of fully developed seeds in each apple and record on your data table.
4. Share your data with the class.

Data Analysis and Interpretation:

a. Using the class dataset, create a plot of the mean apple width (or weight) vs. the number of seeds per apple. Describe the relationship.

b. Is there any evidence of pollinator limitation? If so, what other information might you need to determine this with certainty? (Note: a fully pollinated apple will contain 10 seeds)

References

Campbell, J. W., Daniels, J. C., & Ellis, J. D. (2018). Fruit Set and Single Visit Stigma Pollen Deposition by Managed Bumble Bees and Wild Bees in Citrullus lanatus (Cucurbitales: Cucurbitaceae). *Journal of Economic Entomology*, *111*(2), 989–992. https://doi.org/10.1093/jee/toy008

Garratt, M. P. D., Breeze, T. D., Jenner, N., Polce, C., Biesmeijer, J. C., & Potts, S. G. (2014). Avoiding a bad apple: Insect pollination enhances fruit quality and economic value. *Agriculture, Ecosystems and Environment*, *184*, 34–40. https://doi.org/10.1016/j.agee.2013.10.032

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