Does bilateral symmetry in flowers increase pollination efficiency?

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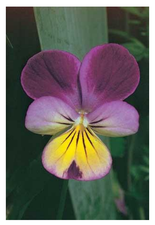
Introduction

- Several flower lineages have evolved bilateral symmetry from ancestrally radial symmetry.
- One hypothesis for this trend is that bilateral symmetry increases precision of pollen placement on pollinators.
- This would act to minimize reproductive interference amongst floral species, while maximizing the efficacy of pollen transfer.
- Little experimental evidence exists to support this hypothesis despite the logical reasoning behind it.
- We attempted to determine whether the consistency of entry angle of pollinators into a flower differs based on the floral symmetry.

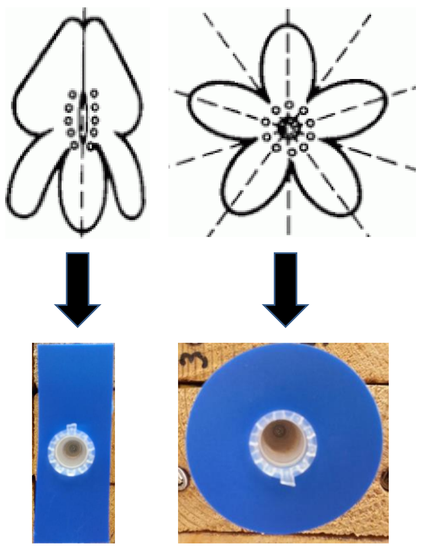


Violet (*Viola tricolor*). Example of a bilaterally symmetric flower.

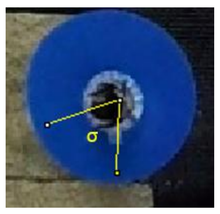
Geranium (*Geranium sanguineum*). Example of a radially symmetric flower.

Methodology

- Bumblebees (*Bombus impatiens)* were recorded visiting both radial and bilateral artificial flower setups within a flight cage.
- The angle of entry for every visit was measured and the standard deviation was determined for each bee on each symmetry.
- Degrees clockwise of vertical were measured positively, and degrees counterclockwise were negative to differentiate directionality.



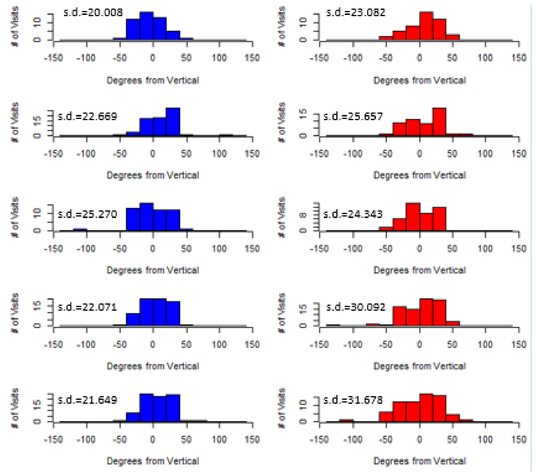
How representative floral symmetries relate to our artificial floral symmetry setups.



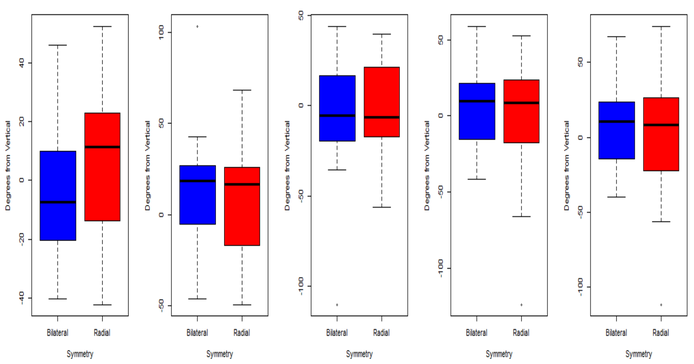
Example of a measurement of entry angle for a radial flower.

Picture of the experimental setup with both symmetries displayed.

Results



Histogram of the entry angles for all flower visits of individual bees (n=5) on each symmetry. Standard deviation values are included. Blue= Bilateral, Red= Radial.

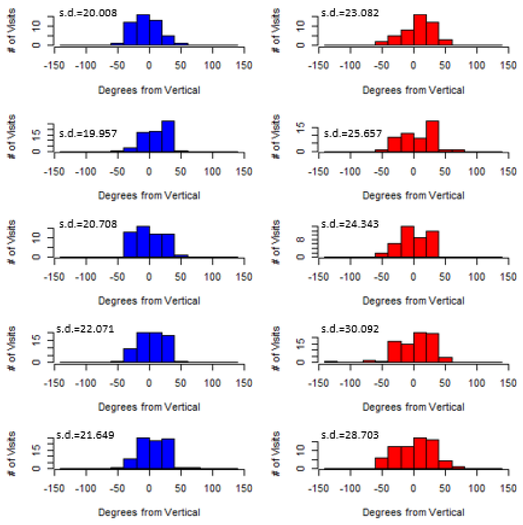


Boxplot of the entry angles for all flower visits of individual bees (n=5) on each symmetry. Blue= Bilateral, Red= Radial.

- A paired t-test was run on the standard deviations for each bee on both symmetries.

p= 0.0769 Conf. Int.= [-0.798,10.072] Avg Diff.= 4.6°

- Three of the visits exhibited specific non-motivated behaviours that we were not interested in measuring. These outliers were removed and the remaining data are presented below.



Histogram of the entry angles for all motivated flower visits of individual bees (n=5) on each symmetry. Standard deviation values are included. Blue= Bilateral, Red= Radial.

p= 0.0045 Conf. Int.= [2.850,8.143] Avg. Diff.=5.5°

Conclusions

- These results suggest that there may be a difference in the level of entry angle variation, with entries to bilateral "flowers" being more consistent.
- This provides some support for the pollen-placement-accuracy hypothesis, which provides enlightenment on why bilateral symmetry is so frequent throughout floral evolution.
- Future work could add another aspect of flower structure that often differs between symmetries (e.g., the plane the flower faces are oriented in, or the 3-dimensional shape of the flowers) to see if greater differences in entry-angle consistency are found.

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