Pollinator foraging distance, mate availability, and pollination success of self-incompatible *Dicentra canadensis*

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Introduction

- Adequate pollinator service and the availability of compatible mates are important for plant reproduction, especially in self-incompatible plants (Campbell and Husband 2007).
- Clonal growth often increases the number of genetically identical individuals in the adjacent area and reduces mate availability among nearby plants (Charpentier 2002).
- Foraging distance of pollinators may substantially influence mating patterns and reproductive success of self-incompatible plants.
- I investigated if pollinators forage among compatible plants of *Dicentra canadensis*, a self-incompatible clonal herb, and examined if its fecundity is pollen limited.

Questions

- **Are pollinators moving among cross-compatible plants?**
  - Are nearby plants less likely to be compatible mates?
  - What is the average distance of pollen transfer by pollinators?
- **Is fecundity limited by inadequate pollinator service or competible mates?**

Study system

Study species

- *Dicentra canadensis* (Fumariaceae).
- Spring ephemeral herb in eastern deciduous forests.
- Anthesis ~ 10 days in early – mid April.
- Primarily pollinated by bumble bee queens.
- Flowers stay open for 5 – 7 days.
- Strictly self-incompatible:
  - Self pollen is present on the stigma.
  - Selfing yields no seed (pers. obs.).
- Produces tubers as clonal propagules.

Study site

- Mathias Grove (N 39º35'; W 82º32'), Rockbridge, Ohio.
- Estimated *D. canadensis* density: 4.78 flowering plants/m^2.

Dicentra canadensis

Representative photograph of the study population at flowering peak.

Methods

Mate availability/distance

- Mate availability – the proportion of haphazardly paired individuals that are cross-compatible (outcross results in fertilized ovules).
- Outcrossed pairs were either: **nearest plants** (physically independent ramets, mean 0.49 m, s.d. 0.25), **20 m**, or **100 m** apart.

Pollinator foraging distance

- Observed on April 21, 22 and 24, 2008.
- 51 foraging routes (46 queen *Bombus* sp, 2 *Xylocopa virginiana* and 2 *Bombylius* sp.)
- Measured the pollinator's foraging distance
  - between two sequentially visited plants (e.g. Fig. 1, X_n).
  - every 6 subsequently visited flowers* (e.g. Fig. 1, $X_1 + X_2 + X_3$)

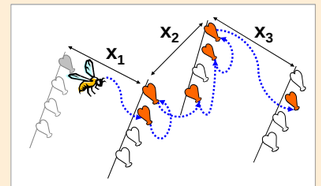

Figure 1. Illustration of a bee visiting 6 flowers* subsequently on 3 plants after leaving a pollen donor.

* Note: a previous study estimated that most pollen was deposited within 6 flowers by bumble bees (Thomson et al. 1986)

Frequency of pollen removal (indicator of bee visitation)

- Estimated from 100 flowers on the 5th day of flowering.

Supplemental pollination experiment

- Control (natural pollination) vs. supplemental pollination with 2 pollen donors from > 100 m away.

Results

Low compatibility among nearby plants

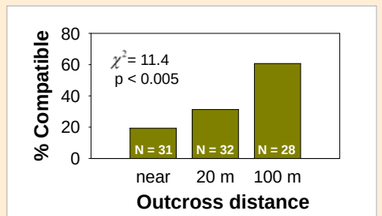

Figure 2. Frequency of compatible outcross at different distances. N = outcrossed pairs.

Pollinator movement (between plants)

- Average distance = 1.0 m (s.d. 1.12) (Fig. 3).
- Visited 2.2 flowers (s.d. 1.1) per plant.

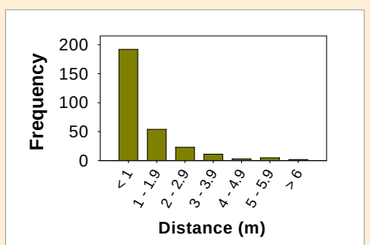

Figure 3. Frequency histogram of distances between sequentially visited plants.

Pollinator movement (6 subsequent flowers)

- On average, pollinators visited 3.01 plants (s.d. 1.01) in a 6-flower foraging bout (Fig. 4).
- Average distance of a 6-flower foraging bout = 2.84 m (s.d. 2.52) (Fig. 5).

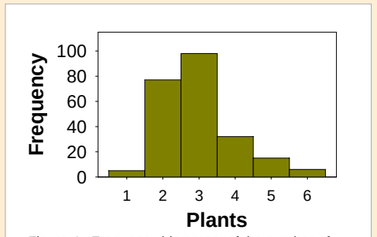

Figure 4. Frequency histogram of the number of plants visited by a pollinator in a 6-flower bout.

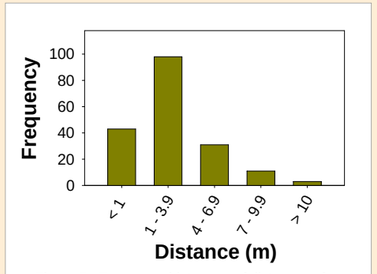

Figure 5. Frequency histogram of distances of 6-flower foraging bouts.

Results: visitation and fecundity

- 71% of flowers had been visited by pollinators on the 5th day of flowering.
- Natural fruit set was lower than expectation based on the 71% flower visitation (Fig. 6).
- Supplemental outcross with distant pollen donors produced 73% more fruits (Fig. 6) and 97% more seed (Fig. 7) than natural pollination alone.

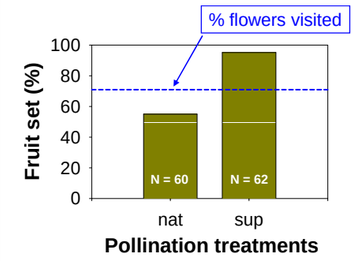

Figure 6. Comparison of fruit set from natual (nat) and supplemental outcross (sup) experiments. Sample size (N) = number of flowers. Dashed line shows the frequency of flowers that had been visited on the 5th day of flowering.

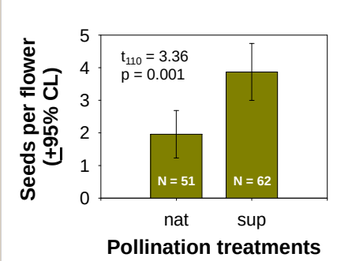

Figure 7. Seed set from natual (nat) and supplemental outcross (sup) experiments. Sample size (N) = number of flowers.

Conclusion

- There were fewer compatible mates available among nearby plants than among plants > 100 m apart (Fig. 2).
- Pollinators tend to forage among nearby plants, which are often cross-incompatible (Fig. 2 – 5).
- Fecundity of *D. canadensis* may be limited by the delivery of compatible pollen because:
  - Natural fruit set was lower than expected with flower visitation (Fig. 6)
  - Supplementing pollen from distant plants increased fruit and seed set (Fig. 6 & 7).

Future study

- Do pollinators behave differently during different stages of anthesis?
  - Low flower density during early anthesis
  - Low nectar availability per unit area during late anthesis

  } Prompt bees to move far?
- Genetic distance: are the incompatible plants clones or close relatives?
- What is the actual pollen carryover distance in this system?

References

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