Pollen deposition curves for bumblebees and leaf cutting bees with alfalfa

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ABSTRACT

Pollinators may differ on how pollen deposition is performed in sequentially visited flowers, and these patterns may be investigated by means of pollen deposition curves. In this study we compared pollen deposition curves between bumblebees and leaf cutting bees in alfalfa. Transgene (pollen donors) and non-transgene (pollen receptors) alfalfa plants placed in an experimental array in a greenhouse were visited by the bee species. The number of transgene pollen grains received and the distances between sequentially visited flowers were recorded in 15 runs for each species. The pollen deposition curves of the two bee species exhibited a statistically significant decreasing amount of pollen grains deposited in consecutive flowers, both when the flower sequence or distance traveled were considered. Bumblebees runs exhibited a less steeply curve (indicating slower depletion of pollen), further distances traveled, higher amount of flowers visited and consequently higher potential for gene flow (transgene escape) when compared to leaf cutting bees. However, among bee variability may also be important for gene flow patterns, and further data analysis are needed to better understand the differences between these two pollinator species.

INTRODUCTION

Pollinators mediate gene flow via pollen within and among crop fields, and may differ on how pollen is deposited in sequentially visited flowers. The pattern of pollen deposition will determine how quickly pollen from a given donor is depleted, and will shape spatial patterns of gene flow.

A pollen deposition curve is used to illustrate the number of pollen grains from a specific pollen donor that get deposited on flowers visited in succession during a foraging bout by a pollinator. Pollinators that deposit a greater proportion of the pollen collected from one pollen donor onto the first flowers visited, for example, will have a more steeply declining pollen deposition curve. Because most of the pollen is deposited on the first flowers visited, this type of curve is generally associated with less gene flow (less transgene escape). However, the amount of flowers visited and the distances traveled by the pollinator also influence gene flow pattern.

In this study we compared pollen deposition curves between two alfalfa pollinators.

STUDIED SPECIES

Medicago sativa
(alfalfa)

Bombus impatiens
(bumblebee)

Megachile rotundata
(leaf cutting bee)

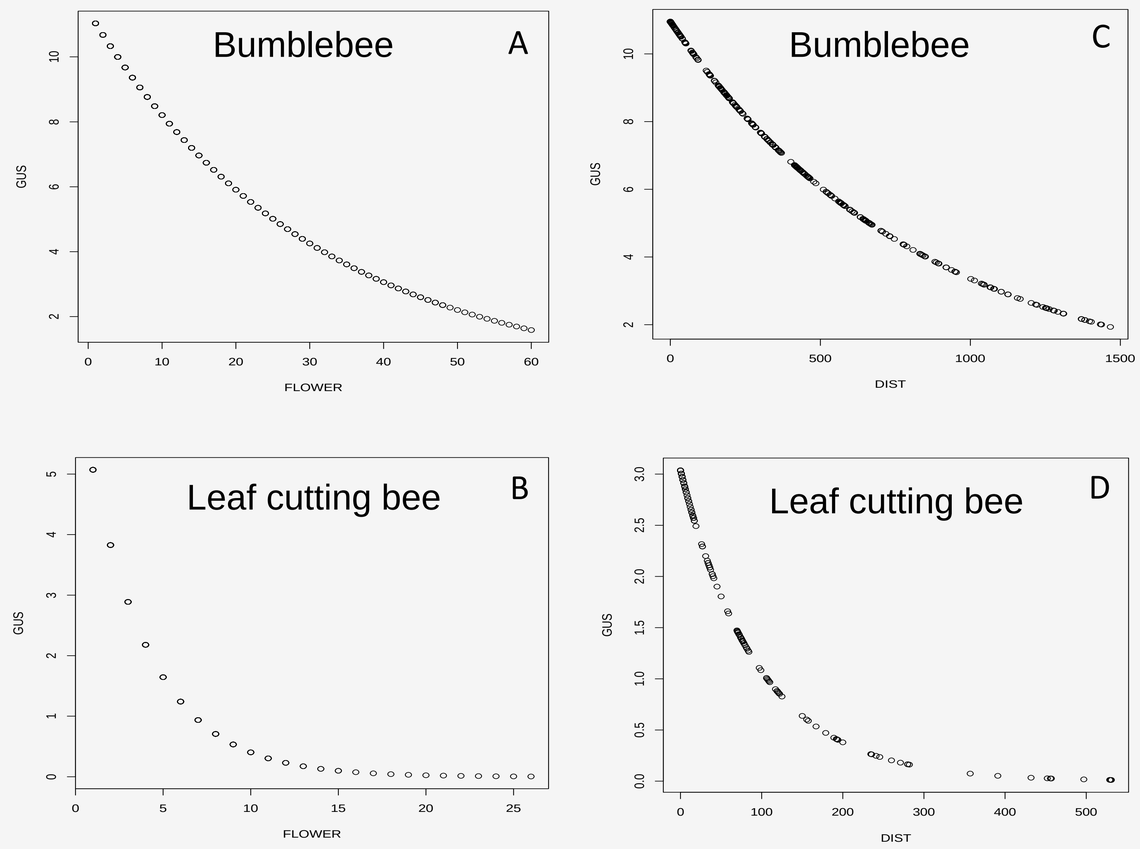
METHODS

- In a greenhouse, alfalfa plants transformed with the *Escherichia coli* β-glucuronidase gene (GUS) were used as pollen donors in an experimental array of non-transgene plants (pollen receptors) whose racemes and flowers were identified with different colors (Fig. 1 A-B);
- The sequence of flowers, inflorescences and individuals visited in 15 runs for each bee species and the distances between sequentially visited flowers were recorded;
- The visited pistils were submitted to a chemical protocol that stains the GUS pollen grains in blue (Fig. 1C);
- The number of GUS pollen grains found in each pistil was counted and fitted Poisson regressions on the number of GUS pollen grains were performed using flowers visited and distance traveled between flowers .

Figure 1: Experiment on pollen deposition. A: Array of non-GUS plants in the greenhouse. B: Marked flowers and inflorescence. C: GUS pollen grains after the chemical protocol.

RESULTS AND DISCUSSION

- The two bee species exhibited significantly declining Poisson fitted curves on the number of GUS pollen grains deposited, both when flower sequence or distance traveled were considered:



Figs. A and B GUS pollen deposition in consecutive flowers visited.
Fig *C* and *D*. GUS pollen deposition with distance traveled between sequentially visited flowers.

- Bumblebees: less steeply curve (indicating slower depletion of pollen), further distances, larger amount of flowers visited and consequently higher potential for gene flow (transgene escape).
- Leaf cutting bees: steeper curves (indicating faster depletion of pollen), closer distances, fewer flowers visited and consequently lower potential for gene flow (transgene escape).
- Although 'average' runs are important to understand the overall tendency of pollen deposition patterns of particular pollinator species, among individual variability may influence gene flow patterns, especially in leaf cutting bees.
- Further data analysis are needed to better understand the differences between these two pollinator species.

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