Do invaders come in peace?
Two invasive species as potential food resources for a generalist bumble bee

Maxime Drossart¹, Maryse Vanderplancka & Denis Michéz²

¹Laboratory of Evolutionary Biology, Research Institute for Biosciences, University of Mons – UMONS, Place du Parc 20, 7000, Mons, Belgium
²UMONS, Place du Parc 20, 7000, Mons, Belgium

Contact: maxime.drossart@umons.ac.be

Introduction

Invasive plant species are frequently pinpointed as drivers of bee decline⁶–⁹. However, their impact on bee population remains quite unclear and still controversial, as bee responses are highly variable among species (i.e., negative, positive or neutral). Changes in plant communities due to invaders could lead to predominance of new floral morphologies as well as differences in plant densities that pollinators have to deal with. Such modifications could then directly impact the energy balance of the foraging activity. Another key factor for the cost-benefit balance is probably the chemical composition of pollen which provides nutrients such as proteins.

In this work, we aimed (i) to compare the chemical composition of pollen from three native plant species, namely Calluna vulgaris, Trifolium pretense and Lythrum salicaria; as well as two invasive ones, namely Impatiens glanduliflora and Buddleia davidii, (ii) to determine whether workers display the same pollen foraging pattern on these species regardless of their invasive behaviour, and (iii) to evaluate whether invasive species affect the nutritional intake of a European native generalist bumble bee species, Bombus terrestris. Our hypothesis is that the two invasive species display an easily accessible pollen resource for the buff-tailed bumble bee, with a similar nutritional composition to the three native ones.

Methodology

Native plants

(i) Comparing the chemical composition (amino acid concentrations and profiles) of pollens (for floral and loads)

(ii) Comparing the foraging behaviour (e.g. visiting rate, foraging time) on each plant species

(iii) Comparing the foraging efficacy (i.e. pollen and amino acid intakes per hour (mg/h)) for each plant species.

Results and discussion

Table 1: The concentration (mg/g) of total free amino acids (TAA) as well as the concentrations of essential amino acids (EAA) and the proportion of EAA to TAA for the pollen of the five host plants (mean ± SD). Values with the same letter are not significantly different. A: The concentration of total and essential amino acids as well as the concentration of amino acid profiles and proteins on the pollen loads among bees from the four invasive plant species. B: The concentration of amino acid profiles and proteins on the pollen loads among bees from the four invasive plant species.

Plant species TAA content (mg/g) EAA content (mg/g) App-Glu+Glu content (mg/g) Proline content (mg/g) Plant species TAA content (mg/g) EAA content (mg/g) App-Glu+Glu content (mg/g) Proline content (mg/g)

Calluna vulgaris (n=7) 279.4 ± 19.84 a 131.5 ± 10.25 a 44.7 ± 3.45 a 16.2 ± 1.06 a Calluna vulgaris (n=7) 279.4 ± 19.84 a 131.5 ± 10.25 a 44.7 ± 3.45 a 16.2 ± 1.06 a

Trifolium pretense (n=7) 542.2 ± 32.91 b 244.3 ± 20.13 b 99.4 ± 5.37 b 36.3 ± 2.37 b Trifolium pretense (n=7) 542.2 ± 32.91 b 244.3 ± 20.13 b 99.4 ± 5.37 b 36.3 ± 2.37 b

Lythrum salicaria (n=7) 305.2 ± 26.1 a 109.4 ± 7.65 a 57.6 ± 5.07 a 19.1 ± 1.70 a Lythrum salicaria (n=7) 305.2 ± 26.1 a 109.4 ± 7.65 a 57.6 ± 5.07 a 19.1 ± 1.70 a

Impatiens glanduliflora (n=7) 222.3 ± 27.5 c 117.4 ± 10.2 c 38.3 ± 3.14 c 10.7 ± 0.86 c Impatiens glanduliflora (n=7) 222.3 ± 27.5 c 117.4 ± 10.2 c 38.3 ± 3.14 c 10.7 ± 0.86 c

Buddleia davidii (n=7) 670.0 ± 40.3 d 240.7 ± 20.9 d 47.3 ± 7.58 d 10.7 ± 1.10 d Buddleia davidii (n=7) 670.0 ± 40.3 d 240.7 ± 20.9 d 47.3 ± 7.58 d 10.7 ± 1.10 d

Statistical results: t(α=0.05) = 6.7, 5.9, 3.8, 2.5, 2.0, 1.0, 0.8

(i) Chemical suitability of B. davidii and I. glanduliflora: The five plant species contained the full spectrum of EAA but floral pollen and loads showed variable amino acid concentrations and compositions according to their botanical origin, as already highlighted in previous studies⁶–⁹. However, our results revealed that pollen loads from the studied invasive plants had on average lower concentrations of proline (amino acid involved in the flight metabolism⁶⁵–⁶⁸) compared to those from native species. By contrast, histidine (essential amino acid) was more abundant in pollen of I. glanduliflora, than in pollen of native species as already shown by Harmon-Threatt and Kremen⁷. Overall, despite these differences, I. glanduliflora and B. davidii provide resources not consistently different in terms of amino acids from native plants, suggesting that generalist bumble bees may use them without change in their global pollen diet³⁵.

(ii) Foraging behaviour: Different pollen foraging behaviours (i.e. visiting rate (Fig. 2a) and foraging time (Fig. 2b)) may be described for the five plant species: (i) a few foraging trips carrying small pollen loads; e.g., workers foraging on C. vulgaris and to a lesser extent on I. glanduliflora, (ii) many foraging trips carrying small pollen loads (e.g., workers foraging on B. davidii), and (iii) a few foraging trips carrying large pollen loads (e.g., workers foraging on T. pretense and to lesser extent on L. salicaria). All these pollen foraging behaviours are likely related to the floral morphology and not to the plant type (invasive or not).

(iii) Foraging efficacy: Considering both pollen foraging behaviour and pollen chemical composition, foraging on T. pretense provided the highest nutritive intake (Fig. 3). Evidence is that the nutritional intake was related to both host-plant morphology and pollen quality rather than to the host-plant invasive behaviour. However, further studies are needed to corroborate this finding, taking into account invasive plants with peculiar (i.e., unusual) flower morphologies and pollen composition.

Conclusion

The spread of invasive plant species directly impacts the plant community composition of invaded sites, leading to losses in plant diversity⁶⁸. Such decrease in plant diversity would be detrimental to pollinator health by affecting the nutritional intake of bees⁵⁵. Two situations can be distinguished. On the one hand, some generalist species (e.g. B. pascuorum, B. terrestris) are able to maintain their nutritional intake while incorporating new pollen resources in their diet, including invasive plant species⁶⁵–⁶⁸. On the other, this could impact a large array of oligolectic bees and species with a lower plasticity in their pollen diet that are intimately linked to native plants⁶⁵,⁶⁸. Further studies are needed on generalist species as well as specialists for a better understanding of the impact of invaders. Such understanding is clearly necessary to develop mitigation strategies for maintaining the bee diversity as well as the inherent ecosystem services.