The effects of invasive pollen on the seed set of a native plant

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Introduction:

Biotic invasions are a substantial threat to biodiversity and ecosystem functioning (Mack et al. 2000). Numerous studies have shown that invasive plant species compete for resources important to vegetative growth (Levine et al. 2003), however, competition for pollinator services by invasive plants may also impact native plant fitness by reducing reproductive success. One mechanism occurs when invasive pollen is deposited on a native stigma by pollinators who visit both species. The presence of invasive pollen on native stigmas may affect the seed set of the native species in various ways. The foreign pollen could induce stigma closure (Waser and Fugate 1986), allelopathy, or crowd out conspecific pollen on the stigma (Galen and Gregory 1989). One especially ubiquitous introduced species, *Brassica nigra* (black mustard), forms dense stands of yellow flowers and has rapidly spread throughout sensitive coastal sage scrub communities in southern California. Here, I investigate the potential effects of heterospecific pollen transfer between this exotic species and native, *Phacelia parryi*.

Objectives:

1. **Test whether the occurrence and timing of invasive *Brassica nigra* pollen affects fruit and seed production of native plant, *Phacelia parryi***
2. **Determine the extent to which *B. nigra* pollen is found on *P. parryi* stigmas in a natural field setting.**

Methods:

Objective 1: In spring of 2012, we conducted a hand –pollination experiment at the greenhouses of UC Irvine. Flowers on 28 *P. parryi* individuals received four kinds of hand-pollination treatments: *P. parryi* pollen only (control), *P. parryi* and *B. nigra* pollen simultaneously, *P. parryi* pollen 3 hours prior to *B. nigra* pollen, and *B. nigra* pollen 3 hours prior to P. parryi pollen. Experimental flowers were emasculated prior to pollination to prevent self fertilization. Each plant received two replicates of each of the four treatments. The seed sets for the two flowers of a given treatment on a plant were averaged prior to statistical analysis. Seed sets were compared across the 4 treatments using randomized block ANOVA with the plant as a block.
Objective 2: In spring of 2013, seeded patches of *B. nigra* were used to create four density treatments that surrounded 1-meter^2 areas around potted *P. parryi* individuals. "Low density" treatments contained between 50 and 500 flowers of the invasive while "high density" treatments contained more than 1,000 flowers. "Near" treatments contained no *B. nigra* but were within 5 meters of a patch of the invasive and "far" treatments also contained no *B. nigra* and were further than 5 meters from a patch of the invasive. Invasive pollen grain transfer to native stigmas was examined and compared among treatments. Conspecific and heterospecific pollen deposition was compared among treatments using a one way ANOVA.

Hand Pollination Treatments:

P only

P + B

P then B

B then P

P = *Phacelia parryi* (native)
B = *Brassica nigra* (invasive)

Figure 2. Invasive plant, *Brassica nigra* being visited by a honeybee in Orange County, CA

Results: Hand Pollinations

The four hand pollination treatments differed in seeds per flower ($F_{3,80}$ = 7.89, P< 0.0001). Based on a priori contrast, the control had a significantly greater seed set per flower (P=0.0014) and per fruit ($F_{1,68}$=6.64, P=0.0122) than the average of the three *B. nigra* treatments (Fig. 3). A Tukey test for multiple comparisons, indicated a significant difference in seeds per flower between the simultaneous application treatment and all the other treatments (Fig. 4, P < 0.05).

DEPENDENT VARIABLE	SOURCE	DF	MS	F	P
Seeds per flower	Plant	27	2259.469	2.71	0.0003
	Treatment	3	6571.857	7.89	0.0001
	P-only vs. average of 3 invasive mixes	1	9106.248	10.94	0.0014
	3 invasive mixes	2	5267.5	6.33	0.0028
	Error	80	832.477		
Seeds per fruit	Plant	27	1816.872	2.02	0.0104
	Treatment	3	2841.362	3.16	0.0302
	P-only vs. average of 3 invasive mixes	1	5971.58	6.64	0.0122
	3 invasive mixes	2	1561.63	1.74	0.1841
	Error	68	899.996		

Figure 3 Randomized block ANOVA with plant as block and a priori contrasts

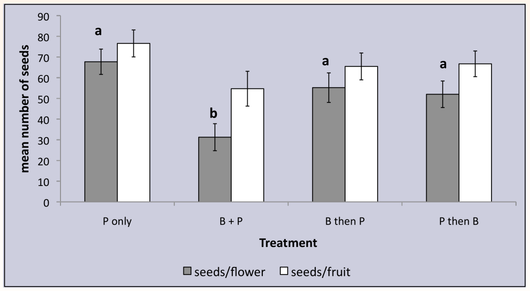

Figure 4. Seed set in different hand pollination treatments. Different lower-case letters represent statistical differences among treatments based on Tukey multiple comparisons. Error bars represent +/- 1 SE

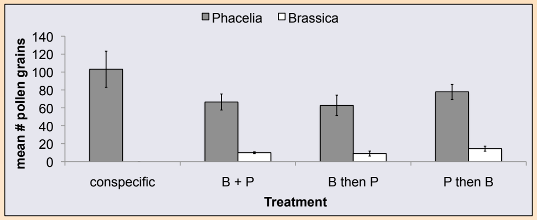

Figure 5. Mean pollen grains deposited of each species in hand pollination treatments. All treatments contained similar amounts of conspecific and invasive pollen (One-way ANOVA P > .05). Error bars represent +/- 1 SE.

Results: Invasive Pollen Deposition in the Field

The quantity of *B. nigra* pollen grains deposited on *P. parryi* stigmas in the high invasive density treatment was significantly higher than in the other treatments (Fig. 6). The amount of *B. nigra* pollen grains deposited on native stigmas in the field is similar to the invasive pollen quantities placed on native stigmas in the greenhouse hand pollinations.

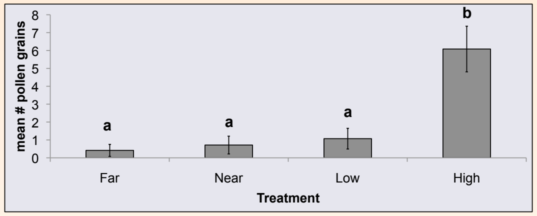

Figure 6. Mean number of pollen grains deposited in invasive density treatments. Different lower-case letters represent statistical differences among treatments based on Tukey multiple comparisons. Error bars represent +/- 1 SE

Conclusions and Future Directions:

Deposition of *B. nigra* pollen may have a negative competitive effect on the seed set of *P. parryi*, but only when both types of pollen are applied simultaneously. Because *B. nigra* produces allelopathic glucosinulates, it is possible that its pollen has inhibitory effects on native pollen that prevent it from properly germinating on the stigma or interfere with pollen tube growth. In vitro and In vivo experiments are currently being conducted to better understand the mechanisms behind these results.

Acknowledgments:

Thanks to my advisor, Diane Campbell, to Peter Bowler at the UCI Arboretum, and my undergraduate assistant, Grace Yu.

References:

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