The effects of invasive polens 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 polen is deposited on a native stigma by pollinators who visit both species. The presence of invasive polen on native stigmas may affect the seed set of the native species in various ways. The foreign polen could induce stigma closure (Waser and Fugate 1986), allelopathy, or crowd out conspecific polen 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 polen transfer between this exotic species and native, Phacelia parryi.

Objectives:
1. Test whether the occurrence and timing of invasive Brassica nigra polen affects fruit and seed production of native plant, Phacelia parryi 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: polen only (control), P + B, and B. nigra polen simultaneously. P: polen 3 hours prior to B. nigra polen, and B. nigra polen 3 hours prior to P. parryi polen. 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 plant as block and a priori contrasts. The four hand pollination treatments differed in seeds per flower (F = 7.89, P < 0.001). Based on a priori contrast, the control had a significantly greater seed set per flower (P=0.0014) and per fruit (F = 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).

Objective 2: In spring of 2013, seeded patches of B. nigra were used to create four density treatments that surrounded 1-meter² areas around potted P. parryi individuals. “Low density” treatments contained between 5 and 50 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 from a patch of the invasive. Invasive polen grain transfer to native stigmas was examined and compared among treatments. Conspecific and heterospecific polen 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 = 7.89, P < 0.001). Based on a priori contrast, the control had a significantly greater seed set per flower (P=0.0014) and per fruit (F = 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).

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

Conclusions and Future Directions:
Deposition of B. nigra polen may have a negative competitive effect on the seed set of P. parryi, but only when both types of polen are applied simultaneously. Because B. nigra produces allelopathic glucosinulates, it is possible that its polen has inhibitory effects on native polen 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.

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References:

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

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

Figure 7. 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.