EVALUATING THE RESILIENCE OF *PIERIS NAPI OLERACEA* BUTTERFLIES TO EXOTIC INVASIVE PLANTS

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ABSTRACT

Figure 1. A marked *P.n. oleracea* female ovipositing on her host plant of choice.

We explored the relationships between *Pieris napi oleracea* (Harris, 1829) and two exotic invasive plants—garlic mustard (*Alliaria petiolata* [Bieb.] Cavara & Grande), and narrow-leaved bittercress (*Cardamine impatiens*) in western Massachusetts. While *A. petiolata* creates a known population sink for some native Pierid species, there is evidence that *P. n. oleracea* is adapting to the plant. **Our study found evidence that *P.n.oleracea* is continuing to adapt to garlic mustard.** Meanwhile, we explored both maternal and larval responses to *C. impatiens*. Ovipositing females appeared to accept *C. impatiens* as a suitable host plant. Larvae appeared to accept *C.impatiens* as a food source and developed well on it. In consideration of these finding, we conclude that ***C. impatiens* likely poses no threat to the *P.n.oleracea*** of Massachusetts, and may even be beneficial to recovering populations.

INTRODUCTION

Pieris napi oleracea (Figure 1) is a native butterfly species currently listed as "threatened" in the state of Massachusetts. One notable threat to this population is the invasion of garlic mustard (*Alliaria petiolata,* Figure 2). Garlic mustard is an exotic invasive plant that acts as an ecological trap for *P.n. oleracea* (Keeler & Chew 2008) — female adults are attracted to oviposit on the plant, but the larvae do not survive or develop well on it. However, there is evidence that *P.n.oleracea* is adapting to the hazardous plant (Courant et al. 1994, Acuna & Chew, unpublished data)**. One primary objective of our study was to evaluate the current ability of *P.n.oleracea* larvae to develop on garlic mustard, in relation to previously recorded rates.**

Figure 2. Bolting garlic mustard (*Alliaria petiolata*)

In addition to garlic mustard, there is another invasive plant, narrow-leaved bittercress (*Cardamine impatiens,* Figure 3), that is predicted to move into *P.n.oleracea* habitat in the near future. *C. impatiens* belongs to the same genus as the butterflies' native host (*Cardamine diphylla*), thus we predict it contains a similarly acceptable chemical profile. **Our study sought to predict how the native butterfly will react to this new potential host in terms of maternal oviposition preference and larval development.** Both maternal behavior and larval acceptance are necessary for successful incorporation of a new host plant. By assessing the responses of *P.n. oleracea* to these two invasive species, we are able to begin answering larger conservation questions, such as:

Figure 3. Bolting narrow-leaved bittercress (*Cardamine impatiens*).

Can *P.n. oleracea* survive the invasion of *A. petiolata* via adaption?

How will the incoming invasion of *C. impatiens* influence *P. n. oleracea* population recovery?

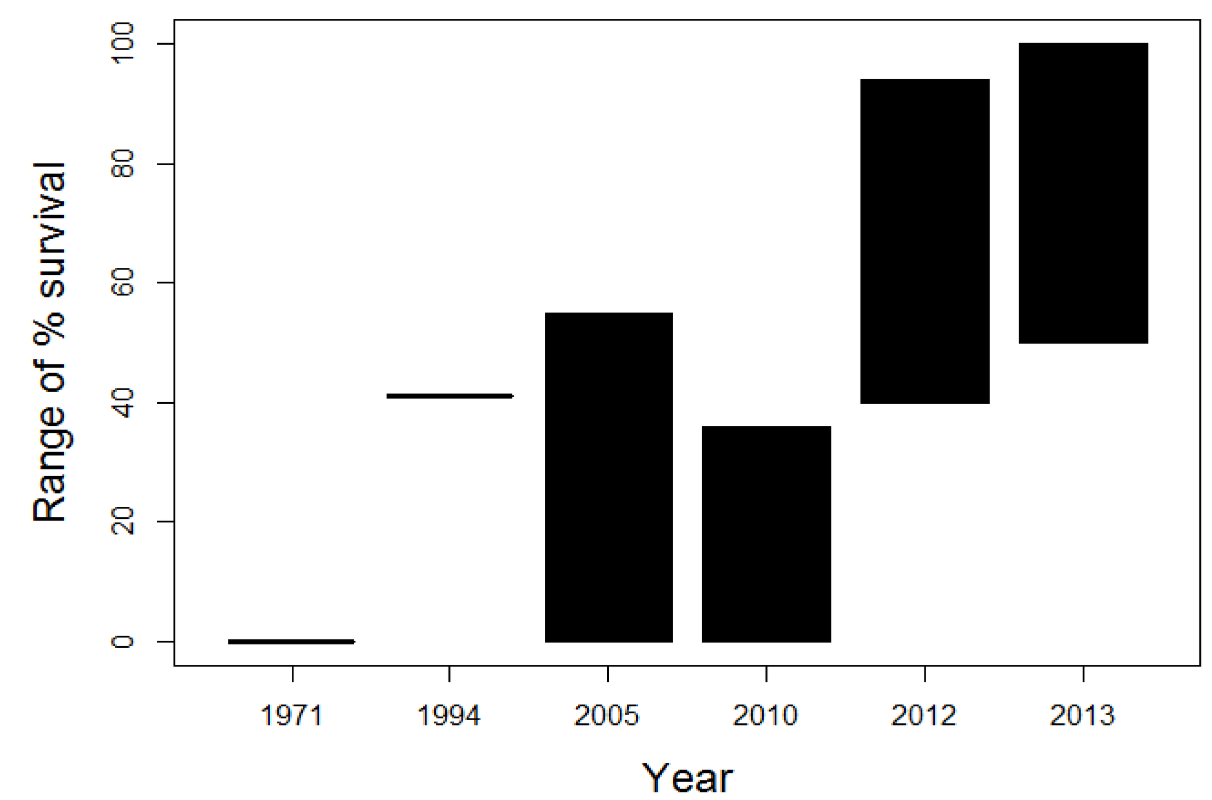

Figure 4. Change in *P.n. oleracea* larval survival on *A. petiolata* over time. Data sources: 1971- Bowden (1971), 1994- Courant et al.(1994), 2005- Keeler & Chew (2008), 2010- Steward & Chew (unpublished data), 2012- Acuna & Chew (unpublished data), 2013- Current study.

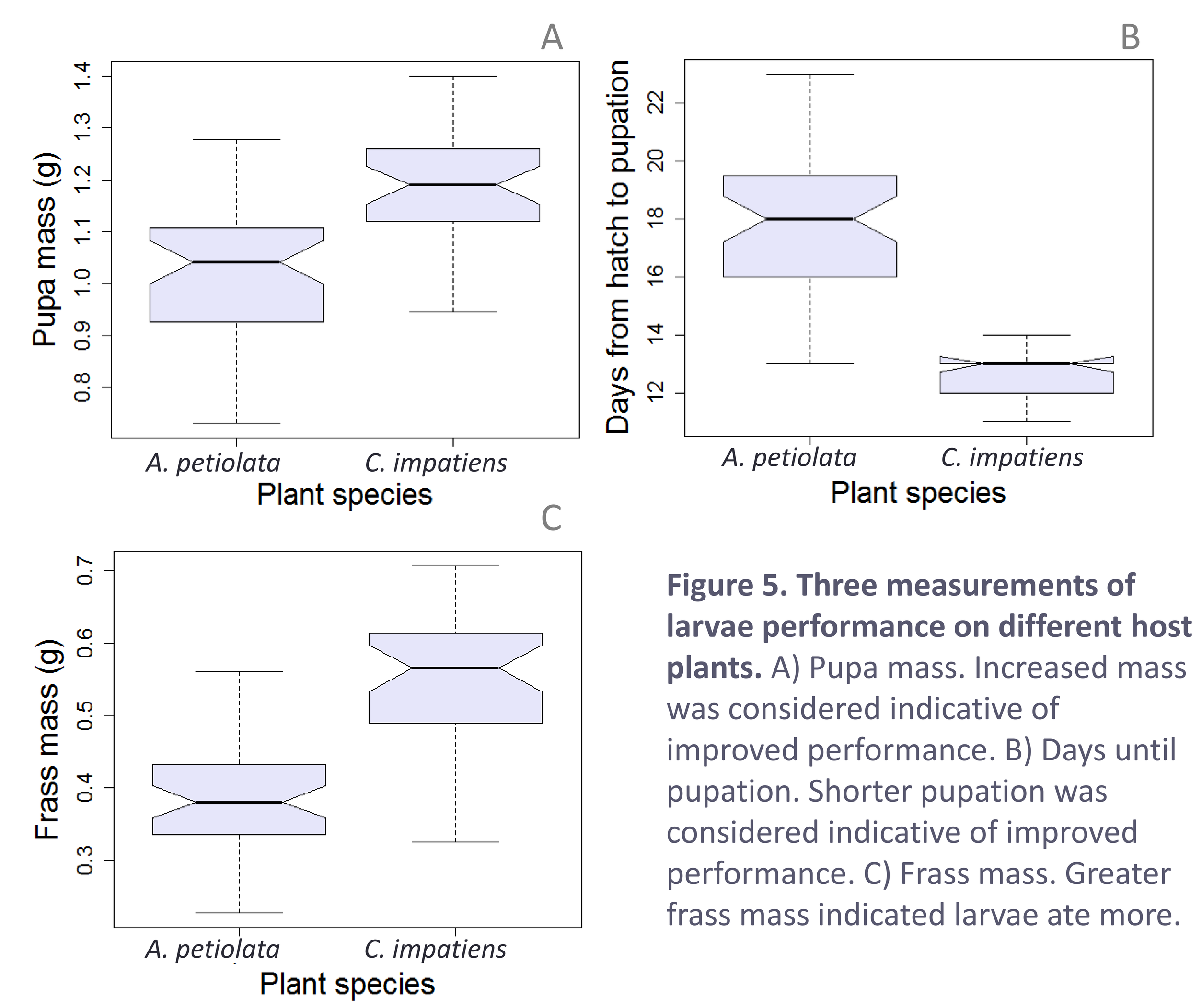

Figure 5. Three measurements of larvae performance on different host plants. A) Pupa mass. Increased mass was considered indicative of improved performance. B) Days until pupation. Shorter pupation was considered indicative of improved performance. C) Frass mass. Greater frass mass indicated larvae ate more.

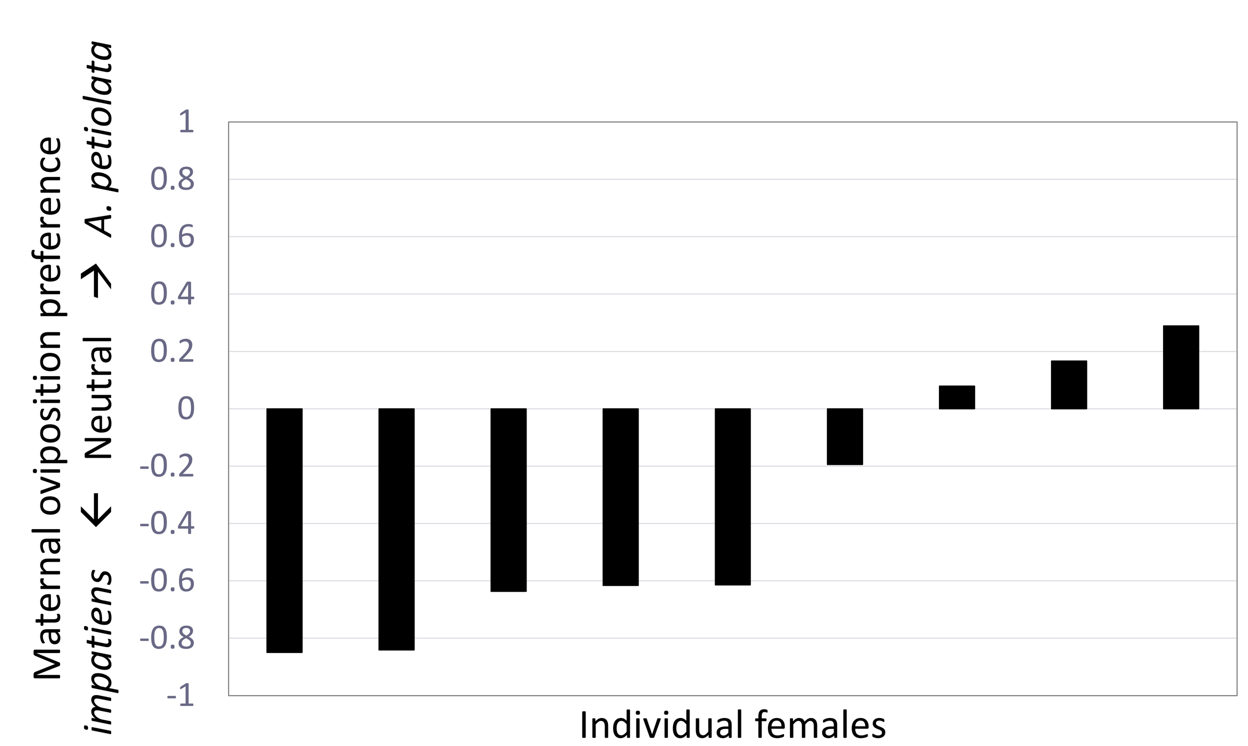

Figure 6. The oviposition preference of *P.n.oleracea* mothers when choosing between *A. petiolata* and *C. impatiens*. Maternal oviposition preference index (OPI) was calculated as (CI-AP)/(CI+AP), with CI equal to the mean number of eggs oviposited on *C. impatiens* per hour of exposure, and AP equal to the mean number of eggs oviposited on *A. petiolata* per hour of exposure.

METHODS

P.n.oleracea females were captured from fields in Lenox, Massachusetts. Individuals were maintained indoors in mesh enclosures with water and honey solution available on sponges (Figure 7). Each day, individuals were offered one potted plant of each species.* Eggs were removed daily and allocated to petri dishes until they hatched. Upon hatching, larvae from each mother were allocated via split-brood design to petri dishes with leaves of their assigned treatment plant. Larvae were fed ad libitum until pupation. Frass was collected throughout the 5th instar.

Figure 7. Experiment setup included two potted plants available for oviposition, inside a mesh enclosure with honey and water on sponges.

**Cardamine pratensis*, a known "good host", was also included during oviposition assays and larval rearing, although results are not reported here.

RESULTS

- Total larval survival of each mother's offspring on *A. petiolata* ranged from 50% to 100% (Figure 4). **The overall larval survival rate on *A. petiolata* was 89%.**
- Total larval survival of each mother's offspring on *C. impatiens* ranged from 67% to 100%. **The overall larval survival rate on *C. impatiens* was 96%.**
- Larvae reared on *C. impatiens* reached greater final pupal masses ($p<0.001$), exhibited fewer days between hatch and pupation ($p<0.001$) and produced a greater mass of frass during their fifth instar ($p<0.001$) than those reared on *A. petiolata* (Figures 5A, 5B and 5C respectively).
- 5 out of 9 mothers had a strong preference (OPI>|0.5|) for *C. impatiens*. No mothers demonstrated a strong preference for *A. petiolata* (Figure 6).

CONCLUSIONS

- **Survival of *P.n.oleracea* larvae on *A. petiolata* appears to have increased**.
- By all measurements implemented in this experiment, (oviposition preference, frass mass, pupal mass, survivorship, and pupation length) ***C. impatiens* appears to be a suitable host plant for *P.n.oleracea*.** Mothers accepted it as a site for oviposition and larvae performed successfully on it.

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