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Can *Darapsa myron* (Lepidoptera: Sphingidae) successfully use the invasive plant *Ampelopsis brevipedunculata* as a food resource?

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II. ABSTRACT.

Although biological invasions are generally thought to negatively impact native fauna, native herbivores that can utilize invasive plants may benefit. The East Coast of the United States has been invaded by the vitaceous plant *Ampelopsis brevipedunculata*. The invaded range of *A. brevipedunculata* overlaps with that of the native *Vitis labrusca*, a closely-related species that is a host plant for the native moth *Darapsa myron* (Lepidoptera: Sphingidae). We reared *D. myron* larvae on either *V. labrusca* or *A. brevipedunculata* to assess whether development and survival differed on the two plant species. Larval growth and survival to pupation was only 5% on *A. brevipedunculata* compared to 30% on *V. labrusca*, suggesting that the invasive species is an unsuitable hostplant for *D. myron*.

Key Words: invasive species, enemy release, performance, hostplant

III. TEXT

Increases in global transportation and trade have facilitated an ever-increasing number of species invasions. Non-native plant species often pose substantial ecological and economic problems, and many have become abundant in an array of ecosystems. The “Enemy Release Hypothesis” (Keane and Crawley 2002) posits that the success of some particularly ubiquitous invasive species may be due to the lack of natural enemies in the introduced range. Herbivores and plant pathogens keep populations in check by reducing plant growth and reproduction; the absence of such enemies may provide introduced species an important advantage over native ones (Heckman et al. 2017).

How closely related an invasive plant is to plants in its invaded range is often correlated with herbivory on the invasive species (Grutters et al. 2017). Many native lepidopterans benefit from non-native plants. *Papilio polyxenes* (Lepidoptera: Papilionidae), a specialist on Apiaceae, feeds readily on a range of introduced species in this family (Wagner 2005). *Manduca sexta* (Lepidoptera: Sphingidae), a Solanaceae specialist, utilizes tomato in areas far beyond the native range of the plant (Wagner 2005, Reisenman et al. 2013). More generally, introduced *Taraxacum* and *Plantago* spp. serve as hosts for many native butterflies and moths in North America (Stamp 1997, Wagner 2005, Brown et al. 2017). The ability of a native herbivore to use an invasive plant may contribute to an increase in the native herbivore’s population and allow it to benefit from some biological invasions.

Ampelopsis brevipedunculata is an Asian plant. It is invasive in riparian areas of the eastern United States, where it competes with the native *Vitis labrusca* (Emerine et al. 2013) and other plants. As both plants are in the Vitaceae family, herbivores that feed on *Vitis* may be able to feed on *Ampelopsis*. *Darapsa myron* is native to most of North America and feeds on the *Vitis* species and other native Vitaceae (Tuttle 2007). It is also known to feed the native *Ampelopsis* species, *A. cordata* and *A. arborea* (Beadle and Leckie 2012), that can be found in coastal regions of Connecticut nearby to our study area (Staff 2017). We present the results of research addressing whether the invasive *A. brevipedunculata* is a suitable host plant for locally-collected *D. myron* larvae.

MATERIALS AND METHODS

In September 2016, seeds were collected from *A. brevipedunculata* growing in Charlestown, Rhode Island and *V. labrusca* growing in Kingston, Rhode Island. The harvested seeds were stratified for 4 months within moist paper towels in a Ziploc bag at 4°C. In spring 2017, stratified seeds were sown into starting trays filled with metro-mix 830 (Sungro brand, Agawam, Massachusetts) in a heated (24-28°C) greenhouse. Germinated seedlings were individually transferred to plastic 3.8L pots filled with a 50:50 topsoil: perlite mix, and dosed as necessary with NPK 24-8-16 fertilizer (Vigoro brand, Lake Forest, Illinois) diluted to 15 ml/l water.

In May 2017, unrelated adult *D. myron* within our captive colony derived from wild-caught populations the year before were placed together in 30cmx30cmx30cm net cages (Monarch Watch Shop, Wilmington, Delaware). Cages generally contained four of each sex at a time, and we had three cages for adults. Once mated, females were held individually in paper bags for oviposition. Eggs from different females were incubated at 20°C in individual 240mL polypropylene cups (Pactiv brand, Lake Forest, Illinois); water was streaked on the inner lid surface of each container to prevent desiccation.

D. myron eggs hatched within seven days of being laid. Newly-hatched larvae were placed individually in a 1.9L glass mason jar (Ball Brand, Fishers, Indiana) that contained a single *A. brevipedunculata* or *V. labrusca* leaf. In order to prevent wilting, the cut petiole of each leaf was kept in a microcentrifuge tube filled with an agar/water solution (2.8 g/L). The two treatments (*Ampelopsis* and *Vitis*) were each replicated 20 times for a total of 40 jars. No more than five larvae from each female were placed into either treatment group. We weighed an additional ten newly-hatched larvae and averaged their weights to determine a standard hatchling weight. The larvae used in this initial weighing were not used in the subsequent experiment.

Jars were checked daily for larval mortality. Each surviving larva was weighed after seven days. Following the weighing, each larva was transferred to a new (clean) jar that contained fresh host plant material. Because of their small size, larvae that died before day seven were not weighed. Larvae were weighed again on days 14, 21, and at death or pupation. Larvae received new foliage whenever the existing material appeared desiccated or had been consumed; regardless of its appearance, all foliage was replaced on days 14 and 21. Pupae were allowed to harden for four days prior to the final weighing.

For each larva, we recorded the hatch date; weight at days seven, 14, and 21; weight at death/pupation; and the time to death/pupation. Data on larval weight at days seven, 14, and 21 were analyzed using rm-ANOVA, with treatment (*Ampelopsis* and *Vitis*) as the across-subjects factor and time as the between-subjects factor. Treatment-level differences in time to pupation and pupal weight was analyzed using a two-sample t-test. Between-treatment differences in the likelihood of pupation were analyzed using a chi-square test. All statistical analyses were performed using JMP 10.0 (SAS 2010).

RESULTS

D. myron larvae reared on *A. brevipedunculata* were smaller and gained weight more slowly than those reared on *V. labrusca*. There was a marginally-significant difference in weight gain (treatment $F_{1,23} = 3.11$, $p = 0.091$) and the difference between *V. labrusca*- and *A. brevipeduncuata*-reared larvae increased over time (time*treatment $F_{2,22} = 3.37$, $p = 0.053$).

Six of 20 *V. labrusca*-reared larvae, but only one of 20 *A. brevipedunculata*-reared larvae, pupated ($\chi^2_1 = 4.7$, $p = 0.030$). Larvae reared on *V. labrusca* pupated in 24 ± 0.37 [Standerd Error] days at a weight of 0.96 ± 0.144 g; the only surviving *A. brevipedunculata*-reared larva pupated after 22 days at a weight of 1.06 g. While we had planned to statistically analyze treatment-level differences in the time to and weight at pupation, the fact that only one *A. brevipedunculata*-reared larva pupated prevented us from doing so.

DISCUSSION

The poor survival of *D. myron* larvae on *A. brevipedunculata* suggests that this invasive plant is an unsuitable host. Because predation and parasitism can drive lepidopteran larval mortality above 98% (Wagner 2012), host-related mortality from plant defenses or nutritional inadequacies must be minimal in order to ensure a stable population. As densities of this exotic *Ampelopsis* continue to increase, the resulting competitive exclusion of native Vitaceae species (Emerine et al. 2013) may decrease densities of *D. myron* and other native Vitaceae-feeding lepidopterans.

While *A. brevipedunculata* has the potential to become extremely abundant in southern New England, it is currently patchily distributed in this region and the native Vitaceae continue to persist. As a result, it seems unlikely that *A. brevipedunculata* presents a near-term threat to local *D. myron* populations. It is also worth noting that although northeastern populations of *D. myron* do not co-occur with native *Ampelopsis* species, a single *D. myron* larva was able to complete its development on the invasive plant. Sharp increases in *A. brevipedunculata* abundance should favor those *D. myron* individuals capable of utilizing it as a host. This adaptive change may alter host selection in affected *D. myron* populations as demonstrated in other invasive plant/herbivore interactions noted by Brown et al. (2017). Southern populations of this moth that co-occur with the native *A. cordata* may also be more likely to feed on *A. brevipedunculata* (Grutters et al. 2017), and should be similarly evaluated.

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