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Can *Darapsa myron* (Lepidoptera: Sphingidae) Successfully Use the Invasive Plant *Ampelopsis brevipedunculata* as a Food Resource?

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

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15 **Word Count:** 1,884 words

16 **II. ABSTRACT.**

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

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

27 **III. TEXT**

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

36 How closely related an invasive plant is to plants in its invaded range is often correlated
37 with herbivory on the invasive species (Grutters et al. 2017). Many native lepidopterans benefit
38 from non-native plants. *Papilio polyxenes* (Lepidoptera: Papilionidae), a specialist on Apiaceae,
39 feeds readily on a range of introduced species in this family (Wagner 2005). *Manduca sexta*
40 (Lepidoptera: Sphingidae), a Solanaceae specialist, utilizes tomato in areas far beyond the native
41 range of the plant (Wagner 2005, Reisenman et al. 2013). More generally, introduced *Taraxacum*
42 and *Plantago* spp. serve as hosts for many native butterflies and moths in North America (Stamp
43 1997, Wagner 2005, Brown et al. 2017). The ability of a native herbivore to use an invasive plant
44 may contribute to an increase in the native herbivore’s population and allow it to benefit from
45 some biological invasions.

46 *Ampelopsis brevipedunculata* is an Asian plant. It is invasive in riparian areas of the
47 eastern United States, where it competes with the native *Vitis labrusca* (Emerine et al. 2013) and
48 other plants. As both plants are in the Vitaceae family, herbivores that feed on *Vitis* may be able
49 to feed on *Ampelopsis*. *Darapsa myron* is native to most of North America and feeds on the *Vitis*

50 species and other native Vitaceae (Tuttle 2007). It is also known to feed the native *Ampelopsis*
51 species, *A. cordata* and *A. arborea* (Beadle and Leckie 2012), that can be found in coastal
52 regions of Connecticut nearby to our study area (Staff 2017). We present the results of research
53 addressing whether the invasive *A. brevipedunculata* is a suitable host plant for locally-collected
54 *D. myron* larvae.

55 MATERIALS AND METHODS

56 In September 2016, seeds were collected from *A. brevipedunculata* growing in
57 Charlestown, Rhode Island and *V. labrusca* growing in Kingston, Rhode Island. The harvested
58 seeds were stratified for 4 months within moist paper towels in a Ziploc bag at 4°C. In spring
59 2017, stratified seeds were sown into starting trays filled with metro-mix 830 (Sungro brand,
60 Agawam, Massachusetts) in a heated (24-28°C) greenhouse. Germinated seedlings were
61 individually transferred to plastic 3.8L pots filled with a 50:50 topsoil: perlite mix, and dosed as
62 necessary with NPK 24-8-16 fertilizer (Vigoro brand, Lake Forest, Illinois) diluted to 15 ml/l
63 water.

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

71 *D. myron* eggs hatched within seven days of being laid. Newly-hatched larvae were
72 placed individually in a 1.9L glass mason jar (Ball Brand, Fishers, Indiana) that contained a

73 single *A. brevipedunculata* or *V. labrusca* leaf. In order to prevent wilting, the cut petiole of each
74 leaf was kept in a microcentrifuge tube filled with an agar/water solution (2.8 g/L). The two
75 treatments (*Ampelopsis* and *Vitis*) were each replicated 20 times for a total of 40 jars. No more
76 than five larvae from each female were placed into either treatment group. We weighed an
77 additional ten newly-hatched larvae and averaged their weights to determine a standard hatchling
78 weight. The larvae used in this initial weighing were not used in the subsequent experiment.

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

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

93 RESULTS

94 *D. myron* larvae reared on *A. brevipedunculata* were smaller and gained weight more
95 slowly than those reared on *V. labrusca*. There was a marginally-significant difference in weight

96 gain (treatment $F_{1,23} = 3.11$, $p = 0.091$) and the difference between *V. labrusca*- and *A.*
97 *brevipedunculata*-reared larvae increased over time (time*treatment $F_{2,22} = 3.37$, $p = 0.053$).

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

104 DISCUSSION

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

112 While *A. brevipedunculata* has the potential to become extremely abundant in southern
113 New England, it is currently patchily distributed in this region and the native Vitaceae continue
114 to persist. As a result, it seems unlikely that *A. brevipedunculata* presents a near-term threat to
115 local *D. myron* populations. It is also worth noting that although northeastern populations of *D.*
116 *myron* do not co-occur with native *Ampelopsis* species, a single *D. myron* larva was able to
117 complete its development on the invasive plant. Sharp increases in *A. brevipedunculata*
118 abundance should favor those *D. myron* individuals capable of utilizing it as a host. This

119 adaptive change may alter host selection in affected *D. myron* populations as demonstrated in
120 other invasive plant/herbivore interactions noted by Brown et al. (2017). Southern populations of
121 this moth that co-occur with the native *A. cordata* may also be more likely to feed on *A.*
122 *brevipedunculata* (Grutters et al. 2017), and should be similarly evaluated.

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