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Variation in desiccation resistance between different Rhagoletis zephyria populations spanning the Cascade Mountains

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Adaptive variation in snowberry maggot fly (*Rhagoletis zephyria*) desiccation resistance across the Cascade Range

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**ABSTRACT**

Local adaptation to environmental gradients can be an important source of variation that allows populations to evolve in response to environmental challenges. The snowberry maggot fly (*Rhagoletis zephyria*) is found throughout the different climate regions of Washington state. However, populations vary in their resistance to desiccation as an early pupa. We found that in low humidity treatments, desiccation resistance is predicted by annual precipitation and elevation and is tightly correlated with fly emergence the following season. Our results suggest that the variation in desiccation resistance in *R. zephyria* is adaptive. *Rhagoletis zephyria* hybridizes with the agriculturally important invasive apple maggot, *R. pomonella*, and introgressing drought-adapted alleles may make this pest a better invader of Washington’s arid apple growing regions.

**RESULTS**

**INTRODUCTION**

Local adaptation to different environments is a mechanism by which adaptive variation can be maintained in natural populations. This “standing variation” provides the potential for adaptation to a changing environment (e.g. climate change) or may even be shared between species via adaptive hybridization. The snowberry maggot fly, *Rhagoletis zephyria*, is a native species that infests snowberry fruit across North America. One of its sister species is the apple maggot fly, *R. pomonella*, which infests apples on the west side of the Cascades but not in arid Central Washington. *R. zephyria* is a univoltine species whose lifecycle is highly reliant upon the fruiting season. Flies will mate on or near snowberry bushes and females will then deposit their eggs onto snowberries. The eggs hatch within the berries, where larvae use the fruit for nutrients. After sufficient growth, the larvae drop out of the fruit and form a puparium, in which they will remain overwinter until their emergence as flies the following spring. The species is most vulnerable to environmental factors in early pupariation due to a high surface area to volume ratio and their high rates of water loss in preparation for diapause.

**METHODS**

- Pupae from all 7 locations collected from berries and weighed
- 8 day exposure at 22°C, then weighed again
- 85% RH 4°C Simulated overwintering chamber 4 months
- ca. 85% RH 22°C monitor fly emergence
- 43% RH desiccation chamber
- 85% RH control chamber

**DISCUSSION**

- Emergence in Bellingham, Snoqualmie, and Cle Elum is dependent on humidity treatment (Chi-squared test, p<0.01 for all three following a Holm-Bonferroni correction), while emergence in the other four populations was independent of treatment (p>0.05). (Figure 1).
- Percent weight remaining fell in two significantly different (ANOVA p<0.0001 and Tukey’s HSD) groups for both high and low humidity treatments that coincide with the Cascade crest (Figure 2).
- A correlation test between proportion weight remaining and proportion emerged found a significant correlation for low humidity treatment and a strong correlation for high humidity treatment (Figure 3).
- Elevation and annual precipitation of the sample locations were significant factors in modeling percent weight remaining for pupae subjected to the low humidity treatment (Multiple linear regression p<0.05, p<0.01, respectively).

Our results show evidence of adaptive variation in desiccation resistance in *R. zephyria* populations across Washington corresponding to an environmental gradient. We can conclude that, in general, *R. zephyria* originating from drier environments can better withstand desiccation. These results have implications when analyzed in respect to closely-related sister species *R. pomonella*. Asymmetric introgression has been documented between *R. zephyria* and *R. pomonella*. One hypothesis as to why *R. pomonella* do not infest apples east of the Cascades is their lack of resistance to the dry climate. Perhaps, if there is indeed a heritable genetic component to desiccation resistance, hybridization may allow for increased desiccation resistance in the apple maggot, allowing it to withstand the drier environment east of the Cascade Range. Further studies must be done in order to identify areas of the *Rhagoletis* genome that are associated with variation in desiccation resistance and their potential for introgression into the *R. pomonella* genome.

**References:**