Ecology and genomics of toxicity in Heliconius butterflies

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INTRODUCTION

Heliconius butterflies are an important model system in evolutionary biology and in evolutionary genomics (e.g. 2,3). The long-term research on Heliconius has shown that a central phenomenon underlying the rapid wing pattern radiation and speciation in Heliconius is Müllerian mimicry, in which species with varying levels of cyanogenic toxicity share the cost of predator learning by mimicking each other’s warning coloration. The mimicry-driven adaptive radiation of wing patterns and related genomics have been a major focus of research. However, very little is known about one of the basic phenomena underlying the process: the toxicity of the butterflies (Fig. 1). Recent studies particularly stress the need to investigate ecological traits to understand the evolution of toxicity in mimetic species.

MAIN QUESTIONS AND METHODS:

1) How does toxicity vary in natural populations? Intraspecific variation of toxicity in Heliconius erato and its main host, Passiflora biflora, collected along an environmental moisture gradient in Panama. Is toxicity plastic or genetically-determined? What is the heritability of toxicity?

2) Is chemical defense costly? The associations of butterfly toxicity with energy-expensive life-history and fitness traits.

3) Genomics: What cellular mechanisms underlie variation in butterfly toxicity? Transcriptional / genome-wide association study comparing butterflies of high vs. low toxicity. What are the mechanisms of trade-offs between toxicity and life-history and fitness traits?

CONCLUSIONS:

Previous studies on Heliconius toxicity:

V Mostly lab populations
V Between-species comparisons (e.g. 5-8, but see 9)
V Chemistry, metabolic pathways and genetics of cyanogenic glucoside metabolism (e.g. 6,7,10.11, also in Zygaena moths 12)
V Few ecological factors studied

Special/novel in this 3-year (2017-2019) post-doc project:

V Wild populations, both the butterfly and its main host plant
V Environmental gradient
V Intraspecific variation
V Experimental assessments of correlations between toxicity and life-history and fitness traits
V Genomics of toxicity and correlated traits

References:
12) Zagorovskiy & Muller 2011. Phytochemistry 72, 1585-1592