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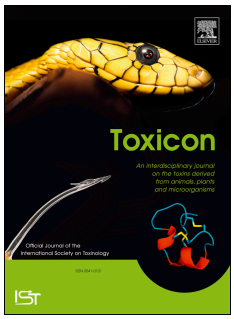

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PII: S0041-0101(17)30336-7

DOI: 10.1016/j.toxicon.2017.10.026

Reference: TOXCON 5754

To appear in: *Toxicon*

Received Date: 8 August 2017

Revised Date: 6 October 2017

Accepted Date: 23 October 2017

Please cite this article as: Arbuckle, K., de la Vega, Ricardo.C.Rodrí., Casewell, N.R., Coevolution takes the sting out of it: Evolutionary biology and mechanisms of toxin resistance in animals, *Toxicon* (2017), doi: 10.1016/j.toxicon.2017.10.026.

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Coevolution Takes the Sting Out of It: Evolutionary Biology and Mechanisms of Toxin Resistance in Animals

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Abstract

Understanding how biotic interactions shape the genomes of the interacting species is a long-sought goal of evolutionary biology that has been hampered by the scarcity of tractable systems in which specific genomic features can be linked to complex phenotypes involved in interspecific interactions. In this review we present the compelling case of evolved resistance to the toxic challenge of venomous or poisonous animals as one such system. Animal venoms and poisons can be comprised of few or of many individual toxins. Here we show that resistance to animal toxins has evolved multiple times across metazoans, although it has been documented more often in phyla that feed on chemically-armed animals than in prey of venomous or poisonous predators. We review three types of gene-product based resistance: 1) toxin scavenging, where molecules produced by the envenomed organism bind and inactivate the toxins; 2) target-site insensitivity, including landmark cases of convergent changes that make the molecules normally targeted by animal toxins refractory, and; 3) off-target repurposing, where envenomed organisms overcome toxicity by exploiting the function of toxins to alter their physiological effect. We finish by discussing the evolutionary processes that likely played a role in the origin and maintenance of toxin resistance. We conclude that antagonistic interactions involving poisonous or venomous animals are unparalleled models for investigating microevolutionary processes involved in coevolution and linking them to macroevolutionary patterns.

1. Introduction

Recurrent interactions between species are thought to generate coevolutionary dynamics such that, as one species evolves, selective pressures on the other change (Carval and Ferriere, 2010), eventually leading to genotypic changes due to reciprocal selection, i.e. coadaptation (Clayton et al., 2015). Antagonistic interactions are often

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