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Evolutionary insight merges with toxicology

Monosson, Emily. 2012. **Evolution in a toxic world: how life responds to chemical threats.** Island Press, Washington, D.C. xii + 223 p. $35.00, ISBN: 978-1-59726-976-6 (alk. paper).

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The book *Evolution in a toxic world* aims to demonstrate the importance of evolutionary principles in understanding and predicting life's responses to chemical toxicants. It succeeds in providing an evolutionary history of toxicants and a compelling argument that evolutionary insight can better prepare us for today's and tomorrow's toxic insults.

There are three major parts to the book. Part 1 provides an evolutionary history of earth's earliest toxins that life had to battle—ultraviolet light, oxygen, and metals—and the major defenses that overcame these toxins. This section does an excellent job of presenting the historical challenges of these early toxicants and identifying the potential mismatches between life's defenses and drastic changes in the concentrations of UV, oxygen, and metals.

Part 2 provides a coevolutionary explanation of the consequences of toxins in three distinct areas: cancer, plant-animal interactions, and the endocrine system. Although the major heading of "Plant and animal" is a bit misleading regarding some of the content of this section, each chapter offers interesting ideas worth a read. A major gap in this

section is the lack of discussion of recent progress related to how vertebrate, nonhuman animals (mammal, birds, and fish) interact with toxins. Inclusion of these examples would have provided a tighter link between natural coevolving arms races in wildlife and those emerging in humans that would benefit audiences. In addition, the focus on cytochrome P450 (CYP) detoxification enzymes as the major animal defense against toxins, although warranted because of the great amount of research on them, may present a biased view to readers that this is the most important defense. Readers should be aware that the evolution and function of alternative detoxification pathways in vertebrates (e.g., conjugation pathways) can have synergistic and potentially more important implications for understanding toxicity than CYPs. Despite these few oversights, the chapters and content included in the second section provide compelling evidence consistent with the ultimate theme of the book—that there has always been and will continue to be a coevolutionary battle between toxins and defenses against those toxins.

Part 3 provides an overview of how humans contribute to toxic overloads and how the environment responds. It describes the emergence of evolutionary toxicology as a discipline based on studies documenting the rapid genetic adaptation of wild species to toxic overloads caused by humans. This section highlights the disturbing rate of formation and accumulation of toxins, many of which are not regulated. This section paints a bleak picture of the fate of humans and wildlife to toxins based our past and future contribution to toxins in the environment. There are few solution proposed. Instead, the section proposes that new methodologies such as proteomics and toxicogenomics and the consideration of individuals, populations, communities, and ecosystems will offer some of the answers we need to combat future toxic overloads.

Woven throughout the chapters is the common theme that although the source, composition, concentration, and distribution of chemicals may vary, the cause of toxicity is always due to an overwhelmed defensive network. Understanding the mismatches between toxins and defenses is key to predicting devastating consequences to toxins by organisms. This book provides the starting dialog that is needed between evolutionary ecologists and toxicologists if we want to be prepared for our future toxic world (e.g., green chemistry and nanoparticles). The book provides a suite of difficult questions and leaves the answers to those questions up to the next generation of evolutionary toxicologists—who hopefully read this book.

The book should appeal to a broad audience and will spur future interest in the fields of evolutionary toxicology. The well-written historical accounts of common toxicants and the concise writing will stimulate interest in toxins and defenses by the general public. Yet, there is enough content and detail to keep students of ecology, evolution, molecular biology, environmental biology, wildlife biology, geology, chemistry, and toxicology interested. For example, ecologists will be introduced to potentially novel concepts such as the defensome (the network of molecular defenses against toxins that maintain homeostasis), hormesis (opposite responses to high and low concentration of toxins), attractor state (adaptive capacity of cells to switch between states or function), and the "toxome" (a comprehensive catalog of the genetic mechanisms and pathways of toxicity) that can help test hypotheses related to chemical interactions among soils, plants, herbivores, predators, and the environment. Likewise, toxicologists will gain from understanding the evolution of toxins and the body's defense mechanisms to better understand and predict individual variation in responses to toxins. Expert researchers and novices will all benefit from digesting the multidisciplinary perspectives, highlighted examples and future research questions, and concerns that prevail in each chapter. In every section, there are ample references provided for more in-depth investigations of specific topics. Finally, instructors of organismal biology, earth science, and toxicology will find many interesting examples in this book, specifically in the appendix, to complement lectures or to serve as a foundation to stimulate more in-depth discussion of evolutionary toxicology in upper-division courses.

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