

## BOTANY

**The Ecology of Plant Secondary Metabolites: From Genes to Global Processes**

By G. Iason, M. Dicke, and S. Hartley [Editors]. 2012. Cambridge University Press, UPH, Shaftesbury Road, Cambridge. CB2 8BS United Kingdom. xiii + 335 pages. 60.00 USD. Cloth.

Plants produce a diverse array of chemical compounds, some of the major groups of which include flavonoids, tannins, terpenoids, alkaloids, glycosides, and sterols, to name only a few. These are collectively called plant secondary metabolites (hereafter, PSMs), and there has been much debate about their roles over the past half-century or so. From the early idea that this diverse array of chemicals was simply waste products of metabolism, functional roles for these compounds were proposed beginning in the late 1950s. Such roles include defense against herbivores and pathogens, mediation of interactions with competitors, facilitation of pollination, and protection from abiotic stresses such as ultraviolet radiation. This book further elaborates the functional roles of PSMs by reviewing the evidence for multi-trophic, multi-scale relationships between PSMs and the ecosystems (or ecosystem components) in which they occur. This book is the result of a British Ecological Society symposium entitled "The integrative roles of plant secondary metabolites in natural systems", which was held at the University of Sussex in 2010. Sixteen review articles cover the function, ecology, and evolution of PSMs, including suggestions on ways forward for various research topics.

There is a huge body of literature on the occurrence and characterization of PSMs, and a smaller but still extensive amount of research on the effects of particular compounds or families of compounds on individual herbivores, but the field of study delving into the modes of operation of these compounds within the ecosystems in which the plants live (with their diverse species assemblages, seasonality, and complex inter-specific relationships) is still relatively young. This book aims to review this latter state of knowledge. Since this is still a relatively new area of ecological research, several of the chapters focus on the conceptual framework within which experimental studies should be conducted. Other chapters focus on particular experimental systems, or particular classes of compounds, and summarize what is known and where new research should focus.

One of the ideas that arises frequently in the chapters of this book is that there is a large amount of variability in the production of PSMs, between individuals of the same species, or even within an individual plant, depending on developmental stage, ecological context (below- or above-ground tissues), or the stress being imposed on the plant (herbivores, drought, ultraviolet

radiation, cold, etc.). In order to control for numerous variables, laboratory experiments often have been conducted to determine efficacy and mode of operation of particular compounds. Another approach to determining the mode of operation is to use mutant strains of the PSM producer that may be limited in their production of the PSM or that may produce large amounts of that compound, and compare the effects of varying levels of the PSM on test herbivores. These kinds of experiments are helpful in pulling mechanisms apart, especially when accompanied by studies of the genetic basis of these mutations and the parts of the biosynthetic pathways that are affected, but several of the chapters in this book also make the point that the ultimate goal of ecological PSM research is to understand how these compounds function in real ecosystems, with all of their complexity, interconnections, and spatial and temporal variability.

The chapters in this book cover a broad spectrum of PSM-related topics. Some of these include: natural selection for anti-herbivore PSMs, temporal changes in PSM production, ecological benefits of mixtures of PSMs, PSMs and abiotic stresses, PSMs in freshwater macrophyte-herbivore interactions, links between the soil microbial community and plant foliar defenses (relationship between below-ground and above-ground effects), the effects of PSMs on vertebrate herbivores, polymorphisms in PSMs and the extended chemical phenotype, and dynamics of PSMs relative to food chains, ecosystem dynamics, and evolutionary dynamics.

This book provides a leading-edge review of the roles of PSMs in their broader ecological contexts. It is technical, but it provides fascinating insights into the roles of some of the vast array of compounds that plants produce, not only at the individual plant-herbivore level, but at broader ecosystem levels, including multiple trophic levels. Furthermore, and perhaps most importantly, it provides numerous suggestions for future research, including guidance on how some of the more important research questions should be framed. For anyone involved in the study of plant secondary metabolites, co-evolution, natural selection, and ecosystem function, this book is most worthwhile.

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