have done a service to the scientific literacy of those who support protection of natural resources and human health.

**LITERATURE CITED**


**Key words:** adaptation; evolutionary ecology; microevolution; plants; selection.

Evolution is at root a historical discipline, focused on pattern and process of diversification, whereas ecologists usually focus on contemporary phenomena such as interactions, demography, behavior, distributions, and so forth. Population biologists often have a hand in both camps, and this is the tradition within which the sub-discipline of evolutionary ecology arose. Evolutionary ecology has existed at least since Darwin’s time, but has flourished in recent decades, particularly since the publication of Pianka’s text of the same name (now in its 7th edition) and the advent of journals with similar titles. In the intervening years, edited volumes on the topic have appeared, but none that has focused on the specific advances to the discipline provided by the study of plants. Gregory Cheplick’s new book, Approaches to plant evolutionary ecology aims to address that gap.

Cheplick’s text is organized into 10 chapters. After introductory material in the first chapter, the second chapter reviews natural selection conceptually as well as methodologically. The next two chapters address the history and recent use of common gardens and reciprocal transplants as means to identify local adaptation and agents of selection. The fifth chapter reviews insights from molecular markers for estimating genetic variation, adaptation, and some other evolutionary processes. The next four chapters focus on agents of selection (abiotic, competitors, microbes, and animals) that have received the most attention in the literature. The final chapter poses questions, focused on natural selection, adaptation, and biotic interactions, that might productively be addressed in the future.

I enjoyed reading this book. Cheplick has a pithy, informative style of writing, and his occasional use of vernacular or light humor is entertaining. He treats the topics he reviews thoroughly, for the most part. There is a good level of methodological detail included, which would be helpful for someone weighing tradeoffs with respect to alternative approaches to tackling a question. This volume could also be a valuable starting point for a new graduate student or advanced undergrad in need of an introduction to the topic. There is scant theoretical background provided for the subjects, however, which Cheplick argues is well covered elsewhere.

The themes in this volume—selection, adaptation, microevolution, common gardens, reciprocal transplants, biotic and abiotic influences—are unimpeachably foundational to plant evolutionary ecology. These themes, more to the point, are handled with aplomb. In the chapter on natural selection, for example, Cheplick reviews published estimates of selection gradients (both linear, nonlinear, and correlational), and addresses apparent trends in selection for various categories of traits (e.g., size, phenology, and especially physiological). This segues into a nice introduction to path analysis of selection, which provides insight into hypothesized relationships among traits and their effects on fitness. Together, this forms an insightful review of selection studies with some comparative perspective on traits often measured. Cheplick notes that many estimates of nonlinear and correlational selection have been weak or not statistically significant, but he misses an opportunity to point out that few studies have marshaled a sample size sufficient to detect nonlinear selection.

Another strength is the chapter on competitive interactions among plants. At the outset, Cheplick places the chapter firmly into an evolutionary context by emphasizing that genotypic variation in performance in response to competition (i.e., $G \times E$ interaction) is necessary for adaptive evolution to competitors. In the subsequent review of studies examining evidence for evolutionary responses to competition, Cheplick helpfully calculates relative competitive performance (RCP) values from previously published studies, where necessary and possible, to facilitate direct comparison among studies. In aggregate, Cheplick provides a nuanced perspective on the diversity of approaches used to explore how competition influences plant evolution, ranging from artificial selection to studies of fine-scale genotypic variation, as well as some knottier challenges such as kin selection and allelopathy.

A welcome strength of the text is the attention devoted throughout to classical quantitative genetic approaches, such as estimates of Lande and Arnold phenotypic selection gradients, heritability, and genetic variance components. This era of “Illumina- tion” (e.g., current advances in genomics) can sometimes distract from the insights available from lower-tech approaches. Cheplick does a fine job reviewing many key contributions made possible by modern molecular techniques, but he also makes plain by example that a carefully designed, classical genetic experiment will remain a viable tool for important questions well into the future. Notably, this was also the conclusion of a recent commentary in the journal Evolution by Mark Rausher and Lynda Delph.

These are all areas with which Cheplick holds expertise, having devoted a career of research to these topics and more, and such perspective helps for consolidating a vast literature into themes that are well wrought and comprehensible for readers. Understandably, Cheplick’s work is highlighted throughout the book, occasionally to excess, as for example when he devotes 3.5 pages and three figures to one paper which (unexpectedly?) reported selection due to environmental

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**BOOK REVIEW**

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**ERICA FLEISHMAN**

*John Muir Institute of the Environment*  
*University of California*  
*The Barn, One Shields Ave.*  
*Davison, California 95616 USA*  
*E-mail: efl eishman@ucdavis.edu*

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**Approaching plant evolutionary ecology**


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**ERICA FLEISHMAN**

*John Muir Institute of the Environment*  
*University of California*  
*The Barn, One Shields Ave.*  
*Davison, California 95616 USA*  
*E-mail: efl eishman@ucdavis.edu*
heterogeneity in a common garden. Cheplick also develops excellent examples from many other sources throughout the text. Pillars of plant population biology—Turreson; Clausen, Keck and Heisey; Snaydon; Bradshaw and others—are featured prominently, but also included are strong examples from recent studies focusing on, for example, serpentine adaptation, molecular genetics of adaptation, and ecotypic adaptation to soil moisture in *Avena barbata*. Overall, coverage is broad and well balanced.

Cheplick emphasizes empiricism and microevolution in this book. You won’t find any phylogenetic trees among the figures, and “phylogeny,” as well as “speciation” and “life history” are among the terms missing from the index, surprisingly, for a book on evolution. Although Cheplick includes an uncontroversial rationale for why phenomena such as selection, local adaptation, and microevolutionary processes should be considered part of plant evolutionary ecology, the justification for omissions from this circumscript, such as those mentioned above, could use clearer articulation. Evolutionary ecology is admittedly a big topic, and Cheplick seems to have managed it by drawing a bright line around the population.

Nonetheless, much of what is covered bumps up conspicuously against speciation or other macroevolutionary phenomena. Ecotypic differentiation and local adaptation portend reproductive isolation, and several species used to illustrate local adaptation in the text (e.g., *Lasthenia*, *Mimulus*, *Anthoxanthum*, to mention a few) have published estimates showing reproductive isolation or restricted gene flow among ecotypes or populations. Perhaps this is more noticeable because of a spate of recent studies implicating ecological phenomena in the evolution of reproductive isolation and species. Similarly, after a nice section summarizing evidence for pollinator-mediated selection on flowers, Cheplick nods toward studies with *Aquilegia* and *Lithophragnu* to underscore the potential for coevolutionary dynamics between pollinators and flowers, but falls short of sharing evidence, for example, supporting hypotheses of co-speciation between *Ficus* and *Agaonidae* or between *Yucca* and *Prodoxidae*. The distinction here seems to fall on a rather fine line. In the same chapter, Cheplick provides an excellent summary of evidence for population- and genotypic-level plant adaptation to herbivores, as well as studies involving *Datura* and *Solamun* showing how different herbivore species can impose contrasting patterns of selection on resistance. Given this context, it seems odd not to mention examples of evolution within plant lineages in herbivore defense—May Berenbaum’s classic work with coumarin evolution or Anurag Agrawal’s work with milkweeds come to mind.

Despite such shortcomings, Cheplick’s treatment is a thorough reference for the areas covered. This book will certainly remain at hand on my bookshelf, and I recommend it to my students.

Christopher T. Ivey

Biological Sciences
California State University
Chico, California 95928 USA

E-mail: citvey@csuchico.edu

Opening our minds to conserve open spaces


Key words: collaboration; fragmentation; landscape ecology; resilience; scale.

In 1968 Allen Kneese, an environmental economist with the organization Resources for the Future, coined the term “problemshed” to describe the need to integrate varied disciplines and perspectives in framing “desirable institutional arrangements for environmental management” (Kneese 1968). Steven Born, emeritus professor of urban and regional policy at the University of Wisconsin-Madison, has often invoked the term to denote “a way of thinking more broadly about resource problems than geographic and ecological entities, e.g., recognizing external users, resource exports, problems spanning boundaries, etc.” (S. Born, pers. comm.). The term occasionally resurfaces, especially in the realm of water policy and management. It may well find even broader use in the future, for it gets to heart of the matter: to solve complex problems and encourage resilience in our ecosystemic relations, we must learn to think and connect and act at the appropriate scale of time and space, and we must be able to think flexibly across all scales.

This is the essential premise of Charles Curtin’s *The science of open spaces*. Curtin writes that “collaborative research, conservation, and resource stewardship plays out across different scales...[and] understanding the implications of scale is key to sustaining social or ecological systems of any size.” His focus is on large landscapes and their dynamic, interacting social and ecological processes. His term for this is *open spaces*, through which he seeks “to invoke not only the challenge of physical size but also of time, ecology, culture, and all elements therein. This is a fundamentally different approach to science that reconceptualizes both problems and solutions to generate more timely and effective means of addressing the conservation challenges we face today.” In this, Curtin is both drawing upon and extending the interdisciplinary innovations of the last generation (landscape ecology, agroecology, conservation biology, ecological economics, etc.). And he taps into the common cause they share: countering the fragmentation of our landscapes, cultures, and understanding. He writes, “Ecological and social fragmentation are closely linked; it is impossible to sustain human culture and well-being when the ecological fabric in which they are embedded is diminished.”

Curtin’s text is studded with many such pithy observations. They emerge not only from Curtin’s knowledge of systems science, hierarchy theory, and adaptive management; he has also distilled and field-tested them through his work as a place-based conservation biologist, embedded in communities struggling and aspiring to achieve sustainability. Curtin has worked with the science program of the collaborative, rancher-led Malpai Borderlands Group in the wide-open rangelands along the Arizona/New Mexico/Mexico boundary (full disclosure: so have I); and with collaborative fisheries management initiatives along the Maine coast. Two case-study chapters describe these places and experiences, providing the foundation upon which he constructs his conceptual framework.

Although heavily invested in these efforts personally, Curtin strives to step back for an objective look at lessons learned.