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Current Understanding of Succession

Primary Succession and Ecosystem Rehabilitation. Lawrence R. Walker and Roger del Moral. Cambridge University Press, Cambridge, United Kingdom, 2003. 456 pp., illus. $130.00 (ISBN 0521800765 cloth).

Natural and anthropogenic disturbances to ecosystems are ubiquitous, and disturbance and succession are inextricably linked. The spatial and temporal dynamics of vegetation following disturbance have long been of interest in ecology. In *Primary Succession and Ecosystem Rehabilitation,* Walker and del Moral provide a comprehensive review of succession theory and the current state of research in this important area. The authors note that succession (defined as species change over time, or turnover) is at once an easily observable phenomenon and an unpredictable puzzle. The goal of this new book, aimed at anyone interested in the consequences of disturbance, is to provide a comprehensive understanding of the mechanisms of primary succession that will facilitate the search for more efficient resource use and habitat rehabilitation.

The sequence of topics covered in the book's nine chapters is logical, and the writing is understandable and easy to read. An introductory chapter provides a nice foundation of viewpoints, definitions, methods, and unknowns. Here, the authors acknowledge their view of succession as a process of change that is not always linear and rarely reaches equilibrium. Creation of a barren substrate (i.e., disturbance) is treated next, followed by a chapter on successional theory. The chapter on theory presents a succinct historical review that identifies milestones in the development of the succession concept, which will be quite helpful to students. Chapters discussing several basic mechanisms that drive successional change move from consideration of soil development to the life histories of early colonists to species interactions. A chapter on successional patterns then focuses on different types of trajectory, temporal dynamics, and environmental feedbacks. The last two chapters address applications of succession theory for rehabilitation and future research directions. Each chapter ends with a section that summarizes the chapter's content and places it in context with the rest of the book. Students will find the glossary quite helpful as well.

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Points made throughout the book are richly illustrated by an impressive array of examples from around the world. The synthesis of studies done in many places is a key strength of the book. Of course, it also includes many examples of succession (on Mount St. Helens in Washington and along the floodplain of the Tanana River in Alaska) that are derived from the authors' personal experiences. However, I found it especially valuable to read about studies with which I was not previously familiar. Among the chapters, I found the one on applications of theory for rehabilitation to be least satisfying. The discussion of concepts used in restoration ecology may be a helpful introduction to this area for students, but the chapter focuses more on the conceptual framework and potential pitfalls than on achieving restoration. However, that too may largely reflect the state of the science.

The book is up-to-date on current topics in succession research, covering such issues as the influence of plants on soils, the importance of landscape context for succession, the need to understand how processes interact at various spatial scales, the question of whether assembly order influences the course of succession, and the identification of conditions that may promote divergence, or multiple stable states, over convergence. The authors nicely summarize some key unknowns in successional understanding. For example, they rightly note that too few studies exist for robust generalizations to be made about successional trends in the heterogeneity of soils. In the final chapter, on future directions, Walker and del Moral state their expectation that successional theory will develop through modeling, experimentation, and the search for generalities. They identify important research directions, such as understanding the role of animals as herbivores and seed predators during early succession; investigating the predictability of the development of a primary sere; and studying the mechanisms, spatial variability, and effects of soil organisms in regulating species turnover. The successional implications of how plants alter soils are also identified as an exciting research area. The authors suggest that significant gains in understanding will be made by linking processes such as biomass accumulation, nutrient turnover, and biotic interactions to the control of species turnover.

Despite the title's focus on primary succession, this book will be a good read and a useful reference both for students and for practicing scientists interested in the larger field of vegetation dynamics. The authors note in the first chapter that primary and secondary succession are points on a continuum and are not always clearly distinguishable from each other. All of the chapters contain information and examples derived from secondary as well as primary succession. For example, disturbances considered in the book include animals, patch dynamics, fire, and hurricanes, all of which initiate secondary succession, along with volcanoes, glacial retreat, and other earth movements that initiate primary succession. Thus, the synthesis of literature and concepts presented applies widely to studies of vegetation dynamics. Walker and del Moral have done a superb job of summarizing current understanding of succession, and I recommend this book to all who are interested in the patterns and causes of vegetation change following disturbance.

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FARMERS AND SCIENTISTS WORKING TOGETHER TO IMPROVE CROPS

Farmers, Scientists, and Plant Breeding: Integrating Knowledge and Practice. David A. Cleveland and Daniela Soleri, eds. CABI Publishing, Wallingford, United Kingdom, 2002. 368 pp. $100.00 (ISBN 0851995853 cloth).

By examining crop improvement issues from the perspectives of the farmer and scientist, David Cleveland and Daniela Soleri, both from the University of California–Santa Barbara, render a considerable service to the field of plant breeding, especially to that subfield directed toward crop improvement in developing countries. There is no question that conventional plant breeding has made enormous contributions to global food security. In developing countries, yields of improved rice, wheat, and, to a lesser extent, maize varieties have increased dramatically in favorable growing environments over the last 30 years as a result of plant breeding. However, the performance of these varieties under less favorable conditions has been

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disappointing, and other important food crops in developing countries have benefited much less from the efforts of breeders.

In the late 1970s and early 1980s, scientists and development experts involved in crop improvement for developing countries observed that the environments in experiment station–based breeding programs did not represent those in which many disadvantaged rural farming populations lived and cultivated their crops. Similarly, the target traits of classical breeding programs (primarily yield and to some extent pest resistance) were not necessarily those of greatest importance to impoverished small farmers. As a result of these observations, on-farm and farmer-participatory plant breeding schemes were developed to better identify which traits are indeed of importance to farmers and to better evaluate the environmental adaptation of breeding materials. Somewhat later, the objective of maintaining genetic diversity was added as another rationale for farmer participation in plant breeding, though I confess that this connection always seemed to be tenuous at best.

In this volume, Cleveland and Soleri assemble a broad set of participatory plant breeding (PPB) experiences from around the world. Although their stated objective is to try to tease out what scientists and farmers can learn from one another's very different approaches to plant breeding, their 11 case studies also end up providing a reasonable summary of the state of the art of PPB. In most chapters, there is a well-developed rationale for adopting a participatory approach under the environmental and socioeconomic conditions at hand. Many of the chapters clearly demonstrate that breeders can learn a tremendous amount from farmers.

The comprehensive chapters by Soleri and colleagues and Joshi and colleagues draw from many years of experience in Asia, the Middle East, and Latin America. They include in-depth discussions of methodologies and reasonable conjectures as to which outcomes may be more site-specific and which may have broader applicability. Ceccarelli, one of the fathers of PPB, and Grando present a compelling and well-documented case for the applicability of the approach to cereal systems in the semiarid environments of the Middle East and North Africa. Bänziger and de Meyer also present a very useful summary of their PPB efforts to develop stress-tolerant maize for southern Africa; however, their described work extended only over a two-year period. Indeed, several of the participatory breeding studies included in this volume covered only a few years' work, far too short a period to assess any impact of such a radical change in breeding approaches.

This leads to one of my significant criticisms, not only of this volume but of PPB in general. There is considerable anecdotal evidence that this approach can be effective. But I am aware of very few peer-reviewed critical analyses of how cost-effective it is or why it is effective. A number of chapters state categorically that they have no quantitative data demonstrating that PPB is actually better than conventional breeding. A PPB program can be very costly in terms of researcher and farmer time, travel, and land resources. If the positive outcomes are simply the result of a better understanding or sampling of the environment and farmer needs, could the same result not be obtained simply by identifying the target populations, conducting well-designed farmer surveys, and carefully distributing selection and evaluation fields across the target environments? There are many ways to improve a breeding program through a solid connection with farmers, without requiring that the farmers participate actively in most stages of the breeding program or become plant breeders themselves. It is important to develop tools for determining which aspects of a PPB approach, under what circumstances, are likely to pay significant

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dividends. I had hoped that this volume would begin to provide these tools, but I was disappointed.

I was struck by the range of philosophical rigor captured within this volume. Most of the chapters communicated some sense of missionary zeal associated with PPB. This was generally well within acceptable levels, with the exception of the chapter by Frossard. This attack on the International Rice Research Institute (IRRI, where I worked during the years he refers to) lacks supporting data and is laden with ideological rhetoric. What is striking is that the politically motivated (anti–Ferdinand Marcos) farmer's movement known as MASIPAG (Magsasaka at Sayantipiko Para sa Ikauunlad ng Agham Pang-Agrikultura, or Farmer–Scientist Partnership for Development), which Frossard praises, has been in the business of developing rice varieties for 15 years. MASIPAG began its rice improvement activities because the modern semidwarf varieties being produced by IRRI and Filipino national rice scientists allegedly did not meet the needs of local farmers. Yet, as Frossard freely admits, MASIPAG cannot demonstrate that its results are superior to classical rice-breeding efforts carried out by Filipino or international scientists. Indeed, from his description of MASIPAG's methodology, it is simply replicating classical breeding approaches. Frossard grudgingly admits that IRRI has undergone massive changes in its research and breeding programs in response to farmers' needs and the desire to have an impact on less favorable rice environments. Not surprisingly, his admission is relegated to a lengthy footnote at the end of his chapter. I am somewhat surprised that the editors did not demand more rigor in this particular chapter.

At the other end of the philosophical spectrum is the excellent chapter by Duvick, "Theory, Empiricism and Intuition in Professional Plant Breeding." Duvick's treatment of this subject serves as a worthy summary of the important take-home messages of this entire volume. He artfully illustrates how the interaction among farmers and breeders is a complex affair. Wise breeders will pay close attention to what farmers do and will weave the knowledge they gain into their breeding programs. Despite my earlier criticisms, Duvick makes a good case, as do other contributors, that not all of the benefits from PPB will be easily quantified. The organization of the volume would have been significantly improved if this chapter had come at the end, serving as a philosophical or intuitive synthesis.

This book will be of interest primarily to plant breeders with an interest in exploring PPB as a dimension of their crop improvement programs. Likewise, policymakers in developing countries and development assistance agencies should benefit from a number of the chapters as they wrestle with resource allocations for conventional and PPB approaches. I hope they will come away with the message that some degree of farmer participation is necessary for breeding programs that target difficult environments to be successful.

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CITY LIFE

Understanding Urban Ecosystems: A New Frontier for Science and Education. Alan R. Berkowitz, Charles H. Nilon, and Karen S. Hollweg, eds. Springer-Verlag, New York, 2002. 523 pp., illus. $49.95 (ISBN 0387952373 paper).

Biologists have tended to ignore cities, for reasons that are probably obvious. On a personal level, most naturalists would rather be as far away from concrete as they can. On a professional level, urban ecosystems are a complicated

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mosaic of natural and artificial systems that produce a blend of dynamics that is much more difficult to describe than an undisturbed natural ecosystem. Consider, for example, the dynamics of a distant mountain plant community in comparison with the complex dynamics of plants found in a typical urban park. In the latter, large subsidies of nutrients and toxic pollutants, immigration of nonnative species, and many other anthropogenic disturbances are blended with natural processes such as ecological succession to determine the park's plant and animal community composition.

The rapid and seemingly inexorable spread of cities across the globe is forcing at least some biologists to realize that urban ecosystems deserve more study (e.g., Pickett et al. 2001). As cities increasingly expand across huge areas of the landscape, residential and commercial development of the land has become the dominant cause of species endangerment in many areas. Where conservationists were once pitted against farmers in the struggle to preserve habitat, they are now more often allies trying to preserve land from urban development.

The goal of *Understanding Urban Ecosystems,* therefore, is admirable. Understanding urban ecosystems is crucial to species conservation in at least two ways (McKinney 2002). First, urban planning and growth can incorporate ecological principles to produce development that is much less harmful to natural ecosystems and communities of native species. There is an enormous untapped potential for such things as the design of roads that are less harmful to animal migration, of buildings that kill fewer birds, and of landscaping that promotes native species conservation. Second, and perhaps more important in the long term, the highly urbanized general public can become more educated about the natural world in their immediate environment. How can suburbanites be concerned about abstract conservation motives when most cannot even identify the majority of species in their own backyards?

This book is largely focused on the second of these goals. It contains 30 articles that mainly address educational, economic, psychological, and other social aspects of educating people about urban ecosystems. These articles were contributed by attendees of the 8th Cary Conference, held at the Institute of Ecosystem Studies in 1999. The attendees come from a wide diversity of backgrounds, so that, even more than most edited volumes, this book speaks with many voices.

The articles are organized into four sections. Section 1 stresses the importance of understanding urban ecosystems. Many readers of *BioScience* already appreciate this importance, but they may not be familiar with the role of community development and environmental justice in urban systems, which the authors discuss in this section. Section 2 contains nine articles describing how urban ecosystems work from the perspective of both natural and social scientists. William Rees, for example, discusses ecological economics in relation to the well-known ecological footprint concept. Anne Spirn provides an informative overview showing how urban ecology can make significant contributions to urban planning. The ten articles in section 3 address educational aspects of urban ecosystems, especially ways to improve teaching people about urban ecology. Bruce Grant's article on campus ecology is useful to those involved in educating college students and administrators about implementing ecologically sustainable ways of life on campuses. Louise Chawla and Ilaria Salvadori discuss ways to promote learning about urban ecosystems in childhood education. On a broader level, articles by Kathleen Hogan and Kathleen Weathers and by Gary Smith discuss the development of systems thinking in curricula. Section 4 contains visionary articles about ways to implement urban ecosystems education in the coming decades. As noted by Rodger Bybee, this will include significant educational reform. William Burch and Jacqueline Carrera outline ways that

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urban recreational and work environments can be enhanced to improve the mental and physical health of urbanites as well as their understanding of natural systems.

In my opinion, educators with nonbiology backgrounds will gain a lot more from reading *Understanding Urban Ecosystems* than will biologists. Few biologists need to be convinced that urban ecosystems are important. The ecological principles in the book are either very basic, and therefore well known to anyone with a biology background, or very abstract, with limited conservation applications. Like the ecosystem paradigm itself, many of the ideas relating to urban ecosystems are very interesting but are often difficult to directly apply to real-world situations.

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