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FROM SPECIES TO ALTERED LANDSCAPES

Author: BLOCKSTEIN, DAVID

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Could Do Better

America's Environmental Report Card: Are We Making the Grade? Harvey Blatt. MIT Press, Cambridge, MA, 2005. 277 pp. $27.95 (ISBN 0262025728 cloth).

In the last few years there have been many notable books reporting on the state of the US or global environment. These include *The End of Nature,* by Bill McKibben (New York: Random House, 1989); *Something New under the Sun: An Environmental History of the Twentieth-Century World,* by J. R. McNeill (New York: Norton, 2000); *Red Sky at Morning: America and the Crisis of the Global Environment,* by James Gustave Speth (New Haven: Yale University Press, 2004); and *Collapse: How Societies Choose to Fail or Succeed,* by Jared Diamond (New York: Viking, 2004). None of these authors should be confused with environmental doomsayers, yet they all deliver a somber message. Sufficient compelling scientific information exists that would lead rational people to be concerned about immediate and long-term effects of environmental change on human well-being.

Harvey Blatt's new book, *America's Environmental Report Card: Are We Making the Grade?* can now be added to the list of sobering and informative books on the environment. Written for the layperson, it assesses the state of the US environment in terms of water use, flood control, waste disposal, soil conservation, energy conservation and global warming, air pollution, ozone control, and nuclear waste disposal. The grades Blatt assigns to different aspects of the nation's environment range from A– (ozone control) to D (energy conservation and global warming), with an overall evaluation of C. I had concerns about whether the grading was on a curve. Presumably, the author had benchmark standards in mind in order to assign these grades, but unfortunately these were never made clear. Assigning standards for environmental integrity is clearly difficult but seems a prerequisite to any evaluation.

The book is filled with facts about the state of the US environment, many of which are shocking. For example, as of 2003, 270,000 miles of rivers and streams were too polluted for fishing and swimming; about 70 million people, 25 percent of the American population, live near a toxic waste site, and 1 in 10 women of childbearing age is at risk for having a baby born with neurological problems due to *in utero* mercury exposure. These examples are noteworthy because all are relevant to recent policy proposals by the Bush administration. Proposals to relax the standards of the Clean Water Act and Clean Air Act will exacerbate water and air pollution, respectively. Incentives to increase power generation, coupled with relaxed emission standards for coal-fired power plants, will increase mercury levels in the environment. And exemptions of Department of Defense lands from environmental regulations are likely to increase the amount of toxic waste; the military is responsible for the generation of more than one-third of the nation's toxic waste each year.

I have found these facts useful in discussions with local government officials and social acquaintances. They tend to dispel the optimistic view held by many Americans that we are on a trajectory toward better environmental quality. However, the connections between statements in Blatt's book and the peer-reviewed scientific literature are very uneven. Many references are to the popular literature and may not withstand scrutiny if brought into the policy or legal arena.

Throughout, the author is unambiguous in stating that nearly all of America's environmental problems are political and social, not scientific, problems. For the most part, the scientific community knows how to address environmental degradation, but scientists are often distant from the policy arena. Blatt also candidly acknowledges that special-interest groups and corporations have an undue influence on US environmental policies that is disproportionate to their numbers. This influence seems to be pronounced in the current political setting, in which environmental regulations have been reduced or only weakly enforced.

The question remains as to what to do with all the facts contained in this book. In the concluding chapter, the author attempts to dispel some myths and provide some guidance that may lead to greater environmental quality. For example, he claims, beliefs that environmental regulations cause widespread unemployment, plant shutdowns, and loss of businesses to foreign countries are generally untrue. The reality is that environmental regulations can often lead to economic gains. Many of his suggestions are directed at the individual and focus on decisions we all make on a regular basis—that is, what vehicle to purchase, how long to stay in the shower, and whether to recycle. This type of guidance seems somewhat trite given the scale of America's environmental problems, but it could be argued that the collective effect of individual choices can be pronounced.

One of the more interesting topics discussed in the concluding chapter is the benefits of environmental taxes. The true costs of agriculture and industry are often in the form of externalities—water pollution from agricultural runoff and increased respiratory disorders due to smokestack emissions, for example—that are imposed on the public, not on those who financially benefit from these activities. Taxing environmentally destructive activities has the dual advantage of raising revenue for environmental protection and providing health and quality-of-life benefits to the public. As the author points out, many countries have adopted systems of environmental taxes that have not resulted in significant economic impacts but have provided substantial environmental benefits. Unfortunately, America is not one of these countries.

The facts presented in *America's Environmental Report Card* should prove useful to citizens who want to be better informed about the actual state of Amer-

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ica's environment. The book should also dispel the belief that America is the global leader in environmental protection. However, how to act on this information is less clear. Convincing the American public that environmental protection and restoration should be high on their list of priorities seems a formidable task.

BARRY R. NOON
Department of Fishery and Wildlife Biology
Graduate Degree Program in Ecology
Colorado State University
Fort Collins, CO 80523

FROM SPECIES TO ALTERED LANDSCAPES

How the Earthquake Bird Got Its Name and Other Tales of an Unbalanced Nature. H. H. Shugart. Yale University Press, New Haven, CT, 2004. 240 pp., illus. $27.50 (ISBN 030010457X cloth).

If a book can't be judged by its cover, neither should its title, or even its table of contents, be expected to accurately portray its contents. Clever chapter titles such as "The Rat that Held Time in Its Nest" and "The Wolf that Was Woman's Best Friend" suggest a popular and somewhat lightweight recounting of animal tales. However, the recent book by Hank Shugart, W. W. Corcoran Professor in the Department of Environmental Sciences at the University of Virginia, is much more than a collection of stories and anecdotes about natural history. It is an information-packed, well-referenced, and wide-ranging book that covers the gamut of landscape ecology from fundamental principles to complex human–nature interactions.

The titles follow from Shugart's formula of beginning each chapter with an excerpt of historical narrative, from Pliny the Elder (AD 81) to ornithologist George Lowery (1955), followed by several pages of discussion about the species of interest. The examples serve to introduce the topic of the chapter. A discussion of pack rats and their middens introduces paleoecology and climate change. The earthquake bird—the now extinct Bachman's warbler, whose nickname refers to its former abundance in the tangles and downed trees that resulted from 19th-century earthquakes in the swamplands of the southeastern United States—naturally leads to a discussion of disturbances. And so it goes.

The format works well once the reader understands what the book is about. I admit to some frustration when the first chapter, which was ostensibly about the ivory-billed woodpecker ("The Big Woodpecker that Was Too Picky"), mentioned the woodpecker on only 6 of 23 pages. The chapter introduces landscape ecology, covering gap dynamics, interspecific relationships among trees, and nearly everything in between those topics. The seven figures (including a highly theoretical flow diagram illustrating "the complex relationships among trees of four simple ecological roles"), 27 footnotes, and one table (but also one poem) in the first chapter are probably enough to scare off the lay reader who picks up the book expecting something much lighter.

Shugart has a lot to offer readers who persevere. He is a polyglot who weaves information from many fields into a compelling presentation. Shugart offers ecological facts and theories, served up with a discussion of the societal influences of Jean-Jacques Rousseau and a smorgasbord of arcane facts—for example, rabbit was a prominent part of the menu at the installation of the Archbishop of Canterbury in 1443 (a relevant tidbit, because it shows the abundance of this introduced species in Britain).

A number of examples refer to Australia, where Shugart has spent part of his career. Perhaps the most interesting is the complex story of the tiny Leadbeater's possum, a species once thought extinct and found only in forests of old-growth mountain ash (*Eucalyptus regnans,* the world's tallest flowering plant, at over 100 meters tall). The possums nest in stumps and snags of trees killed by catastrophic wildfires. Fires of this magnitude are very infrequent, with the last ones—the Black Friday fires—having occurred in 1939. The possums are facing a crisis because their current nesting trees are decaying, and the regrowth trees generated by the 1939 fire will not be mature enough for nesting until 2140. Complicating this population bottleneck are forest practices that do not allow trees to reach sufficient age for possum nesting, in addition to policies to prevent catastrophic forest fires.

As is almost inevitable in this "world of wounds" that passes for nature at the beginning of the third millennium, there is a strong conservation message. Three of the nine focal species in the parables that begin the chapters are extinct (great auks, Bachman's warblers, and New Zealand moas), and a fourth, the ivory-billed woodpecker, was assumed by Shugart and others to be extinct until its remarkable rediscovery earlier this year (Fitzpatrick et al. 2005). There is also discussion of the extinct passenger pigeon—the most abundant land bird in the world as recently as two centuries ago—in the chapter about the red-billed quelea of Africa ("The Most Common Bird on Earth").

It is instructive to reexamine the chapter involving the ivory-billed woodpecker now that we know that the presumption of its extinction was mistaken. Shugart's premise is that the woodpecker was "too picky": its specialized feeding habits, utilizing a "rare element" of the forest, require extensive acres of floodplain forest. These massive woodpeckers eat grubs found underneath the bark that is scaled off from large, newly dead old-growth trees. The replacement of these trees requires sufficient time for the forest to regenerate, and to sustain the woodpecker there must be an area that provides enough trees in this condition.

Shugart summarizes, "The sad demise of the ivory-billed woodpecker reveals much about the dynamics of natural vegetation. From the forest in which it occurred, the bird appears to have required a short-lived but slowly generated portion of the gap replacement cycle. Its feeding habits required large, standing-dead trees with loose bark and insects underneath, a condition that is not always generated in the cyclic change in a forest; some

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trees, because of wind and other factors, fall over while still alive" (p. 22).

He continues, "The woodpecker 'used up' its scant resource rapidly because of its habit of only removing the loose bark of the trees to search for insects. A large tract of mature forests would be required to supply enough forest mosaic elements to satisfy the bird's needs. The clearing for agriculture of the floodplain forests of the U.S. South spelled trouble for a large animal that required a significant amount of mature forest to meet its highly specialized feeding requirements" (pp. 22–23).

This description of the species' requirements and the conditions necessary to fill those requirements is accurate. Happily, despite the clearing of the floodplain forests, enough forest has remained for this "ghost with wings" to persist, out of human sight, for 60 years. Having survived into the 21st century, the woodpecker faces a regenerating forest, thanks to the foresight of conservationists and hunters, that offers hope for its continued, albeit tenuous existence. An understanding of the principles of landscape ecology elucidated in this book has allowed The Nature Conservancy, the US Fish and Wildlife Service, and others to purchase and protect nearly half of the 500,000-acre "big woods" of eastern Arkansas, and allow natural regeneration to restore that forest, to meet the current needs of at least a small number of big woodpeckers. For this species and others to continue to exist, however, calls for even more understanding and application of ecological principles.

Ecological principles involve more than vegetation change and wildlife-habitat requirements. The next intellectual frontier is the complexity of human–nature interactions. This is addressed in several chapters, but mostly in demonstrating effects of human habitation (principally through disturbance, introduced species, and climate change). The final chapter, "Planetary Stewardship," documents people's ability to change entire vegetation regimes, but offers little in the way of solutions. Nonetheless, an understanding of how landscapes change and how humans have been a part of these changes for millennia is a key precursor to conservation.

The intended audience for the book is not obvious to me. Presumably the book was written to have some appeal to an educated lay reader. However, despite the parables and many examples and interesting anecdotes, I'm afraid that the content may be out of reach of anyone who has not taken an ecology course. It appears that many of the chapters are derived from Shugart's own teaching experience. The book would be ideal for a graduate seminar or even as supplemental reading in a graduate course in advanced or landscape ecology. It is certainly also a useful refresher for this reader with a two-decades-old degree in ecology who is no longer engaged in research. It should serve equally well for many others with some background in ecology and a bit of patience.

DAVID BLOCKSTEIN
National Council for Science and the Environment
1707 H Street, NW
Washington, DC 20006

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KEEPING IT IN THE FAMILY

Evolution of Communication Systems: A Comparative Approach. D. Kimbrough Oller and Ulrike Griebel, eds. MIT Press, Cambridge, MA, 2004. 338 pp., illus. $45.00 (ISBN 0262151111 cloth).

Evolution of Communication Systems: A Comparative Approach, the fourth volume in the Vienna Series in Theoretical Biology published by the MIT Press, addresses a hallmark feature of human evolution—our unparalleled facility for complex symbolic communication. The advanced status of human symbolic communication, exemplified by spoken and written language, is well articulated by contributing author Charles T. Snowdon: "Nothing that nonhuman animals can do approaches the complexity of our vocabulary, our grammar, the concepts and ideas, both concrete and abstract, that we can express; our playfulness and creativity as we devise new words like *Xerox* and *fax;* as we pun, write poetry or novels, or express our love for one another" (p. 131).

Reconstructing the evolution of human symbolic communication presents serious conceptual and methodological challenges. Did human languages evolve gradually from more primitive signal precursors? If so, how similar to these precursors are "primitive" communication systems in present-day nonhuman animals? Are there general rules for symbolic communication that cut across all species? And why have other species not evolved similarly advanced communication systems? These and related questions, many of which trace back to Charles Darwin and George Romanes, are the focus of 16 chapters penned by cognitive and behavioral psychologists, linguists, biologists, and a philosopher. The editors, D. Kimbrough Oller and Ulrike Griebel, from the University of Memphis, Tennessee, have done admirable work integrating a diverse population of chapters into a fairly cohesive unit. Introductory and closing chapters provide helpful guides, and liberal cross-referencing highlights common themes. I had one minor complaint: the title and cover photographs (of cuttlefish and a walrus) imply that the book will address communication in nonhuman animals on its own terms. This is not the case.

Most chapters address, and some as their raison d'être, the constituent properties and infrastructure of complex symbolic language. Numerous authors also suggest sequences by which symbolic language may evolve. Be ready here for challenging terminology; the semantics of semantics, in which language is both medium and content, can be alarmingly complex. Several chapters on this front, notably those by Ruth Garrett Millikan, William F. Harms, and Chris Sinha, were virtually unreadable, at least to this biologist. Yet other chapters offered clear and interesting insights. It was fascinating to

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see how behavioral scientists (Snowdon, Irene M. Pepperberg, Jennifer A. Mather) placed their work on nonhuman animals in the broader context of the book. I was particularly impressed by Peter Gärdenfors's hypothesis about how humans differ from other animals in communication abilities. Gärdenfors suggests that humans are unique in that we use symbolic language to refer to objects, actions, and goals that are not necessarily present in our immediate environments, but that may exist purely in our own "inner worlds." Such capacity for "detached representation," a term coined by Gärdenfors, enables humans to plan future events that are not cued by immediately available stimuli. With this comes an ability to construct abstract symbolic categories, for example to group individual referents (names) into categories based on shared properties (nouns). Human language thus stands apart from other complex communication systems, such as those of bees, which may appear symbolic on the surface but only address immediate stimuli or situations, and which appear not to be categorical. The concept of representations used by Gärdenfors is refreshingly consistent with its normal, familiar usages in cognitive ethology and neuroethology.

And what of language evolution? One observation of central interest, discussed by numerous authors, is that language evolved in concert with vocal learning and advanced cognitive capacities. Vocal learning provides humans an ability to develop otherwise arbitrary "sound-meaning mappings" (James R. Hurford, p. 302), and advanced cognitive capacities set the context in which fine-resolution symbolic representations are articulated. Other species, however, may also possess similar traits but have not evolved symbolic language. Vocal learning, for example, has evolved in songbirds, and advanced cognitive capacities have evolved in African grey parrots; but neither uses symbolic communication. What, then, is so special about people?

Traditionally, answers to this question have been mostly of an "environmental or technical" nature (R. I. M. Dunbar, p. 257), addressing, for example, unique features of human vocal physiology, or how advanced vocal learning or cognitive abilities delimit universal "rules" or "grammar" on which language is built. Such approaches were pioneered by Noam Chomsky; see Marc Hauser's 1996 book *The Evolution of Communication* (Cambridge, MA: MIT Press) for a helpful overview of this literature. But, as evident in both Hauser's and the present book, the focus is now shifting to stress how human language evolution may have been catalyzed by our unique ancestral social circumstances.

A common emerging theme is the importance of cooperation, and this is where the book excels. I particularly recommend the quartet of chapters by Dunbar, Gärdenfors, W. Tecumseh Fitch, and Snowdon. Dunbar reviews his "gossip" theory of language evolution, which argues that symbolic language evolved as a means by which our ancestors maintained social bonds as group sizes increased during hominid evolution. This task was previously accomplished by grooming, but became unmanageable in larger groups because time required for grooming encroached on other critical tasks such as foraging. Gärdenfors further suggests that symbolic language enabled our ancestors to plan future actions, and that such planning revolved largely around selection for cooperative ventures. Fitch takes these ideas to a more detailed level of resolution, arguing that language, being both cheap and honest, carries the imprint of kin selection. Thus the ability to share complex information among kin, with regard to behavioral ventures such as group foraging, would favor kin groups with comparatively strong language proficiency. Fitch's focus on the importance of language within family groups concurs well with data on language ontogeny and function. Snowdon reviews work on communication and cooperative breeding in New World primates. Of particular interest is his re-

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search on vocalizations in tamarin families, in which changing patterns of adult vocal behavior were shown to guide food choice by juveniles. Even more intriguing are data that suggest that adult tamarins teach their infants about which vocalizations they should use in which contexts.

The conceptual emphasis of *Evolution of Communication Systems,* then, is on cooperation. Perhaps selection for cooperative behavior, playing out on a receptive "biological platform" (Snowdon, p. 145) of vocal, imitative, and cognitive proficiency, indeed powered language evolution. The level of agreement among authors on the importance of cooperation is impressive. The editors report that the workshop "resulted in an extremely lively exchange of these ideas, filled with probing questions and *much laughter*" (preface, my italics). Is, then, the study of linguistics, a field long rife with controversy, itself entering a new age of civility?

JEFFREY PODOS
Department of Biology
University of Massachusetts
Amherst, MA 01003

WHY CARE ABOUT BACTERIAL SPECIES?

Microbial Diversity: Form and Function in Prokaryotes. Oladele Ogunseitan. Blackwell Publishing, Malden, MA, 2005. 292 pp., illus. $84.95 (ISBN 0632047089 paper).

In the introduction to *Microbial Diversity,* Oladele Ogunseitan states that his purpose is to eliminate the gap between "the appreciation of [the diversity in] large animal and plant organisms (macrobiodiversity) and the widely acknowledged ignorance of the diversity of microorganisms (...microbiodiversity)." His book goes a long way toward achieving this goal.

Ogunseitan is a professor of environmental health, science, and policy at the University of California, Irvine (UCI). He received his PhD from the University of Tennessee, Knoxville, in 1988 and joined the faculty at UCI shortly thereafter; he has published extensively on molecular microbial ecology and the use of proteomics and genomics in assessing the genetic and physiological richness of environmental microbial communities. Among other honors, Ogunseitan has been a Global Environmental Assessment Faculty Fellow at Harvard University and a UNESCO–ASM visiting resource fellow. These experiences have provided him with the time and expertise to write an excellent book on microbial diversity.

The work is divided into two major sections. The first consists of five chapters that discuss concepts and methods used to define and study microbiodiversity. Both culture-based and molecular methods are explained in detail. The descriptions and excellent illustrations allow the reader to understand how to carry out the techniques and how to apply them to the study of microbial diversity. Debate over the idea of a "bacterial species" is presented in the first chapter of the book. This discussion is perhaps the author's most important contribution to the reader's understanding of microbiodiversity. As scientists learn more about the microbial world, it becomes more, rather than less, difficult to define a bacterial species. Ogunseitan begins his explanation with a discussion of the traditional concepts of species that have often been applied to plants and animals. He then points out the pros and cons of each of these hypotheses and how well each may be applied to developing a concept of species for prokaryotes. His arguments are laid out in a thoughtful and informative manner that presents the many sides of this difficult question, whose answer influences scientists' ideas of both microbial diversity and evolution. He ends his first chapter with a discussion of the emerging concepts of bacterial taxonomy and systematics and how these concepts apply to the study of microbial ecology.

The second section, composed of six chapters, relates how the techniques and concepts presented in the preceding section have been used to broaden our understanding of microbial diversity. Ogunseitan begins with a chapter devoted to a discussion of microbial evolution. Several chapters that follow explain the cycling of biologically important chemical elements and compounds and how the roles of environmental microorganisms in these processes have led to microbial diversification.

Additional chapters deal with the interactions among microorganisms and between microorganisms and macroorganisms in the environment. Each of these interactions is discussed in the context of how it has affected microbial evolution and diversity and how, in turn, microbes have influenced the development of their environments. The book ends with a chapter entitled "Microbial Diversity and Global Environmental Issues." This excellent summary chapter introduces current environmental issues such as pollution, climate change, and preservation biology. It discusses the use of microbial diversity as an index of environmental changes and the role of microorganisms in providing solutions to these problems. This chapter clearly stresses the urgency of these issues for the 21st century.

The work is intended for use as a textbook. Several special features facilitate this use: extensive illustrations (including four-color plates), text and image boxes, questions for study at the end of each chapter, lists of suggested readings for each chapter, a CD-ROM to facilitate classroom presentations, and a dedicated Web site. Particularly successful are the outstanding text and image boxes, many devoted to historically important events in the development of molecular microbial ecology. Such insights are important to help students develop an understanding of the flavor as well as the facts of this discipline. The Web site contains resources for instructors, including suggestions for presentation of the material in each chapter and a sample class syllabus. Student resources include animations, interactive exercises, and links to related Web sites.

The "questions for further investigation" found at the end of each chapter are indeed thought-provoking, and many require a significant amount of research to develop a proper answer. Instructors

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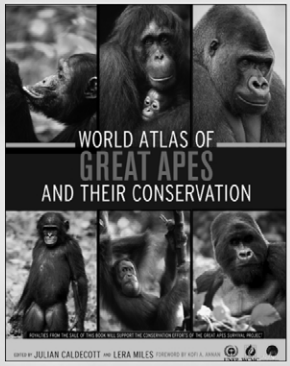
may want to use them as assignments or as subjects for classroom discussion. The book includes an appendix of fully sequenced microbial genomes, a glossary of terms, and an index. Unfortunately, the index is minimal and the glossary incomplete, with subject-specific terms missing or inadequately defined. I hope that a second edition will remedy the problem by expanding the index and glossary.

Although the instructional resources make for a useful text, determining the level for which it is most suited is problematic. The author suggests its use in one or more of the courses that the American Society for Microbiology recommends as the core of an undergraduate curriculum in microbiology (introduction to microbiology, microbial physiology, microbial genetics, and microbial diversity). I gave the book to colleagues in my department who teach each of these classes. As a group, they agreed that its place in this curriculum should be as a reference or supplemental text for the brightest and most involved students. The level is probably too high for the average undergraduate, and the subject is too specific for use as a general text in any of these courses. It is probably better suited to a graduate course in microbial diversity or microbial evolution.

Despite its limitations as an introductory textbook, this work is an excellent introduction to microbial diversity for readers with a serious interest in the subject. It is extremely well written and rigorous in its presentation and attention to detail. Although the technical subjects it addresses are often difficult, the text is never abstruse. The facts are well documented, and the book contains an extensive reference list of primary sources (in addition to the suggested readings at the end of each chapter). *Microbial Diversity* is a good read, and a thorough introduction to a complex topic.

ROBERT V. MILLER
Regents Professor of Microbiology and Molecular Genetics
Oklahoma State University
Stillwater, OK 74078

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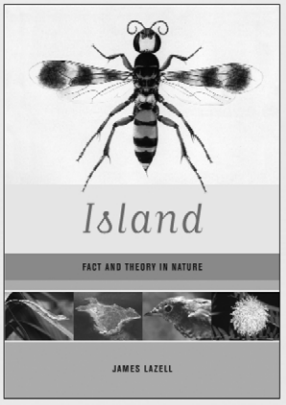


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