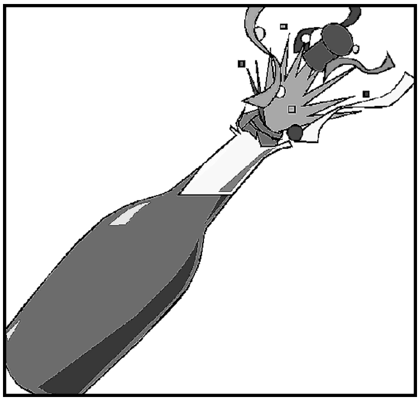
Smart for one, dumb for all

Luxury Fever: Why Money Fails to Satisfy in an Era of Excess. Robert H. Frank. Free Press, New York, 1999. 326 pp. $25.00 (ISBN 0-684-84234-3 cloth).

Economist Robert H. Frank has written a stimulating book that integrates research from psychology, evolutionary biology, and economics to address the raging "luxury fever" that is needlessly consuming precious resources in "overdeveloped" economies. Frank documents how luxury consumption in western industrialized countries has been rising at an astronomical rate even though recent psychological research shows that there is scant correlation between this consumption and levels of stated life satisfaction.

Why, then, are some wrist watches selling for $20,000, huge houses of 10,000 square feet or more being built, and myriad other forms of conspicuous individual consumption rapidly increasing, even as social spending on education, infrastructure, the environment, and other things that would raise the average level of life satisfaction in society is decreasing? Frank describes how this perverse "luxury fever" occurs when individuals pursue their strong individual incentives to increase their relative position in society by consuming more than their peers. But when everyone behaves in this way, relative consumption (and perceived life satisfaction) remain constant, while absolute consumption (and related negative impacts on natural resource use, the environment, and education spending) soars.

Luxury fever is one of a class of phenomena known by various names in different disciplines: negative externalities (Pigou 1940), social traps (Cross and Guyer 1980, Costanza 1987), social dilemmas (Ostrom et al. 1999),



the prisoner's dilemma (Axelrod 1984), and the tragedy of the commons (Hardin 1968). Frank cleverly labels these phenomena as situations that are "smart for one, but dumb for all." Once one begins to look, clear examples of these situations can be found everywhere, in such phenomena as drug addiction, pesticide overuse, arms races, environmental pollution, and high fashion. Although these phenomena have been recognized by economists, they have largely been relegated to the status of interesting but relatively minor anomalies. But Frank clearly points out just how pervasive, important, and wasteful they are and how eliminating them can save literally billions of dollars while actually improving human welfare. The "invisible hand" of the market cannot be relied on to solve these problems, Frank notes, because "far from being a principle that applies in most circumstances, the invisible hand is valid only in the special case in which each individual's rewards are completely independent of the choices made by others. In the rivalrous world we live in, precious few examples spring to mind" (p. 271).

After describing current trends in luxury consumption in often shocking detail, Frank looks at the psychological research on the determinants of life satisfaction and combines that research with research on human evolution. Individual humans have clearly evolved to respond much more strongly to relative position in a group than to absolute position. As in all animal species, the competition to survive and reproduce rewards individuals that are relatively more successful at finding mates and raising offspring than their peers. In humans and many other mammals, mate selection by females is influenced by the relative status of males, because male status is often correlated with the success of their offspring. But these evolutionary processes, Frank points out, can be smart for one but dumb for all. For example, the relative size of a male elk's antlers determine his mating success. But although the relative sizes of antlers in the population have remained constant, the absolute sizes have increased, in a kind of "arms race." The problem with this strategy is, of course, that big antlers hinder the male's movements and make them easier targets for predators. Likewise, individual humans get caught in the same kind of trap by pursuing their (perfectly rational) individual incentives to increase their relative status. The net effect is no change in relative status—but huge increases in wasteful consumption, with its related costs.

Frank's solution to luxury fever is a strongly progressive consumption tax. A simple one-line amendment in the US tax code would exempt all savings from income taxation. With this modification, the income tax would tax only consumption, obviating the need to specify which consumption was "luxury consumption," and (because of its steep progressivity) it would do so without adversely affecting the poor. This consumption tax would have the effect of increasing the costs of conspicuous consumption for individuals (and thus reducing it) while freeing up significant resources to pursue increased "inconspicuous consumption"—things like education, infrastructure, environmental protection, and family time. Given the psychology of relative consumption and satisfaction, this change could occur with absolutely no decrease in human welfare. In fact, average life satisfaction would increase because relative individual consumption would not change and the neglected forms of social consumption could be increased with the resources from the tax.

Why has so obvious a "win–win" move not already occurred, and what are its chances in the future? Frank answers the first part of this question with the famous joke about the economist who sees a $10 bill lying in the street and concludes that it couldn't really be a $10 bill because if it were, someone would have already picked it up. The first step is to clearly and convincingly lay out the problem and the solution as Frank has done—in effect, to point out that the $10 bill is, in fact, just lying on the ground. Indeed, the idea of a broad consumption tax (and the reasons for it) has been around for many years. It was first proposed by Thomas Hobbes in 1651 and has surfaced many times during the last 300 years (Seidman 1997). Frank concludes that it will be just a matter of time before the obvious benefits of such a tax are recognized and the plan is implemented—after all, most political changes have a significant gestation period. But there are also obvious impediments to implementing such a tax in the current political climate. In political systems run more and more by special interests, it is difficult to agree on any policy that might hurt even one of those interests, even if only in the short run.

Frank supports the tax idea by noting the "success" of environmental taxes in solving pollution problems caused by forms of social traps analogous to luxury fever. In reality, pollution taxes are still only very sparingly used and have a long way to go before they can be said to have solved pollution problems, even though the obvious win–win nature of this solution has been pointed out by a broad range of commentators and demonstrated in the few situations for which it has been tried (Bernow et al. 1998). The political barriers to implementing pollution taxes are similar to those for implementing a broad-based consumption tax, even though both taxes are really "money for free" from society's point of view.

Overcoming the political impediments to meaningful tax reform will require "government by discussion" (Sen 1995) rather than by interest groups and media manipulation. If social issues of the importance of those in Frank's book can be discussed rationally by society at large, then such obvious social win–win solutions as ecological tax reform and a progressive consumption tax can be appreciated and implemented. In a few countries, this kind of social discussion occurs reasonably well, but in most it is a far cry from current political reality. Just as it is difficult for an animal caught in a trap to free itself, it is also difficult for a society caught in a social trap to free itself—even when the nature of the trap and the way out has been clearly identified. Let's hope that we don't have to bite off our social foot to escape the invisible hand.

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COUNTERING BIOLOGICAL WEAPONS' GRAVE THREAT

Biological Weapons: Limiting the Threat. Joshua Lederberg, ed. MIT Press, Cambridge, MA, 1999. 351 pp., illus. $20.00 (ISBN 0-262-62128-2 paper).

The grave threat posed by biological weapons to global security is real. So points out Defense Secretary William S. Cohen in the foreword to *Biological Weapons: Limiting the Threat*. The security problems posed by biological weapons, particularly their potential use by terrorists to cause mass casualties, presents a significant challenge—both to the medical community, to prepare for a horrific biological weapons attack, and to the political community, to prevent such an event from occurring. International agreements have so far failed to remove the threat of biological weapons. The 1972 Biological Weapons and Toxins Convention did not prevent Iraq from carrying out a major biological weapons development program. Nor did it halt the massive biological weapons program of the former Soviet Union that has been detailed by Ken Alibek, a former leader in that illicit program, who defected to the United States with tales of huge stockpiles of smallpox, anthrax, and other deadly agents. Particularly frightening are the attempts by terrorist groups such as the Aum Shinrikyo, which carried out the nerve gas attack on the Tokyo subway, to acquire biological weapons that could cause massive civilian casualties, and the possibility that scientists from the former Soviet biological weapons programs may have moved into state-sponsored terrorist programs in Iraq and North Korea.

It is against this background that

Joshua Lederberg has assembled a group of contributors to consider the scientific, medical, and policy issues involved in trying to minimize the threat posed by biological weapons. The book brings together a number of chapters detailing the reasons for concern and the approaches of the arms control and medical communities to limit the threat. The authors have great expertise, not only in the scientific aspects of biological weapons but also in the policy aspects. They bring to readers their firsthand experience at investigating allegations of biological weapons development and developing policies to reduce the threat of biological warfare and bioterrorism.

The book begins with the reasons for concern, including the historical uses of biological weapons in warfare, and then leads to the more modern era of the threat of the continuing biological weapons programs of the former Soviet Union, Iraq, and bioterrorist groups. Some of these latter chapters detail the investigations and consequences of several incidents involving the release of biological weapons. The book also covers the political response—from US domestic laws to international efforts to strengthen the Biological Weapons Convention—and the medical community's attempts to prepare for the inevitability that a public health response will be needed to respond to a biological weapons attack. The result of the book's interesting mix of science, medicine, public policy, and fear is a superb overview of the threat posed by biological weapons and the policy challenges involved in trying to limit that threat. The chapters show clearly that balancing the legitimate needs of the scientific and medical communities to further biomedical research with the need to deter biological warfare and bioterrorism presents perplexing policy dilemmas.

It should be noted, however, as pointed out in the acknowledgments at the front of the book, that most of the chapters first appeared as papers in the 6 August 1997 issue of the *Journal of the American Medical Association* (*JAMA*). There has been some updating, but for the most part their scope and content are unchanged. But the messages of the chapters are as important and relevant today as they were 2 years ago. Anyone who did not read the articles when they appeared in *JAMA* should read them now in this volume. The plots of the novels *The Cobra Event* (Preston 1997) and *Vector* (Cook 1999) are all too realistic. Biological weapons are a grave threat—one that, unfortunately, we all must consider.

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OBJECTIVE SCIENCE AND POLITICS: CAN THEY COEXIST?

Science Under Siege: The Politicians' War on Nature and Truth. Todd Wilkinson. Johnson Books, Boulder, CO, 1998. 384 pp. $18.00 (ISBN 1-55566-211-0 paper).

Politics still controls the purse strings of land management agencies, and few bureaucrats or scientists in their right minds are willing...to bite the hand that feeds them. It means that science is forever a hostage to politicized science and meddling. (p. 110)

This disconcerting statement is the implicit message of a superbly written and extensively researched book about eight courageous scientists who refused to remain silent on their professional convictions about damage to public-land resources perpetrated by agency management actions. All eight were ordered to carry out management actions that they believed to be environmentally damaging, to rewrite environmental documents, to make public statements contrary to their beliefs, or simply to remain silent. The case studies span eight western states and involve five federal and one state land-management and environmental agencies.

Before moving to Montana, journalist Todd Wilkinson covered the violent-crime beat for the *Chicago Tribune*. That investigative experience gave him an excellent background for probing into the cases described in this book. Now a scholar of western environmental issues, he writes for numerous media, including the *Christian Science Monitor*, *Bozeman Chronicle*, *Audubon*, and *High Country News*.

Science Under Siege begins with a foreword by David Brower, who uses it as a forum once again to castigate the Glen Canyon Dam, as he does in numerous settings. It continues with an introduction by Jim Baca, former director of the Bureau of Land Management (BLM). Baca supported a BLM whistleblower featured in this book and, according to Wilkinson, was "forced out" of BLM by Secretary of Interior Bruce Babbitt for his "activism" in the agency's resource-management directions. The author follows with a prologue, "Remembering the Spirit of Rachel Carson," describing his entrée into the world of scientific whistleblowers and the generic strategies used by what he calls "corrupt politicians and bureaucrats" to intimidate and silence them.

The first chapter, "Confessions of a Timber Beast," features Jeff DeBonis, a former forester with the US Department of Agriculture Forest Service (USFS), who enthusiastically administered extensive Oregon timber cuts until he realized the environmental consequences of his actions and began refusing cut assignments. The second chapter, "A Grizzly Future," discusses a Yellowstone National Park bear biologist, David Mattson, who challenged his superior's claim that Yellowstone's grizzly bears were increasing and should be removedx from threatened status under the Endangered Species Act (cf., Mattson 1996).

"Latter-Day Frogs" chronicles the efforts of herpetologist David Ross, of the Utah Division of Wildlife Resources (DWR), to call attention to the tenuous status of the western spotted frog, *Rana pretiosa*, caused by the rapid habitat destruction accompanying the state's headlong economic growth. In "Fear and Loathing the EPA in Las Vegas," Wilkinson highlights Environmental Protection Agency water-quality specialist Jeffrey van Ee, a Sierra Club activist on weekends who publicly opposed USFS funding of desert tortoise research, contending that the funds were more urgently needed for habitat restoration. His own agency ordered him to remain silent on the issue, even on his own time, or lose his job.

"The Combat Biologist" tells the tale of USFS fishery biologist Al Espinosa, who insisted on speaking out about the damage his agency was doing to Idaho streams and fish stocks with extensive clear-cutting and logging road construction. Ronald Carrel Kerbo, the "Caveman Poet" and chief of cave protection for the National Park Service, opposed oil and gas drilling that could alter the delicate environments sustaining sensitive underground ecosystems in thousands of square miles of karstic cavern networks in southern New Mexico.

Ben Lomeli, the "Riverkeeper," was a BLM hydrologist who spoke out against groundwater withdrawals in southern Arizona that threatened the continued flow of the San Pedro River, "the last free-flowing river in the desert Southwest." Howard Wilshire, "Moonwalker," was a US Geological Survey geologist who voiced concerns over the ecological effects of off-road vehicle use and possible groundwater transport of isotopes from a proposed belowground nuclear waste dump in California's Mojave Desert.

All of these principled people incurred the wrath of colluding economic interests, local politicians, and agency higher-ups. Some were ostracized socially, some were scorned by their agency peers, and some received death threats. All but two paid for their commitment to the American public's resourcesx with early resignation, dismissal, or pressured transfer. The book ends with an epilogue, "Defending the Defenders," with short essays by administrators of three whistleblower and professional ethics organizations. These essays describe ways in which conscientious employees can speak out in the face of bureaucratic and corporate pressures and cases in which doing so has both contributed to protection of the First Amendment right to free speech and other constitutional liberties and stimulated changes in some organizations.

Science Under Siege is an important book that needs wide visibility. It is an interesting book, filled with enlightening detail on the technical aspects of the eight resource situations. And it is a troubling book on several counts.

It is troubling for a reviewer bent on a fair assessment of the scenarios painted by the author. While granting that his portrayals may be fully accurate and objective, one would, in the interests of objectivity, like to hear "the other sides to the stories." Wilkinson (personal communication) has informed me that he carefully selected cases of well-established, productive scientists to avoid the possibility of featuring malcontents with personal grudges against superiors and their organizations. I am familiar with the DeBonis and Mattson cases and know that they are described accurately. But I also know that the Utah legislature's hatchet job on the Utah DWR, described by Wilkinson, had been brewing for some time and had broader causation than just its concerns over Ross's actions on the western spotted frog.

Readers will be troubled by the prospect of how pervasive the subversion of science, as described in this book, actually is among the agencies. Wilkinson believes that it is widespread although generally more subtle than the blatant cases he selected for calling attention to it. But is it as common as he contends? I know many committed, highly professional agency administrators who would not coerce their scientists in the ways chronicled in this book. Yet, in the author's defense, I am also aware of a stream of publications detailing similar cases (cf., Schiff 1962, Chase 1986, Smith 1988, Hirt 1994, Yaffee 1994, Hutchings et al. 1997).

Whatever or not the subversion of science is as widespread as this book implies, Wilkinson's major concern is with the full use of scientific knowledge in decisions on public resources. He wrote *Science Under Siege* to help ensure that combat biologists, like the eight he has profiled, will be fully heard in the policy process.

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TWO SIPHONS UP

The Freshwater Mussels of Tennessee. Paul W. Parmalee and Arthur E. Bogan. The University of Tennessee Press, Knoxville, TN, 1998. 328 pp., illus. $50.00 (ISBN 1-57233-013-9 cloth).

The Freshwater Mussels of Tennessee, written by two of North America's most respected malacologists, is an important and long-anticipated addition to the freshwater mollusk literature. The inclusion of fundamental, general information—such as basic mussel biology, taxonomy, and conservation status—sets this book apart from other state and regional treatments of freshwater mussels, which typically contain only species descriptions and range maps. Indeed, this book is the closest thing out there to a textbook on freshwater mussels.

Paul W. Parmalee and Arthur E. Bogan have arranged the book into two sections. The first section (chapters 1–11) provides a broad discussion of mussel biology and ecology, ranging from basic shell structure, to aboriginal exploitation of mussels, to translocation as a conservation strategy. These chapters are expertly crafted, providing important information without relying on technical terms that might be unfamiliar to non-specialists. The illustrations and photographs are well done, although I would have liked to have seen a few more included. For example, in the chapter on structure, development, and growth, a diagram of bivalve internal anatomy would assist the non-malacological reader in understanding how a clam feeds. Similarly, in the treatment of life history in the same chapter, drawings or photographs of glochidia and conglutinates would strengthen the reader's comprehension of these fascinating life-history strategies. I learned a great deal from the chapter on the history of classification of North American freshwater mussels, but this chapter will be less useful to non-specialists. Although most of the chapters were comprehensive, the chapter on the ecology of freshwater mussels was overly brief, considering the large amount of interest and emerging literature in this area over the last decade.

The second section of the book (chapters 12–15) is devoted to species accounts of the approximately 130 mussel species historically or currently known from Tennessee (over 40 percent of the North American mussel fauna!). Each account includes North American and Tennessee range maps, synonymy, shell descriptions and photographs, and information on the species' life history, ecology, and current status. The inclusion of the North American range maps makes the book especially useful to those working outside of Tennessee, particularly because many of the species occur throughout the Interior Basin and no North American mussel atlas exists. The list of synonym species names will make the book invaluable to those trying to wade through the confusing landscape of constantly changing mussel nomenclature. The highlight of this absolutely first-rate section is the inclusion of two color photographs accompanying each species account. Anyone working with freshwater mussels knows that they are often quite variable and rarely look like the idealized sketches or photographs of pristine specimens in most books. In Parmalee and Bogan's book, the photographs are of typical rather than flawless specimens and have been selected to encompass the variation one might see in the field. These photographs alone are worth the price of the book.

The Freshwater Mussels of Tennessee will make a valuable addition to the libraries of anyone interested in freshwater mussels, including academicians, students, agency scientists, and hobbyists. The general information in the first section, the exceptional species descriptions and photographs, and the inclusion of North American range maps will make the book quite useful to those working both in and outside Tennessee and well worth the $50 price tag.

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BIOINFORMATICS—A MIDDLE WAY

Bioinformatics: The Machine Learning Approach. Pierre Baldi and Soren Brunak. MIT Press, Cambridge, MA, 1998. $40.00 (ISBN 0521621674 cloth).

There is a range of scientific theories. At one end are compact algorithmic theories that capture a bit of nature so well that we call them laws. In so doing, we flirt with the idea that nature is merely following these directives. At the other end of the spectrum are lists (e.g., functional annotation of proteins, catalogues of organisms, lists of geologic formations) that are sometimes ordered by taxonomic principles. These compendia capture the details of what has been studied. Both approaches have long and proud histories. And both are used to extrapolate from the known to the unknown. "Physics envy" is what biologists have been said to suffer from because they have few examples of laws, those compact algorithmic formulations that have more cachet than theories based on compendia because laws, in Newton's phrase, capture the handwriting of God.

Biologists have long since gotten over any feelings of inferiority, and with molecular biology in their sails they are making ever more ambitious claims and explorations. Biologists want to align similar protein and DNA sequences, find genes in genomic DNA, apply functional annotation to new or little-studied proteins, classify proteins, build protein phylogenies, understand expression patterns of thousands to tens of thousands of genes simultaneously, and store and retrieve all of this information easily. But the problem of doing so without the compass of compact formulations still exists. There is a huge amount of data, and its production is not slowing down to wait for theory to catch up. This situation invites a reexamination of the spectrum of theories. The middle ground between algorithms with initial conditions, at one end, and lists with classification principles, at the other, is the domain of statistical classification, neural networks, Bayesian inference, machine learning, hidden Markov models, and the approaches that Pierre Baldi and Soren Brunak map out in *Bioinformatics: The Machine Learning Approach*.

Baldi and Brunak apply these approaches to problems from predicting protein structure to identifying signal peptide cleavage sites, finding coding regions in genomic sequences, annotating functions of unknown proteins by finding similar known ones, and inferring evolutionary trees. If you are new to machine learning approaches in bioinformatics, what will surprise you the most is how much can be extracted from the patterns of known sequences. The techniques that are cataloged in this book allow researchers to pick out the relevant features and discard the rest and to find patterns that are not obvious to the human curators of the data. There is no magic in these inferences—the information has to be present in the representation of the data. Or, as Baldi and Brunak caution (in the context of discussing neural networks), "there are tradeoffs between different encodings." Even if all you do is to let the authors take you through their whirlwind tour of examples, you (as a biologist) will feel a palpable shift, from the reductionist's intuition that it is necessary to build on every bit of biophysics and biochemistry to choosing just those features that give the best predictions for the question of interest.

At the core of the book is Bayesian analysis. Bayesian methods seek to know the probabilities of a model's parameters, given particular data. These methods work by calculating, knowing, or guessing (and then adjusting) the probability of the data, given the model, the probability of the data itself, and the a priori probability of the model. It was Thomas Bayes, an eighteenth-century clergyman, who first connected these conditional probabilities in a formula that makes it possible to calculate the fourth, given any three of them (Bayes 1763). The authors' fondness for Bayesian analysis is evident in their clear and accessible treatment of it. Bayesianism has a large and vocal following. There are interesting philosophical issues raised by asking what the probability of a model is before we have any data. The authors shrug this off as a problem that is diminished as data sets get bigger. But in so doing, they miss an opportunity to reflect on the complicated relationship between evidence and hypotheses.

Baldi and Brunak use a Bayesian framework throughout the book to explicate feed-forward neural networks, hidden Markov models, hybrid approaches, models of sequence evolution, and stochastic grammars. The first two topics, neural networks and hidden Markov models, are paired with chapters containing illustrative applications. These application chapters are a whirlwind tour of many of the successes of machine learning in recent computational biology. The liberal use of references make the example-filled chapters a good place to start exploring contemporary bioinformatics, even if you find the more mathematical chapters taxing.

Baldi and Brunak's accessible treatment of Bayes theorem illustrates my biggest complaint with this book. They seem to have difficulty keeping the focus at a particular pedagogical level. Their explicit goal is to reach out to a wide audience, which includes "students and more advanced researchers... readers with stronger background in mathematics, statistics and computer science [and] biologists and biochemists." To accomodate such a wide audience, the treatments move rapidly from technical to shallow and back, leaving the overall impression that treatments are too brief. The handful of appendices do not successfully bridge the gaps. Making machine learning approaches accessible to a wide audience is such a difficult balance that, although I am tempted to criticize them, I sympathize with their challenge. Nevertheless, I feel that many of the examples and most of the mathematical sections would have benefited from extended discussion. As a guide for someone new to the field, the book has surprisingly little criticism of the methods that are discussed. Their obvious familiarity with the topics could (and ought to) lead more often to an assessment of where and when different approaches are appropriate and what pitfalls to expect. Only rarely do we find statements like this one, in the context of a discussion of hidden Markov models: "In our practice, we have often observed that Viterbi learning yields good results when modeling protein families, but not when modeling general DNA elements, such as exon or promoter elements, where non-Viterbi learning performs better" (p. 159).

Each year, more whole genome sequences become available. As a result, it is now possible to start looking for regularities within and between genomes. Although most biologists' interests are far broader than what is found in genomic sequences, the approaches described in this book will become a part of every biologist's training in the future. But should a biologist try to learn these methods from this book? As I have already mentioned, the focus, especially for those new to the subject, is uneven. This problem is compounded by an uncomfortable number of typos (even in the formulas) and prose that is so casual in places (e.g., "many proteins will for sure not be able to do without cysteines") that the reader may wish that the editors had kept the author on a tighter leash. The book ends with a useful chapter that lists Web sites at which many of the techniques have been implemented. Links to Web sites are notoriously liable to change, but this section and the copious references are a welcome addition for readers who wish to explore further.

The greatest challenge for contemporary biologists is turning huge amounts of data into knowledge. As Midgley (1989) has discussed, information becomes knowledge only when it can be used and applied broadly. When specialists no longer have the time or inclination to read one another's work, and when the amount of data far outstrips our ability to be familiar with even a tiny fraction of it (there are between 70,000 and 140,000 different human genes and their coding sequences account for only 5% of the human genome), the risk is that information will never become knowledge. We are running into our own cognitive limits when it comes to understanding genomic information, and the frequent result is caricature (the idea that a single gene is responsible for or explains a complicated behavior or trait—for example, fat gene, gay gene, risk-taking gene). Alternatively, it leads to the desire to return to a less complicated time (e.g., attempts to remove evolutionary biology from the curriculum in Kansas and other states). There are other ways to make sense of the glut of information. Machine learning approaches are prime candidates to mine available genomic patterns and take those first steps, at least in the area of bioinformatics, from data to knowledge.

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AM I NOT A FLY LIKE THEE?

Time, Love, Memory: A Great Biologist and His Quest for the Origins of Behavior. Jonathan Weiner. Knopf, New York, 1999. 300 pp. $27.50[AQ1] (ISBN 0-679-44435-1 cloth).

In his previous book, the Pulitzer-prize winning *The Beak of the Finch* (Weiner 1994), Jonathan Weiner discussed wide-ranging issues in evolutionary biology while focusing on Peter and Rosemary Grant's investigations of natural selection operating on Darwin's finches in the Galapagos Islands. In *Time, Love, Memory*, Weiner uses a similar approach. He focuses on Seymour Benzer, who pioneered the study of genetic mutants affecting behavioral traits in the fruit fly *Drosophila melanogaster*, but he never loses sight of broader themes and concerns.

The first half of *Time, Love, Memory* is largely about the intellectually peripatetic Benzer and his changing research programs. Like many of the pioneers of molecular biology, Benzer was originally a physicist. Soon after starting graduate school at Purdue in 1942, he entered into a secret war-related mission: improving semiconductors for use in radar. This work, done while he was still in his early 20s, also led to the development of the transistor. While working on his doctorate, Benzer (again like many renegade physicists) read Erwin Schrodinger's *What Is Life?* Schrodinger's book and a chance meeting with the geneticist Salvador Luria led the restless Benzer to Max Delbrück and bacteriophage genetics. Although such a dramatic change was risky (especially because neither Benzer nor his family had any money), Benzer felt compelled to follow his curiosity. He felt that "happiness is the pursuit of curiosity" and that "a fall from pure science is a fall from grace" (p. 45).

Benzer made several important contributions to the theory of the gene. Around the time that Watson and Crick discovered the double-helical structure of DNA, Benzer was using phage to demonstrate that "genes, much like the atoms, are not indivisible points but solid objects that could be split and dissected" (p. 52). That is, recombination can occur not only between genes but also within the classical gene. Unfortunately, Weiner does not devote enough coverage to this area of Benzer's research. For instance, he neglects Benzer's important contribution to the language of genetics. Benzer, understanding that the single term, "gene," could not encompass all of the connotations existing within the classical definition, instead proposed three new terms to replace "gene": muton (for the unit of mutation), recon (for the unit of recombination), and cistron (for the unit of function; the name is derived from the cis–trans complementation test; Judson 1979). The last term is still used frequently, although the first two are not, now that it is known that individual nucleotides are the units of mutation and recombination.

After a decade or so of phage molecular genetics, Benzer again became restless and spent 1965 on sabbatical leave in the lab of Roger Sperry, a Caltech neurobiologist. Benzer realized that if he wanted to unravel the genetics of behavior, he would need a simpler, more tractable model system than the vertebrates used by Sperry and his students. The intellectual remains of Thomas Hunt Morgan's fly lab and talks with Ed Lewis, who was using classical genetics to investigate how *Drosophila* developed, led Benzer to the fly. Benzer's choices of the fly as research organism and classical genetics as a tool were met with snickers from both Sperry's group and molecular biologists. This response was not unsurprising. Despite the rich history of genetical research in *D. melanogaster*, in 1966 both classical genetics and *Drosophila* were in eclipse. What Benzer proposed to do with flies seemed far removed from the forefront of either molecular genetics or human behavior. Moreover, this was a time when the nature–nurture pendulum had swung far to the environmental side. Benzer took all of this in stride and kept working, following his curiosity.

Benzer's persistence soon paid off. *D. melanogaster*, like many animals, has a daily cycle with distinct periods of activity and rest. In the early 1970s, Ronald Konopka, a graduate student in Benzer's lab, discovered mutant flies that did not have a 24-hour cycle. Some had shorter cycles, some had longer cycles, and some were arrhythmic. Using classical genetic mapping techniques, Konopka found that all of these mutants had defects in the same gene, which he named *period* (*per*, for short). Benzer's lab, in short order, would discover other mutations affecting time (the "clock" genes), courtship ("love"), and memory in flies. Much of the success of his graduate students and postdocs in uncovering such mutations was due to clever experimental design and resourcefulness, in addition to dogged determination.

Benzer's group later moved on to work on *Drosophila* eye development and on neurological aspects of behavior. Weiner's discussion of this work, in the second half of the book, focuses more on Benzer's former students and postdocs than on Benzer himself. One of the stars of this group is a Brandeis geneticist, Jeff Hall. Along with his molecular biologist colleague, Michael Roshbash, Hall was involved in a race with the Rockefeller University–based Michael Young, first to clone and later to sequence the *per* locus. Unfortunately, for many years after the gene was sequenced, no one knew what it did. Not until the late 1980s did researchers first begin to unravel what *per* does and how it interacts with other genes (such as *timeless*) to regulate activity patterns in flies. In the meantime, several different labs started sequencing clock genes from vastly different organisms, including fungi and mice. Amazingly, all of these organisms had genes with similar structures and functions as *per* and *timeless*. These discoveries demonstrate two things: the traits we care about most often involve interacting complexes of genes, and these genes are usually highly conserved across superficially very different organisms.

Part of what makes such stories so interesting is Weiner's frequent use of literary allusions. For instance, he notes that the first recorded use of the terms nature and nurture appeared in Shakespeare's *The Tempest*, and that 2500 or so years before President Clinton, the Greek philosopher Paremenides wrote a poem to ponder the inherent mysteries of "esti," the Greek word for "is." With these allusions, Weiner illustrates that inquiries about the mysteries of time, love, and memory are very much part of what makes us human and long predate modern science. Indeed, Weiner begins the book with a quote from the poet, mystic, and critic of science William Blake: "Am I not a fly like thee?/Or art not thou a man like me?" Blake's question sets the stage for one of the questions Weiner wants his readers to ponder: To what extent can dissecting the genetics of behavior in *D. melanogaster* and other model organisms inform us about human behavior and its genetic bases?

Weiner displays the range of differences of opinion about this question within the scientific community by interviewing two influential Harvard biologists, Richard Lewontin and Edward O. Wilson. Wilson, the author of the books *Sociobiology: The New Synthesis* and *Consilience*, sees behavioral genetics studies in model organisms as a foot in the door, and a better model than psychoanalysis, to understanding the human condition. Thus his mantra, "Better Benzer than Freud." Ironically, it was the molecular biologists—who, Weiner notes, Wilson detested—who have provided Wilson and his supporters with their best ammunition: the conservation of gene function across diverse taxa. Lewontin, who Benzer aptly described as "a fine drosophilist, a great contrarian, and a polemicist against much that is central to Western science," is much more skeptical. Although Lewontin will readily admit that he taught "basic behavioral genetics of simple organisms" in his course on genes and behavior, he retorts, "I certainly did not say that mutants in *Drosophila* are why I hate lima beans" (p. 218). It is not just socio-political differences that contribute to the Lewontin–Wilson debate but also differences in which scientific or, more precisely, epistemic values they hold dearest: synthesis, in Wilson's case, and rigorous accuracy, in Lewontin's. This point has been recently addressed by Ruse (1999), who concludes, "Lewontin looks down on those who do not have his exacting standards. Wilson is scornful of those who are not willing to take a chance—who fear the 'whiff of grapeshot' as one pushes into the unknown" (p. 184–185).

So where does Benzer stand? For the most part, Weiner portrays Benzer as a detached scientist, preferring to work quietly on his flies than to engage in political debate. But when Benzer does discuss these issues, he appears to take a position in between that of Lewontin and Wilson. Although Benzer does believe that behavioral genetic studies in flies will shed some light on "time, love, and memory" in humans, he is cautious. He is also concerned that the media and some scientists have oversold the link between genetics and behavior. This link, he states, has "become an idea of complete destiny. I think that's wrong. Genes are not always expressed. Even if you work with fruit flies, you see that genes are not always expressed" (p. 236–237). From his work with fly genetics, Benzer also knows that even the genetic component of human behavior is unlikely to be simple—that "gene for X" thinking is overly simplistic.

My own opinion is that the manner in which humans think limits the extent to which we share behavioral similarities with other organisms, particularly nonprimates. Language deeply permeates our cognition and, in turn, our behavior. The extent to which even other primates can form the types of representations and thoughts about thoughts that humans can is still an open and controversial question (Budiansky 1998), but surely insects lack this capacity altogether. The complexities of language change the way we view and sense time, love, and memory. But regardless of how much we can learn about human behavior from studies of flies, how flies behave and how genes influence those behaviors are fascinating and worthy topics in their own right. Weiner's book is a fitting tribute to Seymour Benzer and the other pioneers inx this field.

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WHAT DOES SCIENCE EDUCATION REFORM LOOK LIKE?

Student-Active Science: Models of Innovation in College Science Teaching. Ann P. McNeal and Charlene D'Avanzo, eds. Saunders College Publishing, Philadelphia, PA, 1997. 490 pp., illus. $42.75 (ISBN 0-03-024307-6 paper).

Science, mathematics, engineering, and technology (SME&T) faculty members received a real wake-up call in the early- to mid-1990s. *A Nation at Risk* (NCEE 1983) had sensitized faculty to the "pipeline problem," in which many undergraduate students began as science majors but then switched to other majors, and they were eager to enhance access to science and mathematics education for a population of students whose demographics had changed dramatically during the previous two decades. SME&T faculty also responded to the call to improve science literacy for all students, not just those who would go on to research careers. In so doing, many faculty members were confronted for the first time with students who were quite different from themselves. Sheila Tobias' book *They're Not Dumb, They're Different* (Tobias 1990) was the first glimpse that many faculty had of how large numbers of students perceive their introductory science classes. Tobias chronicled the experiences of students who opted not to pursue SME&T majors, and many faculty members saw for the first time how their teaching practices, assessment methods, and content coverage failed to meet the learning needs of the majority of their students.

A flurry of reports soon followed, each of which offered an array of recommendations for improving undergraduate SME&T education. Some, such as the American Association for the Advancement of Science's *The Liberal Art of Science* (AAAS 1990) and Project Kaleidoscope's *What Works: Building Natural Science Communities* (1991), provide a sampling of innovative SME&T courses and curricula around the country in the form of sidebars or appendices. However, several key reports, most notably *Shaping the Future* (NSF 1996) and *From Analysis to Action* (NRC 1996) contain dozens of recommendations aimed at all stakeholders in undergraduate education. However, these reports provide few specifics about how these recommendations could be translated into actual practice in classrooms and teaching laboratories. For instance, although few faculty would argue with a recommendation to "use instructional technology effectively," SME&T departments and faculty members likely do not have a clear idea of what that means, even for their discipline or their type of institution.

In the first two chapters of *Student-Active Science*, Jeanne Narum and John Jungck, two leaders of the reform movement, each provide an overview and a perspective on the past decade of reform and innovation. However, this book goes much further than discussing SME&T education policy to offer actual examples of how to improve undergraduate science and mathematics education. Although it is the proceedings of a June 1996 conference sponsored by the National Science Foundation, the book's superb organizational features make it far more than a collection of papers presented at a conference. Icons throughout the book alert readers to major themes, such as "Institutional Setting," "Problem-Based Learning," "Evaluation and Assessment," and "Interdisciplinary Approaches," that connect specific sections of text and related policy issues. "Hot Tips" throughout the volume describe specific activities that have been tried at a variety of colleges and universities. A concluding section, consisting of a single chapter, provides guidance for faculty who wish to conduct workshops on innovative teaching practices on their own campuses. Contact information for the people who contributed to the volume is also included. The book's editors, Ann P. McNeal and Charlene D'Avanzo, are clearly in tune with the needs of their readers, who are also their colleagues.

The main content of *Student-Active Science* is divided into five sections covering background, comprehensive curricular reform, assessment and evaluation, interdisciplinary courses and curricula, and discipline-specific innovations. Individual chapters within the latter four sections provide in-depth examination of a specific course, curriculum, or assessment strategy. *Student-Active Science* is comprehensive, with descriptions of courses in the life sciences and physical sciences, but it contains no specific examples of innovation for courses in the earth sciences.

The book includes several other features that make it an excellent tool for faculty members interested in learning more about SME&T education reform. In addition to the icons and contact information, a compendium of institutional data from the colleges and universities whose courses are described, including total enrollment, course enrollment, section size, and course organization (i.e., length and frequency of class periods), is provided at the end of the book. Given the book's emphasis on inquiry-based science, readers should not be surprised to find that many of the case studies are of laboratory courses. If the book has any shortcomings in terms of content, it would be the limited number of examples of innovation in large lecture courses, whose faculty often feel the most constrained by the sheer number of students as well as by space limitations and departmental expectations (or sometimes the lack of specific expectations).

A Web site for *Student-Active Science* provides an alternative way of accessing all of the book's content (see www.saunderscollege.com/lifesci/studact/index.html). All of the material in the book is hyperlinked at the Web site. The 10 "major themes" icons provide an excellent way to navigate among related chapters. However, just as the book could benefit from an index, this site could be improved with a search engine to cross-reference information by discipline, institution, or participant. The "Instructor's Idea

Exchange" interactive form is fully functional, although it is not entirely clear what the editors have done with this information because the 36 "Hot Tips" on the Web site are the same as those in the printed book. The site provides e-mail and Web links to all of the individuals and institutions featured in the book.

As an illustration of the book's approach, chapter 19 provides an overview of a new way to organize content in organic chemistry. In this new approach, material is organized conceptually (analogous to the Yellow Pages, according to Paul Scudder, the chapter's author) rather than as a database of facts (the White Pages model). As a result, students need not view organic chemistry as a set of facts to be memorized. Instead, they develop analytical reasoning skills that can transfer to their other courses.

How can case studies such as Scudder's be used by other faculty members for teaching their own courses? Do these overviews provide readers with an adaptable curriculum or a comprehensive syllabus, set of lecture notes, assignments, and tests? As it turns out, the descriptions of the courses contain all of these attributes in general, but none of them in detail. Although some readers may be frustrated by this absence of detail, the book's intention is not to prescribe a single approach or modus operandi for improving undergraduate SME&T. Instead, just like the way of teaching and learning that the book advocates, the chapter authors provide just enough information to help faculty members think creatively about what might work for their students, their departments, and their institutions. This message is at the heart of Project Kaleidoscope's decade-long effort at undergraduate SME&T education: "The underlying premise... is that reforms must be adapted, not adopted...the pattern for reform must be institutionally appropriate. Yet we are convinced that reforms initiated in one setting can be reshaped for another" (Project Kaleidoscope 1998).

Education is not a one-size-fits-all enterprise. As this book amply demonstrates, even the best ideas in student-active SME&T will need to be modified to fit new settings or to be used by different instructors. However, *Student-Active Science* provides an excellent place to begin the process. Institutions, departments, and individual faculty members who have embraced national calls for reform can now delve more deeply into the processes and outcomes of such efforts across a range of disciplines and types of institutions.

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Publishers' information

Books from the following publishers were reviewed in this issue. To order books, or for more information, contact the publishers at:

Alfred A. Knopf, 800/733-3000; www.randomhouse.com/knopf
The Free Press, 212/632-4986; www.SimonSays.com
Johnson Books, 800/824-5505; www.jpcolorado.com
The MIT Press, 617/253-5646; www.mitpress.com
Saunders College Publishing, 800/544-6678; www.saunderscollege.com
The University of Tennessee Press, 800/621-2736; sunsite.utk.edu/utpress
Wadsworth Publishing Company, 800/354-9706; www.wadsworth.com

A BRIGHT SPOT IN ENVIRONMENTAL SCIENCE

Living in the Environment: Principles, Connections, and Solutions. 10th ed. G. Tyler Miller Jr. Wadsworth, Belmont, CA, 1997. 842 pp., illus. $89.75 (ISBN 0-534-51912-1 cloth).

Sustaining the Earth. 3rd ed. G. Tyler Miller Jr. Wadsworth, Belmont, CA, 1998. 374 pp., illus. $52.75 (ISBN 0-534-52884-8 paper).

I began the first semester of my undergraduate career with an environmental science class that used the fourth edition of G. Tyler Miller's *Living in the Environment*. Although that course and book left an indelible impression on me during my formative college years, this new edition does even more. It has reminded me that the biology I found so interesting, particularly ecology, is a critical part of environmental science. It has also made me realize that environmental science is not just environmental cleanup, but a way of developing solutions to stop environmental problems before they happen.

It is clear to almost all scientists that

Taking In the Sites

In the pages of *BioScience*, biologists discuss a wide range of topics pertaining to organisms, systems, and processes on Earth. However, as a new millennium begins, and as these same biologists consider the future at AIBS' annual meeting this month, compelling questions remain as to the state of life beyond Earth. Astrobiology—"the study of the origin, evolution, distribution, and destiny of life in the universe" (**astrobiology.arc.nasa.gov/overview.html**)—attempts to answer these questions.

At **nai.arc.nasa.gov**, the NASA Astrobiology Institute has created a virtual community for people to discuss and learn about astrobiology. Although not necessary to access the site, free registration enables users to ask astrobiologists questions and participate in forums. Press releases and an image gallery also provide information on the topic. Educators might want to check out the sections on teaching astrobiology and astrobiology for kids, although the latter section is still being developed. The Web site also features focus articles on its home page; past titles include "Microbial Mats and Stromatolites" and "Life from a Dirty Snowball."

Astrobiology Web **www2.astrobiology.com/astro** is a central location for finding information and links to other Web sites on such topics as Antarctica and space exploration, exobiology, ethical concerns in astrobiology, and exploring ice worlds. Hyperlinks to up-to-date space science news, news organizations, Usenet newsgroups, and NASA webcasts are also provided.

Marsbugs: The Electronic Astrobiology Newsletter (**www.lyon.edu/webdata/users/dthomas/marsbugs/marsbugs.html**), a free online publication, examines the life sciences in relation to planetary science and space exploration. Past issues from this 7-year-old newsletter are archived online and available in PDF format. The content of each issue includes brief articles as well as news releases from organizations such as the National Science Foundation and the National Academy of Sciences.

Other sites of interest include:

Ad Astra (Astrobiology issue): **www.nss.org/adastra/astrobiology/home.html**
SETI Institute Online: **www.seti-inst.edu**

—*Rebecca L. Saxer*

the environment has continued to degrade since the first edition of *Living in the Environment* was published in 1975, even with a productive and ever-expanding environmental movement. Although Miller covers environmental degradation thoroughly, the news in *Living in the Environment* and in *Sustaining the Earth*, a shorter, less-detailed version of *Living in the Environment*, is not all bad. In both books, Miller shows the progress that has been made with each environmental problem and emphasizes the success of the millions of hardworking people who are behind such solutions. He then informs the reader what is left to be done to reduce or even eliminate each problem completely and challenges the reader to help solve such problems.

All undergraduates, regardless of major, should be exposed to a course in environmental science. Miller's work illustrates that an understanding of environmental science is critical to the health of our planet and even the survival of our own species. Where both of Miller's textbooks go beyond the popular works of Edward O. Wilson, Paul Ehrlich, and others is that they not only describe environmental problems but also detail possible solutions and analyze the costs and benefits of each solution in terms of economics, human lifestyle, and other, more esoteric variables. For example, Miller takes recycling to task—asking "Does recycling make economic sense?"—and shows that it does under some conditions but may not under others. Miller states in the preface to *Living in the Environment* that he has attempted to keep this edition as free as possible from bias, a recurring (and understandable) problem in environmentally oriented textbooks. Through his prodigious use of the cost–benefit approach, Miller succeeds at minimizing bias. Yet, even with the technical nature of many of the topics, much of his writing is just as enjoyable as that of Wilson.

Miller sets the tone for both books in the first few pages, where he notes that two trees have been planted in tropical rainforests for every tree used to make the book and that he himself funds the protection of several hectares of tropical forest to compensate for his personal paper use. This commitment as an environmental steward and role model is one that other authors should emulate.

The tenth edition of *Living in the Environment* is up-to-date and on the cutting edge of the field, considering issues such as debt for nature and emerging technologies. This edition also provides a comprehensive discussion of the basic principles that students must understand if they are to evaluate environmental problems (e.g., a diagram clarifies the difference between accuracy and precision). It also provides a complete explanation of the human population explosion and possible solutions (e.g., a table lists the relative effectiveness of different methods of birth control).

Living in the Environment is divided into eight major sections: "Humans and Nature: An Overview," "Scientific Principles and Concepts," "The Human Population," "Major Global Problems," "Energy Resources," "Resources and Pollution," "Sustaining Biodiversity and Ecological Integrity," and "Environment and Society," with a total of 28 chapters. Each chapter begins with a case study that sets the stage for the information that follows; 78 additional case studies are spread throughout the text to provide a more in-depth look at environmental concerns. In addition, 21 guest essays allow world-renowned researchers and activists such as Anne and Paul Ehrlich, John Cairns, and even the late Julian Simon to present their views on the environment. A variety of other learning tools are found in each chapter, including "Pro/Con," "Connections," "Solutions," and "Individuals Matter" boxes. Together, these useful tools help provide an integrated view of environmental problems. The book's beautiful color illustrations, explanatory diagrams, and photographs provide visual stimulation and complement the text.

There are many other things to like about this book. In particular, the appendices are expansive and comprehensive, including lists of environmental publications, addresses of environmental organizations and environmentally related federal and international agencies, major US environmental legislation, and a complete glossary and index. One of the most valuable resources in the appendix is a description of how to link ideas visually by creating concept maps (designed by Jane Heinze-Fry). Creating such maps can help students understand the connections between different topics covered in the book. The inside of the front cover contains such a flow diagram for the entire book, which is useful for gaining an overall picture of the subject. In another appendix, Miller lists actions that students can do to help preserve and protect the environment.

A new resource for the tenth edition is the World Wide Web. At a Web site set up by the publisher (www.brookscole.com/biology/member/student/millerlite10/index.html), students can click on a chapter in the Website contents and find specific hyperlinks for many of the subjects covered in the book. The Web site also includes a search engine, critical thinking questions, and interactive quizzes. Other supplemental resources to the tenth edition include an instructor's manual, a guide and software for critical thinking, a laboratory manual, a set of acetates and transparency masters, and *Environmental Articles*, a collection of more than 200 papers that are indexed by topic and geographic location and can be customized for specific courses by picking any combination of articles and having them bound for students.

As is the case with any major textbook, *Living in the Environment* is not without some minor quirks, but these are trivial at best. For example, no sources are cited throughout the text or even in a bibliography. Instead, the author provides a list of readings that provide backup for most of the information in the book. Although the lack of citations is understandable given the main purpose of this book—undergraduate education—I found myself wanting more specific sources to explore. Perhaps a listing of specific citations could be included in an instructor's manual. I also found the recall questions and answers at the bottom of most text pages to be rather annoying, both because they distract the reader and because many of them are not related to the topic at hand. Here Miller seems to have gone a bit far in his efforts to challenge undergraduate learners, but at least we cannot fault him for effort.

Sustaining the Earth, which is now in its third edition, is a shorter, less detailed version of *Living in the Environment*, which Miller apparently created to reduce student costs for courses that cover less information. Nevertheless, it still has excellent coverage of most topics and would be satisfactory for many introductory courses. *Sustaining the Earth* also includes many of the updates to the larger version, including efforts to reduce bias, expansion of many topics, and the addition of Web links. The biggest disappointment of this textbook is that it is printed entirely in black and white. After comparing the two texts, it is clear that color makes a difference: The color photographs and figures help *Living in the Environment* by grabbing the reader's attention and making it more attractive to read. Moreover, some of the figures were easier to comprehend in color than in black and white, particularly when parts of the figure were specifically color-coded in the larger work.

Living in the Environment is clearly more appropriate as a general reference, and I expect it will serve as a better book for most environmental science courses as well. In contrast, *Sustaining the Earth* could act as an excellent, inexpensive supplementary text in some courses, or perhaps as a main text in a course for nonmajors or where expense is more of a consideration. Whichever book they use, faculty and undergraduates that choose to enter Miller's environment will find the experience educational, sobering, and yet exhilarating. It is a journey that all students should travel.

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NEW TITLES

Birds of Africa: From Seabirds to Seed-Eaters. C. Stuart & T. Stuart. MIT Press, Cambridge, MA, 2000. 176 pp., illus. $29.95 (cloth).

Destroying the Word to Save It: Aum Shinrikyo, Apocalyptic Violence, and the New Global Terrorism. R. J. Lifton. Holtzbrinck Publishers, New York, 1999. 374 pp. $26.00 (cloth).

Late Cretaceous and Cenozoic History of North American Vegetation. A. Graham. Oxford University Press, New York, 1999. 350 pp., illus. $95.00 (cloth).

Life, Temperature, and the Earth: The Self-Organizing Biosphere. D. Schwartzman. Columbia University Press, New York, 1999. 241 pp., illus.

$40.00 (cloth).

Mineral Nutrition of Crops: Fundamental Mechanisms and Implications. Zdenko Rengel, ed. Haworth Press, Binghamton, NY, 1999. 399 pp., illus. $125.00 (cloth).

Owls: A Guide to the Owls of the World. C. Konig, F. Weick & J. H. Becking. Yale University Press, New Haven, CT, 2000. 462 pp., illus. $50.00 (cloth).

Turfgrass Insects of the United States and Canada. 2nd ed. P. J. Vittum, M. G. Villani & H. Tashiro. Cornell University Press, Ithaca, NY, 1999. 422 pp., illus. $60.00 (cloth).

The World History of Beekeeping and Honey Hunting. E. Crane. Routledge, New York, 1999. 682 pp., illus. $95.00 (cloth).

NOW IN PAPERBACK

Defending Illusions: Federal Protection of Ecosystems. A. K. Fitzsimmons. Rowman & Littlefield Publishers, Lanham, MD, 1999. 272 pp., $22.95 (paper).

The Extended Phenotype: The Long Reach of the Gene. R. Dawkins. Oxford University Press, New York, 1999. 313 pp., $16.95 (paper).

Flowering Plants of the Galapagos. C. K. McMullen. Cornell University Press, Ithaca, NY, 1999. 370 pp., illus. $29.95 (paper).

Freshwater Ecoregions of North America: A Conservation Assessment. R. A. Abell, et al. Island Press, Washington, DC, 1999. 319 pp., illus. $65 (paper).

A Natural History of Domesticated Mammals. J. Clutton-Brock. Cambridge University Press, New York, 1999. 238 pp., illus. $39.95 (paper).

Primate Communities. J. G. Fleagle, C. Janson & K. E. Reed, eds. Cambridge University Press, New York, 1999. 329 pp., illus., $29.95 (paper).

Tiger Haven. B. Arjan Singh. Oxford University Press, New York, 1999. 230 pp., illus. $14.95 (paper). ❑