Book Reviews

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Classic Readings in Tropical Ecology

Chazdon, Robin L., and Timothy C. Whitmore, editors. 2002. **Foundations of tropical forest biology: classic papers with commentaries.** The University of Chicago Press, Chicago, Illinois. xvii + 862 p. $85.00, £66.50 (cloth), ISBN: 0-226-10224-6 (alk. paper); $35.00, £24.50 (paper), ISBN: 0-226-10225-4 (alk. paper).

This volume of 56 classic papers in tropical biology is closely modeled after a previous volume by the same publisher (Real, Leslie A., and James H. Brown, editors. 1991. Foundations of ecology: classic papers with commentaries. The University of Chicago Press, Chicago, Illinois). Like the previous volume, it represents an attempt to provide an assemblage of classical writing representative of the breadth of the discipline within a historical context. The book is divided into twelve parts, each of which includes from three to seven papers plus a substantive commentary (by various authors) that provides an overview of the papers and why each was selected.

Tropical biology is recognized by ecologists as a discipline unto itself though it is difficult to know if this is due entirely to the remarkably high biodiversity of the tropics or to more profound ecological processes in some way unique to tropical communities. Clearly there is much current interest in tropical biology, not only in the Neotropics but globally. As such it is appropriate to make available to students a representative sample of the most essential historical literature. Faced with such a challenge, the editors of this volume, assisted by an editorial board of twelve other persons, made admirable selections.

It may come as somewhat of a shock to ecologists over the age of forty to learn that work published is the 1980s is now considered ''classical,'' but, in fact, six papers are included from that decade. Mercifully, the editors did not include any papers from the 1990s, which we may suppose they still consider contemporary. A total of twenty papers are from the 1970s, fourteen from the 1960s, six from the 1950s, one from the 1940s, two from the 1930s, and seven from the nineteenth century. The distribution of selections by decade makes obvious the fact that tropical biology did not begin to really flourish until the past half-century, when ecology matured as a discipline and travel opportunities became available to ecologists to perform research in tropical areas. The selections from the nineteenth century are, not unexpectedly, representative of the great explorer-naturalists of that era, individuals such as Henry Walter Bates, Alfred Russel Wallace, Alexander von Humboldt, and Thomas Belt. Oddly, none of Charles Darwin's writings about the tropics are included.

Tropical biology encompasses many ecosystem types but the editors of this volume make it clear that they have biased the work to selections dealing almost entirely with forest biology. Their justification for this restriction is reasonable. The book itself is large, at 862 pages, and yet most tropical biologists will immediately recall papers they value and consider to be worthy of being called ''classic,'' that are not included. Any attempt to broaden the coverage beyond forest-based studies, would only make the book superficial.

Another concern in representing tropical biology is regional. Is there balance in selection of writings between the Old and New World tropics? The editors are apparently sensitive to this issue and have provided many examples of studies based in Asia and Africa as well as in the Neotropics, the region in which most North American tropical ecologists do their work.

The twelve sections into which the book is divided represent essentially four emphases: historical exploration, biodiversity patterns and causal factors, species interactions, and anthropogenic effects, including conservation and sustainability. Some of the placements of various papers seem somewhat arbitrary. For example, few would doubt that Jürgen Haffer's paper on speciation in Amazonian forest birds would merit inclusion in this volume. It is not included among the seven papers in Part Three, ''Ecological and evolutionary perspectives on the origins of tropical diversity,'' but instead appears in Part Two, ''What shaped tropical biotas as we see them today?'' There seems to be a rather narrow distinction between these two sections. Even more odd, Jared Diamond's paper on the distributional ecology of New Guinea birds is placed in a section whose focus is ''Human impact and species extinction.'' I don't see how this otherwise-remarkable paper has much, if anything, to do with that subject area.

Ultimately anyone using this book who is well versed in the literature of tropical biology will ask, ''are these the selections I would have made?'' Discussions among the editors must have been lively. The papers, some of which are somewhat abridged, do, in my view, form a suitable and complementary representation of most of the foundations for tropical terrestrial biology. There are some major topic omissions such as island biogeography, for example, and the book goes very lightly on papers dealing with animal behavior as such. Of perhaps greater concern is the sparse inclusion of papers dealing with ecosystem-level processes, such as primary productivity, biogeochemical cycling, and soil characteristics. There are only three papers included that deal with this immense area of tropical research. But most students of tropical biology will probably have a strong interest in the areas of research represented by the selections included, particularly factors determining diversity and complex interactions among species. These areas of study are the essence of what makes tropical areas ecologically unique.

Each paper is reproduced exactly as it was first published, so that the typefaces, font sizes, etc. are highly variable from one selection to the next. I think it unlikely, however, that most users of the book will simply read it straight through. Thus, the jarring differences among appearances of the inclusions should not be a problem for the reader.

Given that the essence of this book is really the work done in the decades from 1950 to 1990, it would be most interesting to contemplate what a second volume would look like if published, say, in 2050. Hopefully there will be such a volume.

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THE EVOLUTION OF CHICAGO'S NATURAL HISTORY

Greenberg, Joel R. 2002. **A natural history of the Chicago Region.** The University of Chicago Press, Chicago, Illinois. xviii + 595 p. $40.00, £25.50, ISBN: 0-226-30648-8 (alk. paper).

Only a thousand human generations ago, Chicago was covered with ice. Since that time the region has been covered by water, by boreal forests, by deciduous forests, and by dry prairie vegetation as the post-glacial climate changed. Now much of the region is covered with human landscapes. The spatial and temporal pattern of changes in geology and climate are accessible in some detail because they are not very far in the past. The biodiversity of the Chicago region is rich, for the region overlaps the prairie and deciduous forest biomes and has elements from the boreal forest as well. There is more to tell, for this rich natural history as been dramatically altered by human economic activities. The watershed now flows to the Gulf of Mexico rather than the St. Lawrence River. The shore of Lake Michigan has been filled and reconstructed as park protected by rip-rap. The swell and swales of ancient beaches have been flattened for homes. Rain hits impervious surfaces that cover about a third of the area in residential areas and flows quickly through sewers into canals. The biggest changes have been brought about by exotic plants and animals deliberately or accidentally introduced. Nature persists in places nonetheless. Many species survive only on small bits of unabused land in county, state, and federal preserves, but other native species have learned to live in either residential or commercial environments. Joel Greenberg's book tells the story of the natural history of the communities and species that did and still do inhabit this biologically interesting and now very heavily populated region.

The first chapter briefly describes the forces, ice, weather, fire, and human activity, that have shaped the land and the species that occupy it. Following naturalists' convention that considers human activity destructive, Greenberg says humans ''impose upon the landscape a uniformity that is now virtually complete.'' Having struggled to find a way to categorize animal usage in human-dominated landscapes, I find human landscapes, the cemetery, the new housing development, the sprawling mall, the transportation corridor, to have less similarity in species composition than natural communities.

The next nine chapters describe the communities of the Chicago region. These communities include prairie, shrubland, savannas, forests, wetlands, rivers, and small lakes that will be familiar to all ecologists, plus some distinctive local communities such as Lake Michigan, the grand marshes of the Kankakee and Calumet Rivers, and the beaches and dunes of Lake Michigan. Each chapter begins with quotes describing the preagricultural conditions. Greenberg has conducted prodigious scholarship in assembling early descriptions. Quotations come from diverse and sometimes unexpected sources, including early newspapers. Even historically astute students of the region will see novel reports. While old letters make better and more entertaining reading than information in the Public Land Survey and business records of purveyors of game and pelts, narrative descriptions are sensitive to the weather and to the perspectives and purposes of the recorder. Extreme events are recorded because they are rare. Everyday events rarely attract writers or readers.

Since neither ancient nor contemporary storytellers are likely to tell consistent stories about natural areas, some frustration is inevitable. Beyond diverse reactions among people to nature is the change in nature itself from season to season and from year to year. Even quantitative data will fail to tell us what prairies were really like in different places in the same year or in different years in the same place unless data include each difference as a variable.

As an example, consider converting narratives to a quantitative picture of vegetation height on the tallgrass prairies. The quote ''No one can conceive the emotion that rises up in the bosom of the traveller as he stands on the broad prairie, and sees the horizon settling down upon one wide sea of waving grass . . . '' suggests that the typical vegetation height on the tallgrass prairie was below chest high. Otherwise how could a broad horizon be visible? Another description suggests much taller vegetation, but the only quote with a number suggests tallgrass prairies were rather short, ''Oh! the beautiful grounds, not a tree and full of grass about 15 inches high. . . . '' The reader has a picture, but it resembles a collage rather than a single image.

What were forests like? Unlike the prairie, large blocks of woodlands were preserved, but only after many were logged and most were grazed. Nearly eradicated at the beginning of the 20th century, white-tailed deer at the beginning of the 21st were reaching densities 5–10 times higher than those considered healthy. In the forest section Greenberg focuses on current controversies of forest management rather than early anecdotes. The book informs the reader without recommending a particular conviction about the way to improve forest health.

Greenberg describes the special communities of the Chicago region with skill. Each new generation of Chicagoans needs to hear about the vulnerability of Lake Michigan. How new species, from the lamprey to the zebra mussel, invade Lake Michigan via canals and ships is a warning that must be sounded over and over. New invasions of the lake are still occurring. The huge marshes of the Calumet and Kankakee rivers once held innumerable birds and remained a wilderness far longer than their nearby location would suggest. The drainage of the Kankakee marsh was completed in 1917. Surprisingly, Greenberg found no records that the people who hunted and fished in these marshes stood up for them as they were being drained. Today there is an attempt to rebuild a small part of the marsh, but although the U.S. Fish and Wildlife service has authority to establish a refuge in the Kankakee basin, local opposition has foiled progress.

After completing the description of the communities, Greenberg marches through taxonomic groups, insects, reptiles and amphibians, birds, and mammals. In the insects we learn that ''several insects have suffered major population crashes for reasons not understood.'' Other insects have been rediscovered after many years of neglect, many through the efforts of Dr. Ron Panzer. In the faunal chapters we learn that populations of reptiles and amphibians have been especially hard hit by changes in the region. None of those species has rebounded the way some birds and mammals have. Canada geese, sandhill cranes, white-tailed deer and coyotes were pushed to the edge of extinction, but have rebounded recently. Greenberg tells all these stories beautifully. As might be expected from an observer focused on birds, the information on mammals is not always accurate. *Peromyscus maniculatus* is described as among three species ''that have expanded their ranges and numbers over the years'' when the reality is that the prairie deer mouse (*Peromyscus maniculatus bairdii*) has declined from being 85% of the *Peromyscus* to less than 1% (Pergams, O. R. W., and D. Nyberg. 2001. Museum collections of mammals corroborate the exceptional decline of prairie habitat in the Chicago region. Journal of Mammalogy **82**: 984–992).

The book includes 94 figures, some of which are maps but most of which are old, interesting photographs. Appendices, notes, bibliography and index occupy 123 pages. With so many species and people in the text, it is not surprising that not all possible entries are in the index. The notes include the results of many interviews and personal communications that add flavor to the book.

The final 12 pages present a view of the future. A trend that I noted is that the ''Chicago Region'' continues to expand. Early books included most of Cook County and parts of Lake Counties of both Illinois and Indiana. Greenberg and the popular flora by F. Swink and G. Wilhelm (1994. Plants of the Chicago Region. Fourth edition. Indiana Academy of Sciences, Indianapolis, Indiana) include counties in Wisconsin and Michigan, as well as Illinois and Indiana. Other trends include people trying to create residential areas hospitable to native plants and animals. There certainly are more glossy photos of local nature now than ever before. Whether that means that ''natural history and conservation have moved into the realm of the mainstream'' as Greenberg suggests in his preface or rather that people are so isolated from nature that their experiences of nature depend on photographic or some other technological interface is an open question. Many species have prospered recently because game is no longer a substantial part of urban diets. Native species will persist in the Chicago region and even in the city itself, but native communities probably will not unless people are willing to devote resources to that goal.

The natural history of the region is rapidly evolving, but *A natural history of the Chicago Region* is the fittest source of information on the flora and fauna and is likely to remain so for many years.

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Plant–Animal Interactions for the Classroom

Herrera, Carlos M., and Olle Pellmyr, editors. 2002. **Plant–animal interactions: an evolutionary approach.** Blackwell Science, Malden, Massachusetts. xii + 313 p. $69.95, ISBN: 0-632-05267-8.

Since the majority of animals rely on energy fixed by green plants, it's no wonder that the study of plant–animal interactions is a mainstay in ecology. Given the popularity of plant–animal interactions research, it is perhaps surprising that few textbooks have emerged on the topic. We welcomed the volume edited by Herrera and Pellmyr because the last two texts on the topic were produced over 15 years ago. This attractively packaged paperback is targeted at entry-level graduate students and upper-level undergraduates. Indeed, a successful text in plant–animal interactions would introduce readers to the rich natural history of interactions, modern conceptual issues, and enough methodological detail to seed ideas on how to tackle the important questions. The ideal textbook on plant–animal interactions would also include a wealth of information across levels of biological organization, from a healthy dose of mechanistic (i.e., chemical and molecular) to holistic (i.e., community and ecosystem) studies, spanning the range from ecology and behavior to micro- and

macroevolutionary theory. This admittedly tall order would be quite difficult to synthesize, organize, and present in a single book.

To tackle plant–animal interactions in a somewhat more manageable approach, Herrera and Pellmyr chose an evolutionary approach, while focusing on terrestrial and macroscopic organisms. This text covers the major areas of plant–animals interactions thoroughly, nicely balancing both ecological and evolutionary approaches, and plant vs. animal perspectives. An emphasis on multi-species plant–animal interactions was also pervasive throughout much of the book. We found this perspective to be a refreshingly modern approach since these interactions have historically been viewed as a pairwise process between two species. Ample space is devoted to understanding the net outcome of simultaneous natural selection by mutualists and antagonists. The balanced approach is reflected in the book's structure; two chapters each are devoted to sections titled ''mostly antagonisms'' and ''mostly mutualisms.'' These titles appropriately recognize the context dependence of most species interactions.

In general, the chapters of Herrera and Pellmyr's edited volume provide consistently thorough coverage of the major topics and conceptual issues in plant–animal interactions and we appreciated the integration of evolutionary and ecological approaches. We found chapters 3–9 to be particularly synthetic and broad in their scope. Our favorite chapters were those by Strauss and Zangerl (plant–insect herbivore interactions), Pellmyr (pollination), and Thompson (the future) because they seemed balanced in their treatment, covering ecology to macroevolution, and targeted the right audience. Equally interesting, although less evolutionary in their approach, were the chapters by Danell and Bergström (mammalian herbivory), Herrera (seed dispersal), and Beattie and Hughes (ant–plant interactions). If the lack of strong evolutionary approaches truly represents a gap in those subdisciplines, it would have been nice to highlight those missing links and provide a road map for how to proceed in unraveling the evolution of those interactions. Perhaps the only major terrestrial interaction that we would have liked to see covered in a separate chapter would have been plant–parasitoid interactions. A large literature now indicates that plants release cues that directly attract parasitoids and there are numerous studies on how parasitoids use this information to find hosts, and on the ultimate trophic consequences of the interaction. The chapter by Beattie and Hughes covering ant–plant interactions highlights some of the same conceptual issues, but is also distinct.

Although the book has the usual advantages and disadvantages of an edited volume, the big advantage is that chapters are written by experts in each field. Having said that, we found the first two chapters of *Plant–animal interactions* difficult to digest. Price's introductory chapter presents an attempt at broad synthesis. Although his approach leads to a plethora of useful information, it is often dwarfed by too many details, too much terminology, and overly complex figures. Labandeira's chapter on the history of plant–animal associations is a stimulating addition to the traditional topics covered in plant–animal interactions. Still, at nearly twice the length of all other chapters, the fossil perspective is overly descriptive and borders on encyclopedic.

Our other criticisms are few and relate primarily to the treatment of coevolution, which is perhaps the most recurring theme in this text. Although several chapters use coevolution as a driving conceptual framework, it is defined and redefined in different chapters without parallel structure (i.e., micro- vs. macroevolutionary definitions). Given coevolution as a theme and the explicit recognition of context dependence in community-wide interactions as the norm, it perhaps surprising that very little attention was given to the diffuse coevolution concept—that is, community members may alter the patterns of reciprocal selection in a binary species interaction. Although Labandeira briefly introduces diffuse coevolution, he does so strictly in a phylogenetic perspective and dismisses it as too difficult a process to evaluate because of the multitude of mechanisms that can result in diffuse coevolution. John Thompson has recently advocated the abandonment of the diffuse coevolution concept, and perhaps the authors of this book have followed his logic. However, several authors present examples of community members altering the patterns of reciprocal selection, and we feel that development of the diffuse coevolution concept would have strengthened the conceptual backbone of the book.

Overall there is much to recommend this book and we both plan to use it as background material for future upper-level undergraduate classes in plant–animal interactions. Despite some quirks in a few chapters, we hope to see wide usage of the book as the primary source for a class due to its thorough coverage, balanced approach emphasizing multispecies interactions, and well-conceived future directions. This book is likely to guide the development of research projects by students who will be the next generation to study plant–animal interactions.

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Feral Cabbages, Mutant Monarchs, and Monster Sewer Sludge: The Uncertain Ecologies of Genetically Modified Organisms

Letourneau, Deborah K., and Beth Elpern Burrows, editors. 2002. **Genetically engineered organisms: assessing environmental and human health effects.** CRC Press, New York. 438 p. $74.95, ISBN: 0-8493-0439-3 (alk. paper).

Herbert Baker gave a talk on the behaviors of cabbages escaped from cultivation at an evolution meeting at Berkeley in the early 90s. Baker's talk was both fascinating, because the plant forms in his photographs were virtually unrecognizable, and bewildering, in that a biologist of his stature should bother with the unimposing stray cabbage. It seems now that Baker's genius was at work at several levels: first, in recognizing 1) that crop plants outside of cultivation respond to natural selection and then, 2) that their responses upon escape, whether innocuous or aggressive, are largely unpredictable. Feral cabbages may pose no hazard per se, but provide irrefutable evidence that genetically modified organisms may adapt and persist outside of cultivated fields.

The implications of this work comes into clear focus following my reading of Letourneau and Burrows' edited volume, *Genetically engineered organisms: assessing environmental and human health effects.* The goal of the project was to discuss the ecological and environmental risks of releasing genetically modified organisms: plants, animals, microbes, and viruses, in large-scale applications. The editors brought together scientists from the U.S. and Western Europe following an ESA symposium of a similar name (Spokane, Washington, 1999). The resulting collection of research and review articles provides a timely summary of existing work, and makes clear the difficulties of assessing the ecological risks of organisms whose biologies are unknown.

Three related concerns appear repeatedly throughout the work: estimating the components of risk, predicting unintended effects, and adopting the precautionary principle. Most authors define risk as the product of the probability that a hazardous event will occur, times the consequences arising if it does take place, summed across all potential hazards. These hazards have been termed unintended effects. Unintended effects are likely to be overlooked in standard risk assessment trials because a small number of genotypes are evaluated in a limited number of environments, often for a single generation. Genotypic variability, plasticity, and the evolution of the phenotype, as well as introgression and recombination, will generate far more phenotypes than can be evaluated in limited field trials, however. Further, the release of an organism into a complex system will assuredly create a complex cascade of unintended effects. Traavik (Chapter 12) summarizes assessment of genetically engineered vaccines: ''At the moment, it is not possible either to assess or to manage the potential environmental risks involved. Most likely, we have not yet even conceived of all the theoretical risks.''

The likelihood of unintended effects lead most Authors in this volume to advocate the ''Precautionary Principle.'' Letourneau et al. (Chapter 3) characterize this code as follows: ''if data to make a decision are lacking, the conservative pathway is taken rather than an assumption of low environmental risk.'' The precautionary principle, then, is to assume the worst until proven otherwise. In practice, industry and regulatory agencies appear to have adopted a principle of minimal risk, that approval of a potentially beneficial genetically engineered organism should not be delayed by hypothetical hazards.

Assuming the worst seems warranted given the issues raised in these chapters. The most alarming events are those for which hazards are suggested in lab trials, but whose behaviors in the field are virtually unknown. These include: 1) the stability and persistence of naked DNA in nature, 2) the probability of creating through recombination new pathogens with novel pathogenicities and host preferences, 3) the creation of more efficient disease vectors, 4) the horizontal transfer of genetic information, irrespective of taxonomic boundaries, 5) the recognition that transgenes have a limited lifespan and that their utility will degenerate through mutation or recombination, and, 6) the abandonment of traditional methods of pest, weed, and disease control with the prospect of biotechnological solutions.

Overall, each author attempts to bring a balanced, rational perspective to the questions at hand. The issue is not whether genetically engineered organisms are inherently good or bad, but how best to adequately assess the ecological and environmental risks of release. The resulting chapters constitute an engaging, sometimes shocking read of actual or potential risks of transgenes in natural systems. While this space precludes a chapter-by-chapter summary, I must identify a few of the book's highlights. Klinger (Chapter 1) demonstrates the shortcomings of existing models of crop-weed hybridization that result in grossly underestimating the probability of gene flow. Bergelson and Purrington (Chapter 2) summarize their work on the costs of transformation and resistance in genetically modified *Arabidopsis.* Their elegant experimental design is, ironically, a tribute to traditional plant breeding programs. Power's discussion of transgenic virus-resistant crops (Chapter 5) is, frankly, alarming. She identifies three imminent risks of releasing crops genetically transformed by viruses for resistance to viruses, yet makes clear there are little data with which to evaluate these risks. Stotzky (Chapter 8) cautions against the use of plants as factories in production of bioactive chemicals because, as the factories degrade, their genetic material may remain intact when bound to clays and humic substances. Tappeser et al. (Chapter 9) discuss the risks of genetically modified microorganisms and recombinant DNA in what is perhaps the most startling chapter of the book. Here they identify clear shortcomings in current risk assessment strategies relevant to microbes. Braig and Yan (Chapter 10) outline an ''emerging'' approach to the control of insect vectors of disease: to link transgenes to biological behaviors that intentionally accelerate its spread in host populations with the goal of driving the host species

to extinction. Spielman et al. (Chapter 11) quickly point out the limitations of the approach. Lastly, Traavik (Chapter 12) explains the potential environmental risks of genetically engineered vaccines.

Letoureau and Burrows' volume would be an exceptional selection for a graduate seminar or faculty discussion group, or perhaps even an undergraduate colloquium. Each chapter is rife for debate in that the data are few and the implications are huge. The volume is well organized, and nicely produced. It is somewhat surprising, however, that the authors provide neither introduction nor summary. Although this format allows readers to come to their own conclusions, it has left me wondering whether consensus or clear recommendations can be made when each system seems to demand its own answer. Further, the title is misleading. Much of the text is committed to identifying potential ecological and environmental risks of releasing genetically engineered life forms with little practical consideration of how to assess them, and with virtually no discussion of the effects on human health.

Selectively bred plants and animals have served as models for evolution, genetics, and physiology since the beginnings of our science. Ecologists have until recently shunned agricultural systems, preferring instead to study intact, unperturbed, pristine environments. This volume makes clear that impacted systems will dominate the landscape in our lifetimes and that well-trained ecologists and evolutionary biologists must come to address the complex biological issues that will undoubtedly arise following the release of genetically engineered organisms.

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Design and Analysis: Uncertain Intent, Uncertain Result

Quinn, Gerry P., and Michael J. Keough. 2002. **Experimental design and data analysis for biologists.** Cambridge University Press, New York. xvii + 537 p. $110.00 (cloth), ISBN: 0-521-81128-7; $45.00 (paper), ISBN: 0-521-00976-6.

The percentage of statistical analyses in the ecological literature that are incorrect is high. Thesis advisors, journal editors, textbook writers, and statistics professors have not done their job well. So new books on design and analysis are always approached with great hope.

This hefty volume by two of Australia's more quantitatively sophisticated ecologists is written for biologists and environmental scientists. Readers are presumed to have had one or two semesters of introductory statistics. It begins with a detailed, ten-page table of contents and ends with an extensive and useful bibliography. There are very good sections on some topics. By its end, however, it is apparent that this volume is not one that will reverse the tide of statistical malpractice.

The intent of the book is not completely clear, and its title is misleading. This is not a book one would select for a course in experimental design sensu stricto, i.e., the design of manipulative experiments. The authors state that the book's ''approach is to encourage readers to understand the models underlying the most common experimental designs.''

But they also state, ''Our emphasis here is on dealing with biological data—how to design *sampling* [our emphasis] programs that represent the best use of our resources . . . '' The book is, in fact, as much about observational studies as experimental ones. Seven chapters (6, 13–18), constituting 35 percent of the text, deal exclusively or almost exclusively with statistical analysis of observational studies; reference to observational studies is frequent in other chapters; and 70 percent of the text boxes with worked examples concern observational studies. On the other hand, sampling design is formally covered only in three pages of text, while about 91 pages are devoted to experimental design. The blurring of the distinction between observational and experimental studies creates confusion and fosters error.

The subject matter is apportioned roughly as follows: scientific method (8 pages), graphical exploration of data (14 pages), statistical analysis (379 pages), study design (94 pages), and presentation of results (16 pages).

The section on the scientific method is useful for its summary of the different positions of a number of philosophers and scientists on the topic, its citation of several key recent works not yet well known, and its recognition that both inductive and deductive approaches are required for the advance of science.

A tremendous range of topics is covered. Critical review of many of the more fundamental ones reveals problems.

For their chapters on design, the authors have adopted a confusing and superfluous terminology from the social and behavioral sciences. The term *subject* is at the core of this terminology. But *subject* has never been a statistical concept. On one page it is used to mean block, on another to mean experimental unit, on another to mean evaluation unit, and so on. They refer to crossover designs as ''subject × treatment designs'' and to designs where experimental units are monitored on two or more occasions as ''subject × trial designs.'' Later there is a section titled ''Crossover designs,'' but it does not mention that these are the same ones earlier termed ''subject × treatment designs.'' They describe a simple randomized complete block design study of differences in frog abundance on burned versus unburned plots that was moni-

tored in each of three years, and then later refer to year as the treatment factor in this study and burn condition as a ''within subjects'' factor.

Other confusions relating to design are present. The sampling units in observational studies they sometimes call ''experimental units,'' a term appropriate only to manipulative experiments. They claim that ''[t]he most common situation in biological experiments [with randomized complete blocks designs] is where. . . the blocks used in the experiment are a random sample from a larger population of blocks,'' whereas in fact this is a very uncommon situation. They describe one study as having a split-plot design whereas it actually has a randomized complete block design with two levels of blocking and a single treatment factor. They strongly recommend against unequal replication and fractional factorial designs on grounds of difficulties they *may* pose to analysis; yet strong arguments for both often can be made on the grounds of objectives, ethics, cost considerations, and logistics—and we should not let the tail wag the dog. Easy statistical analysis is a secondary objective.

Pseudoreplication is defined as a design problem characterized by the taking of multiple samples from experimental units where there is only one experimental unit per treatment. In fact, pseudoreplication is not a design error but rather an error of statistical analysis and interpretation. And it does not refer to absence of treatment replication. Sacrificial pseudoreplication is one of the commonest types (Hurlbert, S. H., and M. D. White. 1993. Experiments with freshwater invertebrate zooplanktivores: quality of statistical analyses. Bulletin of Marine Science 53: 128–153; Lombardi, C. M., and S. H. Hurlbert. 1996. Sunfish cognition and pseudoreplication. Animal Behaviour 52:419–422) and by definition is possible only where there are *multiple* experimental units per treatment. In three places, analyses constituting pseudoreplication are inadvertently presented as examples of the correct way to do things. In a section on ''pooling'' the authors argue, in effect, that sacrificial pseudoreplication is an acceptable procedure so long as the power to detect the real differences among experimental units is low.

This volume perpetuates some widespread but unjustifiable conventions of statistical analysis. Let's start with fundamentals. The authors acknowledge that ''[t]here is no reason why all tests have to be done with a significance level fixed at 0.05'' but do not acknowledge that there is no need in most research situations to specify any α value whatsoever. Evaluation of evidence is not a black-and-white matter. Clear interpretation and good writing will dispense with the habit and crutch of calling certain results ''significant.''

There is confusion as to the definition of *P*. The authors incorrectly state that *P* ''is the probability of a result occurring by chance in the long run if H_0 is true. . . .'' Early on they argue that a high *P* value constitutes evidence that the alternative hypothesis (H_A) is ''incorrect,'' but later they correctly recognize that it argues only for suspension of judgment as to the correctness of H_A versus H_0.

Their assessment of the validity of one-tailed testing is ambivalent. They confuse the issue of what might be predicted with that of what would be of interest. They cite approvingly one of their own studies that justified one-tailed testing with the claim that a result in the direction opposite that predicted would have been ignored. Use of one-tailed tests indicates statistical misunderstanding at several levels. It reflects the black-and-white thinking of fixed significance levels, confusion between the testing of research hypotheses and the testing of statistical hypotheses, and failure to recognize that, applied to a given data set, a one-tailed test yielding a $P = 0.04$ and a two-tailed test yielding a $P = 0.08$ are two exactly equivalent summaries of the same information and should lead to identical conclusions as to what the evidence shows (Pillemer, D. B. 1991. One- versus two-tailed hypothesis tests in contemporary educational research. Educational Researcher 20:13–17; Lombardi, C., and S. Hurlbert. 1995. Misprescription and misuse of one-tailed tests. Association for the Study of Animal Behaviour Newsletter 23:14).

The issue of multiple testing and Type I error is raised at many points in the book and considered ''a most difficult'' one by the authors, though it should not be. They accurately state that ''[a] Type I error is when we mistakenly reject a correct H_0'' and that ''most common H_0's in biology, and other sciences, are always false.'' But then, instead of taking the next logical step and concluding that Type I errors are likely to be very rare and can simply be evaluated as an unlikely possibility on a test-by-test basis, the authors revert to the antediluvian ''alpha paranoia'' of many of our statistical forefathers. They state, erroneously, that ''[a]s the number of tests increases, so does the probability of making at least one Type I error among the collection of tests'' and that ''[t]he probability of at least one Type I error among the family of ten tests [being carried out in a hypothetical example], if each test is conducted at α equals 0.05 and the comparisons are independent of each other, is 0.40.'' Without knowing how many, if any, of the null hypotheses being tested are true, it is not possible to calculate the probability of making one or more Type I errors. For most investigations that probability is likely to be zero.

The authors recognize that the many conventional procedures available ''to keep the [maximum] family-wise Type I error rate [possible] at some [fixed] reasonable level'' are problematic. They require arbitrary decisions as to what constitutes a ''family'' of tests and as to what the family-wise α should be set at; and if conventionally low values of α are used, power will be greatly reduced. With respect to ''planned comparisons'' they thus conclude: ''Our broad recommendation is that the default position should be *no adjustment for multiple testing* [our emphasis] if the tests represent clearly defined and separate hypotheses.'' To emphasize the import of this helpful recommendation, they might have pointed out how widely it is ignored by authors, reviewers, and editors.

For ''unplanned comparisons'' the authors feel that procedures entailing fixed family-wise Type I error rates may often be appropriate. They present no clear rationale, however. It is time for us all to face the music: there is no legitimate employment for the games of Mssrs. Bonferroni, Duncan, Dunnett, Ryan, Scheffé, Student-Neuman-Keuls, and Tukey! The attention given to those games is distracting and makes it less likely the reader will absorb the full significance of the ''broad recommendation'' quoted above.

Related issues are raised in the authors' discussions of repeated measures designs. They recommend Greenhouse-

Geisser-adjusted error degrees of freedom for testing for time and time × treatment effects in such studies, but use *unadjusted* error degrees of freedom in examples they present. Nowhere do they acknowledge that separate date-by-date analyses—without correction for ''multiple testing''—is a perfectly valid, simpler, more informative, and less error-prone approach to such data.

In discussing meta-analyses, the authors specify that these must employ ''a measure of effect size. . . that incorporates the variance of the effect.'' They cite favorably four books and review articles that advocate this decades-old conventional wisdom. Yet, the illogic and defects of such standardized indices of effect size in most situations are clear (Hurlbert, S.H. 1994. Old shibboleths and new syntheses [review of Design and Analysis of Ecological Experiments, edited by S. M. Scheiner and J. Gurevitch]. Trends in Ecology and Evolution 9:495–496; Petraitis, P. S. 1998. How can we compare the importance of ecological processes if we never ask, ''Compared to what?'' Pages 183–201*in* W. Resetarits, Jr. and J. Bernardo, editors. Experimental Ecology: Issues and Perspectives. Oxford University Press, New York). Repair of damage that has been done to the intelligibility of meta-analyses in most disciplines by blind use of standardized indices would require a book longer than that under review.

A final topic with problems is that of data transformation. The authors accurately state that ''[t]he most common transformation is the log transformation.'' But later they claim that ''[t]he most common type of transformation useful for biological data . . . is the power transformation. . . , which transforms Y to Y^p, where p is greater than zero. For data with right skew, the square root transformation, where $p = 0.5$, is applicable, particularly for data that are counts (Poisson distributed) . . . .'' In fact, the square root transformation will usually be a bad choice, as count or other types of abundance data will rarely even approximately conform to a Poisson distribution; nature is patchy. Square root transformation will often lead to problems like that evident in their Figure 9.7. There the mean minus one standard error or standard deviation takes one into negative values for limpet density. Log transformation of data does not permit such illogical results. When a data set contains zeros, use of log transformation requires addition of some constant to all values in the set; the authors mention four different options for selecting that constant but give no advice as to which is correct.

Our focus on its problems notwithstanding, it is evident that a great deal of scholarship has gone into this book and that there is much good advice in it. Production of a definitive and flawless volume covering such a wide subject matter seems not yet to be feasible, however. The existing statistics books and primary literature still contain too much misinformation on too many topics. Correction of this will require a Herculean effort—many critical, narrowly focused reviews by many scholars over some period of time—before broad syntheses become a manageable task for one or two authors. New construction evidently requires deeper digging and the repair or replacement of old foundations.

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Spotlight

RECENT PUBLICATIONS OF PARTICULAR INTEREST

Ricketts, Edward Flanders. 2002. **Renaissance man of cannery row: the life and letters of Edward F. Ricketts.** The University of Alabama Press, Tuscaloosa, Alabama. liv + 283 p. $39.95, ISBN: 0-8173-1172-6 (alk. paper). This book, edited by Katherine A. Rodger, recounts the life and letters of the man on whom John Steinbeck modeled ''Doc'' in *Cannery Row*. This book contains a biographical essay of Ricketts and annotated copies of 136 letters.

Denny, Mark W., AND Steven Gaines. 2002 (paper), 2000 (cloth). **Chance in biology: using probability to explore nature.** Princeton University Press, Princeton, New Jersey. xiii + 291 p. $59.50, £40.00 (cloth), ISBN: 0-691-00521-4 (alk. paper); $29.95, £19.95 (paper), ISBN: 0-691-09494-2 (alk. paper). This book is an introduction to chance and probability with chapters on discrete and continuous patterns of disorder, random walks, statistics of extremes, and noise. There are problems at the end of the chapters and worked explanations of the answers to those problems at the end of the book.

BOOKS AND MONOGRAPHS RECEIVED THROUGH OCTOBER 2002

Aguirre, A. Alonso, Richard S. Ostfeld, Gary M. Tabor, Carol House, and Mary C. Pearl, editors. 2002. **Conservation medicine: ecological health in practice.** Oxford University Press, New York. xxiv + 407 p. $45.00, ISBN: 0-19-515093-7 (acid-free paper).

Ainley, David G. 2002. **The Adélie penguin: bellwether of climate change.** Columbia University Press, New York. xiv + 310 p. $59.50, £42.50, ISBN: 0-231-12306-X (alk. paper).

Apollonio, Spencer. 2002. **Hierarchical perspectives on marine complexities: searching for systems in the Gulf of Maine.** Complexity in Ecological Systems Series. Columbia University Press, New York. xii + 229 p. $59.50, £42.50 (cloth), ISBN: 0-231-12488-0 (alk. paper); $29.50, £20.50 (paper), ISBN: 0-231-12489-9 (alk. paper).

Audesirk, Teresa, Gerald Audesirk, and Bruce E. Byers. 2003. **Life on earth.** Third edition. Prentice Hall, Upper Saddle River, New Jersey. xxvii + 635 p. + CD-ROM. $81.33, ISBN: 0-13-065309-8.

Baron, Jill S., editor. 2002. **Rocky Mountain futures: an ecological perspective.** Island Press, Washington, D.C. xxviii + 325 p. $65.00 (cloth), ISBN: 1-55963-953-9 (acid-free paper); $32.50 (paper), ISBN: 1-55963-954-7 (acid-free paper).

Box, Elgene O., Tohru Nakashizuka, and Anton Fischer, editors. 2002. **Dynamics of temperate forests.** Vegetation Science 17. Opulus Press, Uppsala, Sweden. 148 p. SEK 250.00, ISBN: 91-88716-26-0.

Brunner, Ronald D., Christine H. Colburn, Christina M. Cromley, Roberta A. Klein, and Elizabeth A. Olson. 2002. **Finding common ground: governance and natural resources in the American West.** Yale University Press, New Haven, Connecticut. xiii + 303 p. $35.00 (cloth), ISBN: 0-300-09144-3 (alk. paper); $17.00 (paper), ISBN: 0-300-09145-1 (alk. paper).

Chaisson, Eric J. 2001. **Cosmic evolution: the rise of complexity in nature.** Harvard University Press, Cambridge, Massachusetts. xii + 274 p. $17.95, ISBN: 0-674-00342-X (alk. paper).

Clements, William H., and Michael C. Newman. 2002. **Community ecotoxicology.** Hierarchical Ecotoxicology Series. Wiley and Sons, Hoboken, New Jersey. xiii + 336 p. $110.00, ISBN: 0-471-49519-0 (acid-free paper).

Cox, George W. 2002. **General ecology laboratory manual.** Eighth edition. McGraw-Hill, New York. viii + 312 p. $60.75, ISBN: 0-07-290974-9 (acid-free paper).

Cushing, J. M., R. F. Costantino, Brian Dennis, Robert A. Desharnais, and Shandelle M. Henson. 2003. **Chaos in ecology: experimental nonlinear dynamics.** Theoretical Ecology Series. Academic Press, New York. xiv + 225 p. $65.00, £45.00, ISBN: 0-12-198876-7 (alk. paper).

Décamps, Henri, and Odile Décamps. 2001. **Mediterranean riparian woodlands.** Conservation of Mediterranean Wetlands. Number 12. Tour du Valat, Arles, France. 139 p. €10.00, ISBN: 2-910368-44-0.

Denny, Mark W., and Steven Gaines. 2002 (paper), 2000 (cloth). **Chance in biology: using probability to explore nature.** Princeton University Press, Princeton, New Jersey. xiii + 291 p. $59.50, £40.00 (cloth), ISBN: 0-691-00521-4 (alk. paper); $29.95, £19.95 (paper), ISBN: 0-691-09494-2 (alk. paper).

The H. John Heinz III Center for Science, Economics and the Environment. 2002. **The state of the nation's ecosystems: measuring the lands, waters, and living resources of the United States.** Cambridge University Press, New York. xviii + 270 p. $25.00, ISBN: 0-521-52572-1.

Hofrichter, Richard, editor. 2002. **Toxic struggles: the theory and practice of environmental justice.** The University of Utah Press, Salt Lake City, Utah. xv + 260 p. $17.95, ISBN: 0-87480-737-9 (acid-free paper).

Kohler, Robert E. 2002. **Landscapes and labscapes: exploring the lab-field border in biology.** The University of Chicago Press, Chicago, Illinois. xv + 326 p. $58.00, £41.00 (cloth), ISBN: 0-226-45009-0 (alk. paper); $22.00, £15.50 (paper), ISBN: 0-226-45010-4 (alk. paper).

Kondratyev, Kirill Ya., Alexei A. Grigoryev, and Costas A. Varotsos. 2002. **Environmental disasters: anthropogenic and natural.** Springer Praxis Books in Environmental Sciences. Springer-Verlag, New York. xxvi + 484 p. $149.00, ISBN: 3-540-43303-1 (acid-free paper).

Kruckeberg, Arthur R. 2002. **Geology and plant life: the effects of landforms and rock types on plants.** University of Washington Press, Seattle, Washington. x + 362 p. $35.00, ISBN: 0-295-98203-9 (alk. paper).

Kruuk, Hans. 2002. **Hunter and hunted: relationships between carnivores and people.** Cambridge University Press, New York. xii + 246 p. $65.00 (cloth), ISBN: 0-521-81410-3; $24.00 (paper), ISBN: 0-521-89109-4.

Mullen, Gary, and Lance Durden, editors. 2002. **Medical and veterinary entomology.** Academic Press, New York. xv + 597 p. $99.95, ISBN: 0-12-510451-0 (alk. paper).

Perrow, Martin R., and Anthony J. Davy, editors. 2002. **Handbook of ecological restoration.** Volume 1: Principles of Restoration. Cambridge University Press, New York. xvi + 444 p. $100.00, ISBN: 0-521-79128-6.

Perrow, Martin R., and Anthony J. Davy, editors. 2002. **Handbook of ecological restoration.** Volume 2: Restoration in Practice. Cambridge University Press, New York. xvii + 599 p. $100.00, ISBN: 0-521-79129-4.

Ploger, Bonnie J., and Ken Yasukawa, editors. 2003. **Exploring animal behavior in laboratory and field: an hypothesis-testing approach to the development, causation, function, and evolution of animal behavior.** Academic Press, New York. xix + 472 p. $44.95, ISBN: 0-12-558330-3 (alk. paper).

Primack, Richard, Ricardo Rozzi, Peter Feinsinger, Rodolfo Dirzo, and Francisca Massardo. 2001. **Fundamentos de conservación biológica: perspectivas latinoamericanas.** Fondo de Cultura Económica, México City, México. 797 p. ISBN: 968-16-6428-0.

Ricketts, Edward Flanders. 2002. **Renaissance man of cannery row: the life and letters of Edward F. Ricketts.** The University of Alabama Press, Tuscaloosa, Alabama. liv + 283 p. $39.95, ISBN: 0-8173-1172-6 (alk. paper).

Robson, Craig. 2002. **Birds of Thailand.** Princeton Field Guides. Princeton University Press, Princeton, New Jersey. 272 p. $49.50 (cloth), ISBN: 0-691-00700-4; $24.95 (paper), ISBN: 0-691-00701-2.

Sachs, Jessica Snyder. 2001. **Corpse: nature, forensics, and the struggle to pinpoint time of death.** Perseus Publishing, Cambridge, Massachusetts. x + 270 p. $15.00, ISBN: 0-7382-0771-3.

Schwartzman, David W. 1999. **Life, temperature, and the earth: the self-organizing biosphere.** Columbia University Press, New York. xx + 241 p. $54.50 (cloth), ISBN: 0-231-10212-7 (alk. paper); $27.50 (paper), ISBN: 0-231-10213-5 (alk. paper).

Shoemaker, Candice A., editor. 2002. **Interaction by design: bringing people and plants together for health and well-being: an international symposium.** Iowa State Press, Ames, Iowa. xxiv + 331 p. $59.99, ISBN: 0-8138-0323-3 (alk. paper).

Smil, Vaclav. 2002. **The earth's biosphere: evolution, dynamics, and change.** The MIT Press, Cambridge, Massachusetts. viii + 346 p. $32.95, £22.50, ISBN: 0-262-19472-4 (alk. paper).

Sunquist, Melvin E., and Fiona Sunquist. 2002. **Wild cats of the world.** The University of Chicago Press, Chicago, Illinois. x + 452 p. $45.00, £31.50, ISBN: 0-226-77999-8 (alk. paper).

Westhead, David R., J. Howard Parish, and Richard M. Twyman. 2002. **Instant notes: bioinformatics.** The INSTANT NOTES Series. BIOS Scientific Publishers, New York. viii + 257 p. $27.95, ISBN: 1-85996-272-6.

Yoshida, Toshio. 2002. **Portraits of Himalayan flowers.** Timber Press, Portland, Oregon. 124 p. $39.95, ISBN: 0-88192-551-9.

Young, James A., and Charlie D. Clements. 2002. ***Purshia*: the wild and bitter roses.** University of Nevada Press, Reno, Nevada. xiii + 266 p. $39.95, ISBN: 0-87417-491-0 (alk. paper).