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Book Review

Nutrient Cycling and Limitation: Hawaii as a Model System

P. Vitousek. Princeton University Press, Princeton. Princeton Environmental Institute Series, 2004, xx + 223 pages. Price US$79.50, paper US$35.00. ISBN 0691 11580 X.

Nutrient Cycling and Limitation has its roots in the long-neglected and currently unfashionable field of plant succession. Almost no mention is made of those topics – such as conservation biology, competition, rarity, species diversity and the link with ecosystem properties – that constitute the core of contemporary plant ecology. Rather, the book is about the dynamics of plant nutrients in terrestrial ecosystems: where nutrients come from, how long they persist in soils, and how nutrient flows through terrestrial ecosystems are regulated by feedback systems involving soil microbes, plant physiology and plant litter.

The study of model systems and the utilization of environmental gradients is given concise exposition in chapters 2 and 3. Vitousek clearly regards this methodological theme as being of central importance, for it provides the subtext to almost every page. He argues the case for model systems in general, and environmental gradients in particular, as being the field ecologist's most parsimonious route to scientific enlightenment. He enthusiastically concludes that Hawaii is the best place in the world to study terrestrial plant nutrient dynamics, and presents a body of research findings that comprise a quite profound understanding of many of the fundamental biotic and abiotic processes that shape the world.

One of the most impressive aspects of *Nutrient Cycling and Limitation* is the scope of the material it covers, and the extent to which the material is integrated to provide a truly ecosystem-level overview, that is itself placed neatly within a global context. I am aware of few scientific writers since Darwin who have shown such facility. Vitousek's gift for synthesis is exemplified by chapters 2 and 3, in which plate tectonics, geomorphology, atmospheric circulation, evolution, topographic effects on climate, and their consequences for weathering and soil chemistry, are all seamlessly interlinked to provide a very complete background to his research.

Starting from Walker and Syers' (1976) model of phosphorus and nitrogen availability through long-term soil development, Vitousek considers the implications of nutrient dynamics for biological processes. He discusses the various parameters that could be measured, outlining their individual merits and drawbacks, and detailing potential confounding factors and his strategies for circumventing them. Assumptions are explicitly enunciated – an all too rare thing in ecology – and evidence is carefully weighted according to its reliance on assumption. Also notable is the emphasis on the widely differing time scales across which strong interactions occur. Whereas some of the processes discussed are of merely wrist-watch duration, they occur within a time frame of geological dimensions. Vitousek convincingly argues that nutrient dynamics are the product of a variety of processes that operate on time scales that differ by many orders of magnitude, and that few of these processes occur independently of the others.

Drawing upon earlier ideas from successional theory, *Nutrient Cycling and Limitation* presents plants as being active participants in ecosystems. Vitousek points out that volcanic substrates contain very little nitrogen; it has to be obtained from atmospheric sources, and plants play a prominent role in this process. In particular, the complex feedbacks between soil nutrient availability, plant nutrient-use efficiency, leaf longevity, leaf litter decomposition and soil microbial communities are discussed in considerable detail. This section will be of great interest to many researchers.

In the final chapter, Vitousek incorporates recent ideas on biological stoichiometry to discuss 'flexibility', the ability of an element to cycle more rapidly than expected when biological demand is high. He argues that the flexibility of an element, rather than its relative abundance, is the factor that constrains biological processes. If correct, this would represent a significant advance in understanding ecosystem dynamics. Vitousek also employs a simulation model to explore the consequences of his findings, and to investigate the implications of his ideas, thereby generating a whole new set of research questions.

Nutrient Cycling and Limitation is an impressive work of scholarship, written in a style that renders it accessible to the lay reader. Its main shortcoming is the mediocre index; fortunately it has a detailed table of contents. Regardless, the book provides a wide-ranging and authoritative coverage of a crucial topic. Perhaps equally importantly, it demonstrates the value of pursuing a research direction irrespec-

tive of scientific fashions and government funding priorities.

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Fitness Landscapes and the Origin of Species

S. Gavrilets. Princeton University Press, Princeton, 2004, 476 + xvii pages. Price AUD$68. ISBN 0691117586.

This is an impressive book. Its strength lies in Gavrilets' clear vision of what he is trying to achieve in the book, along with his obvious breadth in the subject matter. The central question is, 'What do mathematical models tell us about speciation?'. Gavrilets wishes to: (i) thoroughly review the various approaches to this question that have been adopted during the last 40 years; (ii) synthesize the results; and (iii) do so in a manner that is useful to those without in-depth mathematical training. He pursues these goals with rigour and clarity, beginning each chapter with a summary of what he will cover, and finishing each chapter with a summary of the significance of the results from the models.

Gavrilets concentrates on simple, analytical models, where explicit answers can be given to a suite of questions, such as 'What is the waiting time till speciation?'. He regards numerical simulations as problematic, as their results are often difficult to generalize, but occasionally reverts to them when analytic solutions are not available. In these cases he is guarded in his comments. Although the maths is central to this book, Gavrilets is always aware that it is a tool to understanding; the focus remains on the biology. He frequently ties a particular model back to a real-world example, and questions the biological realism of assumptions made in the models he surveys. The chapter summaries extract general principles about speciation, but he is always very careful to qualify them, point out deficiencies, and urge further explorations when not enough results are in.

There are many equations in this book. For those with only a modicum of mathematical ability, it is still possible to follow much of what is going on; though it is sometimes not an easy task. Gavrilets avoids complex derivations and proofs in the text (readers are directed to his web site for these). He concentrates on using the equations to pick out the role that particular parameters (such as migration rate) play in speciation, the sensitivity of these parameters, and the interplay between them. Graphs, diagrams, and tables are put to good use to help the reader grasp what is going on in the equations. However, there are times when the going gets rough. Gavrilets' desire to cover all significant models in the area means that a barrage of different models is sometimes presented with few interpretive comments (most evident in part 3).

The book is divided into three parts, with a total of 11 chapters. Part 1 (Fitness Landscapes) introduces fitness landscapes based on Wright, beginning by differentiating two types of landscape present in Wright's work. Gavrilets explores speciation on 'rugged landscapes', where a population must pass through a 'fitness valley', and concludes that it is unlikely that stochastic events can drive speciation on these landscapes. Gavrilets then introduces a key concept for the rest of the book: that of the 'holey' landscape. He argues that high dimensional landscapes inevitably contain large interconnected bands of genotypes that have nearly the same fitness ('neutral networks'). The genetic divergence required for speciation can proceed along these interconnected 'fitness ridges' via neutral mutations, rather than having to traverse a 'fitness valley'.

In Part 2 (The Bateson-Dobzhansky-Muller Model), Gavrilets reconstructs a simple model (attributed to the above authors), which describes a 'holey' landscape. After exploring this simple version, the model is expanded to a multidimensional one, using various techniques to extract some general principles. He concludes that both allopatric and parapatric speciation are possible on 'holey' landscapes with certain realistic assumptions. He then extends this model again by incorporating spatial interactions showing a number of interesting results including differences in speciation dynamics between 1D systems (such as shorelines) and 2D systems (such as lakes or continents).

In Part 3 (Speciation via the joint action of disruptive natural selection and non-random mating) Gavrilets explores fitness landscapes that are not fixed, but change under different population or spatial structures. This requires different techniques to the previous section, so there is a distinct change of pace here. Disruption and non-random mating are first considered separately (in two separate chapters) and then together. This section is extremely interesting, but also the most difficult. Gavrilets shows that sympatric speciation is possible in some situations.

This is a dense book, requiring a concerted effort to get the most out of it. But it is also a rich book, full of sober, well-considered insights, and there is a sense of real progress in understanding the variety of situations in which speciation can occur. Any investment in this book is well rewarded.

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Practical Methods in Ecology

P. A. Henderson. Blackwell Science, Oxford, UK, 2003, 163 + vii pages. Price AUD$66. ISBN 1405102446.

What every budding biologist should know but is often afraid to ask. Or is it? In the words of the author, this book is aimed at 'undergraduate biologists and their lecturers' and his objective is to make the detail in *Ecological Methods* (Southwood & Henderson 2000) more accessible to his aimed readership. In addition he 'hopes that part of the book will be useful for sixth-form and high school students'.

Henderson knows *Ecological Methods* well as he studied under Southwood and was a co-author of the third edition of that book. *Practical Methods in Ecology* has some competitors including Krebs (1999), Southwood and Henderson (2000) and Sutherland (1996) and has to be viewed against that background and the stated audience.

The book has 12 chapters that cover planning, sampling and analysis. The first chapter covers the planning issues and some important practical issues that address OH&S matters and the impact that sampling may have on the environment or species under study. The second chapter provides a very brief introduction to descriptive statistics, comparing two sites, and an introduction to comparing medians and measuring the correlation between variables.

The next five chapters cover methods for population size estimation. The methods start with quadrat and grab sampling based methods, move on to mark-recapture and distance sampling methods and finish with a discussion of relative methods and population indices. The next two chapters cover estimating age and growth, and life-tables and population budgets.

The final three chapters are directed more towards community sampling. Measures of species richness and habitat quality scores are covered. An introduction to gradients is provided within the framework of *beta*-diversity. The last chapter addresses questions on comparing and classifying communities and is primarily about data management and multivariate analysis.

Some chapters are enhanced by the use of 'ecological applications' which place the described methods in an ecological context and often describe the protocols required to implement the method. Elsewhere, in the relevant chapters, there are citations to the literature where greater technical detail can be found about the techniques described.

The first chapter should perhaps be the corner stone of the book but in my mind fails to address the issue of defining the question to be answered by a field sampling technique. While Henderson provides many welcome caveats about issues that need to be addressed in planning a sampling regime, there remains a need for greater discussion of the relationship between defining the research question and developing a protocol for collecting data necessary to answer the question. Given that the primary audience for the book is students, be they tertiary or secondary, the absence of a discussion of the merits and limitations of the techniques outlined in the book with respect to the range of questions that students could attempt to address is a weakness and a missed opportunity.

My other areas of concern are the apparent mismatch between some of the techniques given such prominence in this book when the primary audience is students, and the failure to offer advice, or pointers as to where such advice might be found, on how to handle the material collected. For example, there is a relatively detailed description of grab samplers. Such tools are unlikely to be readily available to students except those at institutions involved in an active sea bed research programme.

Has the author presented today's students with a valuable introductory text to the often complex world of sampling to answer an ecological question? In my view the answer to this question is probably no. The book clearly catalogues a range of sampling protocols but fails to place them in an adequate ecological context to enable students to assess which technique is most suitable to address their research questions. The competitors (e.g. Sutherland 1996) may require greater effort on the part of the reader but have more to offer for a very similar price.

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The Insects: An Outline of Entomology (3rd Edition)

P. J. Gullan and P. S. Cranston. Blackwell Publishing, Oxford, 2005, xvii + 505 pages. Price AUD$72.99. ISBN 14051 11135.

The value of an authoritative and captivating textbook cannot be understated. A bad textbook can tarnish an entire subject, and many of us will remember at least one lifeless tome, written in the type of 'mental disappearing ink' that leaves no impression on the brain. Fortunately, the third edition of Gullan and Cranston's *The Insects: An Outline of Entomology* is an excellent text that will help to foster in undergraduates a lifelong interest in entomology. It can also be kept long after graduation to be used as a professional reference.

The book presents basic knowledge clearly, whilst also providing a synopsis of many current entomological attitudes, recent discoveries and controversies. Accordingly, the text of this edition has been greatly expanded for some fields undergoing rapid growth, and some completely new topics are introduced, including Mantophasmatodea. Particularly appealing is the emphasis on emerging ideas and the balanced presentation of conflicting hypotheses in several areas, especially in phylogenetics and evolution. For example, there is discussion of challenges (outlined in Hooper 2003) to the integrity of well-loved data on industrial melanism in peppered moths *Biston betularia* (Linnaeus) (Lepidoptera; Geometridae). Critically therefore this text helps to expose students early to the argumentative nature of science and encourages them to debate, rather than become indoctrinated.

The 17 chapters flow well when read from cover to cover, but are also stand alone pieces that can be browsed selectively. The writing is concise, lively and erudite throughout, often reminiscent of the styles of Wigglesworth (1972) and Oldroyd (1964). A discussion of insect diversity, cultural significance and conservation opens the book. Excellent chapters on anatomy and physiology follow, and these include some of the clearest descriptions I have read of external morphology. The authors also further enliven these topics by placing structure and function of the insect body into environmental and ecological contexts.

'Sensory Systems and Behaviour' are somewhat artificially combined into one chapter. Most of the behavioural information presented here is specifically concerned with sensory stimulus processing, whereas other aspects of behaviour, such as hormonal responses and evolution, are covered throughout the book. However, even though this chapter may benefit from a title change, the content is fascinating. 'Reproduction', and the logical combination of 'Insect Development and Life Histories' form the subjects of the next two chapters. Both sections deal particularly well with the confusing diversity of insect reproductive mechanisms and developmental strategies.

Two new chapters have been added to this edition: Chapter 7 addresses recent developments in insect systematics and defines major taxonomic divisions of the Insecta down to order level, and Chapter 8 describes progress and difficulties with understanding insect biogeography and evolution. A series of six chapters follows, with each discussing major ecological radiation and adaptations of insects, including ground dwelling, aquatic and social lifestyles, and the development and maintenance of insect defences. Two applied chapters are then presented on 'Medical and Veterinary Entomology' and 'Pest Management'. Finally, there are some general instructions for insect collection, curation and identification. A handy reference appendix is also included that provides a brief, illustrated guide to each order.

Beautifully illustrated text boxes, many of which were newly written for this edition, are used to present examples of principles discussed and recent research findings. Also, boxes that summarize characteristics of individual orders are included in some chapters to feature taxa illustrative of chapter topics; for example, Mantodea and Strepsiptera each have a box in Chapter 13 'Insect Predation and Parasitism.' This approach has mixed success: the order boxes expand on the predominantly morphological and phylogenetic information presented under systematics, however, there is an irritating repetition of some facts already included in that chapter.

The layout of this book is exceptional, down to the attractive front cover and the use of red and black font to distinguish titles, key words and boxes from the main text. The stunning illustrations are not only a treat for the reader, but also set an excellent example for students on how to use pictures to effectively convey information. In short, I heartily recommend that you use this magnificent book to teach, but also, buy it for yourself.

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Ecological Engineering for Pest Management: Advances in Habitat Manipulation for Arthropods

G. M. Gurr, S. D. Wratten and M. A. Altieri (eds). CSIRO Publishing, Collingwood, Australia, 2004, 244 pages. Price AUD$145. ISBN 0643 09022 3.

The dominant approach to controlling pests in agricultural systems over the last 50 years has been responsive rather than preventive (Lewis *et al*. 1997). The inherent flaw in this 'silver bullet' approach is that it encourages short-term solutions rather than fundamental changes that provide long-term sustainability. This argument lies at the core of *Ecological Engineering for Pest Management*. Each of the contributing authors outlines ways, whether tested in the field or theoretical, in which agricultural systems can be engineered to enhance resistance to pest incursions.

The book is easy to read and is enhanced by thoughtful editing of the volume. For example, effective cross referencing between chapters helps to reinforce links and minimize repetition. The chapter topics span a wide range of approaches from landscape manipulations to molecular techniques for species identification, and the book as a whole provides a good overview that would be valuable to students of pest management. I feel that the terminology promoted within the book (e.g. conservation biological control, ecological engineering) is of questionable utility, and much of what is described in relation to these terms can be adequately encompassed by current definitions of integrated pest management and habitat manipulation. What is not questionable, however, is the value of the issues and evidence presented in the book. They will undoubtedly contribute to ecological understanding and the improvement of pest management.

Some chapters are more evidence based than others, which are quite theoretical in nature. Authors were most convincing when they focused on case studies and discussed theory with reference to a particular control technique in a specific agricultural situation. For example, the discussion of the agroecological bases of ecological engineering by Nicholls & Altieri is supported by tangible examples whilst providing an in-depth exploration of underlying concepts (physiological susceptibility of plants, pest stable ecosystems and so on). The chapter of Menalled, Alvarez & Landis covers the potential applications of molecular-based techniques, above and beyond genetic modification of crops, for pest management. Whilst not being overly familiar with molecular techniques, I found this chapter accessible and stimulating. The information provided should help catalyse communication between people trained in molecular disciplines and those not familiar with the wider applicability of these technologies.

Khan & Pickett present a positive chapter with practical solutions describing the use of 'push-pull' strategies for the management of stem borer in rural Kenya. The development of a Napier grass perimeter around maize plots served to 'trap' stem borers and significantly reduced their presence in the crop, and contributed to an increase in parasitization (Khan *et al*. 2001). In the chapter by Pfiffner & Wyss I was interested to learn that the Swiss government has subsidized the planting of native wildflower strips (including seven endangered species) on farms since 1993. Government support is clearly critical to increasing the adoption of sustainable agricultural practices.

There is a wide range of technologies available to pest management strategists and all authors seem to agree that using two or more of these in unison will provide more resilient pest control than any one alone. An example of this can be found in the chapter of Khan & Pickett who advocate the combination of push-pull strategies with genetically engineered *Bt* maize to reduce the selection pressure on stem borer populations by transgenic plants. Additional benefits would include increased numbers of natural enemies (here the grasses act as a source) leading to increased predation in the crop.

The increasing social awareness of, and sensitivity to, the negative impacts of monocultures and reliance on chemical controls in agriculture is one factor driving the adoption of sustainable management techniques. If farmers, at all scales and from all socio-economic backgrounds, are going to continue to adopt these technologies it is up to researchers to continue developing techniques so that they are locally applicable and consistently reliable. The information collated in this book is salient for all students of pest management and will provide them with a basis from which to explore methods of improving the sustainability of modern agriculture.

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Tropical Forest Diversity and Dynamism

E. C. Losos and E. G. Leigh (eds). University of Chicago Press, Chicago and London, 2004, 645 pages. Price US$38.00. ISBN 0226 493466.

How can so many kinds of tropical trees coexist in a uniform tract of tropical forest? This is one of the significant questions this book attempts to answer, by presenting the current findings from an extensive network of standardized large scale (25–50 ha) forest dynamics plots established in the 1980s and early 1990s.

The book developed from a symposium organized by the Center for Tropical Forest Science (CTFS) in 1998, which was the first gathering of scientists involved in an international network of large-scale forest dynamics plots in which all free-standing trees and large shrubs over 1 cm in diameter are marked, mapped and identified. It aims to provide standardized quantitative and qualitative information on every plot, as well as a comparative analysis of the plots.

The book is structured in seven parts. Part 1 introduces the tree-plot network, and reports on two decades of research from a 50 ha plot on Barro Colorado Island, which formed the foundation for the development of the plot network. Part 2 focuses on biogeography, climate, soils and structural variation, to explain how these factors contribute to floristic characteristics across the geographical range of the forest dynamics plots. Part 3 considers habitat specialization and species rarity, providing evidence of contrasting species maintenance mechanisms across the plot network. Part 4 looks at the implications of local variation in canopy disturbance and soil structure for species diversity.

Part 5 looks at the diversity of tropical trees, and considers the neutral theory of forest ecology; that trees die at random regardless of their species, and that seed parents of their replacements are like-wise chosen without reference to their species. Part 5 questions how trees reproduce in species-rich sites by considering how far successful pollen travels and what proportion of a tree's seed is pollinated by other trees, and discusses the effects of reducing forests to fragments. Part 6 looks at species coexistence and the role of pest pressure in maintaining diversity in tropical forests. The final section presents standardized qualitative and quantitative descriptions of 15 of the CTFS network of forest dynamics plots which range from Panama to the Congo to Thailand and Sri Lanka.

The book's significance is that the long-term nature of the plots has allowed the testing of several fundamental hypotheses that form the basis of explanations of the mechanisms of diversity, including the well-known intermediate disturbance hypothesis, the pest pressure relationship and the specialization of species to different habitat or light levels. Moreover, several surprising findings are presented, for example, the assumption that mixed species stands are richer in tree species than monodominant stands is not so, at least in the Democratic Republic of Congo.

This publication is no undergraduate text and assumes substantial prior knowledge. It will be of benefit to eclectic postgraduates and field researchers looking to develop, refresh and advance their own theories, and in particular to those wishing to compare and contrast their own findings from permanent sample plots with tropical forests elsewhere. However, the style of writing and the loose structure do not make the book suitable for those seeking clarification, quick reference, or structured explanation of contemporary theories. It is written in a more thought-provoking style and consequently readers may have to consult the index to find what they want. Also I am a little disappointed that there is no overall synthesis of the findings, or a substantial treatment of the practical implications for conservationists, foresters and policy makers. This may not have been the objective of the book, however, those fortunate enough to be involved in such important research ought to have a mandate to inform those making the decisions about use, conservation and reservation. Here such an opportunity is lost.

This criticism should not belittle the wealth of information presented, and readers should appreciate what an enormous undertaking establishing and reporting on such a network of large scale plots is. I have no doubt continuing research on the CTFS forest dynamics plots will provide the foundation for rapid advancement of our understanding of tropical forest dynamics. I look forward to the publication of further results from the plots.

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