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BEHAVIORAL ECOLOGY AS AN APPLIED SCIENCE?

Caro, Tim M., editor. 1998. **Behavioral ecology and conservation biology.** Oxford University Press, New York. xv + 582 p. $90.00 (cloth), ISBN: 0-19-510489-7; $55.00 (paper), ISBN: 0-19-510490-0.

Conservation biology is a multidisciplinary science that utilizes principles and methods from a number of sciences such as ecology, population biology and genetics, systematics, and behavior. However, there are relatively few books or papers that explore the discipline and then demonstrate those concepts and methodologies that apply to conservation biology. This volume attempts to do that in the area of behavioral ecology.

Utilizing a group of international scientists, the editor has identified six areas where behavioral ecology can be used more effectively by conservation biologists; these include: baseline behavioral ecological data and conservation problems; baseline behavioral ecological data and conservation intervention; mating systems and conservation problems; mating systems and conservation intervention; dispersal and inbreeding avoidance; and human behavioral ecology. Each of the six parts includes a forward by the editor and three papers written by other scientists (one part has two papers). The editor wrote the first chapter and epilogue. The first chapter covers broad principles of conservation biology and behavioral ecology and suggests ways in which the latter can be utilized by the former. In the epilogue the editor suggests how behavioral ecology could be refocused to address conservation issues. In an Afterword chapter, Daniel Rubenstein discusses the practical aspects of integrating behavioral ecology into such things as helping to form conservation policy, avoiding pitfalls of changing from "conservation biologists" to "biological conservationists," and discussing how behavioral ecologists fit into the area of applied biology. This chapter, as well as the introduction (Chapter 1), should be required reading for all students and professionals. There are both taxonomic and subject indices. These indices appear to be comprehensive in their coverage.

Each of the 18 chapters (excluding the two chapters written by the editor) provide overviews of some aspect of behavioral ecology and then provides the strengths and weaknesses of that behavior for use in conservation biology, recommendations for the future, and a summary of the chapter. At the end of each chapter there is an extensive reference section which is both comprehensive and current. The individual chapters range from being limited to a relatively small group of organisms (e.g., Chapter. 4, "Future prey: some consequences of the loss and restoration of large carnivores") or, as with most chapters, to providing a broader overview (e.g., Chapter. 6, "Contributions of behavioral studies to captive management and breeding of rare and endangered mammals").

Although covering a broad range of concepts, the chapters are heavily weighted toward mammals (seven chapters plus three on human behavioral ecology). There are also three chapters that deal with general concepts and utilize a variety of examples, two chapters dealing primarily with birds, one chapter using fish, and one on the decline of amphibians. This text would have been more comprehensive and perhaps appeal to a wider audience if more diverse groups of organisms had been represented.

In spite of the heavy leaning toward mammals, I believe that this volume does point out the important role that behavioral ecology plays in conservation biology. It also could provide a model for other volumes dealing with other disciplines (including psychology and sociology) that provide important data to conservation biology. I believe this book should be on the bookshelves on any person involved with behavior, ecology, and conservation. Although, it probably could not be used as a stand-alone text, many of the presented concepts can be utilized for courses in the above areas, including applied courses in such areas as wildlife management.

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PUTTING FOOD WEBS INTO CONTEXT

Dettner, Konrad, Gerhard Bauer, and Wolfgang Völkl, editors. 1997. **Vertical food web interactions: evolutionary patterns and driving forces.** Ecological Studies. Volume 130. Springer-Verlag, New York. xxi + 390 p. $129.00, ISBN: 3-540-62561-5 (acid-free paper).

An abiding issue in community ecology is the predictability (or lack thereof) of community structure. The recently retired German ecologist Helmut Zwölfer during his career focused on this issue, using as a model system those insect food webs based on thistles. His overall conclusion was that these microcommunities often seem to have predictable patterns of organization, and that understanding these patterns requires close analysis of evolutionary processes and constraints, including life history evolution and the evolution of specialization. This edited volume is warmly dedicated to Professor Zwölfer on the occasion of his retirement. Its pages are filled with the work of those he influenced, including students, colleagues, and friends. As in many edited volumes, the papers vary widely in scope and sophistication. Some of the contributions are narrowly descriptive or do not reach strong conclusions, and to my taste might better have been put in specialist journals, but many contain interesting results broadly pertinent to the interplay of evolutionary processes and ecological patterns. The volume belongs on library shelves, but its price will likely preclude purchase by most individuals. Space precludes commenting on each chapter, so here I sketch highlights and broad themes.

The opening set of papers focuses on tephritid flies. Bush and Smith review the debate regarding allopatric vs. sympatric speciation, a debate greatly stimulated by Bush's own studies of speciation in the tephritid *Rhagoletis*. This debate about speciation has significant implications for community ecology. Because mechanisms of sympatric speciation typically require resource or habitat specialization at species formation, sympatric speciation tied to such specialization in theory provides an automatic mechanism of coexistence. Many tephritids, however, are not specialists. For instance, Romstöck-Völkl documents variability in host plant use among syntopic plant species and across the range of a single tephritid species, involving the interplay of host quality differences, natural enemies, and plant phenology, and Goeden reviews co-occurrences of tephritids in southern California, concluding that overlapping host use by generalists is the typical pattern. Any evolutionary accounting of community organization must deal with the evolution of generalization as well as specialization.

The volume then moves to a diverse array of host-parasite interactions. Bauer provides an overview of the interaction of freshwater pearl mussels (*Margaritifera*) and the salmonid hosts for its parasitic larvae. This is an unusual parasitic system, for the parasite has a much longer life cycle than its host. The interaction is asymmetric; the parasite completely depends upon its hosts, but has no noticeable reciprocal impact upon host abundance. Within a biogeographical realm, parasite species are generalists within the salmonid guild (possibly because of their passive mode of host infection), but parasites are not cross-infective across biogeograpic realms. Bauer suggests that these features may reflect asymmetries in evolutionary rates arising from very long parasite generations. Contrasting patterns are revealed by the impact of parasites on *Daphnia* are the focus of an interesting, wide-ranging review by Ebert et al. These authors convincingly argue that parasites often have a substantial impact on zooplankton population dynamics. They present a mathematical model of the epidemiology of these systems, incorporating both classical, density-dependent transmission, and density-independent spore uptake from the sediment. The latter route of transmission can dramatically alter the expected population dynamics of *Daphnia*-parasite interactions. The paper provides an excellent example of the utility of mathematical models of host-parasite dynamics, based on a firm understanding of life history patterns and mechanisms of interactions.

One large area of ecology which has remained largely immune to the charms of mathematical theory is chemical ecology. The next set of chapters present case studies which highlight the idiosyncratic impacts defensive chemicals have in food chains. Dettner discusses the trophic transfer of cantharidin, a monoterpene highly toxic to mammals and many arthropods. This compound, produced only by blister and oedemerid beetles, is an effective chemical defense. Yet insect taxa with a widely scattered phylogenetic distribution often actively seek out cantharidin (often by scavenging). The evolution of an ability to detoxify particular compounds, and then to use them in defenses, clearly can mold the evolution of arthropod food webs. Thematically similar phenomena are described by Topp (for an oligophagous chrysomelid, which uses the phenolglycoside defensive compounds of its host, willows, to repel insectivorous birds) and Tomaschko (pycnogonids, a phylogenetically ancient lineage of marine arthropods, use ecdysteroids partially gathered from food for defense against predator crustaceans). Traditional analyses of food webs emphasize trophic transfers of energy or nutrients such as nitrogen. These chapters to me highlight the rich range of resources—vitamins, defensive compounds, and so on—which often may govern the evolution of trophic interactions, and which are largely neglected in the food web literature.

The next cluster of chapters describes interactions between aphids and their natural enemies. Dixon intriguingly contrasts the effectiveness of predatory ladybirds on coccid scale pests, and their ineffectiveness on aphids. Based upon detailed studies of life histories, patch use, and the potential for cannibalism, he convincingly argues that this difference in biological control arises from the consequences of differences in relative developmental times and mobility for predators and prey in these systems. Völkl describes a fascinating pattern of interactions among aphids, aphid-attending ants, and parasitoids. Although ants protect aphids against some parasitoids, other parasitoids have evolved mechanisms to circumvent this protection. Some of these aphid specialists are now indeed dependent upon ant-attended resources! Given that a parasitoid can avoid ant predation, it can enjoy its own enemy-free space, with lower hyperparasitism rates, and a more predictable resource base. Stadler argues that, overall, host plant characteristics dominate the evolution of life history traits in aphids, but with significant modifications due to natural enemy impacts and ant attendance.

The final section of the book includes several descriptive studies of multitrophic communites with a wider taxonomic scope. Stechmann describes patterns in the diversity of natural enemies specializing on aphids in a German agricultural landscape. He concludes that species composition of these assemblages in cereal croplands largely depends on processes over larger spatial units. Achtziger contrasts hemipteran communities in hedges and forest margins. Hedges are an anthropogenic habitat whose communities are assembled by colonization from a preexisting pool. Achtziger argues that the structure of these assemblages nonetheless has considerable predictability. Boller et al. describe biodiversity in vineyards in Switzerland; they suggest that increasing perennial forb diversity can enhance biological control of vine pests, by sustaining a diverse array of alternative prey, which in turn support generalist predators. Price et al. use the interaction between sawflies and willows and populars as a model system, to gracefully portray how plant-insect interactions can be governed by plant modular demography over short time-scales, and landscape dynamics over longer time-scales.

The editors conclude by extending themes raised elsewhere in the volume, such as life history influences on trophic interactions. They provide a particularly useful overview of chemical aspects of trophic interactions. These include the production of volatiles at one trophic level which directly influence the behavior of higher trophic levels, and potential flows through food webs of toxicants used as defensive strategies (often against generalist predators). The papers in this volume collectively emphasize factors often ignored in standard empirical food web studies—such as landscape processes and spatial flows, life history variation (e.g., relative generation lengths of consumers and resources), chemical ecology, and the physical refuges provided by plant architecture—and not as yet systematically incorporated into general food web theory. The broadening of perspectives on food webs hinted at by the papers in this volume will doubtless provide fruitful directions for food web researchers for many years to come.

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BLURRING THE BOUNDARIES OF CO_2 RESEARCH

Luo, Yiqi, and Harold A. Mooney, editors. 1999. **Carbon dioxide and environmental stress.** Physiological Ecology Series. Academic Press, San Diego, California. xiv + 418 p. $69.95, ISBN: 0-12-460370-X (alk. paper).

As Luo and Mooney point out in the preface of this book, we cannot become complacent about our ability to predict future plant and ecosystem responses to global change. That is, in spite of the large body of research conducted to date on direct effects of CO_2, we are really just beginning to intensively study the interactions among atmospheric CO_2 concentrations and environmental stress. This is important because these stresses, including drought, temperature, salinity, nutrients, UV-B, and atmospheric pollutants, will moderate plant and ecosystem responses to CO_2. By the same token, elevated CO_2 may itself have a moderating influence on these or other environmental factors.

This volume, in the Academic Press Physiological Ecology series, presents what Luo and Mooney term an initial discussion of important interactions of environmental stress and atmospheric CO_2. The book's objectives are to summarize our current understanding of how CO_2 interacts with the individual environmental stressors listed above, and to stimulate future research, particularly at the ecosystem level. Sixteen chapters, written by a strong collection of 33 authors, cover three general sections, including (a) CO_2 and stress interactions, (b) evolutionary, scaling, and modeling studies, and (c) summary and synthesis. As with other books in the series, this volume will be a important primer and point of departure for many investigators, particularly students and those relatively new to global change biology. Those more familiar with the primary literature will still find this collection of papers useful, not only for review and reference but also, I expect, for teaching purposes. Most chapters in the book are well organized and well written, and a few chapters are written with a refreshing clarity and directness of purpose.

The first two chapters of the large section on interactions cover effects of water on photosynthesis from the plant up to ecosystem level, followed by two analogous chapters covering temperature effects. Subsequent chapters deal with salinity, UV-B, and ozone effects. The final three chapters in the first section deal with nutrient, rhizosphere, and nitrogen cycling interactions. For my own purposes, the chapters by Hsiao and Jackson (on water stress) and Hungate (on feedbacks through the nitrogen cycle) are particularly good resources. None of the chapters dealing with interactions can cover more than, essentially, two factors, i.e., CO_2 and a single stressor or process. This may be a necessary constraint for a book of this nature: because CO_2 interactions are complex, it would be difficult to make any one chapter as comprehensive as a reader might like. For example, the first of two chapters on plant, population, and ecosystem responses to temperature and CO_2, while otherwise very useful, missed some potential because of its limited treatment of the large amount of primary literature in which temperature $\times$ CO_2 interactions are explicitly addressed.

In the second section, an interesting chapter by Sage and Cowling raises the question of how well adapted plants might be to current and future high CO_2 environments. They suggest that CO_2 is not a lethal selection agent, nor results in strong directional selection. After discussing evidence regarding the longevity of many species (e.g., *Populus tremuloides* clones that may be as much as one million years old), and the rapidity with which atmospheric CO_2 has risen, Sage and Cowing present experimental evidence demonstrating that environmental stressors may have a greater impact on plants under low CO_2 environments than under current or predicted CO_2 levels. They suggest that if plants are, in fact, adapted to low CO_2 environments, these adaptations may be limiting responses observed under current and future climates. This begs the question of the role of phylogeny in shaping future ecosystems.

Another point of interest emphasized by Ågren, Shaver, and Rastetter, in their chapter on nutrient dynamics and limitations, is that ecologists and physiologists alike "in general do not seem to appreciate the importance of the interactions between carbon dioxide and nutrients." This sentiment might also be applied to the other environmental stressors discussed in this book. However, Field, in the first of two synthesis