learning R, and Roughgarden's book (Roughgarden, Jonathan. 1998. Primer of ecological theory. Prentice Hall, Upper Saddle River, New Jersey), which is a more rigorous introduction to theoretical ecology using MATLAB.

In summary, I praise the combination of book plus freely available code, and I think that freely available figures, data, and examples should be standard for all textbooks (the ideal being to have books freely available for individual users). The book does not cover all of ecological modelling (an impossible task), and is targeted at the application of simple models for aquatic systems. I would recommend the use of the book especially for an introductory modeling class for early graduate students in ecology and other disciplines (chemistry, physics, etc.) that share a common boundary with ecology.

Stefano Allesina

National Center for Ecological Analysis and Synthesis (NCEAS)
735 State St., Suite 300
Santa Barbara, California 93101
E-mail: allesina@nceas.ucsb.edu

Ecology, 90(8), 2009, pp. 2336–2337

Ecological models of mutualism, exemplified by interactions between ants and myrmecophiles

Stadler, Bernhard, and Anthony F. G. Dixon. 2008. **Mutualism: ants and their insect partners.** Cambridge University Press, New York. viii + 219 p. $110.00, ISBN: 978-0-521-86035-2.

Key words: ants; aphids; mutualism; myrmecophiles; species interactions.

Don't let the book's title fool you: this book is much more about mutualism theory than it is about interactions between ants and myrmecophilous (i.e., "ant-loving") insects. The goal of *Mutualism: ants and their insect partners* is not really to review the natural history of ant-myrmecophile associations, but instead to explore current ideas about the ecology of mutualism and to illustrate these ideas with examples drawn from the literature on ants and myrmecophilous insects (i.e., aphids, treehoppers, scale insects, and lycaenid butterflies).

The book begins by discussing some of the major conceptual issues associated with mutualistic interactions among species (in Chapters 1 to 3). Like others before them, the authors argue that in comparison to competitive and trophic interactions, the study of mutualism has been neglected by ecologists. However, they also recognize that many important advances have been made in this area in the last few decades. In particular, it has become increasingly evident that mutualisms are common and integral parts of all natural communities and, as such, that we stand to gain considerable insight from ecological models that incorporate mutualisms. Stadler and Dixon take the view that all interactions among species fall somewhere along a continuum between mutualism and antagonism, and that this outcome varies in space and time and depends on the community in which the interactions are embedded. Many of the core arguments of this book are presented in Chapter 3, in which the authors first review the main theories relating to the evolution of mutualism and then discuss life history, population dynamic, and metapopulation models that deal with mutualisms. In this chapter, Stadler and Dixon emphasize density-dependent processes at work in mutualistic interactions; I share their view that more research is needed to understand how population density affects the costs and benefits of mutualism and consequently the population dynamics of mutualistic species.

In Chapters 4 and 5, which represent the middle section of the book, the authors draw on empirical studies of mutualisms between ants and myrmecophilous insects to exemplify the general arguments put forward in the previous conceptual chapters. Ants form mutualistic associations with the larval and/or adult stages of many Hemiptera and Lepidoptera, including species of aphids, membracids, coccids, and lycaenids. These are "food-for-protection" mutualisms, in which the hemipterans or lepidopterans provide the ants with nutritious rewards (i.e., honeydew) and, in return, the ants protect them against their natural enemies. The second author of this volume, Tony Dixon, has spent a career studying the biology of aphids, and brings to this review a mature and exhaustively thorough perspective on associations between aphids and ants. Generally speaking, relationships between ants and myrmecophilous insects have been well studied since they are typically systems that can be easily manipulated in experiments that tease apart costs and benefits. Moreover, many features of ant-myrmecophile mutualisms are common to most mutualisms; for example, they vary from facultative to obligate, they may be generalized or highly species-specific, and they are affected by local abiotic and biotic conditions. The authors' goal in describing in detail empirical studies of the costs and benefits, population dynamics, and conditionality of ant-myrmecophile mutualisms is to extrapolate from these systems to mutualisms in general.

One of this book's strengths is that Stadler and Dixon discuss not only the life history and population-level consequences of mutualism, but also the effects of mutualism at metapopulation, community, and metacommunity scales. They begin Chapter 6 by asking the question: how are ant-myrmecophile mutualisms influenced by top-down and bottom-up forces in the local community? Clearly, predation pressure and other top-down effects have an impact on ant-myrmecophile interactions, because when predators and other enemies of hemipterans and lepidopterans are scarce, these insects have little need for ants. Similarly, ant-myrmecophile mutualisms can be influenced by many bottom-up forces, including the nutritional quality, spatial distribution, and defenses of plants fed on by myrmecophilous insects. Stadler and Dixon also introduce the concept of "metamutualism" in this chapter, and although, oddly, they never define the term explicitly, I took it to mean a set of populations interacting as mutualists at the local scale and linked via dispersal at the regional scale. As the authors

themselves point out, their metamutualism concept has much in common with Thompson's idea of a "geographic mosaic" (Thompson, John N. 2005. *The geographic mosaic of coevolution*. The University of Chicago Press, Chicago, Illinois), except that the latter also applies to antagonistic interactions. While the idea may not be entirely new, the authors have captured the emphasis and direction of current research into mutualism, as ecologists work to remedy the "clear shortage of studies that address the community- [and higher] level effects of mutualistic associations."

The scope of this book is extremely broad, but the book itself is only a slim 183 pages of text. For a review of its size, it is packed with information, including scores of bibliographic citations and numerous figures reproduced from the primary literature. Inevitably, however, the authors sacrifice depth for breadth, and thus some topics, like the connection between metamutualism and geographic mosaic theory, are discussed only cursorily. Perhaps as a means of being more efficient, the authors rely quite heavily on ecological jargon and write in a condensed and occasionally convoluted manner. (Take for example the following sentence: "Now, considering the ant-plant defence system via EFNs and the ant-homopteran-lycaenid/nectar production system gives an interesting meta-mutualism configuration in which two separate mutualistic interactions meet and might change the strategies and affect the evolution of the partners of ants.") Given the book's astonishingly high price ($110 and not a single color photo or figure), students are unlikely to be able to afford to purchase this book. But for researchers who are active in this area, a new book on the ecology of mutualism has been long overdue. The last comprehensive treatment of the subject was published over twenty years ago in an edited volume (Boucher, Douglas H., editor. 1985. *The biology of mutualism: ecology and evolution*. Oxford University Press, New York). So even though *Mutualism: ants and their insect partners* is more of a sketch than a masterpiece, it is nonetheless a timely and relevant contribution to the field.

Megan E. Frederickson

Harvard University
Society of Fellows and Museum of Comparative Zoology
Cambridge, Massachusetts 02138
E-mail: megan@post.harvard.edu

Submit books and monographs for review to the Book Review Editor, Janet Lanza, Biology Department, University of Arkansas at Little Rock, Little Rock, Arkansas 72204 USA (telephone (501) 569-3500).

We welcome offers to review books for *Ecology*, but we cannot accept an offer to review a *specific* book. Anyone who wishes to review books for *Ecology* should send a current *curriculum vitae*, a description of competencies, and a statement of reviewing interests to the Book Review Editor. Authors of reviews must verify they they have no confilict of interest that might interfere with their objectivity, and that they have not offered (and will not offer) a review of the same book to another journal.

Spotlight

Recent Publications of Particular Interest

Brodowsky, Pamela K. 2009. **Destination wildlife: an international site-by-site guide to the best places to experience endangered, rare, and fascinating animals and their habitats.** Penguin Group, New York. xiv + 384 p. $20.00, ISBN: 978-0-399-53486-7. All readers of *Ecology* are likely to love seeing rarely encountered wildlife. This book describes more than 200 sites with interesting wildlife from North and South America, Africa, Europe, Asia, and Australia. Each site description is about two pages long and contains details such as hours of operation, contact information, best times to visit, and tips to make your visit comfortable.

Heinrich, Bernd. 2009. **Summer world: a season of bounty.** HarperCollins, New York. 253 p. $26.99, ISBN: 978-0-06-074217-1. Another Heinrich book is always worth investigating. This one provides tales of adaptations of animals to surviving and reproducing in spring and summer, including wood frogs, bald-faced hornets, hummingbirds, and mosses and lichens.

The mutualism between ants and trophobiont insects is widely known as an interaction where the trophobionts are usually defended from their natural enemies by the ants. Ants can also remove...Â However, few studies have been conducted in field conditions to test the effects of mutualism on the associated arthropod community. In this study, we tested the hypothesis that the mutualism between trophobiont insects and ants decreases the abundance and species richness of the associated arthropod community, supporting a more stable community. Ant-plant interactions are geographically widespread,[13] with hundreds of species of myrmecophytic plants in several families including the Leguminosae, Euphorbiaceae, and Orchidaceae.[3] In general, myrmecophytes (or ant plants) usually provide some form of shelter and food in exchange for ant "tending," which may include protection, seed dispersal (see myrmecochory), reduced competition from other plants, hygienic services, and/or nutrient.Â homopteran myrmecophiles, ants protect Lycaenid larvae from predatory insects (including other ants) and parasitoid wasps, which lay their eggs in the bodies of many species of Lepidoptera larvae.Â ^ D. Janzen, "Coevolution of mutualism between ants and acacias in Central America," Evolution, vol. 20, 1966, pp. 249-275. Mutualism is an interaction between diï¬€erent species in which they beneï¬t each others. existence. 1.2 Why are we studying mutualism? It is said by Boucher that Elementary ecology literature tells us that organisms interact in. three fundamental ways; competition, predation and mutualism [3]. There has been plenty. of credible work done in the areas of predator-prey and competition models, however we. ï¬nd that when researching our chosen area, it has been largely neglected in ecological. literature until very recently. It is hard not to agree with Bascompte and Jordanoâ€™s viewÂ This is the most common type of mutualism and is exempliï¬ed by plants. producing fruit that is eaten by birds and the birds helping to dispose the seeds through. excretion [2].