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A Nontechnical Introduction to "Biocontrol as Usual": Review of Ann Hajek, *Natural Enemies*

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Book Reviews

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A NONTECHNICAL INTRODUCTION TO “BIOCONTROL AS USUAL”

Hajek, Ann. 2004. **Natural enemies: an introduction to biological control**. Cambridge University Press, New York. xv + 378 p. \$110.00 (cloth), ISBN: 0-521-65295-2 \$50.00 (paper), ISBN: 0-521-65385-1.

Key words: biocontrol; non-target effects; ecological risk; invasive species; natural resource policy.

Increasing recognition of the problems posed by invasive, exotic species has led to a recent upsurge of interest in the potential of biological control as a sustainable management strategy. The idea that “natural control” could be re-established on a species in its new environment is a seductive one, nurtured by a small set of impressive success stories and the belief in a simple solution (“silver bullet”). Yet, recent serendipitous discoveries also make it clear that attempts to engineer the outcome of species interactions in new systems can lead to undesired direct and indirect effects of unanticipated magnitude on non-targeted native species and recipient communities.

Thus, the magnitude of the invasives problem, along with the emerging evidence of ecological risks associated with introducing exotic natural enemies, suggest that there is a need for a rigorous, conceptually based, introductory biological control text. Ideally, such a text would compile and illuminate the relevant intellectual concepts, and then present well-quantified examples of the application of such knowledge in the limitation of invasive species populations and their community impacts. It would address the evidence required to resolve the important questions emerging from the contemporary debate over the efficacy and safety of deliberate species introductions.

This text instead introduces the student to the diverse groups of natural enemies that have been used or considered for biological pest management and to the lore of the field. The level seems appropriate for undergraduate non-science majors. The book begins with an advocate’s perspective on the necessity of biological control (BC), based primarily on the traditional (and, I think, now false) dichotomy of “natural balance” vs. broad-spectrum chemicals (e.g., DDT). Then, after a brief introduction to biological control, the rest of the book is divided into five parts: I, strategies of BC; II, BC of invertebrate and vertebrate (animal) pests; III, BC of weeds; IV, BC of plant pathogens and plant parasitic nematodes; and V, BC—Concerns, changes and challenges.

Part I (Chapters 3–5) describes: (1) classical, (2) augmentative (inundative, inoculative), and (3) conservation/enhancement strategies of BC. The approach is descriptive, and no theory is presented as a foundation. While both augmentative and conservation biocontrol are presented and intermittently mentioned subsequently, the main focus of the book is on classical biological control, the release of exotic (or

modified) organisms as potential control agents of undesired species.

Part II is divided into seven chapters (6–12). The first chapter, titled “Ecological basis for use of predators, parasitoids, and pathogens,” is the only one in which the theory of interactions and their outcomes is presented systematically. Although ecological principles form the crucial conceptual foundation of BC, the theory included is elementary, qualitative, and unanalytical in its presentation. These principles also were presented without any analysis of the underlying assumptions, the conditions affecting the prediction of outcome, or the effects of indirect and higher order interactions. Each of the succeeding six chapters first provides a brief, non-technical description of a major group of natural enemies used against animal pests: predators, insect parasitoids, parasitic nematodes, bacterial pathogen, viral pathogens, as well as fungi and microsporidia. Each chapter then provides an unanalytical summary of several anecdotal case histories involving “successful” control of a targeted pest species by members of the group.

Part III (Chapters 13–15) starts with an overview of phytophagous organisms and a very traditional synopsis of plant population ecology. This introduction is followed by chapters on phytophagous invertebrates, phytophagous vertebrates, and plant pathogens as biocontrols. These chapters summarize several well-known case histories, as did the chapters on natural enemies of animal pests. Little relevant theory and no analyses are presented, for example of factors that varied between the more successful and less successful cases of attempted control of invasive plants.

Part IV has two chapters. Chapter 16 describes the biology and ecology of antagonists in simple terms, and then Chapter 17 discusses microbial antagonists of plant pathogens and plant parasitic nematodes. These chapters follow the style of previous sections, with a non-technical introduction to the organisms, followed by anecdotes describing their past uses.

Part V (Chapters 18–19), finally, presents a biocontrol practitioner’s perspective on some of the safety and conservation issues raised by recent evidence of non-target effects of BC (Chapter 18), and on other issues involving the application of BC (Chapter 19). The other issues include the use of natural enemies in integrated pest management (IPM) programs, integration with other types of pest management, and “adding an ecological emphasis to pest management.” The latter is, of course, something most ecologists would have emphasized throughout rather than just at the end of the book. In fact, many opportunities were missed to present in context both the need for more ecological input and the value of increased analysis of potential ecological interactions associated with deliberate introductions of exotic species. The argument that since few non-target effects have been quantified to date, few must have occurred still is not persuasive to me. Little effort has been expended to quantify the efficacy in limiting targeted

species, much less the subtle, but potentially significant, impacts on nontargeted species and the community.

Finally, important environmental issues were not addressed. First, I did not find a discussion of potential widespread indirect effects of adding exotic species into new communities. Yet, for example, we now know that augmentation of the over-wintering food supply for mice, as a result of population growth by an ineffective biocontrol insect, can indirectly alter native plant densities. Second, host range is represented here, as it has been for 50 years, as indicative of the ecological risk. Host range and host specificity are quantified as the relative acceptability and the relative performance of individual insects (or pathogens) across a set of potential hosts. Few dispute that host range measures an important component of ecological risk. However, from this text you would not know that the adequacy of the information and how it is used continues to be debated. For example, is evidence that a native species is acceptable as a host sufficient to stop an introduction of the exotic organism? Not necessarily. Additionally, does host specificity provide enough information to predict population growth and host use in a new environment? Not usually. For example, lower preference and slower development rate on a native host become irrelevant when a BC agent disperses into a habitat without the preferred (targeted) host, as happened when the weevil *Rhinocyllus conicus* dispersed into central sand prairies. Also, can eventual population levels of a consumer be predicted by relative rates of individual acceptance and development on hosts? No, except possibly for strongly competing species. Furthermore, relative rates of individual acceptance and development under test conditions provide no information about how the physical and biological environment will affect both individual behavior and population numbers in new assemblages of species in the new recipient communities. Thus, estimates of individual performance fall short of predicting agent population

growth, population dispersion, and amount of use of secondarily accepted native species (other dimensions of ecological risk) and, so, community interaction outcomes. Each of these issues has emerged recently as an unanticipated effect of an exotic species introduction against an unwanted species in a biological control project. Yet, the student reading this book will not be prepared to think about and address any of these issues.

In sum, the book presents a non-technical summary of the groups of organisms that feed on others for their livelihood and an advocacy for their use in invasive species management. It is a nicely produced text, with few typos and good illustrations. The strength of the text, in my opinion, lies in the enthusiasm for the organisms, especially the entomophilous fungi with which Hajek is so familiar. However, biological control is more than the re-establishment of natural control; it is a form of environmental engineering under new conditions; as such, it merits application of the same scientific rigor developed for other forms of engineering. Such rigor involves both good natural history, which is clearly represented in this text, combined with comprehensive, theory-based criteria for both success and safety, which is not well represented. I doubt that entomology, ecology, and microbiology students would find the text sufficiently challenging or particularly useful. Thus, I think that the book could be suitable for undergraduates who are not science majors, especially if instructors take it upon themselves to balance to the advocacy embedded throughout the text.

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CONSERVATION

Hamblen, Clive. 2004. **Conservation**. Studies in Biology. Cambridge University Press, New York. x + 368 p. \$75.00 (cloth). ISBN: 0-521-80190-7; \$30.00 (paper), ISBN: 0-521-00038-6.

Key words: conservation planning; biodiversity; protected areas; monitoring.

The latest book in the popular Studies in Biology series by Cambridge includes a small and handy volume simply titled *Conservation*. I was a bit intrigued by the aim of this book, since the broad and interdisciplinary field of conservation is a difficult topic to cover by any one person, or in a small book. Clive Hamblen appears to be well qualified to take on

this large task since he works with an interdisciplinary group at Oxford, and has had a broad range of experience in assessing conservation projects in human-dominated and natural systems both in temperate and tropical biomes. His work with terrestrial insects as biodiversity indicators gives him a particularly interesting perspective to address the complex issue of human interactions with ecosystems.

Just reading the introduction, the reader gets the clear impression that while short, and wide ranging in coverage, the author is taking a particularly thoughtful and broad take on this topic. It is quite readable and consistent in style, perhaps a benefit of a single-author book. It was refreshing to see it established at the outset how conservation, as it is viewed here, is anything but a recent endeavor. Hamblen shows that the desire for and practice of conservation has been going on for several millennia, and that even for such "recent" areas