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Ecologically Sound Biological Control for Invasive Species?: Review of Pedro Barbosa, ed., *Conservation Biological Control*

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Book Reviews

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Ecologically Sound Biological Control for Invasive Species?

Barbosa, Pedro, editor. 1998. **Conservation biological control.** Academic Press, San Diego, California. xxii + 396 p. $69.95, ISBN: 0-12-078147-6 (alk. paper).

The timeliness of *Conservation biological control*, edited by Pedro Barbosa, is striking. Invasive exotic species often represent an economic cost for agriculture and sometimes an environmental threat to the integrity of native vegetation in national forests, parks, and reserves. Problems caused by the most obvious noxious species are bringing more public awareness of invasives. As a consequence, on 3 February 1999, President Clinton issued an executive order to coordinate and stimulate research and management of invasive exotic species.

One technique for managing invasive species that is now being advocated as environmentally friendly is classical biological control. The USDA has accelerated agency efforts to provide biological control solutions to the management of a wide range of noxious and potentially noxious species. The main focus of this effort is on the discovery, evaluation, and release of exotic species from the area of origin of the invasive species to limit its population size in its new environment. Additional work within the USDA is focused on finding exotic agents to control ''native pests'' and to develop genetically modified organisms as biocontrol agents.

Classical biological control has an appeal for environmentalists, since it is based on the idea of re-establishing coevolved, potentially limiting interactions. However, it is now clear that this approach can have side effects. Classical biological control ignores the fact that organisms adapt to new environments, and it assumes that the new ecosystem is structurally and dynamically similar to the original ecosystem, making direct and indirect ecological effects predictable. Yet, some ecologists have argued that the deliberate release of exotic species poses ecological risks that are either difficult or impossible to quantify. Our recently published evidence (Louda, S. M., D. Kendall, J. Connor, and D. Simberloff. 1997. Ecological effects of an insect introduced for the biological control of weeds. *Science* 277:1088–1090) suggests that such risks have been seriously underestimated in previous releases. These findings have stimulated a renewed controversy over the magnitude of the ecological risks associated with the deliberate release of exotic and engineered species into new environments.

In this book, Barbosa and colleagues focus on another, potentially less hazardous strategy for biological control.''Conservation biological control'' involves the preservation, facilitation, and augmentation of native natural enemies to increase their quantitative, limiting effects on populations of invasive species, both native and exotic. One primary tool to do so is habitat management to enhance natural enemy survival, performance, and effectiveness. The approach recognizes both the importance of native generalized predators and the influence of adapted predator complexes to ecosystem resistance to invasion. Since the risks associated with manipulating coexisting species in situ are clearly lower than those with releasing additional exotic species, conservation biocontrol merits serious consideration as an alternative strategy.

So, what do we know about the preservation, facilitation, augmentation, and effectiveness of native natural enemies in the limitation of actually or potentially invasive species? Do we know what limits the effectiveness of native predators and parasitoids, and can these factors be manipulated to improve the limitation exerted? After reading this book, my conclusion is that we know both more than I thought and less than we need to know.

The basic ideas, theory, and present practices in conservation biocontrol rely on a long history of ecological research on natural enemy interactions in natural systems and its application in managed ecosystems. The chapters of this book, written by a number of eminent scientists: 1) document some of this history (Ehler), 2) argue for the potential of the approach, even in annually cropped agroecosystems (Barbosa), 3) suggest applicable concepts from ecological theory, and 4) review natural enemy facilitation against an array of pests by a wide range of natural enemy types.

I learned some interesting things from the chapters on specific systems and interactions. These are the contexts in which we actually know the most about the control natural enemies exert in economically important contexts. For example, some chapters review the use of: weed strips in row crops (Nentwig, Frank, and Lethmayer), pesticide interactions with natural enemy preservation (Ruberson, Nemoto, and Hirose), engineered crop influence on natural enemies (Hoy et al.), and the use of microbial organisms (Fuxa). Other chapters review the manipulation of specific systems or interactions, such as applying entomopathogenic nematodes against turf pests (Lewis, Campbell, and Gaugler), enhancing predaceous ant protection for tree crops (Perfecto and Castiñeiras), facilitating natural enemy impact on aphids in pecans (Dutcher), augmenting natural control of spider mites in perennial crops (Nyrop, English-Loeb, and Roda), encouraging antagonists of epiphytic microorganisms on fruits and vegetables (Wilson), exploiting fluorescent pseudomonads against soilborne pathogens (Lucas and Sarniguet), and increasing herbivory by native insects on weedy plants (Newman, Thompson, and Richman). In sum, manipulation of habitat to encourage natural enemies, especially in perennial crops and orchards, has a strong, positive track record, encouraging further consideration and development of conservation biological control.

I was most intrigued, however, by the chapters that attempt to apply basic ecological concepts to the management of invasive or outbreak species populations. Early in the book, Letourneau takes a creative approach. She argues that key concepts from conservation biology, such as fragmentation, metapopulation dynamics, and restoration dynamics, can be

transferred to foster new concepts in the conservation of natural enemies in agroecosystems. While I was impressed, I was not quite convinced. This is clearly a direction for future research. Barbosa and Benrey review the influences of plants on parasitoids, and Barbosa and Wratten examine the influence of plants on invertebrate predators. These chapters argue that we should be selecting traits in crop plants that directly improve parasitoid or predator success. Again, while the idea is interesting, I wanted to see more data that supported its effectiveness to be convinced.

Several chapters meld ecological theory directly to agroecosystem dynamics. For example, Landis and Menalled propose that agroecosystems fit the disturbance model for communities. And, they ask: how can we use what we know about patterns and processes in disturbed, degraded systems to augment natural enemy control of problematic, invasive species in croplands? They make a good conceptual case for habitat management to conserve natural enemies in the agricultural landscape mosaics, a spatial contruct further explored by Ferro and McNeil, reinforcing a major theme also developed by Gurr, van Emden, and Wratten. Yet, I could not help thinking that these arguments will need to be developed further to convince my farmer friends to sacrifice crop area and clean crops and field borders in order to maintain habitat for parasitoids and predaceous beetles. Perhaps this is where the case histories and current successful practices can be used to support the concept of habitat management and the effectiveness of natural enemy conservation for the control of invasive species.

Finally, Newman, Thompson and Richman, wrote the only article focused on invasive weeds, the cause of more than half of our pesticide expenditures annually. They review the factors that limit the success of exotic biological control agents, and they argue that the data are now sufficient to suggest that conservation and augmentation of native insect herbivores can be a viable strategy, contrary to the common paradigm of only 10–15 years ago. I think they make a good case. However, since they use my research to help make their case, how could I disagree? Perhaps even more important, this is also the only chapter that moves explicitly beyond the row crop definition of managed ecosystems to consider invasive species in native communities, such as rangelands and aquatic systems. Perhaps weeds are the only invasive species of significance in native communities, though I doubt this. Or, perhaps, conservation of natural enemies in native communities is less likely to be effective, though I also doubt this. More likely, invasive plants are obvious and perceived as a threat to the economic use of native rangelands. Since chemical controls in rangeland are usually not cost-effective, classical biological control has been advocated and actively pursued. Yet, documentation of the actual environmental problem posed by specific targeted species is usually inadequate, and the potential ecological costs are not well known. Thus, I would like to see more consideration of the costs, as well as benefits of control, associated with invasive species in native communities. Perhaps conservation biological control will be the best solution in rangelands as well.

In conclusion, the book is timely. The suggested alternative approach to biological-based management of invasive species is exciting in its ecological justification and its sustainability. Environmental risks associated with pest management in production agriculture and management of invasive species in open lands can be reduced by application of what we know. Enough is presently known to advocate increased use of natural enemy conservation methods in long-lived, perennial crops, for example. Yet, this is a nascent field, and there is clearly much to be learned. More research is warranted on this exciting, important interface between theory and its application for the management of invasive species. This book is an excellent introduction to the current state-of-the-art in the preservation, facilitation, and augmentation of native natural enemies as biological controls.

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