I.1 Biological Control: An Introduction

D. A. Streett

DeBach (1964) defined biological control as "the action of parasites, predators, or pathogens (disease-causing organisms) in maintaining another organism's population density at a lower average than would occur in their absence." A more recent definition proposed by the National Academy of Sciences (1987) for biological control is "the use of natural or modified organisms, genes, or gene products to reduce the effects of undesirable organisms (pests), and to favor desirable organisms such as crops, trees, animals, and beneficial insects and microorganisms."

While many people may share the wider view of biological control that encompasses the methods broadly defined by the National Academy of Sciences, Garcia et al. (1988) make some valid arguments for using DeBach's definition because it emphasizes the concepts of self-sustaining and density-dependent regulation of one species by another. For land managers' purposes, the more traditional definition of biological control proposed by DeBach will be used in this introduction.

Constraints on the use of chemical pesticides may benefit the development of biological control options and their implementation in an integrated pest management (IPM) program. The U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) (1994 unpubl.) defines IPM as "the selection, integration, and implementation of pest management tactics in a systems approach on the basis of anticipated biological, economic, ecological, and sociological indicators." For a more thorough discussion of IPM, refer to the excellent review article by Cate and Hinkle (1993) describing the history and progression of IPM.

Biological control is usually achieved through one or a combination of the following approaches: conservation, augmentation, and classical biological control.

- Conservation is an approach whereby management systems are manipulated to enhance or conserve naturally occurring biological control agents.
- The augmentation approach includes both inoculative and inundative releases of biological control agents. An inoculative release depends upon the biological control agent reproducing, persisting, and spreading on its own accord in the pest population. Inundative releases are more of a short-term control measure with biological control agents causing a more immediate reduction in the pest population but lacking the ability to persist or spread in the environment.
- In the classical approach, exotic (not native) pest species are controlled by the introduction and establishment of exotic biological control agents. Classical biological control has been extremely successful at controlling pests, and current Federal regulations are adequate to monitor and safeguard the importation of biological control agents (Soper 1992).

The approach to classical biological control proposed by Hokkanen and Pimentel (1984, 1989) involves the selection of promising biological control agents from exotic sources for the control of native pest species. Major premises for this approach are a greater likelihood for success using this new association and the ability to control native pests, which represent 60–80 percent of all pest species (Hokkanen and Pimentel 1989).

In the early 1990's, a parasitic wasp and a fungus from Australia were imported into the United States for evaluation as biological control agents against rangeland grasshoppers in the Western United States. Some scientists raised concerns regarding whether the importation of exotic agents would result in some risk to the environment. While concerns about the release of exotic biological control agents are sensible, no major problems are reported from the use of these agents in the United States (Carruthers and Onsager 1993). For a more detailed discussion of this issue, see Lockwood (1993a, b) or Howarth (1991) and Carruthers and Onsager (1993) and/or chapters VII.4 and VII.6 in the Future Directions section of this handbook.

Here in section I, some review chapters on the current status of biological control of grasshoppers discuss the potential of parasites, predators, and pathogens. Various authors in this section describe some research projects funded during the USDA, APHIS, Grasshopper Integrated Pest Management (GHIPM) Project. Topics include identification of fungal pathogens, laboratory assays to assess the effectiveness of *Nosema locustae*, and construction of bird nest boxes. These chapters provide a solid foundation of knowledge on the biological control of grasshoppers. Basic and applied research will continue to be essential in the development and implementation of biological control strategies.

Selected References

DeBach, P. 1964. The scope of biological control. In: DeBach, P. ed. Biological control of insect pests and weeds. New York: Reinhold: 3–20.

Carruthers, R. I.; Onsager, J. A. 1993. Perspective on the use of exotic natural enemies for biological control of pest grasshoppers (Orthoptera: Acrididae). Environmental Entomology 22: 885–903.

Cate, J. R.; Hinkle, M. K. 1993. Insect pest management: the path of a paradigm. Spec. Rep. Alexandria, VA: National Audubon Society. 43 p.

Garcia, R.; Caltagirone, L. E.; Gutierrez, A. P. 1988. Comments on a redefinition of biological control. Biosciences 38: 692–694.

Hokkanen, H.; Pimentel, D. 1984. New approach for selecting biological control agents. Canadian Entomologist 116: 1109–1121.

Hokkanen, H.M.T.; Pimentel, D. 1989. New associations in biological control: theory and practice. Canadian Entomologist 121: 829–840.

Howarth, F. G. 1991. Environmental impacts of classical biological control. Annual Review of Entomology 36: 485–509.

Lockwood, J. A. 1993a. Benefits and costs of controlling rangeland grasshoppers (Orthoptera: Acrididae) with exotic organisms: search for a null hypothesis and regulatory compromise. Environmental Entomology 22: 904–914.

Lockwood, J. A. 1993b. Environmental issues involved in biological control of rangeland grasshoppers (Orthoptera: Acrididae) with exotic agents. Environmental Entomology 22: 503–518.

National Academy of Sciences. 1987. Report of the research briefing panel on biological control in managed ecosystems. Washington, DC: National Academy Press. 206 p.

Soper, R. S. 1992. U.S. Department of Agriculture, Agricultural Research Service national biological control program: policy, and constraints. In: Charudattan, R.; Browning, W. H., eds. Regulations and guidelines: critical issues in biological control. Washington, DC: U.S. Department of Agriculture, Agricultural Research Service: 49–52.

References Cited—Unpublished

U.S. Department of Agriculture, Animal and Plant Health Inspection Service. 1994. Grasshopper program manual. Frederick, MD: U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine. 159 p.