

NATURE AND SCOPE OF BIOLOGICAL CONTROL

Notes

I. DEFINITIONS

A. H. S. Smith (1919) first used term "biological control" to signify the use of natural enemies (whether introduced or otherwise manipulated) to control insect pests.

B. P. DeBach (1964) further refined the term and distinguished "natural control" from "biological control":

Natural control is "the maintenance of a more or less fluctuating population density of an organism within certain definable upper and lower limits over a period of time by the actions of abiotic and/or biotic environmental factors" (see Fig. 1.1).

Biological control (from the ecological viewpoint) is "the action of parasites, predators, or pathogens in maintaining another organism's population density at a lower average than would occur in their absence" (see Fig. 1.2).

C. van den Bosch et al. (1982) modified the terms somewhat and referred to:

Applied biological control as the "manipulation of natural enemies by man to control pests"; and

Natural biological control as that "control that occurs without man's intervention".

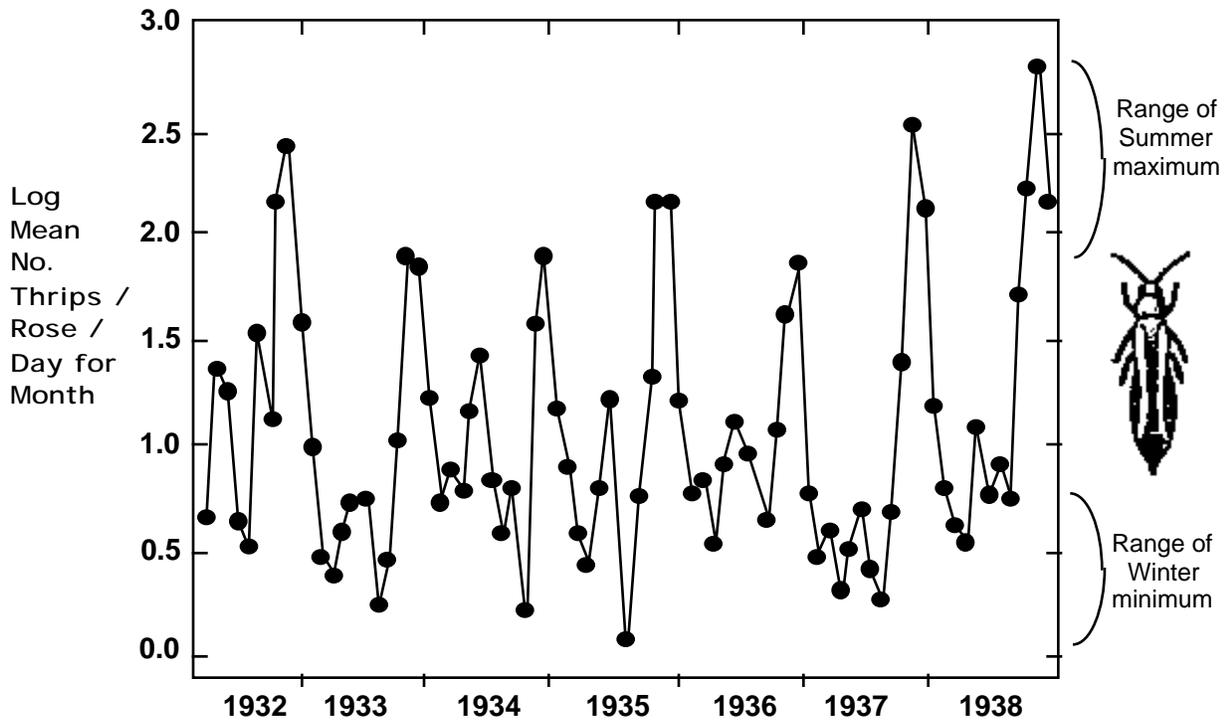


Fig. 1.1. Mean monthly population density counts of adult *Thrips imaginis* on roses at Adelaide, Australia. Modified from Varley et al. (1974); consult for more information.

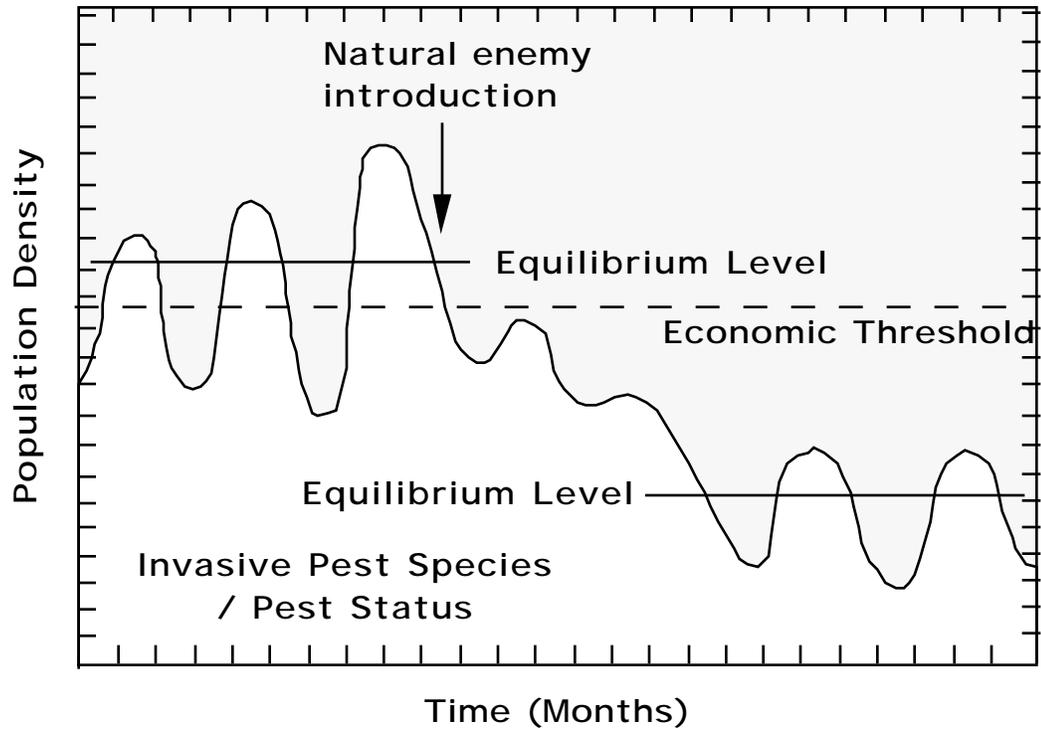


Fig. 1.2. Reduction in pest numbers following introduction of natural enemy: premise of classical biological control. Figure modified from van den Bosch *et al.* (1982).

Notes

Applied Biological Control may be broken down into 3 major categories:

1. CLASSICAL BIOLOGICAL CONTROL: the control of a pest species by introduced natural enemies
2. AUGMENTATION OF NATURAL ENEMIES: actions taken to increase the populations or beneficial effects of natural enemies
3. CONSERVATION OF NATURAL ENEMIES: the premediated actions purposely taken to protect and maintain populations of natural enemies

D. Later definitions were expanded by "non-biological control purists" to include factors such as host plant resistance, autosterilization, genetic manipulation of species (including genetic engineering), cultural controls, non-conventional insecticides (insect growth regulators, etc.), and transgenic plants. In this course these methods will not be considered as "biological control." Biological control will be discussed as the science that deals with the role that natural enemies play in the regulation of the numbers of their hosts, especially as it applies to animal or plant pests.

II. Major Types of Organisms Targeted for Classical Biological Control

- A. Arthropod pests (mainly insects and mites)
- B. Weed species (herbs and shrubs)
- C. Other (vertebrates, snails, algae, fungi, trees)
- D. Animal by-products (cattle dung)

III. Types of Natural Enemies

- A. Pathogens: viruses, bacteria (and their toxins), protozoa, fungi, nematodes
- B. Parasitoids and Predators:
 - 1. Insects and Mites (major groups worked with)
 - 2. Other: snails, vertebrates

IV. Brief definitions

- A. Pathogen: A microorganism that lives and feeds (parasitically) on or in a larger host organism and thereby causes injury to it.
- B. Predator: An animal that feeds upon other animals (prey) that are either smaller or weaker than itself.
- C. Parasitoid: A parasitic insect that lives in or on and eventually kills a larger host insect (or other arthropod).

V. General comparison of an insect parasite (medical term) and a parasitoid

- A. Parasitoids usually destroy their hosts during development; parasites do not.
- B. The parasitoid's host is usually in the same taxonomic class (Insecta); not the case for parasites.
- C. Parasitoids are large relative to their host; parasites are small compared to hosts.
- D. Parasitoid adults are freelifing while only the immature stages are parasitic; not the case for parasites.
- E. Parasitoids develop on only one host individual during the immature stages; parasites change hosts.
- F. With respect to population dynamics, parasitoids are similar to predatory insects; not the case for parasites.

VI. General Advantages of Biological Control include:

- A. High level of pest control at low cost;
- B. Self-perpetuation at little or no cost following the initial effort;
- C. Almost total absence of harmful effects on man and the environment;
- D. Utility of some types of BC agents as biotic insecticides; and
- E. General inability of pests to develop resistance to BC agents (new evidence suggests this may not hold up).

VII. General Limitations of Biological Control include:

- A. The host (pest) population will continue to exist at a level determined by the properties of the host, its natural enemies and of the habitat they occupy;

- B. The effectiveness of natural enemies must be considered relative to man's economic thresholds;
- C. The attainment of biological control of one major pest on a crop necessitates the elaboration of a system of integrated control for other pests of the crop, if any exist; and
- D. The research necessary in seeking a biological control solution to a problem is often demanding in terms of scientific and technical staff, funds, and time, and a solution cannot be guaranteed in advance.

VII. Scope of Biological Control

Biological control is a sub-discipline of applied ecology. To adequately practice it, one should have a firm understanding of population and behavioral ecology. Without systematics and proper identification of pests and their associated natural enemies, biological control as a science would fail to function. In this course, the following topics will be addressed over the next several weeks:

- History and Development of Biological Control
- Relationship of Systematics to Biological Control
- Biology and Impact of Predators
- Biology and Host Relationships of Parasitoids
- Traits Common to Predators and Parasitoids
- Insect Pathology in Biological Control
- Biological Control of Weeds
- Population Dynamics - Considerations
- Factors Affecting Population Growth
- Predator/Prey & Parasite/Host Interaction Models
- Factors Limiting Parasitism
- Density Independent Mortality & Population Regulation Theories
- Foreign Exploration and Importation of BC Agents
- Trials and Tribulations of a Foreign Explorer
- Environmental Concerns relative to Biological Control
- Establishment and Evaluation of the Impact of Natural Enemies
- Theories of Classical Biological Control
- Analysis of BC Successes and Case Histories
- Conservation of Natural Enemies
- Enhanced Biological Control Through Pesticide Selectivity
- Augmentation of Natural Enemies
- Natural Enemies in IPM Systems
- Biological Control in Hawaii's Crop Systems
- The Role of the Hawaii State DOA in biological control

QUESTIONS

1. What is the difference between biological control and natural control as defined by DeBech?
2. What are abiotic environmental factors?
3. What are the three major categories of applied biological control? How do they differ?
4. What types of organisms are most commonly targeted in biological control programs?
5. What types of organisms are used as biological control agents?
6. What are the limitations of biological control as a management tactic?

REFERENCES

- DeBach, P. 1964.** The scope of biological control. p. 3-20. *In Biological Control of Insect Pests and Weeds* (P. DeBach, editor). Chapman and Hall Ltd., London. 844 pp.
- Doutt, R. L. 1964.** The historical development of biological control. p. 21-42. *In Biological Control of Insect Pests and Weeds* (P. DeBach, editor). Chapman and Hall Ltd., London. 844 pp.
- van den Bosch, R., P. S. Messenger, and A. P. Gutierrez. 1982.** An introduction to biological control. Plenum Press, New York and London. 247 pp.
- Van Driesche, R. G. and T. S. Bellows, Jr. 1996.** Biological control. Chapman and Hall, New York. 539 pp.
- Varley, G. C., G. R. Gradwell, and M. P. Hassell. 1974.** Insect population ecology - an analytical approach. Univ. Calif. Press, Berkeley and Los Angeles. 212 pp.

READING ASSIGNMENT:

Chapter 1: pp. 3–20; Chapter 2: pp. 21–31, **Van Driesche, R. G. and T. S. Bellows, Jr. 1996.** Biological control. Chapman and Hall, New York. 539 pp.