Biological Control and Refuge Theory

In classical biological control, biologists introduce an imported parasitoid in order to reduce the density of an accidentally imported insect host. If the pest density declines and the introduced natural enemy achieves moderate-to-high frequencies of attack, projects are considered successful. An association between successful biological control and high parasitization is to be expected. Hawkins et al. (1) found that maximum parasitization rates occurred when hosts had little protection from parasitoids (that is, small refuges), and they conclude (1, p. 1430) that susceptibility to parasitism (that is, high rates of parasitism) is a "significant estimate of the probability that the parasitoid introduction will reduce host densities." We find this conclusion suspect for five reasons.

1) The literature used by Hawkins et al. is likely to be biased in favor of the refuge hypothesis because cases of pest populations declining with low rates of parasitization are unlikely to be recorded as examples of successful biological control (2).

2) Refuge size is estimated by Hawkins et al. as one minus the proportion of the pest population parasitized. By definition, high parasitism characterizes successful biological control, therefore the argument that small refuges favor the success of biological control is a tautology.

3) Most simple measurements of "percent parasitism" contain errors or distortions arising from the influences of host and parasitoid phenologies (3). Single values cannot characterize host-parasitoid interactions, and maximum values are unlikely to be typical over longer times or in different areas (4).

4) Contrary to the prediction made by Hawkins et al., successful biological control can result from the use of agents that are characterized by low rates of parasitization in their native habitat (5). Natural enemies that are rare in their native habitat may have superior potential as control agents when released in exotic habitats (6).

5) Hawkins et al. attribute seven cases of high parasitization (above 60%) in unsuccessful biological control projects to climatic mismatch between parasitoids and hosts. We question how such high rates of parasitization could be achieved if climatic factors "reduce parasitoid reproduction, survivorship, or host synchrony ..." (1, p. 1431).

Variation in the susceptibility of insects to predators, parasitoids, and disease is important. Mechanisms for encapsulating parasitoids, hiding from predators, and resisting disease influence the impacts of natural enemies in native and exotic habitats, but measuring refuge size from the observed maximum parasitization of successful biological control programs does not yield new understanding or predictability to the practice of biological control.

REFERENCES


22 December 1993, accepted 10 March 1994

Hawkins et al. (1) demonstrate a significant and robust relationship between the outcome (success or failure) of a potential biocontrol program and the maximum percentage parasitism achieved by the parasitoid agent following its initial release. They propose that this relationship illustrates that the size of a "ref-
Biological Control and Refuge Theory
Judith H. Myers, James N. M. Smith and Joseph S. Elkinton

Science 265 (5173), 811.
DOI: 10.1126/science.265.5173.811

Use of this article is subject to the Terms of Service

Science (print ISSN 0036-8075; online ISSN 1095-9203) is published by the American Association for the Advancement of Science, 1200 New York Avenue NW, Washington, DC 20005. 2017 © The Authors, some rights reserved; exclusive licensee American Association for the Advancement of Science. No claim to original U.S. Government Works. The title Science is a registered trademark of AAAS.