Biological Control of Insects

California's subtropical climate favors establishment of natural enemies of agricultural insect pests

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One third of the 100 or so insects introduced successfully into the continental United States for biological control, are established in California.

Outstanding examples of successful biological control in California are the cottony cushion scale, the citrophilus mealybug, long-tailed mealybug, black scale, and alfalfa weevil.

Present work includes studies for the control of red, purple and other scale insects, on citrus, red mites on citrus, avocado and walnut, grape leaf skeletonizer, elm scale, olive scale, etc.

The citrus blackfly, spread over most of Mexico, presents a serious threat to the citrus industry of California. In an effort to check the spread of the pest before it reaches California, the parasite, *Eretmocerus serius*, was introduced in Mexico in 1943. The parasite became exceedingly abundant but the very dry winter period greatly hampered it and—except in a few localities—citrus blackfly infestations remained as heavy as before. A search was made in Pakistan and India, where climatic conditions are comparable, and four parasites from that region are now established in Mexico. Field control has already been accomplished in several localities.

Work in Hawaii

Biological control work in Hawaii is generally acknowledged to have saved the sugar industry by control of the sugar cane beetle borer, Anomala beetle, several species of armyworms, the Chinese grasshopper, the cane aphis, mole cricket, and three species of mealybugs. Other pests controlled by natural enemies on the Islands include the fern weevil, torpedo bug on fruit trees, coconut scale, rice borer, a cockroach, the taro leafminer, and others. The oriental fruitfly, which overshadows all other insect problems in recent years, is the subject of intensive investigation by five co-operating agencies, including the University of California. Four introduced parasites—particularly *Opius oophilus*—have greatly reduced the fruitfly in Hawaii, brought it under control on Oahu, and are approaching the same degree of control on the other islands.

During the past 60 years, many biological control projects have been undertaken in various parts of the world. Thirty to 40 pest species have been brought under full commercial control, and the number in which only partial control was accomplished is much larger. From this mass of information some general conclusions may be drawn to guide future work.

General Conclusions

Biological control is accomplished quickly, or not at all.

A parasite or predator destined to control its host will demonstrate control in the area of release within three host generations. With some insects this may cover a period of only six months. In general, it is believed that a three-year test of any imported species—if colonized throughout the range of its host—is adequate to demonstrate its potentialities.

An effective parasite can be established easily, and often by release of only a few individuals. Rapidity of increase and control occurred in every instance in which detailed data are available.

The parasite destined to control its host is obviously adapted to the environments into which it is introduced; otherwise it would not be able to increase consistently to the point of control in the minimum of time.

The difficulty with which a parasite or predator establishes itself, may be taken as basis for judging its potential future value. A parasite that is difficult to establish will never be fully effective because the same factors that hinder its establishment operate to prevent eventual control of the host.

Parasite Establishment

No instance is known where a parasite became established with difficulty, and later attained a dominant role in control of its host. Nor is an instance known in which a parasite after its establishment, passed through several years of limited existence before it attained a dominant status

No data support the belief that an introduced parasite may in time adapt itself more fully to a new environment. Some species may persist in small numbers for many years and then suddenly build up enormously, giving a false promise of control. In these cases, the climatic conditions are temporarily favorable to the parasite; so long as they prevail it will do well, but as soon as more normal conditions are restored the parasite subsides to its earlier ineffective status.

Tropical Areas Favored

Successful biological control work occurs most frequently in tropical and subtropical areas. California, which may be classed in part as subtropical, has provided successful results comparable to those obtained in areas having even milder climates.

In tropical and subtropical areas, where growing conditions are favorable throughout the year, without need for hibernation or diapause, the natural enemies can increase without hindrance.

In temperate regions, enforced hibernation during the winter often brings complications that may prevent establishment and effectiveness. The introduced species may not be able to withstand the low winter temperatures, though these are not equally detrimental to the host. An alternate host may be required to carry the parasite over the winter, and if a suitable host is not available, the parasite is unable to persist from year to year.

Tropical conditions are not always favorable, as periods of extreme heat and aridity are just as detrimental to natural enemies as is the winter period in the temperate regions.

In biological control work, any pronounced departures from climatic conditions that are constantly favorable throughout the year in temperature, rainfall, and humidity, is certain to reduce the frequency of success. In areas such as Hawaii, where year-round conditions are favorable, the chances of successful biological control of a pest are probably better than even. In temperate regions such as most of North America, full control will be attained in only a small proportion of the projects.

During the past 60 years a total of more than 600 species of parasites and predators have been imported into the continental United States. Approximately 100 have become established in various parts of the country with about one third of them in California.

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