Prospects for Development of Biological Control Methods for Crop Protection in the U.S.A.

Carl B. Huffaker

Division of Biological Control
Department of Entomological Sciences
University of California
Berkeley, California 94720

Introduction

As you have heard in various ways, use of classical biological control is cheap, permanent as a rule, and environmentally sound. The recent explosive expansion of the concept of integrated control or integrated pest management (IPM), the development of special pheromones (kairomones), and especially the advances in the area of biological control of plant pathogens, present new opportunities for using biological control organisms in pest control.

The terms of this Conference "use of beneficial organisms" imply mainly natural enemies, i.e., parasitoids, predators, pathogens, and antagonists. Also, competing organisms and allies of a natural enemy may satisfy the implications. Conventionally, action of parasites, predators and pathogens has been equivalent to the term *biological control.*

Unfortunately, there have been attempts to broaden this meaning to include all *biologically based* forms of pest control. This seems unreasonable in that it correctly excludes mainly *conventional* types of chemical control, but use of the newer or *nonconventional* chemicals such as hormones, pheromones, antifeedants and other behavioral chemicals—i.e., chemicals that produce adverse behavioral or physiological responses of the organisms—is included. One difficulty is that some of these newer chemicals are closely related to the conventional ones. But, more important, their use is not at all comparable ecologically to use of natural enemies. Equally disturbing has been the effort to include under "biological control" the whole group of manipulations designed to curtail the multiplicative capacity of pest insects by releasing sterile males or other genetically deranged stocks, through which infertility results or deleterious genes of the *same species* would be incorporated into the natural population, with inimical effects in later generations. The use of resistant varieties of the crop organism itself has long been considered by some (e.g., Sweetman, 1936, and later) to be "biological control." Wilson and Huffaker (1976) noted that these broadenings of the term are not generally accepted, and that R. L. Doutt had cautioned that such expansion ". . . has the damaging effect of obscuring the unique functional and ecological basis of biological control . . .." Two recent events accent these dangers. First, Richardson (1978) has indicted biological control because problems arose in the sterile male eradication program for the screwworm fly, *Cochliomyia hominivorax* (Coquerel), in Texas. This indictment is inapplicable because the sterile insect release method is not biological control in the accepted sense. Secondly, questions have been posed concerning the possible safety and utility of using insect hormones (e.g., Newsom et al., 1976). Again, such an indictment has no relevance to biological control, for hormone application is chemical control, not biological control.

In this paper, I deal only with use of natural enemies, i.e., parasitoids, predators, pathogens, and other population-interacting antagonists which are themselves *different species* than the target pest organisms or crop organisms. There is population interaction with the pest population in such a way that the pest is suppressed, or perhaps even regulated. Such natural enemy action pest interaction is an inherent part of the process of natural control of populations. This is not true for man-manipulated genetic or hormonal derangements of a population.

The subtle and less understood role of antagonists of plant pathogens is illustrated by Snyder et al. (1976, p. 533): "Although direct predation of the pathogen may take place, as in the biological control of one insect by another, indirect phenomena are probably more common to plant pathogen control." These authors and Baker and Cook (1974) note that exploitation of a soil nutrient by an antagonist may deprive the pathogen of necessary energy, or an antibiotic produced by a microorganism may inhibit development of a pathogen. Thus, the action may be direct, or indirect through a chain of biological events, but by definition must involve biological activity of one or more organisms acting to control *another* (my italics).

The publication of the U.S. Department of Agriculture (USDA) "Biological Agents for Pest Control--Status and Prospects" (USDA, 1978) deals specifically with much of what this presentation is about. That publication by implication considers such genetic derangements of target species as biological control agents. They are biological agents, but not conventional *biological control* agents. The publication also deals with the coordination and organizational activities required in the conduct of biological control, and recommendations are made to advance the field. I will only very briefly deal with this latter area. Some of this is covered by Huffaker et al. in a separate paper of the Plant Protection Congress. In order to suggest promise in the field, the major part of this present paper is a resume of work in major problem areas.

Recent Biological Control Developments

Truck and field crops

An interesting development in control of Mexican bean beetle, *Epilachna varivestis* Mulsant, is the use of early season releases of the Indian parasite *Pediobius foveolatus* (Crawford) (R. I. Sailer, personal communication, 1979). This parasite cannot survive year round in the U.S.A. because of the long winter period of complete absence of host larvae. Early studies of the effects of annual inoculative releases of this parasite on Mexican bean beetle populations in soybeans were conducted in Maryland (Stevens et al., 1975), with promising results. Dr. Sailer has conducted similar studies in Florida. Releases of 4,000 *Pediobius* in or near Alachua County, Florida, April 1975, reduced the beetle population in 1976 over a 1,000 square mile area to a ". . . scarcely detectable level," and the parasite had dispersed northward about 400 miles, but southward only 40 miles.

Since almost no beetles were present in Alachua County in 1976, and sizable populations would be present in Marion and northern Florida counties, releases of *Pediobius* were made early in the season in these latter areas in 1976. By September of that same year ". . . no live 4th instar Mexican bean beetles could be found in a 10,000 square mile area of north Florida, south Georgia and southeast Alabama." Dr. Sailer reported that in the following year, 1977, there were no economic populations of the beetle anywhere in Florida, south Georgia and southeast Alabama. The populations were apparently so reduced that without any further *Pediobius*