
Development of integrated pest management in California

Ray F. Smith

The term integrated pest management was coined in the early 1970s, but the history of IPM in California can be traced back through the emerging integrated control of the spotted alfalfa aphid in the 1950s to earlier, pre-World War II biologists' struggles with California pest problems and even to ideas developed just after the turn of the century.

The earliest use of the term *integrated control*—at least in the context of pest control—dates from 1954. Most discussions of the origins of integrated control have centered on the over-dependence on and the over-use of chemical pesticides after World War II and the unfavorable consequences that resulted: the development of pest populations resistant to pesticides, rapid resurgence of target pest populations following treatment, and outbreaks of secondary pests. Then, as the story goes, these events were coupled with the wisdom of a few omniscient soothsayers, and integrated control came into the world.

Today it is relatively easy to trace a thread of thought back through the history of plant protection to the early California pioneers such as Charles W. Woodworth and others of the late nineteenth century and early twentieth century. We can pick out pieces from their early writings that fit the integrated control philosophy of today. The fundamental ecological principles involved, such as concepts of interactions within an ecosystem and population regulation, were advocated by some plant protection scientists nearly a century ago, although these were not clearly articulated as a pest control strategy. Before 1900, battles raged between the chemical control advocates and the biological control proponents. At that time, who could tell who was right and who was wrong in their predictions? Some of this controversy is still with us today. But the past 30 years have taught us that both of these early protagonists were wrong: We need both chemical control and biological control for adequate plant protection.

As the agricultural experiment stations emerged in the United States in the late nineteenth century, entomologists and plant pathologists began to discover biological explanations for the earlier,

empirically developed pest control methodology which had been restricted largely to natural and cultural measures, sometimes augmented by minimal use of the earliest insecticides or fungicides. Partly by intuition and partly because there was little choice, leading entomologists advocated an ecological approach to pest control. In spite of this position by leading entomologists, over the next half-century there occurred a gradual erosion in the understanding of the importance of ecology in controlling insect pests. There were, of course, exceptions, and from time to time a plea was made for the ecological approach. Charles W. Woodworth, Professor of Entomology at the University of California, advocated an ecologically based pest management approach throughout his long career. In 1896, he stated that everyone should have a clear idea of the controls available and how to apply them.

Woodworth also discussed the need for carefully evaluating each mortality factor and investigating the interactions of the separate components in terminology that clearly showed his familiarity with what we now call the ecosystem concept and the density-dependent mortality. He was the first entomologist to point out the important fact that percent parasitism of an insect pest is not a valid criterion for assessing the efficacy of a parasite. The effectiveness of a parasite is evaluated better in terms of the numbers of the pest evading the parasite attack per unit area or per host plant. This is not correlated with percent parasitism.

The late 1930s saw the beginnings of integrated control when the Woodworth traditions of a total approach to economic entomology were coupled with the biological control demonstrations of Harold Compere, Albert Koebele, and Harry Smith in California.

Finally, one other person provided a link between the foundations established by Woodworth and his colleagues in the first quarter of this century and modern integrated control. That person was A.E. Michelbacher, who is well known for his many significant contributions to entomology, but perhaps not so well known for his relationship to integrated control.

In his "Recommendations for a More Discriminating Use of Pesticides," published in 1939, we find the essential ingredients of modern integrated control. Later, in other papers, Michelbacher greatly amplified this broad ecological approach to pest control.

With this heritage of ecological approach to pest control woven throughout the University of California Agricultural Experiment Station, it is not surprising that the challenge of the spotted alfalfa aphid in California in the mid-1950s produced modern integrated pest management (IPM).

Some crop protection specialists continue to discredit the IPM concept as representing only new jargon applied to long-established crop protection practices. We acknowledge that IPM is not a disjunct development in crop protection—it is an evolutionary stage in pest control strategy—but it represents a new conceptual approach that sets crop protection in a new context within a crop production system. Many components of IPM were developed long ago, but IPM as now conceived is unique: based on ecological principles, it integrates multidisciplinary methodologies in developing agroecosystem management strategies that are practical, effective, economical, and protective of both public health and the environment. The early efforts of crop protectionists to control pests with ecologically-based cultural methods were not satisfactory; consequently, entomologists, plant pathologists, and, later, weed scientists were preoccupied with the discovery of pesticides that were economical and effective. Unfortunately, chemical methods were often used not to supplement cultural methods but to supplant them.

Our state of technology and understanding of host-pest interactions has evolved to the point that an integration of pest control tactics for multiple classes of pests is not only feasible but necessary, given the inadequacies of single-method, single-discipline approaches and their potential for undesirable effects on nontarget beneficial and pest species.

Ray F. Smith is Professor of Entomology, University of California, Berkeley.