rives from his ontogenetic studies showing that individuals of one population when raised under fluctuating feeding conditions forage in a more variable manner than those raised under stable conditions. Both essays highlight the importance of understanding the genetics that underlies and possibly constrains the evolution of feeding behavior.

As these examples show, great strides have been made toward understanding the rules by which animals make foraging decisions. Nevertheless, there is still a long way to go. Maximizing the rate of energy acquisition, or any other "basket of currencies," is not the same as maximizing fitness. Only the most rudimentary beginnings have been made toward integrating physiological, morphological, and information-processing constraints into foraging theory. And more work is needed at integrating foraging behavior with social behavior. In this volume a start is made, and the melding of the different perspectives and techniques of workers in three disciplines highlights many important issues for the future. Since the results of so many field studies are summarized and used to assess the significance of theoretical predictions the book will be required reading for anyone working on feeding behavior. In general, the essays are short, are well written, and contain just enough figures to convey clearly the results of the experiments. These features place the volume within the grasp of anyone with a basic understanding of behavior, ecology, or psychology.

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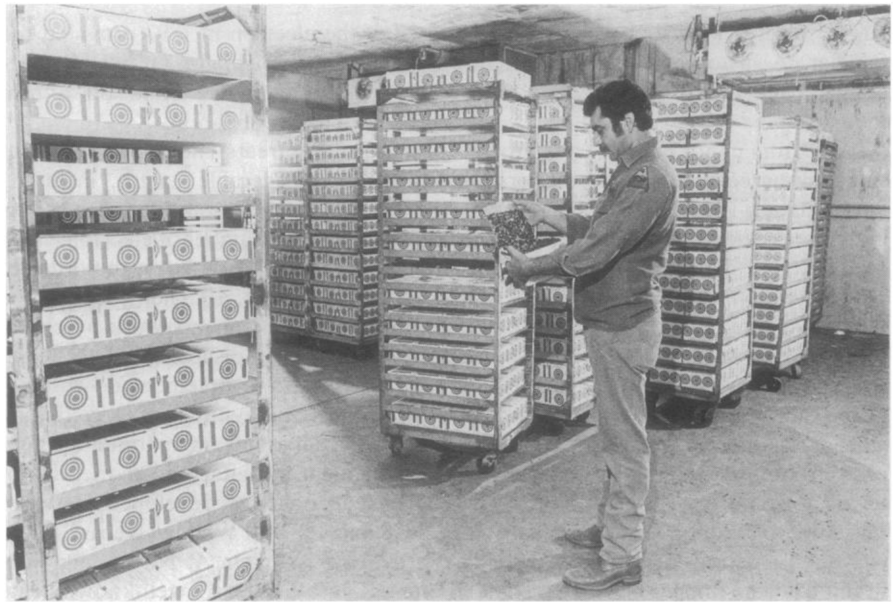
The Shift from DDT

Insects, Experts, and the Insecticide Crisis. The Quest for New Pest Management Strategies. JOHN H. PERKINS. Plenum, New York, 1982. xx, 304 pp. $29.50.

This book is an account of economic entomologists' response to the "insecticide crisis" of the late 1960's, when public concern about the environment, coupled with the problems caused by continued use of persistent chemicals, forced economic entomologists to develop and test, in short order, other ways of dealing with insect damage. Perkins discusses the major alternatives tried in the 1970's, not in a narrowly technical fashion (though economic entomologists will find much of interest) but stressing the social, political, intellectual, and economic context of the work. He shows how the organization and professional goals of economic entomologists, the bureaucratic and political structure that supported them, and their own beliefs about humanity's place in nature affected their search for control methods. Perkins's own training in history and biology, his experience as a staff member evaluating some of this work, and his thorough research (including interviews with many of the people involved) make this an unusually detailed and sophisticated study.



"Sterile screwworm flies ready for aerial release." [From *Insects, Experts, and the Insecticide Crisis*; source, USDA/APHIS]

The book begins by presenting the background to the insecticide crisis in two chapters that discuss, respectively, the discovery and application of the discovery of the problems raised by its use. Perkins is less concerned with the environmental problems and the hazards to human health than with insect resistance and the destruction of natural enemies, and he passes over the entomologists' reactions to the relevations of *Silent Spring* and to the public attack on DDT in the late 1960's by the Environmental Defense Fund.

The second section has three chapters on the development and testing of alternatives to chemical control. There were two main methods, integrated pest management and—a name Perkins coined—total population management. The first, developed from classical biological control, used a combination of techniques to reduce pest populations to a level below that at which they would cause economic damage. It stressed the need to establish a system that would allow the farmer to live with the insect. The second, which grew out of the combination of techniques and a sophisticated understanding of insect population dynamics and behavior, had a more ambitious end—to eradicate major imported crop pests. Integrated pest management was tested against pests of several major crop systems in a study (the Huffaker project) funded by the Department of Agriculture, the Environmental Protection Agency, and the National Science Foundation—a strange assortment of bedfellows. Total population management was tested in controversial boll weevil eradication projects in the Deep South and North Carolina.

The third section, almost half the book, considers the framework in which the insecticide crisis arose and solutions were proposed—the conceptual and philosophical foundations of economic entomology and the 20-century revolution in agricultural technology and production. Two chapters deal with the dual character of economic entomology as science and technology, the generation and use of knowledge in the field, and the ideas about nature and humanity's relationship to it that affected entomologists. All this is placed in the framework of Thomas Kuhn's concept of paradigms, a word I find more confusing than enlightening. Two chapters on the changes in agriculture in the 20th century and how they affected economic entomology and entomologists bring us to a final chapter in which Perkins reviews the ways in which he has linked the research strategies of insect control specialists to the demands and ideas of the larger society. Much of the material is familiar to historians, but not in this context, and Perkins's overview unites the narrative.

Aside from minor quibbles and professional disagreements about matters of interpretation (which are not important in a short review) my qualms about the book have to do with the arrangement. The separation of the philosophical and conceptual framework of entomology from the account of the applied work tends to diminish and to blur the effect of deep-seated ideas upon research strategies and may tempt readers who would profit from it to skip the theoretical material. I would urge them not to. The relegation of economic factors, particularly the transformation of the American farm under the impact of mechanization and the flood of farm chemicals, to the later chapters also detaches an important part of the story from its proper place. There are, though, good reasons for these choices, and *Insects, Experts, and the Insecticide Crisis* deserves the careful attention and consideration of anyone interested in how science and scientists act in our society.

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Theories of Chemical Bonding

Electrons and Valence. Development of the Theory, 1900–1925. ANTHONY N. STRANGES. Texas A&M Press, College Station, 1982. xii, 292 pp., illus. $28.50.

The historical development of the concept of valence and its relationship to the nature of the chemical bond constitutes the principal theme of this book. That the chemical bond is electrical in nature followed from J. J. Berzelius's dualistic electrochemical theory, enunciated in 1811; that structural considerations also were of crucial importance for organic compounds became clear during the succeeding three decades and highlighted the shortcomings of Berzelius's theory. Only after Hermann von Helmholtz argued persuasively in his famous Faraday Lecture of 1881 that if atoms exist positive and negative "atoms of electricity" must also exist, and only after Svante Arrhenius proposed his electrolytic dissociation theory in 1887, did chemists have their attention drawn anew to the fundamental importance of electrical binding forces. J. J. Thomson's discovery of the electron in 1897 provided the essential ingredient for putting the theory of the chemical bond on a firm experimental foundation.

The author treats Thomson's contributions at considerable length, including Thomson's momentous demonstrations in 1906 that the number of electrons in an atom is relatively small, on the order of its atomic weight. He then turns to the reception of Thomson's work by chemists: Thomson's discovery of the electron, at times supplemented with his picture of Faraday tubes of force linking two adjacent atoms, constituted the central element in unitary polar theories of chemical bonding developed between 1898 and 1907 by Walther Nernst, Richard Abegg, William A. Noyes, and William Ramsay. Abegg's well-known "rule of eight"—that all atoms possess a maximum of eight electrons available for bonding—assumed particular importance during this period as well.

The next stage in this electrostatic approach to bonding involved the basic assumption that the chemical bond results from the complete transfer of one or more electrons from one atom to another. This view was developed in America before 1915 especially for organic molecules by K. George Falk and John M. Nelson at Columbia University and Harry S. Fry at the University of Cincinnati, followed by Julius Stieglitz at the University of Chicago and Noyes at the University of Illinois. The failure of chemists to find Fry's electronic isomers or "electromers" ultimately undercut this unitary electrostatic theory. More important in this respect, however, was the emergence of a dualistic approach to bonding—that nonpolar forces involving no electron transfer had to be considered side by side with polar forces. This view was advanced in 1913 by William C. Bray and Gerald E. K. Branch at M.I.T. and by G. N. Lewis at Berkeley.

Lewis ultimately emerges as the central figure in this history: His concept of the shared electron-pair bond, whose origin can be traced to his cubical static atom of 1903, was first published in 1916. This concept reconciled polar and nonpolar theories by tracing the bonding in both cases to a pair of electrons shared by the two bonded atoms. Its meaning was conveyed pictorially by representing the bond as a pair of dots. By 1923 Lewis's theory had become embedded in the minds of most chemists, although its deeper meaning had to wait until the emergence of quantum mechanics a few years later.

An intriguing theme throughout his book is the interplay, or lack of interplay, between contemporary developments in chemistry and physics. Chemists and physicists were interested in very different consequences of atomic and molecular structure in the period in question—the former focusing on valence and bonding, the latter on spectra. Chemists consequently showed little appreciation for contemporary advances in theoretical physics, even for Niels Bohr's model of 1913. The author's account of how Lewis changed his attitude toward the Bohr atom from antagonistic to supportive between 1913 and 1923 constitutes a significant contribution of this book.

Its major shortcoming perhaps can be traced to the author's lack of attention to the secondary literature, especially in the history of physics. Cognizance of this literature, for example, would not have led him to cite J. J. Thomson's 1919–1920 views on atomic structure approvingly. It seems that the author did not even draw on the *Dictionary of Scientific Biography* for important insights into the work of the figures he discusses. It is to be hoped that he will continue his researches and explore in more detail some of the avenues his valuable book opens up for historical investigation.

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Photosynthesis

Electron Transport and Photophosphorylation. J. BARBER, Ed. Elsevier, New York, 1982. xvi, 288 pp., illus. $89.75. Topics in Photosynthesis, vol. 4.

This volume is the fourth in a series on photosynthesis. The first three concentrated on chloroplast structure and function, primary processes of light harvesting and energy transfer, and photosynthesis in relation to model systems. The themes suggested for the present volume concern the mechanisms by which redox energy is converted to adenosine triphosphate (ATP). In this vein, an editorial summary proposes that central consideration in the book be given to spatial interactions between functional protein complexes in the photosynthetic membranes, mobility of proteins, and protein complexes in a fluid membrane matrix. Furthermore, it is suggested that the Z-scheme for the electron transport pathway of green plants and algae should be