The value of archival research is further demonstrated in Fine's essay "Einstein's realism" (1984). Many scientific realists claim to find in Einstein a co-religionist and ally in their holy war with the instrumentalists and other legatees of a moribund Viennese positivism. But Fine argues that Einstein's realism is not a philosophical doctrine, according to which theories derive their meaning and warrant from their aim of providing approximately true descriptions of an observer-independent reality, as opposed to providing merely a tool for prediction, as the instrumentalist asserts. Einstein's realism is instead, according to Fine, a program for scientific inquiry, based upon the belief that the way of formulating theories most likely to promote scientific progress is to posit real physical systems and associated, definite, observer-independent properties, in contrast to quantum theory in its Copenhagen version, which is portrayed as according the observer a primary role. The psychological significance of this belief is reflected in Fine's calling it "motivational realism."

Less convincing is the essay "What is Einstein's statistical interpretation, or is it Einstein for whom Bell's theorem tolls?" (1984). Most commentators attribute to Einstein a statistical interpretation of quantum mechanics, according to which the state function refers not to an individual system, as Bohr would claim, but to an ensemble of systems, quantum mechanical probabilities being explained in terms of the statistical distribution over the members of the ensemble of the various possible definite values of an observable. But Fine argues that Einstein's remarks about the state function better fit Fine's own "prism model," also a statistical interpretation, but distinguished from the standard one by the assumption that for every measurement there are some members of the ensemble for which no result is obtained. The prism model explains the puzzling results of the Bell experiments without having to admit any non-locality, whereas the standard statistical interpretation, ascribing definite values of all observables to all members of the ensemble, is, arguably, refuted by those experiments. Thus Fine hopes to spare Einstein an unhappy fate, but the resulting interpretation is anachronistic.

With Fine's two "NOA" essays—"The natural ontological attitude" (1984) and "And not antirealism either" (1984)—we shift from history to contemporary problems. NOA represents an important new turn in the old controversy over scientific realism, one that should find a sympathetic audience even more among scientists than among philosophers of science. Fine rejects the realists' grounding of the ontological assumptions and the truth claims of science upon some extratheoretical relation (such as "approximate correspondence") between theories and the world. He rejects as well the antirealists' replacement of belief in the reality of posits and in the truth of theories by something safer, like belief in their empirical adequacy. The root difficulty, according to Fine, is that both realist and antirealist see science as needing a global interpretation or justification. NOA, by contrast, takes science "on its own terms," allowing questions about the posits and truth claims of science, but insisting that they be answered by the methods and standards of science itself. The philosopher's role on NOA's ark (Fine's pun) is modest—alongside, not above the scientist. It is not unlike the role accorded the philosopher by recent antifoundationalist thinkers, such as Richard Rorty, and has much in common with the philosopher's role in that other nautical analogy, introduced by Otto Neurath and promoted by W. V. O. Quine, in which science is compared to a boat that must be reconstructed not in drydock but at sea, one plank at a time.

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Holistic Pest Management

Ecological Theory and Integrated Pest Management Practice. MARCOS KOGAN, Ed. Wiley-Interscience, New York, 1986. xx, 362 pp., illus. $54.95. Environmental Science and Technology. Based on a symposium, San Antonio, TX, Dec. 1984.

By contrast with contemporary ecological theory, which has been shaped by a rich blend of conceptual thought, mathematical modeling, and experimentation, the practice of managing pests in agriculture has been shaped mainly through immediate response to perceived need to control pests at any cost, usually involving the "magic-bullet" approach of pesticide application. For most of this century, there was relatively little concern with how herbivore pests interacted with the crop plants they ate or the predators, parasites, or pathogens that ate them. Beginning in the 1960s, however, pest management practitioners began to take a more ecological approach to pest control within a framework of integrated pest management (IPM). The philosophical core of IPM is holistic. Ideally, it provides for integration of approaches to maintaining pests below damaging levels and for attention to the effects human intervention may have on multiple components of the ecosystem. Even so, IPM has fallen short of attaining its ideals, at least partly because of its lack of a sufficiently broad and robust conceptual background rooted in ecological theory.

It is on account of the gap between tenets of ecological theory and designs of pest management systems that some of North America's most astute and provocative ecological theorists and ecologically minded pest management proponents were brought together for the symposium of which this collection of 12 papers is the proceedings. The volume provides, in my judgment, the most sophisticated treatment of related aspects of ecological theory and IPM practice available under one cover.

Richard Levins sets the holistic tone of the volume by providing an incisive overview of how the approach to pest control has proceeded from "brute force" tactics of pesticide overuse to IPM tactics, which are viewed as still relying too heavily on multiplicities of human intervention. Drawing upon his experience in ecological systems analysis and as an agricultural adviser to Third World countries, Levins makes a compelling case for an approach that embraces much greater recognition of large-area, ecosystem-level processes and gentler, less frequent intervention.

Three forceful chapters focus on theory relevant to interpreting population and community level processes. Daniel Simberloff evaluates aspects of the dynamic equilibrium theory of island biogeography in relation to management of insect pests of crops as well as to design of nature reserves. He comes to the arguable conclusion that theory may offer little of practical value in either vein. In fact, Simberloff contends that agriculture has benefited from not being hasty in putting an ecological theory to practice. In examining population theory in relation to pest outbreaks, Donald Strong emphasizes the looseness and stochastic complexity of density relationships among plants, herbivore pests, and natural enemies of pests, cautioning that it is unrealistic to expect tight equilibrium relationships and long-term stability in agricultural (or even natural) systems. Peter Kareiva explores one of the most intractable aspects of animal ecology bearing upon pest management in a critical analysis of movement patterns of pests, parasites, and predators in crops. He refers to some of his own inventive, mechanistically rooted field experiments and generates a series of models (employing partial differential equations) aimed at illuminating the influence of pest movement on patterns of crop damage.

Six chapters delve into the theoretical background of principal pest control tactics. The most satisfying of these chapters, indeed in my opinion the best in the entire volume, is that by Kogan on plant defense strategies and host-plant resistance. Kogan masterfully weaves historical developments in insect-plant interaction theory with host-plant resistance theory and practice, treating in depth such fundamental ideas as coevolution and sequential evolution between plants and insects and the chemical nature of genetically based and environmentally induced plant defense. Sean Duffey and Ken Bloem examine in detail whether host-plant resistance to insects can be used compatibly with biological control agents in IPM programs. Through a physiological approach, they demonstrate convincingly for some plants that complexes of compounds (both secondary and primary) thought to be advantageous agriculturally because they confer resistance to pest depredations actually can be detrimental to these purposes by having even stronger negative effects on parasitoids and pathogens that attack the pests. This contribution is valuable also for its illustration of how an imaginative reductionist approach can aid in formulating new theory. In a chapter on the ecology of insect-pathogen interactions, Robert May outlines factors that govern whether a pathogen of an insect is capable of maintaining itself within a host (pest) population and keeping that population at a comparatively low level. Like Strong, May emphasizes the difficulties that nonlinearities and dynamic complexities inherent in any relation between a host and its enemies pose for pest management decisions. Two chapters, one by Donald Herzog and Joseph Funderburk on ecological bases for habitat management and cultural control in insect pests and the other by Robert Metcalf on the ecology of chemical control of insect pests, are well-rounded reviews tracing historical and recent developments. Both underscore the need for greater appreciation of evolutionary and ecological relationships among webs of plants, herbivores, and natural enemies of herbivores for environmentally compatible cultural and chemical management approaches. The last chapter in this section, by George Kennedy, illustrates how strategies for managing arthropod-transmitted virus diseases of crops that have not been generated by ecological theory have nonetheless proven consistent with predictions emerging from theory.

The book concludes with two chapters having broad concern. David Pimentel, in providing an overview of economic losses due to pests in the United States and the monetary, environmental, and social costs of pest control, describes how crop losses due to insect pests since the 1940s have nearly doubled despite a ten-fold increase in insecticide use. Even though this loss has been appreciably offset by increased crop yield, it points to a need for greater consideration of ecological factors. In the final chapter and one of the best, Paul Risser compares system stability and fundamental processes such as patterns of nutrient flow in natural and agricultural ecosystems. He concludes that essential though only partial understanding of agroecosystems can be gained from natural systems and that useful approaches are most likely to arise from models that anticipate the needs of agriculture not only on local but also on regional and global scales.

In sum, the book provides much insight into a range of theoretical ecological concerns bearing directly or indirectly on pest management strategies and tactics. It can be highly recommended to all ecologists and others interested in IPM. I had hoped it might also serve as the much-needed new textbook for courses in IPM. For that purpose, however, it is too heavily weighted toward insects and too little toward weeds and plant diseases. Moreover, there is no treatment of theories of sampling pest and natural enemy abundance or theories relevant to decisions on need for intervention to prevent pest damage. These are fundamental concerns of current IPM practice.

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