# Book Reviews

## Insect Populations: The Central Question

**The Ecology of Insect Populations in Theory and Practice.** L. R. CLARK, P. W. GEIER, R. D. HUGHES, and R. F. MORRIS. Methuen, London; Barnes and Noble, New York, 1967. 246 pp., illus. $8.

One of the most important but least tractable problems of ecology is the identification of the mechanisms that control population density. In the search for laws governing abundance of organisms, ecologists have posed the central question: Is population density self-regulating? If it is, then abundance can be said to be stabilized and nature balanced in the strict sense. Entomologists have played a leading role in the development of the subject, and they have been responsible for the formation of two sharply opposed schools of thought. One group, which began with C. W. Woodsworth, L. O. Howard, and W. F. Fiske nearly 60 years ago and more recently has included H. S. Smith, A. J. Nicholson, and M. E. Solomon, has argued from deductions and fragments of empirical evidence that density *must* be self-regulating. If it is not self-regulating, that is, if "density-dependent" factors do not at some point or other come into play, then density-independent factors must force population numbers up and down in a random-walk pattern until they either become astronomically large or go to zero. In its extreme form—as exemplified by the recent "social conventions" theory of V. C. Wynne-Edwards—this interpretation assumes the occurrence of self-regulating mechanisms to be universal and to involve elaborate adaptations on the part of many species.

The opposing argument had its origin in the more recent "physical factor ecology" of F. S. Bodenheimer and B. P. Uvarov and has been most effectively advanced in some of the writings of H. G. Andrewartha and L. C. Birch. The latter authors have attacked the density-dependence argument as no more than a beguiling mental construction. They have cited cases in which most of the fluctuation in population can be accounted for by correlated fluctuation in weather variables, and they have assigned density-dependent factors to a minor, even trivial role in nature.

Meanwhile, data suitable for the resolution of the problem have been inconspicuously accumulating in long-term studies of insect populations. A majority of these studies concern pest species and have been conducted over a period of years by economic entomologists striving for practical results and with no theoretical axes to grind. The importance of the book under review is that it provides the first thorough, objective evaluation of enough of these results to begin to make some real sense of the matter. The truth as seen by Clark *et al.* is not at all simple, as of course one might have expected from the nature of the controversy. It might be very roughly summarized as follows: Density-dependent controls are widespread and possibly universal, but they vary immensely in kind and in the frequency and intensity of their operation from species to species. In some species these controls are paramount, holding numbers relatively steady or locked in predictable oscillations, whereas in others they are lax or even absent over long periods of time, with the result that weather gains nearly complete sway. The details are spelled out in intensive accounts of ten of the best-studied insect species. Objectivity is achieved by the regular use of original data and lengthy quotations from the original authors. Much of the material had previously been limited to entomological journals and agricultural house organs and was not well known, even to those population ecologists with the greatest stake in the matter. To select one example, I was especially interested in the account of the role of polymorphism in the oscillations of the Engadin Valley, Switzerland, populations of the gray larch budmoth. According to the authors' interpretation, at low densities a "strong" form gains the advantage by virtue of higher reproductive capacity and tendency to disperse; then, as high densities are reached, the "weak" form is favored because of its greater resistance to granulosis virus; next it begins to replace the "strong" form, only to be attacked by hymenopterous parasites which favor it differentially, thus starting the cycle back down again. Characteristically, nothing approaching this particular form of density-dependent control was found in the other nine species reviewed.

The book is at its best in its dispassionate review of earlier contending hypotheses and the small but growing set of case histories that are beginning to select among them. It also contains a good deal of practical advice for economic entomologists planning population studies. It is weak in its neglect of the mathematical theory of demography and competition, which to an extent seemingly unappreciated by the authors forms the conceptual basis for most of the current empirical research. The writing is also uneven and in spots distressingly pedantic or defensively vague—in other words, the mark of the committee is upon it. The weaknesses of the book are such that it will not be very suitable as a textbook, but it will make valuable extra reading for both graduate students and professionals. In sum, a notable contribution to the literature of ecology.

E. O. WILSON
*Biological Laboratories,*
*Harvard University,*
*Cambridge, Massachusetts*

## Development of Optics

**Historical Aspects of Microscopy.** Papers read at a conference, Oxford, England, March 1966. S. BRADBURY and G. L'E. TURNER, Eds. Published for the Royal Microscopical Society. Heffer, Cambridge, England, 1967. 235 pp., illus. 42s.

A better title for this book would have been "Papers on the History of Optics and the Study of Vision," since only one-fourth of it is devoted specifically to the microscope. In particular, the entire first half is occupied by a long and fascinating paper on "The mechanistic hypothesis and the scientific study of vision" by A. C. Crombie which discusses ancient and medieval concepts of the mechanism of vision, and leads up, like a mystery story to its solution, to the discoveries

of Kepler, Descartes, and others at the beginning of the 17th century. Knowing what we know today, one is tempted to be surprised or even contemptuous that a mechanistic interpretation of vision was adopted so slowly, but the problems are by no means solved. We know only a little of the mechanisms at work within the retina in the processing of an image for transmission down the optic nerve and have even less understanding of the subsequent fate of the image. It is healthy to recapitulate the struggle that was necessary to solve the problem of the first steps in vision.

An article by T. Mulvey on "The history of the electron microscope" again gives us a feeling for the pace and character of an important scientific development. It is to be regretted, incidentally, that the fundamental patents of Reinhold Rüdenberg, which are discussed in Mulvey's references (Gabor, Freundlich), were not mentioned. Rüdenberg's priority as inventor was upheld in American courts and, much later, in Germany, though it is clear that commercial secrecy and his difficulties as a Jew in Berlin severely limited the influence of his ideas. Mulvey's paper correctly describes the development of the electron microscope, in which Rüdenberg apparently played no part; but the invention was legally his.

Two papers are devoted specifically to the optical microscope, S. Bradbury on "The quality of the image produced by the compound microscope: 1700–1840," and G. L'E. Turner on "The microscope as a technical frontier in science." Both give valuable new quantitative information about the actual performance of the microscopes available to early users. Papers by J. R. Levene on "The mechanism of accommodation" and Joseph Needham and Lu Gwei-Djen on "The optick artists of Chiangsu" complete the book.

W. LEWIS HYDE
*Institute of Optics,*
*University of Rochester,*
*Rochester, New York*

## A Formalism for Quantum Physics

**Lectures on Quantum Field Theory**. P. A. M. DIRAC. Belfer Graduate School of Science, Yeshiva University, New York; Academic Press, New York, 1966. 159 pp. $7.50.

P. A. M. Dirac, the author of this somewhat puzzling book, is a giant of 20th-century theoretical physics. His name has long been an everyday adjective for physicists who speak, for example, of the Dirac equation, the Dirac delta function, and of Fermi-Dirac statistics. Any teacher of quantum mechanics will sooner or later refer his students to "Dirac's book" (*Principles of Quantum Mechanics*, first published in 1930). In that astounding work, Dirac achieved a definitive and lasting formulation of the new quantum mechanics, almost at the moment of its birth.

The present volume is the record of a series of 32 lectures on quantum field theory given at Yeshiva University in 1963–64. Special emphasis is placed on quantum electrodynamics (the quantum-theoretical version of Maxwell's electrodynamics), the most successful dynamical theory of modern times. Since its foundations were laid by Dirac himself (1926), these lectures are of particular interest.

The book is devoted largely to an exposition of a novel point of view concerning the divergence difficulties of quantum electrodynamics. Dirac believes that the most serious divergence is that associated with the so-called vacuum fluctuation diagrams. He asserts that these terms are simply dropped in the "usual" treatments, unlike the divergences which are handled by mass and charge renormalization, and that "one really gives up all pretense of logical development in places." This point of view leads Dirac to far-reaching conclusions: the Heisenberg picture of quantum mechanics is "good," the Schrödinger picture is "bad," and the two are not equivalent. Furthermore, the state vectors are not elements of a separable Hilbert space.

The overall aim of the lectures is to formulate quantum field theory entirely in the Heisenberg picture, thereby "cutting a lot of dead wood from the usual presentation." The kind of space in which the dynamical variables or $q$-numbers operate is not specified. For quantum electrodynamics, Dirac makes the "radical assumption" that a physical state corresponds to a $q$-number rather than to a vector. The interpretation of the new formalism is illustrated in part by computations of the anomalous magnetic moment of the electron and the Lamb shift, but is otherwise left incomplete.

Dirac's opinions regarding the necessity of inequivalent Schrödinger and Heisenberg pictures and the need, in particle physics, for a state space "bigger" than a Hilbert space will probably not be shared by many theorists at the present time. A quite different point of view regarding the difficulties of quantum field theory is expressed, for example, by R. F. Streater and A. S. Wightman in their book *PCT, Spin, and Statistics, and All That* (Benjamin, 1964).

The conversational flavor of the lectures has been preserved, and the reader's enjoyment is enhanced by the realization that he is being piloted through the infinite electron sea by the man who invented it.

J. SUCHER
*Department of Physics and Astronomy,*
*University of Maryland, College Park*

## A Culture in Mexico

**The Mixtec Kings and Their People**. RONALD SPORES. University of Oklahoma Press, Norman, 1967. 287 pp., illus. $5.95.

For over 500 years before the Spanish Conquest, the southern Sierra Madre of Mexico was populated by the Mixtecs, a people with a culture characterized by sophisticated gold jewelry and multicolored picture books. While other Mesoamerican cultures have received scholarly attention, the Mixtec has been relatively ignored. The neglect appears strange in the presence of the elements for systematic study which Spores details: accessible archeological sites in abundance, 16th-century documents, and present-day native Mixtecs.

*The Mixtec Kings and Their People* constitutes a pioneer effort at bringing together some of this material and making inferences from it. The author has visited the sites he describes, and deciphered and translated many of the documents he draws upon from archives in Mexico City and Seville. His conclusions are painstakingly drawn. All this gives the work its authoritative tone.

Although historical documents are utilized extensively, the approach is anthropological: it extracts generalities from the data. The picture that emerges for prehispanic times shows the Mixtecs living in limited valley enclaves in