Mechanisms of Insect Dispersal

Migration and Dispersal of Insects by Flight. C. G. JOHNSON. Methuen, London, 1969 (U.S. distributor, Barnes and Noble, New York). xxii + 766 pp., illus. $24.

It is a blessing that British biologists, unlike most of their American colleagues, understand the difference between proximate and ultimate causation and can therefore discuss physiology intelligently. In writing the first modern treatise on insect dispersal, C. G. Johnson has passed confidently back and forth across the little-explored border zones between physiology, behavior, and ecology. The happy result is the formalization of a new branch of entomology and the clearing of the way for new advances in population biology.

The principal theme of this book is that most effective dispersal in insects occurs not through local appetitive movements but through migrations, during which insects travel in a hard, persistent manner and cannot easily be distracted by the stimuli that in other circumstances govern their lives. "A vigorous, even explosive, scattering of individuals often seems as part of a routine in the lives of many species and is no casual, incidental, or humdrum process. Indeed it is a highly adaptive and evolved necessity consequent upon the brevity of the life of most insects or the transience of many breeding places." Migratory flight in particular is viewed by Johnson as the prime locomotory act of many if not most winged insects. The flights follow patterns tailored to the individual needs of the species. The members of some species conduct lengthy powered flights in a single direction. A majority, however, use their wings to work their way up into the wind and to maintain themselves there while being carried along. The migration periods are tightly programmed. In general the flights are conducted by young adults, especially females, at the age of maximum reproductive value in the Fisher sense. Whatever the exact timing, females reduce ovarian development to a minimum at the period of maximum likelihood of flight—a principle Johnson refers to as the "oogenesis-flight syndrome." The migration of an insect is usually triggered by token stimuli that herald the approach of favorable flight conditions or otherwise inform the insect that its physiological state is right. My favorite example is one discovered by K. Graham and cited, among many others, by Johnson. When adults of the bark beetle *Trypodendron lineatum* first leave their burrows they are positively phototactic and attempt to fly. During the flight they swallow air until a bubble forms in the proventriculus, which then causes them to revert to negative phototaxis and settling. If the experimenter inflates the proventriculus of a previously flying beetle, it will cease flight; but if he punctures the bubble it starts flying again.

The book is massively documented from sources that are unfamiliar to most ecologists, who will find particularly useful the reproduction and evaluation of data from such entomologist authors as P. A. Glick, J. S. Kennedy, L. R. Taylor, and Johnson himself. There are lengthy treatments of the relevant aspects of reproductive physiology and orientation behavior and of migration and dispersal in the better-studied groups of insects, including especially the plague locusts. The theory, originated by E. S. Brown and T. R. E. Southwood, that the intensity of programmed migratory activity is a function of the stability of the preferred habitat, finds ample support from new sources. Johnson's chapters on aerial transport, with his separate analyses of vertical and horizontal displacement as functions of individual behavior and weather pattern, must be rated as outstandingly good.

I hesitate to discuss shortcomings in a book of 763 pages and with over 1200 titles in the list of references. But in view of the relative unfamiliarity of the subject it is worth noting what this book does not attempt to do. The author's aim is to synthesize knowledge of the mechanisms rather than the results of migrations. He stops just short of population genetics and evolutionary theory, even though the empirical information he treats is vital to these subjects. Consider for example that gene migration is the least understood of the Darwinian operators, and that without some measure of dispersal the majority of the models of population genetics cannot be applied to natural populations. Consider also that we cannot even hope to define a population without a knowledge of dispersal—what are the limits of a population, for instance, from which 20 or 70 percent of the adult members migrate each generation in some undetermined direction for unknown distances? Johnson also stops short of biogeography. Recent studies with traps have shown, as he says, that there is a "constant rain of millions of insects of all kinds on to open areas where they cannot survive . . . practically the whole land surface of the earth is also subject to a similar, largely unseen, but incessant 'bombardment.'" Moreover, the contribution to the aerial plankton varies enormously among the insect taxa, in ways that must have profound influence on their global distribution. The correlations between the rich data from dispersal studies on the one hand and insect biogeography on the other are left largely to the future. In providing a sound basis for such extensions, however, Johnson has gone beyond the mere review of another entomological subject; he has made a significant contribution to general ecology with implications for the future of evolutionary studies.

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Breeding and Environment

The Ecology of Reproduction in Wild and Domestic Animals. R. M. F. S. SADLEIR. Methuen, London, 1969 (U.S. distributor, Barnes and Noble, New York). xii + 324 pp., illus. $12.

This major review brings together a wide range of studies on the effects of light, temperature, nutrition, density, and social factors on such aspects of mammalian reproduction as attainment of puberty, onset of breeding season, pregnancy, parturition, lactation, and survival of young to weaning. Over two-thirds of the 700 or so references were published in the last eight years, and the references are often from sources found only in the most complete libraries. Especially useful is the detailed information on domestic animals gleaned from animal-breeding and agriculture journals. Although the majority of the studies were done on rodents, rabbits, and domestic and game species, all the major orders of mammals are represented.

The book considers each of the facets of the reproductive process mentioned above, with each environmental stimulus being considered in turn. This pattern is repeated through the chapters. Sections are further subdivided by specific animal groups so that immediate reference is possible without duplication of information. Special attention is given to the relevance of observations from experimental populations to natural ones. Sadleir also compares natural

and experimental populations with regard to social factors in reproduction. In view of the many variables, the author's organizational feat is impressive. Attention is drawn to experimental studies where uncontrolled variables may be significant and where the experimental conditions may have little relevance to normal social conditions in the wild. His failure to include sample sizes along with percentage comparisons reduces the value of some of the data. A glossary or index of common names would also have been helpful to nonmammalogists.

A book on the ecology of reproduction in mammals will appeal to a wide variety of scientists. Whether they are concerned about proliferating swarms of humans and the effects of their density or are bent on breeding beef or reducing the growth of rodent populations, this compendium of research will be useful. Its pages are filled with tables and figures. Obviously, the subject is complicated and only a beginning has been made, but Sadleir has pointed clearly to the gaps. A comparison with similar, recent studies of birds will be fruitful.

Our ignorance of the control of reproduction in wild ungulates is quite astounding in view of their importance as converters of plants into high-quality protein. Recent experiments on African ungulates have demonstrated their higher reproductive rate as well as superior physiological and behavioral adaptations under tropical conditions as compared with domestic cattle. The livestock at present used by Western man were chosen some 6000 years ago. Are these the most appropriate for all of man's varied ecosystems?

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Hosts and Pathogens

Disease Resistance in Plants. J. E. VAN DER PLANK. Academic Press, New York, 1968. xiv + 210 pp., illus. $9.50.

Plant Diseases and Their Chemical Control. E. EVANS. Blackwell Scientific Publications, Oxford, 1968 (U.S. distributor, Davis, Philadelphia). xvi + 288 pp., illus. $12.25.

In *Disease Resistance in Plants* Van der Plank presents many original ideas in a precise, lucid, and readable style, and in a well-organized and logical sequence. In 1963, the author published a book on epidemics of plant disease and their control. The present volume flows naturally from that work. The maintenance of disease-resistant crops is a continuing process. Fungal and bacterial pathogens, when exposed to resistant hosts, evolve races that can overcome the resistance. Van der Plank contrasts two kinds of resistance: vertical, which is based on a few specific genes, and horizontal, which is based on many, the action of which may be indirect. When a vertically resistant variety is attacked in nature, the appearance of disease in the crop is delayed, but, once disease is evident, the pace of attack is not diminished. Characteristically, when horizontal resistance is involved, the pace of the epidemic is reduced. The author illustrates how different varieties of host plants may possess both types of resistance, only one, or neither and discusses how the characteristics of an epidemic differ in each situation. In overcoming host resistance, an evolving pathogen must simultaneously develop contrasting characteristics of aggressiveness toward a susceptible host, depending upon whether the resistance of a host evoking this response is of the vertical or horizontal type. Van der Plank argues that control of obligate parasites, such as the rusts, by vertical resistance requires at least two genotypes of the host in the area under the influence of the pathogen.

Of the two types, vertical resistance is the better known, but the useful life of vertically resistant varieties has generally been short. Horizontal resistance is less dramatic; such plants are often disease-tolerant, rather than hypersensitive, and crops may successfully survive epidemic-favoring conditions. Because horizontal resistance has been less sought, Van der Plank reasons that potentialities for improvement in this type of resistance may be very great. The useful life of varieties with horizontal resistance is likely to be long.

Considering the book as a whole, one notes that the evidence presented in support of the arguments is drawn from relatively few diseases, but they are ones that have been extensively studied, and as a result the examples of principles are the more convincing. By presenting the argument in terms of epidemics and the potential of pathogens to evolve readily when confronted by resistant hosts the author always directs the reader's attention to real situations, however much theory is behind the reasoning. The outlook of the book is one of synthesis and is constructive. It will create improved understanding of disease resistance and stimulate research in the area for years to come.

Evans's book covers physical, chemical, and biological aspects of chemical control of plant disease and is intended as a general introduction. The approach is uniquely broad and will serve well to orient the beginning student who wants an overview free of exhaustive detail. The author presents concepts clearly, with a minimum of technical jargon, while citing evidence adequately to support his presentation. Particularly worthwhile are his discussions of potentialities for control in such contrasting situations as treatment of seed, soil, and foliage and of the limitations on control of foliar diseases when fungicidal sprays are serially applied to combat aerial pathogens.

The broad approach he takes requires the author to generalize concepts. The danger in such an approach to a large and detailed subject lies in the resulting oversimplification. As a result the beginner may believe his understanding to be more comprehensive than is warranted. The experienced worker will be stimulated by this book. He will want to qualify some of the statements, contest others, and introduce a few concepts. He may even be moved to test some of the ideas experimentally. To paraphrase Alice—what is the use of a book that is not stimulating?

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The Biological Clock

Rhythmic Phenomena in Plants. B. M. SWEENEY. Academic Press, New York, 1969. x + 148 pp., illus. $7. Experimental Botany, vol. 3.

Although rhythmic phenomena have been studied for many years, it is only within the past two decades that rhythmicity has been explicitly viewed as a biological regulatory system. The notion that this regulation involves time, that is, that the temporal order and magnitude of biochemical and physiological processes are controlled by an endogenous and rather accurate bio-