action centers linked in series. Photosystem 2 generates a relatively mild reductant and an oxidant that is strong enough to oxidize H_2O to O_2. Photosystem 1 generates a relatively mild oxidant and a reductant that is strong enough to reduce ferredoxin and ultimately nicotinamide adenine dinucleotide phosphate. In both cases, the initial photochemical reaction appears to be the removal of an electron from a chlorophyll complex. The nature of the primary electron acceptor in system 1 has been controversial. Optical absorbance changes and electron spin resonance (ESR) signals that occur under certain conditions suggest that the initial acceptor is a nonheme iron complex called bound ferredoxin. Other experiments implicate another acceptor, "X." It is not yet clear whether X is in the normal sequence of carriers or on a side path. M. C. W. Evans gives a well-balanced account of the experimental observations, in a chapter that emphasizes ESR studies. He favors the view that X is the primary acceptor, but concludes that more work will be needed to settle the question.

Two chapters on photosystem 2 are both extremely well written, detailed but highly readable. In one, R. Radmer and G. Cheniae focus on the mechanism of O_2 evolution. A component "S" appears to become successively more oxidized by the removal of one electron on each turnover of the photochemical apparatus. When S has accumulated four oxidizing equivalents, it reacts with H_2O, generating O_2. Radmer and Cheniae review the evidence that S involves manganese. J. Amesz and L. N. M. Duysens discuss spectrophotometric studies of the primary and secondary electron carriers on both sides of system 2. The electron acceptors appear to be plastoquinones.

The distribution of excitations from the antenna to the two photosystems is treated by W. P. Williams. He considers how the initial distribution of excitations and "spillover" of excitations from one photosystem to the other are regulated so that each can work as rapidly as possible.

Other chapters include discussions of photosystem 1 by J. R. Bolton, of delayed luminescence by S. Malkin, and of linear and circular dichroism by R. P. F. Gregory. All of these contain material of interest, although Bolton's short chapter seems superfluous in view of Evans's more extensive discussion. The chapter on delayed luminescence seems too long in relation to the importance of the topic; that on dichroism is a bit heavy on technical details about commercially available apparatus and thin on experimental results.

Overall, the book provides an up-to-date account of a rapidly moving field. It is well indexed and the chapters are thoroughly cross-referenced. It should be of considerable interest to those beginning work in photosynthesis, to seasoned investigators in the field, and to many more general readers.

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Dormant Bodies

Spore Research 1976. Papers from a meeting, Leeds, Dec. 1975. A. N. BARKER, J. WOLF, D. J. ELLAR, G. J. DRING, AND G. W. GOULD, Eds. In two volumes. Vol. 1, xviii + pp. 1–420, illus. + index. $27.35. Vol. 2, xviii + pp. 421–916, illus. + index. $31.25. Academic Press, New York, 1977.

One would think that a book summarizing research presented at a meeting in December 1975 would by now be so out of date as to be useless. In the case of *Spore Research 1976*, however, the value of the two volumes is not to be searched for in their timeliness, but rather in their breadth and in the depth in which subjects of wide interest are treated. The British Spore Group has been meeting nearly every two years since 1963. This most recent collection of papers reflects the ongoing interests of the major British and Australian spore research groups. The emphasis is on the mechanism of heat and radiation resistance, the genetics of sporulation and germination, spore structure, dormancy, and germination. Few papers deal with molecular biological approaches to understanding sporulation.

A particular strength of these volumes is that they present well-written, detailed research papers containing data of tremendous practical importance. The properties of spores that are most relevant to industrial, pharmaceutical, food, and soil microbiologists are discussed here. Moreover, toxicologists and specialists in infectious diseases will find a wealth of information concerning the production and excretion of toxic substances by a variety of *Bacillus* and *Clostridium* species, as well as analyses of the relationship of toxin production to sporulation. It is interesting to note that only a small minority of the papers describe work with the *B. subtilis* species so much favored by geneticists and molecular biologists.

Some contributions deserve special mention. In the opening chapter E. Freese argues clearly and forcefully that sporulation is not induced by starvation but rather by nutrient limitation leading to metabolic imbalance and slow growth. Freese debunks some commonly held misconceptions about sporulation and recounts the many futile efforts to identify the "repressor" of sporulation. He offers the interesting hypothesis that asymmetric septation triggered by slowness of growth is the key to the onset of sporulation-specific events.

P. Setlow's summary of his elegant work on degradation during germination of spore core proteins is well worth reading, even though the author's more recent studies, some of which have now been published, leave this account somewhat dated.

G. J. Dring and G. W. Gould, two of the editors of the volumes, present a notably lucid description of their theory of the role of water content in determining heat resistance. They have reduced a potentially confusing subject to a form understandable by the uninitiated.

Many contributions should be of interest to readers outside the spore field. Ion transport, membrane proteins, peptidoglycan biochemistry, and gene regulation are all dealt with in ways that have general applicability.

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Pheromones

Chemical Control of Insect Behavior. Theory and Application. H. H. SHOREY and JOHN J. MCKELVEY, JR., Eds. Wiley-Interscience, New York, 1977. xiv, 414 pp., illus. $19.50. Environmental Science and Technology.

Research on chemical communication in insects has reached a state where even the insider has difficulty keeping up with the subject. Since the coining of the term "pheromone" in 1959, more than 100 such substances and related natural products have been chemically characterized and additional signal compounds have been found that more or less mimic natural products. In 1975 a group of specialists in such research met at the Rockefeller Foundation conference center in Bellagio, Italy, to discuss their findings on sensory functions and behavior as well as on matters of application such as "improvements in the traditional ways of managing insect populations."

Throughout the resulting book the authors emphasize how little we actually know of the chain of related functional processes even in relatively simple cases such as the attracting of the male moth to the female. Summarized, the status of this research is as follows: (i) We know many pheromones chemically but know little about the histology and histochemistry of the glands that produce them; further analytical effort is necessary in view of the evidence that many pheromones have several components. (ii) The study of the production, composition, and reception of host substances (attractants, repellents, antifeedants) is still in its beginning. (iii) Pheromone-emitting behavior and odor distribution are not well understood. (iv) Identification of receptor organs and progress in the understanding of sensory transduction have been possible only in some cases. (v) Investigation of central nervous integration has just begun, and little is known about the mechanisms of command and motor control. (vi) Orientational processes are multisensory functions and are little understood.

The book concentrates on signals that are perceived by olfactory organs. After a treatment of the sensory mechanisms, the majority of the chapters deal with the behavioral responses and the nature of host products, pheromones, allomones, and kairomones. The final 100 pages explain the "status and prospects for behavior-modifying chemicals in pest management."

Pheromones, and in particular sexual attractants, are not simple magic means that will enable us elegantly and selectively to eliminate unwanted species and abandon insecticides. But in spite of some disillusionment, there is great potential in the concept of interception of chemical communication in pests at critical phases. To date, pheromones are valued for the detection of expected pest species and for estimation of their population density and have been successfully used to confuse orientation in some cases. Efforts at mass trapping, which was originally thought to be possible, were not successful.

While symposium volumes are often redundant and therefore a special type of pollution, I am glad to see this one in print. Most of the papers are good or even excellent. There is some overlap among the papers, and there are some regrettable gaps (for example, termites are not dealt with). Most unfortunate is that the references following the chapters are not in alphabetical order and that there is no author index. Refinding a given citation out of a total of 1500 in the 24 chapters thus becomes a major task, and that difficulty limits the usefulness of the book.

This is not a book for the beginner (who should rather read H. H. Shorey's 170-page *Animal Communication by Pheromones*, Academic Press, 1976) and will be read from cover to cover only by reviewers, but it is very useful for the researcher, teacher, and pest-control planner.

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