onstrates his capacity to understand and to distill the material—and history, after all, is what is recorded and is not necessarily what actually happened. Using the same material Hallam used I might have given a closely similar evaluation.

For the history for the past 15 years we have in addition to the imperfect published record the memories and documents of many of the principals in the revolution, which if properly weighted should allow a detailed account. To me the part of the book dealing with this era is less satisfying. Hallam, though again he has done better than most writers on this subject, still has not made as much use of such material as one might have hoped. He takes some pains to point out that Holmes proposed a convection-current model of plate tectonics in 1929. Yet, curiously, he later attributes the convection-current model to Hess and gives 1962 as the date, noting that Dietz, who proposed his similar model in 1961, got the idea from a preprint Hess had distributed in late 1960. But from whom had the then-landlubber Princetonian geologist gotten it? Was it from his seagoing rivals at nearby Columbia University, who he often complained were so busy making discoveries that they took insufficient time to publish their findings or to contemplate the ramifications of their observations? An armchair is undoubtedly a great place to sort out thoughts; it is also without doubt that someone has to go fetch the data. Hallam, I feel, at least has an inkling of these derivations.

Hallam is concerned with what constitutes a revolution. Is it when the central idea or observation is made and announced, or is it when a majority accepts it? And if one accepts the latter definition, what constituency is to be polled to determine the consensus?

The real revolution in thought occurred in the 1950's when the reality of continental drift was confirmed by the divergence of polar wander curves determined by paleomagnetism and when the Mid-Oceanic Ridge and its rift valley were discovered and recognized as the line of divergence beween major crustal segments. The 1960's were a time of amplification and proselytization when the bandwagon began to move. To an individual contemporary scientist the answer to when the revolution occurred depends on when he joined. The revolution is over when a majority of active workers are converted, after which the movement becomes an establishment bandwagon. Hallam's book will no doubt be appreciated by revolutionary, would-be revolutionary, neophyte, and last-ditch reactionary alike. It is a good little book on an important subject.

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Respiratory Pigments

Cytochromes. R. LEMBERG and J. BARRETT. Academic Press, New York, 1973. xii, 580 pp., illus. $24.50.

This volume is a valuable research tool to those working with cytochromes, but is a book to be referred to rather than read. It is an encyclopedic guide to the literature up to 1971, written in the compressed, telegraphic style familiar in *Annual Reviews* volumes. The book format is an advantage in permitting a completeness that is denied to the writers of shorter reviews; on the other hand, the customary delays of book publishing mean that this book, considered as a review, was obsolete before it was published. The authors have recognized this difficulty and have provided a 12-page chapter-by-chapter appendix which covers the literature through 1971–1972, but the papers cited there are not mentioned in and have not influenced the text itself.

After two introductory chapters, separate chapters are devoted to eukaryotic cytochromes a, b, and c, bacterial cytochromes and oxidases, the structure of the respiratory chain, physiological aspects of cytochromes, and cytochrome biosynthesis. There is a rather sketchy concluding chapter on cytochromes and evolution. In the sections where the reviewer is most competent to judge, the literature coverage appears to be exhaustive. The authors are not content merely to state the conclusions from current work; they trace in detail the historic development and twists and turns of thinking that preceded what we now know. This frequently makes for heavy going for someone who is trying to learn about cytochromes from the book, and some of the dense summaries packed with literature citations could have been better presented in the form of tables, with less interruption to the narrative text. Much valuable information is present, but uncovering it is often a painful process.

As a result of this tendency to be historical and encyclopedic rather than selective and critical the book is sometimes misleading. For example, a tentative proposal for the conformation of the amino-terminal region of cytochrome c inferred in 1968 from the low-resolution x-ray analysis, and the true structure as presented in 1971 from the 2.8 angstrom analysis, are shown in two successive figures with no indication in the legends that the latter completely supersedes the former. Even more, this book is essentially a "pre-x-ray" treatment of cytochromes. The oxidized horse cytochrome results of Dickerson are summarized, but have little impact on the discussions of the chemistry elsewhere in the book. The name of Scott Matthews does not appear in the book, even though his cytochrome b_5 x-ray analysis was reported in detail at the Cold Spring Harbor Symposium in 1971. (A *Nature New Biology* publication on this work is listed in the appendix.)

I would never give this book to a beginning student who wanted to learn about cytochromes; but I would give it to a graduate student who was moving into unfamiliar territory in the field and wanted to make sure that he had missed nothing among earlier work. It is a valuable research aid, but the ultimate treatise on cytochromes remains to be written.

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The Development of Penicillin

Rise Up to Life. A Biography of Howard Walter Florey Who Gave Penicillin to the World. LENNARD BICKEL. Scribner, New York, 1973. xxii, 314 pp. + plates. $9.95.

In the three decades that have elapsed since penicillin was first used to treat a patient, Alexander Fleming's name has become a household word. Around him has grown the myth of the solitary worker whose destiny "floated in through the window" and who seized the opportunity to give penicillin to the world. Howard Florey, the leader of the Oxford University team that proved that penicillin could actually be used successfully in human diseases, has

stood in Fleming's shadow, even though the Nobel prize for the discovery was awarded jointly to Fleming, Florey, and the chemist member of Fleming's team, E. B. Chain.

Lennard Bickel sets about dispelling the popular idea that Fleming's discovery was the only significant step, after which everything else was inevitable. He contends that Fleming concluded that penicillin could not be purified without destroying its chemical structure and was content to advocate that it be used only for surface infections. The author gives us a picture of Florey as a serious, intense, hard-driving, ambitious scientist whose high standards for obtaining and evaluating scientific data allowed no rest for himself and his colleagues and no compromise with those who had lesser standards. We learn how his personality admirably suited his role of studying carefully the available evidence regarding various substances that seemed to have an antibacterial effect, selecting for his own experiments those that showed the most promise, gathering a team of investigators with the skills needed to fashion these substances into therapeutic agents, and carefully testing them in animals and man, until he had shown that one of them, penicillin, would cure human infections as no other drug had ever done before.

Florey's early life, Bickel shows us, was good preparation for the difficulties that were to follow. Especially it helped Florey push on through many trials and frustrations until Chain found out how to purify penicillin successfully by carrying out the process in the cold and methods could be found to produce enough for the first animal tests and then the large quantities needed to treat patients. Also, a tenacity of purpose, which surfaced during his student days, stood him in good stead when he tried unsuccessfully to interest British pharmaceutical companies in producing penicillin and finally, after much persistence, was able to persuade some American firms to cooperate in large-scale production. But his habitual professional reticence did not allow him to bask in the glow of popular praise.

Bickel makes a good case for his thesis and tells the story well. Unfortunately, he seems to think it necessary to diminish the importance of Fleming's achievement in order to convince us of the significance of Florey's contribution. The reviewer has believed for a long time that Florey was not receiving his due, but he also believes that the Nobel Prize Committee made the proper assessment: Fleming, Florey, and Chain should share equally in the prize, for without any one of the three we probably would not have had penicillin for many years or decades after we did. So great is the significance of penicillin that there is enough glory to go around.

This book is written by an accomplished science writer for the intelligent lay reader, but if the professional reader can overlook the detailed explanations and a certain amount of hyperbole he will find it an interesting account of an important episode in the history of science. Perhaps he will also see in it a reflection of some of his own trials and triumphs as he pursues his less well publicized scientific investigations.

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Insecticides

The Chemistry of Organophosphorus Pesticides. Reactivity, Synthesis, Mode of Action, Toxicology. C. FEST and K.-J. SCHMIDT. Springer-Verlag, New York, 1973. x, 340 pp., illus. $35.20.

Organophosphorus (OP) insecticides are playing an increasingly important role in pest control as the persistent organochlorine compounds are becoming obsolescent both because of the development of resistance on the part of insect pests and because of their pollutant properties. This changing role is emphasized by the rapidly increasing U.S. production of parathion and methyl parathion, which aggregated 19 million pounds in 1960 and reached 56 million pounds in 1970. The greatly increased use of the degradable OP insecticides has had a salutary effect on the quality of the environment. However, most of the OP insecticide used is in the form of highly toxic cholinergic compounds, and these have produced numerous cases of human poisoning and death through misuse, accident, and suicide. Thus the appearance of this authoritative book written by two experienced chemists from the Eberfeld Laboratory of Bayer AG, where Gerhard Schrader, about 1937, began his pioneering work in developing the OP insecticides, is of both historical and current interest.

The book begins with a thoughtful introduction about the role of pesticides in crop production and the challenge of feeding the exploding world population, and recounts the development of the OP compounds. It makes it clear that Schrader's discovery of the nerve gases tabun and sarin took place in 1935–37, antedating both the onset of World War II and the discovery of the first practical OP insecticide, schradan, in 1941, a matter that has often been debated. Parathion and its methyl analog, the most widely used members of the OP group, were not synthesized until 1944. From these beginnings the number of insecticidal OP compounds has certainly exceeded 100,000, and world production is estimated as approaching 200 million pounds.

The authors approach the chemistry of these compounds by emphasizing electronic structure and reactivity, with particular reference to Schrader's formulation in which disubstituted acyl phosphates and phosphorothionates are essential for high activity, and concludes with a condensed section on the confusing subject of OP nomenclature. An excellent chapter of 113 pages on general synthetic methods follows which enumerates the development of the commercial OP insecticides. An amusing item on p. 136 relates the name of malathion to its use in malaria control, when in reality the name was coined from the use of maleic anhydride in the synthesis of the compound, though it has also been ascribed to the compound's mephitic properties.

A chapter on OP biochemistry (105 pages) succinctly summarizes the interactions with cholinesterase, the kinetics of inhibition, structure and activity, insect resistance, metabolism, toxic action, and neurotoxicity. The sections on mechanisms of action are perhaps the least satisfactory of the book, especially with reference to arthropods, where the discussion is simplistic and ignores the considerable amount of histochemical data pointing to acetylcholinesterase of the subesophageal ganglion as the principal target site of OP action. Other disappointing omissions include discussion of desulfuration of phosphorothionates as a critical factor in mode of action and selectivity because of the delay factor, discussion of in vivo lethal synthesis in demeton, phorate, disulfoton, and related systemic insecticides, and the large amount of accurate topical LD_{50} data on insect toxicity of OP compounds, so valuable in structure-activity discussions. Shortcomings such as these are perhaps in-