

mation of great interest to the preparative aspects of the work. Also, as is clearly evident from the current literature, intriguing new areas for the synthetic utilizations of free radical reactions are developing rapidly, including overlap areas between organic and inorganic chemistry, as well as those of biochemical importance.

An appreciation of the subjects summarized in "Free Radical Reactions in Preparative Organic Chemistry" is thus essential for those concerned with current and potential work in the topics covered. Therefore, all chemistry and chemical engineering libraries should certainly have this volume, and many individuals will find the price of a personal copy a sound investment. This book should also prove of direct interest for advanced undergraduates and for graduate students.

DEPARTMENT OF CHEMISTRY  
UNIVERSITY OF SOUTHERN CALIFORNIA  
LOS ANGELES, CALIFORNIA 90007

NORMAN KHARASCH

**Non-glycolytic Pathways of Metabolism of Glucose.** By SIEGFRIED HOLLMANN, Physiologisch-Chemisches Institut der Medizinischen Akademie, Düsseldorf, Germany. Translated and revised by OSCAR TOUSTER, Vanderbilt University, School of Medicine, Nashville, Tennessee. Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y. 1964. ix + 276 pp. 16 X 24 cm. Price, \$12.00.

The original monograph by S. Hollman published in German under the title, "Nicht-Glykolytische Stoffwechselwege Der Glucose" and copyrighted in 1961 by Georg Thieme Verlag, Stuttgart, Germany, has been reviewed by this writer (*J. Am. Chem. Soc.*, **83**, 3922 (1961)). The present translation and revision by O. Touster retains the organization of the material and mode of presentation of the original version. However, the rapid progress of biochemistry in the intervening 3 years necessitated a considerable number of revisions and additions. In particular, some 200 recent references, covering the literature up to October, 1962, were added to the original list of over 1000 references. Touster, himself an authority in this field, has produced an excellent and easily readable translation. The monograph covers both animal and bacterial systems and is characterized by clearness of organization and presentation. A large number of well-printed structural formulas and schemes of reaction sequences are of aid in finding quick orientation in this rapidly expanding field. The book can be recommended to specialists and nonspecialists alike. The former will appreciate the high standards applied in accepting conclusions and the careful weighing of the experimental evidence.

WASHINGTON UNIVERSITY  
SCHOOL OF MEDICINE  
DEPARTMENT OF BIOLOGICAL CHEMISTRY  
ST. LOUIS 10, MISSOURI

CARL F. CORI

**Interpretation of Mass Spectra of Organic Compounds.** By HERBERT BUDZIKIEWICZ, Research Associate, Stanford University, CARL DJERASSI, Professor of Chemistry, Stanford University, and DUDLEY H. WILLIAMS, Research Associate, Stanford University. Holden-Day, Inc., 728 Montgomery St., San Francisco, Calif. 1964. xiii + 271 pp. 19 X 26 cm. Price, \$8.75.

**Structure Elucidation of Natural Products by Mass Spectrometry. Volume 1. Alkaloids.** By HERBERT BUDZIKIEWICZ, CARL DJERASSI, and DUDLEY H. WILLIAMS, Stanford University. Holden-Day, Inc., 728 Montgomery St., San Francisco, Calif. 1964. 233 pp. 19.5 X 26.5 cm. Price, \$10.50.

Although they bear different names the two volumes reviewed here seem to be considered most logically as two-thirds of a trilogy. "Interpretation of Mass Spectra of Organic Compounds," the first third, deals with the fragmentation behavior of organic compounds arranged according to functional groups. The second and third parts, "Structural Elucidation of Natural Products by Mass Spectrometry," Volumes 1 and 2, present applications of the principles discussed in "Interpretation." "Structural Elucidation," Volume 1, which is reviewed here after "Interpretation," deals with alkaloids; Volume 2, which has not yet appeared, will treat other classes of compounds—steroids, triterpenes, amino acids, sugars. These are important books in a dramatically active field.

Not so long ago [*J. Am. Chem. Soc.*, **85**, 2190 (1963)], the reader could still hope that "the ideal book on mass spectrometric applications in organic chemistry" might be on the horizon. That hope has now been sent aglimmering by a single sentence in the Preface to "Interpretation of Mass Spectra of Organic Compounds," the first of the present two volumes, where it is advised that "This book is best read, at least by the uninitiated organic chemist, in conjunction with Beynon's or Biemann's texts, which offer an excellent over-all introduction to mass spectrometry, or with certain selected chapters from some of the other recent monographs."

This is a fair warning, and it should be heeded. A beginner simply should not start with this book alone; it was not intended as a primer. Much is omitted (discussions of operation and instrumentation, of appearance potentials, of molecule ion location); much is treated only briefly (negative ion spectra, high resolution mass spectra); and the discussion of metastable ions on p. xiii is incorrect, since the mathematics of the theory requires that the  $m^* = b^2/a$  relationship hold only for those ions which decompose *after* acceleration. However, these limitations are beside the point; to quote again from the Preface, the authors "have tried as much as possible to avoid overlap with other mass spectrometry texts and to cover material not readily available elsewhere."

The authors' first decision, not to treat those topics well covered elsewhere, seems eminently wise. It would be anticlimatic, for example, to rehash alkylbenzenes and the propylum ion story or to cover in detail aliphatic esters after the superb chapters on these subjects by Grubb and Meyerson and by Ryhage and Stenhagen, respectively, in McLafferty's compendium. In general, the chapters of the latter book seem areas to avoid by other authors, since there they have the real ring of authority. The authors' second decision, to present material not readily obtainable elsewhere, is then the crux of the matter, and the book stands or falls to the extent that they succeed or fail in this more limited objective. To this reviewer, they succeed.

They have performed a considerable service, both to the student desiring to learn mass spectral interpretations and to the organic chemist already versed in the field who wishes to find data on a compound type in a convenient form. While nearly all of the data presented in the book are already available in the primary literature, they are not readily available. This applies especially to the wonderfully various but poorly indexed spectra of the A.P.I. "Catalog of Mass Spectral Data." The present volume is worth its price just for its assembling of the A.P.I. spectra into functional group categories. For example, if one wishes to know how amides fragment in a mass spectrometer, he can leaf through the A.P.I. spectra or he can find a page of discussion in one earlier book on mass spectrometry of organic compounds, isolated comments in a second, and no index entry in a third. However, in "Interpretation of Mass Spectra of Organic Compounds," he finds references to aliphatic, to cycloalkyl, to steroidal, and to tertiary amides, and in eleven pages of text he finds simple amides discussed at length: secondary and tertiary acetamides readily lose ketene, long-chain primary amides give a peak at  $m/e = 59$ , etc. This is precisely the sort of information desired by an organic chemist looking at a mass spectrum. Many other sections are similarly and uniquely useful in the book which, in many respects, seeks to describe the present state of the art. For this reason, the book is recommended to every organic chemist who seeks to interpret mass spectra.

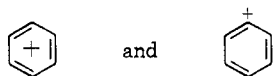
In a subject fraught with the temptation to speculate wildly, the authors have been generally restrained and have documented carefully those fragmentations supported by deuterium labeling, though a particularly welcome addition would have been a general chapter of advice to the unwary, marking pitfalls and stressing the need for concrete evidence. In some cases metastable ion peaks are cited, but that tool could have been employed considerably more widely than it is in confirming fragmentations, as would McLafferty's odd-even rules in explaining them.

It is easy to find faults in any book. In this one coverage is rather uneven, some functional groups being accorded more than their due, others less. Those in the favored category usually have been studied in the authors' laboratory. Thus, isohexyl cyanide does not seem to deserve four pages, nor does the likelihood of encountering an unknown alkyl isothiocyanate seem to warrant the five and one-half pages devoted to this class of compound while one looks in vain for epoxides. Among the heterocycles, substituted pyrroles rate thirteen pages, substituted pyridines only four, imidazoles none. However, this unevenness is

probably justified by the simple lack of available data in a new field, while the stress on the authors' research must result at least in part from the simple fact that their laboratory produces more mass spectral publications than any other.

Probably not enough spectra have been analyzed and the generalizations reached are based on too few. The present book may well serve as a stimulus to fill the gaps in our mass spectral knowledge. It is especially to be hoped that the authors will bring "Interpretation" up to date periodically to take into account new data.

In the symbolism employed for fragmentations and ions, not everyone (not Beynon, Biemann, McLafferty, Ryhage, Reid, and Meyerson, for example) is of the Djerassi fishhook-arrow school, so the chapter, "Note to the Reader" (repeated verbatim, but with an added footnote in "Structure Elucidation") is in the nature of a missionary effort. It is probably a worthwhile book-keeping effort, especially for students, to try to keep track of the electrons, and the fishhooks, arrows, and dots are useful reminders. However, it does require care and even the authors occasionally place fishhooks where arrows are required (*e.g.*, on pp. 175, 244, and 260) or use the  $\cdot+$  scheme inconsistently (as on p. 260). Moreover, it does not seem pedagogically advisable in a book to be used by students to write resonance forms of the same compound as individual entities for fragmentation purposes (as on p. 239). Too, the different meanings of the symbols



(both used on p. 192) need to be stressed somewhere.

All of these misgivings, though, do not obscure the generalization that "Interpretation of Mass Spectra of Organic Compounds" is the most successful attempt to date to systematize organic mass spectral fragmentation patterns.

The general appeal of the second book, "Structural Elucidation," Volume 1, is not as great. One does not have to be both an alkaloid chemist and a mass spectrometrist to wax enthusiastic over this volume, but he probably should be one or the other.

Yet here, too, there are two chapters of general interest. One of these evaluates the utility of the mass spectral method in natural products chemistry and delineates the information to be gained from it—molecular weight, functional groups, skeletal structure. This chapter provides much useful information, but has omitted some. For example, Nuclides markets a single focusing mass spectrometer, and both Atlas and Hitachi market double focusing instruments. Here, as in the "Interpretation" volume, deuterium labeling may be over-stressed as a panacea. Very recent results with high resolution mass spectrometry, especially in Biemann's laboratory, suggest it may be at least as useful as deuterium labeling. Readers of Ryhage and Stenhagen since 1956 may also take issue with the statement that "Except for a few isolated instances, the use of mass spectrometry in the field of natural products did not start until around 1960."

The second general chapter is delightful though. This deals with techniques of deuteration, and provides a very useful guide to the methods available for specific deuterium labeling in various positions about carbonyl, hydroxyl, and aromatic groups, and elsewhere in organic molecules. The useful information detailed extends to a list of suppliers of deuterated reagents, and the chapter is over-all the best available on the subject.

The remainder of the book covers the characteristic fragmentation patterns of a number of classes of alkaloids. Many chapters end with a statement summarizing the results of the chapter. Of this material, eight chapters and 131 pages deal with indole alkaloids, six chapters and 54 pages with other classes. Although Biemann's book covers many of the same compounds in the indole series, the present volume is two years more recent. The stress on the indole alkaloids might seem disproportionate until one recognizes that it is precisely the indole alkaloids which have been most studied, especially by the Biemann and Djerassi groups, so that this book, like "Interpretation" can be said to represent the "present state of the art."

A very helpful chapter, which would have been welcome though perhaps impossible to write, would be one summarizing how to assign an unknown alkaloid to one class or another. The impression gained by the treatment here is that mass spectrometry is a highly useful tool in the field, provided one already knows he is dealing with an iboga or an aspidospermine alkaloid, but that this prior knowledge depends on other information like ultraviolet spectra or biogenetic correlations.

As a final comment, the publishers are to be congratulated on taking their place with Reinhold (and the authors with the Fiesers) in demonstrating that it is quite possible to publish a book rapidly. The authors state in the Preface that publication was less than three months after receipt of the manuscript and this is apparent, since a number of the references are to 1934 papers. The reduction in publication time is to be warmly cheered; much of the credit doubtless goes to the authors for their cooperation in meeting deadlines.

Speed, of course, is not without its disadvantages: the book has a somewhat hurried look about it and errors have inevitably crept in, though some (but not all) of these are corrected in an errata sheet sent to purchasers of the book. The over-all advantages of speed of publication in an area as active as this are enormous, however. One can only await with interest the arrival of "Structure Elucidation," Volume 2, and this reviewer closes with the repeated hope that the authors will keep their works current with new editions.

DEPARTMENT OF CHEMISTRY AND KENNETH L. RINEHART, JR.  
CHEMICAL ENGINEERING  
UNIVERSITY OF ILLINOIS  
URBANA, ILLINOIS 61803

**International Series of Monographs on Analytical Chemistry.**  
**Volume 12. Organic Polarographic Analysis.** By PETER ZUMAN, Polarographic Institute, Czechoslovak Academy of Science. The Macmillan Co., 60 Fifth Ave., New York 11, N. Y. 1964. x + 313 pp. 15 × 22.5 cm. Price, \$6.50.

This book represents a concise and all-inclusive review of the applications of polarography to organic chemistry. The author is eminently qualified for this presentation since he has worked with all phases of this technique.

The book consists of twelve chapters which discuss basic principles, instrumentation, experimental techniques, classes of polarographically active compounds, direct and indirect methods of analysis, separation techniques, practical applications, and applications to organic syntheses, isolation of natural products, studies of reaction rates and equilibria, and structures of organic substances. Numerous procedures are presented in detail in a number of the chapters to illustrate the efficacy and simplicity of the method.

Ample cross references and a comprehensive index facilitate its usefulness both as an introductory and reference text for organic polarography.

Errors are infrequent and are mainly involved in setting up the formulas on pages 123 and 134. Linguistic errors are rare.

The principal omission in applications is the use of the polarographic behavior in aprotic solvents as a rapid method of determining which organic compounds are capable of forming monovalent anion radicals.

This text should prove invaluable not only as a starting point for the neophyte who is interested in possible uses of polarography in organic systems but also as a reference text for the specialist working in this field.

DEPARTMENT OF CHEMISTRY STANLEY WAWZONEK  
UNIVERSITY OF IOWA  
IOWA CITY, IOWA 52240

**Chemical Applications of Infrared Spectroscopy.** By C. N. R. RAO, Department of Chemistry, Indian Institute of Technology, Kanpur, India. Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y. 1964. xiii + 683 pp. 16 × 23.5 cm. Price, \$19.50.

This rather impressive volume is a full-scale attempt to cover the whole field of the chemical applications of infrared spectroscopy which the author considers as the most powerful tool at the disposal of the organic chemist. It can be divided roughly into two equal parts: the first part concerns the general applications of infrared spectra in organic chemistry; the second one, specific applications.

A comparison of the first part with the monographs of Jones, *et al.*, and of Bellamy makes it abundantly clear that Dr. Rao has leaned extensively on these earlier publications both for source material and format, completing their material and covering the new developments up to 1962. The approach is essentially em-