ton product. To a 20-mg. sample of protein in 2.2 ml. of 0.1 molar sodium acetate buffer of *p*H 5.6 was added 66 μg. of potato phosphatase[7] and the mixture incubated at 37°. In order to determine proteolytic activity as well as the liberated inorganic phosphorus, the reaction mixture was divided, after incubation, into two parts. To a 1-ml. portion, an equal amount of 20% trichloroacetic acid was added, the mixture immersed in boiling water for 10 minutes and the inorganic phosphorus determined after centrifugation of the precipitated protein. With the aid of the hemoglobin method[8] the second sample was assayed for proteolytic activity. The results, together with additional experimental details, are summarized in Table I.

As shown in Table I, potato phosphatase dephosphorylates pepsin and pepsinogen without loss of its proteolytic activity. This indicates that the phosphorus in these proteins is not essential for either the enzymatic activity of pepsin or the pepsinogen–pepsin transformation.

Although not shown in Table I, intestinal phosphatase also dephosphorylates pepsin but at *p*H 8.9. Exposure of the protein to this alkaline reaction results in loss of the proteolytic activity. Pepsinogen is also dephosphorylated by intestinal phosphatase. The latter protein, however, is stable at *p*H 8.9 and proteolysis of hemoglobin is observed on subsequent conversion to pepsin at *p*H 2. In contrast with the potato and intestinal phosphatase, that derived from prostate and active at *p*H 5.3 does not act on pepsin. Since this is the enzyme that removes selectively the phosphate group that is lost in the $A_1 \rightarrow A_2$ transformation of ovalbumin,[4] the linkage of the phosphorus in pepsin is probably different from that of the A_1 component of ovalbumin that is attacked by the prostate enzyme.

TABLE I

ACTION OF POTATO PHOSPHATASE ON PEPSIN AND PEPSINOGEN

Reaction mixture	Time of incubation at 37° in hours	Phosphorus released per 1 ml. protein soln., μ g.	Phosphorus released by enzyme % of total phosphorus	Relative specific proteolytic activity[a]
Pepsin	0	0	0	100
Pepsin	24	0	0	96
Pepsin + potato phosphatase	24	8.24	99.0	96
Pepsinogen	0	0	0	100
Pepsinogen	24	0	0	98
Pepsinogen + potato phosphatase	24	7.7	96.0	113

[a] The relative specific activity of a freshly prepared enzyme solution is taken as 100.

I wish to express my sincere thanks to Dr. B. L. Horecker of the National Institutes of Health, Bethesda, and to Dr. G. Schmidt of the Boston Dispensary, Boston, for the samples of phosphatases used in this work.

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[7] Kornberg, unpublished.

[8] Anson in Northrop, Kunitz and Herriott, "Crystalline Enzymes," Columbia University Press, New York, N. Y., 2nd edition, 1948, p. 305.

BOOK REVIEWS

Polarography. Second Edition. Volume I. Theoretical Principles, Instrumentation and Technique. By I. M. KOLTHOFF, Professor and Head of Division of Analytical Chemistry, University of Minnesota, Minneapolis, Minnesota, and JAMES J. LINGANE, Professor of Chemistry, Harvard University, Cambridge, Massachusetts. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. 1952. xvii + 420 pp. 16 × 23.5 cm. Price, $9.00.

All those interested in polarography will welcome the publication of the second edition of this authoritative treatise. As the authors point out in the preface of this new edition, the polarographic literature has tripled in size since the publication of the first edition in 1941, and the book, in its new edition, is divided into two volumes covering the fundamentals and the applications, respectively. The present review covers the first volume.

The material has been brought up to date by extensive revision of the text and by the addition of several new chapters. As a result, the text of the first volume is almost twice as long as its equivalent in the first edition.

Part I covers the theoretical principles of polarography. The basic principles of polarography and voltammetry are discussed in Chapter I. The theory of the diffusion current is extensively discussed in the following three chapters. The reader is guided very firmly in mathematical derivations in these and other chapters. Derivations are thoroughly presented and the various steps in the mathematical reasoning are clearly indicated. Recent developments such as modified forms of the Ilkovic equation, experimental studies of the influence of the capillary characteristics on the diffusion current, and current–time curves are reviewed. Following a chapter on polarography in non-aqueous media, there is a detailed discussion of the various factors affecting the diffusion current. This thorough exposé of the theory of the diffusion current is followed by six chapters dealing with polarographic waves. The very difficult problems presented by polarographic maxima are discussed in Chapter X; analytical applications of the suppression of maxima are reviewed in the same chapter. The theory of reversible waves was well developed at the time of the publication of the first edition, and virtually no change was made in this part of the book, except for the introduction of a new section on dropping amalgam electrodes. In contrast, much new material is presented in Chapters XIV and XV, in which the remarkable studies of the Czechoslovak school on kinetic, catalytic and adsorption waves are reviewed. The Brdicka–Wiesner theoretical treatment based on the concept of the thickness of reaction layer is used throughout the discussion, and the reader is duly warned about the approximate nature of the derivations. The more rigorous treatment of Koutecky and Brdicka is briefly discussed, but the reader is referred to the original paper for the mathematical details.

In Part II, entitled "Instrumentation and Technique," the authors review the abundant literature on polarographic instrumentation. The increase in the size of this section of the book is indicative of the great advances made in the field of instrumentation during the last decade. Chapter XVI which covers polarographic instrumentation, contains a discussion of conventional polarographs, a review of differential and derivative polarographic methods and a brief treatment of oscillographic polarography. Various types of electrodes and cells are described in Chapter XVII. Much new material is presented in the following chapter entitled "Common Operations in Polarographic Analysis." This chapter will be particularly useful to those who have not yet mastered the technique of polarography, but the section of this chapter dealing with electrolytic separations will also attract the attention of the advanced worker. This first volume is concluded by a chapter on voltammetry with solid microelectrodes.

Professors Kolthoff and Lingane have fully succeeded in presenting a well-balanced and logically organized exposé of the theory and methodology of polarography in its present status. By reading this book the student of polarography can master the fundamentals and make himself acquainted with some of the important but yet unsolved theoretical problems of polarography. If the reader is on safer ground in the field of instrumentation, or if he is mainly interested in the applications, he will find all the material needed for a rational use of the polarographic method.

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Statistical Theory with Engineering Applications. By A. Hald, Professor of Statistics, University of Copenhagen. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 1952. xii + 783 pp. 17.5 × 26 cm. Price, $9.00.

This book contains twenty-five chapters. The fundamentals of the calculus of probabilities and applications are treated in the first two chapters. The remaining twenty-three chapters deal with methods of representing data, the fundamental properties of empirical and theoretical distributions, some limit theorems and sampling distributions, the distribution of the mean, the χ-square distribution, the distribution of the variance and the variance ratio, the distribution range, statistical control, analysis of variance, designs of sampling investigations and experiments, linear regression analysis, two dimensional normal distribution, multi-dimensional correlation and regression, the binomial and Poisson distributions, multinomial distribution and χ-square test, sequential analysis, and the main points of a statistical analysis.

Hald's treatise should serve as an excellent and greatly needed course of training in statistics for engineering students on the senior and graduate level and also as a reference for those who have had previous extensive training in statistics. A systematic and complete exposition of the pertinent theory is presented from the standpoint of a mathematical statistician.

The engineer without formal training or experience in statistics will find this book difficult to use. The extensive mathematical formulations and derivations overshadow the applications. An engineer untrained in the field will have difficulty in selecting the procedures and formulas best suited for his immediate needs. Although examples are provided in most of the chapters, no unsolved problems have been provided for student exercises. This detracts somewhat from the value of the book as a text, since the burden of supplying suitable problems rests with the instructor.

The material on quality control and acceptance inspection is timely and well chosen. An excellent example is given of the Doolittle solution of the method of least squares. The references are extensive and carefully annotated.

In the past, engineers seeking information in statistics have been obliged to seek guidance from statisticians in other fields, in the biological and social sciences, and to take courses in statistics in these several departments to encompass their needs. Halds's book thus provides a suitable text-book in the engineering field independent of other sources. The Danish origin of this book does not detract from its use by American engineers.

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The Chemistry of Synthetic Dyes. Volume One. By K. Venkataraman, Director, Department of Chemical Technology, University of Bombay, India. Academic Press, Inc., 125 E. 23rd Street, New York, N. Y. 1952. xvi + 704 pp. 16.5 × 23.5 cm. Price, $14.50.

For some years there has been a need for a comprehensive survey of the broad field of dye chemistry from the standpoint of modern organic chemistry. The present treatise in two volumes covers this field in detail, and brings together in carefully organized form a large amount of material otherwise widely scattered. It includes not only the chemistry of dyes and intermediates but the history of synthetic dyes, industrial organization, raw materials, the action of light on dyes, and the relation between color and constitution.

The titles of the twenty-two chapters of Volume I which follow give an indication of the thorough coverage of the subject: Introduction, Raw Materials, Intermediates, Diazotization and Diazonium Salts, Classification of Dyes, Application of Dyes, Color and Its Measurement, Color and Chemical Constitution, Nitroso Dyes, Nitro Dyes, Azo Dyes—General, Monoazo and Disazo Dyes, Mordant Azo Dyes, Constitution of Metal–Dye Complexes, Trisazo and Polykisazo Dyes, Urea and Cyanuric Acid Derivatives, Direct Cotton Dyes Aftertreated on the Fiber, Pyrazolones, Thiazoles, Stilbene Dyes, Azo Dyes for Cellulose Acetate and Azoic Dyes.

Among the many sources of information which the author has used, are numerous reference books and reviews and particularly the reports which have now become available on the German dyestuff industry. In connection with these reports the author emphasizes the fact that they do not always represent the latest methods actually employed by the Germans, but that they do serve as a general guide.

Of particular value to chemists interested in dyes is the very extensive bibliography and the free use of literature references in the text. This makes it possible to find a discussion and the pertinent literature on almost any phase of dye chemistry or the related organic chemistry. With the stated intention of emphasizing recent trends the author has limited patent citations mainly to the last few years. References are given however to the better sources for coverage of the older patent literature.

In a number of controversial areas the author has included critical discussions and has focused attention on problems needing further investigation.

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Vinyl and Related Polymers—Their Preparations, Properties, and Applications in Rubbers, Plastics, Fibers, and in Medical and Industrial Arts. By Calvin E. Schildknecht, Celanese Corporation of America. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1952. xi + 723 pp. 16 × 23.5 cm. Price, $12.50.

In view of the rapid growth of addition type polymers, this book is a most timely and comprehensive publication. It is particularly important to the young industrial chemist, to the student, or to anyone embarking on some new phase of vinyl polymers because it treats synthetic rubbers, plastics and fibers "which have shown such amazing industrial growth" from a practical aspect. It stresses the chemistry and physics of polymers and polymerization, the advantages and limitations of products, basic invention, operable patents and methods of synthesis; and yet one finds a wealth of information on new and unusual monomers with vital tables and properties.

The first chapter on styrene serves as an introduction. For the novice with a limited knowledge of physical and organic chemistry, it illustrates methods and types of polymerization, defines terms, explains viscosity and molecular structure, and relates properties and methods of fabrication. In logical fashion styrene copolymers are clearly and completely discussed with fundamental postulates and equations, yet avoiding bulky derivations and detail. The voluminous literature on synthetic rubber has been condensed. Selected recipes, catalysts and short stops as used in Germany and the United States are given.

By the end of the third chapter on styrene derivatives, vinyl aromatics and heterocyclics, one begins to appreciate the work and thoroughness that characterizes this book. In concise fashion the maze of data is reduced to essentials. Each monomer is discussed in a perspective that orients the reader as to its importance and generates a feeling that none have been neglected or overlooked. The deluge of references quickly enables one to find the original work (some 4000 have been given). One finds a generous quantity of graphs and tables of physical properties, chemical formulas, equations of syntheses and pictures. Trade names are listed at the end of the chapter with identifying compositions and manufacturers. These include excellent foreign coverage.

In like fashion, the remaining eleven chapters deal with the acrylates and methacrylates, vinyl acetate, vinyl chloride and vinylidene chloride and fluorovinyl polymers. The contrasting problems of the field are revealed in the chapters on the high pressure polymerization of ethylene and the low temperature, ionic polymerization of isobutylene. Vinyl ether, vinyl ketones, nitrogen-vinyl and sulfur-vinyl compounds account for the final chapters.

The choice of examples is superlative; each is a key to the interpretation of some new fact. In attaining breadth, detail has not been sacrificed. The persons whose work the author has cited, the recognition given, the mass of patents screened, the foreign literature reviewed, the very current nature of the information, all reveal a unique insight into this broad subject.

This is an ideal book, provocative, excellent for the practical researcher. From the volume production chart in the front to the graph on patents *versus* year issued at the end, the treatise is well worth reading and should find a ready place on the reference shelf of all persons associated with vinyl polymers

THE DOW CHEMICAL COMPANY
MIDLAND, MICHIGAN STEVENS S. DRAKE

Molybdenum Compounds—Their Chemistry and Technology. By D. H. KILLEFFER, Chemical Consultant, and ARTHUR LINZ, Vice President, Climax Molybdenum Company. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. 1952. xiv + 407 pp. 16 × 23.5 cm. Price, $10.50.

In this 400 page book an attempt is made to describe the chemistry of molybdenum compounds. The book is divided into fourteen chapters which differ widely not only in their size, but in the quality of presentation, understanding, accuracy of reporting data from the literature and in the critical evaluation of so-called published facts.

In their preface the authors bemoan the chaotic state of the chemical literature of molybdenum and attempt to create a monograph more satisfactory than Gmelin, Abegg, Mellor and Friend. The authors state these treatises "report everything published about the chemistry of the element, true and false, probable and fantastic. They are in no sense critical, but rather include all references without attempting to assess values or to resolve contradictions." Although the authors' outcry is justified, and not only regarding the chemistry of molybdenum, their book, in this reviewer's opinion, does not measure up to the Gmelin Handbook, to mention only one.

Chapters I–VIII are devoted to the inorganic chemistry of molybdenum. They are written rather sketchily and without taking advantage critically of the information available in the literature. The subject matter is not well organized as can be seen from the following two examples:

After discussing the physical properties of molybdenum on pages 13–17, the authors mention briefly molybdenum nitride and carbides and then discuss molybdenum mirrors, films and glass molybdenum seals on p. 19, to be followed with no apparent connection by paragraphs on the thermodymamics of molybdenum reactions. A second example is in the chapter on molybdenum halides with an insert on molybdenum carbonyl. It is hard to find references to specific compounds of molybdenum in the book because it has no systematic principle, as, for example, Gmelin's Handbook where every compound between specific elements can be found in a particular section, if known to chemical science.

Chapter IX discusses briefly the structural chemistry of molybdenum. It is written by Linus Pauling and his mastery of the subject shows up the authors at a disadvantage.

Chapter XI is devoted to analytical procedures and discusses in minute detail the methods used by the Climax Molybdenum Company in its analyses of molybdenum products. This is valuable to the laboratory technician but the reviewer has looked in vain for the chemical principle or basis for any particular determination. No chemist can sensibly judge the advantages or disadvantages of an analytical method unless he knows the chemical reaction on which it rests. No chemical equation is ever used to describe the principle of the reaction used.

Nearly half of the book is occupied by Chapter XIV. Although this reviewer is highly critical of the first part of the book, this one chapter deserves unstinted praise and redeems the value of the whole book. This half is a unique feature, not only of this book but of any book on the chemistry of a specific element. The authors have attempted to gather and correlate the whole catalytic chemistry of molybdenum, including all scientific and patent literature on the subject, a most tedious undertaking. The chapter contains a complete patent survey, first arranged alphabetically by countries and second by consecutive patent numbers. It also includes a subject index and a complete literature survey on molybdenum catalysts.

In view of the increasing interest in catalytic chemistry, not only by industry but from the purely scientific standpoint, such a survey will become increasingly desirable in monographs on the chemistry of other metals. Such an attempt has not been made by the treatises originally mentioned and will be welcomed by all scientists interested in this field.

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Quantum Theory of Matter. By JOHN C. SLATER, Professor of Physics, Massachusetts Institute of Technology. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y. 1951. xiv + 528 pp. 16.5 × 23.5 cm. Price, $7.50.

With the appearance of this book, the revision of Slater and Frank's well-known *Introduction to Theoretical Physics* is now complete. The first portions of the revision have appeared as *Mechanics* and *Electromagnetism* by J. C. Slater and N. H. Frank.

The present volume begins with the most elementary topics in quantum mechanics, develops the basic principles, and applies them to atomic and molecular structure, and to the metallic state. There follows a discussion of the properties of matter in bulk, including mechanical, chemical and thermal properties, electrical conductivity, the nature of dielectrics, and magnetism.

Readers familiar with the *Introduction to Theoretical Physics* will find here the same lucid style of writing. The details of quantum mechanics are necessarily mathematical, and the writer on the subject must steer a course which avoids on the one hand the risk of presenting merely a mass of equations, and on the other of a non-mathematical discussion which fails to give enough detail to make it possible to use the material. Slater avoids these difficulties by proceeding slowly, with extensive verbal descriptions. Much of the mathematical detail is put into appendices (21 of them), and numerical illustrations are mainly contained in the 182 problems.

Some chemists may be disappointed by the brevity of the treatment of valence. Very little is included of the resonance theory which is now playing such a role in organic chemistry. To the physicist, for whom the book was primarily written, this is of no great importance, and perhaps its omission from this book is wise in view of the fact that resonance theory involves not only quantum mechanics but a large body of empirical evidence as well.

The treatment of the chemical properties of matter is again very brief. But a complete treatment would mean a chapter on the whole of chemistry, which would be a little too long to include in this volume.

This book, like its companion volumes, is primarily intended as a textbook. This purpose is admirably fulfilled, and the student meeting the subject for the first time should get a sound start in the field. Because it is a textbook, it is less useful as a reference work. Many important points are made in the problems, and while this is a most useful teaching device, it makes them difficult to find in a hurry.

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The Physical Chemistry of Surface Films. By WILLIAM D. HARKINS, Andrew MacLeish Distinguished Service Professor Emeritus, University of Chicago. Reinhold Publishing Corp., 330 West Forty-second Street, New York, 36, N. Y. 1952. xvi + 413 pp. 16 × 23.5 cm. Price, $10.00.

The first three chapters of this book are revised versions of articles Professor Harkins wrote for Jerome Alexander's "Colloid Chemistry." They concern surface films on solids and liquids. Two other chapters on soap solutions and emulsion polymerization are largely direct quotations from the author's papers, together with short connecting passages.

The book, then, is of the nature of a memorial volume which summarizes Professor Harkins' long and distinguished career as a surface chemist. Because of the range of his interests, the book covers a large number of topics, but these topics are quite naturally treated from the standpoint of the author's school.

Therefore, the book is not a textbook or monograph, and it is not designed to be read by someone unacquainted with the field. Anyone with a working knowledge of surfaces, however, will find the book extremely stimulating. We are fortunate that the author was able to gather together and edit his many ideas before his death.

The last chapter is by E. J. W. Verwey, and is on the electric double layer. It, also, is reprinted from Alexander's book.

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Acids and Bases—Their Quantitative Behaviour. By R. P. BELL, F.R.S., Fellow of Balliol College, Oxford, and University Demonstrator in Physical Chemistry. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1952. vi + 90 pp. 11 × 17 cm. Price, $1.50.

The title of this book is somewhat misleading. Its contents are more limited than the title might indicate to many chemists, at least in the United States. A more accurate title would have been, "The Brönsted–Lowry Theory of Acids and Bases."

As an explanation of the Brönsted–Lowry theory, the book is a well-written and comprehensive presentation. If the limited subject matter is kept in mind, the chapter headings convey a good idea of their contents: I. The Nature of Acids and Bases. II. Acid–Base Equilibria in Water. III. Acids and Bases in Nón-Aqueous Solvents. IV. Interionic Attraction in Acid–Base Equilibria. V. Acid–Base Strength and Molecular Structure. VI. Acid–Base Catalysis. VII. Alternative Uses of the Terms Acid and Base.

The first three chapters contain a good historical introduction to the subject of acids and bases, regardless of which theory one may prefer now. However, chapter III contains none of the recent work on quantitative titrations in non-aqueous solvents, particularly by J. S. Fritz. The fourth chapter deals with ionization constants, activity coefficients and the salt effect. Chapters V and VI on molecular structure and catalysis give an excellent brief account of a subject upon which the author has written previously in papers and in other books.

The last chapter is the only one that discusses the Lewis theory of acids and bases, and then merely to give the author's reasons for preferring the Brönsted–Lowry theory. These reasons seem to be advanced from the standpoint of a misapprehension that is fairly common, one that may have originated from the failure of Lewis to emphasize sufficiently the importance of displacement in acid–base phenomena. This misapprehension is that somehow the Lewis and the Brönsted–Lowry theories conflict with one another.

Actually no conflict exists, because the Lewis theory includes the Brönsted–Lowry theory as one kind of displacement reaction. A base may displace another base from combination with a primary acid. For example, ammonia displaces trinormalbutylamine from combination with boron fluoride. If the primary acid is the proton, the displacement of one base by another is covered by the Lewis theory and by the Brönsted–Lowry theory in exactly the same way. Thus for displacement reactions of hydrogen acids the two theories are identical.

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Synthetic Methods of Organic Chemistry. Vol. 5. By W. THEILHEIMER. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. 1951. xii + 612 pp. 16 × 23$^1/_2$ cm. Price, $14.00.

This present volume is a member of a series which records new methods for the synthesis of organic compounds, improvements of known methods and also old proved methods that are now to be found in periodicals. The system of Weygand has been adopted and reactions are grouped on a simple, although purely formal basis. This system has been outlined in the review of Volume 1 (H. Heymann, THIS JOURNAL, **68**, 1393 (1946)).

Syntheses are recorded in the subject index by starting materials and end products, together with systematic arrangement based on the method of synthesis.

Volume V consists of a collection of abstracts of organic synthetic methods which have been published during 1948 and 1949. In addition, this volume contains a cumulative index for the five volumes in this series.

There are abstracts of methods of preparation for about six hundred and seventy substances, practically all of which have appeared during 1948 and 1949. Interspersed among these entries are references to preparations which have appeared in the earlier volumes of this series.

A tremendous amount of work was involved in this systematization of information dealing with the synthetic methods of organic chemistry. Not only are the editors of this volume to be commended, but equally outstanding has been the work of the publishers. Organic chemists will find this volume to be very valuable and it is hoped that this series will be continued.

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Thiophene and Its Derivatives. By HOWARD D. HARTOUGH, Socony-Vacuum Laboratories, Paulsboro, New Jersey. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. 1952. xvii + 533 pp. 16.5 × 23.5 cm. Price, $16.50, Sub. Price, $15.00.

This book represents the first exhaustive survey of the chemistry of thiophene and its derivatives since the classic work of Steinkopf. The thoroughness with which the author has covered his subject is indeed amazing. The very abundant information on physical properties, such as in the excellent chapter by Dr. Hochgesang on molecular structure and spectroscopy of thiophene and its derivatives, is a distinctive feature of this book, which also endeavors to list every known derivative of thiophene.

The book is much more an extremely thorough compilation than a critical exposition of the chemistry of the thiophene group of compounds. It is therefore not as easy, or enjoyable to read as similar volumes in the Elderfield series. The comparison is not really a fair one, however, since the purposes of the two series are so clearly different.

The worker actively engaged in research on thiophene compounds will undoubtedly find Dr. Hartough's book an essential addition to his library, while the general reader is not likely to profit so much from it.

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