will describe the stereochemistry of the C-19 methyl group in the heteroyohimbine series.

Acknowledgments.—The authors wish to thank the National Science Foundation for financial support. They are also sincerely indebted to S. B. Penick & Co. for supplying the compounds used in this study, and to Dr. William Taylor for his assistance.

DEPARTMENT OF CHEMISTRY MAURICE SHAMMA
THE PENNSYLVANIA STATE UNIVERSITY
UNIVERSITY PARK, PENNSYLVANIA JANE B. MOSS

RECEIVED SEPTEMBER 27, 1961

BOOK REVIEWS

Monographs in Statistical Physics and Thermodynamics. Volume 2. Thermodynamics with Quantum Statistical Illustrations. By P. T. LANDSBERG, Professor of Applied Mathematics, University College, Cardiff, Great Britain. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. 1961. x + 499 pp. 16 × 23.5 cm. Price, $14.50.

"Thermodynamics" by Landsberg is a welcome addition to the growing class of original monographs on theoretical thermodynamics. The opening three chapters, which comprise the meat of the volume, discuss the general theory. With the help of the conceptual apparatus of elementary topology, the author provides the most critical analysis yet available of the Carathéodory theory of entropy and absolute temperature and the thermodynamic theory of the third law. The fourth and fifth chapters, which we shall discuss later, are concerned with applications of the fundamental principles. A series of appendices amplifies some of the discussion in the preceding chapters. The book concludes with a selected bibliography with comments (it was amusing to note that, according to Landsberg, Gibbs' papers on thermodynamics were "published round about the turn of the century"). Worthwhile references are distributed throughout the volume. Many fine and unusual problems are inserted at appropriate intervals. A particularly valuable set is to be found on p. 95 where various shades of meaning of the terms "reversible" and "quasi-static" are analyzed.

It must not be thought that "Thermodynamics" is free from defects. Several criticisms can be leveled against it. The principal one is that the book is difficult to understand. This is due in part to a slightly ponderous style, but more profoundly it is related to the difficulty of maintaining mathematical rigor without loss of physical clarity. If deductive rigor is to be retained, it is necessary to adopt postulates and these are quite arbitrary from the mathematical viewpoint. However, if they are to be satisfactory to the physical scientist, they must represent idealizations of reality, preferably in the form of inductions from experiment. Landsberg understands this; yet the rationalizations which he presents for his postulates are not always entirely satisfactory. For example, the chemist may be dissatisfied with section 21 in Chapter IV on "the extension of thermodynamics to open and non-equilibrium systems." There, a vague and misleading impression is first given that open systems in equilibrium must be accorded the same treatment as systems not in equilibrium. Then, the important matter of defining the energy and entropy of open systems is evaded by the adoption of a definition (p. 129) of "simple" systems for which energy and entropy are asserted to exist and an assumption (p. 136) that many systems are simple. It is not clear whether his definition and assumption apply to electrochemical systems and other complex thermodynamic systems of interest. In this instance, generality has not hurt the mathematics, although it has resulted in a loss of physical clarity. Chapter IV, whatever its defects, is in the classical spirit of the earlier chapters. Chapter V on "Combinations of Thermodynamics and Statistical Mechanics" is, on the other hand, not in the same spirit, but is largely a sophisticated introduction to the statistical mechanics of ideal gases and radiation. In the later sections such diverse topics as "temperature dependent energy levels," "transition probabilities" and "thermodynamics as a precursor of quantum mechanics" are also discussed. The chapter is interesting and valuable, although it is not so penetrating as the first three and it does detract from the unity of the monograph.

Although it is not uniformly outstanding, "Thermodynamics" should be studied by every advanced student of theoretical thermodynamics and particularly by prospective authors of elementary textbooks on thermodynamics. Landsberg has surely achieved more than his modest ambition to "contribute something to our understanding of thermodynamics and to the exposition of its principles."

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF KANSAS RICHARD J. BEARMAN
LAWRENCE, KANSAS

Free Radicals in Biological Systems. Proceedings of a Symposium held at Stanford University, March, 1960. Edited by M. S. BLOIS, JR., H. W. BROWN, R. M. LEMMON, R. O. LINDBLOM and M. WEISSBLUTH. Academic Press Inc., 111 Fifth Avenue, New York 3, N. Y. 1961. xviii + 387 pp. 16 × 23.5 cm. Price, $14.50.

The role of free radicals in biological systems is a question of considerable interest to biologists, chemists and physicists. The importance of the problem is evident from the list of biological processes in which free radicals have been put forward as decisive participants: enzymatic oxidation–reduction, photosynthesis, vision, carcinogenesis, radiation damage, synthesis of biological polymers and aging. The field has been in an increasingly active state of development especially since the development of the electron spin resonance (ESR) technique (1946) and the first use of this technique to observe free radicals in biological materials (1954). ESR studies have now led to detailed experimental evidence regarding the biological roles of free radicals. The widespread occurrence of free radicals in oxidation–reduction enzyme systems has been demonstrated. Detailed quantitative kinetic investigations of ESR signals in such enzyme systems have established new mechanisms and thermodynamic constants not available from conventional biochemical experiments. Characteristic ESR signals have been observed in photosynthetic systems and their kinetic properties analyzed. Free radicals have been observed in living animal tissues, and their relation to physiological processes described. A distinctive difference between free radical concentrations in normal and cancer tissue has been reported. The ESR technique has been used to demonstrate a clinically important difference between normal and pathological liver samples.

The field is in its infancy and many unsolved problems stand in the way of its further development. Among these are the need for ESR spectrometers capable of analyzing living systems with high sensitivity and high resolving power; improvement of methods for quantitation of ESR signals in terms of free radical concentration; development of criteria for associating an ESR signal with a particular substance in complex systems; techniques for observing short-lived ESR effects in irradiated tissues; methods for ESR observations on biological samples larger than 0.1 ml. (the present maximum); development of experimental strate-

gies for ESR studies in clinically important areas to which it may apply (cancer, aging, enzymatic oxidation–reduction systems in specific tissues); the relation of free radicals to unsolved problems of energy transport in biological systems.

The book under review is entitled "Free Radicals in Biological Systems" and contains 29 papers presented at a symposium of that title held at Stanford University in March, 1960. There were 59 participants in the symposium: 7 from abroad, 24 from California and the remainder from elsewhere in the U. S. According to its planner the symposium was designed to "review the progress that had been recently made and to assess the future." It is appropriate therefore that the volume be evaluated against the foregoing summary of the present accomplishments and problems in the field.

Over one-third of the papers deal with the effects of ionizing radiation on solid-state systems of biological interest. They vary considerably in length, experimental detail and depth of analysis. At one extreme is a highly informative treatment of ESR signals in oriented single irradiated crystals of glycine; at the other is a wholly empirical comparison of ESR signals from irradiated "mechanical" and "molecular" mixtures of 16 different amino acids with those due to irradiated cow tail hairs.

About one-fourth of the papers are on free radical components of oxidation–reduction enzyme systems. These, too, vary considerably in content. One paper is chiefly a report of failure to detect an ESR signal in a particular enzyme system and repetition (at a lower level of resolution) of other ESR observations previously reported by other investigators. Another paper derives, from purely optical data, a scheme involving a free radical intermediate, without reporting whether the critical ESR experiments have been done. Since a note to this paper, added in proof, withdraws the scheme, the critical experiment has apparently been carried out, but with negative results. In contrast, a detailed paper (35 pages) on certain flavoprotein enzymes discusses correlated optical and ESR data. This paper is also distinguished in that it represents the only effort reported in the symposium to describe quantitative changes in free radical concentration associated with enzyme activity. Despite the obvious importance of quantitative data in enzyme studies, they are difficult to achieve, and require, for example, careful control over the dielectric properties of the instrument cavity and over comparisons between samples and standard concentrations of free radicals. Unfortunately the quantitative data presented in this paper do not greatly advance our knowledge of this problem. The quantitative data are contained in two figures. In one of these, the ordinate which relates to ESR-determined free radical concentration, is marked "% semiquinone" but neither the legend nor the paper's text describes what experimental procedures and calculations were involved in the derivation of this term. The second figure is intended as a quantitative comparison of ESR and optical data from a butyryl dehydrogenase system as a function of time. Its value is rather limited by the lack of an ordinate which relates to ESR data.

The volume contains a single 4-page paper on ESR studies of photosynthetic systems. This paper contains some interesting conclusions regarding the quantum yield of photo-induced spins but, being so limited in scope, hardly reflects what is now known about ESR observations of photosynthetic systems. The only other papers on light-induced free radicals are two brief reports of essentially trivial observations of ESR signals in plant pigments.

Problems relating to ESR instrumentation are considered in three papers. One includes a useful discussion of principles involved in maximizing the applicability of ESR spectrometers for biological work. Another paper describes the construction of a flow apparatus for ESR spectrometers (elsewhere in the volume, results of the application of a similar apparatus to enzyme studies are given). The third paper describes a double cavity designed "for precision measurements of radical concentration" in ESR spectrometers. The usefulness of the paper to a reader interested in accomplishing this end is somewhat limited by the fact that no quantitative data are given, results being embodied in statements such as "Two samples of DPPH were compared and found very nearly equal in signal amplitude."

A comparison of the contents of this volume with the foregoing summary of the status of the problems suggests that the symposium does not accurately reflect the experimental results, or the unsolved problems of current studies on free radicals in biological systems. Certain editorial inadequacies add to the difficulty which the reader will encounter in using this volume as a guide to the field. The chief of these is that in a number of instances observations which repeat, confirm or contradict earlier work previously published by others are put forward without any mention of the earlier observations.

COMMITTEE ON MOLECULAR BIOLOGY
WASHINGTON UNIVERSITY BARRY COMMONER
SAINT LOUIS 30, MISSOURI

Chemobiodynamics and Drug Design. By F. W. SCHUELER, Ph.D., Professor and Chairman, Department of Pharmacology, Tulane University, School of Medicine, New Orleans, Louisiana, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N.Y. 1960. xiv + 638 pp. 16 × 23.5 cm. Price, $19.50.

This pretentious book attempts to cover all the scientific and practical considerations which now (and in the future ideally could) enter into decisions as to what chemical compounds should be synthesized in order to achieve substances of desired physiological activity.

Although written with great enthusiasm and imagination the text is stuffed with quasi-philosophical absurdities typified by "Scientific investigation is a form of *living growth* in the truest sense of the words and everything which stifles [*sic*] the pulse of life becomes dead—QED!" (p. 587), and is marred by numerous gross misconceptions, careless errors and haphazard documentation.

All things considered it is the belief of the reviewer that this book could seriously misguide a normally unsophisticated student and would prove an unbearable burden to any normally sophisticated teacher who attempted to use it as a text or reference work.

ORGANIC CHEMICAL RESEARCH SECTION
LEDERLE LABORATORIES DIVISION SELBY B. DAVIS
AMERICAN CYANAMID COMPANY
PEARL RIVER, N. Y.

Treatise on Analytical Chemistry. Part II. Analytical Chemistry of the Elements. Volume I. Edited by I. M. KOLTHOFF, School of Chemistry, University of Minnesota, and PHILIP J. ELVING, Department of Chemistry, University of Michigan, with the assistance of ERNEST B. SANDELL, School of Chemistry, University of Minnesota. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. 1961. xxi + 471 pp. 16.5 × 24 cm. Price, $16.00; subscription price, $14.00.

The volume under review is the first of a series of volumes of Part II of this Treatise. It is devoted to the analytical chemistry of hydrogen; water; the gases of Group 0 of the periodic system, and to the alkali metals. Six different authors have contributed to the volume, but the style has been made as uniform as possible by editorial policy.

In addition to analytical methods, there is a thorough introduction (32 pp.) to inorganic nomenclature by W. C. Fernelius, and a chapter (9 pp.) on the general concepts of the underlying philosophy of analytical chemistry by James I. Hoffmann. The various chapters on the elements contain much information on chemical and physical properties, like that normally included in books on general chemistry.

The chapter on hydrogen (23 pp.) by H. F. Beeghley also summarizes information on deuterium and tritium as well, but it is chiefly concerned with the estimation of hydrogen in metals and alloys, either by combustion, vacuum fusion, or by heating *in vacuo*. The determination of hydrogen in organic substances is covered elsewhere in the treatise.

The chapter on water (137 pp.) by J. Mitchell, Jr., follows the general lines of the book on "Aquametry" of which he is co-author. The method of Karl Fischer properly receives main emphasis among the chemical methods for water. There is, however, a thorough review of other chemical methods as well as a brief outline of physical techniques. The uses of infrared measurements, nuclear magnetic resonance spectroscopy, mass spectrometry, neutron scattering and radiometric methods are reviewed, together with numerous conventional applications of physical meas-