
COMMUNICATION TO THE EDITOR

ISOLATION OF A CRYSTALLINE SELENIUM-CONTAINING ORGANIC COMPOUND FROM PLANT MATERIAL

Sir:

Horn, Nelson and Jones¹ and Franke and associates,^{2,3} in connection with their study of the diseases of farm animals apparently caused by selenium in grain, have shown definitely that the selenium is present in an organic form intimately associated or combined with protein. It is important to ascertain the chemical nature of this organic selenium compound and to determine the manner in which it is tied up in the plant, and for several years we have been attempting to isolate it. We have now succeeded, after many failures, in obtaining a crystalline selenium compound having the properties of an amino acid. This substance has been obtained repeatedly from different lots of the same source material in the form of well-defined, elongated prisms. Analyses show it to have the percentage composition: C, 33.38; H, 5.83; N, 10.98; Se, 20.62; S, 4.20; O, 24.99 (by difference).

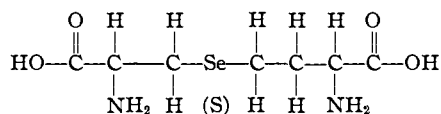
These analytical results correspond to the empirical formula $C_{21}H_{44}N_6Se_2SO_{12}$. The compound gives a strong ninhydrin reaction, and all of its nitrogen is in the amino form. Its equivalent weight is 130.5. It decomposes at 263–265°. It is insoluble in alcohol and organic solvents, and is difficultly soluble in water. The selenium in the compound is notably stable.

(1) M. J. Horn, E. M. Nelson and D. Breese Jones, *Cereal Chem.* **13**, 126 (1936).

(2) K. W. Franke, *J. Nutrition*, **8**, 609 (1934).

(3) K. W. Franke and E. P. Painter, *ibid.*, **10**, 599 (1936).

The fact that all the nitrogen is in the amino form suggests a compound of a simple type. By substituting selenium for sulfur, the simple formula, $C_7H_{14}N_2O_4Se$, is derived, which suggests that we may be dealing with an isomorphous combination of two compounds, $C_7H_{14}N_2O_4Se$ and $C_7H_{14}N_2O_4S$, in the ratio of 2 to 1, respectively. Such an assumption is in agreement with the structural formula



Whatever its structure, it appears that we are dealing with a naturally-occurring new type of amino acid of unusual scientific and economic interest.

This report is wholly preliminary. Further work is in progress and the results will be published later in greater detail.

PROTEIN AND NUTRITION RESEARCH DIVISION
BUREAU OF AGRICULTURAL CHEMISTRY AND ENGINEERING
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M. J. HORN
D. BREESE JONES

RECEIVED DECEMBER 13, 1939

NEW BOOKS

Calculations of Quantitative Analysis. By CARL A. ENGELDER, Ph.D., Professor of Analytical Chemistry, University of Pittsburgh. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y., 1939. viii + 174 pp. 15.5 × 23.5 cm. Price, \$2.00.

This book contains three hundred problems divided into fifteen groups of twenty problems each. The odd-numbered problems are provided with answers and are intended for home assignments. The even-numbered problems are without answers and are intended for class

work, quizzes, or examinations. At the beginning of each section is a short discussion of theory, followed by several examples of typical problems and their solutions. At the end of the book are several tables useful to the student of analytical chemistry.

This book should find ready use in many courses where sufficient emphasis is placed on the solving of problems as a means of learning stoichiometry and other phases of analytical chemistry.

CHESTER M. ALTER

A History of Chemistry. By F. J. MOORE, Ph.D., Late Professor of Organic Chemistry in Massachusetts Institute of Technology. Revision prepared by WILLIAM T. HALL, Associate Professor of Analytical Chemistry in Massachusetts Institute of Technology. Third edition. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y., 1939. xxi + 447 pp. Illustrated. 14.5 × 21 cm. Price, \$3.00.

This latest edition of Professor Moore's book is a careful attempt to retain the general characteristics of the earlier editions and at the same time incorporate into the volume recent advances in chemistry, many more biographical notes and valuable additions to the older periods which had been somewhat neglected. In the main part of the book, there are one hundred and twenty more pages printed on thinner paper, giving no increased bulk to handle.

There are but few adverse criticisms. A number of corrections suggested by Professor Oesper in his review of the second edition unfortunately have not been made.¹ In a publication containing so many facts it is hard to avoid a few errors such as the date when Madam Curie was awarded the Nobel prize (p. 355) and the omission of Lomonosov in the index (p. 440). The biographical notes which have been inserted in the text occasionally make the account seem somewhat disconnected but they serve a purpose that is exceedingly important. The biographical material includes the more important recent books on history of chemistry, yet all but a few of the references in journals such as *Isis* and *The Journal of Chemical Education* are omitted.

The chapter headings are practically the same except that the concluding one is now a single long chapter combining the three preceding the last of the second edition. This is a wise move as the topics of inorganic chemistry, physical chemistry and radioactivity are inseparably connected. The scattering of the final chapter on Chemistry in the United States with many additions through the entire text where the information is pertinent, not only eliminates the former sense of isolation which was given to American Chemistry but also presents the history too often ignored by foreign writers. The introduction and history of the growth of organic chemistry is more logical and greatly improved. Numerous additions to the biographical material, including the brief life history and contributions of famous living chemists, particularly Nobel prize winners, are a distinct asset since the work of living chemists will be a background for the future. Few histories discuss the work of contemporary chemists. Therefore this book will remain up to date for a longer time. The author also indicates that it is increasingly difficult to keep up with all fields of chemistry so that this biographical material demonstrates that the science is progressing at a rate never before equalled.

There are quite a number of new illustrations and some of the former dubious and less important ones have been eliminated. Instead of feeling that the book is a trifle too brief to be used as an essential purchase by students of the history of chemistry, the new edition contains enough material to make the reviewer feel that it gives a splendid foundation from which to start toward further

reading. Both the author and publisher are to be congratulated upon producing so fine a revision without increasing the price.

VIRGINIA BARTOW

Semimicro Qualitative Analysis. By ARTHUR R. MIDDLETON, Ph.D., Professor of Inorganic Chemistry, Purdue University, and JOHN W. WILLARD, B.S. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y., 1939. xi + 446 pp. 7 figs. 16 × 23.5 cm. Price, \$3.50.

The text outlines a course of qualitative analysis which can be covered in nine to six hours per week for one semester. The preliminary study of the behavior of the common ions, practice in the solution of solid materials and the removal of interfering ions, analysis of seven practice unknowns (not graded) and of eight unknowns require 32 laboratory periods. At Purdue, an additional 14 laboratory periods are devoted to the analysis of salt mixtures and alloys.

A special section gives a detailed description of the semimicro technique. The working directions are presented in detail and the methods have been tested with large classes. The separations are performed in centrifuge cones and the volumes of precipitates are made the basis for the estimation of quantities. An interesting rigid scheme of elimination is followed in the detection of anions. Only a few organic reagents are used.

The theoretical part, which occupies nearly half of the volume, contains much useful information. The sections on the use of units in chemical calculation and on the precipitation of metallic sulfides are of special interest, and the sharp distinction between homogeneous and heterogeneous equilibria is a commendable feature. While the advisability of the introduction of the definition of acid and base in accordance with the conceptions of Hantzsch may be questioned and the substitution of hydronium ion for hydrogen ion is objectionable as long as the state of hydration of the other ions is not indicated in the equations, the animated presentation recommends the book, which rates among the best of its kind.

A. A. BENEDETTI-PICHLER

Inorganic Syntheses. Volume I. By HAROLD SIMMONS BOOTH, Western Reserve University, Editor-in-Chief, and L. F. AUDRIETH, JOHN C. BAILAR, JR., W. CONARD FERNELIUS, WARREN C. JOHNSON and RAYMOND E. KIRK. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y., 1939. xiii + 197 pp. 31 figs. 16 × 23.5 cm. Price, \$3.00.

The dedication in the fly leaf of Volume I of *Inorganic Syntheses* reads as follows:

To

the countless unknown but valiant soldiers of science upon whose labors *Inorganic Syntheses* are based, this series of volumes is dedicated in the hope that it will ease the toil of future legions.

This dedication helps one to realize the amount of labor and enthusiasm which has preceded the compilation of this

(1) R. E. Oesper, *J. Chem. Education*, **8**, 2101-2102 (1931).

book, and the unselfish devotion of the editors, the contributors, and those who have verified the procedures of the contributors.

In this first volume of the series appear sixty-six procedures for the preparation of a diverse assortment of inorganic substances. The arrangement is in Chapters I to VIII for the Groups of the Periodic Arrangement with Chapter IX reserved for materials or techniques of value to chemists. In this volume the only contribution to Chapter IX is No. 67, A Laboratory Cement. Potassium Fluoroborate is placed in Chapter III, Mono-chloramine in Chapter V and Silicomolybdic Acid in Chapter VI.

The appearance of the contributions appears to follow their availability rather than any systematic plan arranged by the editors. Nevertheless, a good index makes it possible to quickly find if a desired procedure has appeared, and the necessarily unsystematic order of appearance is not really a serious disadvantage.

Some of the methods offered are new but many are improvements on older procedures. Where it is thought helpful a critical survey of known methods introduces the directions for the synthesis and a summary of the more common properties follows the directions. The most important references are given. It should be regarded as fortunate that exhaustive lists of references are avoided. The plan of checking all of the syntheses in independent laboratories and the critical editing of each synthesis by every editor helps greatly to ensure the reliability of the procedures, and it illustrates the degree of devotion shown by all who are engaged in this enterprise.

This series of volumes of Inorganic Syntheses which is so happily begun in this Volume I is destined to be one of the major contributions to chemistry.

ARTHUR A. BLANCHARD

The Merck Index. Fifth Edition. An Encyclopedia for the Chemist, Pharmacist, Physician, Dentist and Veterinarian. Compiled and published by Merck & Co., Inc., Rahway, N. J., 1940. 1060 pp. 17 × 23.5 cm. Flexible fabric. Price, \$3.00.

This new edition of Merck's Index contains so much reference material of extreme value that a brief review cannot possibly do it justice. The list of chemicals and drugs that characterizes the series occupies 592 pages as compared with 570 pages in the Fourth Edition. The descriptions have been simplified, rewritten and rearranged. Many substances of recent importance are included, such as sulfapyridine and α -tocopherol. Structural formulas of many of the complex organic compounds are now given for the first time.

Following this section and not appearing in earlier editions are lists of coal tar colors and dyes used in foods, drugs and cosmetics, with descriptions (4 pages); indicators with properties, including adsorption, mixed, oxidation-reduction and universal indicators (5 pages); important minerals with characteristics, in tabular form (20 pages); and of special usefulness, 350 pages devoted to a list of chemical and clinico-chemical reactions, tests and reagents, listed by names of authors, covering and presumably amplifying the material previously found only in

the rare German list "Merck's Reagenzien Verzeichnis." This is supplemented by an 18-page index arranged by names of substances tested for or employed.

In the remaining 70 pages are found descriptive lists of culture media, fixatives and staining solutions with formulas for their preparation, miscellaneous tables of units of measurement and their equivalents; thermometric equivalents, specific gravity comparisons, anti-freeze mixtures, cooling mixtures, constant humidity solutions, boiling and solidification temperatures of common, useful organic materials, refractive indexes and specific gravities of some important liquids and solids, weights per gallon of many organic liquids; and finally antidotes for poisons (12 pages).

The size of type generally used is smaller than that employed in *Chemical Abstracts*, but the arrangement of the vast amount of material collected into these 1060 pages is so clear, well spaced and uncomplicated as to make possible an almost immediate location of desired information. The labors of the compilers, Drs. Rosin, Addinall and Cone must have been great in preparing so comprehensive and essentially useful a volume.

WILLIS A. BOUGHTON

Chemische Gasreaktionen. (Chemical Reactions in the Gaseous Phase.) By H. J. SCHUMACHER, Director of the Physical Chemical Institute of the University of Frankfurt. Theodor Steinkopff, Residenzstrasse 32, Dresden-Blasewitz, Germany, 1938. xviii + 487 pp. 53 figs. 125 Tables. Price, RM. 32.25; bound, RM. 33.75.

This monograph is third in a series edited by Professor K. F. Bonhoeffer. The first two dealt with photochemistry and with solids. This is restricted to the kinetics of homogeneous thermal reactions in the gas phase.

The book is encyclopedic in its thoroughness. It contains over a thousand references and covers the fundamental theories and practically all the quantitative researches published in the field up to 1938. The conclusions of the various investigators are given accurately and fairly. Occasionally the author makes a critical comment or suggests a different interpretation but in general he merely abstracts the findings of the different researches.

The first 121 pages are concerned with the theories of chemical kinetics. The chapter headings show the wide variety of subjects covered: the laws of mechanical collisions, application of the classical Boltzmann statistics to the velocity and energy distribution in ideal gases, bimolecular collisions, derivation of thermodynamical quantities from statistical mechanics, transfer of energy in collisions, unimolecular reactions, theory of bimolecular reactions, three-body reactions, the quantum mechanical calculation of the absolute rate of reactions. These theories and their formulas are given clearly but the original papers, which are cited, must be consulted for details and proofs.

The second and larger part of the book describes the results of experimental researches. It may be read independently of the theoretical part, which it supplements and illustrates. The several chapters describe first, second and third order reactions, atomic reactions, free radicals,

tracer experiments with deuterium, ortho-para hydrogen conversion and homogeneous catalysis.

The treatment of chain reactions in the last sixty-eight pages is excellent though handicapped by the exclusion of photochemical reactions.

Free radicals and their part in gas kinetics are treated briefly.

The influence of pressure on the specific reaction rate and the observed change from first to second order at low pressures is reviewed. The theories of Lindemann, Hinshelwood, O. K. Rice, Ramsperger and Kassel are summarized and illustrated with over fifty different gas reactions. In the opinion of the reviewer many of these illustrations which depend on pressure measurements alone will need revision if future experimental work shows the reactions to be more complicated. In some cases at least it is likely that the changes appearing at low pressures may be explained by intermediate chemical steps and wall effects.

All the investigations which make up the kinetics of gas reactions have been treated impartially without nationalism or race prejudice. One wonders however if the author was not handicapped in giving adequate recognition for help in the theoretical part of the book, particularly on the wave mechanical calculation of absolute reaction velocities. The footnote to Chapters X and XI "ferner H. Epstein unveröffentlicht" (besides H. Epstein unpublished) may be expressing one of the tragedies of science. With their heritage of internationalism scientists have a special responsibility in helping to bring about a new world order.

The book is clear, complete and well organized, a good example of the thorough German reference books which have done much to bring fundamental science to its present level. Unquestionably "Chemische Gasreaktionen" is the most complete and most up-to-date review of the literature on the kinetics of gas reactions.

FARRINGTON DANIELS

Thorpe's Dictionary of Applied Chemistry. Fourth edition, revised and enlarged, Vol. III. Chemical Calculations-Diffusion. By JOCELYN FIELD THORPE, C.B.E., D.Sc., F.R.S., F.I.C., and M. A. WHITELEY, O.B.E., D.Sc., F.I.C., Imperial College of Science and Technology. Longmans, Green and Company, 114 Fifth Avenue, New York, N. Y., 1939. 608 pp. Price, \$25.00.

The first volume of the Fourth Edition of this Dictionary was reviewed in the November, 1937, number of THIS JOURNAL and the second volume in the January, 1939, number. The comments and commendations previously given apply equally well to this volume so that little more needs to be added. The 608 pages of this third volume cover the same part of the alphabet which required 352 pages in the third edition. This volume contains long articles, many of them entirely new, on chemical calculations, chemical warfare, chlorine, chlorophyll, chromium, cinchona alkaloids, colloids, colorimeters, condensers, copper, corrosion of metals, cyanides, deuterium, diazo-compounds, diffusion and many others. The list of about sixty contributors is a roster of distinguished British chemists.

GRINNELL JONES

Compositiones Variæ. From Codex 490, Biblioteca Capitolare, Lucca, Italy. An Introductory Study. By ROZELLE PARKER JOHNSON. The University of Illinois Press, Urbana, Illinois, 1939. 116 pp. 18 × 27 cm. Price, \$1.50.

The progress of civilization is dependent upon the transmission, to successive generations, of the accumulated knowledge of the past. We are familiar with the main route by which the transmission of chemical knowledge has taken place. The extensive empirical information accumulated by the highly civilized nations of antiquity—Egypt, Chaldea and India—between 3500 and 750 B. C., fertilized by the speculations of the Greek philosophers in the immediately succeeding centuries, found expression in the earliest works on chemistry, namely, those written by the Greek-Roman-Egyptian scientists of northern Egypt in the first, second and third centuries of our era. Most of these, tinged with the alchemical speculations of the period, were destroyed, either as a result of the decree of Emperor Diocletian in 296 against alchemical literature or in the burning of the Serapeum. Some, however, were translated from the Greek into Syrian, into Arabic, and thence finally, in the eleventh century, by scholars in Spain and Italy, into Latin.

There was, however, an alternative route by which the accumulated empirical knowledge of the ancients was transmitted to modern times. Skilled artisans, craftsmen and technicians from the earliest times possessed books of recipes and directions for the prosecution of their art, craft or technology. The earliest surviving example of such a handbook is the collection of Assyrian cuneiform tablets of the seventh century B. C. found in the library of King Assurbanipal at Sardanapalus dealing chiefly with the manufacture of glass and of various pigments. The next surviving example is the Leyden Papyrus X found near Thebes and dating from the third century of our era, composed of a large number of quantitative chemical and technological recipes. It contains little or no theoretical discussion and has distinctly the character of a laboratory manual.

The next representative of this tradition is the manuscript entitled "Compositiones Variæ" described in the present book. This manuscript, dating from about 800 A. D., again is a collection of technical and chemical recipes made by the monks attached to the ancient monastery at Lucca in Tuscany. Its 135 recipes deal with dyeing, the preparation of dyes and of pigments, gilding, varnishing, soldering, gluing, the working of metals and their preparation, the manufacture of glass, parchment, etc. These recipes are unsystematic and are often unduly condensed, but the information given is precise and definite. The mysticism and symbolism so prevalent in later books on alchemy, are completely absent. From the nature of the material and the omissions it appears that they were intended chiefly as reminders for those already skilled in the practice of the various arts with which they dealt.

The chief contribution of the present work is to show that these recipes, on the one hand, can be traced back successively to similar recipes found in such antecedents as the Latin Papyrus X and the Assurbanipal Tablets and, on the other hand, are substantially identical with similar recipes published in succeeding centuries, thus demonstrat-

ing beyond question the reality and importance of this route via recipe book or laboratory manual for the transmission of the chemical knowledge of the ancients.

Anyone concerned with the history of chemistry will find this monograph interesting and illuminating and will wish success to the further studies in this connection which the author mentions. It is unfortunate that the parallel references are given only in the original Greek and Latin, as this considerably restricts their interest and usefulness to the general reader who retains but little of his knowledge of these languages.

ARTHUR B. LAMB

Kurzes Lehrbuch der Enzymologie. (Brief Textbook of Enzymology.) By Dr. phil. THEODOR BERSIN, Professor of Physiological Chemistry at the University of Marburg. Second edition. Akademische Verlagsgesellschaft m. b. H., Sternwartenstrasse 8, Leipzig C1, Germany, 1939. viii + 183 pp. 32 figs. 16 × 23.5 cm. Price, RM. 11; bound, RM. 12.80.

Dr. Bersin has expanded his interesting book with new material, which appeared in the literature since the publication of the first edition in 1938 (reviewed in THIS JOURNAL, 60, 1274 (1938)). The new edition includes brief descriptions and microphotographs of the recently crystallized apozymase, catalase, papain and the several chymotrypsins.

While some references to the literature are given in the book, a more extensive bibliography would greatly improve its value.

HENRY TAUBER

BOOKS RECEIVED

November 10, 1939, to December 10, 1939

F. C. BAWDEN. "Plant Viruses and Virus Diseases." Chronica Botanica Co., P. O. Box 8, Leiden, Holland, and G. E. Stechert and Co., 31 East 10th St., New York, N. Y. 272 pp. Approx. \$4.00 (7 Dutch guilders).

THEODOR BERSIN. "Kurzes Lehrbuch der Enzymologie." Second edition. Akademische Verlagsgesellschaft m. b. H., Leipzig, Germany. 183 pp. RM. 11; bound, RM. 12.80.

G. K. T. CONN. "The Nature of the Atom." Blackie and Son, Limited, 50 Old Bailey, London, England. Distributed in the United States by Chemical Publishing Co., Inc., 148 LaFayette Street, New York, N. Y. 115 pp. \$1.50.

G. K. T. CONN. "The Wave Nature of the Electron." Blackie and Son, Limited, 50 Old Bailey, London, Eng-

land. Distributed in the United States by Chemical Publishing Co., Inc., 148 LaFayette Street, New York, N. Y. 78 pp. \$1.50.

P. J. DURRANT. "General and Inorganic Chemistry." Longmans, Green and Co., 114 Fifth Avenue, New York, N. Y. 547 pp. \$2.75.

GERHARD HERZBERG. "Molecular Spectra and Molecular Structures. I. Diatomic Molecules." Translated by J. W. T. SPINKS. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. 592 pp. \$6.50.

ALBERT P. MATHEWS. "Physiological Chemistry." Sixth edition. The Williams and Wilkins Co., Baltimore, Maryland. 1488 pp. \$8.00.

MARTIN MEHMEL. "Nomogramme zum Mineralbestimmen mit Röntgenstrahlen." Verlag der Deutschen Mineralogischen Gesellschaft, Berlin W 35, Germany. 13 pp.

ELMER S. MILLER. "Quantitative Biological Spectroscopy." Mimeographed by the Burgess Publishing Co., Minneapolis, Minnesota. 213 pp. \$3.50.

S. SNIJDER. "Periodiek Systeem der Elementen met Toelichtingen." P. Noordhoff, N. V., Uitgerszaak, Gröningen, Holland. 1 p. Dutch fl, 0.75.

R. STREBINGER. "Praktikum der qualitativen chemischen Analyse. Einschliesslich Mikro- und Tüpfelreaktionen." Verlag Franz Deuticke, Vienna, Germany. 154 pp. RM. 6.

ARTHUR I. VOGEL. "A Textbook of Quantitative Inorganic Analysis, Theory and Practice." Longmans, Green and Co., 114 Fifth Avenue, New York, N. Y. 856 pp. \$5.00.

A. G. WARD. "The Nature of Crystals." Blackie and Son, Limited, 50 Old Bailey, London, England. Distributed in the United States by Chemical Publishing Co., Inc., 148 LaFayette Street, New York, N. Y. 114 pp. \$1.50.

"Abeggs Handbuch der anorganischen Chemie, Die Elemente der achten Gruppe des periodischen Systems. Vierter Teil. Nickel und seine Verbindungen." Verlag von S. Hirzel, Königstrasse 2, Leipzig C 1, Germany. 310 pp. RM. 40.

"Gmelins Handbuch der anorganischen Chemie." Edited by E. PRIETSCH. 1 Ergänzungsband, Teil 2. "Aluminiumlegierungen Patentsammlung." By G. APEL. Verlag Chemie, G. m. b. H., Berlin W 35, Germany. RM. 49.50.

"Vitamin E." Society of Chemical Industry, Clifton House, Easton Road, London, N. W. 1, England. 88 pp. 5 shillings.