

BOOK NOTES

Enough for One Lifetime: Wallace Carothers, Inventor of Nylon. M. W. Hermes, American Chemical Society and Chemical Heritage Foundation, Washington, DC, 1996. xvii + 345 pp. Cloth (typeset), \$38.95.

Wallace H. Carothers was a brilliant chemistry, whose research at DuPont on polymerization resulted in an intellectual clarification of this field. On the practical side, his work produced neoprene, a useful type of synthetic rubber, and the nylon polyamide fibers and plastics. He was thus the founder of a new chemical industry, and his career deserves a full-length biography. The book by Matthew Hermes fills this gap. Hermes is a Ph.D. chemist and professional research worker.

Carothers (1896-1937) received his bachelors degree at tiny Tarkio College in Missouri. His father Ira was connected with Capital Cities Commercial College in Des Moines, Iowa, and Wallace had a year of study there. He transferred because Ira was a devout member of the United Presbyterian Church, which ran Tarkio College; Tarkio wished to recruit more students. Wallace had become interested in chemistry from reading books on popular science, and his interest was solidified by Arthur Pardee, a Johns Hopkins Ph.D., who taught at Tarkio during Wallace's second and third year. Wallace taught Tarkio's science courses for two years after Pardee's departure. Graduating at the age of 24, Carothers took graduate work in chemistry at Illinois, where he earned his Ph.D. in 1924 with Roger Adams, working on the development of platinum oxide for catalytic reduction. He became the accepted leader of the graduate students at Illinois; Marvel called him the best organic chemist he had ever seen. Although occasionally moody, he published independent work as instructor at Illinois which showed his ability and originality.

In 1926 he became instructor at Harvard, where the senior organic chemistry, E. P. Kohler and J. B. Conant, were both old friends of Roger Adams.

He does not seem to have been very happy at Harvard; he was not a particularly good lecturer, and he was not a natural experimentalist, preferring to read and think about organic chemistry.

At DuPont, C. M. A. Stine had proposed that an outstanding chemist be hired, to work on problems of his own, with several Ph.D. collaborators. Stine felt that such a program would be valuable to DuPont, in ways which could not be specified in advance. Adams, Marvel, and Conant recommended Carothers, and he started work at DuPont in 1928. He had evidently been thinking about polymerization and high-molecular-weight compounds for some time, and his work at DuPont involved fundamental studies in polymer chemistry. After three years of experimental work and study, Carothers published in *Chemical Reviews* a comprehensive discussion of polymerization, which distinguished addition polymerization from condensation polymerization. This paper showed remarkable insight and a very broad knowledge of organic chemistry. Kohler assigned it as required reading to his class in advanced organic chemistry at Harvard, and he appeared to take satisfaction in Carothers' accomplishments.

In about seven years of work at DuPont, Carothers not only clarified the conceptual bases for polymer formation and structure but also did the research from which neoprene rubber and nylon eventually developed. In 1935, the nylon project was removed from Carothers' control, partly because of his increasing absences and disabilities.

Nylon required extensive development work before it was brought to market, and the indispensable effort of E. K. Bolton at DuPont in this respect is de-

scribed in the book. Bolton realized that if polyamides were to be commercially successful, they must be made from readily available starting material. He thus insisted on 6-6 nylon (from adipic acid and hexamethylenetetramine) and worked out practical methods for obtaining these starting materials from benzene. Carothers' polyamide was a 5-10 polymer, with a diacid from castor oil as one component; Bolton saw that this starting material could not support any appreciable commercial development.

Carothers' problems with alcoholism and depression increased during the early 1930s; and, although he got what medical care was available, there was no effective treatment for either condition at that time. Hermes gives the harrowing details of his path to suicide, which occurred on April 29, 1937, before the practical results of his nylon research became known. Adams was telling graduate students in 1937 that outstanding results would come from Carothers' work.

Hermes, a former employee at DuPont, has done a thorough piece of research, interviewing surviving con-

temporaries of Carothers and utilizing the available documentation. The book, although not always felicitous in style, provides as complete a picture of Carothers as we are likely to get. In addition to his scientific talents, Carothers had lively and broad cultural interests, particularly in classical music; and these are described in detail. He appears to have been a man worth knowing for many reasons.

We may think that Carothers was fortunate to have moved to DuPont. Even if he had attained tenure at Harvard, he would not have had the skilled assistants and facilities which he enjoyed at DuPont, and his production of significant work was undoubtedly greater there than it would have been at Harvard. Stine's project at DuPont was important for the company and also for Carothers personally.

Hermes' book gives us a good picture of a great chemist and his times. It can be recommended to students and general readers, as well as to chemists. *D. S. Tarbell, Distinguished Professor of Chemistry Emeritus, Vanderbilt University, Nashville, TN 37235.*

Arrhenius. From Ionic Theory to the Greenhouse Effect. Elisabeth Crawford, Science History Publication/USA, Canton, MA 02021, 1996, xiv + 320 pp. Cloth, \$49.95.

This is a research-oriented book dealing with the scientific career of Svante August Arrhenius, pioneer physical chemist and Nobel laureate in 1903. It is a well-documented account of his accomplishments, the ups and downs of his professional life, and his interactions with other scientists. As such, it should be of value to anyone doing research in the history of chemistry, particularly a person contemplating a biographical study of one of Arrhenius's colleagues, perhaps Wilhelm Ostwald or Jacobus Van't Hoff.

This book is not likely to appeal to a chemist who simply wants to learn more about Svante Arrhenius, the man and the scientist. There are three problems.

The book contains almost nothing about the personal life of Arrhenius. His second marriage, in 1905 to Maria Johannsen, is covered in one sentence. Of his four children, only one is even mentioned and then only in infancy. More critically, reading this book, I got no

impression as to what kind of a person Arrhenius was outside the laboratory.

Neither the author nor the publisher seems to have made any effort to make the book interesting. It is bound in black and set in small type; page after page after page consists of unbroken prose. I was never able to get through more than one chapter in a single sitting.

The author consistently uses the scientific language of a century ago in describing Arrhenius's research. Crawford, like Arrhenius, uses the terms "active molecules" and "inactive molecules." It would have helped to point out that today we refer to these simply as ions and molecules. The phrase "activity coefficient" was used by Arrhenius (and Crawford) to mean something completely different from what it connotes today. This makes it difficult, indeed nearly impossible, for the modern-day reader to follow Crawford's description of the development of Arrhenius's model of ionic dissociation.

This is the first book-length biography of Arrhenius to appear in the English language. There are, however, several well-done biographical sketches written in English. The best of these, in my opinion, is that written

by H. A. M. Selders in (surprise!) the *Dictionary of Scientific Biography*, Vol. 1, pp. 296-302. Another sketch of interest to the nonspecialist is that written by George Fleck in *Nobel Laureates in Chemistry 1901-1922*, pp. 115-22.

Finally, there are two splendid articles relating to Arrhenius and the ionic theory in the scientific literature of long ago. One of these, entitled "Electrolytic

Dissociation," was produced by Arrhenius himself when he received the J. Willard Gibbs Medal at Yale [*J. Am. Chem. Soc.*, 1912, 34, 353-364.] Then there is the "Arrhenius Memorial Lecture" delivered by a friend and colleague, Sir James Walker [*J. Chem. Soc.*, 1928, 1380-1401.] Both are anecdotal, informative, and well worth reading today. William L. Masterton, Department of Chemistry, U. Connecticut, Storrs, CT 06269.

Edward Frankland. Chemistry, Controversy and Conspiracy in Victorian England. Colin A. Russell, Cambridge University Press, Cambridge, 1996. xx + 520 pp. Cloth (Typeset), \$100.

The source material for this first-ever, full biography of Edward Frankland (1824-1899) is largely private: five sets of papers, those still extant numbering in the several thousands, all in the possession of descendants of Frankland. Author Russell was fortunate enough to gain access to this material and arrange for its photocopying on microfilm, which is permanently housed at the Open University [C. Russell and S. Russell, "The Archives of Sir Edward Frankland: Resources, Problems, and Methods," *Brit. J. Hist. Sci.*, 1990, 23, 175-185.] An autobiography (*Sketches from the Life of Sir Edward Frankland*) printed privately in 1901, 2nd expurgated edition 1902, served as an additional resource but in a very limited way.

This biography is a realization of Professor Russell's long-held goal of presenting a well-rounded picture of a fellow Lancastrian whom he describes as "probably the most important figure in British chemistry in the last century." It includes the material on Frankland's early life in Russell's publication: *Lancastrian Chemist: The Early Years of Sir Edward Frankland*, Open University Press, Milton Keynes, 1986. The book consists of 17 chapters, in which Frankland's life is traced from his illegitimate birth to his "last journey," with copious details in between about his education both in England and under Kolbe in Germany, his early research which contributed so significantly to the understanding of valency, his professional career as academician in Queenwood, Manchester, and finally London, his role as a public servant, consultant, and entre-

preneur, the evolution of his own family, and his retirement. Throughout the book the author paints vivid images of Frankland the man: his fragile self-confidence, enormous experimental skills, strong personal ambitions, lack of effectiveness as a lecturer, solitary personality, ambivalence toward religion. The style of writing convinces readers that Professor Russell is taking us on a personal voyage with Frankland, reliving his 75 years, much as the Ghost of Christmas Past accompanied Ebenezer Scrooge on such a journey. We are often invited to consider what Frankland was 'thinking' at critical junctures in his life and made to sense his devotion or antipathy toward family, friends, and professional colleagues.

The book is handsomely presented in sharp print on glossy paper with a generous offering of choice photographs, figures, and drawings. It is full of quotations all carefully annotated as befits a scholarly work; yet the style makes it eminently readable. This reviewer noted very few typographical errors. It was a surprise that there is no mention of Edward's chemist grandson, Edward Percy Frankland (b. 1908), the son of Percy Faraday Frankland (b. 1880); for these constitute one of the few known trios of chemists spanning three successive generations.

Author Russell has made an immeasurably significant contribution to chemical historians by facilitating access to the archival material from Edward Frankland's private papers. The Open University deserves credit for its financial support of this project over an extended period. Furthermore, he has used the material to provide insight into the scientific and social historical setting in which Frankland exerted considerable influence on the way in which chemists thought, practiced their skills, and communicated their ideas. Paul R. Jones, University of Michigan

A Life as Lived. Leonore Hollander, Raspberry Press, Sebastopol, CA, 1996. (Paper).

Dr. Hollander's book is a delightful autobiography, with all the joys and hardships, the terror and sympathy, the hope and realism, the light and darkness one could imagine. She is the American daughter of a Jewish father and German mother, and much of the book relates to her life in Germany during World War II. She wrote the book in bits and pieces, with some repetition at times which makes the book that much more interesting. It is enjoyed best by reading whichever chapter strikes one's fancy as a vignette which stands alone. Then one can read the whole book in stricter chronological order.

Those of us who are "golden-aged" will chuckle and reminisce as we read about Leonore's childhood; perhaps members of the Division of the History of Chemistry will best note the historical events in chemistry which are described from time to time; women will read with awe about the trials the young mother of three experienced after her divorce as she cared for her children during World War II and will marvel at the attempt she

made to keep her marriage together over those trying times and will relate to the problems she had finding a suitable position when she returned to America (in contrast to her fulfilling work in Europe); and all chemists will be fascinated, as I was, as Dr. Hollander describes her interaction with several Nobel laureates in chemistry (three of whom were her colleagues in the laboratory; her Ph.D. mentor at Illinois was Vincent duVigneaud). This wonderful woman chemist is a compassionate, caring person who has lived a full life as a scientist, mother, grandmother, and benefactor. Her Quaker persuasion has kept her strong through her troubles and happy in better times. Her travels have given her the opportunity to meet people in all walks of life, in many countries. Her advice is a summation of her "life as lived:

The way to learn about our world is to travel as much as possible, do as much as you can, and open your heart and your eyes—rather than your mouth—to the people who come your way. *Helen M. Free, Bayer Diagnostics, Elkhart, IN 46515-0070*

Eilhard Mitscherlich. Prince of Prussian Chemistry. Hans-Werner Schütt, American Chemical Society and Chemical Heritage Foundation, Washington, DC, 1997. xvi + 220 pp. Cloth (Typeset).

This is a translation into English by Professor William Russey, Juniata College, of the original German

edition, *Eilhard Mitscherlich: Baumeister am Fundament der Chemie*, Deutsches Museum, München, 1992. The original was reviewed in this journal by A. J. Rocke (*Bull. Hist. Chem.*, 1992-93, 13-14, 70).