BOOK REVIEWS

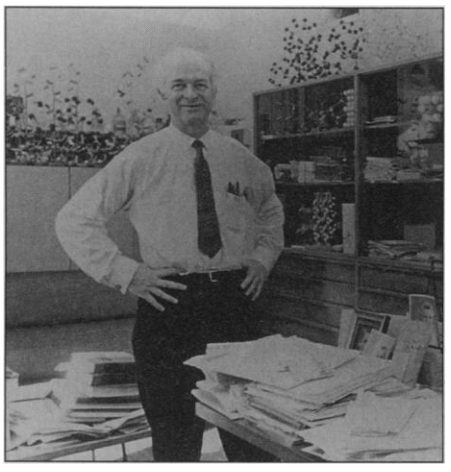
A Career Without Compromise

Force of Nature. The Life of Linus Pauling. THOMAS HAGER. Simon and Schuster, New York, 1995. 721 pp. + plates. $32.50.

Linus Pauling. A Life in Science and Politics. TED GOERTZEL and BEN GOERTZEL. With the assistance of Mildred Goertzel and Victor Goertzel; drawings by Gwen Goertzel. BasicBooks, New York, 1995. xviii, 300 pp., illus., + plates. $27.50.

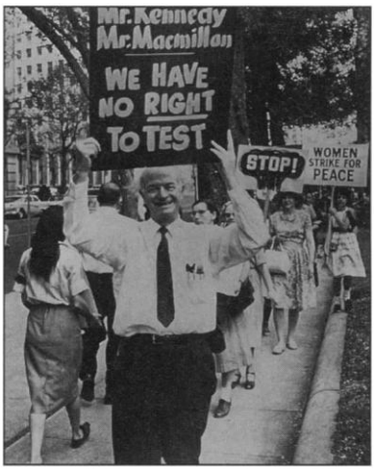
Linus Pauling in His Own Words. Selections from His Writings, Speeches, and Interviews. BARBARA MARINACCI, Ed. Touchstone (Simon and Schuster), New York, 1995. 320 pp. $27.50; paper, $14.

Linus Pauling was a great scientist and educator, as well as a courageous, outspoken, and often controversial public figure. The biographies of Pauling by Hager and the Goertzels cover his life-span, from his birth in Portland, Oregon, in 1901 to his death in Big Sur, California, in 1994. They describe his scientific achievements—and failures—and recount his campaigns against nuclear bomb testing and the attacks on him by congressional investigating committees, as well as dealing with the human-interest matters of family and conflicts with other scientists. The biographies do a good job of conveying two important stories. One story is of how great discoveries are often made, involving a mix of hard work, perseverance, inspiration, salesmanship, and luck. The other is of how a courageous scientist and educator can affect national and international policies.



"Pauling in his Caltech office around 1957, surrounded by molecular models." [From *Force of Nature*; Linda Pauling Kamb]

Pauling's most successful scientific work concerned the structure of matter—the atomic and molecular structure of crystals and the electronic structure of atoms and molecules. He even made sustained attempts to describe atomic nuclei in terms of geometrical structures. Hager's descriptions of some of Pauling's scientific accomplishments in these areas are fascinating. Chemists will be particularly interested to read the story of the near-simultaneous development of valence bond theory by Slater and Pauling in 1931. Hager also gives an accurate description of the stylistic differences between Pauling and Robert Mulliken in connection with their advocacy of competing approximations to molecular electronic structure, namely valence bond theory and molecular orbital theory. At scientific meetings Pauling was always a charming and often convincing speaker, whereas Mulliken was neither, usually mumbling abstractly in an inaudible voice. (Mulliken was kind and friendly in private discussions, but clarity of speech was never a strong point with him.) The personality difference between Pauling and Mulliken was one factor in the early greater popularity of valence bond methods relative to molecular orbitals. Both descriptions of molecular electronic structure are of course quantum mechanical first approximations and if suitably refined lead to the same picture. The question in essence was always which was the more useful first approximation, and for unsaturated hydrocarbons the answer today comes out strongly in favor of the molecular orbital approximation. On the other hand, both biographies state that Pauling considered the idea of valence orbital hybridization to be his greatest scientific achievement. This has certainly stood the test of time, being a concept employed by every chemist and described in virtually all chemistry textbooks. Pauling presented many of his ideas on molecular electronic structure in his famous book *The Nature of the Chemical Bond*, first published in 1939, and also in various editions of his *General Chemistry* and *College Chemistry*. These books changed chemical thinking and chemical education.



"Pauling picketing the White House, 1961. The next evening, Pauling dined inside with the President and Mrs. Kennedy and a group of distinguished intellectuals. Jackie Kennedy told Pauling at the dinner that her daughter, Caroline, had looked out the window at this protest and asked, "Mummy, what has Daddy done now?" [From *Force of Nature*]

Pauling's first major contribution to molecular biology came with his 1949 demonstration, with H. Itano and J. Singer, that sickle-cell anemia is a "molecular disease," due to a mutation in the hemoglobin molecule. These investigators showed that this abnormality was inherited in Mendelian fashion, and this, as Hager points out, constituted a landmark in the history of both biology and medicine. In 1962 Pauling in collaboration with E. Zuckerkandl also used hemoglobin as a "molecular clock," creating the scientific field of molecular evolution. Molecular biology was thus united with the classical fields of evolutionary biology and paleontology. Pauling also made a fundamental contribution to enzymology when he proposed that enzyme combining sites would bind structural intermediates in chemical reactions.

On a number of occasions Pauling told me that he was "lucky" to have discovered the alpha helix, an important structural component of many proteins. The two biographies certainly support the notion of deserved luck. On his 50th birthday in 1951, Pauling together with R. Corey and H. Branson sent their famous paper on the helical configurations of polypeptide chains to the *Proceedings of the National Academy of Sciences*. Although it proved to be based on sound theoretical arguments and the planarity of the peptide bond, the structure was not supported by the x-ray diffraction data available to Pauling at the time. This work was an innovation in methodology, termed the stochastic approach to macromolecular structure. Pauling and his collaborators used this approach to discover

Vignettes: Organizational Functioning

Perhaps the most important question to ask about the scientific approach to employee selection concerns its utility or value. What is the payoff to an organization for using this difficult and time-consuming approach to selection? The answer is not easy to determine. Research has shown that scientific selection can result in the hiring of better employees, but its effects on overall organizational functioning are not as clear.

—*Paul E. Spector*, in *Industrial and Organizational Psychology: Research and Practice* (Wiley)

I know a trainer whose lionesses came to her aid when a male tiger tried to attack her during a show. Possibly the lionesses helped out because the trainer was also a female and was to some extent a group member—certainly more so than the aggressive male tiger could ever have been. Or the lionesses may have seen the difficulty in the ring as a potential threat to themselves and merely wanted to nip trouble in the bud. Whatever the reason, though, the event would not have encouraged anyone seeking to domesticate a lion, because cooperative aggression is not a quality people want in their slaves.

—*Elizabeth Marshall Thomas*, in *The Tribe of the Tiger: Cats and Their Culture* (Simon and Schuster)

another basic structural unit of proteins, the beta-pleated sheet. Pauling's luck ran out in 1953 when he proposed a structure for DNA that proved to be incorrect. This failure to get the right structure has been attributed in part to the fact that his proposed structure was a rush job and he neglected to pay attention to Erwin Chargaff's findings on DNA base pair stoichiometry. Also there can be little doubt that "anti-communist" political opposition to him in 1952 took a toll on both Pauling's time and energy. His competitors James Watson and Francis Crick took advantage of Pauling's own stochastic method in their successful structure modeling.

Pauling's Nobel Prize in Chemistry in 1954 was followed by a Nobel Peace Prize in 1963. The chemistry prize was greeted with virtually universal acclaim by scientists worldwide, whereas Pauling's Peace Prize was criticized by official actions of the U.S. government, some academics, and a number of newspapers. Although the description of these events by Hager is accurate and well documented, it is hard for anyone who has not experienced such events to appreciate the truly oppressive political environment in the United States during the 1950s and '60s. I signed Pauling's 1957 petition against nuclear bomb testing with apprehension concerning possible adverse consequences to me. In my opinion Pauling had a major impact in the international decision to stop atmospheric nuclear bomb tests, to the benefit of everyone.

Pauling's major scientific discoveries were made while he was a member of the chemistry faculty of the California Institute of Technology. His departure from the Institute in 1963 left a legacy of achievement that is recognized today with the Linus Pauling Lecture Hall in the Gates Laboratory of Chemistry, the Linus Pauling Lectures, and the Linus Pauling Professorship of Chemistry.

Pauling had a stubborn streak with respect to his own scientific work. He would rarely admit a mistake or sympathize with a difference of opinion. This is brought out in both biographies, and parallels my own experiences with him when we crossed swords on molecular orbital theory, the molecular basis of anesthesia, and quasicrystals. Pauling was obviously self-confident, as one can glean especially in reading his own words in the anthology by Barbara Marinacci. He also had a subtle arrogant streak. This surfaces in Hager's book where reputable scientists are referred to as "nondescript," a term doubtless due to Pauling himself. Another Pauling characteristic was that he rarely volunteered information on his research that was "in progress" but not published or soon to be so. I discovered this on more than one occasion when I described work of my own only to find out that he had investigated the same subject but not published on it. A notable example was during the 1950s when I described my work on nuclear hyperfine splittings in organic molecules, a subject he had evidently thought carefully about in the midst of his work on macromolecular structures and on ferromagnetism and his problems with adversarial politicians. Missing from all three books is a side of Pauling that I knew from many private one-on-one conversations—warm, friendly, generous, a vast breadth of scientific knowledge, and a great sense of humor.

Although Pauling was often controversial and was sometimes criticized in both scientific and political arenas, it is incontrovertible that he had a major impact on science, education, and international peace. It is entirely appropriate that we now have a variety of books dealing with his life and thoughts. The two present biographies are also valuable from the viewpoint of the history of science as well as of politics in the United States during this century. The book by Hager is particularly well-written, comprehensive, and well-documented.

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Books Received

Animal Cell Electroporation and Electrofusion Protocols. Jac A. Nickoloff, Ed. Humana, Totowa, NJ, 1995. xx, 369 pp., illus. Spiralbound, $64.50. Methods in Molecular Biology, 48.

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Climate Change Atlas. Greenhouse Simulations from the Model Evaluation Consortium for Climate Assessment. Ann Henderson-Sellers and Ann-Maree Hansen. Kluwer, Norwell, MA, 1995. x, 159 pp. $155 or £99 or Dfl. 220. Atmospheric and Oceanographic Sciences Library, vol. 17.

DNA Repair Mechanisms. Impact on Human Diseases and Cancer. Jean-Michel H. Vos. Springer-Verlag, New York, and Landes, Austin, TX, 1995 (distributor, CRC Press, Boca Raton, FL). xx, 384 pp., illus. $89. Molecular Biology Intelligence Unit.

Einstein's Greatest Blunder? The Cosmological Constant and Other Fudge Factors in the Physics of the Universe. Donald Goldsmith. Harvard University Press, Cambridge, MA, 1995. viii, 216 pp., illus., + plates. $22.95.

Flame Structure and Processes. R. M. Fristrom. Oxford University Press, New York, 1995. xvi, 510 pp., illus. $95. Johns Hopkins University/Applied Physics Laboratory Series in Science and Engineering.

The Guinea Pig. Healing, Food, and Ritual in the Andes. Edmundo Morales. University of Arizona Press, Tucson, 1995. xxviii, 180 pp., illus. $40; paper, $19.95.

Handbook of Enzyme Biotechnology. A. Wiseman, Ed. 3rd ed. Horwood (Prentice Hall), Englewood Cliffs, NJ, 1994. xii, 738 pp., illus. $85. Ellis Horwood Series in Biochemistry and Biotechnology.

Introduction to Nonlinear Science. G. Nicolis. Cambridge University Press, New York, 1995. xvi, 254 pp., illus. Paper, $24.95.

Microbial Gene Techniques. Kenneth W. Adolph, Ed. Academic Press, San Diego, 1995. xviii, 487 pp., illus. $85. Methods in Molecular Genetics, vol. 6.

Nuclear Wastelands. A Global Guide to Nuclear Weapons Production and Its Health and Environmental Effects. Arjun Makhijani, Howard Hu, and Katherine Yih, Eds. MIT Press, Cambridge, MA, 1995. xxvi, 666 pp., illus. $55.

One-Dimensional Metals. Physics and Materials Science. Siegmar Roth. VCH, New York, 1995. xii, 247 pp., illus. $95. York, 1995. xviii, 497 pp., illus. $84.95; paper, $34.95.

Physiological Plant Ecology. Ecophysiology and Stress Physiology of Functional Groups. Walter Larcher. 3rd ed. Springer-Verlag, New York, 1995. xvi, 506 pp., illus. $54.50. Translated from the German edition (Stuttgart, 1994) by Joy Wieser.