Book Reviews

Spokesmen of Science

The Maturing of American Science. A Portrait of Science in Public Life Drawn from the Presidential Addresses of the American Association for the Advancement of Science 1920–1970. ROBERT H. KARGON, Ed. AAAS, Washington, D.C., 1974. viii, 258 pp. $15.95; to members, $11.95.

This collection includes 15 of the annual addresses delivered by retiring presidents of the AAAS in the half century prior to 1970. The prospect of exposure to so awesome a concentration of official wisdom will not instantly produce a spasm of intellectual excitement even in the most assiduously inquiring mind, but this should not deter any reader concerned with science and society in the 20th century from consulting this volume. All the speakers have earned the right to be heard on broader topics than the research that brought them distinction, and all those represented have used the opportunity well.

The aim of the editor, "to highlight important changes in science-society links," has been admirably fulfilled by his choice of speeches presented chronologically under section titles that themselves tell a story: A Scientific Society: From New Era to New Deal; The Scientist's Endless Frontier: World War II and After; The Burdens of Privilege; and Time of Troubles: The Endless Frontier Reconsidered. Kargon's concise introduction provides a useful survey of federal science-related organizations from World War I on and just enough background and pinpointing of themes to give the book coherence.

Noting the importance of World War I in focusing "attention upon the expanded role of scientists in society" and in imbuing scientists "with a new confidence and a sense of destiny soon to be realized," Kargon emphasizes the contribution that Robert A. Millikan made to America's future scientific leadership through his insistence upon support for more science professorships and more research centers. But, says Kargon,

> Whereas scientists like Millikan and his colleague [George Ellery] Hale doubtless felt the lure of government intervention, with all the resources and power it would bring, they likewise feared government control or interference and remained steadfast in their faith in the altruism of American business leaders and the ultimate social wisdom of development along lines laid down by American individualism.

Experimentation with private and public forms of organization and support of research is one of several themes that recur throughout the speeches. Others are the relative value of basic and applied research, the growth of industrial laboratories and of team research, and, increasingly, concern about the nature of scientists' responsibility for the application of their work, for the framing of public policy, and for the impact of science on humane values.

The choice of speeches was, of course, designed to show the shifting importance of these themes and the changing attitudes of a society in which science was becoming a more and more influential factor. Charles D. Walcott's references to conservation in 1924, for example, reflect quite different social and political parameters from those of Paul Sears's 1957 preview of the environmental crisis. Yet Walcott's address, which like others of the interwar years displays a strong residue of 19th-century optimism and faith in progress, even overtones of Social Darwinism and Manifest Destiny, nevertheless leaps ahead 40 years in calling for an interdisciplinary approach to problems of energy and in deploring the segregation of women scientists.

Although the term "technological assessment" does not appear until Bentley Glass used it in 1970, an underlying anxiety as to whether science is good or bad is there all along. In the '20's its background was the lingering threat of science to religious faith recently publicized by the Scopes trial; in the '30's the critical impulse was economic. In 1939 Wesley C. Mitchell deplored the antiscientific feeling evident in "a widespread disposition to hold science responsible for the ills men are bringing upon themselves—for technological unemployment, for the rise of autocracies, for the suppression of freedom, for the heightened horror of war."

The problem had become far more complex by the time Warren Weaver tackled it in 1955. Placing man's remarkable success in understanding the physical and biological world in the context of other great human achievements—the enunciation of principles of personal conduct by religious leaders and the development of the arts—Weaver argued that the danger posed by the success of science lay not in its destructive powers but in the possibility that by misleading us "concerning the real nature of science and its relationship to the rest of life" this success might destroy our sense of value. Antipathy to science, which Weaver aptly described as a combination of fear, mistrust, and overestimation, had its origin, he thought, in superstitions and half-truths, which he endeavored to counter by discussing at length the characteristics that make science a universal human activity. So skillfully did Weaver generalize his defense that until he quotes in passing a few of the more vitriolic attacks launched upon scientists in the wake of the Oppenheimer hearings one tends to forget the *mise en scène*.

Today, when philosophers, political scientists, sociologists, and psychologists threaten us with a whole family of new academic disciplines based upon how they severally view the scientist and his works, not to mention a growing corpus of literature by interpreters of science interpreting each other, it is good to come back to such competent, albeit subjective, explanations of what scientists think their profession is all about as those of Weaver and Alan Waterman, who presented a masterly exposition of the scientist's code and its self-enforcing mechanisms in his 1964 address, "The Changing Environment of Science."

While the reappearance of old problems in new guise is one of the fascinating things about this review of five decades, the later half of the period sees some new patterns of thought and behavior clearly emerging. With the war still in progress, Arthur H. Compton commented in 1944 on the difficulty of maintaining secrecy in regard to weapons requiring large-scale industrial enterprise and hinted at the interest in international cooperation which already existed in some sectors of the still-

secret Manhattan Project. The growing commitment to internationalism that developed after the war and the benefits to be derived therefrom were the topic of Walter Orr Roberts's 1969 speech advocating more projects such as the Global Atmospheric Research Program.

In addition to Roberts's discussion of the positive things that science could accomplish through international collaboration, Kargon chose for the final section two other addresses that pointed up even more dramatically the alterations that 50 years had made in the way scientists viewed their world and in how society regarded them. That scientists should have more influence, if not actual political power, and that both pure and applied research should expand had been generally accepted as good in the '20's. By 1968 skepticism on both points, with consequent loss of confidence, had affected the scientific community more seriously than society at large.

On the matter of if and how scientists should become active in politics, Don K. Price, dean of the Harvard Graduate School of Public Administration and one of the few social scientists to serve as AAAS president, tried to bring his theoretical insights and his long experience in public service to the aid of his scientist associates currently suffering from the dual shock of intellectual attack and threatened withdrawal of financial support:

> If scientists wish to maintain the freedom of their science and, at the same time, play a rational and effective role in politics, they need to adopt a strategy that is more modest in its hopes for the perfectibility of mankind and more pessimistically alert to the dangers of power—not only power that is obviously political but the power that calls itself private as well. They should start by acknowledging in theory what in the United States we have always taken for granted as a practical matter: that reductionism in scientific knowledge, while it may provide the fundamental advances in scientific theory, does not alone provide the answers in the realm of policy, or the basis for a political ideology.

And finally there is Bentley Glass's keynote speech for the present decade, "Science: Endless Horizons or Golden Age?" to represent the skepticism of the '70's about the hitherto comforting concepts of progress and infinite growth. That the political and the natural scientists both leave us with many provocative questions is at least evidence that the maturity postulated in the book's title is not to be equated with stagnation.

While these speeches amply portray professional idealism in the form in which it still animates older scientists, they do not adequately reflect the latter-day idealism that has produced splinter organizations of scientists dedicated to various forms of political and social action. Whether or not one agrees with specific objectives of these groups (or condones the disruption of AAAS meetings that a few adherents have instigated), the fact that scientists have organized to boycott war research, to finance the election of peace-oriented legislators, or to provide the public with more adequate information is a now well-established phenomenon that should not have been ignored by the spokesmen of science.

To deliver a definitive judgment on Kargon's editorship of this volume would require following his steps through all the 35 annual addresses he did not include. Taking the more positive and less time-consuming course, I will say that in my view here is an unexpectedly readable and highly informative collection of sources that conveys the substance and the spirit of 20th-century science more effectively than any secondhand summary can possibly do and is therefore to be recommended both as a teaching tool and as general reading.

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Organic Radicals

Free-Radical Chemistry. Structure and Mechanism. D. C. NONHEBEL and J. C. WALTON. Cambridge University Press, New York, 1974. xvi, 572 pp., illus. $35.

Free radical reactions are important in organic chemistry, and, worldwide, generate well over a thousand publications a year. As a consequence of this plethora, the secondary literature consists of reviews of specific topics and large, multiauthored compendia, of which Kochi's *Free Radicals* (1973) is the most successful example. Relatively short monographs that sort out the significant principles and present a unified view have been badly needed, and except for those by Walling (1957) and Pryor (1966), such overviews have been notably lacking. This book, intended to "integrate the approaches of the organic and physical chemist in consideration of kinetic and mechanistic aspects of reactions both in solution and the gas phase" and aimed at upper-level students and professional chemists, goes a long way toward filling this need. Its appearance is particularly opportune, since recent advanced texts in physical organic chemistry tend to give radical reactions rather short schrift. (One such text on my desk allows them two pages.)

The authors start with a rather general survey of types of radical reactions, radical-forming processes, and the physical properties and detection of radicals, giving a particularly good discussion of the powers of electron spin resonance spectroscopy and of the geometry and electronic structure of radicals. The balance of the book takes up radical reactions according to class of radical and reaction type. This approach leads to some confusion, since radical displacements and additions, two of the most important reaction types, are discussed chiefly in the chapters on classes of radicals. It's all there somewhere, however, and the reader can locate what he wants in the good topical index. (The book contains no author index.) Particularly good discussions of the reactions of atoms and small alkyl radicals, chiefly in the gas phase, and of homolytic aromatic substitution are presented. There is also a long chapter on radical oxidations and reductions, currently a most exciting topic in free radical research.

The authors make a point of discussing physical chemical principles and generally handle them well. The overall kinetics of chain reactions (in contrast to competitive kinetics) is treated rather cursorily, however. This is an important defect, since overall kinetics defines the conditions for carrying out successful synthetic chain reactions and explains why many superficially plausible processes fail to occur. Radical stability, although discussed at length, is never clearly defined. There are two definitions: one thermodynamic and, with alkyl radicals, usually associated with R–H bond dissociation energies; the other kinetic, and related to reaction rates. The two kinds of stability are obviously related, but it is becoming increasingly evident that highly hindered radicals may be kinetically very stable even though they are thermodynamically stable only in respect to their dimers.

Finally, two reaction classes receive less attention than they deserve: radical reactions on molecular oxygen, which are covered in 19 pages (compared to 53 for homolytic aromatic substitution); and polymerization, which is scarcely