BOOK REVIEWS

Chemistry and Its Images

Chemical Sciences in the Modern World. SEYMOUR H. MAUSKOPF, Ed. University of Pennsylvania Press, Philadelphia, 1993. xxii, 417 pp., illus. $39.95 or £37.95. The Chemical Sciences in Society Series.

Despite its often poor image as the intellectually dullest of the physical sciences (which, needless to say, is quite unfounded) or the current chemophobia that incriminates it in the poisoning and pollution of our cities and countryside, chemistry is, in fact, the 20th century's central science. It services and underwrites our understanding of biology, medicine, solid state physics, and the whole gamut of technologies we use every day and all the time. Intellectually it forms a necessary part of our understanding of cosmology, geology, evolution, archeology, and biotechnology. Above all, it underwrites our health care system. In this chemical century our daily material culture and well-being depend fundamentally upon the chemist's extraordinary ability to synthesize three-dimensional molecular structures on demand.

Why then does chemistry have such a poor image? Why is there so much ignorance of it among the public? Is it because the field underwent no great conceptual upheaval at the beginning of this century comparable to those associated with Planck, Einstein, and Bohr in physics and Freud in psychology? Is chemistry less well integrated into our sense of cultural history because, seemingly, it has failed to raise any interesting philosophical issues? Has its image of material creation fostered by textbooks, industrial advertising, and the consumer's shopping cart caused it to be taken for granted until a Bhopal-type disaster sends shockwaves through the media? It was to explore such issues that the Beckman Center for the History of Chemistry called a meeting of chemists, historians, and high school teachers in Philadelphia in May 1990. Fifteen of the papers presented at the meeting, together with three shorter comments on the conference papers, are now published in revised form in *Chemical Sciences in the Modern World* under the able editorship of Seymour Mauskopf.

Like Tom Harrison's brilliant verse music drama, *Square Rounds*, which delighted but puzzled audiences at the British National Theatre in 1992, *Chemical Sciences in the Modern World* plays with aporia on several levels. In Harrison's play the belief that science is the instrument whereby human life can be improved is juxtaposed with the events of the First World War (the "chemist's war"), when Fritz Haber's solution to the Victorian problem of feeding the world's hungry, the fixation of atmospheric nitrogen, becomes instead the raw material for the explosives trinitrotoluene and gun cotton. Harrison explores the tension between promise and delivery, creation and destruction, while at the same time showing through myth and drama how an understanding of history helps to resolve these contrasts and paradoxes. Indeed, in a venturesome essay in this book, Science Museum curator Robert Bud wonders whether the only way to display chemistry meaningfully to the general public is by invoking myth.

A similar point is made by E. N. Brandt, a former public relations officer of the Dow Chemical Company, who argues that the public outcry over the use of alar in apple growth, or over the use of napalm in Vietnam, might have been less emotional had there been more historical awareness of the role of pesticides in increasing agricultural productivity since 1900 and of the precedent in antiquity of "Greek Fire" as a weapon of war.

The snag is, as Christopher Hamlin demonstrates in a fascinating essay on environmental chemistry, that our versions of history will differ according to whether we believe that our understanding of ecological chemistry is sufficiently mature to lead to actions (yes, we can solve the ozone problem if need be) or, following the sociologists of knowledge, that policies are generated by social needs which themselves then generate knowledge to justify actions. Citing three case histories concerned with water analysis in the 18th and 19th centuries and Victorian sewage-recycling schemes, Hamlin shows how scientific experts disagree when problems are "transcientific" (that is, are incapable of solution at the time). Inevitably, in such circumstances experts become spokespersons for the vested interests of themselves or others.

Nevertheless, Brandt's point about the clarification that history can provide is underlined by Suzanne White in an analysis of the post-1945 "chemogastric revolution." Since the carcinogen prohibition of the Delaney Clause in the 1958 Food Additives Amendment is once again the subject of debate, it is interesting to have White's considered view that neither it nor the original Harold Wiley Food, Drug and Cosmetic anti-adulteration Act of 1906 was anti-science in intent. They were, rather, populist responses "to the growing perception that an increasingly powerful industry was willing to push past known scientific limits in pursuit of profit" (p. 344). The commercial aspects of modern industrial research are investigated by John E. Lesch in a vivid, evenhanded examination of the development of the sulfa drugs in Germany by I.G. Farben. Whereas these drugs are usually portrayed as the result of discovery and development by the lone investigator (in this case Gerhard Domagk, who had the 1939 Nobel Prize for Medicine denied him by Hitler), Lesch explores the roles of the chemists Heinrich Hörlein and Fritz Mietzsch within the same company. Overall, he suggests, pharmacological work on sulfonamides must be seen as examples of "rational engineering" and industrialized invention scripted and directed by Hörlein and largely executed by Mietzsch, with bacteriological backup by Domagk. The value of these engineering and managerial perspectives is confirmed in John Kenly Smith's impressive general overview of the 20th-century American chemical industry as an interactive, not sequential, interplay of science, technology, and commerce.

The five aforementioned complementary essays portraying what the editor describes as the production and public-interface sides of chemistry will be of interest to both general readers and historians of science. They are prefaced by a set of essays on the practice of chemistry from a theoretical or philosophical, technical, and social point of view that will mainly interest professional historians. As a group these opening essays raise the questions whether there is a distinctively chemical way of theorizing and, the perennial favorite of historians of science, whether science has its own rational, logical, and objective momenta or whether scientific change is explicable solely in terms of social and cultural contingencies.

Although the latter view has been pressed by some sociologists of knowledge ("science is social relations"), the consensus among Yakov M. Rabkin (in a diffuse essay on instruments in chemistry), Robert E. Kohler (in an intriguing paper on biochemical genetics in which *Drosophila* and *Neurospora* are treated as instruments and as systems for the production of knowledge), and Alan J. Rocke and Frederic L. Holmes (respectively on the controversies generat-

Vignettes: Molecular Pride

Molecular biologists may have done more to confound the meaning of homology than have any other group of scientists. . . . Why this confusion of terms has arisen in molecular biology is not clear; perhaps the term homology is thought to make the work sound more like science than would use of the simple and obvious word similarity.

—*David M. Hillis*, in *Homology: The Hierarchical Basis of Comparative Biology* (Brian K. Hall, Ed.; Academic Press)

Francis Crick proclaims that "The ultimate aim of the modern movement in biology is in fact to explain *all* biology in terms of physics and chemistry." Such a thoroughgoing reductionism is a kind of neo-mechanical view of reality, and since it is the "mechanical" problems which get solved first in the development of a science (clocks are easier to understand than clouds), it is scarcely surprising the biologists are tempted, in the first generation of their quantitative success, to espouse such opinions.

—*John Polkinghorne*, in *The Faith of a Physicist: Reflections of a Bottom-Up Thinker* (Princeton University Press)

ed by Kolbe and Liebig over the theoretical construction of organic chemistry) is that cognitive aspects can never be ignored or subsumed into social ones. Social factors, though not insignificant in the choice of chemical problems, especially in an industrial and commercial context, come into their own in the academic context when discoveries and opinions have to be "sold" to a peer group that governs the reward systems. As Rocke convincingly demonstrates, despite the value of sociological perspectives to historians, "the power and vitality of scientific ideas and logic, the constant regulating appeal to the empirical world, and the contingent influence of individuals ought not to be underestimated" (p. 112).

This eclectic approach to the historiography of chemistry, or of science generally, will make good sense to practicing historians and to reflective scientists. However, as William B. Jensen points out in a polemical essay on the publics for the history of chemistry, the vast majority of chemists care nothing for history and do not read books on their subject anyway. Might this state of affairs have less to do with something lacking in chemists' education than with the nature of chemical philosophy since the 1830s? As Mary Jo Nye suggests in her essay in the first part of the book, chemists, unlike physicists, have in seeking precision and rigor come to regard multitheoretical representations of the same phenomenon as perfectly acceptable. Though chemistry does not raise deep philosophical questions about the cosmos and the meaning of life (as, historically, astronomy, geology, and biology have done), there is nevertheless a metaphysical basis to modern chemistry rooted in its sheer complexity as a mature and empirically rich science.

Apart from a minority who, as Jensen remarks, are eager "to gain as much conceptual insight as possible into the nature of chemical phenomena" (p. 266), these qualities of the discipline mean that most chemists can operate successfully without a historical perspective. Personally, I feel bound to agree with Jensen that professional historians of chemistry (and of science) are as much to blame as practicing chemists for their failure to make the history of the chemical sciences seem interesting and relevant. *Chemistry and the Modern World* undoubtedly goes some way to bridge the gaps between chemists, historians, and their publics by demonstrating how the insights of historical research can help chemists themselves, policy-makers, and the general public understand policy issues involving the chemical sciences.

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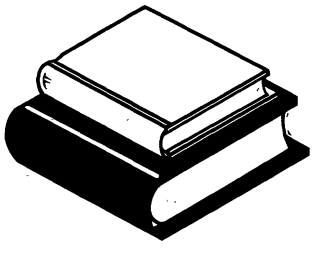

Red Sea Enigmas

Geologic Evolution of the Red Sea. ROBERT G. COLEMAN. Clarendon (Oxford University Press), New York, 1993. x, 186 pp., illus. $59.95 or £45. Oxford Monographs on Geology and Geophysics, 24.

Anyone looking at a map of the Red Sea can only be impressed by the remarkable parallelism of the Red Sea shores. A tracing of one coastline between 16°N and the Gulf of Suez fits perfectly on the other. The same is true for the Gulf of Aden. It is as if there were a clean fracture through the continental crust extending from the entrance of the Gulf of Aden through to the Gulf of Suez. This implies that the Red Sea has parted by nearly 400 kilometers at its widest, and yet we know this cannot be so, as the Danakil horst is in between and continental rocks have been found in boreholes in the north. The exact extent of oceanic crust underlying the Red Sea sediments and the reason for the remarkable parallelism of the coasts remain enigmas.

With the development of marine geophysics and surveying there has been considerable exploration of the Red Sea over the last few decades. Eighteen deeps have been discovered along the axis of the Red Sea, some of which have hot brines and heavy metal deposits including some silver and gold. The brines are enriched in lead, zinc, copper, iron, manganese, and aluminum derived from hydrothermal circulation of sea water with the underlying basalts, at temperatures sometimes exceeding 330°C. This remarkable discovery was followed by the equally remarkable discovery of the "black smokers" along the East Pacific Rise and Juan de Fuca spreading centers, where comparable heavy minerals have been found. These discoveries have led to a whole new field of mineralogy of spreading centers and are leading to a better understanding of ancient and modern mineral deposits. Unfortunately, exploitation of the heavy metals could be an environmental hazard, as the Red Sea is a finely tuned ecosystem with remarkably beautiful fauna and flora.

In contrast, the exploration for hydrocarbons has been less successful (apart from the Gulf of Suez). The Red Sea has large thicknesses of sediments along its margins that have received the attention of many oil companies. There have been 53 boreholes around the coasts and only two (undeveloped) hydrocarbon finds—in the most northeasterly part and in the Tokar delta off the Sudan coast at 18 to 19°N. Both finds were of gas and condensates. Having a spreading center, the Red Sea has high heat