

surroundings, homesickness, and heart-break for those left behind are things that she thoroughly understands, and this understanding, conveyed without sentimentality, makes the book warm and human. Even so, one wonders if she does not understate the anguish of uprooting even for those successful enough to be included in this study. One casual reference to "refugee psychology" suffices for what was once a painfully common phenomenon of maladjustment, though not perhaps so marked in the scientific community as in others.

At the same time one misses certain perspectives that an American writer would have brought to the task. The background of economic depression is here, but not the corollary upsurge of pride and interest in America's own cultural past that to Mrs. Fermi's contemporaries was one of the most significant aspects of the depression experience and that surely affected their receptivity to artistic and literary stimuli from Europe. There is an excellent brief survey of the background of the exclusion provisions of the immigration act of 1924 but little reference to the character and distribution of recent waves of immigrants that determined attitudes toward those who came in the '30's. And, as 19th-century history testifies, 100-percent Americanism was not a "novel" concept.

Fifty years ago the struggles of young immigrants in the promised land, movingly described by Mary Antin, Jacob Riis, Edward Bok, and others, were avidly followed by the American reading public, young and old alike. One notes that Mrs. Fermi's highly literate new Americans of the '30's produced no comparable classics of aspiration and fulfillment. For established European intellectuals America was a physical haven; it was not a promised land. In the beginning they undoubtedly regarded it with considerable condescension. And these immigrants were too old. There is no romance in middle-aged adjustment, and their very success made it relatively easy for their children to become American.

But the audience too has changed in 50 years and seeks perhaps more generalized testimony about past experience than those earlier tales of individual struggle and achievement. One answer may lie in the kind of personalized history represented by *Illustrious Immigrants*, full of pitfalls and sure to be resisted by professional historians, but pointing the way perhaps to a new genre of historical writing, somewhere between the memoir and the supposedly objective recital of historical events.

ALICE KIMBALL SMITH
*Radcliffe Institute,
Cambridge, Massachusetts*

An Earlier Day in American Science

American Science in the Age of Jackson. GEORGE H. DANIELS. Columbia University Press, New York, 1968. xii + 282 pp. \$7.95.

Science in Nineteenth-Century America. A Documentary History. NATHAN REINGOLD, Ed. xii + 339 pp., illus. Hill and Wang, New York, 1964; cloth, \$5.95; paper, \$2.45. Macmillan, London, 1966; 30 s.

Despite the rapid development of the history of science as an academic discipline in the past two decades, the history of American science remains largely unwritten. Most professional historians of science have ignored it, regarding American contributions to science before 1900 as too slight to merit attention. Historians of the United States have usually considered the history of science as lying outside their field of interest and competence. But the subject has not been totally neglect-

ed. Such scientist-historians as Joseph Ewan and George White have written and inspired numerous articles and monographs on the history of botany and geology in America and have edited scholarly reprint editions of American works in these fields. At the same time, a small band of American historians trained in social and intellectual history have turned their attention to the role of science in American history. The former group of writers tends toward the "internal" history of science, the latter toward its "external," or contextual, history.

The two books under review are good examples of the contextual approach. Both writers focus attention on mid-19th-century developments, both stress the growing professionalization of American science, both examine its institutional form and development, both attempt to display science as an integral

part of American history. But each has his own distinctive way of treating these subjects.

Daniels approaches American science in the period 1815-1845 from two distinct but related points of view. The first two chapters and the appendices of his book present a picture of the American scientific community in the Jacksonian era. The remaining chapters analyze and illustrate the general ideas about science and scientific method prevailing among scientists and philosophers of science at that time. Very little is said about the actual science of the period, except by way of illustrating the influence of philosophical and religious presuppositions on scientific investigation.

As a basis for defining the scientific community in Jacksonian America, Daniels has made a careful study of 16 scientific journals of the period. From the ranks of the contributors he selects 56 "leading scientists," who together accounted for more than half the articles in these journals. The biographical and bibliographical sketches of 55 of these men, given in appendix 1, are one of the most valuable features of the book. Daniels also analyzes the content of the articles in his 16 journals, presenting the results in tabular form. These data are then used to refute the common misconception that American science in the early 19th century was unspecialized, strongly utilitarian, and preoccupied with natural history at the expense of the physical sciences.

Daniels's account of the professionalization of American science and of its relations with philosophy and religion leads him into an extended analysis of the "Baconian" philosophy of science in America—a complex of ideas and attitudes derived partly from Bacon, partly from the Scottish common-sense philosophers, and partly from Protestant natural theology. These chapters constitute a valuable contribution to American intellectual history and, more generally, to the history of the philosophy of science, a largely neglected subject. Since American scientists were not given to writing treatises on the philosophy of science, Daniels is forced to base his account to a considerable extent on the writings of philosophers such as Levi Hedge and Samuel Tyler—men forgotten today but influential in their own time. Daniels then tries to show how ideas about scientific method were reflected in the general pronouncements of the scientists themselves and in their

scientific practice. He concludes that the scarcity of high scientific achievement in the United States during the Jacksonian era was due less to the lack of an adequate institutional framework for the pursuit of science than to the acceptance of simplistic "Baconian" conceptions by the scientists of the period. This is an interesting discussion, but much of it is vitiated by Daniels's failure to distinguish clearly between two rather distinct scientific traditions, the tradition of natural philosophy and the tradition of natural history. To this reviewer it seems clear that Bacon's concept of "natural histories" as a first step toward the creation of an experimental natural philosophy that would give man control over nature had very little bearing on the rise of systematic natural history in the manner of Tournefort, Ray, Linnaeus, and Cuvier. That tradition looked back to Aristotle. It never aspired to attain control over nature or discover laws of nature in the Newtonian sense. The only causes it knew were final causes, which Cuvier identified with the conditions of existence. Nor did it, as Daniels seems to imply, develop out of the matrix of natural philosophy. Fathered by Aristotle, it developed primarily in the medical schools, although nonmedics like Ray and Cuvier made important contributions to it. Thus, to explain the failure of American naturalists to rise above the concept of natural history stated in Cuvier's classic phrase *nommer, classer, et décrire* by invoking the influence of a "Baconian" philosophy of science is completely to misread the history of natural history. One suspects that most of the ideas about scientific method that Daniels holds responsible for the lack of brilliant scientific achievement in the United States were also current in England, where science rose to glorious heights in this period. Charles Lyell was profoundly influenced by natural theology, and Darwin believed that he had proceeded on "pure Baconian principles" in arriving at his theory of natural selection. Doubtless there is some connection between theories of scientific method and actual scientific achievement, but the extent and nature of the connection are still a mystery.

Nathan Reingold undertakes to portray the American scientific community of the 19th century by means of excerpts from the correspondence of scientists of the period, prefacing each group of letters with a brief introduction identifying the correspondents and

placing them in historical context. These introductions are remarkably well done. Taken together, they constitute a concise outline and interpretation of American science in the 19th century.

For purposes of orderly presentation Reingold groups most of his materials under two broad headings, The Geophysical Tradition and The Natural History Tradition, both viewed as subheadings of "geographical science." In the geophysical tradition he includes work in astronomy, geodetics, hydrography, oceanography, meteorology, terrestrial magnetism, and the like. Natural history includes mineralogy, geology, paleontology, botany, and zoology. "Under the banner of geography," writes Reingold, "there was a kind of unity of the sciences whereby most scientists were enlisted in the eminently practical task of describing the physical and natural characteristics of the nation, as well as other portions of the earth." In keeping with this approach, Reingold stresses the role of government, especially the federal government, in providing a practical, institutional context for science—in state geological and natural history surveys, in the Wilkes Expedition and the railroad surveys, in the Coast Survey, the Smithsonian Institution, and other governmental agencies. The picture that emerges is one of growing specialization and professionalization under the pressure of practical governmental necessity. The role of the colleges and scientific societies is regarded as subsidiary.

On the whole, the letters are well chosen. The reader catches glimpses of William Maclure mixing science and social reform, of Joseph Henry struggling to make a place for research at the Smithsonian Institution, of Gray and Dana corresponding with Darwin, of Newcomb and Michelson planning experiments on the speed of light. How much these glimpses will mean to readers unacquainted with the history of science is problematical, but they will almost certainly prove highly useful to students in history of science courses.

On several issues of interpretation Daniels and Reingold do not see eye to eye. Daniels cuts the middle period of American science off at 1845, whereas Reingold expands it to 1870. There can be little doubt that Reingold is sounder on this point. The years 1810–1820 were an important transition period, marked by the death or retirement of most of the leading scientists of the early republic, the formation of new sci-

entific societies, and the establishment of the *American Journal of Science*. But it is difficult to regard the years 1840–1850 as a similar watershed in either American or European science. Not until the 1860's and 1870's were there striking changes in the structure, outlook, and leadership of science.

In his remarks on the classification of the sciences, however, Daniels cleaves much more closely to historical reality than does Reingold, whose attempt to unite the scientific researches of the period under the general rubric of "geography," divided into geophysics and natural history, is interesting but unhistorical. Generally speaking, the sciences were divided among natural philosophy, natural history, and the purely medical sciences, but the dividing lines were not very clear. Chemistry was thought of as belonging to natural philosophy but was frequently taught in medical schools. Mineralogy partook of both natural philosophy and natural history. "Biochemistry" and "geophysics" were unheard of.

On the question of pure versus applied science, Reingold is more inclined to stress the practical orientation of American research than is Daniels. As a matter of fact, though much lip service was paid to the idea of science as the servant of man, relatively few scientists spent time and energy devising practical applications of scientific principles. Natural historians were preoccupied with naming, classifying, and describing, geologists and paleontologists with straightening out the geological record, physicists and chemists with the progress of their sciences. Only in the government agencies was there much attention to practical results, and even there the spirit of pure research was not absent.

Both Daniels and Reingold emphasize the tendency toward professionalization in American science in the mid-19th century, even to the point of overstressing it. The contrast presented by Daniels between the state of American science in 1800 ("a disorganized group of amateurs without common goals or directions") and its condition in 1845 ("the professional body that they had become by mid-century") seems overdrawn. In 1845, as in 1800, the majority of American scientists were either medical men or science teachers in liberal arts colleges. Daniels himself notes that almost half of his 56 most prolific contributors to scientific journals were M.D.'s. Some of them taught

one or more sciences in a medical school; some did not. Some were practicing physicians, others not. Many engaged in scientific research having little or no connection with medicine. Undoubtedly they were the backbone of the scientific community, but were they "professional scientists," either in fact or in their own estimation? If so, so were their 18th-century predecessors.

Unlike Daniels, Reingold ignores the medical community and concentrates on scientists connected with government operations of one kind or another, perhaps because his own researches have dealt chiefly with Bache, Henry, and others of their stamp. Undoubtedly the sense of professional identity was strongest in this group. But it is worth noting that Henry's contributions to physics, which were not inconsiderable, were made while he was a college professor rather than while he was a government administrator.

Daniels's sociological approach to the scientists of the Jacksonian period leads him to attribute to them a more self-conscious attitude toward themselves and other groups in American society than most of them actually had. Their frequent appeals to natural theology were not, as Daniels seems to suggest, a conscious "misuse of science" for the purpose of validating their professional status. On the contrary, the majority were evangelical orthodox Protestants who conceived science as the study of God's works. To represent them as "emerging professionals" concerting a careful strategy and tactics vis-à-vis a better-established group of professionals, the clergy, is to refashion history to make it conform to the dictates of modern sociological analysis.

Both authors make a strong plea for the importance of the kind of history of science exemplified in their books. Unfortunately, Daniels attempts to justify his approach by questioning the validity of another kind of history of science, the kind that focuses on the internal development of particular sciences and groups of sciences. It may be true that some practitioners of the "internalist" school have tended to judge past science in the light of current science instead of viewing it in its own context, but this "presentist" tendency afflicts all kinds of historians. Daniels himself is not completely free of it, as the comments above have indicated. Nor does Daniels strengthen his case by adopting Thomas Kuhn's

distinction between "normal science" and "revolutionary science" and representing his own book as a study of "normal science" in the Jacksonian period. Whatever one may think of Kuhn's dichotomy (this reviewer finds it extremely dubious), it provides no basis for dismissing or undervaluing the internal dialectic of scientific thought. Kuhn himself is a strong adherent of the "internalist" approach to the history of science. And even Daniels must admit that a history of American science which makes very little reference to the scientific achievements of Joseph

Henry, Asa Gray, and James Hall (to mention only three able scientists) is a little like *Hamlet* without Hamlet. Daniels and Reingold have made important contributions toward elucidating the structure and role of science in 19th-century American society. To complete the picture others must undertake to portray the work of American scientists of that period as an integral part of the intellectual adventure of Western man.

JOHN C. GREENE

*Department of History,
University of Connecticut, Storrs*

In the Laboratory World: Reflections on Productivity

The Search for Understanding. Selected writings of scientists of the Carnegie Institution. CARYL P. HASKINS, Ed. Carnegie Institution, Washington, D.C., 1967 (distributed by Walker, New York). xxiv + 330 pp., illus. \$6.

To celebrate the 65th anniversary of the Carnegie Institution, its biologist-president has brought together 22 essays, written by past and present members of the research staff, in what amounts to an institutional festschrift. Plainly, a research organization that, as early as 1904, could span the continent by establishing a Station for Experimental Evolution (now, the Genetics Research Unit) at Cold Spring Harbor and an observatory on Mount Wilson has much to celebrate. As an operating rather than fund-granting organization, it was a distinct social innovation to begin with and, in the fields of science which are its concern, it has been innovating ever since.

The papers in this volume reflect its wide-ranging interests: astronomy (five papers), genetics (two), embryology (three), plant biology (two), geochemistry (one), archeology (one), and, as by-products of these interests, the history, philosophy, and organization of science (with six papers that can be included here). The earliest of them—the classic paper by George Harrison Shull on the method of raising hybrid corn—appeared in 1909; the most recent one, by Merle Tuve, reflecting on the implications of complementarity for physics and the humanities, appeared in 1966. The score of authors comprise a galaxy of contributors to one or another branch of science in the 20th century.

This barebone description of the book is true—and thoroughly misleading, for it could give the impression that we have here a chaos of disconnected essays on diverse parts of science. The book is anything but that. Practically all the papers—both those that discuss the character of the scientific enterprise and the many more that exemplify some aspects of it—form a coherence by conveying a sense of both the mood and the practice of science. Much of this, I think, results from the quality of mind exhibited in them that transcends profound differences in subject matter. Common understandings about the nature of scientific work are transmitted across The Wall which, since the cold war was declared between C. P. Snow and F. R. Leavis (or even the older one between T. H. Huxley and Matthew Arnold), we have been told divides scientists and humanists. But the authors of this book, evidently non-belligerents all, manage to communicate with readers of every description simply by reflecting upon rather than merely reporting their specialized work.

I was quite taken by Haskins's description of these essays as contributions "to the fine literature of science," a phrase whose meaning he goes on to explain: "If the [scientific] work is of philosophical cast, and if the writer, in addition to being a first-rate scientist, is also a first-rate man of letters, then there may be a rare by-product which can constitute one of the most enduring heritages of all for our culture, the brilliant scientific essay."

The principal unifying theme of the book is captured in its title, taken from an essay by Haskins's predecessor, Van-