Book Reviews

New Ideas in America

Creation by Natural Law. Laplace's Nebular Hypothesis in American Thought. RONALD L. NUMBERS. University of Washington Press, Seattle, 1977. xii, 184 pp. $15.

Opposition to Darwin's theory of the evolution of man has raised sufficient popular controversy over the past century to create a general impression that the United States has a religious culture against which scientists must struggle to establish their secular truths. Historians have long recognized that that impression is inaccurate. In many respects—political, social, intellectual—America can be seen as the first modern nation. Recently, historians of science have shown also that antebellum culture accorded the highest value to science. Leading American colleges required science at the core of their curricula, scientists were the center of the nascent intelligentsia, and faith in applied science was a primary value in the democratic ideology. In *Creation by Natural Law*, Ronald Numbers demonstrates that the scientific and religious establishments had accepted a naturalistic theory of the origin of the solar system decades before the *Origin of Species*.

Within the general framework of Newtonian gravitational theory, Laplace hypothesized in the 1790's that the solar system had evolved by condensation of a gaseous nebula. Planets condensed out of the sun's rotating atmosphere. Laplace's theory undermined one of Newton's own proofs of the existence of a deity, which was that the design of the planetary orbits (which lie in a plane) could have been accomplished only by supernatural purpose. Despite the atheistic purpose of Laplace, in the 1830's and 1840's this nebular hypothesis won wide acceptance in the United States. The latent atheism was subverted by the authors of the Bridgewater Treatises, who showed how the hypothesis fitted into an argument by design, with the deity working out his plan by secondary causes. With the orthodoxy of the nebular hypothesis protected, American scientists went ahead to accept the theory on its scientific merits, paramount among which was Daniel Kirkwood's "analogy," a mathematical ratio between the diurnal rotation of the planets and their gravitational "spheres of attraction."

A debate between James Dwight Dana, an editor of the *American Journal of Science*, and a biblical literalist, Tayler Lewis, seemingly settled the question whether a nebular hypothesis could square with the Mosaic account of creation. Drawing on the work of Arnold Guyot, an immigrant scientist, Dana argued in *Bibliotheca Sacra*, a New England Congregational journal, that the Mosaic chronology of creation could be interpreted naturalistically. The Bible's "formless waters" of the first day corresponded to a gaseous nebula, with "light" generated by chemical action following the gravitational condensation of the gas. Similar interpretations were brought forth for the other biblical epochs.

Acceptance of the nebular hypothesis had become sufficiently entrenched that Asa Gray, appealing for Darwinian evolution in the 1860's, pointed to the hypothesis as an analogy in inorganic development for the organic development of species. Furthermore, just as the nebular hypothesis had been teleologically interpreted, so also organic evolution could be seen as the fulfillment through secondary natural laws of God's plan for man. Gray's deism was less popular among fellow scientists in the post–Civil War era than before, but nonetheless, Numbers maintains, his appeal to the nebular hypothesis indicated the manner in which American intellectual culture had been prepared for evolutionary theory.

Numbers's account of the reception of the nebular hypothesis is based on extraordinary reading of the literature and an exhaustive search of manuscript collections. As a basic narrative, it is unlikely to be significantly changed by later scholars. Unfortunately, his plausible thesis has only indirect evidence at its most interesting point: the connection between the pre-Darwinian popular acceptance of the nebular hypothesis and the rapid assimilation of Darwinian evolution. He asserts that "the nation's intellectual communities suffered surprisingly little trauma as they successfully and rapidly assimilated the new scientific doctrine [evolution]. Much of the credit for making this possible should go, we think, to the nebular hypothesis" (p. 105). His evidence is that advocates of evolution frequently had previously accepted the nebular hypothesis, and that leading Darwinian spokesmen appealed to the nebular hypothesis in support of evolution. Yet Numbers is unable to establish the direct link between a scientist's espousal of the nebular hypothesis at one time and Darwinism at another. It is more probable, as Numbers hints, that the nebular hypothesis was one element in a growing scientific culture in which secular naturalism broadly prepared the way for Darwinism. Also, Numbers is unable to establish a direct connection between denominational acceptance of the nebular hypothesis and Darwinism, admitting in an appendix that acceptance of the one did "not necessarily" lead to the other (p. 123). Despite these difficulties, which stem from restricted focus, Numbers's work, one of the very few histories of the reception of a scientific idea and its development in the United States, gives glimpses of the relationship between science and secular culture and should be of wide interest to scientists as well as historians.

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Media Figures

The Visible Scientists. RAE GOODELL. Little, Brown, Boston, 1977. x, 242 pp. $9.95.

American science, which went public in a big way only after World War II, was slow to produce the kind of code of conduct for communication and popularization it had formulated for other facets of the scientific career. Therefore, there was a tendency to be conservative. Praise was bestowed upon journalists who gave science a good press in books and articles about the wonders of basic research, and upon distinguished scientists who published their scattered general writings and speeches in an effort to educate the citizenry of the modern age.

Two forces acted to alter this situation. The first was the emergence of a se-

ries of public issues with strong scientific-technological components, ranging from the atomic bomb to genetic engineering. The second was the eagerness of news media to cover lively science stories. Television made it possible for the popularizing scientist to reach a new and large audience. Compare the number of readers of one of George Gamow's popular works with the audience reached by Carl Sagan when he makes one of his regular appearances on the Johnny Carson show.

Rae Goodell has read and synthesized most of the literature produced by those who have studied the impact of these two forces and has added a valuable concept of her own: the visible scientist. A scientist's visibility is not dependent upon spectacular scientific achievement. Neither need he have the ability to popularize abstruse scientific ideas or the power to marshall the opinion of the scientific community. Visibility hinges upon his involvement in the controversies surrounding science-related political and social issues and upon his talent for making the most of the media of mass communication.

From a list of 45 visible scientists Goodell has chosen to discuss eight in detail: Paul Ehrlich, Barry Commoner, Glenn Seaborg, Linus Pauling, B. F. Skinner, Margaret Mead, Carl Sagan, and William Shockley. These names remind us what are the major scientific issues in the minds of the educated populace. Environmental problems, control of human behavior, space science, and nuclear weapons are the critical ones.

What common characteristics do diverse individuals, ranging from Shockley to Mead, possess to make them visible scientists? The answer is that they all deal with hot topics like pollution, overpopulation, or life on other planets. These subjects are well suited to the needs of journalists, who spend more time on the coverage of science policy issues than they do in the popular exposition of new scientific advances.

There are many scientists working on relevant policy issues, but the visible scientist does it with a special flair. He or she makes news as a result of being simultaneously controversial, colorful, and articulate. When Ehrlich responds to Commoner, or vice versa, it is newsworthy, as is virtually any public appearance or statement by Shockley. Skinner is remembered for raising his infant daughter in one of his specially contrived boxes and teaching pigeons to play Ping-Pong, and Pauling claims to have found the cure for the common cold in massive doses of vitamin C. Ehrlich, Commoner, Skinner, Mead, and Sagan all have written popular books and magazine articles; Ehrlich and Mead are sought after for the lecture circuit; and Sagan, forced to ration his time as a public figure, relies upon television to reach his very large audience. In addition to being able to speak and write well the visible scientist is able to manipulate reporters, editors, publishers, and television commentators in order to get a forum for his point of view. Indeed, in some cases science writers have come to feel that they are being exploited by the more adroit visible scientists.

Whatever other characteristics contribute to the visibility of this select group of scientists, we can be certain that they have a solid reputation in their fields of research. They might stray from their bailiwick—Shockley is the prime example—to make pronouncements on other areas of science and on war, peace, and the good life, but they have a recognized scientific base from which to meander and return as they please. No matter how outré their statements or actions they can be identified, for purposes of quotation in the media, as a leading population biologist, Nobel prize winner, or foremost American anthropologist.

With the exception of Glenn Seaborg, the visible scientists Goodell discusses are not part of the U.S. scientific establishment. They include in their ranks Nobel prize winners and past presidents of the AAAS, but they are essentially outsiders who are prone to take controversial stands and use the personal traits that have made them popular to advance their side of the argument. In short, they make good witnesses at a congressional hearing but are not likely to find a place on blue ribbon scientific panels, which are reserved for statesmen of science.

Visible scientists might, at times, become an embarrassment to the silent majority of American scientists. They adopt extreme, sometimes untenable, positions on sensitive matters and deliberately cultivate public attention. Society, however, benefits from the existence of a group of scientists ready to engage in open discussion and dispute. They provide the American people with alternatives to the official responses of the scientific establishment. Science also benefits in the long run. Science policy debates held in public, even if acrimonious and divisive, present a more realistic picture of scientific practitioners. They are seen as men and women capable of coupling logic and reason with commitment to a cause.

All of this and more will be found in Goodell's well-written and fast-paced book. Much of the supporting material on scientific communication is well known to students of the field and to close readers of *Science*. The concept of the visible scientist, however, is welcome as a new tool to be used by those concerned with determining how science issues become political ones and assessing the role played in their resolution by a new breed of scientific spokesmen.

To my mind one important question about the visible scientist has not been adequately dealt with (although it might be in the doctoral dissertation upon which the book is based). Precisely to whom are these scientists visible? Goodell's original list was garnered from two surveys made of science-news experts and college students (journalism majors). The bias was clearly on the side of news media and the educated middle-class public likely to buy and read a new book by Sagan or Mead. Would a truly broad public survey generate these same names? I doubt it.

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Developmental Genetics

Gene Activity in Early Development. ERIC H. DAVIDSON. Second edition. Academic Press, New York, 1977. xvi, 452 pp., illus. $18.50.

Eric Davidson's book is an attempt to summarize our present knowledge of cell differentiation in the early stages of embryonic development. It is firmly based on the proposition that development is directed by an unfolding program of changing gene expression and hence that an understanding of cytodifferentiation must be sought in the detailed mechanism of gene regulation. In recent years the importance of the relation between developmental biology and genetics has been reemphasized, but there has been interplay between them since their early days. T. H. Morgan, one of the founding fathers of modern genetics, was a developmental biologist and an important member of the American school that believed that early events in cell differentiation depended on the activity of heterogeneous egg cytoplasm in setting up spatially and temporally diverse patterns of gene expression. Eric Davidson is a descendant of this school. His approach is to examine the evidence for changing patterns of gene expression in the embryo, to quantify them, and to