Book Reviews

The Days of Self-Help

The Patronage of Science in the Nineteenth Century. G. L'E. TURNER, Ed. Noordhoff, Leyden, The Netherlands, 1976. vi, 218 pp. Dfl. 55. Science in History, 1.

By the end of the Victorian era, during which the British state loomed larger in providing services on an unprecedented scale, scientists customarily complained about the lack of official foresight in not providing more handsomely for scientific research and other scientific activities. Moreover, they liked to point to Britain's commercial and military rival, Germany, as a nation outstripping their own in this regard. When in H. G. Wells's *Food of the Gods* the earnest scientist, Mr. Bensington, was prevented by his cousin Jane from "experimenting" upon tadpoles in their flat, he insisted that "nothing ought to stand in the way of the Advancement of Science, and she said that the Advancement of Science was one thing and having a lot of tadpoles in a flat was another; he said that in Germany it was an ascertained fact that a man with an idea like his would at once have twenty thousand cubic feet of laboratory placed at his disposal, and she said she was glad . . . that she was not German." Historians of science, perhaps traumatized by the debates of the post-Sputnik era, usually have taken Mr. Bensington's side, and have assumed that lavish state support is natural, necessary, and right for all historical periods. Today, however, many historians are taking a second look, and seem to be veering toward the position of Cousin Jane. Has state patronage, as the editor of the volume reviewed here claims, "come to operate like the Sorcerer's Apprentice, and must be halted in its mechanical liberality"?

The Patronage of Science in the Nineteenth Century contains five essays. The first, by Robert Fox, explores "Scientific enterprise and the patronage of research in France 1800–70"; the second is J. B. Morrell's "The patronage of mid-Victorian science in the University of Edinburgh"; and the third is D. S. L. Cardwell's "The patronage of science in nineteenth-century Manchester." Each of these three in its own way extols individual initiative and self-help. Fox sees the much-discussed decline of French science as caused, not by the relative parsimony of the French government, but by the lack of initiative of the French scientists who turned from a corporate research ideal to popular lecturing and public careers as means for advancement. Morrell deftly shows, using the University of Edinburgh as his example, that scientific research and teaching became more expensive by the mid-Victorian period and eager scientists were hampered by governmental restraint. They had to rely instead upon the traditional British virtues of self-help and individualism. In this they were encouraged by the government, which "expected that the stimulus of private competition and the liberality of private patronage should be utterly exhausted before state subsidies should be given to the University" (p. 87).

Cardwell turns to the much-neglected urban scene and provides an able overview of the rich and complex scientific and technical developments in Victorian Britain's most interesting city. He concludes that the "endowment of science in Manchester over the years 1800–1914 is perhaps the best instance of self-endowed or self-supporting science on record," even while pointing out that the city enjoyed, as America did, hidden subsidies from elsewhere in the form of immigrants to the scientific community (pp. 108–109). In the fourth essay, however, R. M. MacLeod provides useful balance to the self-help picture by investigating in detail the efforts of the Treasury to support science. Although civil servants tended not to appreciate the "ultimate value of fundamental research," men of science underrated "the necessity of accountability" (p. 160). MacLeod's sound conclusion that it "was this collective difficulty" that resulted in useless controversy bears lessons for us today. Finally, W. H. Brock has written a provocative overview, listing the various sources both public and private on which Victorian scientists drew in order to patch together incomes for scientific work. He notes that while British science in the 19th century "presents an overall impression of laissez-faire and self-help . . . other forms of patronage, including state support, were present to a degree and were taken advantage of by men of science seeking their careers" (p. 200).

Although *The Patronage of Science in the Nineteenth Century* by offering excessive praise to self-help often appears to make a virtue of necessity—then and now—it is a valuable beginning. By focusing attention upon the problems surrounding the sources of support for science, the contributors encourage others to attack these issues on a broader front. It should be noted, however, that individualism, self-help, and voluntarism are not explanations but descriptions. Fox's interpretation (quoting Renan) of national differences on the basis of "the peculiar characteristics of the French mind" is a provocative challenge, not a satisfying clarification. Victorian scientific institutions were formed by concerned groups in response to the external pressures of urbanization and industrialization, and to the internal forces generated by specialization and scientific advance. It remains for historians to describe the resolution of these forces and to explain the mechanisms of the evolution of the institutions so generated.

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India's Commitment to Science

Building Scientific Institutions in India. Saha and Bhabha. ROBERT S. ANDERSON. McGill University Centre for Developing-Area Studies, Montreal, 1975. x, 124 pp. Paper, $3.50; developing countries, $2. Centre for Developing-Area Studies Occasional Paper Series, No. 11.

India, a country of large economic and social challenges, exploded a nuclear device in 1974, launched a satellite in 1975, and committed $110.2 million of its national budget to atomic energy and nuclear research plus $24 million to space research in 1973–74. With the Tata Institute of Fundamental Research, the Saha Institute of Nuclear Physics, the Council of Scientific and Industrial Research (India), and a network of atomic and space

centers and laboratories stretching across the country, India maintains a science and technology establishment of considerable proportions.

How did this situation arise? What moved a poor country where scanty funds, old equipment, a difficult climate, and the indifference of students and scientists militated against a lively research tradition to a position where its theoretical and experimental work is recognized around the world?

Important aspects of the answer to these questions lie in Robert Anderson's small book, based substantially on interviews with Indian and other scientists between 1967 and 1975. The author selects the lives of two preeminent but strikingly different scientists, Meghnad Saha (1893–1956) and Homi Bhabha (1909–1966), with well-established international reputations in astrophysics and in cosmic-ray and elementary-particle theory, respectively, and examines the social, educational, political, and philosophical influences that caused them to impart distinctive and determining influences to the development of Indian science. In doing so, Anderson sets up a biographical model for studying the growth of scientific institutions and the play of personality and power in molding a scientific community, and suggests the pertinence of comparative studies of scientists and scientific-institution building in other countries. These, he writes, "could provide an empirical basis for understanding the characteristics of the entire scientific community."

Saha and Bhabha represent distant ends of the social and organizational spectrum of science. Saha, the son of a small shopkeeper from East Bengal, rose scholastically by way of Dacca College and Presidency College Calcutta and the universities of London and Berlin, became a fellow of the Royal Society, and, in the impecunious period of Colonial science in India in the 20's, began to influence the establishment of scientific academies and journals, encouraged university-based research, notably in mathematics and astrophysics at Allahabad and Calcutta, established the Saha Institute of Nuclear Physics (1950), and entered Parliament in 1951 for the purposes of planning national industrial development and relating science and technology to "the problem of living for India's millions."

Bhabha, contrastingly, was a member of a wealthy Parsi family. He studied at Cambridge, trained in theoretical physics at the Cavendish Laboratory, won a fellowship in the Royal Society, and began a prestigious career in wartime India, where he put his thrust not in the universities but in the Tata Institute of Fundamental Research, which he founded in 1945, in building close and "indispensable" relations with Nehru, and in shaping the Indian Atomic Energy Commission. Essentially Bhabha personified the scientific aristocracy of Big Science. He was "a career science organizer" who worked closely within government, donning a variety of official hats yet managing to retain a necessary measure of scientific autonomy. At his death in an air crash in 1966, he held a formidable array of official posts including secretary to the government of India in the Department of Atomic Energy, ex officio chairman of the Atomic Energy Commission and director of the Atomic Energy Establishment of Trombay, director and professor of theoretical physics at the Tata Institute, and chairman of the Scientific Advisory Committee to Cabinet. Bhabha's influence lay behind the Canada-India Reactor Agreement of 1956; his "policy of flexible nuclear development," writes Anderson, "had been skillfully woven into the agreement in such a way that it was impossible for Canada to later insist on adequate safeguards." His drive and initiative laid the ground plan for the complex of India's atomic reactors and laboratories. From differing standpoints, Bhabha and Saha both sought self-reliance for Indian scientists, Bhabha seeing this in the adaptation of imported models to gain time and ensure training and Saha preferring an independent science and technology tied to socialistic economic development. Their separate influences in fact produced institutes that "have promoted an expert-dependent or specialist-dependent pattern of social development."

Anderson's contrapuntal biographical analysis is a novel approach to the sociology of science. Yet the method is not entirely successful. There is considerable fragmentation and repetition, and an amount of indigestible detail is scattered through the text. What does emerge, however, is a store of information on India's scientific arena across the formative years from the '20's to the mid-'60's, and some fertile evidence for historians and sociologists of science in other countries of the pervasive and dynamic influence of highly motivated individuals on the formation of national policy in science.

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Chemical Communication

Animal Communication by Pheromones. H. H. SHOREY. Academic Press, New York, 1976. viii, 168 pp., illus. $16.50.

Twenty-five years ago, when Nikolaas Tinbergen's influential work *The Study of Instinct* summarized the state of a newly emerged ethology, chemical communication still was an obscure phenomenon relative to the visual and auditory systems on which the discipline had been based. Virtually no pheromones were then chemically known, and no attempt had been made to formulate principles concerning their transmission and reception. The key literature comprised fewer than 50 articles.

The situation has since been radically altered as a result of three lines of technical advance: the introduction of gas chromatography, and subsequently gas chromatography coupled with mass spectrometry, permitting the identification of secretory products in microgram quantities; the invention of special neurophysiological techniques, such as the electroantennogram, that led to a better understanding of the chemoreceptor systems; and the development of physical models by which transmission of odorants through water and air could be analyzed. The study of chemical communication now ranks as a small discipline in itself. Investigators have identified hundreds of pheromones and continue to discover new ones at an accelerating rate. General principles of the evolution of the communicative systems have begun to emerge with clarity. In fact, far from being obscure, pheromones are the dominant signals of communication in animals and microorganisms. They are generated, transmitted, and received as precisely as visual and auditory systems that serve equivalent functions.

H. H. Shorey has written a useful account of our present knowledge of chemical communication, shorter but better organized and more easily read than the multiauthored *Pheromones* (1974) edited by M. C. Birch. It is in fact a primer of the subject, quickly covering the main principles with well-chosen examples and figures but backed up by a thorough bibliography of 726 titles. *Animal Communication by Pheromones* can be read either as an introductory textbook or as supplementary material in courses on animal behavior. It can also be consulted by scholars as a reference work and guide to the literature.

Shorey, an entomologist, understandably stresses biological aspects of