research ethic and fought anti-vivisectionist legislation but was more important as a teacher, popularizer, and administrator than as a participant in research. In Philadelphia, by contrast, S. Weir Mitchell made significant discoveries but was unable in the late 1860s to gain the professorship that would free him from the need to practice medicine. Henry P. Bowditch, owing to independent wealth, social connections, and a progressive university, became the "prototypical" American physiologist, establishing the field's first research laboratory and training center at Harvard in the 1870s. The Johns Hopkins University's resources and commitment to medicine were such that the Englishman H. Newell Martin, in spite of modest abilities, was able to build a physiology-centered biology program that enjoyed great success from 1876 to the late 1880s.

Physiologists employed most of the same entrepreneurial strategies as other scientific discipline builders, but their commitment to vivisection meant they had to overcome not merely indifference on the part of the public but outright hostility. Though Fye emphasizes the difficulties that resulted, there are indications in the book that physiology's controversiality also benefited the professionalization process. Anti-vivisection bills opened opportunities for physiologists to lobby and thus gain recognition and support from the large number of physicians who believed broadly in scientific progress; moreover, the widespread belief that experimentation on live animals exposed a physician to patient boycotts and loss of reputation supported the claim that physiological research could only be performed in universities by people paid to do so.

In 1887 academic physiologists moved beyond their bases at Harvard and Hopkins to establish the American Physiological Society as a national organization limited to research-oriented scientists. Fye suggests that by 1915 a network centered around the APS dominated the American medical system. These men believed that their subject provided both the specific ideas and the ways of thinking necessary for a truly scientific medicine. They defined the job pool for the next generation of physiology professors, and they took on the tasks of administering medical education and research. In addition, they established links to practice, both by promoting and occupying the first full-time clinical professorships and by establishing the standards for clinical research. Physiologists thus consciously put themselves at the core of American medicine in the 20th century.

The conclusiveness of Fye's argument is limited by the narrowness of his focus on successful linear "development." Though he reports the opposition of conservatives such as Harvard surgeon Henry J. Bigelow to organizing medicine around experimental physiology, for example, he does not assess the cogency or significance of oppositional arguments in the context of the time. Fye also minimizes the significant tensions within the research elite; university physiologists competed both with biologists, who considered the study of vertebrates intellectually unimportant, and with bacteriologists, who promised therapy without the labor of understanding the organism's internal processes. The book is important, however, for reasserting the central importance of experimental science in the social transformation of American medicine. Physiologists were self-interested entrepreneurs, but they believed in what they were selling, and they produced what was widely considered a superior product.

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Mastery of the Infinite

To Infinity and Beyond. A Cultural History of the Infinite. ELI MAOR. Birkhäuser, Boston, 1987. xviii, 275 pp., illus. $49.50.

The riddles of infinity are unsettling: how can space and time go on forever? But how could they not? If there are boundaries, what lies beyond them? When Newton and Leibniz argued the question, neither mustered any enthusiasm for his own position; instead, each channeled his effort into showing the contrary position untenable. Indeed, Kant was persuaded that neither position was tenable; he said our minds were not fitted to handle the question, and it must remain forever a riddle. But it did not. The German mathematician Bernhard Riemann solved the riddle in the middle of the 19th century. Infinite extent had been needlessly intertwined with the absence of boundaries; Riemann's solution was a "model" for space that was finite in size but nonetheless had no boundaries or edges. Riemann's model attracted little attention until, half a century later, Einstein used it to formulate his theory of gravity.

Maor sketches briefly some of the aspects of this story, but he concentrates on its origins—in the struggles of the Greeks to master infinity. They were successful in using infinite processes—for example, to get approximate values for the ratio of the perimeter of a circle to its diameter. But an infinite process is only *potentially* infinite: there is no limit how far it can be extended, but when actually used it is taken only to some finite stage. What troubled the Greeks most was the idea of a completed, or actual, infinity. As Maor explains, this was a consequence of their mathematical idiom: they simply had no language for thinking about an actual infinity. Nor did that language emerge in the European Renaissance, when the infinite processes of calculus acquired a central role in science.

The breakthrough came only a century ago, through the efforts of a single man, Georg Cantor. He overcame the resistance to an actual infinity by getting the mathematical community to rethink its views. Traditionally, for example, the counting numbers 1, 2, 3, . . . had been considered only potentially infinite, because any representation of them was necessarily finite. By contrast Cantor looked at the set of counting numbers as a whole; the set itself, he insisted, is an actual infinity. Cantor made sets into mathematical objects of study. His theory of sets not only gave infinity a concrete form, it provided it with a rich and complex structure. He showed that there are infinities of different sizes and each is infinitely larger than its predecessor.

To the Greeks, though, the embodiment of infinity was the plane of Euclidean geometry. The Arabs and the Europeans devised several ingenious methods to encompass and contain that limitless expanse. Maor points particularly to the power of projective geometry and the simpler technique of inversion to "gather in" the infinitely distant. The remarkable artist Maurits Escher quite deliberately used inversion for this purpose; Maor provides samples of his work and makes it clear that Escher's intention was indeed to make an "infinite-world-in-an-enclosed-plane." A different way to "tame" the infinite plane is to cover it with identical shapes in a repeating pattern. The ubiquity of these patterns in Islamic art is well known; Maor underscores their spiritual message: "By showing only a finite portion of a design which in its entirety is infinite, the believer is reminded of his frailty and insignificance under the reign of the Almighty." He does not mention, however, a recent development in which the plane is tiled by identical shapes but in a pattern that does *not* repeat. This surely reflects an even greater mastery of the infinite plane, because the crutch of repetition has been cast aside.

Maor has written a book that places the ideas of infinity in a cultural context and shows how they have been espoused and molded by mathematics. He is selective in his choice of topics, but not narrow—included are map-making, religion, symmetry, cosmology, aesthetics, philosophy. His writing is clear and direct; he does not avoid discussing mathematics, but he skillfully traces a path through his argument that avoids technical burdens. The general reader, for whom the book is intended, will find much that is fascinating and enjoyable.

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Some Other Books of Interest

Plants in Danger. What Do We Know? STEPHEN D. DAVIS and eight others. International Union for Conservation of Nature and Natural Resources, Cambridge, U.K., 1986. xlvi, 461 pp., illus. Paper, $21.

It is noted in the preface to this book that, although much has been written about threatened plants, "it is . . . clear that plant conservation . . . is not yet fully accepted as a fundamental part of conservation as a whole." Attributing this in part to ignorance of how much information on plants is available, the compilers have set out to provide a guide to sources of information that will answer the question posed in the subtitle. After an overview chapter, an essay on "conclusions for the future," and other introductory material, entries for some 200 nations and territories (including islands and island groups), listed alphabetically, are presented. Ranging in length from a few lines to several pages, the entries generally give data on area and population and brief summaries of the floristics and character of the vegetation of the locale, followed by bibliographies of checklists, floras, field guides, and other publications and, where possible, names and addresses of voluntary conservation and nature study groups, botanical gardens, and other relevant organizations. Laws protecting plants are also summarized. Appendixes list general and regional references with a geographical index and give the status of various countries with respect to the ratification of conservation conventions.—K.L.

Science and Technology in Chinese Civilization. CHENG-YIH CHEN, ROGER CLIFF, and KUEO-MEI CHEN, Eds. World Scientific, Singapore, 1987 (U.S. distributor, Taylor and Francis, Philadelphia). xx, 352 pp., illus. $64. From a workshop, San Diego, CA, and a conference, Berkeley, CA, summer 1985.

This collective volume provides, in the words of the principal editor, a "representative sample of current work in the history of science and technology by Chinese scholars." The volume opens with six papers under the heading Mathematics: a comparison of early Chinese and Greek work on the concept of limit, an account of mathematical formalisms in ancient China, and discussions of the work of Tsu Ch'ung-Chih (429–500) on the value of pi, of Wang Lai (1768–1813) on number systems of variable base, of Bao Qi-Shou (19th century) on combinatorial functions, and of Li Shan-Lan (1811–1822) on summation of series and powers and the volume of curved-surface pyramids. Five papers under the heading Science discuss the use of historical records in modern astronomy, three ancient books on optics, the generation of chromatic scales in 5th-century bells, early meteorological instruments (wind gauge, rain gauge, and evaporator), and earthquake records. The final section of the volume, Technology, contains papers on early metallurgy, sliding bearings and lubrication (tribology), and the development and spread of gunpowder and rocketry, the last of which is also the subject of the most recent installment of Joseph Needham's *Science and Civilisation in China* (volume 5, part 7; Cambridge University Press, 1986). The Chinese characters for names and key terms are inserted in the text, and the reference lists include many items from the Chinese-language literature. The volume also includes an index and a brief chronology of Chinese history.—K.L.

History of Electron Microscopes. HIROSHI FUJITA, Ed. Japan Scientific Societies Press, Tokyo, 1986 (U.S. distributor, International Specialized Book Services, Portland, OR). x, 219 pp., illus. Paper, $38.

The present volume devoted to electron microscopy as it developed in Japan was prompted by the 11th International Congress on Electron Microscopy, which was held in Kyoto in 1986. The volume opens with a group of nine papers by Japanese authors who recount early efforts in Japan, dating mainly from the establishment in 1939 of an electron microscopy subcommittee of the Japan Society for the Promotion of Science and including work during and immediately after World War II. Work at three universities (Tohoku, Tokyo, and Osaka) and four commercial firms (Hitachi, Shimadzu, Toshiba, and JEOL) is described. The commercial development of electron microscopes is the subject of five further papers, which deal with Philips and Zeiss as well as Akashi, Hitachi, and JEOL and include many photographs and lists of features and specifications of the equipment discussed. The text, entirely in English, reads awkwardly in spots and suffers from lapses in proofreading, but these sections contain much factual information and could be a useful complement to *The Beginnings of Electron Microscopy*, a collection of memoirs by scientists from various countries edited by Peter W. Hawkes (Academic Press, 1985; reviewed in *Science* **231**, 63 [1986]). The "catalogues" section that concludes the volume consists of advertisements from a number of manufacturers, Japanese and otherwise, of electron microscopes and related equipment.—K.L.

Books Received

Antibiotic Resistance Genes. Ecology, Transfer, and Expression. Stuart B. Levy and Richard P. Novick, Eds. Cold Spring Harbor Laboratory, Cold Spring Harbor, NY, 1986. xviii, 436 pp., illus. $68. Banbury Report, 24. Based on a meeting, Cold Spring Harbor, NY, 1986.

Beyond the Mechanical Universe. From Electricity to Modern Physics. Richard P. Olenick, Tom M. Apostol, and David L. Goodstein, Eds. Cambridge University Press, New York, 1986. xiv, 574 pp., illus. $24.95.

Biochemical Modulation of Anticancer Agents. Experimental and Clinical Approaches. Frederick A. Valeriote and Laurence H. Baker, Eds. Nijhoff, Dordrecht, 1986 (U.S. distributor, Kluwer, Norwell, MA). xviii, 350 pp., illus. $69.95. Developments in Oncology. From a symposium, Detroit, MI, June 1986.

Biochemistry of Virus-Infected Plants. R. S. S. Fraser. Research Studies Press, Letchworth, Hertfordshire, England, 1987 (U.S. distributor, Wiley, New York). x, 259 pp., illus. $54.95. Research Studies in Botany and Related Applied Fields, 3.

The Biological Chemistry of Marine Copepods. E. D. S. Corner and S. C. M. O'Hara, Eds. Oxford University Press, New York, 1986. x, 349 pp., illus. $73. Oxford Science Publications.

Biological Nomenclature Today. A Review of the Present State and Current Issues of Biological Nomenclature of Animals, Plants, Bacteria and Viruses. W. D. L. Ride and T. Younes, Eds. ICSU Press, Miami, and IRL Press, Oxford, U.K., 1987. vi, 70 pp. Paper, $20. International Union of Biological Sciences Monograph Series, no. 2. Based on a symposium, Brighton, U.K., July 1985.

Cancer Biology and Therapeutics. Joseph G. Cory and Andor Szentivanyi. Plenum, New York, 1987. x, 276 pp., illus. $49.50. From a symposium, Tampa, FL, Jan. 1986.

Carcinogenesis and Adducts in Animals and Humans. M. C. Poirier and F. A. Beland, Eds. Karger, New York, 1987. viii, 116 pp., illus. $66.25. Progress in Experimental Tumor Research. From a workshop, Cambridge, MA, Feb. 1986.

Cardiac Electrophysiology and Pharmacology of Adenosine and ATP. Basic and Clinical Aspects. Amir Pelleg, Eric L. Michelson, and Leonard S. Dreigus, Eds. Liss, New York, 1987. xviii, 395 pp., illus. $66. Progress in Clinical and Biological Research, vol. 230. From a symposium, Bala Cynwyd, PA, May 1986.

Direct Methods Macromolecular Crystallography and Crystallographic Statistics. H. Schenk, A. J. C. Wilson, and S. Parthasarathy, Eds. World Scientific, Singapore, 1987 (U.S. distributor, Taylor and Francis, Philadelphia). xiv, 425 pp., illus. $62. From a school, Madras, India, Dec. 1985.

Disordered Semiconductors. Marc A. Kastner, Gordon A. Thomas, and Stanford R. Ovshinsky, Eds. Plenum, New York, 1987. xiv, 778 pp., illus. $115. Institute for Amorphous Studies Series.

Diving Birds of North America. Paul A. Johnsgard. University of Nebraska Press, Lincoln, NE, 1987. xii, 292 pp., illus. $45.

Dynamical Systems and Singular Phenomena. Gikō Ikegami, Ed. World Scientific, Singapore, 1987 (U.S. distributor, Taylor and Francis, Philadelphia). x, 244 pp., illus. $39. World Scientific Advanced Series in Dynamical Systems, vol. 2. From a conference, Kyoto, Japan, July 1986.

Early Detection of Occupational Diseases. World Health Organization, Geneva, 1986 (available from