Book Reviews

Histoire générale des sciences. vol. 2, *La Science moderne (de 1450 à 1800)*. René Taton, Ed. Presses Universitaires de France, Paris, 1958. vii + 800 pp. Illus.

This is the second of three projected volumes surveying the history of science. Fortunately, it maintains the same high standards of style and accuracy set by the first volume. In terms of subjects and periods covered it should perhaps be compared with the works of A. Wolf. [*A History of Science, Technology, and Philosophy in the 16th and 17th Centuries* (London, ed. 2, 1950), and *A History of Science, Technology, and Philosophy in the Eighteenth Century* (London, ed. 2, 1952)]. On the whole, it is superior to Wolf's two volumes, particularly as to accuracy, but the reader will still want to have the nice collections of illustrations included in the Wolf volumes, and he will still find useful the attention paid by Wolf to technology and philosophy.

For a volume so complex as this volume of the *Histoire générale*, a résumé of the organization is helpful. The book is divided into three principal parts: "Renaissance," "Seventeenth century," and "Eighteenth century." A shorter fourth part, on the sciences outside of Europe, has been added. Within each of the main divisions there are topical subdivisions. After a brief introduction, by P. Delaunay, on some general aspects of the Renaissance, there are three master chapters, by A. Koyré, on the exact sciences in the Renaissance. The natural sciences in the Renaissance are treated in five later chapters—three by Delaunay on human biology (medicine, zoology, and geology, respectively); one by M. Daumas on chemistry; and one by A. Davy de Virille on botany. The second principal part is introduced by a chapter on the general character of the scientific revolution, by R. Lenoble. This is followed by J. Itard's survey of mathematics from symbolic algebra to the infinitesimal calculus and by a chapter on 17th-century mechanics, by R. Dugas and P. Costabel; one on observational astronomy, by G. Walusinski; one on mathematical optics, by M. A. Tonnelat; one on magnetism and electricity, by Lenoble; and one on chemistry, by Daumas. Natural sciences in the same period (the 17th century) are treated in four chapters: by E. Guyénot, on biology; L. Dulieu, on medicine; Davy de Virille, on botany; and R. Furon, on geology.

The third principal part, covering the 18th century, follows a similar topical arrangement: Dugas and Costabel, Tonnelat, and Daumas continue into the 18th century the treatment of their respective subjects. In addition, C. Morazé has prepared an introductory chapter, while Taton has added a chapter on mathematics; J . Lévy, one on astronomy; Costabel, one on accoustics; G. Allard, one on heat; and E. Bauer, one on electricity and magnetism. This third part concludes with five chapters on the natural sciences: by J. Rostand, on the crucial biological problems of the century; G. Canguilhem, on animal physiology; Dulieu, on medicine; Davy de Virille, on botany; and Furon, on the geological sciences. The fourth and last principal part of the volume consists of three chapters: one on science in the Far East, by J. Chesneaux and J. Needham; one on Indian science, by J. Filliozat; and one on science in Colonial America, by J. Taton and I. B. Cohen.

There are several points which make this the outstanding survey volume on the period from 1500 to 1800. (i) It is rich in detail. For example, this is the only single volume on the history of science that includes an adequate treatment of the history of mathematics (although I must admit that in treating mathematics separately and not in relationship to the development of the physical sciences, some of the effectiveness of including mathematics in the history of science is lost). (ii) The authors are all experts in their respective fields. This obviously makes for greater accuracy of detail and for accuracy in the reporting of recent research, an advantage that outweighs the loss of unity evident when there is more than one author.

Incidentally, this volume seems less unified stylistically than the first volume, a fact which stems in large part from the extraordinary diversity of subject matter and the consequent diversity of treatment. (iii) The contributors assume that the reader knows some science. In line with this assumption, many of the authors write in some detail about the scientific significance of the developments. Hence, for the most part, the contributors avoid the cardinal sin of most such surveys—inclusion of the names and dates of significant individuals without any clear and just evaluation of their contributions. (To be sure, the cataloging approach is not completely avoided, particularly in the sections on the natural sciences.) (iv) There are good illustrations and indexes. The volume is handsomely, if not fully, illustrated with 48 plates and 36 figures. Subjects and proper names are separately indexed. The inclusion in the same index of the names and dates of the scientists mentioned will be useful to the reader who has no background knowledge of the history of science. (v) The bibliographical references are adequate. A selected list of readings is given at the end of each of the principal parts. Needless to say, these lists vary considerably in completeness and usefulness.

It is inevitable that the reader with specialized knowledge of one or more of the many areas discussed in this volume will want to praise particular discussions or, conversely, to question facts and conclusions in his area of competence. A summary review hardly seems to be the place to discuss these individual topics. I cannot refrain, however, from mentioning the masterful discussion by Koyré of the Copernican revolution. It has become fashionable of late to emphasize Copernicus' lack of mathematical originality. Hence, it is good to have Koyré's reaffirmation of the scientific and philosophic importance of Copernicus' astronomy. I am also tempted to point out that the treatment of Galileo's mechanics, while generally able, contains points that certainly demand discussion, if not modification. Hence, while it is true that Galileo stated one form of the law of falling bodies in 1604 in a letter to Paolo Sarpi, as everyone knows, the reader should be reminded that at that time Galileo was so uncertain about the details of his discovery that he claimed that the conclusion that the distance of fall is directly proportional to the square of the time (a correct conclusion) can be deduced from the assumption that the velocity of fall is directly proportional to the distance of fall (an incorrect assumption). I also find the discussion of Galileo's treatment of inertia quite inadequate. The only passage discussed at length is the famous passage at the beginning of the "Fourth Day" of the *Discorsi,* wherein Galileo describes projectile motion as taking a parabolic path compounded of uniform inertial motion on a horizontal plane and vertical uniform acceleration. The interesting question is this: How do his views in this passage relate to his often expressed doctrine of circular inertial motion? As I have recently pointed out in my *Science of Mechanics in the Middle Ages,* the two apparently different views of inertia are parts of a single concept of inertia, the horizontal plane being used only where the trajectory of motion is very small in relation to the radius of the earth. Or to put it briefly, the nature of the physical problem of projectile motion allows Galileo to take one further step in abstraction that simplifies the treatment of the problem.

The only major disadvantage of this volume is one that stems from the nature of the genre. As a survey, which includes the work of many contributors in limited space, it does not offer sufficient scope for the thorough treatment of any one line of development. But if survey volumes are desirable and play a role in the spread of knowledge, we can agree that this is an excellent example of the type.

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A Philosopher Looks at Science. John G. Kemeny. Van Nostrand, Princeton, N.J., 1959. viii + 273 pp. $4.95.

The philosophy of science is a broad and highly technical field. Kemeny's book is an attempt to survey this field for the "interested layman"—in 263 rather thinly printed pages of text. How much may one expect? It will be enough —more than enough—if the author conveys clearly to the reasonably literate reader some of the basic ideas of the area. The uninitiated reader will indeed get from this book some notion of the difference between factual and formal truth; of the nature of scientific laws and their use in explanation and prediction; of the issues in the mechanism-vitalism controversy; and of several other problems in the philosophy of science.

Unfortunately, Kemeny does not escape paying the price of saying too little about too much. The price is not merely thinness but a certain muddying of the waters. For example, Kemeny explicates the distinction between formal or mathematical truth and factual truth by using as a paradigm formalized, uninterpreted "geometry." In such a system, only the connections between the axioms and theorems are mathematically true, while, since they are uninterpreted, the axioms themselves are neither true nor false. Upon interpretation, by Euclidean or non-Euclidean concepts, the axioms become contingent factual statements. But the symbols of the same system may also be interpreted into arithmetic concepts, like pairs of numbers and equations, and this results, of course, in analytical geometry. In this case, which is not mentioned by the author, the axioms themselves are also necessary, mathematical truths. Should this case occur to the reader (as well it might), he will be puzzled (as well he may be) by Kemeny's flat statement that *all* interpretations of formalized systems are factually true or false. Geometry is a fine illustration for explaining the structure of scientific theories, but it is a confusing one, unless considerable care is used, for explaining the difference between formal and factual truth.

Also, hobby-horse technicalities are sometimes introduced which, for clarity's sake, might better have been suppressed. An otherwise useful discussion of how theories are verified suffers badly from overemphasis on an unexplicated notion of "simplicity" as a criterion for choosing among alternative theories. Though this permits Kemeny to emphasize, rightly, how complex a matter it may sometimes be to confirm any isolated statement, it also leads him to assert on one page that we can always cling to any theory and, on another, that theories may be definitely falsified. This confusion is abetted by an unnecessarily equivocal use of the word *theory.* (Nor is the cause of clarity served by calling the referents of all defined terms "fictions"!) Similarly, the mathematically rather trivial point that a function can always be found to fit any set of data is not relevant to all the grief about determinism. Although Kemeny realizes this, he confusingly clutters up an otherwise elementary exposition by unduly elaborating this point.

Having caviled this much, let me add that Kemeny's book is refreshingly free of nonsense—of either naive overestimation or obscurantist depreciation of the achievements and limits of science. The "interested layman" will certainly profit from this book, and the confusions created are at least of the kind that stimulate rather than inhibit further study.

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The Canal Builders. The story of canal engineers through the ages. Robert Payne. Macmillan, New York, 1959. ix + 278 pp. Illus. $5.

The publishers of this book have provided an attractive format and careful proofreading. The author, who has written biographies of Mao Tse-tung, Albert Schweitzer, General Marshall, Charlie Chaplin, and Heinrich Schliemann, has produced a disappointing book.

Payne treats successively but discursively the canals of ancient Mesopotamia and Egypt, of classical Greece and Italy, of medieval Italy and France, and of 18th- and 19th-century England and the United States. There are chapters on the Panama Canal and the Suez Canal, in that order, and there is a final chapter on Russian canals and the St. Lawrence Seaway.

If any subject extending "through the ages" is to be successfully presented in a single book, the author must pursue his subject unswervingly, making every sentence do its full share in carrying the argument forward. In this book, Payne repeatedly deserts his subject to include all sorts of peripheral and frequently unrelated items that he has noted in his reading.

The canal engineers are often neglected in favor of more colorful or better known people. For example, in the chapter on canals in the United States, DeWitt Clinton and the Erie canal occupy six pages, but no engineer connected with the project is named. In all, eight American canals are described, but only three canal engineers are identified; of these, the one most fully discussed is allotted but two paragraphs.

The editor should share responsibility for the careless, and in places ungrammatical, writing; there are many pages of exasperating trivia that could have been removed by a careful editor. The book suffers from numerous absurdities, overstatements, and sweeping generalizations.

In a preface, canals are credited with