mension to his genius—and to his strangeness.

After nodding disapprovingly at Newton's inclination to systematize history, Manuel unfortunately allows himself to be infected with the same disease, and he sets out boldly to interpret all of Newton's nonscientific writings through his historical categories. As far as the *Observations on the Prophecies* are concerned, his point must be conceded; one of the contributions of Manuel's book is to place the *Observations* firmly beside the *Chronology* and to demonstrate their prosaic nature, however arcane the title now sounds. But when Manuel attempts to force the theological manuscripts into the same mold, he loses their essential meaning, and the book as a whole fails in its interpretation of Newton's religious outlook. Although he explicitly denies Newton's alleged mysticism and demonstrates its impossibility by further revealing the poverty of Newton's spiritual insight, Manuel persists in recalling it with references, unjustified by the discussion, to Newton's belief in correspondences between the historical and the astronomical worlds. In stressing the fundamental religious purpose of Newton's historical writings and in suggesting their traditional nature in this respect, Manuel ignores the radical character of Newton's religion. Newton wanted to dispense with all of the supernatural elements of Christianity and to equate it with natural religion. Even his chronology cannot be explained as Puritan Biblicism, since astronomical data was given final authority to confirm the Scriptures. Whatever its shortcomings, Manuel's work is a major contribution to Newtonian scholarship; its exposition of Newton's historical writings stands entirely alone, without any rival.

RICHARD S. WESTFALL
Department of History,
Grinnell College

Philosophy of Science

Conjectures and Refutations. The growth of scientific knowledge. Karl R. Popper. Basic Books, New York, 1962. xii + 412 pp. Illus. $10.

This book is a collection of 21 of Karl Popper's more important papers on topics related to the philosophy of science, which have been published during the past 20 years. The title is perhaps misleading in that these papers do not merely represent Popper's own conjectures and his refutations of his critics, but rather they develop a common thesis with respect to the nature of scientific method and knowledge, the now well-established "falsifiability" thesis that scientific knowledge develops by the method of framing "conjectures" (that is, hypotheses) and attempting to refute them by observation or experiment. This thesis first appeared in Popper's *Logic of Scientific Discovery* (*Logik der Forschung*, 1934), and the present volume is important if only because it annotates and extends in some novel ways the major contributions of that work to the philosophy of science.

Popper refrains here as always from that favorite pastime of philosophers since Kant: refuting Hume's arguments on induction. Since Hume most philosophers have tended to assume that acceptance of his conclusions leads to skepticism, and hence they have devoted their time to attempts to refute him and to establish a sound basis for induction. However, no one has been able to develop a refutation of Hume's arguments which satisfies anyone else. Popper adopts the alternative of accepting Hume's analysis of induction and denying that skepticism must result. He argues instead that scientific knowledge is independent of both induction and probability. This does not mean that he is an apriorist or intuitionist in the theory of knowledge. On the contrary, he is an empiricist and fallibilist. He argues that observation can be utilized to test theories precisely because it can validly falsify though it cannot validly verify or even confirm them. Theories that survive such systematic attempts at falsification by the method of deducing their consequences and forming testable predictions on this basis are said to be corroborated, while those that fail are falsified. Corroboration is as close as a scientific theory as a whole can get to truth. What distinguishes a scientific theory from a nonscientific one is not that the former is more probable, which may well be false, but that it is refutable. Theories which are not refutable are not necessarily meaningless, they are just not scientific, not capable of growth.

In the present volume these characteristic themes are developed, elaborated, extended, criticized, and applied to diverse contexts ranging from physical theory to sociology and history to pure philosophy. Popper's comments on social theory are not among his least important contributions. Scientists whose interests in the logical and philosophical foundations of their subject are in danger of becoming extinguished by certain linguistic inundations in this field might well find in Popper's writings just what they have been looking for: a coherent philosophy of science based firmly on a mastery of the technical details relevant to both fields but not lacking in that breadth of vision and sweep of interest characteristic of the traditional conception of philosophy.

The publishers are to be congratulated for producing a volume attractive in format, free of error, and of a quality that matches the price.

A. B. LEVISON
Department of Philosophy,
Northwestern University

Notes

Selected Readings

Archaeology, edited by Samuel Rapport and Helen Wright (New York University Press, New York, 1963. xvi + 365 pp. $4.95) is a volume of readings published in the New York University Library of Science Series. It is intended primarily for the student and layman and the 28 selections are generally highly readable and well chosen. After an initial section on the aims and methods of archeology, the arrangement is geographical; the connective tissue that appears as introductory comment for each item is brief, informative, and competent.

In scope and treatment this book falls neatly between the two with which it most nearly invites comparison: *Gods, Graves and Scholars* by C. W. Ceram, a one-man popularization of events in the history of archeology, and *The Archaeologist at Work, a Sourcebook in Archaeological Method and Interpretation* edited by R. F. Heizer. This last is geared to the needs of the advanced student and draws mainly from highly professional writings, organized to illustrate archeological procedures, techniques, and interpretations. The readings in *Archaeology* provide excellent fare for the general reader and for the student with an awakening interest in the field.

ROBERT W. EHRICH
Department of Sociology and
Anthropology, Brooklyn College

American Archeology

John Lloyd Stephens' **Incidents of Travel in Yucatan.** vols. 1 and 2 (Victor Wolfgang von Hagen, Ed. University of Oklahoma Press, Norman, 1962. 696 pp. $15) are among the major classics of American archeology. In their entertaining yet soundly informative travelogs they first brought to the attention of the public the glories of the old Maya, and they introduced that word into the American vocabulary. They found an eager audience; the books were among the best sellers of 1845. Although *Yucatan* went into 22 editions, copies are becoming rare items. But they are still important sources for the archeologist, for some of the buildings and monuments described by Stephens, and so masterfully and meticulously depicted by Frederick Catherwood's engravings, have been destroyed or damaged. Forty-four sites were visited, described, and portrayed.

This excellent new edition is therefore most welcome. The full text and all of the illustrations are included, unedited except for the standardization of punctuation, proper names, and a few Spanish and English words. The addition of a few footnotes, several modern maps, and indices makes the work more useful, and in his introduction von Hagen gives an excellent background and full biographies of Stephens and Catherwood.

J. ALDEN MASON
University of Pennsylvania

Physical Sciences and Engineering

Oceanography Source Books

The Sea. Ideas and observations on progress in the study of the seas. vol. 1, *Physical Oceanography*. M. N. Hill, Ed. Interscience (Wiley), New York, 1962. xv + 864 pp. Illus. $25.

This considerable work of reference, intended as a source book of ideas and observations, illustrates the major progress made since the still invaluable *The Oceans* was first published 20 years ago.

Thus, at that time, the theory of wave motion in the sea was essentially little advanced on the classical results of hydrodynamics. Now we have in this volume at least 100 pages devoted to the statistics of the sea-surface and the central concept of the spectrum of waves, from the high frequency ripples to the climatic changes in sea level. Most theoretical attention has been focused on the storm and swell waves, but good accounts are given of the gamut of wavelike motions. Internal waves, too, are now beginning to be systematically investigated. Discussion of the newer theories of the mechanism of energy transfer from wind to waves is brief.

The contributors to this volume have responded to the editorial intentions in different ways. Some chapters are brief reviews; others attempt a fully documented survey of their subject. In this respect, Malkus' most readable chapter (of over 200 pages) on large scale interactions between atmosphere and ocean is a highlight. Malkus uses energy budgets and flux computations with the intention of achieving some understanding of the central problem of the dynamics of the ocean-atmosphere system. The problems are posed, data critically examined, and partial solutions suggested within the limitations of the data. On the other hand, there are only 20 pages devoted to the solubles, insolubles, and gases in the oceans, although some aspects can be expected to be expanded in volume 2 of the series.

The theory of ocean currents too has changed its emphasis over the years. Much theoretical work is now directed toward understanding the circulation of the oceans as an entity. These developments are well reviewed.

Aside from the research into the hydrodynamics of the ocean, there are extensive discussions of sound in the sea. Sound is used, for example, to probe the distribution of biological life by using both man-made sources and the animals' own noises. The physical properties of the medium give acoustic methods a prime place in underwater communication.

However, the importance of electromagnetic radiation, of light in particular, in biological processes makes chapters on this subject welcome. The closing chapter on the physical properties of sea-ice complements an earlier one on those of the liquid state and provides much informative detail.

The importance of this book will be in its ability to provide sound information and good references in those fields with which one is not familiar. It probably achieves this end (though a lone reviewer cannot, of course, be sure of this), and it should enjoy a long and useful life in the hands of all oceanographers.

JAMES CREASE
National Institute of Oceanography, Wormley, Godalming, Surrey, England

The Sea. Ideas and observations on progress in the study of the seas. vol. 2, *Composition of Sea Water.* Comparative and descriptive oceanography. M. N. Hill, Ed. Interscience (Wiley), New York, 1963. xv + 554 pp. Illus. $25.

This is the second volume of a three-volume series directed toward giving a view of progress made in the study of the seas during the past 20 years and toward depicting present ideas and