four (11 chapters—or 300 pages) is a regional world survey based on climate and vegetation regions; in the fifth section selected nation-states are briefly considered. The final part is devoted to some observations on man's relation to space and time.

Geography in World Society is the outgrowth of 35 years of teaching experience by the authors; as such it represents the point of view and procedure developed in their classes. The book is almost autobiographical, for it traces the changing ideas of geography over recent decades and includes photographs of many of the leaders. Many sections become quite philosophical, or "conceptual"—a word which appears frequently in the text but which is missing from the index. The graduate student will find much to discuss, but the treatment seems too heavy and wordy for freshmen. The volume represents a tremendous amount of work, with many ideas of value, but I doubt that it will become a widely used text.

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Psychology

Monozygotic Twins. Brought up apart and brought up together. An investigation into the genetic and environmental causes of variation in personality. James Shields. Oxford University Press, New York, 1962. x + 264 pp. Illus. $11.50.

The study of twins can be regarded as a method of observing the outcome of a controlled experiment set up by nature. In this connection monozygotic twins have attracted special attention. Three American investigators, H. H. Newman (a biologist), F. N. Freeman (a psychologist), and K. J. Holzinger (a statistician) published a monograph [*Twins*, University of Chicago Press (1937)] based upon unique case material, 19 monozygotic twin pairs who had been brought up separately. These investigators developed a new method of expressing numerically intrapair similarities, which has been especially helpful in shedding light on the influences of environment on intellectual development. Monozygotic pairs brought up separately were compared with pairs, both monozygotic and dizygotic, brought up together.

James Shields, a British psychiatrist, got in touch with and secured the cooperation of two groups of twins, each composed of 44 monozygotic pairs; twins in one group, the S-group, had been separated early in life and those in the control group, the C-group, had been brought up together. The pairs in each of the groups were selected from 5000 twins who responded to an appeal Shields made on television. An elaborate procedure for establishing the zygosity of the twins was set up, the so-called similarity method. However, despite its usefulness, the number of times the twins in a pair were mistaken for one another was not employed as a criterion of zygosity. Monozygotic twins are incorrectly identified about 80 percent of the time by teachers and 25 percent of the time by parents.

The study is focused mainly on intrapair comparisons of intelligence and various personality traits, with special regard for the importance of certain environmental factors, such as social class and pattern of upbringing.

Shields had to overcome great administrative difficulties in collecting his data. He is well aware of the intricacies and sources of error in twin research. On the average, twins are one quarter of a standard deviation inferior to single-borns in intellectual achievements; this restricts the scope of the generalizations that can be based on findings derived from twin populations. Self-selection may be responsible for the surprising finding that intrapair similarities are of the same magnitude in the C-group as in the S-group. The sex factor may be another source of error, since we know that dizygotic twins of the same sex tend to be much more similar, at least in cognitive achievement, than twins of unlike sex. Finally, the wide age range may have introduced an uncontrolled factor that could have blurred the general picture, especially in the assessment of intellectual differences within pairs. Some previous studies suggest that there is a higher incidence of left-handedness among both monozygotic and dizygotic twins, and this has been explained by asymmetry reversal. Shields seems to accept this finding. But surveys of complete age groups of Swedish conscripts have failed to disclose any difference between twins and single-borns with respect to incidence of left-handedness or any differences between monozygotic and dizygotic twins with respect to concordance of handedness.

An extensive and valuable case history description, based upon clinical interviews, is given. Painstaking procedures are set up in order to establish the effect of early separation. New facets of the complicated interaction of genetic and environmental factors are given.

The author arrives at two general conclusions "for the truth of which there seems to be good support." (i) "Family environments can vary quite a lot without obscuring basic similarity in a pair of genetically identical twins." (ii) "Even monozygotic twins brought up together can differ quite widely." The validity of these statements depends in part on the importance of the sources of error indicated above. In any case, the study makes significant contributions to our knowledge in this field.

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Newtonian Literature

Isaac Newton, Historian. Frank E. Manuel. Harvard University Press, Cambridge, Mass., 1963. xii + 328 pp. Illus. $7.50.

Manuel's study of Newton's historical writings, a unique addition to the corpus of Newtonian literature, is most welcome. Manuel is the first scholar to examine these papers who has been equipped to understand them in their context. He demonstrates that Newton proposed a radical foreshortening of ancient history; by pruning several centuries from the annals of Egypt, Assyria, and Greece, Newton sought to establish the leadership of the Hebrews in the development of civilization. An even more radical procedure underlay his conclusions. By a tenuous argument Newton claimed to locate the equinoxial points on the eve of the Trojan war; since he knew the rate of precession, he was then able to fix the date of the Trojan war and from that date the rest of ancient history. If the topic sounds remote to the 20th century, Newton's work was, as Manuel reveals, the object of acrimonious debate for more than 50 years following its publication. Even though the method and the system did not, in the end, prove to be contributions to historical knowledge, as the author freely acknowledges, a clear understanding of them reveals the considerable scope of Newton's erudition and adds a new di-

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.

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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.

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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.

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