account that requires no background beyond trigonometry and analytic geometry. While some demands may be put on the neophyte's mathematical maturity, the rewards to be gained are great. Among the topics included are: (i) development of the real numbers from the naturals; (ii) existence and uniqueness of decimal, Cantor, and continued-fraction expansions, with rationality tests; (iii) the Hurwitz-Borel theorem; (iv) Liouville's theorem on algebraic numbers; (v) Dirichlet's theorem on diophantine approximations; (vi) the theorem on uniform distribution; and (vii) an elegant introduction to cardinality.

Although the author's tone is informal, his proofs are well motivated and rigorous. More advanced readers will probably regret omissions forced by limitations of space, as I regretted the absence of a more thorough treatment of the integers and the rationals. The scope of the book is, however, remarkably broad. Unfortunately the book suffers from a large number of misprints which will force the less advanced reader to proceed with caution. For example, the displayed equation on page 6 should read $a_1 + a_2' = a_1' + a_2$, and the fraction $1/4^n$, on page 36, line 9, should be replaced by $2^3/4^n$.

In general, however, this book is well suited to serve as an introduction to the real numbers as well as to some of the ideas of analytic number theory. Used in this way it will undoubtedly stimulate many students to explore further the fascinations of the real number system.

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The Pleistocene Epoch

The Deep and the Past. David B. Ericson and Goesta Wollin. Knopf, New York, 1964. xxiii + 292 pp. Illus. $6.95.

The Deep and the Past is intended as a popular account of 17 years of oceanographic research carried out at the Lamont Geological Observatory. The book circulates around the way to and the methods used to discover the "first complete record of the Pleistocene." Therefore, the validity of the use of the words "first" and "complete" must be discussed.

Deep-sea cores penetrating the whole Pleistocene were collected by Kullenberg in 1947. Dutch studies (Zagwijn) have resulted in a curve of the same epoch, which also is in agreement with that obtained from the Swedish cores. The record now offered by Ericson and Wollin deviates markedly from the others.

Foraminiferal analyses, which are their methods of tracing glacial and interglacial ages in the sequences, are complex methods, and the authors have apparently been misguided by them. Two examples will be offered.

The authors stress the necessity of discovering the interstadial in the Würm stage of core sequences (why not also within the Riss?). An interstadial is traced approximately 50,000 to 31,000 years ago by other students and with other methods, but it is not discernible by the way these authors "read" the cores. Therefore they suppose a period at 95,000 to 65,000 years ago as an interstadial and date the last glaciation to 340,000 to 115,000 years ago; it is more likely that Riss-Würm ended about 80,000 (± 7000) years ago, Riss about 100,000 years ago, and that Mindel-Riss falls at about 300,000 to 200,000 years ago.

The absence of the foraminifer *Globorotalia menardii* in some Atlantic cores at approximately 6 to 8 meters indicates, according to Ericson and Wollin, glacial condition (Riss). However, everything seems to suggest that the section was formed during the warmest period of the Pleistocene, which I have correlated with the Upper Mindel-Riss. Their method of tracing the climatic development is therefore questionable.

The authors refer to some potassium-argon datings. An additional one, Lippolt's dating volcanic ash to about 375,000 years, Uppermost Cromerian or Lower Mindelian in age, could have been quoted. This dating suggests an age of the Mindel glaciation of one third of that given by Ericson and Wollin.

One chapter is devoted to the discovery of a horizon with a faunal change and where the Discoasteridae had become extinct. This horizon is suggested as a new Plio-Pleistocene boundary. They believe that this change mirrors a sudden and drastic climatic deterioration. A different interpretation may also be possible.

On the basis of these considerations, Ericson and Wollin's climatic curve for the Pleistocene must be considered incorrect for most of the Pleistocene. Their time scale for ages greater than 200,000 is only a guess. The correlation with the conventional time-stratigraphic units is unlikely, except for the last 65,000 years. In two chapters they then apply this unlikely time scale to Pleistocene cultures, Mammalian succession, and human evolution.

Several other discussions and statements in the book are inconsistent, others are incorrect. But, owing to limited space, examples cannot be given.

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Hydrology

Advances in Hydroscience. vol. 1. Ven Te Chow, Ed. Academic Press, New York, 1964. x + 442 pp. Illus. $15.

With this first volume of *Advances in Hydroscience*, Ven Te Chow, the editor, has initiated a much-needed new means for satisfactorily collecting and disseminating new knowledge resulting from scientific research on water. Volume 1 is a collection of timely articles prepared by authorities in the fields of sonar, hydroelasticity, the statistical hydrodynamics in porous media, hydroballistics, and the hydraulics of wells. The information, with emphasis on physical theories and mathematical analyses, will be most useful to advanced scientific workers.

The article "Sonar," by Bradford A. Becken, describes the field in relation to the gathering of scientific information from the ocean through the use of underwater acoustics. Recent scientific and engineering advances in signal enhancement, transducer design, and receiving-beam formation are illustrated.

In his article "Hydroelasticity," S. R. Heller, Jr., defines hydroelasticity and outlines its scope, largely by analogy to aeroelasticity, to denote its naval counterpart. Heller's article is concerned with differences between aeroelasticity and hydroelasticity, typical static and dynamic hydroelastic phenomena, control-surface flutter, and vortex-induced vibrations.

In "New contributions to hydroballistics," F. S. Burt points out that there is need for considerable improvement in the performance of all types of underwater weapons. Burt gives a brief review of the various aspects of

hydroballistics, with emphasis on current and recent techniques.

Two articles, "Statistical hydrodynamics in porous media," by Adrian E. Scheidegger, and "Hydraulics of wells," by Mahdi S. Hantush, are concerned with the flow of fluids through porous media. These articles are not descriptive, elementary texts but advanced treatises and decidedly mathematical expositions. Their highly mathematical flavor makes these chapters difficult to understand, but they provide valuable insight into the intricacies of groundwater flow.

It is difficult to deduce Darcy's law from the fundamental laws of hydrodynamics, such as the Navier-Stokes equations, because it is impossible to give a complete description of the geometry of the pore system of a porous medium. Scheidegger's article is concerned with an approach that faces the difficulties head on by treating various phenomena only on a statistical basis.

Hantush, in a most important contribution to the field of hydraulics of water wells, covers basic principles and fundamental equations pertaining to the steady- and unsteady-state flow of water in aquifers. Definitions and useful approximations for several functions that are commonly encountered in well problems and in other groundwater flow problems are given. Drawdown and yield formulas are presented for steady- or constant-discharge nonflowing and flowing wells and collector wells in various aquifer systems.

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Problems in Space Science

Unusual Environments and Human Behavior. Physiological and psychological problems of man in space. Neal M. Burns, Randall M. Chambers, and Edwin Hendler, Eds. Free Press (Macmillan), New York, 1963. x + 438 pp. Illus. $9.95.

This introductory text, which attempts to present a concise review of current knowledge about the physiological and psychological problems that man will encounter in the space environment, is divided into two sections, (i) Overviews, and (ii) Specific Problem Areas. In the first, the authors discuss general concepts of human reactions to stress and attempt to derive objective standards of measurement. Relevant experience gained from nonspace stress situations is then presented. In the second part, the environmental stresses anticipated in space flight are treated individually. The chapters, written by 16 specialists in the field, are entitled: "The physiological effects of unusual environments"; "Psychological and psychophysiological indices of stress"; "Computer simulation of man-machine systems"; "Psychological problems of prolonged marine submergence"; "Psychophysiology of high-altitude experience"; "Isolation and sensory deprivation"; "Operator performance in acceleration environments"; "Temperature effects on operator performance"; "Weightlessness"; "Vibration"; "The effects of radiation on integrated behavior"; and "The decade ahead."

The chapter on the effects of acceleration stress on performance is of particular interest in that Chambers discusses observations on Project Mercury astronauts and others who underwent similar stress conditions in high-altitude planes and the human centrifuge. The final chapter, written by the three editors, shows balance and insight in its evaluation of needed research in the field and of the changing concepts in scientific experimentation that are reflected, or even incurred, by a program where "the comfortable cushion of scientific information that traditionally separated the scientist from the engineer" (p. 422) is not available.

The great gaps in our knowledge of the effects of stress on man are perhaps the most important single fact in any treatment of the subject. Not only are we ignorant of many of the varied responses and cumulative effects of single stresses, but also, as Hendler points out in the conclusion of his chapter, "Questions regarding the combined effects of many stresses on physical tolerance and performance capability remain largely unanswered at this time" (p. 349). Although these deficiencies are clearly drawn in the final chapter, they are not stressed in the body of the volume. Understandably, the known rather than the unknown is emphasized. However, there is an assurance, a definiteness, in the presentation of data which could mislead the unwary reader into assuming that a great deal more is known than is, in fact, the case, and which could cause him to accept as proven hypotheses that which further research may undo. The statement, in the last chapter, that "the editors and contributors view our current level of knowledge as meager when compared with all that remains to be known" (p. 419), is certainly an honest view of the situation at the present time. One might wish that this had been the first chapter.

In view of the complexity of the subject discussed, it is obviously not possible to explore all of its aspects in depth in this small volume. It seems fair to state that the authors have reviewed the topics which, with respect to the national space program, appear to be significant to manned space flight. The data that are presented are accurate and current. Extensive and excellent references at the end of each chapter will guide the reader to more detailed studies. The book should be useful, particularly to engineers and designers, as an introduction to an understanding of the techniques and findings of research on the effects of extreme environments on man and the known limits of man's tolerances.

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Airborne Particles

Particulate Clouds: Dusts, Smoke, and Mists. Their physics and physical chemistry and industrial and environmental aspects. H. L. Green and W. R. Lane. Van Nostrand, Princeton, N.J., ed. 2, 1964. xxii + 471 pp. Illus. Plates. $13.50.

In our daily life we are continually in intimate contact with many forms of airborne particulate matter. The suspended particles may be smoke from industrial plants, microorganisms, dust from volcanoes or outer space, salt particles from the sea, or ice crystals. The sun that shines into our rooms shows us that we are living in a cloud of particulate matter. The bluish trails of smoke behind automobiles are nothing but a suspension of very small droplets of oil in air.

What ties together these various phenomena is the character of the particulates. They are aggregates larger than molecules, but still so small that they fall very slowly. The authors have limited themselves to particles that fall with a terminal velocity less than that of a 100-μ water droplet. Within this