in his own terms, he proposes nothing less than a revolution in our concept of science, if not of nature. But it is not clear to me that anyone really holds the view of science which he would demolish. I for one find a great deal more in this book to agree with than might be expected in an exponent of a counterrevolutionary school. The argument depends very heavily on the viability of the terms—*paradigm, normal science, revolution, anomaly, crisis*, and the like. So it has been with many a philosophy of history from Comte to Toynbee. So it has been with many a chapter in the history of science—phlogiston, calorie, ether—and the student of either of these genres (which Kuhn, like Comte, combines) will have learned to be wary of mistaking the terms he gives his subject for its elements, the definitions for the happenings. The argument sometimes comes perilously close to circularity: that is, normal science does not aim at novelty, ergo what is novel is not normal science but an anomaly. On strictly historical grounds, moreover, strong cases might be made for considering books like Newton's *Principia* and Lavoisier's *Traité élémentaire* as summaries of a heritage rather than as models shaping the future. The reader may be referred, for example, to E. J. Dikjsterhuis's treatment of Newton in his recently translated *Mechanization of the World Picture*, where it appears that Newton himself did not adumbrate the laws of motion in the sense in which they were fundamental to classical physics. For example, the proportionality of force to the product of mass into acceleration was imported into the second law in the development of analytical mechanics, not forced upon a school by a revolutionary law-giver. Newton was thinking of impact.

Still, there are not many books which find one making eager jottings in the margin, nor fortunately need one act on these; one may instead, and indeed in candor must, await the full development that Kuhn intends to provide. Meanwhile there can be only admiration for the erudition, the scholarship, the fidelity, and the seriousness that the enterprise reflects on every page. One is safe in predicting that whatever the final success, there will be no petty faults to find. Every historian, moreover, will surely applaud one recurrent and fundamental emphasis, which is that the development of science must be set into the context of a Darwinian historiography and treated as a circumstantial evolution from primitive beginnings rather than the ever closer approach to the telos of a right and perfect science. It is odd, and Kuhn is absolutely right about this, that by instinct scientists tend to see it the latter way. At least their students do, and who else could be responsible for that?

Subsidized Irrigation

The Value of Water in Alternative Uses. With special application to water use in the San Juan and Rio Grande basins of New Mexico. Nathaniel Wollman, Ralph L. Edgel, Marshall E. Farris, H. Ralph Stucky, and Alvin J. Thompson. University of New Mexico Press, Albuquerque, 1962. xxii + 426 pp. Illus. $10.

Is traditional irrigated agriculture really the most efficient use of water in arid regions? If industrial use were expanded, would an adequate labor force and sufficient investment capital be available? With development of the San Juan River and a diversion to supplement flow into the Rio Grande in prospect by 1975, these questions are pertinent for the State of New Mexico, and indeed, for other arid regions. Resources for the Future financed a study, carried out at the University of New Mexico, directed by Wollman and a committee (his coauthors) with the support of several subcommittees composed of faculty members and representatives of the state government. A summary of the study constitutes the first 125 pages of this book; thirteen appendixes, written by the subcommittees or individuals responsible for specific phases of the study, present supporting data and detail the methods employed.

Eight possible patterns of water use were tested. Two rates of diversion from the San Juan River to the Rio Grande and four different schemes of allocation between municipal-industrial and agriculture-recreation were analyzed. Estimated benefits for each pattern of use were obtained by estimating the primary value added for agriculture and industry plus the value added by purchases for all three uses. That industrial water yields by far the greatest return per unit of water use will surprise no one who has considered this problem. That recreational uses rank second and agriculture a poor third may be more surprising. In fact, the conclusion is that irrigation is not possible without subsidy. Utilization of all new water in New Mexico for industry is not feasible, however, because neither adequate labor nor capital can be anticipated. The so-called "high industry" models utilized only about half of the available water for industrial purposes.

The reader may be troubled to find that a situation exists that suggests that the water must be put to use, even if a subsidy is necessary, in order to avoid its diversion to other areas. The reader may also be troubled by evidence that a truly adequate basis for evaluating recreational benefits is lacking, and he may question the inclusion of secondary benefits in the calculations. Methodology, the impact of the various models on the labor force, and the differences between the state and national viewpoints are discussed in an interesting manner.

Since the project would be built with federal funds, the reader may wonder how it would rank among all possible projects which the nation might contemplate. No matter how much one may wish to debate the details of the analysis, it serves to make its intended point without ambiguity—no rational water plan can be developed without a careful study of the value of water in competing uses.

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Earth Science

Petrology. Walter T. Huang. McGraw-Hill, New York, 1962. vii + 480 pp. Illus. $9.75.

This book, which is intended for beginning students and others who need a comprehensive introduction to the broad field of petrology, is not a distinguished effort, although it does have some advantages when compared with many older texts. Its advantages include some use of recent experimental studies on oxide and silicate systems, abundant illustrative material from recent geological literature, and a more up-to-date treatment of the rock-forming minerals from the viewpoint of crystal chemistry. The numerous illustrations are rather well selected,

and sources outside North America are well represented. Students interested in further reading on specific topics will have to depend mainly on the captions to the figures for references. A handful of general references are provided at the end of the book, but none follow the individual chapters. Many authors are mentioned by name in the text, but rarely is so much as a date given to aid the student who wishes to read further. Many specific studies are mentioned, but the name of the investigator responsible is often omitted.

The text is clear and readable but not very well edited. Incorrect spellings and misprints are conspicuous. The sections on igneous and metamorphic rocks apparently owe much to *Igneous and Metamorphic Petrology* by F. J. Turner and J. Verhoogen (McGraw-Hill, New York, 1960), but the story has lost a great deal in the retelling.

In the preface the author states that: "Modern petrology has become physical chemistry applied to the crust of the earth." This is perhaps true, but this book does little to advance the cause. In the discussion, for example, of the calcite-wollastonite-quartz–carbon dioxide equilibrium curve (p. 355), the author reveals an ignorance of the distinction between homogeneous and heterogeneous equilibria, of the significance of a univariant curve, and of the nature of catalysis. Most instructors will undoubtedly conclude that the labor involved in setting students straight on such matters will more than offset the strong points of this text. It is, in general, a rather disappointing book, not up to this publisher's usual standards.

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Paleobotany

Morphology and Evolution of Fossil Plants. Theodore Delevoryas. Holt, Rinehart, and Winston, New York, 1962. ix + 189 pp. Illus. $4.50.

This excellent book is true to its title. Most chapters, or subdivisions of large chapters, consist of descriptions of the internal and external morphology of important members of the groups considered, followed by a discussion of the evolution of the groups and the evolutionary principles illustrated. Each chapter is terminated by a well-chosen bibliography, but literature citations are not made in the text.

The book is distinguished by beautiful illustrations, including many reconstructions, a large number of which were prepared by Delevoryas and his associates. The text, although comprising only 182 pages, is remarkably comprehensive. The writing is concise. Every sentence is important. Emphasis is placed on significant morphological features, such as the order of maturation of primary xylem, nodal and petiolar anatomy, the nature of the pitting of the secondary tracheids, branching patterns, vascularization of both vegetative and reproductive structures, and the structure of fructifications. The treatment of all groups is not equally comprehensive, however. For example, Devonian plants, especially psilophytes, and angiosperms are given relatively brief treatments, whereas Pennsylvanian plants, especially lycopsids, sphenopsids, coenopterid ferns, and pteridosperms are given a more intensive coverage.

The book is organized around a traditional classification. The initial chapter, on the preservation of fossil plants, is followed by a discussion of fossil algae, fungi, and bryophytes. The remainder of the book consists of ten chapters on vascular plants, a final chapter of summary and conclusions, and an index. Under the division Tracheophyta, subdivisions Psilopsida, Lycopsida, Sphenopsida, and Pteropsida are considered in sequence. Classes of pteropsids included are Pterophyta, Cycadophyta, Coniferophyta, and Angiospermophyta. Subdivisional and class endings do not conform to the current *International Code of Botanical Nomenclature*, but are, instead, those that have been commonly used in the morphological literature. Some confusion may result, since all except the latter of the class names have also been used as the names of divisions or phyla in several recent textbooks. Among the most interesting are several short transitional chapters entitled "The appearance of land vascular plants," "Seed plants," "Problematical cycadophytes," and a section of one chapter called "Problematical and transitional ferns."

Morphological paleobotany today is a dynamic and rapidly progressing field. Many significant discoveries and interpretations have been made during the past decade which have added to our knowledge of plant evolution. Delevoryas has prepared a book which, more than any other in English, emphasizes the evolutionary aspects of paleobotany. Furthermore, where interpretation and speculation are encountered, they are the thoroughly considered opinions of one who combines the best of classical theory with modern evolutionary thought.

Every biologist interested in plant evolution should own this book. There is not a better book on morphological paleobotany available, no matter what its size.

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Autobiography of a Science

Fifty Years of X-ray Diffraction. P. P. Ewald, Ed. Oosthoek's, Utrecht, Netherlands, 1962. ix + 717 pp. Illus. $11.25.

In July 1962 a commemoration meeting was held in Munich, Germany, to celebrate 50 years of x-ray diffraction. The principal actors in the beginnings of that drama, which took place in 1912, were Max von Laue, W. Friedrich, P. Knipping, and P. P. Ewald. Appropriately enough, the president of the International Union of Crystallography, under whose auspices the 1962 meeting was held, was P. P. Ewald who, looking ahead to the meeting, had been working on a history of x-ray diffraction to be published in time for the meeting.

This book contains eight sections of widely differing lengths, an appendix consisting of biographical notes on the authors, and a subject index. The first three sections are entirely Ewald's work. A five-page introduction is followed by a section consisting of four chapters that describe the early days of x-ray diffraction: Röntgen's work on the physics of x-rays, classical crystallography prior to x-ray diffraction, Laue's discovery of x-ray diffraction, and a chapter devoted to the very early work of the pioneers—the Braggs, Darwin, Moseley, Debye, Hull, and others. In the third section (two chapters), Ewald tells about the principles of x-ray diffraction and discusses the methods and problems of determining crystal structures.

It would be impractical to describe in detail the remaining sections, which were written by some 40 authors. Sec-