populations rather than among individuals. This is especially true for species that make their living by colonization and rapid occupation of new habitats, only to be supplanted rapidly by a more stable community. I am suggesting that weedy species, because of their high rate of deme extinction, may undergo a reasonable amount of evolution at the population level, even though individual selection may be a sufficient explanation of their adaptations. Nature does not always operate by the simplest mechanism, and the principle of parsimony is only a methodological convention, not a fundamental revelation of the structure of the universe.

Occasionally Williams' argument turns against him. I think, for example, that his discussion of genetic assimilation misses the point. Certainly no one claims that genetic assimilation occurs by any means other than by Darwinian selection. It is simply that for some developmental systems organisms that give up developmental flexibility for the assurance of a particular morphology will leave more offspring and are, *ipso facto*, better adapted. Williams' argument that genetic assimilation of a previously facultative response must be a loss of adaptation smacks of the very viewpoint his book is intended to combat. It is not possible to react instantly to a change of environment and the delay may be painful or fatal, so it is sometimes better to build in the response even in the absence of the stimulus. Before the calluses come the blisters, as I discover anew each summer when I first row a boat.

Despite such reservations, however, I believe that Williams' book is excellent in its totality and that it is 95 percent correct. Most of the characteristics of organisms, including social behavior, must be the result of differential fitness at the level of individual genotypes. Only a small part of evolution, although perhaps its most intriguing aspect, has occurred as a response of groups to a higher level of differential fitness.

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Lattice Defects in Quenched Metals

At high temperatures, crystalline solids are literally riddled with holes: many lattice sites which ideally should be occupied by atoms are instead vacant. This phenomenon is in a sense the inverse of the vapor pressure of condensed matter, as if the vacuum were "evaporating" into the solid. Thus, the concentration of vacancies increases rapidly with increasing temperature, often approaching 0.1 percent near the melting point.

One of the more fruitful and interesting methods for studying lattice vacancies appeared in 1952, when J. Kauffman and J. Koehler showed that it was possible to retain most of the vacancies during very rapid cooling from a high temperature. By measuring the effects of quenched-in vacancies on various physical properties, primarily the electrical resistivity, and by observing the annealing out of the excess vacancies, information concerning the thermodynamic and dynamic properties of both isolated vacancies and associated pairs, called divacancies, can be obtained. Unfortunately, the interaction of vacancies with themselves, with impurity atoms, and with other defects often complicates the picture, so that different investigators have not always agreed on the experimental results or their interpretation.

Another aspect of the problem which has received considerable attention during the past eight years is the study of larger-scale defects produced by precipitation of the excess vacancies. Depending on the ambient conditions, the vacancies may aggregate to form voids, stacking fault tetrahedra, and various prismatic and faulted dislocation loops. All of these larger defects have been observed directly by means of transmission electron microscopy. In addition, their effects on the mechanical properties of quenched metals are readily demonstrated.

The present book, **Lattice Defects in Quenched Metals** (Academic Press, New York, 1965. 829 pp., $22), edited by R. M. J. Cotterill, M. Doyama, J. J. Jackson, and M. Meshii, consists of the papers and discussions offered at a conference devoted exclusively to defects in quenched metals. The conference was held at Argonne, Illinois, in June 1964. The book is a timely documentation of a field of investigation that is expanding. Some of the contributions give extensive surveys of experimental results, but there is little of the tutorial review that the nonspecialist would find desirable. Thus, this book is certainly not intended for the general or casual reader, but is frankly addressed to those physical scientists whose research deals with, or is affected by, lattice defects.

The overwhelming majority of the papers are concerned with face-centered cubic metals, and especially with aluminum and the noble metals. There is extensive treatment both of the experimental techniques and methods of analysis. The effects of specimen size and purity, of dislocation content, of quenching temperature and quenching rate, and of various post-quench treatments are analyzed to yield information concerning the energies and entropies of formation and of migration of single vacancies and of divacancies, as well as information on the interactions of vacancies with impurity atoms and dislocations. A wealth of electron micrographs illustrates a variety of larger defects formed by vacancy aggregation, and a number of models are proposed to account for the aggregation processes.

The problems attacked in this work involve really microscopic features of defects in metals, and it is perhaps not surprising that some questions remain unanswered and that the conference proceedings occasionally display a lack of unanimity. In some cases, such as the question of the binding energy of the divacancy in gold, one could almost say that there appears to be little uncertainty—only disagreement. This is, of course, the result of intense interest in a rather complicated problem. The really amazing thing is that we can now begin to zero in quantitatively on such elusive targets, and the detailed picture supplied by the manuscripts of this volume represents as complete an account as one could hope to find of this particular corner of solid state science.

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Earth Sciences

Textbooks on solid-earth geophysics tend to polarize between an elementary survey approach and a specialized advanced presentation. Among the former, there is a variety of available books on earthquake seismology, internal structure of the earth, and exploration geophysics. Advanced texts treat such topics as the earth's gravitational field, satellite geodesy, and elastic wave propagation. To proceed from one to the other and to the journal literature normally requires a detour through mathematical physics.

Interpretation Theory in Applied Geophysics (McGraw-Hill, New York, 1965. 603 pp., $17.50), an excellent and important volume by two Canadian geophysicists, F. S. Grant and G. F. West, attempts to bridge the gap. Grant and West propose to supply the essential material from mathematical physics in a concise form, and to relate this material to the physical measurements obtained in geophysical exploration. One may question whether they have succeeded in materially reducing the mathematical demands on the readers, but they have compressed a tremendous amount of information into a volume of some 600 pages.

The subject matter of geophysical exploration is treated under three headings: seismology, gravity and magnetism, and electromagnetic conduction and induction. Each section is complete in itself and each receives equal space. This division of subject matter is a natural one because the mathematics can be developed from the Helmholtz, Laplace, and diffusion equations respectively. Each of the 18 chapters is preceded by a useful summary of its contents and its relationship to other chapters.

Within each section, the authors have attempted to provide an introductory chapter for perspective, one or more chapters to develop the underlying mathematics, and several chapters to show the use of these results in interpreting physical measurements in terms of geological structure. Relatively little attention is given to measurement techniques, instrumentation, field procedure, or corrections.

The section on seismology treats elastic wave propagation in uniform and nonuniform media, plane and spherical waves in layered media, surface wave dispersion, seismic ray theory, and many other topics. Tensors, contour integration, and other such mathematical tools are used where needed. Individual topics are treated competently, but the overall impression is one of too many scattered items treated too briefly. Despite such chapter titles as "Analysis of seismic records" and "Seismic interpretation," the would-be interpreter will find that much of the discussion is of a peripheral nature.

The second section develops potential theory for use in the interpretation of gravity and magnetic measurements. Detailed interpretation procedures, some presented here for the first time, are based on geological models such as sheets, cylinders, or blocks. Emphasis is given to identifying characteristic features of the anomalies as a basis for interpretation.

The section on electrical conduction and induction disposes of the former in a brief but fairly advanced discussion. A chapter somewhat misleadingly titled "Electromagnetic theory" precedes an excellent, thorough, and partly original discussion of induction effects in geological structures. Characteristic features of the anomaly curves are again emphasized as interpretational tools.

The book is directed to advanced students and professional exploration geophysicists. Certain portions will interest earthquake seismologists, geologists, hydrologists, geodesists, oceanographers, and radio engineers.

This volume will immediately take its place as a basic text and reference in solid-earth geophysics.

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Botany

K. R. Sporne's new pocket-sized book, **The Morphology of Gymnosperms** (Hutchinson, London; Hillary House, New York, 1965. 216 pp., $3), is the first comprehensive treatment of gymnosperm morphology since Chamberlain's *Gymnosperms: Structure and Evolution* (1934). In the meantime many important discoveries have been made, especially in paleobotany and embryogeny, and these have considerably altered some of our notions about evolution and relationships within the gymnosperm complex.

Ten of the 12 chapters treat the nine orders—Pteriodospermales, Bennettitales, Pentoxylales, Cycadales, Cordaitales, Coniferales, Taxales, Ginkgoales, and Gnetales—that the author recognizes. These are distributed among the three classes Cycadopsida, Coniferopsida, and Gnetopsida, but no divisional taxon is named. On page 18 Sporne explains that, because many regard the group as representing an evolutionary level rather than a formal taxon, he prefers to use the common noun "gymnosperms" rather than "Gymnospermae." This alludes, of course, to the naked seeds, which they all possess in common, and leaves open the possibility of polyphyletic origin. However, on page 196, he says that "the evidence which is available at the moment seems to favour the view that the gymnosperms are monophyletic."

Each chapter begins with a formalized diagnosis of the order that it treats. Families are listed under some of the orders, and in the case of several of the families the genera are named. For most of the taxa, whether order, family, or genus, pertinent facts are cited concerning habit, distribution, anatomy, reproductive morphology, embryogeny, and affinities. Chromosome numbers are given where known.

The book is well written in a readable and understandable style. It is illustrated only with drawings, taken mostly from other sources. Although small, the drawings are well made, suitably grouped, and clearly reproduced. An excellent bibliography of 230 entries is appended, and the index is complete. Factual and typographical errors are few. There are some passages, however, that may be a bit puzzling at first—for example, the statement that the genus *Libocedrus* has five species confined to New Zealand and New Caledonia (p. 145). Sporne does not explain that the incense cedar of Oregon and California was transferred to the genus *Calocedrus* many years ago. For the most part controversial matters are impartially dealt with, and arguments for both sides are usually given. Sometimes the author expresses his preference, sometimes he does not.

It is a good book to possess, and constitutes suitable reading for students at all levels.

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General Anthropology

For the past decade mathematicians and engineers have found their exclusive preserve—the computing center—more and more violated by strangers of dubious credentials from other sides of the campus. Social scientists and