fishery technology, much of which consists of compositional studies of commercial fish and fishery products. The task required a shrewd, discerning, and incredulous approach. Love, rising above infatuation with mere chemical analyses, has ably put together a book that is interesting, informative, and at times fascinating. The reader, depending upon his fancy, will find well-balanced discussions on such subjects as the life cycle, differences between and within species, the influence of environment, and phylogeny.

It is said that fish have a phylogenic history at least three times greater then birds and mammals. The chemistry of aquatic forms, on this basis alone, would be expected to offer new and refreshing perspectives in biology. The discussions in this book support such a conclusion. Students of comparative science may well recognize the wealth of provocative data afforded by oceanic species. Indeed, the relevance of marine biochemistry to humans is well documented by discussions of matters such as hormonal controls in spawning and the fate of various foods. Nutritionists may well enjoy dissecting a discussion of the question "Is it possible to acquire a different composition through a change of diet?" Furthermore, accounts of such phenomena as the fascinating ability of *Salmo gairdnerii* to undergo extensive vascular degeneration during spawning, followed by a *reversal* of this process, should stimulate the student of human diseases to take another look at ocean life.

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Tracing Mathematical Concepts

The Nature and Growth of Modern Mathematics. EDNA E. KRAMER. Hawthorn, New York, 1970. xxvi, 758 pp., illus. $24.95.

The Nature and Growth of Modern Mathematics is a monumental volume of 30 chapters written for the purpose of surveying the entire field of mathematics with particular emphasis upon those ideas that have become popular during the 20th century. An "oscillatory-type" spiral approach is used in which the author moves forward historically but also steps backward frequently as the book develops in order to capture the essence of key mathematical concepts. In this way the concepts are traced from their origins in antiquity to their more modern formulations. The writing is richly interlaced with mathematical lore and interspersed with biographical sketches of prominent mathematicians in an attempt to provide insight into the humanistic motivations for the birth of particular mathematical ideas.

A review of the treatment of game theory and probability will illustrate this approach. Early in chapter 9, the stage is set for contrasting the nature of probability theory with that of scientific determinism by discussing 17th-century Newtonian mechanics with its emphasis upon precisely defined relations between present and future conditions of physical events. In the following chapter, "The elements of strategy in war and peace," chance-dominated game theory is discussed, with emphasis upon the contributions of John von Neumann (a brain as superb as von Neumann's provoked Hans Bethe to fancy the possibility of a species superior to man!). At this point, a detour is taken through probability theory, beginning with the classical, 17th-century, Bernoulli-Laplace definition of probability, giving an axiomatic treatment of a few of the fundamental theorems of probability, and concluding with a mention of the need for measure theory due largely to Emile Borel. Pascal's definition of mathematical expectation is utilized in discussing the solution of certain matrix games. This is followed by a treatment of general games and statistical decision theory as advanced by Abraham Wald. One of the concluding chapters of this sequence, "From dice to quantum theory and quality control," begins with an analysis of games of chance as proposed by the 17th-century gambler Chevalier de Méré, leading to a discussion of conditional probability and the modern use of quality control. In this series of chapters, extensive sections are devoted to biographies of earlier mathematicians, such as Euler, Newton, and Laplace, as well as of more modern ones such as Borel, von Neumann, and Wald, in addition to an enlightening description of the highlights of the mathematical ideas. In a similar manner concepts important to algebra, analysis, geometry, logic and foundations, and topology (angelic geometry) are developed.

This volume was written for an audience of well-educated, highly interested laymen and not primarily for mathematical specialists, although it does seem clear that a specialist will enjoy reading this book, particularly those sections that are beyond his specialty. The author has certainly achieved her purpose of writing a stimulating volume for the general reader, but in so doing she has made some sacrifice of precision and mathematical rigor, which some may feel is a shortcoming.

The Nature and Growth of Modern Mathematics richly deserves a place on any mathematical bookshelf. It appears that it will rank very favorably with the popular and successful classic *What Is Mathematics?* written in 1941 for a similar audience by the mathematical scholars Richard Courant and Herbert Robbins.

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Omnipresent Phenomena

Separation of Flow. PAUL K. CHANG. Pergamon, New York, 1970. xviii, 778 pp., illus. $40. International Series of Monographs in Interdisciplinary and Advanced Topics in Science and Engineering, vol. 3.

As he breathes and moves man generates separated flows. Around him wind and water currents give rise to separated flows with vastly varied scales and shapes which have long intrigued him practically and esthetically (witness Leonardo da Vinci's journal). Man was unable to fly until he learned how to streamline his flows, that is, how to minimize separation effects, but on landing and deceleration he promotes flow separation to achieve his ends. Yet his understanding of the omnipresent separation phenomena remains essentially fragmented and empirical. In the presence of largely unavoidable flow instabilities and turbulence, the well-established governing field equations—the Navier-Stokes equations generalized for compressibility—defy even his most powerful computing machines. The problem of flow separation is a highly nonlinear, multidimensional, singular-perturbation problem in partial differential equations, often with only stochastically defined initial conditions—a problem unlike most others scientists have faced.

The author of *Separation of Flow* undertook "an attempt to compile references . . . in basic physical processes, analyses, and experiments covering the

whole area of interest. . . ." He also intended the monograph to be "useful for engineers as a reference." Indeed engineers and scientists who are familiar with the concept of boundary layers will find this monumental, well-organized guide to the mushrooming literature very useful as a handbook reference of low-speed and high-speed separated flows with varied geometries of technological interest. The special strength of the book lies in the more than 550 figures and photographs illustrating the basic features of the flows and reporting typical experimental results.

Had Chang had the opportunity to include more than just a few pages of post-1964 research, he would have probably been more circumspect in a number of his assessments (for example of acoustic theory of cylinder wakes, prediction methods for turbulent boundary layers, vortex bursting, and the significance of protruding probes placed in front of blunt bodies, to which 57 pages are allotted). It is, however, a surprise that Navier-Stokes equations go unmentioned, as do the concepts of matched asymptotic approximations. Exclusive reliance on the (parabolic) asymptotic boundary-layer theory (usually coupled with ad hoc empiricism) tends to obscure the essential feedback (elliptic) nature of separated flows. Deeper exploitation of this nature may well hold the key to further progress whether experimental, theoretical, or numerical. In the meantime evaluating the flow and forces associated with a "curve" thrown by a pitcher will remain more of an art than throwing one. And P. K. Chang's book will be used as a handy reference.

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Radiation Effects

Fission Damage in Crystals. LEWIS T. CHADDERTON and IAN MCC. TORRENS. Methuen, London, 1969 (U.S. distributor, Barnes and Noble, New York). xii, 268 pp., illus. $13.50.

Ever since atomic power became generally available much technological and scientific effort has been directed toward understanding the interaction of various radiations with solids. Nuclear engineers have had to cope with difficulties arising from a gradual change of properties of materials exposed to radiation (Wigner effect) while research chemists, physicists, and metallurgists acquired a magnificent tool (some say toy) for studying a multitude of defects produced in solids by radiation. Chadderton and Torrens's book is an excellent up-to-date introduction to and survey of a particular class of these phenomena: the interaction of uranium fission fragments with crystalline solids. Since fission fragments produce secondary radiations such as electrons (which the authors call for some reason "delta rays") these are also considered in some detail. The book gives much theoretical background concerning fundamentals of the pertinent phenomena: fission, mechanisms of energy loss, collision cross section, several kinds of spikes (thermal, displacement, plasticity), focusing, and others. Much space is also devoted to the experimental methods of irradiation, to direct and indirect observation (electron microscope) of the bombarded solids, to imaging techniques, to tracks in heat-sensitive crystals, to effects in lead iodide and alkali halides, and to other relevant topics.

Considerable space is also occupied by discussion of results obtained, mostly by the authors, on computer-simulated irradiation processes. These computer "experiments" stimulate imagination and provide many fascinating illustrations in the book. The reviewer is, however, skeptical about the degree of significance attached to some of these results, which of necessity sometimes are obtained with drastically simplified pairwise interatomic interactions, in small volumes or in less than in three dimensions. It is only recently that such computer "experiments" are emerging from the convenient but not very realistic pair formalism and other limitations, and attempts are being made to include such factors as noncentral forces and polarization sums (matrix method). It suffices to point out that there is, as yet, no satisfactory estimate of the threshold energy for vacancy formation in alkali halides or of energy losses during the linear propagation of the ensuing neutral interstitial [110] configuration as first suggested by Vosko *et al.* Various mechanisms of defect formation in these crystals have been proposed, and some of them have found support, although a generalization to all alkali halides is still lacking.

One of the fundamental questions in the theory of fission damage is the problem of the effective charge of the fission fragments moving through a solid and of the associated energy loss. The usual Bohr-Linhard theory, referred to in the book, has been very recently modified by Betz and Grodzins, and it will be interesting to see to what extent this will alter the quantitative interpretation of the effects of fission on solids.

The book is very clearly written, is well printed, and has a fair index and a number of references at the end of each chapter. It is a most useful addition to the solid state literature.

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Crystallization Method

Crystal Growth in Gels. HEINZ K. HENISCH. Pennsylvania State University Press, University Park, 1970. 112 pp., illus. $6.95.

Only recently has there been a surge of interest in the growth of crystals in gels, though this method has a history beginning at the close of the last century with the study of Liesegang rings. Henisch has combined the extensive literature on the subject with his own investigations to produce a concise and readable book on this potentially fruitful area of investigation.

This method for growing crystals is relatively simple, and no elaborate equipment is needed. The basic procedure involves crystallization within a gel by chemical reactions between reagents in the gel and liquids or gases that diffuse through it. Variations in growth procedures are illustrated by discussions of compounds such as calcium tartrate, cuprous chloride, and silver iodide. The crystals considered were grown in silica gel. Several other gels such as agar, gelatin, and soft soaps are mentioned, but unfortunately a discussion of crystal growth in them is not developed. The effects of *p*H and aluminum impurities on gelling are considered, and excellent electron micrographs show silica gel structures with interconnected cells of sheetlike form.

Much attention is given to the subject of nucleation. Though foreign nuclei undoubtedly play a role in crystallizing in gels, Henisch develops a good argument to show that homogeneous nucleation is probably more important. The effects of silica gel on suppressing nucle-