fire the reader's imagination; critical discussions of methods and techniques not only provide drama and entertainment, but give the reader an accurate view of the wonders of this powerful research tool. The specialist will find the book provocative and informative. From study of this text, all students of chemistry and biology should obtain a clear and vivid understanding of the uses of tritium as a research tool.

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Mathematics in Practice

Stochastic Processes. M. GIRAULT. Springer-Verlag, New York, 1966. 138 pp., illus. $7.

Modern mathematical theories not only awe applied scientists by their abstruseness but frustrate them as well by not offering much help for their practical problems. The situation has been well put by a theoretical physicist as follows: Mathematical problems arising from applied sciences are like brush fires which demand simple and quick action, but mathematicians are more interested in building spic-and-span fire stations which are too remote for those little fires. If one looks at the various current books on "stochastic processes," one is amazed at the great discrepancy among them, although some have almost identical titles.

On the one hand, there are those austere volumes of which the perusal is well-nigh impossible without years of intensive study in pure mathematics; on the other hand, there are recipe-book or handbook types just as full of equations and formulas but at a level supposedly (and advertisedly) accessible to readers with only "calculus background." The need to bridge the gap is obvious; bridging it is difficult indeed. Yet one could also easily imagine contemporaries of Newton and Leibniz shaking their heads over those fluxions and exclaiming over the absurdity of teaching that kind of stuff (namely the "calculus" just mentioned) to physicists and engineers!

The present effort by Girault to teach stochastic processes to "practical workers [in] Physics, Chemistry, Biology, Medicine, Population, Economics, Organisation, Operational Research etc." is one in a growing literature and should be viewed in this perspective. It presents a number of relatively simple "models" such as Poisson, additive, Markov, second order, and Laplace (alias Gaussian) processes, illustrates them with figures and numbers, and summarizes some of the relevant theory. Even such abstruse matter as infinitely divisible distributions receives some attention; but in contrast there is no discussion of certain familiar types of integro-differential equations encountered in applications. The explanation of the confusion of notation on page 32—"the sign $+$ in $(X + Y)$ denotes a convolution of two probability laws but in $(a + b)$ it denotes a sum of two numbers"—is outmoded and merely adds to the confusion. Even a practical worker nowadays must be taught that the sum of two random variables is just like the sum of two numerical functions and therefore, *in sum*, just like the sum of two numbers. But the probability law of a random variable (not necessarily a sum as in this instance) is not the same as the random variable itself. Without this truly fundamental understanding much in the rest of the book, such as the meaning of an "additive" process, must be incomprehensible or, worse, misapprehended.

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Freshwater Life

A Treatise on Limnology. Vol. 2, Introduction to Lake Biology and the Limnoplankton. G. EVELYN HUTCHINSON. Wiley, New York, 1967. 1127 pp., illus. $39.

This is the second volume of a monumental three-volume monograph. Although it contains only nine chapters, these are nicely subdivided, and each has a concise and adequate summary. The first chapter, "The nature of the fresh-water biota," accounts for about one-quarter of the text. Perhaps the most unusual feature of this chapter is the inclusion of short comments about a host of rare, atypical, and fortuitous inhabitants of fresh waters from all parts of the world. Few aquatic biologists are familiar with *Aldrovandra* (a floating sundew), *Calpasoma* (a Swiss freshwater hydroid), *Limnostylochus* (freshwater polyclad in Borneo), *Planolineus* (Javanese freshwater nemertine), *Aetheria* (an oyster-like mollusk from African rapid streams), and *Potamocypoda pugil* (a Malaysian freshwater crab), for example. The list of freshwater polychaetes is surprisingly long. Only 18 pages are devoted to vertebrates. There is an excellent discussion of the many facets of the physiology of adaptation to fresh waters, but the reader is judiciously left to draw his own conclusions about genetic mechanisms and precise ecological migratory pathways involved in the colonization of lakes and streams by marine and terrestrial ancestors.

A short chapter on "The structure and terminology of lacustrine biological communities" clarifies ecological concepts that are used in the subsequent portions of this volume (and presumably will be in volume 3). The mathematically minded limnologist will be pleased with the chapter on "The hydromechanics of the plankton." This is a remarkable treatment of sinking rates of phyto- and zooplankton in relation to turbulence, size, density, dispersion, and nutrient uptake, especially from the standpoint of ramifications of Stokes's law. "The nature and distribution of the phytoplankton" is a taxonomic consideration based chiefly on ecological nutrient requirements. "Phytoplankton associations" contains an intriguing mathematical consideration of "conditions for multispecific equilibrium." There is a new "provisional" classification of 13 different phytoplankton communities of the euphotic zone, including such associations as oligotrophic desmid plankton, oligotrophic chlorococcal plankton, eutrophic diatom plankton, and myxophycean plankton. Undoubtedly Hutchinson's simple classification will spark a good deal of controversy among phytoplankton specialists. In view of his extensive and complicated classification of lake types in volume 1 of this monograph, I am disappointed and surprised with his oversimplified concept of phytoplankton communities.

"The seasonal succession of the phytoplankton" is a thorough discussion of the frustrating problems of algal population irregularities with respect to physical, chemical, and biological agencies. The literature on antibiosis and biochemical growth stimulators is brought together in a complete and critical fashion. It is notable, however, that "grazing" effects by zooplankton are given only passing attention. I trust volume 3 will elabo-

rate on this phase of plankton productivity. "The nature and biology of the zooplankton" occupies about one-quarter of the text. Treatment is according to major taxa, but consideration is given to a wide range of topics such as general biology, seasonal succession, life history, feeding, and geographical distribution. The section on ecological distribution of calanoid copepods brings together widely scattered literature. Much to my surprise, Hutchinson does not attempt to classify lakes according to their zooplankton communities. The last two chapters, "The vertical migration and horizontal distribution of the zooplankton" and "Cyclomorphosis," are complete literature reviews of these special aspects of zooplankton biology.

More than 1500 references are cited. Hutchinson has a complete grasp of limnological literature which can only be described by using one of his own favorite adjectives—"fantastic." Although he has done a remarkable job in weighing evidence pro and con, there are many paragraphs and short sections where his well-known talents as an essayist are paramount. American limnologists will be impressed with the great emphasis placed on European investigations. In some areas I feel that important American papers have not been given their due. That this fine volume contains little material on pond plankton or stream plankton is a trivial criticism. It is a redundancy to conclude this review by saying that this volume belongs in every limnologist's personal library.

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A Unique Trace Metal

Zinc Metabolism. ANANDA S. PRASAD, Ed. Thomas, Springfield, Ill., 1966. 481 pp., illus. $16.75.

This book was compiled in an attempt to present under one cover a comprehensive review of zinc metabolism. It reviews nutritional, biochemical, and clinical knowledge concerning zinc in plants, animals, and man. The appearance of this book is timely, since, to paraphrase one of its contributors, it appears at the close of the classical period of zinc physiology and at a time when the biochemical role of this trace metal as an essential component of many enzymes is becoming apparent. Moreover, the recent development of new analytical methods—in particular, atomic absorption spectroscopy—now makes it possible to measure zinc in biological materials with relative ease and remarkable sensitivity. Although, as the editor suggests, numerous good reviews of zinc metabolism have been published and this book is not entirely new in that sense, it does bring together widely dispersed data from many areas for consideration by students and scientists interested in this unique trace metal.

The editor and his colleagues describe a new method for analysis of zinc in plasma, red blood cells, and urine with the use of a commercially available atomic absorption spectrophotometer. It appears to be accurate and precise and should hasten the acquisition of new data in human zinc metabolism. A. S. Prasad's extensive studies on zinc deficiency in Egyptian dwarfs are reviewed and supplemented by new data. It is remarkable that the conditioning factors which account for the zinc deficiency in these patients are still poorly understood. The authors imply that such zinc deficiency may be a common denominator in the widespread growth retardation seen in many tropical and subtropical areas.

One is impressed in general by how little is understood in chemical or biochemical terms about the causes or results of zinc deficiency in any plant or animal species. Much phenomenology is gathered together in this book, but few studies in zinc metabolism have been undertaken with a general biochemical hypothesis in mind. The pioneering studies of B. L. Vallee and his co-workers on zinc metalloenzymes would seem to furnish such a framework for future studies.

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