Book Reviews

Theoretical Demography

Introduction to the Mathematics of Population. NATHAN KEYFITZ. Addison-Wesley, Reading, Mass., 1968. xiv + 450 pp., illus. $13.50.

Most textbooks in demography contain sections on the analysis of measurements which introduce elementary ideas of population mathematics. The treatment is always superficial and usually impressionistic. Students who wish for a deeper understanding of the subject must search for papers, some written many years ago, in a wide variety of journals. The need for further knowledge is particularly strong for scientists concerned with less traditional applications—ecologists studying animal populations, anthropologists tracing the development of tribal groups, sociologists examining the demographic effects of family planning, and so on. Keyfitz's book is the first in English—and arguably in any language—to give a thorough and consistent account of a body of materials and researches which can reasonably be called population mathematics.

It is important not to confuse the subject with that of mathematical techniques for the analysis of population data. Some of these appear in the book as a natural consequence of the theme, but it is in no sense a handbook for demographic calculations. Keyfitz's purpose is the elucidation of mathematical relationships which, in some sense, represent or reflect the determinants of structure and change in real populations (models if you like). Once the relations have been defined the interest is in the mathematical development, not the description or interpretation of observations. Rightly and effectively the reader is frequently brought back to the examination of actual data, but in order to illustrate the theories rather than to justify their usefulness. In fact, there are a few places, for example in the discussion of stable population concepts, where the inexperienced in these topics might be misled into the adoption of facile methods which do not take into account the biases and idiosyncrasies of observations.

Since the book has no direct forerunners Keyfitz has had to rely to an unusual extent on his own experience in deciding on scope, balance of topics, and depth and detail of treatment. He has also made substantial original contributions to bridge gaps in theory in order to make tidy exposition possible. In general, he has concentrated on those parts of the subject that help to illuminate the influence of different demographic factors and give guidance on effective measurement. A partial exception is the lengthy study of approximations in the methods and of how to improve their accuracy; in practice, errors in observations are much larger than those that stem from the calculation procedures. A notable feature of the presentation, however, is the close integration of the mathematical derivations with their numerical realization on computers. Accurate and efficient calculation then makes it easier to achieve order and consistency.

The core of the book is the account of the theory of growth in a population subject to birth and death rates dependent upon age. Lotka established the fundamental results in his classic work more than 40 years ago, but these have been deepened and extended since. Analysis in terms of discrete time intervals by matrix algebra has been particularly rewarding in clarifying the underlying processes and bringing the more abstract ideas closer to the practical methods for projecting populations into the future. Keyfitz's consistent use of the discrete matrix approach, alongside the more orthodox difference-differential and integral equation, continuous-time techniques, imposes a unity that helps in the attainment of an overall view, where previously there has been confusing diversity. The elaborations of the mathematics to allow for interacting populations, including the balance of sexes, and birthrate dependence on marriage and parity are described fairly briefly because despite the algebraic complexity little that is new in principle emerges.

The treatment of these basic topics is deterministic, but the last section of the work introduces several probability models by which the effects of chance variation can be gauged. The more direct extensions to growth theory are likely to be of most interest to scientists studying relatively small and simply structured animal populations, but the analysis of reproductive histories of individual women by these means is proving to be of major importance for the understanding of the implications of family planning.

Incidental but far from minor virtues, because of the inadequacy or the specialized nature of other treatments, are the good accounts of certain topics that have wider applications than are relevant here—life tables, graduation of fertility distributions, and sampling variances of demographic characteristics.

The attempt has been made to organize the content and methodology so that the mathematical sophistication required is at a moderate level. This has been done, with considerable success, by keeping strictly within the limits of the degee of development needed for each particular topic and including explanations of the more advanced techniques such as generating functions and the Laplace transform. The mathematics looks, in fact, rather more frightening than it is. Although most scientists will have to put considerable intellectual effort into following the book, they will be repaid by a good understanding of the subject.

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Xenon, Krypton, and Radon

Noble-Gas Chemistry. JOHN H. HOLLOWAY. Methuen, London, 1968 (U.S. distributor, Barnes and Noble, New York). viii + 216 pp., illus. $6.75.

This is a well-written little monograph on a subject that has aroused considerable interest in the last five years. The discovery by Bartlett in 1962 that xenon is a chemically reactive material and the rapid subsequent development of noble-gas chemistry are summarized clearly and authoritatively in this volume. The earlier, comparable monograph by Moody and

Thomas suffered severely from its premature preparation. Many of the early reports in the field were fragmentary and often incorrect, or at least misleadingly interpreted. By now most errors have been corrected, and aside from the still vexing problem of xenon hexafluoride most of the chemistry falls into a reasonably consistent pattern.

The interest in the field is undoubtedly due to the existence of a conventional chemistry for xenon, but Holloway does not neglect the early history of failure to find reaction and the unusual and short-lived species of reaction products that were studied before it was realized that ordinary fluorides and oxides could be synthesized.

Enough of the experimental techniques and preferred preparative methods are given to enable the newcomer to the field to get started with relatively little waste motion. The theoretical discussion is somewhat simplified and, although this may have been intentional given the expected wide range of readers, I have some reservations as to the precision and adequacy of the treatment. For example, the Gillespie ideas are presented in their simplified form and their inadequacy is correctly demonstrated, without, however, any notice of some of the possible refinements that have been suggested. The more recent attempt by Bartell to rationalize the Gillespie predictions with an equivalent molecular orbital approximation unfortunately appeared too late to be included in the volume.

The book is well illustrated, errors are scarce, and the price is low enough to permit a reasonably wide circulation. Teachers of inorganic chemistry will find many useful illustrations of techniques and problems in the chemistry of the noble-gas compounds, and this volume is a most useful key to the subject.

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Quantum Field Theory

Particles and Fields. DAVID LURIÉ. Interscience (Wiley), New York, 1968. xii + 508 pp., illus. $15.

Quantum field theory has a 40-year history. After a long initial period of a rather primitive theory (by today's standards) it reached unforeseen success after World War II when electromagnetic interactions yielded brilliant agreement with high-precision experiments. But the pride in quantum electrodynamics was short-lived when nonelectromagnetic interactions did not yield to the same techniques. As a result, most theorists turned away from field theory to attempt new and different ways, while a small group turned to mathematics for the answers.

The work of these relatively few theorists was soon dubbed "axiomatic quantum field theory." But the importance of their work lies not in their axioms but in their attempt to bring rigorous mathematics, including the mathematics of the present century, to bear on the problems of field theory. Rigorous field theory, now some 15 years old, has produced a large number of fundamental results. Based on these, our present knowledge of quantum field theory is so far advanced over the theory of the early 1950's that today we can rightly call that theory "naive."

It is a little surprising, therefore, that none of this advancement can be found in *Particles and Fields*. What one does find, however, is a fine account of *naive* quantum field theory (chapters 1 through 6) and its developments since the early 1950's (chapters 7 through 10). The book serves thereby a very useful purpose for those who are interested in fundamental questions: it shows how the heuristic use of mathematics in field theory leads to many contradictions and inconsistencies; how a theorem proven heuristically (p. 317) is found to be invalid (6 pages later) when bound states are present; how the Yang-Feldman equation derived in perturbation expansion differs from the nonperturbative results, and so on. Thus this textbook shows to every serious student of theoretical physics the need for a rigorous approach. In this respect alone it teaches a great deal.

At the same time, *Particles and Fields* provides many important computational methods which are the basis of much of the phenomenological theory in present-day particle physics. There is an excellent chapter on currents, coupling constants, and sum rules which includes the Goldberger-Treiman relation and a treatment of the important papers by Fubini and Furlan, by Adler, and by Weisberger. Dispersion-relation techniques are not included. There are few books in which the Bethe-Salpeter equation is treated in as much detail as in this one. Of course, this is also where the author can draw heavily on his own research work. The chapter on the functional method is strongly influenced by its heuristic development; some statements that cannot stand up under rigorous scrutiny should therefore not be surprising. Highlights of the first six chapters include explicit applications to spins 1 and 3/2 of the Bargmann-Wigner equation, an introduction to internal symmetries, and a lucid explanation of renormalization by means of the chain approximation.

As a textbook, *Particles and Fields* is quite readable and is provided with problems at the end of each chapter which supplement the text and furnish omitted proofs. The prerequisite is at least two semesters of graduate quantum mechanics. The book is printed well and contains a good index, as well as references at the end of each chapter. There is little doubt that *Particles and Fields* will be used widely as a first course of quantum field theory. And there is also little doubt that the thoughtful students will want to go beyond this book to a more rigorous treatment.

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Archeological Research

New Perspectives in Archeology. SALLY R. BINFORD and LEWIS R. BINFORD, Eds. Aldine, Chicago, 1968. x + 374 pp., illus. $9.75.

This volume is composed of 16 articles, plus critiques by six discussants and three very short introductory pieces by the editors. Most of the papers were presented, in their original form, "at an all-day symposium entitled 'The Social Organization of Prehistoric Communities' held at the 64th Annual Meeting of the American Anthropological Association at Denver in November, 1965." For publication, however, many of the original papers have been substantially revised, and five additional ones have been included.

On the whole, this is a provocative and stimulating collection and a significant one. Although individually of rather uneven quality, the articles taken en masse present an overview of current archeological interests among the younger archeologists which is remarkably consistent and develops quite an impact. The mere breadth of temporal and areal coverage is exciting: from the Middle Paleolithic to recent Apache and