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.

W. BRASS
London School of Hygiene and Tropical Medicine, London, England

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