visualizing the nature of convergence with different forms of initial deviation from the stable population age structure.

The third part of the book is perhaps potentially the most valuable in practical terms. This constitutes a study first of the effects of fertility that changes at a constant rate with mortality remaining constant and second of changing mortality with fertility constant.

The analysis of fertility changes at a constant rate is an extension of some work in Coale and Zelnik's *New Estimates of Fertility and Population in the United States*. Approximate analytic expressions for the birth function and age structure at any time are developed for the cases where (i) fertility has been constant for a long time and then changes at a constant rate, (ii) fertility has been changing at a constant rate for a long time and then becomes constant, and (iii) fertility has been changing at a constant rate and then alters to a different constant rate of change. Such formulations can be used to evaluate the growth effects of a population with fertility continuously declining to replacement, and then with constant fertility at replacement level.

The treatment of declining mortality is less satisfactory. To obtain analytical approximations for the age structure, changes in mortality during early childhood have to be specified in such a way as to produce the same effects on the age structure as constantly declining fertility. Such a pattern of change would appear unlikely, at least in terms of the Coale and Demeny "West" model life tables. Even when such a pattern does occur the agreement between the approximate functions for age structure and the age structure derived by projection does not appear to be very good.

It is unfortunate that the estimation of the effects of declining mortality on an initially stable population should be the least adequately handled element of this book, because such analytic formulations are potentially the most useful in analysis of population data from developing countries. That Coale is aware of this need is clear—witness his work with Demeny in the United Nations Manual IV, "Methods of Estimating Basic Demographic Measures from Incomplete Data." It would appear, however, that the methods used to deal with changing mortality in that manual were those outlined in this book. Further work is undoubtedly required in this field, although Coale's is the best available so far.

The fourth part of the book is an analysis of cyclical fluctuations in fertility (around a constant value). This too has appeared elsewhere in almost identical form (*Demography*, Vol. 7, No. 1), and this fact is again not mentioned. First the effects of a simple, sinusoidal fluctuation of fertility are investigated. If the amplitude of the cyclical variation is small the birth sequence is an exponential multiplied by a cyclical function of the same frequency. However, in general, the amplitude will be different and there will be a shift in phase. A thorough study is made of the variations of amplitude and phase shift for different frequencies of variation in fertility. Not surprisingly, maximum amplification in birth cycles is achieved when the fertility fluctuations have a period of about the mean length of a generation—that is, when maximum fertility occurs when survivors from the previous maximum of births reach the childbearing ages and hence the fluctuations are amplified. Similarly, maximum attenuation of the birth cycle occurs when the period of fertility fluctuations is about twice the mean length of a generation—when peak fertility occurs while the survivors of the previous minimum of fertility are of childbearing age.

The analysis of a simple sinusoidal pattern of variation becomes too complicated to be of great use when the amplitude of the fluctuations becomes too large—harmonics are introduced. Finally a Fourier analysis of any time pattern of fertility is obtained, but this provides no simpler a formulation in the general case than a succession of projection matrices. Thus the attempt at Fourier analysis does not contribute to our understanding of population dynamics and therefore is of largely academic interest, as I think Coale would agree.

In conclusion, this book is an impressive contribution to the understanding of the dynamics of human populations. Most of it is entirely original to Coale. On the whole the presentation is near perfect. Although occasionally results are presented before their justification—which is irritating to the reader—the explanation is never more than a page or two after the result. The style is very clear, for which most social scientists will be grateful, especially when reading about amplifiers and electrical circuits. Although Coale regards the level of mathematics as unsatisfactory, it did not seem so to this reader; it is adequate for the demographic tasks at hand, and this is a book *about* demography *using* mathematics—for which we may be grateful!

Finally a word of appreciation for Erna Harm, who did the computer programming for most of the computations in the book—it is no mean task finding roots of integral equations or evaluating high-order Fourier series. The ultimate debt is to Coale for his remarkable book, which is perhaps the best single contribution to the field since the work of Lotka (and this despite Lopez's proof of weak ergodicity), although with its more heuristic approach—perhaps of necessity given Coale's self-claimed mathematical limitations—of a slightly different nature from Lotka's work.

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Parasites

Life Cycles of Coccidia of Domestic Animals. YEVGENIY M. KHEYSIN. Translated from the Russian edition (1967) by Frederick K. Plous, Jr. Kenneth S. Todd, Jr., Ed. University Park Press, Baltimore, 1972. xii, 264 pp., illus. $18.50.

The Coccidia are a large and important group of parasites, with complex life cycles, which cause serious disease in domestic and wild animals and, occasionally, in man. In 1970, toxoplasmosis, a disease of considerable importance in man, was found to have a developmental cycle of coccidian nature in the intestine of cats. Thus Coccidia are of interest to those in medicine as well as to those in veterinary medicine and to biologists.

The author of this monograph, who died in 1968, was one of the foremost investigators of Coccidia, particularly the life cycles and cytology of species occurring in rabbits. The four families of the suborder Eimeriidea are considered in detail in the book, with emphasis on the Eimeriidae, which include most of the species that cause disease. The morphology and physiology of the various stages in the life cycle, the development of these, the course of infection, the survival of the oocysts outside the bodies of the host, sporulation of the oocysts under various conditions, and factors affecting initiation of infection by Coccidia receive major attention. Much of the information presented concerns Coccidia of domestic animals, but data

pertaining to Coccidia of invertebrates are given for comparison. Also, descriptions of the known species of Coccidia of domestic animals and a number of good diagrammatic illustrations are included. The pertinent literature up to 1965 is well covered.

In writing this book Kheysin attempted to summarize the knowledge concerning the life cycles of the Coccidia of domestic animals, with emphasis on the cytological and physiological aspects. He was successful in achieving this purpose, and the book should be useful to anyone wishing such a review.

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Thermal Physiology of Man

The Stress of Hot Environments. D. McK. KERSLAKE. Cambridge University Press, New York, 1972. x, 316 pp., illus. $19.50. Monographs of the Physiological Society, No. 29.

Considering the fact that a large fraction of the world's human population is frequently exposed to high environmental temperatures, the number of books dealing with the biological reactions to this particular form of stress is small. Its well-organized presentation of the older and newer concepts of thermoregulation in hot environments makes this one a welcome source of information for the qualified reader. The writer leads the reader from the physical characteristics of human thermoregulation through participating physiological functions to the practical application of evaluating thermal stress in quantitative terms. The frequently used mathematical concepts are all defined in terms based on the recently proposed standard system of symbols for thermal physiology (*J. Appl. Physiol.* **27**, 439 [1969]). Because of the present status of this system in the biological sciences, the author and the reader are faced with certain problems. Many biologists are not used to employing terms like kilopascal for vapor pressure or $W/m^2 \cdot kPa$ for the coefficient of heat exchange by evaporation.

Throughout the book there is an emphasis on peripheral rather than central mechanisms of heat regulation in man, especially in relation to cardiovascular adaptations. Since the text deals exclusively with responses of the human organism to heat, a large section of the book is devoted to the specific cutaneous cooling system of man. The present information on the regulation of sweating is adequately reviewed; particularly, problems related to the depression of sweat gland activity are discussed in detail.

An evaluation of the various indices of heat stress currently employed is the culmination of the earlier chapters. Though the thoroughness of the analysis is commendable, the fact remains that no one index will satisfy every possible condition, especially if one takes into consideration individual differences in size, shape, and physiological responses. In this respect a discussion of the location, density, and function of cutaneous thermal receptors would have added to the value of the monograph. It is a well-known fact that human subjects with similar measurable physiological responses to heat do not necessarily perceive a standardized thermal stress with the same intensity.

The scientific terminology used, the practical appendices, and the large number of references (431) should make this a useful book for scientists and engineers who are concerned with problems of man and his thermal environment.

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Bacteria

Spore Research 1971. Proceedings of a meeting, Harrogate, Yorks., England, Dec. 1970. A. N. BARKER, G. W. GOULD, and J. WOLF, Eds. Academic Press, New York, 1972. xiv, 370 pp., illus. $17.

Sporeforming bacteria and bacterial endospores have been the subject of several recent books and review articles. Research on bacterial sporeformers has been published in the proceedings of the bacterial spore conferences that have been held each four years since the first international spore conference was organized by H. Orin Halvorson in 1956. This book is the first publication of the proceedings of the British Spore Group and invited foreign guests.

In light of the many recent and detailed reviews of this specialized field of research, it might seem that another book on the subject is unnecessary. However, this book is quite different in scope from previous research reviews. Much of the recent research has been directed toward studies of bacterial sporulation, germination, and outgrowth as model systems for cellular differentiation, and these processes have been subjected to extensive analysis by biochemists and geneticists. The biochemical and structural bases for the dormant and resistant states of the spore have been similarly studied. These studies have for the most part concentrated on those species of the aerobic sporeforming bacteria more amenable to genetic and biochemical analysis in the laboratory. Studies of anaerobic sporeformers and researches of a more practical nature have received less attention, although they are of great importance to the health-related sciences and to the preservation industries. It is these that are the principal subject of the present book.

The book opens with a thoughtful review of the effects of oxygen on anaerobic sporeformers and the nature of obligate anaerobiosis. There are five papers and one abstract dealing with germination of clostridial spores. Several other papers cover the effects of *p*H, drying, various chemicals, and recovery temperature on the heat resistance and outgrowth of spores. All are of importance to applied microbiologists. Although these papers set the general theme of the book, there are several on other topics, including a series of three excellent papers describing the sporulation, spore structure, germination, and natural occurrence of thermophilic actinomycetes.

Actinomycetes resemble fungi by producing a mycelium, but in cytological features of the spore and in the sporulation process, as observed by electron microscopy, they have much in common with bacteria of the genera *Bacillus* and *Clostridium*. The spores of at least some species are as resistant to heat as the hardier bacterial spores and contain dipicolinic acid. Several other papers present studies of the fine structure of the spores, the chemistry and structure of parasporal inclusions, and taxonomy of sporeformers. A paper by P. D. Walker and his associates deserves special mention. These scientists have described attempts to locate spore components in ultra-thin sections of spores. It is unfortunate that the labeled antibody techniques described did not provide a conclusion concerning the intracellular location of dipicolinic acid, but there is reason for optimism that that day is at hand.

The major criticism of this book is that the title misrepresents the contents. Spore research in 1971 has brought