Multiplication from a statistical viewpoint

Mathematical Models of Conception and Birth. By Mindel C. Sheps and Jane A. Menken. Pp. xxiii+428. (University of Chicago: Chicago and London, 1973.) £9.25.

IN the last two decades a new approach has thrown light on the biological factors underlying the statistics of human reproduction. It is an approach which involves considering a sequence of stages in the reproductive process (such as a period of susceptibility to conception, pregnancy, or post-partum sterility).

Mathematical models play an important role in these studies mainly because such models offer a way of dealing with quantities which are not directly measurable; for instance, the probability of conception in one menstrual cycle, or, to take an even more intractable example, the distribution of such probabilities over populations of women. By using mathematical models and computer simulation, it is possible to relate assumptions about quantities not accessible to direct measurement to observable quantities such as birth rates, intervals between births and so on. The study of such models produces a number of surprising results. For example, contraception which reduces the probability of conception among women at risk by $x\%$, will not reduce the number of births by $x\%$, but by much less. Thus, an average contraceptive effectiveness of well over 60% will probably be required to reduce births by 40%.

The work under review is a careful, detailed, clear and authoritative survey of this fast expanding subject. It is fully up to the high standards set over three decades by the publications of the Princeton Office of Population Research. The work is published as a posthumous memorial to the senior author, Mindel Sheps, who made fundamental contributions in this field of research. She died just before publication of the book.

The book offers more than the title promises. The mathematical analyses of a great variety of models are discussed. Extensive tables are given, showing the results of varying the parameters which enter into the models. This kind of material was to be expected. In addition, however, the book contains expositions of the parts of probability theory on which the models are based. The reader unacquainted with renewal theory, Markov chains or Markov renewal processes will find an introduction here. There is also coverage of basic distribution theory and various mathematical techniques so that in principle a reader equipped only with calculus and a basic course in mathematical statistics could use this book. In effect, it may be viewed as a text of much of applied probability theory (and some statistical theory) with detailed applications in one special area. As befits a mathematical textbook, there are worked examples and exercises for the reader at the ends of chapters, with answers at the back of the book.

What the reader will not find (with occasional exceptions) are examples of real data to the analysis of which these models can be applied. For example, a long chapter is devoted to models of the intervals which elapse between marriage (or some other suitable initial point of observation) and the first conception or first birth. The authors justly remark, at the beginning of this chapter, that "data on conception times and related phenomena have been used a great deal both in investigations of the biological basis of reproduction and in efforts to evaluate the effectiveness of contraception". Yet not a single recorded distribution of intervals to the first conception or birth is actually shown, nor are references given to publications where such data may be found.

Paradoxically, this lack of contact with reality may increase the sale of the book. For it can probably be used in courses on applied probability theory and stochastic processes given by lecturers with no experience in analysing demographic data. Common interest in, and common-sense knowledge of, sex and reproduction are all that is required.

The book may strengthen the suspicion (which is unjustified in this case) that probabilistic models are the toys of mathematicians and computer specialists not seriously concerned with the phenomena on which the models are expected to throw light. **J. Hajnal**

Molecular collisions

Molecular Collision Theory. (Theoretical Chemistry: A Series of Monographs.) By M. S. Child. Pp. 300. (Academic: London and New York, September 1974.) £8.50; $22.00.

IN recent years rapid progress has been made in the experimental investigation of molecular scattering. These experiments are a very important source of information about the potential surfaces on which it is supposed that nuclei move. Molecular collisions may conveniently be classified into three broad classes—elastic, inelastic and reactive. Each class is sensitive to a particular aspect of the potential surface. This book is intended as an introduction to the theory required for the interpretation of elastic, inelastic and reactive scattering experiments in chemistry. Emphasis is placed on the analytical treatment of quantum mechanical and semiclassical aspects of molecular scattering.

Chapters 2–5 present the quantum-mechanical and semiclassical theories of elastic scattering. They include such important topics as the Born approximation, the semiclassical phase shift, rainbow and glory scattering and orbiting. The theory of inelastic scattering is expounded with the aid of the scattering matrices in the next four chapters. The final chapter is devoted to reactive scattering. There are five appendices on relevant mathematical topics, including continuum wavefunctions and classical mechanics.

In the selection of material emphasis has been placed on obtaining analytical expressions of practical value to those involved in interpreting chemical experiments. The book is very successful in this respect and is likely to be popular with research students and others. It is authoritative, penetrating and compact. Although there are a number of minor errors I strongly recommend the book. **A. D. Buckingham**