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REVIEWS

An Introduction to Mathematical Physiology and Biology. By J. Mazumdar. Cambridge University Press, 1989. 208 pp. £27.50 or $49.50 (hardback); £9.95 or $16.95 (paperback).

Mathematical biology is not a new discipline, but it is a young one. The variety of biological phenomena is enormous, and the areas in which mathematical analyses have made a substantial contribution are relatively small and isolated from each other. They do not link to form a coherent body of knowledge, such as a mature discipline possesses. Textbooks of mathematical biology tend to reflect this, and this book is no exception. It covers a somewhat disparate selection of topics in which mathematical models have contributed to biology, and in which the mathematical development is of intrinsic interest.

Fruitful application of mathematical modelling in biology involves much more than mathematical analysis. Essential elements of a biological system must be abstracted in a form that can be analysed mathematically. The chosen elements of the system must be described in quantitative terms, based on experimental data which are often incomplete. Once the analysis is done, the results must be interpreted in a way that advances biological knowledge. Often, the mathematics is the easiest part in this process. Few textbooks on mathematical biology are successful in conveying this to the reader. In this book the emphasis is on the mathematical development, which is generally clearly set forth, but the success in providing biological motivation and interpretation varies considerably from chapter to chapter.

The opening discussion of dimensional analysis is useful but sometimes confusing. Next, the essential ideas of diffusion are clearly presented, followed by some more detailed mathematical analyses whose biological relevance is not brought out. The discussion of the dynamics of populations, while mathematically clear, gives a bare minimum of biological background and interpretation. In contrast, the discussion of biogeography provides good insight into the biology. Unfortunately, this chapter does not read well, and looks like classroom notes.

The remaining chapters of the book are devoted to physiological topics. Some basic concepts of pharmacokinetics are given. The chapter entitled 'Biological fluid mechanics' is concerned mainly with tube flow, and lacking discussion of topics such as the significance of the Reynolds number, animal locomotion and peristalsis, gives little idea of the richness of the field. The next chapter provides a good coverage of the origin and propagation of the arterial pulse and the effect of arterial stenoses. A brief discussion of ventricular mechanics is followed by a detailed review of work on heart valve vibrations. This seems out of place in this book, although it succeeds better than other chapters in giving the flavour of research in physiological fluid mechanics. Finally, the superficial and misleading discussion of medical devices would have been better omitted.

The book would have benefited from closer editing. There are numerous minor errors and some not so minor (Poiseuille did not derive 'Poiseuille's formula', as stated on p. 111).

Overall, this book gives a clear exposition of the main mathematical ideas in several areas in which mathematical biology has been fruitful. The level is appropriate for advanced undergraduate and beginning graduate students of applied mathematics. In this sense, the author has succeeded in his aims. However, he has missed many opportunities to provide biological background and insight. We must look elsewhere for texts that will prepare mathematicians for the challenges involved in working with experimental scientists on current problems of physiology and biology.

T. W. SECOMB

Agrometeorology. Edited by F. PRODI, F. ROSSI and G. CRISTOFERI. Comune di Cesena, 1987. 498 pp.

This volume of proceedings of the 2nd International Cesena Agricultural Conference consists of papers on the following agrometeorological research topics: snowcasting, satellite meteorology, hail, icing frost, crop irrigation, meteorology in crop protection, productivity forecasting, and environmental factors in crop growth.

The commonest theme in these papers is the development of computer communications and information systems, including remote sensing technology, and their application to agrometeorological research over the past thirty years. However, I beg to differ from the conference chairman's claim that agrometeorology is a young science. Forms of this type of research, based on synoptic weather observations, can be traced back to Victorian times at, for example, Rothamsted Experimental Station in the U.K.

Within each section it is possible to find papers that give a good overview of current research activity related to the special topics. These few papers therefore make very useful background reading for any newcomer to the subject, giving insight into the range of spatial and temporal scales of observational inputs to agrometeorology and the necessity to link them and formulate simple advisory rules. A good example of this is in irrigation-scheduling research where satellite-borne infrared thermometry is being used to monitor crop foliage temperature, which can be related to plant water stress through the conservation equations of mass and thermal energy. This information can be used in a water-budgeting procedure to quantify the need to irrigate crops. Alternatively, by linking information on water stress, availability of nutrients and photosynthesis through crop growth models, biomass production can be forecast.

On the other hand information links are less well established for the study of the dispersal phase of crop diseases which are transported by bacteria and fungal spores, as well as by insects and aphids. There is a great deal of scope, beyond what is demonstrated in this volume, for some contribution from fluid mechanics to knowledge of the relationship between particular groups of pests, the microclimate of crop, and transport length scales of atmospheric turbulence, particularly in unstable boundary layers and during rain.

Of critical importance to many agrometeorological problems is the interpretation of observational information in the context of the decision making process in agricultural management. Usually the apparent simplicity of the control options disguises the complexity of the underlying physical and biological processes. However, the direct control of hail precipitation by cloud seeding, even on a local scale, is a very complex control option and in my opinion is given undue weight in this volume, compared with the use of more practical alternatives.

In conclusion I would encourage fluid dynamicists who are seeking a new outlet for their skills to dip into this volume, bearing in mind that there are many questions in agrometeorological research still seeking satisfactory explanation. Closer links between biological disciplines and fluid mechanics in agriculture will, I have no doubt, help to put into focus the most useful scaling parameters and influence the observations and models of future agrometeorological research.

P. J. WALKLATE

SHORTER NOTICES

Turbulence and Diffusion in Stable Environments. Edited by J. C. R. HUNT. Oxford University Press, 1985. 319 pp. £32.

Stably Stratified Flow and Dense Gas Dispersion. Edited by J. S. PUTTOCK. Oxford University Press, 1988. 430 pp. £45.

The Institute of Mathematics and its Applications organized a conference at Cambridge in March 1983 on 'Models of turbulence and diffusion in stably stratified regions of the natural environment', and a follow-up conference at Chester in April 1986. The first conference proceeding deals with a great diversity of stratified flows: the atmospheric well-mixed layer, the nocturnal boundary layer, smoke plumes, heavy gas clouds, cooling water from power stations, partially mixed estuaries, shallow seas, and the benthic boundary layer near the bed of the ocean. The second focuses upon dense gas dispersion, a subject of great concern following the major disasters in 1984 at Mexico City (liquified petroleum gas) and at Bhopal (methyl isocyanate). As is to be expected for a subject in a rapid state of development, there is no uniformity of scientific or didactic style. In both books there are laboratory and field experiments, philosophical discussions, exact solutions of simplified model equations, numerical k-ϵ models with up to 13 adjustable parameters, and large-eddy computations. The consistent typing makes these books more readable than many camera-ready conference proceedings.

High-Performance Single-Phase Heat Exchangers. By A. ZUKAUSKAS. Hemisphere, 1989. 515 pp. £68 (hardback), £35 (paperback).

This is an English translation (edited by J. Karni) of a Russian book published in 1982 and enlarged with some new data. The author works in the Institute of Physical and Technical Problems of Energetics in Vilnius, Lithuania, and in the preface he notes that the book 'to a large extent reflects the accumulated labour of the Institute's staff'. The significance of the words 'single-phase' in the title appears to be that the coolant does not undergo a change of phase in the course of the heat transfer. The book is largely about the heat transfer from a hot surface over which gas or liquid is flowing, the hot surface being either interior to the fluid, as when the fluid flows past a cylinder or a plate, or exterior to the fluid, as when the fluid flows through a tube. The emphasis is on forced convection in which buoyancy forces are negligible. A fluid dynamicist would thus see the book as an extensive assembly of data on that basic problem, the interplay of advection and molecular diffusion, although the form in which the data are presented is intended to be useful to the engineer rather than illuminating to the analyst. Many of the references to relevant work in fluid mechanics look rather old, and the discussion of computer-generated numerical solutions is clearly behind the times. The comprehensiveness of the account of single-phase forced convection, as known to workers in the Soviet Union, might make the book useful for reference.

Transport Phenomena in Polymeric Systems. Edited by R. A. MASHELKAR, A. S. MAJUMDAR and R. KAMAL. Ellis Horwood, 1989. 447 pp. £45.

This book contains eight unrelated reviews of transport processes in various polymeric systems, dilute or concentrated polymer solutions, polymer melts, or solid polymer. The authors are mostly authoritative. About half the articles will be of some interest to readers of *JFM*, especially the thoughtful article by Giesekus & Hibberd on the difficult question of drag reduction in turbulent flow due to the presence of small amounts of long-chain polymers in solution. There are three articles on flow of non-Newtonian fluid: one on steady axisymmetric flow with circulation about the axis by Mitschka, Wein & Wichterle, one on flow through granular media by Kemblowski, Dziubinski & Sek, and one on laminar flow in ducts with heat transfer by Lawal & Majumdar. The other four articles are on molecular modelling, polymerizing liquids, thermal conduction in polymeric liquids, and heat and mass transfer in solid polymers.

Accuracy Estimates and Adaptive Refinement in Finite Element Computations. Edited by I. BABUSKA, O. C. ZIENKIEWICZ, J. GAGO and E. R. DE A. OLIVEIRA. Wiley, 1986. 393 pp. £45.

The first sentence of the preface claims boldly that 'The finite element method today is the standard procedure of analysis for most problems of structural and fluid mechanics in stationary and transient states'. (Surely they mean *numerical* analysis?) That may be an overstatement so far as fluid mechanics is concerned, but there can be no doubt about the importance of the finite element method for the numerical analysis of problems of flow near awkwardly shaped boundaries. Each of the 21 articles in this book was presented as a lecture at a conference in Lisbon in 1984, and together they may give a 'state-of-the-art' picture. The articles are divided into two groups, one headed 'basic theory and application to elliptic problems' and the other 'fluid mechanics and transient problems'. The articles have been written independently, even though they are called chapters, and there are no explanatory comments showing how they fit together. Despite appearances this is essentially a volume of conference proceedings.

Theoretical and Applied Mechanics. Edited by P. GERMAIN, M. PIAU and D. CAILLERIE. North-Holland, 1989. 454 pp. $144.75 or Dfl. 275.

This volume records the proceedings of the 16th International Congress of Theoretical Mechanics, organized by the International Union of Theoretical and Applied Mechanics and held at Grenoble in August 1988. These four-yearly congresses attract about 1000 participants, and provide a forum for discussion of developments over the whole field of mechanics, usually with more emphasis on the 'theoretical' than on the 'applied'. The volume contains 39 preliminary pages and 28 postscript pages of poorly organized material about the Congress (although not a normal table of contents of the volume), and the texts of 23 of the longer lectures delivered at the Congress. Two of these lectures were set pieces, one at the opening of the Congress and one at the closing, and, presumably intentionally, both were in the topical area of dynamical systems: the first a rather demanding lecture by V. I. Arnold on 'Bifurcations and singularities in mathematics and mechanics', and the second a more audience-friendly account of 'The pendulum from Huygen's Horologium to symmetry breaking and chaos' by J. W. Miles. Eight of the lectures were given as introductions to short mini-symposia on the topics 'Mechanics of large deformation and damage', 'The dynamics of two-phase flow', and 'Mechanics of the Earth's crust'. The remaining 13 lectures were invited from notable scholars in different countries and the subjects vary widely within fluid and solid mechanics; this is where one looks for enlightenment on what is happening at the cutting edge of research at the present time.