Nonlinear explanations

Robert M. May

Fractals, Chaos, Power Laws: Minutes from an Infinite Paradise. By Manfred Schroeder. *Freeman: 1991. Pp.429. £24.95, $32.95.*

ONE of my ambitions is to write an essay on why some books about science — Hawking, Penrose, Gleick — succeed beyond all reasonable expectation, whereas others languish. My problem is that, like the publishers themselves, I can explain these successes in retrospect better than in prospect. Easier to understand is the 'Jaws II' syndrome, whereby one book that has captured the popular imagination is followed by others that amplify the theme.

Which brings us to *Fractals, Chaos, Power Laws: Minutes from an Infinite Paradise* by Manfred Schroeder. The general level and style suggest that Schroeder is targeting an audience of mathematically literate scientists, aiming to go beyond James Gleick and others both in dealing with a wider range of topics and in treating them in greater depth. Although the title leads off with Fractals, Chaos, much of the emphasis is on scaling phenomena or Power Laws and on their pervasive occurrence in physics, chemistry, biology, music and elsewhere.

I found the book very engaging, but also very exasperating. Schroeder covers a vast amount of territory, much of it going beyond what previous books have made familiar. There are, for example, interesting discussions of scaling and symmetry in relation to "acousticians, alchemy, and concert halls", to Bach "composing on all scales", to trees, rivers, arteries, lungs, and stock markets. Old gambling paradoxes are discussed in relation to new themes. Some of the exposition is rather demanding, yet will reward those who persist: how to determine fractal dimensions from time series or fracture surfaces, or how to compute the dimension of a strange attractor.

The subtitle exemplifies the more exasperating aspects of the book. *Minutes from an Infinite Paradise* is a marvellous phrase, but I still have no clue how it relates to the book's contents. Far too many of the explanations are themselves nonlinear (you cannot understand any of it unless you understand all of it); some passages are excessively telegraphic, whereas others meander. For instance, there are 32 pages on the quadratic map, which go into some of the fascinating details of its cascades of period doubling and its apparently chaotic behaviour. Despite the generous length, I found this discussion hard to follow, and the description of "chaos . . . interleaved with periodic windows" left me with the impression that the author does not really understand what is going on in this regime. Earlier popularizations of chaos have been criticized for giving insufficient credit to non-American workers. Schroeder discusses early Russian work, but does not mention the yet earlier work of the Finn Myrberg, nor of the French; given the abundance of references and other scholarly apparatus in this book, such omissions are less excusable than in earlier books.

At the telegraphic extreme is a chapter entitled 'Percolation: from Forest Fires to Epidemics', where the word epidemic is used in the third and the second to last paragraphs, but epidemics as such are never discussed. In the chapter on 'Noises: White, Pink, Brown, and Black', Schroeder refers to a recent paper by Redfearn and Pimm (see *Nature* **334**, 613–615; 1988) as showing that fluctuations in terrestrial animal populations get larger as the observation interval lengthens. In fact, this paper has stimulated a lively correspondence, and its conclusions are by no means apodictic. Schroeder's point is, however, illustrated unambiguously by the pink noise spectrum characteristic of environmental fluctuations in the sea, which are not mentioned. These criticisms, and others that could be made, might look nitpicking, but — given the softness in the areas I know well — I am left wondering whether the book's admirably wide coverage has been achieved at the expense of consistent accuracy.

Schroeder was one of the first people to see the purely artistic possibilities inherent in computer graphics. Indeed, he won first prize at the International Computer Art Exhibition in 1969. The graphics in this book are thus excellent, and the inset of nine coloured figures would be stunning if earlier coffee-table chaos books and calenders had not already spoiled us. I especially like the illustration, and supporting analysis, of the fractal basins of attraction generated by Newton's iterative method applied to $z^3 = 1$. And those not already familiar with the Mandelbrot Set will enjoy the illustration of fat little Mandelbrots nested one within the other, an infinite regression that gives a kind of concreteness to pre-scientific visions of life not coded by DNA but rather unfolding from generation to generation through successive homunculi, nested like Russian dolls inside the egg.

More than other recent books in its general area, this book conveys a sense of the broad sweep of recent work on chaos, fractals and scaling laws. Read in this spirit, as an impressionistic guidebook and not as a map, it is fun. □

■ *An Eye for Fractals: A Graphic and Photographic Essay* by Michael McGuire has just been published by Addison-Wesley at $29.95, £24.75. It contains 90 black and white photographs plus an annotated bibliography.

Robert M. May is in the Department of Zoology, Oxford University, South Parks Road, Oxford, OX1 3PS, UK.