origin of the urge, the fascination that drives physicists, mathematicians, and presumably other scientists as well? Psychoanalysis suggests that it is sexual curiosity . . . . This explanation is somewhat irritating, and therefore probably basically correct. Sexual curiosity is at the root of science, but it is relayed by something else, namely the fact that the world is understandable." You may or may not agree, but this is one of umpteen asides that will keep coffee-time discussions lively.

John Casti is a member of the Institute of Econometrics, Operations Research and System Theory at the Technische Universität in Vienna. His book is considerably longer than Ruelle's (408 pages of main text, and 64 pages of notes and guidance for further reading) and, with its many graphs and other technical details, would seem to be aimed more narrowly, at a general audience of scientists. It is divided into six main sections, with the overall structure broadly paralleling that of Ruelle's book. In the first chapter, Casti treats "correlations, causes, and chance", discussing prediction and explanation in science and more generally. He begins with probability theory and statistics, and ends with chaos and strange attractors. The next four chapters give detailed accounts of four particular topics, with emphasis on chaos or on earlier work on catastrophe theory: climate and weather prediction; pattern formation and development ("from blobs to babies"); stock-market predictions (a review of older methods along with speculation about new ones based on strange attractors); and the theory of conflicts and wars ("wargasms as chaostrophes"). In the sixth chapter, Casti takes up philosophical questions about the nature of proof in mathematics, touching on Penrose tiling, Turing machines and Gödel undecidability on the way. He concludes the main text with brief thoughts about "what can we know for sure?".

In contrast with Ruelle's short and graceful essays, Casti's more detailed book is replete with all manner of typographic business. There are paragraphs with 'bullets', indented paragraphs set in smaller type, slogans in 'boxes', text presented as a dialogue between voices, along with tables, graphs, equations and cartoons. Each chapter ends with a summary, presented as a formal "term grade" for our ability in the various fields to predict and explain. The result is that the reader will find the average page visually lively, or cluttered, according to taste.

Both these books are excellent. Ruelle's repays reading, no matter how much or how little one already knows about chance and chaos. Casti's is good for those who want details, and is particularly timely in providing a wide-ranging introduction to the possible, though debatable, relevance of nonlinear dynamics and chaos to predicting exchange rates, marginal rates of bonds and other economic indicators. □

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# Physics in biology

*Thomas A. McMahon*

**Newton Rules Biology: A Physical Approach to Biological Problems.** By Colin Pennycuick. *Oxford University Press: 1992. Pp. 111. £20, $49.95 (hbk), £9.95, $19.95 (pbk).*

PHYSICS and biology were once the interests of the same scientists. Galileo, Descartes, Borelli, Boyle, Hooke, Poiseuille and Helmholtz all contributed to both. In the preface to this book, the author introduces A. V. Hill, a hero of modern-day animal physiologists, who began his career as a mathematician. Hill went on, in the early and middle part of this century, to become famous for showing how Newton rules biology; that is, how simple physical principles can be invoked to understand the results of experiments concerning muscle mechanics and energetics and the physiology of locomotion. Pennycuick says that one of his objectives in writing this book was "to show how Hill's way of thinking created a thread which links biological events at the cellular level, through animal locomotion, to the large-scale properties of ecosystems".

That is a big task, and he has made a substantial start in this slim volume. His subtheme within the physics-in-biology theme is the subject of physical dimensions. He begins by saying exactly what dimensions are, and how they are used and misused. Taking a number of examples from an important and delightful paper by Hill (the written version of a talk given as an evening discourse at the Royal Institution in 1949), the author discusses how the wing-beat frequency of birds varies with body size; why it would be expected that a two-metre fence would be sufficient for keeping both large and small antelopes in a confined space; and why fleas would need special rubber-like springs, as well as muscles, to jump. Along the way he finds room for developing insights about the mechanics of muscle. I particularly liked his elucidation of how one might calculate the energetic cost of maintaining tension in one's own biceps muscle by finding experimentally the maximum shortening speed, dividing by the extended length, and dividing again by 16 to get the rate of energy consumption per cubic metre of muscle per pascal of stress maintained. I also liked the discussion of how the speed of muscles must be matched to the load. Human fingers, he says, have fast flexor muscles for rapid manipulation, and, as a result, people tire quickly when they hang from a window ledge. Orangutans, by contrast, can hang from their fingers for long periods but "are not suited to tasks that involve rapid finger movements".

Later, Pennycuick develops his dimensional theme with an introductory discussion of Mandelbrot's fractal geometry and what it might mean to biologists. In an example concerning the spacing of bald eagle nests on Amchitka and Adak Islands of the Aleutian Islands, he concludes: "the nest density is 2.6 times greater on Amchitka than on Adak, even when account is taken of Amchitka's more rugged coastline". This conclusion is available in spite of the curious fact that the spacing between nests is not, according to the author's arguments, "something which can be measured with a tape measure". Pennycuick ends with two chapters on dimensional aspects of ecosystems, including those that are modified by human activities. □

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## New editions

- *Russian–English Translator's Dictionary: A Guide to Scientific and Technical Usage* by M. Zimmerman and C. Vedeneeva, 3rd edn. Wiley, £65, $139. For a review, see *Nature* **312**, 670 (1984).
- *Supermanifolds* by B. DeWitt, 2nd edn. For a review, see *Nature* **313**, 329 (1985). Cambridge University Press, £50, $95 (hbk), £19.95, $37.95 (pbk).
- *Physics of Massive Neutrinos* by F. Boehm and P. Vogel, 2nd edn. Cambridge University Press, £40, $69.95 (hbk), £15.95, $27.95 (pbk).
- *An Introduction to the Rock-Forming Minerals* by W. A. Deer, R. A. Howie and J. Zussman, 2nd edn. Longman, £21.99 (pbk).
- *Mountain Weather Climate* by R. G. Barry, 2nd edn. Routledge, £60 (hbk), £18.99 (pbk).
- *Plants and Microclimate: A Quantitative Approach to Environmental Plant Physiology* by H. G. Jones, 2nd edn. Cambridge University Press, £55, $100 (hbk), £19.95, $39.95 (pbk).
- *The Biochemistry of the Nucleic Acids* by R. P. Adams, J. T. Knowler and D. P. Leader, 11th edn. Chapman and Hall, £24.95 (pbk). For a review of the tenth edition, see *Nature* **326**, 223 (1987).