20th-Century Science

The World of Elementary Particles. Kenneth W. Ford. Blaisdell, New York, 1963. xii + 247 pp. Illus. Paper, $2.95; cloth, $4.50.

If a course in the philosophy of 20th-century science is to be taught, let this book give the outline for the lectures. Kenneth Ford begins with a cautionary preface in which he states that theories of physics try to summarize experimental findings in a simple way, but that most theories have a limited lifetime and are usually replaced by more general theories. Thereafter his clear and lively text describes with simplicity and wit the range even to the most sophisticated of current concepts and problems.

In the eight chapters of the book Ford surveys, without mathematics, almost the entire view of the physical world as we know it today. It is nicely told, in words familiar to a high school student—the four known force fields, the conservation laws, the symmetry concepts and their dominance of contemporary reasoning, isotopic spin, strangeness, the quantum aspects, the uncertainty principle, and the consequent importance of probabilities. Even the TCP theorem, in the whole and in its separate parts, is made clear with the use of Feynman diagrams, rotation of the book, and mirrors.

The most vital problems now facing us are posed: for example, the mass difference of muon and electron, the mass differences of the strongly interacting particles and their resonances, and the problem of why the stronger interactions obey more conservation rules than the weaker interactions.

Cosmology is introduced to the reader by way of an invitation to consider the energy stored in the cosmic neutrino flux.

This book has something for everyone. For the high school student, it gives a familiarity with the contemporary vocabulary and an exposure to the commonsense basis of the current ideas. On the next go-around, in college, one hopes that the student will have a sense of recognition and that he will be more acceptive of these lines of thought and more eager to have mathematical statements of them. For the college student, it is at once a review and an introduction. For the nonscientist, say members of the League of Women Voters, whose influence let us not underestimate, this book demonstrates a thoughtful sequence of examples of the content of pure research, which is something we all find hard to define otherwise.

For the philosophers of science, the examples give pause. Ford questions whether man can really picture a four-dimensional world, or a particle that is a wave, or the situation in a system traveling at the speed of light, and whether these limits to man's imagination will ultimately bound his understanding of nature.

The author distinguishes between the classical or permissive laws of nature and the modern or prohibitive laws of nature. He questions whether man's asymmetry of time can be reconciled with fundamental particles' asymmetry of time, if man is a collection of such particles. This is a distinction to keep the philosophers off the streets, just as the following one will keep the psychologists off the streets: "The scientist generally is inclined to call most profound that which is most simple and most general, he is not above calling a truism profound." And to bemuse the art historians: "Modern science, which could begin only after breaking loose from the centuries-old hold of Aristotelian physics, now finds itself with an unexpected Aristotelian flavor, coming both from the increasingly dominant role of symmetry principles and from the increasingly geometrical basis of physics."

As for the experimental physicist, who spends months or even years at a time fighting the breakdowns of complicated equipment until it all works together to make a single measurement, Ford's book is a delightful review and an invitation to consider what puzzle one would most like to solve next. It is furthermore a reminder of the ignorances we take for granted day-by-day—for example this pinprick: "It happened to be called the speed of light because the photons . . . are the only massless particles whose speed has been accurately clocked."

And for the theoretician who has everything at the tips of his neurons, let him gaze at a book full of phrases, nicely and clearly written, such as one seldom sees.

Now for the complaints, without which book reviews are said to be incomplete. Ford's book has almost no credits or references, not even to the great milestones of experimental and conceptual leaps forward; thus, the curiosity awakened by this manuscript has no immediate place to go. (The index is nice, an unexpected bonus.) The jacket reminds us of *McGuffey's Reader* found in our grandfather's attic, but *de gustibus* is perhaps the gentle rejoinder, for I found someone who liked it. Nevertheless this book, with a lovelier cover —perhaps a xerograph of a swarm of galaxies—and with pretty end papers —for example, bubble chamber pictures—could easily be the sleeper for the birthday gift trade, and perhaps even a book club bonus!

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Colloid Chemistry

An Introduction to Clay Colloid Chemistry. For clay technologists, geologists, and soil scientists. H. van Olphen. Interscience (Wiley), New York, 1963. xvi + 301 pp. Illus. $10.

This book, which represents an attempt to bridge the gap between the colloid chemist and the clay mineralogist in the geological sciences and in soil science, is written primarily from the viewpoint of the colloid chemist. The treatment is elementary and consists of chapters dealing with the general principles of colloid chemistry, clay mineral structures, the colloidal properties of clays, and clay-organic interactions. The most complete sections are those that deal with aggregation, flocculation, dispersion, stability, gelation, and the peptization of clay suspensions. The author uses a number of illustrations, many of which deal with drilling muds and other applications in the petroleum industry.

The scope of the subject matter treated represents a broad field of interest, and the attempt to cover this spectrum in a short book has resulted in superficial treatment of some aspects. This is true with respect to the discussion of colloid systems in general and with respect to the discussions of clay mineral structures and ion exchange. The disadvantages of the superficial treatment in the text are partially overcome by references at the

end of each chapter and by the inclusion of more refined treatments and calculations in the appendices. These include data on montmorillonites, electric double-layer calculations, and van der Waals attraction between unit layers. Unfortunately, however, the appendix on the preparation of clay suspensions is over-simplified to the extent that it is misleading and may even present some difficulties in any attempt to use this section as a guide for methods and procedures. The organization is fragmentary, in that some of the same principles or phenomena are discussed in different chapters in addition to the synopsis and appendices.

This book should be of value as a general introduction to the field or for use in introductory courses that deal with clay colloids.

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Invertebrate Zoology

The Physiology of Earthworms. M. S. Laverack. Pergamon, London; Macmillan, New York, 1963. x + 206 pp. Illus. $7.

Laverack's purpose was to review the work on oligochaete physiology since the publication of Stephenson's *The Oligochaeta* (1930). The need was obvious; an entire chapter is devoted to *neurosecretion*, a term that does not appear in Stephenson's monograph. Seven chapters deal with physiological attributes of universal concern: "Biochemical architecture," "Digestion and metabolism," "Nitrogenous excretion," "Respiration," "Neurosecretion," "Nervous system," and "Behaviour." Four chapters have a decidedly vermiculous, if not strictly oligochaete touch: "Calciferous gland," "The axial field," "Water relations," and "The physiology of regeneration."

In concentrating on terrestrial species, Laverack had little choice. The bulk of earthworm physiology has been related to perhaps one or two dozen species, and among these we find few aquatic forms. Happily, the volume is "species oriented"; seldom does one find any implication of that nondescript beast, "the" earthworm.

Physiologists will find this book comfortable reading. Laverack sticks to his subject and moves surefootedly through evaluation of laboratory procedures and evidence. Occasionally the oligochaetologist will be troubled—for example, with statements like the following: *Lumbricus terrestris* and *Eisenia foetida* are "fairly closely related"; "the geographical location may be important in arriving at results and conclusions"; and "Oligochaetes are able to regenerate both the anterior and posterior ends with almost equal facility."

On two points, I have bias of long standing. First, inasmuch as laboratory procedures usually indicate precision, it appears insufficient to describe humidity conditions in experimental work as being "at a satisfactory level," and second, I question the synonymy of *aestivation* and *diapause* as applied to earthworm biology.

These few criticisms are not intended to be descriptive of the volume, for it is a fine piece of work. They do underscore an inherent limitation in a brief treatment by a specialist, in which, of necessity, concepts and ideas must be drawn from other areas. If it is inadmissible for the systematist, the ecologist, or the morphologist to be a trifle wobbly in his physiology, perhaps some reciprocity can be expected.

The list of references (more than 300 titles), index, and illustrations are pertinent and well done. The book must be considered an authoritative treatment in which the students of invertebrate zoology will find a vast array of potential avenues for investigation.

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Biography

Erasmus Darwin. Desmond King-Hele. Scribner's, New York, 1964. viii + 183 pp. Illus. $3.95.

Erasmus Darwin, grandfather of the great biologist who established the theory of evolution, had his own notions on the subject, notions that call forth enthusiastic praise in this appreciative biographical essay. The elder Darwin was an ardent broker of 18th-century scientific ideas. Although he undertook few experimental investigations, he had a truly voracious interest in all of science, its prospects, and its application to human affairs. He met frequently with industrialists and urged them to pioneer in applications of technology. His garden in Lichfield was laid out according to the *Systema Naturae* of Linnaeus. His bulky treatises expounded a comprehensive system of materialistic psychology and physiology for both plants and animals, based in large part upon the analogies between them. He was one of the most effective physicians of his time. The distinctive effort of Darwin's life, in which he sought to apply his theories about popular education, was the production of three long poems in an attempt to enlist popular understanding for science. The poems are a tour de force of exposition, even though they employed trivial poetic modes suited only to the audience of fashion Darwin tried to reach. King-Hele has provided a good selection of this poetry—for example, his summary of evolution (from *The Temple of Nature*):

Organic Life beneath the shoreless waves
Was born and nurs'd in Ocean's pearly caves;
First forms minute, unseen by spheric glass,
Move on the mud, or pierce the watery mass;
These, as successive generations bloom,
New powers acquire, and longer limbs assume;
Whence countless groups of vegetation spring,
And breathing realms of fin, and feet, and wing.

By expounding a notion of progress from lower to higher forms of life, Darwin sought to advertise the explanatory powers of science and the epic grandeur of its subject matter. King-Hele contends that his enterprising, self-contradictory, and enormously conjectural notions constituted the first "well-rounded" and "satisfactory theory of evolution with evidence in support." In the interest of this argument, he has had to deny that Erasmus Darwin meant what he wrote about the influence of a male parent's imagination on the endowment of his offspring. Nor is it clear how this use of the word "theory" could be justified in any rigorous sense. The author suggests that the reputation of Charles Darwin is partly undeserved because Erasmus Darwin anticipated him. He does not support this contention with any considered estimate of Charles Darwin's achievement and averts his glance from some of Erasmus Darwin's writings in order to deny his close similarity to Lamarck. Erasmus Darwin's notion of evolution did not arise