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.

M. E. HARWARD
Materials Research Laboratory, Pennsylvania State University

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.

WILLIAM R. MURCHIE
Department of Biology, Flint College, University of Michigan

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

from situations encountered in the course of research, but only from ambitions for a total explanation of organic nature.

It is a measure of Erasmus Darwin's success as an exponent of the scientific vision of nature that King-Hele should register so generous an estimate of his place in history. He is compared to Leonardo and to Goethe and is credited with an influence on the Romantic poets, as well as on Charles Darwin, which it is doubtful that he exerted. For the most part, however, the author lets his versatile and imaginative subject speak for himself, for his speculations, and for his belief in the importance of science in the advancement of knowledge and the progress of man.

PHILIP C. RITTERBUSH
Office of Senator McIntyre, Washington, D.C.

Earthquake Seismology

An Introduction to the Theory of Seismology. K. E. Bullen. Cambridge University Press, New York, ed. 3, 1963. viii + 381 pp. Illus. $9.50.

The appearance of this updated edition of Bullen's valuable textbook on earthquake seismology is most welcome. The book remains primarily an exposition of basic theory, a concise and lucid presentation of fundamentals, but much material of current interest has been added. This includes three new chapters on long-period oscillations of the earth, seismic effects from nuclear explosions, and planetary seismology.

The plan of the earlier editions is retained. The first six chapters, nearly one-third of the book, lead from the general theory of elasticity into a discussion of waves and vibrations, and to a consideration of the body and surface waves important in seismology. The presentation is in the nomenclature of Cartesian tensors, although no prior familiarity is assumed; vectors, where needed, are also indicated by subscript notation rather than by conventional symbolism. Most of the discussion refers to infinitesimal motion in uniform media, but effects of imperfect elasticity and finite strain are considered.

Chapter 7, on seismic ray theory in a spherically symmetrical body, is the only chapter on basic theory which has been substantially rewritten for this edition. It is a condensation of material published elsewhere by the author.

Brief chapters on seismic energy and instrumentation principles precede a long chapter in which Bullen describes the construction and use of travel-time tables. Chapters 12 and 13 offer detailed discussions of the physical constitution, particularly density, of the earth's upper layers and deep interior. In the remaining quarter of the book, Bullen considers briefly a variety of topics: long period oscillations; earthquake mechanism, distribution, and periodicity; nuclear explosions.

Bullen is chairman of the Department of Applied Mathematics at the University of Sydney as well as a distinguished seismologist. Not unexpectedly, thorough treatment is given those topics to which he, sometimes in collaboration with Sir Harold Jeffreys, has made important original contributions: seismic ray theory, construction of travel-time tables, and determination of the earth's density distribution.

The omission of references from the first edition was remedied in the second. In this third edition, there is a bibliography of nearly 700 items, grouped in 33 categories and arranged chronologically through 1963. Russian authors appear under-represented with only 31 entries, if we consider their contributions to seismology. A comprehensive 19-page index adds to the value of the text.

This third edition maintains and improves on the high standards of the previous editions.

HAROLD M. MOONEY
Department of Geology and Geophysics, University of Minnesota, Minneapolis

Political Geography

Politics and Geographic Relationships. Readings on the nature of political geography. W. A. Douglas Jackson. Prentice-Hall, Englewood Cliffs, N.J., 1964. xiv + 411 pp. Illus. $6.95.

It is important for the nonsocial scientist to appreciate what Jackson set out to do in assembling the readings in *Politics and Geographic Relationships*. Otherwise he may conclude what some have long suspected—that geography in the United States, once on at least speaking terms with the earth sciences and biology, has finally flown off to find a more congenial home shared by politics, theoretical economics, and metaphysics. Even some rather traditionalist geographers may wonder if the book is really their concern when the authors are able to reach page 223 without needing to explain themselves in maps or charts and when it is noted that rather less than half of the chapters are by geographers. In truth, the title warns us what to expect, for the book is primarily about *politics* and geographical relationships. It may find its widest audience in endeavoring to persuade political scientists or specialists in "government" that there are geographical relationships which should be taken into account when the affairs of nation states are being considered.

The editor has selected 34 papers for inclusion, all previously published. About half of them fall into the orthodox field of political geography, including those by well-known geographers such as Richard Hartshorne, Stephen B. Jones, O. H. K. Spate, Mark Jefferson, Roy Wolfe, N. J. G. Pounds, Norton Ginsburg, and Jean Gottmann. The essays in which they discuss traditional topics include "A free and secure access to the sea" (Pounds), "The nature of frontiers and boundaries" (Kristof), and "National resources and economic development" (Ginsburg), as well as several of a soul-searching character—for example, "What is political geography?" (Hartshorne).

It is this last question, Jackson confesses, which originally led him to assemble these papers for the use of college students, and he enlarges on the problem in an all too brief introductory chapter. In searching for a line of demarcation between political geography and political science, Jackson concludes that the essential distinction lies in the point of view, for, while the latter is concerned mainly with institutional structure, the geographer keeps his eye on the resulting geographical patterns and relationships. Nevertheless, he believes that the geographer should be more fully aware of the emphasis placed on institutional structure by the student of politics, hence the strong representation among the authors of such political theorists as George Santayana, Karl W. Deutsch, Gunnar Myrdal, and Ernest B. Haas.

Taken as a whole the book provides