From a biological point of view it is doubtless good for the members of a group or species to be maintained in full health and vigor with all their faculties perfect. Hitler wanted as much for the German nation. But a worthwhile ethical system requires more than this. It requires some idea of a possible perfection of human nature, both individual and social—an ideal that commands allegiance by its intrinsic appeal. But both Darwin and Spencer labored under the delusion that human beings possessed moral faculties that could and would be perfected biologically by natural selection and the inherited effects of moral training and conduct, with the result, as Darwin put it, that he and Spencer and Lyell would some day be looked back on as "mere barbarians" by a surviving race of men perfected in their mental and moral faculties by the beneficent processes of organic evolution. It remained for Darwin's cousin Francis Galton to suggest that the process could be hastened by human intervention. Why wait for the millennium if you can produce it by eugenic measures?

Finally, what about Richards's contention that the true successors of Darwin were writers like Romanes, Morgan, James, and Baldwin who found mind and morals at the heart of nature and erected metaphysical foundations for this view of things? It is an interesting argument, but not one that squares well with what we know about Darwin, who confessed that he had "no head for metaphysics." The Darwin of the *Origin*, a Darwin barely mentioned by Richards, was content with an evolutionary deism (much like his grandfather's) which viewed the laws of nature as "laws impressed on matter by the Creator" and designed to ensure adaptation and improvement in nature. The Darwin of *The Descent of Man*, however, was a much gloomier and much more perplexed man, unable to reconcile his conviction that competitive struggle was essential for human progress with his deeply felt humanitarian sentiments or to square his "inward conviction" that the universe and "the wonderful nature of man" could not be the result of mere chance with his growing doubt that the human mind, so recently evolved from that of some ape-like creature, could penetrate the riddle of the universe—"A dog might as well speculate on the mind of Newton."

All praise, then, to Robert Richards for his well-researched, thought-provoking, ably argued, and highly readable history of evolutionary theories of mind and behavior, accompanied by appendixes setting forth his own theories of historiography and ethics. Some readers will find comfort in Richards's assurance that Darwin, far from adumbrating Michael Ghiselin's misanthropic views, laid the foundations for a profound monistic metaphysics and an accompanying evolutionary ethics and even opened the way for a scientific historiography of science in his theory of natural selection. Others, including the present reviewer, while readily conceding Darwin's greatness as a scientist, will continue to look elsewhere for moral, spiritual, and historiographical guidance, believing that history belongs irretrievably among the humanities. Human nature has dimensions that escape, and must forever escape, the abstractions of science.

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The Archean

The Young Earth. An Introduction to Archaean Geology. E. G. NISBET. Allen and Unwin, Winchester, MA, 1987. xviii, 402 pp., illus. $60; paper, $34.95.

The Archean eon constitutes the first 2000 million years (43 percent) of our planet's history. Its surviving geological record is fragmentary, altered, difficult to interpret, and quite possibly biased. The same might be said of our current understanding of this period. Nonetheless, Archean rocks hold the answers to some of the most fundamental questions that can be asked about the earth; therefore there are potentially great rewards in the painstaking effort of unraveling Archean history. In *The Young Earth*, E. G. Nisbet has crafted a stimulating discussion of the earth's formative years.

Nisbet appropriately centers his discussion on rocks rather than theories. The difficult job of mapping complex terrains lies at the heart of interpretation, and Nisbet presents illuminating summaries of key field areas that effectively define the dimensions of fruitful inquiry. The powerful analytical tools that can be trained on ancient rock samples are discussed in detail, and the reader is provided a frank evaluation of both the insights to be gained from such analyses and the pitfalls of naïve interpretation. Models are seen as stimulating ways of thinking about data but are not to be confused with data per se (a verity often lost sight of in the literature). In the final analysis, rocks must be the arbiters of controversy in Archean geology.

Archean tectonics and the growth of early continents claim a major portion of this book. A few hard facts such as the presence of detrital diamonds in Late Archean sediments and the petrological relationships observed in ancient crustal profiles sharply constrain theory; whatever else we care to believe, we are stuck with the fact that 3000 million years ago continents were as thick as they are today (if less extensive in area) and, at least locally, subcrustal lithosphere extended downward 150 kilometers or more. Komatiites, highly magnesian lavas that are as distinctively Archean as anything one can name, also receive extended discussion. Nisbet favors the idea of an early komatiitic ocean crust; but he treats his own hypotheses with the same evenhanded criticism that he applies to others'. The economic significance of Archean rocks is summarized well, with gold appropriately occupying center stage.

Although most of his book focuses on crustal and tectonic evolution, Nisbet does delve into biological issues, rightly recognizing that thinking on the origin and early diversification of life is not independent of thinking about crustal development. His brief discussion of the geological evidence for Archean life stresses stromatolites, with rather less attention given to microfossils or (unfortunately, I think) isotopic geochemistry. Paleobiology provides the nontrivial information that life was already present when the oldest negligibly metamorphosed sedimentary rocks were deposited. Geology also places constraints on early metabolic diversity through the elucidation of early environmental conditions, but Nisbet correctly looks to molecular phylogeny for fuller evidence of Archean evolution. Phylogenetic trees based on 5*S* ribosomal RNA, ferredoxins, and phenotypic characters are illustrated, but, unfortunately, the mutual incompatibilities of these trees go unnoted. Given their relative reliability as guides to deep phylogenetic relationships, 16*S* ribosomal RNAs might well have received more attention.

Nisbet presents an unabashedly Gaian discussion of early atmospheric evolution, stating without equivocation that "today, and throughout the geological record, the CO_2 level [in the atmosphere] is set by life." This uncritical acceptance contrasts strongly with his lawyerly accounts of petrological and geophysical issues. Surely the notion that life regulates CO_2 levels is at least as controversial as the idea that the early oceanic crust was komatiitic.

Perhaps Nisbet's most enlightening contribution to life science is his advocacy of hydrothermal vent systems as primary sites of chemical evolution. Most research has assumed a quite different set of environmental conditions for the origin of life, and the chemical-evolution research community has in general been hostile to or dismissive of the rift vent hypothesis, originally suggested by

Jack Corliss. Nisbet's articulate exposition shows why this idea must be taken seriously.

All in all, *The Young Earth* is a rich book, intelligently written and displaying a clear feel for Archean terrains. It is also a very personal book. Nisbet draws again and again on his own experience in the Belingwe greenstone belt of Zimbabwe; he presents provocative opinions on controversial issues; and he weaves his personal as well as scientific philosophy throughout the text. This will undoubtedly strike individual readers differently, but I found it refreshing—reminiscent of an earlier era when the term "scientific literature" was more than oxymoron. *The Young Earth* can be read with pleasure and profit by anyone with a serious interest in our planet's early development.

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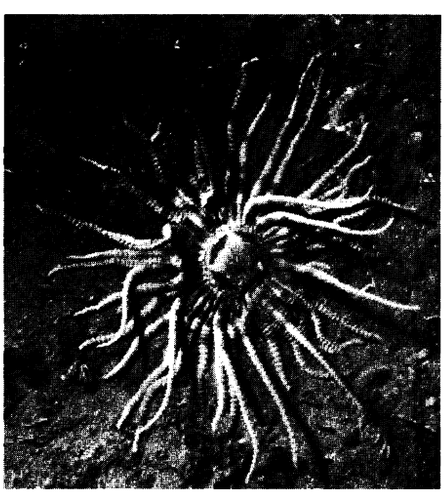
Marine Strategists

A Functional Biology of Echinoderms. JOHN LAWRENCE. Johns Hopkins University Press, Baltimore, MD, 1987. xii, 340 pp., illus. $56.50.

In "functional biology," organisms are seen as units that maximize the two components of fitness, survival and reproduction. There are trade-offs among different "strategies" of acquiring nutrients and allocating them to growth, maintenance, and reproduction. Workers in this field calculate the "costs" of these trade-offs and attempt to identify conditions that lead to maximal return. John Lawrence points out that although this approach may be carried out in theory without considering particular morphological characteristics, every group of organisms has an intrinsic functional morphology that provides particular opportunities and constraints for maximizing fitness. Echinoderms, with their bizarre pentamerous symmetry, internal skeleton, and hydraulic system of coelomic tubes, may be especially suitable for examining how the functional morphology of real organisms can be integrated with theoretical functional biology.



"*Labidiaster annulatus* with arms elevated in the feeding posture." [*Eltanin* sixth cruise photograph, Smithsonian Oceanographic Sorting Center for the National Science Foundation; from *A Functional Biology of Echinoderms*]

After briefly characterizing the phylum and the five main extant classes, Lawrence selectively reviews feeding, maintenance, and reproduction, largely along taxonomic lines. Comparative analyses of the functional morphology of feeding draw from a rich literature on the uses of flagellar currents, tube feet, spines, and Aristotle's lantern. Irregular echinoids are shown to be a functional morphologist's dream, and recent analyses of feeding, respiration, and locomotion in these animals compare in elegance to C. M. Yonge's analyses of bivalve molluscs. I also particularly recommend Lawrence's treatments of circulation, including the perplexing perihemal-hemal systems, and of brooding, even though brooding is uncommon in echinoderms. However, the book does not directly relate such information to theory in functional biology, except for briefly noting when particular processes or features might be costly and merit further study.

A comprehensive treatment of echinoderms would have required a much thicker book than Lawrence's. Some allusion to the rich and diverse fossil record is squeezed in, but there is little or no mention of such topics as digestion and assimilation, endocrine and nervous functions, the perplexing axial complex, photoperiodism, the remarkable catch connective tissue, development, or the diversity of feeding and nonfeeding larvae. Growth, usually a major component in analyses of functional biology, also is treated only in passing, and intriguing examples of asexual reproduction by fission and autotomy are considered without discussion of how such growth increases sexual fecundity of an individual genome.

Lawrence has selected an impressive array of illustrations, including some delightful, near-forgotten drawings from the last century and original synthetic figures and tables of his own. It is a shame that his excellent selection of photographs did not reproduce better. The book will be a valuable resource for well-informed biologists who need selected up-to-date information on echinoderms. It may also serve to reinforce the idea that organisms, here exemplified by echinoderms, do not necessarily maximize their fitness but survive any way they can with history-laden, just-functional morphologies.

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Neuronal Mechanisms

Synaptic Function. GERALD M. EDELMAN, W. EINAR GALL, and W. MAXWELL COWAN, Eds. Wiley, New York, 1987. x, 789 pp., illus. $149.95; paper, $39.95. A Neurosciences Institute Publication. Based on a symposium, San Diego, CA, 1984.

Our classical understanding of synaptic function largely derived from studies of the process mediating the control of muscle function by motor nerves, which involves the release of acetylcholine at the neuromuscular junction. Now, however, new knowledge of the rich variety of synaptic transmission in the central nervous system has made it apparent that some of the classical concepts need to be revised. The 25 chapters in the present volume provide an excellent, up-to-date survey of this large and flourishing area of research. Modern knowledge of synaptic transmission in the mammalian CNS from the viewpoint of the neurophysiologist and those who study ion channels as well as from the perspective of the neurochemist and neuropharmacologist is well reviewed. The first six chapters deal mainly with the electrophysiological analysis of presynaptic mechanisms regulating neurotransmitter storage and release and with properties of voltage-gated ion channels in postsynaptic cells. A second group of six chapters covers the biochemical study of neurotransmitters and their receptors, with focus on such topical areas as the coexistence of neurotransmitters and neuropeptides, synergism between multiple chemical messengers, the role of protein phosphorylation in slow postsynaptic responses, and the molecular analysis of the GABA/benzodiazepine receptor.

A major emphasis of the volume is the attempt to use this new knowledge to improve our understanding of the highest functions of the CNS. Three chapters deal with the special features of connections in neuronal networks, and two of them use the cerebral cortex as their example. The role of synaptic plasticity in memory and learning is well reviewed in a further six chapters that cover hippocampus, cerebellum, and brainstem, *Aplysia*, and the hypothetical roles of