are neglected; and Jurassic ammonites are included only as isolated examples of evolutionary mode by Sylvester-Bradley, even though biostratigraphy, based on ammonites, grew up in the Jurassic and that system is often hailed as the one in which the science has reached peak development. The problems that beset ammonite biostratigraphers in the Cretaceous are tersely summarized by Kennedy and Cobban, but they say little about the nature of ammonite-based zones and shed little light on the rationale of the ammonite biostratigrapher. In fact, one gets the impression that too much homage may have been paid the cephalopods, at least those of the Cretaceous.

To most contributors to this volume, the development of a zonal scheme for the interval of their principal interest seems to be the ultimate goal, rather than just a means to some other end. Consequently, the important business of biostratigraphic correlation is largely ignored—and therein lies the principal weakness of the volume. Correlation, although mentioned, is not discussed adequately in 16 of the 25 papers in the volume. Miller does deal specifically and effectively with the graphic-correlation method introduced by Shaw in 1964, but the power of this procedure is apparently not recognized by other authors (compare, for example, the results Miller achieves with those of Doyle). Hazel discusses various quantitative techniques for assemblage-zone discrimination. Zonal schemes discussed by others, however, seem to have been pieced together mostly by qualitative stacking of biostratigraphic units from various sections without much consideration of the methods of correlation implicit in this procedure. The schemes outlined by Steininger and by Surlyk and Birkelund are admittedly put together from composite sections "correlated" lithostratigraphically.

Concepts and Methods of Biostratigraphy, despite its unevenness, is a valuable collection of papers, which serve in the aggregate as a reasonably inclusive state-of-the-art summary of biostratigraphy. Like most state-of-the-art volumes, this one contains little that is new; but that does not detract from its potential usefulness as a companion to available American stratigraphy texts, in which biostratigraphic aspects of the science take a distant second place to lithostratigraphic ones.

WALTER C. SWEET
Department of Geology and Mineralogy, Ohio State University, Columbus 43210

Lunar Research

The Moon—A New Appraisal from Space Missions and Laboratory Analyses. Papers from a meeting, June 1975. The Royal Society, London, 1977. vi, 606 pp., illus. £38.95. Also published as *Philosophical Transactions of the Royal Society*, Series A, vol. 285.

This collection of 66 papers summarizes recent findings in essentially all the significant areas of current lunar research. With hardly an exception the authors are scientists actively engaged in lunar studies; most of them are working with samples of the moon returned by the Apollo and Luna missions. For the most part, the contributions represent a high level of scholarship and deserve the attention of anyone interested in keeping abreast of current research in this field.

An unusually high proportion of the authors are from abroad; all the European and Commonwealth laboratories that have worked on lunar rocks are represented. This does not affect the flavor of the book significantly. The discipline and standards set by the NASA lunar program have so effectively established common sets of attitudes and values that national differences have become irrelevant.

Almost all the results presented here can be found elsewhere, particularly in the proceedings of the lunar science conferences held annually in Houston, but most of the present authors have taken a broader perspective than is commonly found in those more specialized papers. Nevertheless, reading through a major portion of this book will be hard work for those who have not followed the subject closely. In this regard the organizers of the conference, Harrie Massey, G. M. Brown, G. Eglington, S. K. Runcorn, and H. C. Urey, have done the reader a service by outlining in the preface a tentative consensus concerning the main advances in our understanding of the moon that have been made during the 10 years since the Royal Society was last host to a lunar meeting, and the advances have indeed been considerable. Without the outline, it might prove difficult to know that the authors are writing about the same moon, so diverse are their assumptions, interpretations, and conclusions. To a large extent this is the way it must be in a frontier field of science. For the most part, the data are of very high quality and in good agreement, and the differences arise primarily because authors with various scientific backgrounds treat results with which they are familiar differently from those with which they are not. Also, there is considerable tossing about of the burden of proof on matters about which present evidence is inconclusive. In a number of cases, one gets the impression that a serious and respectful effort to understand why others draw differing inferences from essentially the same data would reduce the number of conflicting conclusions.

But that won't be the entire answer, for there are signs that matters will become more obscure before they are clarified. Most of the authors explicitly or implicitly accept a scenario for the earliest history of the moon that involves equilibrium condensation of minerals from a hot solar nebula and the rapid accumulation of this material into the moon and planets. It is possible that this is more or less what actually occurred, but the present consensus is more a convention than a compelling consequence of the data. As our knowledge of the formation of stellar and planetary systems advances, this simple picture is bound to suffer, and some of the present scanty agreement will be lost with it. It will be interesting to compare the present book with the one that will probably appear in 1987.

The book is beautifully printed; the size of the pages, the margins, and the type are from a different epoch. One cannot escape the thought that the physical volume may prove less perishable than many of the conclusions to be found on its pages.

GEORGE W. WETHERILL
Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D.C. 20015

Primate Evolution

Molecular Anthropology. Genes and Proteins in the Evolutionary Ascent of the Primates. Papers from a symposium, Burg Wartenstein, Austria, July 1975. MORRIS GOODMAN, RICHARD E. TASHIAN, and JEANNE H. TASHIAN, Eds. Plenum, New York, 1976. xiv, 466 pp., illus. $35. Advances in Primatology.

Although this book has some of the deficiencies characteristic of symposium volumes, many of the papers it contains are excellent reviews, apparently more fully developed than the original presentations. The subjects that are well covered are: primate phylogeny as deduced from the fossil record (discussed by Simons and by Walker); albumin and transferrin relationships among primates (Sarich and Cronin); immunodiffusion (Dene, Goodman, and Prychodko); and amino acid sequences for individual proteins of primates (presented in a number of papers).

The book is not simply a presentation

of data. An attempt has been made to achieve a balance between theoretical papers and experimental ones. The authors are deeply interested in the mechanism of evolution and particularly primate and human evolution. Ever since Darwin the issue of human evolution has seemed so important that authors have tried to run before they could walk and have confused philosophical issues that could not yet be approached scientifically with the few issues that might be so approached. As its title indicates, this volume is not immune to the tendency to go too far too soon. "Molecular Primatology" would have been a more descriptive, though less appealing, title.

Grand generalization and controversy continue to be the mark of literature on evolution. Even in the most observationally oriented parts of the book a feeling that the authors are in a hurry is conveyed. This of course makes for lively reading, if not for careful, incontrovertible argument. The issue of the rate of change of protein molecules and its relevance to the rate of morphological evolution pervades the book. Each step is a matter of controversy. Is there a "molecular clock"? Has the rate of protein evolution changed dramatically in later primate evolution? Can we from modern codogenic sequences infer the sequences of species that form ancestral branch points? If so should we use the principle that the smallest possible number of changes have occurred (maximum parsimony), or should we use some more subtle statistical approach? The fact that the past events are not now measurable (and may never be) fuels all the controversies. Fortunately, the "neutralist" versus "selectionist" controversy is present here only as occasional dying embers. Much of what is said in the book about codogenic sequences will have to be rethought now that determinations of hemoglobin messenger RNA and structural gene sequences have shown that very few of the possible synonymous codons are actually used.

The evolution of the DNA sequences is touched on lightly in this volume for the good reason that little is known about it. In a short chapter Jones reviews measurements of certain satellites in human and higher primate chromosomes. There is an interesting chapter (by Hilschmann and 14 coauthors) on the evolution of antibody specificity, with many data on variable-region sequences.

The book ends with a long philosophical chapter by Zuckerkandl, full of henomenology, ideas, and possibilities, that pays little heed to the matter of verification or falsification by measurement. A major idea is that "progressive evolution" is based on the existence of only a limited number of possible variant states of the system of gene regulation. I am not sure "progressive evolution" is a scientific concept, but I am sure we don't know the prime source of variation in evolution and don't know the mechanism or system of gene regulation, nor can we guess whether the system has few or many states that could occur as a result of frequent genomic changes.

On the current state of theoretical evolutionary work as described in this volume I quote higher authority: the Red King acting as judge in *Alice in Wonderland*. The phrase "Red King hypothesis" is used by Moore (chapter 7) to describe maximum parsimony, in full knowledge (I assume) of the Red King's best line: "If there's no meaning in it," said the King, "that saves a world of trouble, you know, as we needn't try to find any."

ROY J. BRITTEN
Kerckhoff Marine Laboratory, California Institute of Technology, Corona del Mar 92625

Vital Processes

Nutrition and the Brain. RICHARD J. WURTMAN and JUDITH J. WURTMAN, Eds. Raven, New York, 1977. Vol. 1, Determinants of the Availability of Nutrients to the Brain. xii, 324 pp., illus. $25. Vol. 2, Control of Feeding Behavior and Biology of the Brain in Protein-Calorie Malnutrition. x, 314 pp., illus. $25.

The field that properly comes under the heading of "nutrition and the brain" may be divided into one large subsection and two much smaller ones. The large one is concerned with undernutrition and the developing brain. Its subject is of evident importance in a world in which the great majority of children are, to our shame, suboptimally fed, and at a time of life when their brains are passing through periods of demonstrable vulnerability to nutritional deprivation. One of the smaller subsections, both in volume of literature and in numbers of affected individuals, is that part of adult clinical neurology which deals with certain specific syndromes of vitamin deficiency, mostly relating to members of the B group of vitamins. It is perhaps surprising, in view of the wide distribution of serious malnutrition, that these specific vitamin-deficiency neuropathies and encephalopathies are uncommon. It would be necessary to search the more erudite departments of neurology in our larger medical centers to find examples of them, and they are not prevalent in Third World populations. The third subdivision of research on nutrition and the brain is that stemming from recent important discoveries made in part by the editors of the series of books these two volumes inaugurate: that fluctuating concentrations of tryptophan and tyrosine in the bloodstream, due to fluctuating dietary intake, help determine concentrations of important biogenic amines, for which these amino acids are essential precursors, in the brain. The mechanism by which such effects occur and their biological significance remain largely obscure, although they are potentially important because of the supposed neurotransmitter functions of the amines concerned.

These three topics, developmental undernutrition, vitamin-deficiency neuropathies, and biogenic "aminology," might have been expected to occupy the pages of the present volumes in the approximate proportion 90:5:5, but the relationship we actually find is nearer to 25:18:10. Moreover, these subjects occupy only about half the text, the remainder being devoted to subjects having only a tenuous relevance to "nutrition and the brain," notwithstanding the endeavor of the authors and editors to justify their inclusion.

The less relevant chapters in many cases are of better quality than the others. The reviewer's task is therefore unenviable: he must criticize many of the relevant chapters for being poor and the good ones for not being relevant. Of course relevance is a relative matter. Practically all processes in the mammalian organism can be represented as ultimately controlled by the central nervous system, as destined themselves to control it, or, often more reasonably, as components of a system whose parts are so interdependent as to render idle any speculation about which controls which. But the ubiquity of the brain in the natural order of things should not exempt editors from closer adherence to the title of their text.

Always more difficult for editors is the achievement of uniformity in style and in level of presentation. In the present volumes we have explanations of what neurons and vitamins are and of the limitations of light microscopy when applied to the brain. None of the explanations would disgrace an undergraduate text, but these are postgraduate volumes, and there should be none among their intended multidisciplinary readership who need to be spoken to in such elementary terms.