to note in the evening paper that the Ford Motor Company has apparently rediscovered the Stirling external combustion engine as worthy of research as a possible replacement for the internal combustion device. Could this lead to research support for further work on small rodents, I wonder?

The last chapter starts with remarks about Jonathan Swift's intuition—before energy metabolism was heard of—of having the Lilliputian emperor adequately guess Gulliver's lunch needs and then talks about how much LSD to give an elephant. Possible doses range from 0.4 to 8 milligrams with some caution against the also-mentioned 80 and just condemnation of the 297 actually used in an experiment. In a letter to the editor of *Science* (**139**, 684–85 [1963]), Paul D. Harwood rightly described that last dosage as an "elephantine fallacy." The elephant so treated died within minutes, and Schmidt-Nielsen very succinctly tells us why and what all we may need to consider if we must indeed experiment with LSD on elephants.

I picked this last item and the one about the Stirling heat engine to illustrate the range of urbane erudition in a book essentially intended as supporting reading for undergraduate students in physiology. I wish I had had it to read when I took physiology, and I recommend it to fellow biologists of all ages as one of the better buys of its kind, especially since it is also issued as a paperback.

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Tierleben in English

Grzimek's Animal Life Encyclopedia. English edition. BERNHARD GRZIMEK, Ed. Van Nostrand Reinhold, New York, 1972. Vol. 10, Mammals I. 628 pp., illus. Vol. 13, Mammals IV. 566 pp., illus. Each volume, $29.95; the set (13 volumes), $325.

Zoo keepers throughout the world know Bernhard Grzimek as the director of the Frankfurt Zoological Garden; long interested in the conservation of African wildlife, he serves as trustee of the Tanzanian National Parks and oversees the operations of the Michael Grzimek Laboratory (named for his son) of the Serengeti Research Institute at Seronera; and he holds an appointment as professor at the Liebig University of Giessen, Germany. With all these commitments, one wonders how he could undertake the imposing task of acting as editor-in-chief of this series. He has worked with over 200 specialists throughout the world serving as editors and contributors. The first edition, in German, appeared in 1968; a special staff of 11 has produced the present English edition.

As one might expect, the treatment accorded the various phyla of animals bears no relation to their numbers in the wild. The emphasis is placed on the larger, more exotic, spectacular, and familiar forms. This is quite natural, for these are the ones commonly seen in captivity and the ones about which we know the most. The series is to consist of 13 volumes. Of these, volume 1 will deal with the "lower animals," volume 2 with insects, and volume 3 with mollusks. The other ten volumes will all concern the vertebrates—three are to cover the fishes, amphibians, and reptiles, three the birds, and four the mammals.

The first two volumes to appear are volumes 10 and 13, the first and, oddly, the last of the sequence dealing with the mammals. Volume 10 is devoted to the monotremes, marsupials, insectivores, and most of the primates. The first chapter considers mammals in general—their anatomy, physiology, ways of life, evolution, and distribution. Thereafter they are discussed by natural groups (families, genera), with details of their behavior, ecology, and relationships. Maps indicate their geographical range, small sketches depict distinctive anatomical features, special symbols designate extinct or endangered species and subspecies. The volume is handsomely and generously illustrated in color, with accurate paintings or photographs of most species discussed, as well as phylogenetic charts and habitat scenes. An appendix includes a systematic classification of Recent mammals, a dictionary of common names (in English, French, German, and Russian), a selected list of references to the literature, and an index. The general format of volume 13 and the manner of treatment are the same as in the earlier volume. Covered are the ungulates or hoofed mammals of the orders Perissodactyla, in part (tapirs, rhinoceros), and Artiodactyla (pigs, hippopotamuses, camels, deer, giraffes, antelopes, cattle, sheep, and goats). Typographical and other errors in both volumes appear to be remarkably few.

A fascinating amount of material is here assembled, and it is authoritative and well presented. The encyclopedia will be an invaluable reference work not only to the personnel of zoological parks but to biologists and naturalists generally. My only complaint is its bulk —these volumes measure 10 by 7 by 3 inches and weigh 4½ pounds each. The use of a lighter stock, and the elimination of the wide inner margins and side headings, would have made them far more compact. As it is, they should well withstand the heavy use they are bound to receive.

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The Biochemistry of Disease

Free Radical Mechanisms in Tissue Injury. T. F. SLATER. Pion, London, 1972. xii, 284 pp., illus. £4.80. Pion Advanced Biochemistry Series, 1.

A central concern in understanding disease is the mechanisms involved in cell injury. The study of cell injury has been largely the province of the pathologists, who have provided an extensive catalog of terms to describe aberrant morphological features of the injured, dying, and dead cell. Investigation of the significance of these structural alterations and the functional changes associated with them is of much more recent vintage, representing an area of overlap for biologists, biochemists, and pathologists. The need for model systems to mimic naturally occurring disease became very apparent when more than a descriptive account of the illness was sought. A very reproducible multifaceted liver injury model, the carbon-tetrachloride-induced rodent liver necrosis, was developed by Cameron and coworkers at University College Hospital. With this system the first modern steps in biochemical analysis of cell injury were taken by Cameron's students Judah, Christie, Gallager, and Rees, and concomitantly the first attempt was made to explain the role of the inciting agent in chemical and physical terms.

Of all the model systems of hepatic change, probably carbon tetrachloride injury and its effects have been most extensively studied. The use of the symmetrical saturated haloalkane suggested a high order of probability that a detailed understanding of its noxious nature could be developed. This material is dehalogenated, be the process of dehalogenation active or passive, enzymic or nonenzymic. It is now evident that this process most likely oc-

curs by a free radical mechanism. This metabolic conversion and the resultant cellular modification, both structural and functional, are one of the central themes of the book by Trevor Slater, himself a product of University College and its environment.

In order to make the discussion of free radical mechanisms in injury understandable, the introductory quarter of the book gives an account of free radicals, their generation and detection. For the chemist, this nonmathematical description may be somewhat disappointing, but its purpose, to introduce free radicals as a potential mechanism for normal cellular processes as well as an agent producing a modified, in fact diseased, cell, is fulfilled. In large part, the text concerns structural and functional perturbations of liver cells following exposure to carbon tetrachloride. The description is extensive, and the emphasis is primarily on the metabolism of carbon tetrachloride, the possible role of the chlorine or chloromethyl groups, and their relationship to the functional distortions. Particular stress is placed on the "self-destructive" role of the microsomal electron transport chain and the role of cytochrome P_{450}. The remainder of the text suggests other possible mediators of cell injury, which could also operate by free radical mechanisms. These include alcohol, light sensitization, and iron deposition states.

The overall intention of providing a timely description of the potential of radical mechanisms in cell injury, as a provocative device for stimulating other investigators to approach this particular subject, is certainly well carried out. Slater has made an extensive survey of the literature. He has selected his data, has support for his case, and has produced a very readable and interesting approach to the biochemistry of disease. If one is to find fault, possibly the absence of discussion of other potential mechanisms of injury that may be involved should be cited, or the fact that the free radical mechanism and lipid peroxidation may be only one of a variety of aberrations produced. Perhaps it should also be mentioned that not all of the changes in the carbon tetrachloride model can be explained by the free radical lipid peroxidation scheme. Nonetheless, this is a novel dissertation, especially so since our changing curricula in medicine and in biology frequently preclude more extensive discussion or understanding of mechanisms from a purely chemical point of view. That pathologists will be exposed to free radicals as a chemical entity with a very significant relationship to cell viability is to be applauded. That this may bring together various approaches to the very real problems of cell injury is more than sufficient justification for the addition of this text to our vast fund of printed information. The particularly pleasant historical account of the progress in biochemical analysis of disease makes the book certainly worth reading.

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Patterning Data

Mathematics in the Archaeological and Historical Sciences. Proceedings of a conference, Mamaia, Romania, 1970. F. R. HODSON, D. G. KENDALL, and P. TĂUTU, Eds. Edinburgh University Press, Edinburgh, 1971 (U.S. distributor, Aldine-Atherton, Chicago). x, 566 pp. + chart. $36.

These proceedings of the Anglo-Romanian conference held in 1970 contain over 50 articles which cover a wide range of topics. There are several strong themes running throughout the volume, however, and the reader will find that on dipping into one article he will be led to others which discuss similar methods applied to different data or different methods applied to similar data. This, of course, gives the whole a welcome unity—a unity that is not normally found in proceedings.

The volume begins with an introductory article by A. C. Spaulding. He points out that archeology, like history, has a commonsense basis of understanding of human dispositions and that very often no explicit theory is needed to explain certain facts.

How far this commonsense approach by itself can take us in the explanation of past events is, of course, unknown, and only time and a great deal of experimentation with it and other approaches will tell. There is much patterning of numerical data that does not need any great analysis, but some does, and in these proceedings we have many mathematical treatments in two large areas, typology and seriation, which deal respectively with clustering and with connected sequences. After discussing artifacts and attributes (as does Moberg in his closing address) Spaulding outlines the basic idea of typology by considering six artifacts $A_1, A_2, \ldots, A_6$ which possess five attributes $V_1, V_2, \ldots, V_5$ among them. In matrix representation it is given by

	V_1	V_2	V_3	V_4	V_5
A_1	0	0	1	1	0
A_2	1	1	0	0	1
A_3	1	1	0	0	1
A_4	0	0	1	1	0
A_5	1	1	0	0	1
A_6	0	0	1	1	0

and from this incidence matrix we can construct a 6×6 symmetric similarity matrix $A = (a_{ij})$ where the similarity coefficient between A_i and A_j is $a_{ij} =$ the number of entries (0 or 1) which A_i and A_j have in common—and so has a maximum of 5 and a minimum of 0. It is obvious that on rearranging the rows and corresponding columns of A we get

	A_1	A_4	A_6	A_2	A_3	A_5
A_1	5	5	5	0	0	0
A_4	5	5	5	0	0	0
A_6	5	5	5	0	0	0
A_2	0	0	0	5	5	5
A_3	0	0	0	5	5	5
A_5	0	0	0	5	5	5

from which we see that we have two clusters of artifacts. Now this is a deliberately simple example, and no mathematical treatment is called for—it could be "seen" in the original matrix. But what if the quantity of data is large both in the number of artifacts and number of attributes? And what if the distribution of 0's and 1's in the original matrix has no "easy to see" pattern? Although, as Spaulding himself points out, artifacts do not exhibit innumerable combinations of attributes—the use of the artifact conditions much of this—we will have areas of contention and more formal techniques are needed. For then the underlying assumptions involved in the clustering will, one hopes, be made explicit. And if they are made explicit the method can be tested on known data and our confidence in the approach thereby increased.

It goes without saying that because of the complexity of the data most formal techniques use the computer.

Hodson makes such points, as well as many others, in the introduction to his article "Numerical typology and prehistoric archaeology" and then proceeds to outline the *K-means* method of cluster analysis. He splits the K-means approach into several stages and, since each has its own problem, discusses them stage by stage. In the first stage we choose a certain number of clusters into which the data are to be split. Now we do not usually know at the beginning of the analysis how