manner. The first group covers certain chemical aspects of flavin nucleotides: semiquinone formation by irradiation of flavoproteins, photochemical reduction of free and enzyme-bound flavins, and products obtained by anaerobic photolysis of riboflavin. One could also include in this group the stimulating contribution by Kosower on pyridinyl radicals.

Mitochondrial enzymes traditionally have been the subject of much argument. It is not surprising, therefore, to find a certain amount of controversy surrounding the papers in the second group, covering mitochondrial flavoproteins and related topics. Previous debates over whose mitochondrial DPNH dehydrogenase was the most "physiological" have now largely been placed by such questions as: At what point in the respiratory chain does rotenone exert its inhibitory effect? What is the nature of the "occult" thiol group in the reduced diphosphopyridine nucleotide (DPNH) dehydrogenase chain? Does the DPNH chain contain more than one flavoprotein? What are the structural differences between the various nonheme iron entities in the mitochondrial electron-transport chain?

The wealth of information available about the chemistry of flavin nucleotides, and the fact that many flavoproteins have been isolated in essentially homogeneous form, might suggest that very little remains unknown about the mechanism of these enzymes. Such is not the case, however, as is evidenced by papers in the final group. Although it is clear that a "minimal" flavoprotein should operate by a two-step mechanism in which reducing power is transferred from substrate to flavin to acceptor, the actual situation encountered in the various flavoproteins is far more complex. Thus, interaction of a substrate with the enzyme-bound flavin can result in formation of the flavin semiquinone, the fully reduced flavin, a charge-transfer complex between the substrate and the flavin, or a group-transfer complex in which the substrate is bonded covalently to the flavin. Similar possibilities exist during interaction of the flavin with the electron acceptor (which, for expediency, is often a nonphysiological oxidant). Further complications arise when the enzyme contains more than one flavin nucleotide or other oxido-reduction groups (such as metals, thiol groups, hemes). It is hardly surprising to note, for example, that both red and blue radicals can be generated from the same enzyme (see discussion, pp. 250–51).

In addition to providing specific information about the mechanism of various flavoproteins, this book is of value in illustrating how the techniques of absorption spectrophotometry (especially when used over short time intervals), electron paramagnetic resonance, and optical rotatory dispersion can be utilized to study complex mechanisms. It is a definitive work both for specialists in this field and for biochemists and chemists in general who may wish to obtain some insight into one of the more rapidly developing areas in the study of enzyme reaction mechanisms.

F. M. HUENNEKENS
Department of Biochemistry,
Scripps Clinic and Research Foundation,
La Jolla, California

A Species in Trouble

Ecology and Behaviour of the Black Rhinoceros (Diceros bicornis L.). A Field Study. RUDOLF SCHENKEL and LOTTE SCHENKEL-HULLIGER. Parey, Hamburg, 1969. 104 pp., illus. Paper, DM 28. Mammalia Depicta.

The authors have conducted a thorough investigation of the black rhinoceros in several East African national parks over a period of almost three years. The reasons for these studies were the apparent ecological changes taking place in the rhino's habitat, an increasing elephant population being one of the major problems. Rhinos and elephants normally coexist; however, serious competition for food and water often occurs. Relationships with other ungulates, as well as predators, showed no special problems.

Black rhinos were found to lead a nomadic life, and did not have individual territories. The same mud wallows, watering and sleeping places, and other areas were used by many different rhinos. Population counts of adults and young were made by both ground and aerial studies. Observations of single animals showed how far they would stray from water, and also how long they could do without it. Feeding habits were watched by following individual rhinos along their daily routes. Specimens of food plants were collected for identification, the result being a large list of bushes and shrubs. Several sick or dying rhinos were shot and examined for possible identification of diseases and parasites and in order to note the general condition of the animals.

Social reaction and mating behavior are well covered. The information obtained is very important, for the breeding of the rhinoceros in zoos is a must. Premating fights, which so often occur in closely confined captive rhinos, were found to be minor or to consist of nothing more than threatening gestures. The authors also found little or no horn rubbing in wild rhinos. Zoo specimens rub their horns to blunt stumps, as compared to the wild rhino's long sharp ones. This could be the result of boredom in the captive rhino.

This work clearly shows that the black rhinoceros is in serious trouble. It seems that even the national parks may be too small to save this beast from extinction. The principal problem is organized poaching, which must be stopped if the species is to survive. To make matters worse, the bush country, which is the rhino's home, is fast becoming dry grassland as a result of drought, brush fires, and the destruction of trees and shrubs, which are the rhino's food, by elephants. To conserve the species in its few remaining strongholds, the authors suggest ecological investigations of these regions over a number of years. These would include analysis of the rhino and elephant populations along with changes in topography and vegetation. Strict control of the elephant herds is also advocated. This could raise the question of which is to survive, the elephant or the black rhino.

NORMAN HESS
Philadelphia Zoological Garden,
Philadelphia, Pennsylvania

Microscopic Anatomy

Comparative Vertebrate Histology. DONALD I. PATT and GAIL R. PATT. Harper and Row, New York, 1969. x + 438 pp., illus. $14.95.

Two major problems must be solved in the production of a book such as this one. First, because the illustrations are crucial to the exposition, some way must be found to include a large number while keeping the price within textbook limits. Second, a mass of scattered and often contradictory observations must be pruned into a logical and useful exposition. In this volume these problems have been dealt with in an ade-

quate, but not altogether satisfactory, manner.

The book is profusely illustrated, almost half of the total page area being devoted to photographs and diagrams. The quality of reproduction is variable. Some of the electron micrographs are quite good, though they lack the crispness of the original publications. A few of the electron micrographs and a larger proportion of the light micrographs appear to have been originally of mediocre quality and are nearly unreadable in reproduction. The problem with light-microscope preparations, as opposed to electron micrographs, is that the material often relies for contrast on differential staining, and this contrast does not carry over well into black-and-white reproduction. Some of the most effective illustrations in this volume are diagrams drawn from electron micrographs. Perhaps more extensive use of the excellent drawings and engravings of light-microscope observations in the older literature might replace the inferior micrographs without increasing the cost of publication. The diagrams produced specifically for the book are generally clear and concise, though a bit pedestrian in execution.

The text quite reasonably uses evolution as the general organizing framework and follows this scheme in a manner consistent with the purposes of the book. Each chapter begins with a general description of the function of the tissue or organ treated and then moves on to more specific details of form and function in different vertebrate groups. Occasionally the exposition seems a bit anecdotal, and more careful editing might have improved the flow of the text and corrected a tendency to bring up a topic, drop it arbitrarily, and then resume the discussion several paragraphs later. It might also be useful to shift the emphasis even more to comparative aspects, spending more time on the lower vertebrates and less on mammalian systems, which have been covered extensively in other texts. Most of the discussion of cellular biochemistry and cytology in the first two chapters is not as well organized as it might be and by misplacing the emphasis presents a rather distorted picture. These chapters would be more valuable if the discussion of the problems of tissue preparation and observation were expanded, and the "molecular biology" omitted.

General references at the end of each chapter refer to literature in books and journals that are likely to be available to most students. It would be helpful to have specific bibliographic references for many of the intriguing statements in the text.

SPENCER J. BERRY
Department of Biology,
Wesleyan University,
Middletown, Connecticut

Water

The Structure and Properties of Water. D. EISENBERG and W. KAUZMANN. Oxford University Press, New York, 1969. xiv + 300 pp., illus. Cloth, $10; paper, $4.50.

Eisenberg and Kauzmann's *The Structure and Properties of Water* is an excellent monograph serving an important need. The aim and scope of the book are outlined in the preface: "Our purpose . . . is to summarize from the voluminous literature on water, some of the most important and reliable data . . . and to present the theories that are most effective in correlating these data. We have made no attempt to produce a compendium of data, . . . but we have tried instead to relate the properties of water to its structure." Furthermore, "Though some data on both electrolytes and non-electrolyte solutions are undoubtedly helpful in understanding the structure of water, we have not ventured into the vast literature concerning aqueous solutions."

The language is clear, concise, and stimulating, if not eloquent. The presentation is complemented by an excellent compilation of tables of pertinent information, as well as by good illustrations. In addition, the book contains excellent subject and author indices and an impressive list of references. It is remarkable, however, that no reference is made to Gmelin's *Handbuch der Anorganische Chemie,* for this multivolume treatise presents (in the sections on oxygen) what is probably the most comprehensive summary available of the known properties of water.

The first four chapters of Eisenberg and Kauzmann's book—"The water molecule," "The real vapour," "Ice," and "Properties of liquid water"—present with clarity the known properties one must consider in seeking an understanding of the structure of water. Some introductory remarks are made regarding the general physical chemistry underlying the discussion in each section, a feature that will undoubtedly prove useful to those who are not trained in physical chemistry.

The last sections of the book, on the structure of water and the various models that have been proposed, are somewhat anticlimactic. In a monograph entitled *The Structure and Properties of Water* a discussion of structural models might be expected to be the most important contribution, yet these portions constitute less than 10 percent of the book. The disappointment one feels is, of course, not to be blamed on the authors: understanding of the structure of water is at present very limited. Because of this the authors have chosen merely to enumerate and to discuss rather briefly some of the more interesting current models and the theories underlying them. The analysis offered is neither profound nor critical. Although the authors are not committed to a particular model, they do imply a slight preference for a suitably modified continuum model—an inclination which probably by now represents a minority opinion. Apparently, the leaning toward the continuum model is based almost exclusively on the analysis of the infrared and Raman spectra, but with no attention paid to the structural properties of aqueous solutions of electrolytes and nonelectrolytes. Thus the authors have deprived themselves and their readers of some important, if indirect, clues to the structure of water, not to mention that the ultimate test of the structural models of water must, in part, be the prediction of the properties of aqueous systems in general.

While the book may certainly be recommended to any scientist who needs to know something about water —from the physical chemist to the biophysicist, or molecular biochemist or any other person required to deal with aqueous systems—it may be a disappointment to, say, the general biologist or cell physiologist. By choice, the authors have completely avoided the discussion of water near interfaces as well as consideration of aqueous solutions. Yet the book will prove indispensable to anyone interested in the more fundamental aspects of the structure of bulk water and will likely remain a valuable reference volume for many years to come.

W. DROST-HANSEN
Institute of Marine and Atmospheric Sciences, University of Miami,
Miami, Florida