are inserted at intervals. This zoogeographic material should help cartographers understand the distribution of animals pictured on old maps, but it is hardly a contribution to zoogeography.

Early cartographers did place many animals in the proper parts of the world, and the details they recorded are indeed the raw materials of zoogeography. Whether or not accumulation of unorganized details is in itself zoogeography is a matter of definition, but it is not what we think of as zoogeography now. Zoogeography is or ought to be the putting together of the details into significant patterns. The old cartographers did not do this, and to force the details they knew into patterns discovered later, as is done in this book, seems to me to distort history.

The story of the yale exemplifies the methodology of the book. Accounts of the eale or yale date from Pliny, who described it as being the size of a hippopotamus but horned, with one horn pointing forward and one back. George devotes more than a page to different imaginary versions of this animal on different maps, and argues that it may have been a water buffalo. I do not find the argument convincing, but at least it is legitimate fun, as cartographic history. However, she then says, "On these early maps . . . the ethiopian and oriental regions are . . . distinguished from one another by the appearance of the yale only in the oriental region." But surely the old map makers did not mean to characterize zoogeographic regions. They simply put the yale, which was unknown to them whether or not it was a water buffalo, where Pliny had said it was.

The book is not even a satisfactory history of the growth of knowledge about animal distribution. Such a history should be based on all available sources, not just on the details that caught the attention of cartographers.

The zoogeographic maps (figs. 3.11, 5.9, and 7.14), which are reprinted from an earlier work by the same author, are scarcely useful or pertinent to the text. They are decorated with crude animal figures, some of which are impossible for even a zoologist to recognize; they are not adequately explained in the text; and some of the arrows on them, intended to show directions of dispersal, are at best ambiguous.

I recommend this book (with reservations) only to cartographers and others interested in the history of animal pictures on maps—this history does have an interest of its own—but I do not recommend it to zoogeographers.

P. J. DARLINGTON, JR.
*Museum of Comparative Zoology,
Harvard University,
Cambridge, Massachusetts*

Light Reactions

Photosynthesis. EUGENE RABINOWITCH and GOVINDJEE. Wiley, New York, 1969. xiv, 274 pp., illus. Cloth, $8.95; paper, $5.95.

This book has little resemblance to the three-volume *Photosynthesis and Related Processes* (Academic Press) by the senior author, an encyclopedic monograph still serving workers in the field as a treatment of the literature before 1956. The new book is, as is noted in its preface, "suitable for introduction into the field of photosynthesis for students with varying backgrounds —from physics to plant physiology."

There are 19 short chapters, most of them written in a chatty style extended even into sometimes corny but effective analogies which any teacher will recognize as memory implants. It is organized for the guidance of the reader (with some sacrifice to redundancy) rather than according to the cold logic of its subject. Some 80 figures, many in diagrammatic style, support the text. Where mathematical relations are given, their symbolism and interpretation are carefully explained. There is a historical flavor injected by the citation of names and places. The bibliography is limited to citations of books, symposia, and reviews, with no listing of particular articles discussed. In short, the book is oriented toward instruction with some sacrifice of scholarly niceties.

The first five chapters present the ancient history and biological significance of photosynthesis and an introduction to energetics. Thereafter the reader is carried quietly into ideas of structure, overall kinetics, quantum yield and action spectrum, energy migration among pigment molecules, the evidence for two pigment systems and photochemical reactions, the reduction of carbon dioxide, and photophosphorylation.

In order to manage all this in a short treatment, the authors have made certain sacrifices. The reader may feel that he is being fed more biophysics and less biochemistry than he would like, and he will find only isolated crumbs on bacterial photosynthesis.

Of several possible criticisms, one is of sufficient interest that it will stand elaborating. In their necessarily simplified historical treatment the authors exaggerate the contributions of their former colleague Robert Emerson and ignore other critical contributions.

The modern period of photosynthesis research dates from 1960, when there were made the first serious suggestions that there might be two independent light reactions. There were already available two observations now taken as evidence. One of these came from Lawrence Blinks in his 1955 report on the phenomenon of chromatic transients, the occurrence of transient changes in the rate of oxygen exchange accompanying changes in wavelength of illumination. Blinks's experiments are a monument to raw curiosity in science, and to omit them, as the authors have done, is to lose some of the drama they sought to inject.

The second piece of evidence was the "red drop," the drop in quantum yield at long wavelength. The authors properly attribute to Emerson and Charlton Lewis the first demonstration of and concern for this anomaly. But there was equal, and, in some respects, even more dramatic evidence from Francis Haxo and Blinks, and this also has been ignored. Emerson tenaciously pursued the anomaly until he discovered the phenomenon of enhancement, an apparently synergistic effect between certain wavelengths of light. He clearly identified the effect with some special contribution to photosynthesis made by light absorbed by accessory pigments, but, contrary to the authors' statements, it was not he who suggested that photosynthesis involves two photochemical reactions. In 1960, at the Johns Hopkins Light and Life Symposium, there were three separate proposals for independent photochemical reactions: by Bessel Kok and George Hoch, by Robert Hill and Walter Bonner, and by C. S. French. The Kok and Hoch proposal was most directly supported by experimental data, but it was the potential diagram proposed immediately thereafter by Robert Hill and Fay Bendall which became the Z-scheme in the current dogma of photosynthesis.

The authors properly dedicate their book to the memory of Robert Emerson. His clear statement of the special and necessary role of accessory pigments was a critical thrust, but it was short of traversing the energy barrier between the imaginative concepts of one light reaction and two. In overzealous homage the authors have claimed more for him than he, a scientist's scientist, would have accepted.

The authors will not be surprised at the criticisms they receive, and they may well rejoin that if others can do better they should have at it. It is not likely that, for purposes of serving the general reader, a better job will be done soon.

JACK MYERS
Department of Zoology, University of Texas, Austin

Sites of Protein Synthesis

The Ribosome. A. S. SPIRIN and L. P. GAVRILOVA. Springer-Verlag, New York, 1969. x, 164 pp., illus. $14.90. Molecular Biology, Biochemistry, and Biophysics, vol. 4.

If one picks up a text or monograph that covers the topic of protein synthesis and looks up the role of the ribosome, one will almost invariably find a representation that has stood for a number of years: that of two truncated spheroids of unequal size, upon whose surfaces are depicted the reaction sequence involved in peptide bond formation. Perhaps most of the enzymatic activities now known to be required for protein synthesis are due to nonribosomal components. Thus we have today a model of protein synthesis written in classic enzymological terms, according to which most of the synthesis takes place rather mysteriously in a "black box," the ribosome. There is no satisfying explanation as yet of the need for this large and very complicated organelle, and we are far from the desired correlation of its structure and function. It is somewhat ironic that this should be the situation, for it has been almost 30 years since the ribosome was first identified from cytological observations, being the first component of the synthetic machinery to be discovered and also the first to suggest the involvement of RNA.

This short monograph is the fourth in a contemplated series of some 60 volumes. Both authors have been active investigators of the ribosome and its role in protein synthesis. The vintage is early 1968, and the book is almost equally divided into two parts: the first half devoted to a consideration of the composition and structure of ribosomes and their components, and the second to the functioning of the ribosome in peptide bond formation. It is indicative of the present state of the art mentioned above that each half of this book could practically stand alone as an independent entity.

The book being a short one, the coverage has been carefully circumscribed. This is not a complete compendium of all the various studies that have been reported on composition, structure, and properties, but rather a selective and limited summary view, with a strong and much needed interpretative flavor to it. Perhaps the major defect in the first half of the book is a very notable omission in a chapter on structural transformations. One of the highlights of recent years, the total reconstitution of one of the ribosomal subunits so elegantly demonstrated by Nomura and co-workers, is not mentioned. Although the full details of this feat were unfolded about the middle of 1968, the authors must surely have been aware of it at the time of the writing, and its omission is to be regretted. The account of reconstitution presented rests heavily on the work of one of the authors and is not a balanced view of this subject. In regard to ribosome function, the latter half of the book is a reasonably succinct account of the enzymological picture, which is about all that can be done at present. There are many facets of protein synthesis that are omitted, such as amino acid activation, polysome structure and function, messenger-RNA turnover and regulatory questions, and the coding problem. Similarly, a chapter at the end devoted to a consideration of antibiotics that interfere with ribosome function leaves a good deal to be desired. Toward the end of the second half of the volume the authors propose a theory for ribosome function, which to this reviewer appears to be not much more than a restatement of the present enzymic picture. The theory still regards the functioning ribosome as a rigid entity, a view which recent evidence suggests may be incorrect, and it cannot account for the great structural complexity. It is probably still too early for a satisfactory theory here.

The chief value of this volume would be as a classroom reference that goes beyond the usual textbook coverage yet presents a reasonably succinct view. It does this admirably. But for a fuller view it will need supplementation as noted above. It will probably have a short half-life of usefulness, being a limited coverage of a field that is experiencing considerable transition at present.

JOEL G. FLAKS
Department of Biochemistry, School of Medicine, University of Pennsylvania, Philadelphia

Materials and Properties

II-VI Compounds. BRIAN RAY. Pergamon, New York, 1969. xvi, 272 pp., illus. $10.50. International Series of Monographs in the Science of the Solid State, vol. 2.

The luminescence and electrical properties of a wide-band-gap material are determined primarily by the defects present in the crystal. II-VI compounds are midway between ionic solids, in which properties are determined by native defects (vacancies and interstitials), and covalent solids, in which these properties are determined by foreign impurities. These compounds will not be well understood until the energy levels and solubilities of the more common native defects and foreign impurities have been determined. At present, many of these properties are unknown, but progress is being made at a linear rate.

The author has attempted to write a concise text on II-VI compounds, to provide the reader with a general idea of how II-VI compounds behave and to serve as a quick reference to the vast literature on these materials. The book is restricted to the tetrahedrally coordinated crystals ZnO, ZnS, ZnSe, ZnTe, CdS, CdSe, CdTe, HgSe, and HgTe. The book is crammed with many useful tables and figures, and the author cites a long list of references in each chapter. There are seven chapters, covering bonding and band structure, crystal growth, fundamental optical properties, luminescence, photoconductivity, transport properties, and applications of II-VI compounds.

All of these subjects, except the applications, have been reviewed previously in a much lengthier and much more complete treatise, edited by Aven and Prener, published in 1967. It is unfortunate that the author chose to write his book so soon after the book edited by Aven and Prener. Many developments which shed considerable light on II-VI compounds are too recent to have been covered in either of