to date. It must be remembered, however, that many important areas of research are ignored completely—for example, irreversible processes in solids, quantum liquids, and chemically reactive systems.

ROBERT ZWANZIG
Institute for Fluid Dynamics and Applied Mathematics and *Institute for Molecular Physics, University of Maryland, College Park*

The Hemoglobinopathies

Abnormal Hemoglobins in Human Populations. A Summary and Interpretation. FRANK B. LIVINGSTONE. Aldine, Chicago, 1967. 482 pp., illus. $12.50.

The sum of man's knowledge of the hemoglobin molecule is a splendid thing to contemplate. The era of molecular biology was, after all, ushered in by Pauling's demonstration that sickle-cell anemia is caused by a variant hemoglobin molecule which differs from normal hemoglobin in its electrophoretic mobility. The subsequent elucidation of the entire structure of hemoglobin, from the primary amino acid sequences of its constituent chains to the quaternary interactions of its subunits, must certainly rank as one of the pinnacles of molecular biology. Analysis of the specific mutations affecting hemoglobin has played no mean role in this progress. How the substitution of valine for glutamic acid at β_6 in Hb S alters the physicochemical properties of the molecule and thus leads to the sickling phenomenon; how the several distinct methemoglobinemias may arise from amino acid substitutions so located that they interact abnormally with the heme group; how the several Lepore hemoglobins may arise from unequal crossing over with the β–δ duplication complex; how the association of four normal β-chains in Hb H drastically alters the oxygen dissociation curve of the molecule—these discoveries and others have provided a wondrous insight into the complexity of the biological integration that evolution has wrought, even at the molecular level. For the physician, the hemoglobinopathies provide a prototype of the precision with which the pathophysiology of all diseases will ultimately be known.

Abnormal Hemoglobins in Human Populations is an attempt to review in detail a single aspect of our knowledge about hemoglobin. It is quite literally a tabulation of the reported frequencies of abnormal hemoglobins, glucose-6-phosphate dehydrogenase variants, and the thalassemias in human populations, as they relate to the hypothesis that these polymorphisms are maintained by the selective resistance of heterozygotes to malaria. Three hundred and nine of the volume's 470 pages are devoted to an appendix in which all the reported phenotype frequencies the author could find in the literature are recorded in one enormous table. Roughly 800 references take up another 49 pages, leaving only 112 pages of text. This is a blessing in disguise, however, since the author's writing is uniformly poor, ranging from a sketchy treatment of the relevant biochemistry to anthropological obscurantisms and lapses in syntax. With respect to the malaria hypothesis, the author concludes that "there were astonishingly few frequencies that did not seem to be explained directly by this hypothesis." The reader is well prepared for this conclusion by the statement in the introduction that "selection by malaria will be assumed to be the major factor in causing the high frequency of these genes."

Genetic heterogeneity poses a serious problem for the gene-frequency school of human anthropologists. The problem is perceived by Livingstone when he declines to speculate on the ancestral relationships of populations containing thalassemia genes "because of the many different point mutations that can result in the symptoms of thalassemia." However, because of the extensive degeneracy in the genetic code, it is clear that even in the case of the Hb β^S "allele" or, for that matter, the Hb β^A "allele" many different nucleotide sequences (that is, different alleles) could give rise to identical polypeptide chains. For the β-chain of Hb A (or Hb S), more than 10^{74} different nucleotide sequences could code for that particular amino acid sequence. This staggering number of *possible* alleles is vastly greater than the total number of hemoglobin molecules that have ever existed on earth. It is not yet known to what extent this enormous potential variation is actually realized. The possibility clearly exists, however, that in the absence of demonstrable inbreeding, the concept of homozygosity may be a theoretical abstraction in human genetics. And if genotypic identity cannot safely be assumed even in the presence of phenotypic identity, it is not clear what inferences about the anthropologic relationships of human populations can, in fact, be made from the study of phenotypic similarities.

There are many minor objections that might be raised to this book. The inclusion of a computer program written in a language that is not in general use is parochial, to say the least, and would seem to serve no useful purpose. There are a number of typographical errors. The author characterizes as "curious" the assumption that "the morphology and epidemiology of parasites have remained unchanged for hundreds, thousands, and even millions of years" (p. 95), yet he does not hesitate to publish the results of computer simulations which assume constant population size, constant migration, constant sex distribution, and constant fitness for 100 generations. Finally, the inappropriate designation of references by numbers and letters and, in one instance, an exclamation point would seem to be an inexcusable expediency for belated additions. No one likes to prepare a bibliography, but some standards should be met in a scholarly work. This book can be recommended only as a tabulation of hemoglobin, glucose-6-phosphate dehydrogenase, and thalassemia phenotype frequencies in human populations.

WALTER E. NANCE
School of Medicine, Vanderbilt University, Nashville, Tennessee

Systematic Zoology

Taxonomy. A Text and Reference Book. RICHARD E. BLACKWELDER. Wiley, New York, 1967. 714 pp., illus. $19.95.

Inevitably, this book invites comparison with Mayr, Linsley, and Usinger's *Methods and Principles of Systematic Zoology* (McGraw-Hill, 1953; new edition in preparation). Although they may be held to cover the same ground, the two books could scarcely be more different in their viewpoint and emphasis.

Taxonomy, as Blackwelder understands it, is "the day-to-day practice of dealing with the *kinds* of organisms [in this case, animals]. This includes the handling and identification of specimens, the publication of the data, the study of the literature, and the analysis of the variation shown by the specimens." Measured by his own definition, Blackwelder's book shows an odd im-

balance. As for the *handling* of specimens, just eight pages, under the chapter title "Curating," are allotted to collecting, sampling, killing, preservation in the field, recording field data, and shipment and storage. Only 15 pages (chapter 5) are devoted to identification. The analysis of geographical variation within species is not dealt with at all, despite the fact that it occupies most of the time of most vertebrate taxonomists today. Statistical treatment is mentioned only to be dismissed: ". . . in the description of taxa, which means the description of the features of individuals or of groups of like individuals, there is little place for statistics as such. . . . In spite of some published statements that taxonomy deals basically with populations, it is easy to see that almost all descriptive taxonomy deals solely with individuals and with groups of individuals which hold the pertinent features in common" (p. 287).

This last argument, which appears in several forms throughout the book, plainly reveals the author's typological bias. (This bias he denies on pp. 345–46, but it is clear that he does not understand the word "typology" as most modern writers use it.) He also believes that "Many writers have thought that the Darwinian revolution in biology must have affected taxonomy. Some have even claimed that it did, but no one has cited examples," and "Recent attempts to combine taxonomy with evolutionary studies have not been highly successful." Of these breathtaking beliefs, I can only say that they are wrong, and I think most working taxonomists will agree with me on the basis of massive evidence.

If those parts of Blackwelder's book that deal with the actual handling and study of specimens are mostly halfhearted and spotty in their coverage, he does warm up in chapters 17, "Taxonomy as a science," and 18, "The nature of classification and of species"; but these really are polemical essays, out of place in a textbook.

In part 6, the author expands into the subject that really interests him most: zoological nomenclature. Here, in 230 pages, he analyzes in detail the latest *International Code of Zoological Nomenclature* (1961 and 1964), which has an English-language text of about 80 pages. Many working taxonomists, particularly entomologists, will agree with at least some of Blackwelder's criticisms of the code. The real question is whether a "text and reference book" should be so heavily burdened with this sort of thing.

What of the reference function claimed in the subtitle? Undeniably, there is much procedural and bibliographic detail here that practicing taxonomists need to have handy. But this information is frequently poorly organized and repetitive, it is heavily interlarded with controversial philosophical ramblings, and too often its facts are wrong or misleadingly incomplete. For example, in a list of commonly used Latin phrases with definitions there appears "*species novum* . . . (pl., *species nova*)"; it should be *species nova* (pl., *species novae*). In a list of American museums with their publications, we read: "Museum of Comparative Zoology (M.C.Z.) at Harvard University; publishes *Johnsonia* (mollusks)." True, but what of the M.C.Z.'s important *Bulletin* (135 volumes published beginning 1863), and its *Breviora* series?

As a text for students of systematics, *Taxonomy* falls short. As a reference work for advanced taxonomists, it may serve as a brief for a minority report.

WILLIAM L. BROWN, JR.
Department of Entomology and Limnology, Cornell University, Ithaca, New York

Properties of Compounds

Physics and Chemistry of II–VI Compounds. M. AVEN and J. S. PRENER, Eds. North-Holland, Amsterdam; Interscience (Wiley), New York, 1967. 862 pp., illus. $30.

At the end of this year the transistor, discovered in December 1947, will come of age. Its discovery has focused the talent and energy of many scientists on the basic and applied aspects of semiconductor research. In reviewing those 21 years, the scientists involved can say that they have been successful, successful beyond their ability to perceive the future.

In the early years, the electrical properties of silicon and germanium were studied and mastered. These two semiconductors have spawned and nourished the transistor and computer industries, which together will soon overshadow the automobile industry in size. About 1954 some scientists began to shift their attention to the properties of the III–V compounds. Once again the knowledge gained from germanium and silicon technology was capitalized upon, and the properties of these compounds were mastered and in 1960 the *p-n* junction laser was discovered. The new laser offered to technology a new method for the efficient conversion of electrical to optical energy. Unfortunately, success showed that only the red-green portion of the visible spectrum could be produced with these compounds, and the search for simple and efficient conversion of electrical to optical energy has shifted to the II–VI compounds, where one hopes to cover the whole visible spectrum.

Although research on the II–VI compounds dates back a hundred years, it is only within the last decade that the sophisticated theoretical and experimental methods which have worked so well with other semiconductors have been brought to bear upon these materials. The most important of these is the use of single crystals, which has led to the understanding of how intrinsic as well as extrinsic defects play a role in determining electrical and optical properties.

This book serves a double purpose in that it brings together for the first time the significant material in the literature and provides good and concise introductions to each of the significant aspects of II–VI compounds. Thus the experienced research worker has a ready and reliable guide to the existing literature and at the same time a scientist new to the field can with diligent study become aware of the major problems. The first seven chapters of this volume cover the basic chemistry and physics of zinc and cadmium chalcogenides. Chapters 8 through 14 cover the various optical and electrical phenomena encountered in these materials. The properties of mercury chalcogenides are described in chapter 15. All the articles show that significant progress has been made in certain selected areas. However, almost every author points out that there still remain important problems to be understood. More recent developments were reported at the International Conference on the Physics of II–VI Compounds held at Brown University in September 1967. The proceedings of that conference should cover work done since this volume was written.

Meanwhile technology waits on the sidelines, ready to take over whenever the simple and efficient conversion of energy into visible light is achieved.

PAUL HANDLER
Department of Physics, University of Illinois, Urbana