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.

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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.

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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-