tially? At the moment, evidence can be marshaled to support various explanations. Although the results are inconclusive, they are nevertheless intriguing. Several papers in this section deal with the evolution of main sequence contact systems (W UMa stars), the most numerous sort of close binary system to be found in the galaxy. The vigorous, if inconclusive, discussion of the subject by the various contributors (Hazlehurst, Webbink, Flannery, Whelan, Vilhu and Rahunen, and van't Veer) is best summarized by the remark of the editors to the effect that the participants were unable to agree on an estimate of the lifetimes of W UMa systems to within a factor of 100!

The book belongs in the library of every serious student of stellar evolution.

ROBERT P. KRAFT
Lick Observatory, University of California, Santa Cruz 95064

Immunity

The Generation of Antibody Diversity. A New Look. A. J. CUNNINGHAM, Ed. Academic Press, New York, 1976. x, 212 pp., illus. $19.75.

This compilation of a dozen essays on the subject of antibody diversity represents a genuine attempt to provide a fresh perspective on a subject of long-standing controversy. The dispute has to do mainly with whether the diverse information coding for multitudinous antibody structures exists completely in the genome of every individual ("germ line theory") or whether a small number of genes gives rise to the diversity by a series of mutational events during development ("somatic theory"). The editor himself clearly favors the latter theory and indeed extends it even further with his notion that diversification reaches its fullest extent as a result of antigen stimulation. Thus, there are three possible explanations for antibody diversity. First, there may be a large number of genes coding for the variable regions of light and heavy chains whose combinations can account for the large number of antibody structures known to exist. Estimates based on known amino acid sequences indicate that the number of such variable genes would have to exceed 10,000. In the second case, there may be a small number of genes ("pauci-gene" as opposed to "multi-gene") giving rise to a large number of antibody structures as a result of exaggerated mutational events occurring during the course of development. Finally, Cunningham's extension of the latter theory postulates that the increased diversity is prompted by antigen stimulation. In this case, combination with low-affinity antibodies on the parental lymphocyte surfaces would cause those cell lines to proliferate, which would in turn lead to a hypermutation-induced expansion of the antibody repertoire, with some of the antibodies having higher affinities. The theory has other attractive features, including plausible explanations of tolerance and self-nonself recognition in general.

Cunningham has chosen a set of authors who, in the main, provide circumstantial support for many of his own viewpoints. This is not to say that they all favor the notion of the necessity of antigen stimulation or even the idea that generation of diversity is primarily somatic. In fact, if my reading is accurate, two chapters definitely favor the germ line theory, five lean strongly to somatic schemes, and the remainder either sit on the fence or incorporate elements of both.

For example, D. G. Braun and his coworkers at Basel discuss the variability patterns of homogeneous antipolysaccharide antibodies ("clonotypes") and conclude that the different phenotypes observed in rabbits must be the expression of different genes in the germ line. At the other extreme, S. Tonegawa and C. Steinberg, in a chapter on RNA–DNA hybridization studies, present convincing evidence and arguments that there aren't nearly enough gene copies in the genome to account for antibody diversity.

There is a tantalizing chapter by David Baltimore and his colleagues on the unique occurrence of the enzyme terminal deoxynucleotidyl transferase in thymocytes, although the authors stop short of actually proposing that this enzyme is involved in the generation of antibody diversity. Other chapters providing apparent support for somatic models include a discussion of the somatic instability of mouse immunoglobulin genes by M. D. Scharff and his colleagues and a good chapter on lymphocyte population dynamics by G. Adam and E. Weiler. Peter Bretscher reviews some standard somatic arguments, especially as developed in his earlier collaborations with Melvin Cohn.

This a well-conceived book, one that anyone interested in the biology of the immune response can read with profit. On the other hand, the issue is clearly not settled, and the genuinely convincing experiments have yet to be executed. If anything, the distinction between "multi-gene" and "pauci-gene" seems to be growing fuzzier (how few is pauci?). And although Cunningham as editor and author has indeed tried to provide a new look at the problem, the large number of ad hoc arguments and models presented leads to an unavoidable and lingering sense of déjà vu.

RUSSELL F. DOOLITTLE
Department of Chemistry, University of California at San Diego, La Jolla 92093

Biological Anthropology

The Measures of Man. Methodologies in Biological Anthropology. EUGENE GILES and JONATHAN S. FRIEDLAENDER, Eds. Peabody Museum Press, Harvard University, Cambridge, Mass., 1976. xl, 654 pp., illus. Cloth, $30; paper, $15.

Perhaps no one alive today has had such a profound effect upon biological anthropology as has William White Howells. It is with especial pleasure that one sees a tribute like this book, honoring Howells on his retirement from active teaching at Harvard, published while the principal continues to work away with no diminution, indeed with continuing growth, in his investigative powers. A bibliography included in this book reminds us of those many publications of Howells's that start with a 60-page report on the Mimbres Valley expeditions in the Peabody Museum Papers in 1932 and continue with six items, of which two are books, in the last two years. My reprint collection turns up yet five more contributions that have appeared since this volume was set in type.

The book also tells us of many other facets of Howells's contributions; the senior authors of the papers it contains were all students of Howells's, and many of the other authors have been heavily affected by his teaching. The range of institutions the authors now represent demonstrates that there has been no deleterious inbreeding here; and the spread of disciplines, methodologies, and citations in the various papers indicates enormous hybrid vigor. To those of us who have not been closely tied to the American scene, the nature of the interconnections of institutions and workers through Howells is most impressive.

The aim of the editors is, however, not only to provide a tribute to Howells but also to display the vitality of biological

anthropology by bringing together a collection of original papers that demonstrate the material and methodological diversity of the field.

The introduction devoted to Howells's life and work is followed by a section on the nonhuman primates. This spans the order, beginning with a study of orangutan social structure and concluding with a discussion of dental reduction in the Indriidae. As importantly, the papers take a diversity of approaches, the paper on orangutans presenting results of a computer simulation, our confidence in which is greatly strengthened by behavioral and biological data from field studies, and that on indriids making use of data of a classical type but discussing them in a broad context, taking into account function, behavior, ecology, and zoogeography in both living ontogenies and fossil radiations.

A second section deals with aspects of growth processes. Again, the work is varied, including an assessment of secular change in body size over a large part of the adult life cycle (a comparison of data from a remote preliterate group gathered by Oliver in 1939 with data on the same group gathered in 1967 by Friedlaender) and a study (by Bleibtreu and Taylor) in which a sequence of multivariate techniques is used to examine somatometric differences between sexes in three different ethnic-racial groups.

A third section is devoted to variation in populations. The papers here range from one showing the importance of basic data from the field (Bailit's paper on dental eruption) through a most useful paper by Baker that displays a series of research strategies, to papers that focus on the genetic results of past adaptation. These last, in their turn, demonstrate a methodological opposition common in population genetic analyses; the single-gene, discrete traits available to Harpending and Chasko contrast with the quantitatively varying traits utilized by Froehlich.

The fourth section, on the uses of bone, is not surprisingly the largest. Bones do yield a great deal of information and they have the undeniable advantage of durability. In a study of a medieval Yugoslav osteological collection Edynak attempts to show just how much can be inferred about life styles through cluster-finding methods and an understanding of the effects of physical stress and the ethnographic picture. This compares with the study by Rightmire of two complementary, but sometimes conflicting, methods for examining morphological distances and thereby deriving information for assessing phylogenetic relationships among populations represented by osteological samples. Capping this section is Hursh's evaluation of a variety of methods for studying cranial form, including some not yet actually tried. This final section of the book demonstrates that Howells's interests are broad enough to encompass the cultural context. Though within anthropology the biological presence is strictly a minority representation, the contributions in this section remind us that anthropology is a "whole" subject and that passage to and fro across the physical-cultural interface has much to offer to both sides. The future of biological anthropology seems assured by the vigor, diversity, and potential of the methods tested throughout this book.

Finally, the demonstration this book provides of Howells's impact upon his students is a clear reminder that the oft-mentioned dichotomy between teaching or research is a false one and that the best teaching cannot be divorced from investigation and scholarly work. *The Measures of Man* cannot be the "measure of the man"; but it comes close.

CHARLES E. OXNARD
Department of Anatomy, University of Chicago, Chicago, Illinois 60637

A Teleost Family

The Biology of the Sticklebacks. R. J. WOOTTON. Academic Press, New York, 1976, x, 388 pp., illus. $29.50.

The sticklebacks, particularly the threespine stickleback (*Gasterosteus aculeatus*), are intensively studied by workers in a number of biological subdisciplines, and it has been difficult to incorporate the diverse information about them (much of which is in unpublished British and Canadian theses) into the design and interpretation of new research. Wootton's book alleviates this problem while providing a review for a more general audience.

The book is divided into two parts, the first consisting of 14 chapters on the threespine stickleback and the second consisting of a chapter each on the other well-defined stickleback taxa (*Gasterosteus wheatlandi, Pungitius, Culaea, Apeltes,* and *Spinachia*) and one on systematics.

It is appropriate that three-fourths of the book is devoted to the threespine stickleback. Its anatomy, distribution, development, ecology, behavior, physiology, reproduction, genetics, and evolution are covered. A detailed review of male reproductive biology is justified by the wealth of information on that topic and by its importance in the development of ethology. Wootton ties together information from different subdisciplines by frequent cross-referencing among chapters, and the first part of the book is further integrated by a final chapter on genetics and evolution.

The chapters on the other sticklebacks cover the same topics as those on the threespine stickleback, but the coverage is limited by lack of knowledge. Distribution maps and drawings of each form are presented, and their biology is discussed in comparison with that of the threespine and other sticklebacks. Numerous aspects of stickleback biology are compared in the chapter on systematics. Each chapter of this part of the book could be read in isolation from the others.

The book has useful author and subject indexes, and the bibliography lacks few important references through 1975 of which I am aware. There are occasional typographical errors, and some of the illustrations are only adequate.

The author points out gaps in knowledge, sets obscure details in a theoretical framework, contrasts and criticizes existing hypotheses, and occasionally proposes new ones. However, some hypotheses are accepted uncritically. For example, the abundance of intermediate phenotypes (semiarmatus) of threespine sticklebacks in polymorphic western European populations is accepted as evidence of gene flow between phenotypically extreme populations, although monomorphic semiarmatus populations are maintained elsewhere by natural selection. A few generalizations about threespine sticklebacks, such as those concerning the duration of the breeding season, minimum size at reproduction, structure of the pelvic girdle, and the distribution of red nuptial coloration over the male's body, are premature. Flaws such as these do not detract from the utility of the book, however. I will reread parts of the book and spend a substantial part of this summer field season collecting data to test hypotheses suggested by it.

MICHAEL A. BELL
Department of Biology, University of California, Los Angeles 90024
and *Section of Fishes, Natural History Museum of Los Angeles County, Los Angeles 90007*