

tude of variation and of selection pressure in a given population. It appears that any of the four combinations of low and high variation with weak and strong selection may be expected. In fact a linear relationship between these variables is quite improbable because adaptation involves the nature (not only intensity) of variation, of environmental factors, and of selection, and these have no simple linear scale of low to high or weak to strong. All this is either hypothetical or ex cathedra as here presented. There is not a single example of competent measurement of selection and variation in the same population, either in nature or in laboratory. The relationship between variation and adaptation is indeed the most interesting theoretical point of the whole investigation of variability, and that subject does have an extensive literature, much of it in molecular or genetic terms, outside Yablokov's field, and much of it published since 1966. This is not said in criticism of the present book, far the best we have within its scope and of its date. It should rather be an incentive for a student of variability to go on from there.

The need for translations such as this and for more intercultural studies is illustrated by the fact that an English symposium on variation in mammals published in 1970 does not contain any reference to Yablokov or to any of the numerous Russian publications cited by him. On the other side, although some revision of Yablokov's work for this translation was made as late as 1972, he makes no reference to that English publication. (It is just listed by title in the scientific editor's foreword.)

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A View of the Hominid Lineage

Uniqueness and Diversity in Human Evolution. Morphometric Studies of Australopithecines. CHARLES E. OXNARD. University of Chicago Press, Chicago, 1975. viii, 134 pp., illus. \$15.

In this semicentennial year of Dart's announcement of the first fossil man-ape, *Australopithecus africanus*, the study of human origins proceeds with ever-increasing sophistication and controversy. Charles Oxnard's book is a very sophisticated study of these fossils which leads him to a controversial opinion. It draws together evidence derived mostly from multivariate statistical analyses of metrical data to support the unorthodox view that "hu-

man bipedality was not the only experiment in this functional direction. The australopithecines may well be displaying for us another experiment in bipedality—one that failed" (p. 120). And further, "the australopithecines had to have been off the main stream of man's development" (p. 121).

This heresy against the prevailing paleoanthropological dogma is not a bolt from the blue, but has survived in isolated pockets since the conversion of most of the scientific hierarchy in the late 1940's. Although few believed that australopithecines were our ancestors at first, the discoveries of Broom, Robinson, Dart, and the Leakeys convinced almost everyone that some of the fossils were on or close to our branch of the primate family tree. Resistance to this view remained, however, especially among certain members of the University of Birmingham anatomy department, notably Solly Zuckerman, Eric Ashton, and later Charles Oxnard (now at the University of Chicago).

Curiously, the multivariate methodology which forms the backbone of Oxnard's book was first applied to australopithecines in *reply* to the Birmingham freethinkers. Zuckerman and Ashton presented *univariate* studies of australopithecine teeth that contradicted the widely accepted belief that these teeth were basically human in form. The late J. Bronowski and his colleague W. Long addressed themselves to this seeming paradox: Why should statistical techniques show different results from what the majority of anthropologists and anatomists believed to be correct conclusions? The problem was the "piecemeal" approach of comparing single measurements. The solution, they proposed, was in the application of *multivariate* analysis, in which measurements are combined into a single analysis to represent the overall affinities of the fossil. The example they gave showed that the australopithecine deciduous canine was human.

Since Bronowski and Long's suggestion, multivariate analysis has been applied to the australopithecines by numerous investigators, and Oxnard is certainly a leader in this effort. His work with colleagues on the shoulder, hip, and foot is well known. This book draws these and other multivariate analyses together in support of the view that australopithecines are not human ancestors. The argument moves from a discussion of animal form and function to a review of primate locomotion, and finally to a review of multivariate analyses of the shoulder, pelvis, talus, toe, metacarpal, and humerus. The concluding chapter brings in some other lines of evidence such as body

proportions and other fossils. It also adds some interesting speculations about human evolution.

Oxnard's approach may still be too piecemeal to convince everyone. For example, the Olduvai talus which is a key-stone to his argument comes from a nearly complete fossil foot, but little reference is made to this fact in the text. This is unfortunate because many claim that this foot is the best evidence there is proving the human affinities of the australopithecines. Likewise the Sterkfontein pelvic bone, which is the structure upon which much of Oxnard's proof rests, derives from a complete (although reconstructed) pelvic girdle which is very humanlike in the opinion of all who have seen it. There are also some methodological problems that detract from the argument. The unusual way Oxnard and his colleagues measure the pelvic bone, for example, appears to bias the results so that one unique feature of the australopithecine pelvis (wide flaring of the iliac blades) greatly affects a large proportion of the measurements. The effects of violating such statistical assumptions as multivariate normality, homogeneity of covariance or dispersion, and unequal sample sizes, as is often done in canonical variate analysis, are not fully evaluated. The fragmentary Sterkfontein scapula is really too poorly preserved to be measured and counted as evidence.

There is no doubt that Oxnard is one of the leading practitioners in the new science of form, the quantifunctional approach to understanding organic structure. His application of this approach to fossil hominids may eventually lead to widely accepted changes in prevailing ideas about human evolution, but this book is too limited in scope to convert most paleoanthropologists. The fossil record is now too complete and too well studied for multivariate analyses of less than a dozen isolated fossil bones and a few additional studies to change many minds.

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Hybrid Discipline

The Genetics of Behavior. J. H. F. VAN ABELEN, Ed. North-Holland, Amsterdam, and Elsevier, New York, 1974. xxiv, 450 pp., illus. \$42.50. *Frontiers of Biology*, vol. 38.

Francis Galton "invented" the scientific study of the genetics of human behavior over a century ago with his pioneering

book *Hereditary Genius*, published in 1869. The modern science of behavior genetics, though, can be dated from the 1960 publication of *Behavior Genetics* by John Fuller and W. Robert Thompson. Now, some two dozen years later, this apparently fertile hybrid between genetics and psychology has fostered its own journal, professional association, textbooks, and collections of papers. (For two seminal examples, see J. Hirsch, Ed., *Behavior-Genetic Analysis*, McGraw-Hill, 1967, and M. Manosevitz, G. Lindzey, and D. Thiessen, Eds., *Behavioral Genetics: Method and Research*, Appleton-Century-Crofts, 1969.) Like all hybrid sciences, this one must pass between the Scylla of triviality and the Charybdis of confusion, avoiding both the platitude that all behavior is under some kind of genetic control and the abortive attempt at unraveling genetic and environmental influences with inadequate conceptual and experimental tools.

The present collection seeks to present an overview of contemporary research in European laboratories. The articles range from discussions of the mathematical tools of genetic analysis, through review articles covering broad reaches of the discipline, to narrowly focused research reports of individual investigators. In each category there are worthwhile articles. Two articles by Jinks and Broadhurst give a solid exposition of the use of mathematical analysis to determine broad and narrow heritability and the number of genes involved in producing a particular trait. However, expositions of these same ideas by the same authors are available elsewhere. Fulker's review of the application of these techniques to human genetics is sound but, like many of the chapters, draws more heavily on earlier literature than seems warranted in view of current research activity. Burnet and Connolly's review of the genetics of sexual behavior in *Drosophila melanogaster* is authoritative and current. The research reports by Lagerspetz and Lagerspetz, by van Abeelen, and by Busser, Zweep, Deol, and van Oortmerssen provide an interesting cross section of rodent behavior genetics from the anatomical-physiological to the ecological level.

As a collection, however, the work suffers from being dated, provincial, and lacking in clear direction. Important American work emphasizing the use of genetic tools to analyze development, such as that of Seymour Benzer or of workers at the world's only Institute of Behavioral Genetics (in Boulder, Colorado), is overlooked entirely or mentioned only in passing. And, since there is no author index, even the passing references are buried. The division of the material into two sections,

the first lumping biometrics with evolutionary aspects and the second supposedly treating phenogenetic and regulatory aspects, seems arbitrary and misleading.

Although the volume does contain some useful material, it seems altogether too flawed to justify the high price for any but the most complete library or specialist collections.

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Compendium on Viruses

Comprehensive Virology. HEINZ FRAENKEL-CONRAT and ROBERT R. WAGNER, Eds. Vol. 1, Descriptive Catalogue of Viruses. 1974. xii, 190 pp., illus. \$12.50. Vol. 2, Reproduction: Small and Intermediate RNA Viruses. 1974. xiv, 340 pp., illus. \$28. Vol. 3, Reproduction: DNA Animal Viruses. 1974. xiv, 488 pp., illus. \$32.50. Vol. 4, Reproduction: Large RNA Viruses. 1975. xii, 348 pp., illus. \$29.50. Plenum, New York.

The coming of age of virology as an independent discipline may be marked by the appearance of the first volume of the journal *Virology* in 1955. Since then the discipline has grown spectacularly, as is evidenced by the increase in the number of journals (in English) devoted to virus research, particularly to molecular virology. The information explosion in the field has prompted Fraenkel-Conrat and Wagner to initiate this series in which they "hope to place the entire field in perspective as well as to develop an invaluable reference and sourcebook for researchers and students at all levels." Four volumes have been published and many more are promised.

The first volume, "Descriptive Catalogue of Viruses," compiled by Fraenkel-Conrat, is in the form of a dictionary and lists the viruses alphabetically. It is divided into three parts: Viruses of Vertebrates and Insects; Plant Viruses; and Viruses of Protozoists. Each virus (or group of viruses) is defined in terms of its physical-chemical and biological properties (if these are known), with emphasis on the former. Data on the amino acid composition of virus proteins and their sequences, as well as the nucleotide sequences of nucleic acids, are provided in tables and figures. There are also a few electron micrographs of representative viruses.

The alphabetical listing of viruses has a certain utility, but as an introduction to

such a series a general classification showing the relationship of one virus to another would have been preferable. The provision of such information has been left to the individual contributors, not all of whom have elected to provide it. Moreover, there are some errors in the catalog—for example, it is incorrect that pseudorabies virus DNA occurs as two components. Finally, the reproduction of the electron micrographs in this as in the other volumes of the series would have been enhanced by the use of glossy paper.

The second volume, subtitled "Reproduction: Small and Intermediate RNA Viruses," begins with a chapter by L. Eoyang and J. T. August on RNA bacteriophages. The authors present a collection of loosely organized facts and references with little interpretation or analysis. This chapter should have set the stage for the following chapters, but it fails to do so, and one must wait until the excellent article on picornaviruses by L. Levintow to find a reasonable discussion and a few diagrams of models for the replication of single-stranded RNA genomes. The shortcomings of the chapter are illustrated by the failure of the authors to indicate the time course of the virus growth cycle to introduce their discussion of transcription and translation.

Little of a definitive nature is known about the details of reproduction of plant viruses. However, one unique aspect of plant viruses is the presence of multiple RNA molecules packaged in different particles, and A. Siegel and V. Hariharasubramanian, the authors of chapter 2, on small plant RNA viruses, wisely concentrate on this aspect. They also point out the significant aspects of plant viruses on which research is under way or is needed.

Levintow (chapter 3) has been most successful in striking the proper balance between an "Annual Reviews" style and a more extensive analysis of the data that would be suitable for a beginning virology student. He stresses the unity rather than the diversity of picornaviruses. It is not as easy to apply the same kind of analysis to the togaviruses, discussed in the following chapter, since the two types, A and B, differ significantly in a number of properties. Nevertheless, R. Pfefferkorn and D. Shapiro deal quite adequately with these differences at each step.

The last chapter in this volume, by W. K. Joklik, reviews the literature on the reproduction of reoviridae. This is a lucid account of an interesting group of viruses by one of the leaders in the field. The author does not hesitate to speculate, and his critical evaluations make for interesting reading.