Book Reviews

An introduction to mathematical genetics Lancelot Hogben. New York: W. W. Norton, 1946. Pp. xii + 260. (Illustrated.) $5.00.

It has been said that no branch of knowledge has become a science until it has been placed on a quantitative basis. However much we may question this view in its application to the general field of biology, we can entertain no doubts of its truth in the special case of genetics. Experiments in hybridization were common enough before Mendel, but they were gropings in the dark, counting for little because they aimed at something beyond attainment by any of the methods used. Mendel changed all that and founded the science of genetics, by showing the way to give hybridization experiments direction and meaning. Biologically, his fundamental innovation was the concept of the particular determiner or factor, in terms of which inheritance was capable of simple description. But this idea would have been of little avail without the means of translating the biological properties of the factor into the numerical properties of the population. Only by these quantitative means could he test his theory and his successors elaborate it.

Mendel's mathematics were simple, both in his derivation of the ratios to be expected from the theory, for which purpose he used the binomial expansion, and in his statistical reduction of the experimental data for testing their agreement with these expectations. Indeed, his statistical treatment consisted of little more than the calculation of the ratios from his data and the recognition that sampling error would lead to these observed ratios only approximating those expected. Later, with very little elaboration these simple methods satisfied all the needs of the early geneticists. Indeed, the algebra of the binomial theorem was often replaced by the simpler, if more tedious, geometry of the checkerboard.

If mathematical genetics had rested at this stage, there would have been found little about which to write; but, as time went on, elaboration became necessary. New statistical methods were needed for the adequate testing of ratios and for the calculation of linkage values from F_2's. Also, the simple methods were no longer enough when geneticists turned their attention to the wider fields of inbreeding, assortative mating, equilibria and change under mutation and selection, and the measurement of gene frequencies in naturally-breeding populations such as man. The ensuing mathematical developments are especially associated with the names of Fisher, Haldane, and Wright; but many others have contributed, and the literature is both extensive and scattered. Prof. Hogben, in a book which is based on a course given to postgraduate students of the University of Wisconsin, has brought many of these results together and attempted to make their derivation intelligible even to those geneticists whose mathematical background is limited.

The book falls into three parts. In the first the author lays the foundation, both genetical and mathematical, for his later treatment. He considers certain basic genetical conceptions, such as those of gene frequencies and mating systems, and illustrates them and their applications by reference to models made with playing cards. The mathematical introduction is more elaborate and includes accounts of certain algebraic series and their manipulation, the calculus of finite differences as used in handling these series, and the binomial expansion, both complete and incomplete.

These foundations having been laid, attention is turned in the second part to the effects of selection, assortative mating and inbreeding, mutation, and isolation. This section is prefaced by some remarks on what the author calls the limitations of mathematical genetics. They are concerned with the principles of gene expression and their effects on the validity of the mathematical findings. The treatment is most comprehensive in regard to the types of selection and systems of mating covered, but their consequences are considered only as they apply to single genes. Systems of genes are not dealt with. As we might expect from the author's own interests, the special problems of human genetics are well to the fore in both treatment and example.

The third part consists of two appendices, one on tests of significance and the other on statistical estimation. These topics are dealt with in a more mathematically thorough than a practically comprehensive way. The most valuable method of testing significance in genetics is by the use of X^2. Yet this is not granted any mention. Again, the method of maximum likelihood is presented without any account of its value in dealing with fragmentary and combined data. It is impossible, of course, to deal adequately in 43 pages with the statistical methods used in genetics, whether from the mathematical or the analytical point of view. Such a brief account should be omitted if space forbids a more comprehensive survey.

The space gained by an omission of the appendices might well have been devoted to developing further the mathematical treatment of genetical situations, which forms the main theme of the book. As we have seen, the topics taken up are discussed thoroughly, but their range is limited. Neither Fisher's treatment of the theory of selection nor Wright's of the composition of populations is included. Admittedly, both are necessarily complex but cannot be neglected on that account.

Formal genetics, the study of hereditary transmission, has shown us how the genotype is built up of the units we call genes, and how these units can change and recombine to give variation of the genetic structure. We are now seeking to enlarge on this foundation, on the one side to understand how the genes themselves are built up and how they act in development, and on the other to understand the genetical composition of populations in all their variation, both natural and under domestication. When we consider, for example, the problems posed by heterosis and its efficient use in agriculture, it is clear that there is still much ground to cover. Our knowledge is as yet almost entirely empirical. To achieve genetical understanding we must work out the properties not only of single genes, but of systems of genes—genes which are not separable in analysis, but which can reinforce and balance one another in variation. Prof. Hogben, like Mendelian genetics

itself, takes us only part way, because, as we saw, he deals with genes only one at a time. He shows us how to cope with the problem of red and white cows in our herds of black and white Friesians. He does not tell us how to cope with the problems of their milk production.

The student will find that this book well repays study. There are a few misstatements of genetical fact, as when it is said that in *Primula* species individuals homozygous for the thrum gene are nonviable, and a few of mathematical scope, as when it is stated that the recombination value can be estimated from F_2 data only when it is the same in both sexes. Nevertheless, this book is unique in the genetical ground it covers and in the attempt to explain the mathematical methods used. Having mastered it, the student will have a deeper insight into the formal properties of mating systems and the formal workings of selection, the principles of which, as Prof. Hogben suggests, are basic to the application of genetics in agriculture and human affairs. Before he can cope with the problem of applied genetics, however, the student will have to learn how these principles are used in a wider variety of situations, in some of which genetical complexity at present precludes mathematical rigor.

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The birds of North and Middle America. (Pt. X.) Herbert Friedmann (commenced by the late Robert Ridgway). (U. S. National Museum Bull. 50.) Washington, D. C.: Government Printing Office, 1946. Pp. xii + 484. (Illustrated.) $1.25.

The present volume, Part X of a monumental catalog of birds of North and Middle America, is concerned with the order *Galliformes*, including the families *Cracidae*, *Tetraonidae*, *Phasianidae*, *Numididae*, and *Meleagrididae*. The scope of Ridgway's and Friedmann's work is indicated by its subtitle: *A descriptive catalog of the higher groups, genera, species and subspecies of birds known to occur in North America, from the Arctic lands to the Isthmus of Panama, the West Indies and other islands of the Caribbean Sea, and the Galápagos Archipelago.*

Volumes in this series deal with description, range, and synonymy, but not with life history. The series, therefore, serves to complement A. C. Bent's *Life histories of North American birds*, also published by the U. S. National Museum. Bent, however, deals only with the birds of the United States and Canada, whereas the present series is concerned with the birds of the entire North American continent and adjacent islands. This more comprehensive treatment is invaluable to the systematic ornithologist who is concerned with continent-wide distribution of races, species, and genera.

As with many other bird orders, the problem of races in the *Galliformes* is a difficult one, and the author must exercise his own choice and judgment in the treatment which he accords them. For example, the present volume, quite naturally, follows the revision of Aldrich and Friedmann in treating the ruffed grouse (*Bonasa umbellus*). There are other systematists who do not agree with this revision. Further, although the racial treatment of the Bob-white (*Colinus virginianus*) has recently been extensively revised by Aldrich, the present volume does not follow his revisions.

In order of appearance, this series of bulletins has virtually reversed the presently-accepted A.O.U. Check-list arrangement. Part I catalogs the *Fringillidae*, and later parts treat other groups in reverse order. Two additional parts now in preparation, or awaiting publication, and dealing with the orders from *Falconiformes* to *Gaviiformes* will complete the catalog.

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Scientific Book Register

ASSOCIATION OF VITAMIN CHEMISTS, INC. (Eds.) *Methods of vitamin assay.* New York-London: Interscience, 1947. Pp. xviii + 189. $3.50.

BRAND, LOUIS. *Vector and tensor analysis.* New York: John Wiley; London: Chapman & Hall, 1947. Pp. xvi + 439. $5.50.

CHERONIS, NICHOLAS D., and ENTRIKIN, JOHN B. *Semimicro qualitative organic analysis.* New York: Thomas Y. Crowell, 1947. Pp. xiv + 498. (Illustrated.)

DANN, W. J., and SATTERFIELD, G. HOWARD. *Estimation of the vitamins.* (Biological Symposia, Vol. XII.) Lancaster, Pa.: Jaques Cattell, 1947. Pp. 531. (Illustrated.) $6.50.

EDDY, SAMUEL, OLIVER, CLARENCE P., and TURNER, JOHN P. *Guide to the study of the anatomy of the shark, necturus, and the cat,* and *Atlas of outline drawings for vertebrate anatomy.* (2nd ed.) New York: John Wiley; London: Chapman & Hall, 1947. Pp. vii + 115. (Illustrated.) $2.00 ea.

FISHBEIN, MORRIS. *A history of the American Medical Association, 1847 to 1947.* Philadelphia-London: W. B. Saunders, 1947. Pp. xvi + 1226. (Illustrated.) $10.00.

JOHNSON, MARTIN. *Time, knowledge, and the nebulae: an introduction to the meanings of time in physics, astronomy, and philosophy, and the relativities of Einstein and of Milne.* New York: Dover, 1947. Pp. 189. $2.75.

PRATT, LYDE S. *The chemistry and physics of organic pigments.* New York: John Wiley; London: Chapman & Hall, 1947. Pp. vii + 359. (Illustrated.) $6.00.

SZENT-GYÖRGYI, A. *Chemistry of muscular contraction.* New York: Academic Press, 1947. Pp. vi + 150. (Illustrated.) $4.50.

VESTINE, E. H., *et al. Description of the earth's main magnetic field and its secular change, 1905–1945.* (Publ. 578.) Washington, D. C.: Carnegie Institution of Washington, 1947. Pp. v + 532. $2.50, paper; $3.00, cloth.

WAKSMAN, SELMAN A. *Microbial antagonisms and antibiotic substances.* New York: Commonwealth Fund, 1947. Pp. ix + 415. (Illustrated.) $4.00.

WELCHER, FRANK J. *Organic analytical reagents.* (Vol. II.) New York: D. Van Nostrand, 1947. Pp. xi + 530. $8.00.