

BIOMETRICAL GENETICS

by
K. MATHER

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Genetics has concerned itself largely with the study by the Mendelian method of sharp differences, as between tall and dwarf peas or coloured and albino rabbits. Yet much of the variation we see around us is not of this kind. It is continuous, the individuals making a series which grades imperceptibly from one extreme to the other, as with stature in man. We have known since Galton's time that this continuous variation is partly heritable, and indeed it is to a large extent the raw material of evolution and of plant and animal breeding. Continuous variation cannot be analysed by the Mendelian method, but Dr. Mather shows how it can nevertheless be demonstrated that the controlling genes are carried in the nucleus, so showing segregation and linkage in just the same way as the genes of Mendelian genetics. Upon this basis he proceeds to develop a biometrical method by which continuous variation can be analysed and understood, and its behaviour predicted. In so doing he is led to discuss the new meanings which many of the familiar genetical concepts take on, when used in this wider field.

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(with C. D. DARLINGTON)

BIOMETRICAL GENETICS

THE STUDY OF CONTINUOUS VARIATION

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WITH SIXTEEN DIAGRAMS



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To
R. A. FISHER
Statistician and Geneticist

PREFACE

THE PROPERTIES of continuous variation are basic to the theory of evolution and to the practice of plant and animal improvement. Yet the genetical study of continuous variation has lagged far behind that of discontinuous variation.

The reason for this situation is basically methodological. Mendel gave us not merely his principles of heredity, but also a method of experiment by which these principles could be tested over a wider range of living species, and extended into the elaborate genetical theory of today. The power of this tool is well attested by the speed with which genetics has grown. In less than fifty years, it has not only developed a theoretical structure which is unique in the biological sciences, but has established a union with nuclear cytology so close that the two have become virtually a single science offering us a new approach to problems so diverse as those of evolution, development, disease, cellular chemistry and human welfare. Much of this progress would have been impossible and all would have been slower without the Mendelian method of recognizing and using unit differences in the genetic materials.

These great achievements should not, however, blind us to the limitations inherent in the method itself. It depends for its success on the ability to assign the individuals to classes whose clear phenotypic distinctions reveal the underlying genetic differences. A certain amount of overlap of the phenotypic classes can be accommodated by the use of genetical devices; but where the variation in phenotype is fully continuous in its frequency distribution, so that no such classes can be defined, the method cannot be used. A different approach is required, one based on the use of measurement rather than frequency.

The first steps were taken nearly forty years ago, when the theory of cumulative factors or multifactorial inheritance, as it was variously called, was formulated. The full implications of this theory have, however, only gradually become realized. In the same way the special types of experiment and statistical analysis necessary for the study of continuous variation have only gradu-

ally become available. Nevertheless, though slow, progress has been real and we are now in a position to see not merely how continuous variation can be explained genetically, but also how experiments can be conducted enabling us to understand and to measure the special genetical quantities in terms of which continuous variation can be analysed and its behaviour in some measure predicted.

The present book does not aim at covering the whole literature of the subject. I have concentrated attention rather on trying to show the kind of evidence upon which the genetical theory of continuous variation is based, to bring out the special problems which it raises, to see how the familiar genetical concepts must be adapted to their new use, and to outline an analytical approach which can help us to understand our experimental results, particularly those which can be obtained from plant material. In doing so I have assumed some knowledge of genetics and statistics. To have done otherwise would have made the text unnecessarily long, for this information can be gained from a variety of other sources.

The data with which I have had to work have been limited by the paucity of experiments adequate in both scope and description and I have therefore been unable to try out the methods, which are described, in as wide a variety of circumstances as could have been wished. These methods are in no sense exclusive or final; indeed their limitations require no stressing. But improvements can be brought about only as more and better experiments are undertaken; and such experiments cannot be planned until we have explored the scope and limitations of those we already have. Improvement of experiment, refinement of analysis and development of theory must be simultaneous and progressive.

Among the experiments upon which I have been able to draw none has been more instructive than that on ear conformation in barley, hitherto unpublished. This experiment was made in collaboration with Dr. Ursula Philip, now of the Department of Zoology, King's College, Newcastle-on-Tyne, and I wish to express my indebtedness to her for allowing its results to be published in this way.

K. M.

April 1947

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* In collaboration with Dr. U. Philip.

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