Genetic variation and selective forces

Kenneth Mather

Inheritance and Natural History. By R. J. Berry. Pp. 350. (Collins: London, 1977.) £6.50.

THE first book in the New Naturalist series was "Butterflies" by E. B. Ford in 1945. In it he spent about one-third of his space stressing the importance of genetical differences, of natural selection and of the numbers of individuals for our understanding of British butterflies as we see them in the wild. It is a tribute to the effort devoted to these aspects of the study of wild populations during the past 30 years, not least by Ford and his students, that the latest (number 61) in this series, written by R. J. Berry, is given over entirely to them. As the editors point out in their preface—unexpected as an addition of this kind may seem to a series dealing primarily with the British fauna and flora—such a book can do much to show us how our plants and animals have come to be as we see them today and how their changes and adaptations are still continuing. In his own preface the author describes his main aims as being "to show the ways in which inherited variation can help to explain the properties of natural populations". And he might have added—"and how the properties of these populations enhance our understanding of the ways in which genetic principles work out in the complex situations of the real world".

The book is of course written primarily for the naturalist, and although the familiar principles of genetics are set out in the early chapters they do not appear in the familiar order or with the familiar emphasis of the student's textbook. In fact, the emphasis from the start is on populations, their uniformities and heterogeneities, and the ways in which they reflect differences due to the ages of the individuals, seasonal influences and the direct action of the environment as well as those due to genetical variation. The basic structure of the genetic materials is described, as of course are the principles of Mendelian inheritance, of the interaction of genes in producing their effects, and of the ways in which one gene difference may affect many characters and one character be affected by many genes. Linkage is also mentioned, but its treatment is brief.

The second chapter takes us to the basic principles of population genetics, starting with the Hardy–Weinberg principle and its use in understanding the genetic structure of populations. Departures from the Hardy–Weinberg equilibrium are considered and the disrupting agencies discussed. Small populations and the drift of their gene frequencies are dealt with at some length, and the consequences of the founder-effect are illustrated by reference to wild populations of voles. It might be objected that the genetic basis of the tooth character at issue in these voles is not clearly established, but it could be held that the detailed genetics is not essential for the naturalist to appreciate what is happening. Mutation, migration, non-random mating and natural selection come next, though fuller discussion of the last two is reserved for later chapters. The notion of genetic equilibria being reached by the opposing actions of these various agencies is also introduced. Chromosome variation, both numerical and structural, is described once again in terms of natural populations and their chromosome polymorphisms.

A chapter is devoted to modes and rates of reproduction and to the various devices that organisms have developed to control their frequencies of inbreeding and outbreeding. This inevitably draws heavily on plants, with their greater variety of breeding systems; here, one feels that Professor Berry is on less familiar ground. It will surprise plant geneticists to find apomixis described as including vegetative reproduction and also as invariably leading to the production of clones. It will also surprise them to find spurges accredited to the genus *Mercurialis*.

The chapter on natural selection covers not only the basic types of selection—stabilising and directional, frequency dependent, density dependent, and so on—but also illustrates both mechanisms and difficulties by reference to the spread of, for example, warfarin resistance and industrial melanism on the one hand, and to the problems of the *gens* in cuckoos and area effects in snails on the other. It is good to see here a reference, albeit a brief one, to the action of selection in domesticated animals and to the way that quantitative variation and its responses to selection are measured and analysed by breeders.

Having dealt with these basic phenomena of genetic variation, reproductive and mating systems, and natural selection in its many forms, Professor Berry turns to populations themselves, their structures and relationships to one another. He discusses gene flow, especially in clines, and the conservative features such as co-adaptation, linkage disequilibria and super-genes, which the genotypes of the individuals show. He considers the consequences of ecological as well as geographical separation and of barriers like the Tingwall Valley in Shetland, though curiously he makes virtually no mention of the remarkable unseen barrier that must be inferred to account for the abrupt change in spotting of *Maniola jurtina* near the eastern border of Cornwall. A feature which lends great interest to these discussions is the summary of his own extensive work on field mice, voles, human skulls and, especially, the house mice of Skokholm—this last being the vehicle which he uses to draw together the ways he sees the various processes as acting in determining the properties of a population. And he concludes with a chapter entitled "Why be variable?" covering such matters as the so-called genetic load of a population, *r* strategies and *K* strategies in relation to the species' biology, the significance of neutral mutations, and the importance of niches in maintaining variability.

This book is not easy to summarise and assess. It should not be judged by the criteria of textbooks, for as the author points out in his preface it was not written as such. This, he adds, relieves it of the need to be as inclusive and balanced as a textbook, and indeed "the chapters that follow involve a selective and therefore idiosyncratic choice of topics and examples". In places, the choice has perhaps been a little over-idiosyncratic, as in the chapter on "Human Influences", which covers everything from Muller's C1B technique for measuring the frequency of mutation to sex-linked lethals in *Drosophila* and the genetic changes in stock animals during their domestication, to human races and eugenics. The book could indeed be criticised as somewhat haphazard in its arrangement and uneven in its treatment. And it is made irritating in places by minor slips and inaccuracies, though some at least of these may stem from a relative unfamiliarity with plants.

Yet, at least one reader of the book has derived both pleasure and profit from it. It is full of information and it clearly brings out the complexity of genetic variation on the one hand and of selective forces on the other. It touches on the action of selection in moulding the genetic system and, while recognising the supreme importance of natural selection in shaping populations, it emphasises the significance of discontinuities and founder effects in setting the range of variation on which selection can act. But above all it is the wealth of examples taken from natural populations and the author's clear enthusiasm for observing wild creatures and trying to understand why they are what they are, where they are, which will make one remember the book. It was written for naturalists many of whom will I believe find in it the ideas and interpretations that they are seeking. And I hope that at least some students will read it and profit by it, even though it is not the textbook from which their fundamental knowledge of genetics must come. □

Kenneth Mather is Professor of Genetics at the University of Birmingham, UK.