

REVIEWS

THE THEORY OF INBREEDING. By R. A. Fisher, 1949. Edinburgh : Oliver and Boyd. Pp. viii+120. 10s. 6d.

The quantitative study of inbreeding began, as Professor Fisher points out, with Darwin. He showed by careful experiment that inbreeding often has effects, such as loss of vigour, likely to incur a selective disadvantage, but that these do not indicate permanent injury to the stock, for vigour is fully restored in the first generation bred by crossing inbred lines. Darwin was concerned to discover the advantage which devices encouraging cross fertilisation give to their possessors rather than to elucidate the cause of the inbreeding depression itself. Indeed no effective approach to this latter problem was possible until Mendel's rules of inheritance were discovered and applied. In general terms, it has become apparent that, genetically speaking, the effect of inbreeding is to increase the frequency of homozygotes of all kinds in the inbred family or population, and that, as a result of dominance, the average expression in a series of homozygotes showing the same gene frequencies as the heterozygotes from which they came, will not be the same as the expression in those heterozygotes.

In practice the use of inbreeding has proved to be of immense importance in crop production. Of the maize grown to-day in the U.S.A., some 90 per cent. is produced by the deliberate crossing of inbred lines—lines which, because of their near homozygosity are genetically reliable and phenotypically stable. They can be tested for combining ability year after year with the confidence that the results of these tests may be legitimately pooled for the detection of fine differences, and that once a good performance has been established it can be repeated at any time, on any scale, for the purposes of commercial production. Similar advantages are being obtained in other crops, sugar beet and onions for example, as the technical problems of inbreeding and crossing are overcome. They are also being sought in domestic animals, though here the special difficulties of slow breeding and expense in maintenance must make progress less speedy.

Three distinguishable, though inter-related, problems present themselves therefore to the geneticist who is interested in the application of his science to crop and stock improvement :—the problem of discovering how, in a quantitative sense, the genotype will respond to the many various modes of inbreeding that are possible ; the problem of how an inbreeding programme can be most efficiently designed for the achievement of its purpose ; and the problem of how the more valuable products of inbreeding can be most efficiently separated from the less valuable for use in the production of commercial crops and stocks.

As the name of the book suggests, Professor Fisher is not specifically concerned with the third problem in *The Theory of Inbreeding*, though we may note that his own methods of conducting field trials have been of major importance in the testing of maize inbreds in the U.S.A., and that his Appendix C on the practical function of inbreeding must be of interest

to all plant and animal breeders. He addresses himself particularly to the question of the genetical achievement to be expected from inbreeding programmes of diverse kinds in species with various genetical constitutions and breeding habits. After an introductory chapter on the history, theory and use of inbreeding, the matter of segregating inbred lines is taken up. Their uses are discussed and the practical problems, numbers of individuals required in a generation, expectation of a suitable mating, and the complications introduced by linked genes, are analysed in special relation to mice. The next chapter is devoted to the development of a comprehensive approach to the mathematical problems which arise in working out the consequences of a system of mating. Initially this is developed in relation to consistent sib-mating, but it is later applied to other systems of mating, to the evaluation of the effect of irregularity in the mating system, to the effects of enforced heterozygosity of gene differences (including the sex difference), and to the inbreeding of species showing polysomic inheritance. Of the three appendices, one has already been mentioned. Another deals with the special problems of efficiency and time which arise when inbreeding a species bearing a single offspring at a birth, and the remaining one discusses the efficiency of self-incompatibility mechanisms, including tristylly, in diminishing the frequency of mating between near relatives in plants.

It will be clear from this list of contents that the book is most comprehensive in its coverage of the analytical problems which arise both in foreseeing the consequences of an inbreeding programme and in designing programmes to fit the special requirements of particular species or aims. This coverage is achieved within a relatively small compass by the generality of the methods developed. Series showing the rise of homozygosity to be expected under particular mating systems and particular circumstances have long been familiar in the genetical literature: indeed the first, that for continued selfing, was given by Mendel himself. Fisher's approach contrasts with these in that it can be applied to any system of mating in any circumstances, and permits irregularities to be taken into account. It is made all the more valuable in this latter respect, by the unexpected effects which irregularities may have. Sib-mating and parent-offspring mating are, when carried out in separate programmes, equally efficacious systems of inbreeding. Yet either, if occurring as an irregularity in one generation of a programme based on the other, results in a loss of efficiency of about 15 per cent. in terms of generation time. This result also serves to illustrate the essentially practical value of many of the conclusions reached; for it is upon such a consideration that the breeder carrying out an inbreeding programme must base his judgment as to whether a readily available but irregular mating would be more expeditious than the continuation of the regular system by a mating which may take some time to mature.

A further result which brings out the great value of the method in the consideration of special cases is the demonstration that, in spite of the loss of efficiency caused in the general case by the intercalation of sib-mating in a series of parent-offspring matings and *vice versa*, systems in which matings of these kinds are deliberately included in a cycle can be considerably more efficient than the uniform systems themselves in rendering homozygous marked sections of chromosomes, such as the differential segment of the X. Again the practical aspect is clear for, in deciding whether

to use such a cyclical system, the inbreeder must compare the increase of efficiency achieved for the marked segment with the reduction in efficiency for the remainder of the chromosomes. Fisher shows how this can be done with precision.

Enough has been said to show how valuable a book *The Theory of Inbreeding* is. Geneticists may complain that it is not easy reading. Yet to those possessed of persistence and a little mathematical accomplishment, the difficulties will smooth themselves out. Indeed, chapter III is an introduction to matrix algebra, and its genetical uses, which at least some of us would have found useful on many occasions in the past. And whatever trouble the reader must take in following the mathematical methods used, he will be amply repaid not only by the insight he gains into the ramifications of inbreeding but also by the increased confidence and precision which he can bring to the practical problems of designing and carrying out inbreeding programmes, whatever his aim in their use and whatever the vagaries of the species with which he may be concerned.

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THE BIOLOGY OF MENTAL DEFECT. By Lionel S. Penrose. Sidgwick and Jackson, 1949. Pp. xiv+285. 21s. Preface by Professor J. B. S. Haldane.

The perennial problem of mental deficiency may be approached from the point of view of a variety of special studies, such as medicine, genetics, psychiatry, law or sociology. From any one of these angles an exhaustive treatment could be undertaken. The successes of specialists in their own fields have sometimes given rise to an unjustifiable optimism about the final solution of the problem. Early and accurate diagnosis, hormone therapy, shock treatment, psychological training, legal protection for both the defective and the society he lives in, and positive and negative eugenics, all have their contributions to make. A synoptic survey of the whole field shows that the problem is much more complex than was originally suspected, but the ultimate alleviation, cure and prevention of mental deficiency on a considerable scale will no doubt be achieved by a synthesis of many different methods and researches.

In his earlier book, *Mental Defect*, Professor Penrose described the subject as providing great opportunities for research, especially in the fields of genetics, medicine and sociology. Advances made in the fifteen years which have elapsed since then now warrant a much more integrated treatment. The ramifications of the subject are enormous, and "to limit the task here, medical and psychopathological conditions encountered in mental deficiency practice are discussed chiefly within a framework of genetics". The aim of the book is to present the problem of mental deficiency from the broader aspect of human biology so that its study can be more readily related to the remainder of sociology and medicine.

Penrose commences with a general historical survey and then goes on to consider the incidence, definition and measurement of mental deficiency. This is followed by a chapter on the principles of classification. Next, there is a discussion of the rival claims of nature and nurture to be the causative agents of mental defect. The subsequent five chapters are especially concerned with the genetical aspects of the problem, dealing with dominant, recessive and sex-linked defects; the genetics of intelligence and its relation to differential fertility; and methods of analysis in human