CHAPTER 20

THE GENETICS OF MAN

Man is, in many ways, very unsuitable as an object for the study of genetics. Families are too small for dependable determination of ratios, desired test matings cannot be made, and study of more than a very few generations for any particular purpose is not often possible. The social implications of human genetics are so great, however, that the subject *must* be investigated; and there are some real advantages in the material. For no other organism do we have such detailed and extensive information on anatomy, development, biochemistry, physiology, pathology, evolution, and population statistics. These advantages have, in fact, led to important advances in basic genetics through the study of human material, notably in connection with the blood groups (see Chapter 15) and the biochemistry of hemoglobin variants.

The systematic study of the genetics of man began before the Mendelian era with the work of Francis Galton, beginning in 1865; the two best-known accounts of his work are the books *Hereditary Genius* (1869) and *Natural Inheritance* (1889).

Following 1900 there accumulated a body of information concerning the Mendelian inheritance of a large series of aberrant conditions in man, beginning with Farabee's account of brachydactyly (short fingers) in 1905.

In 1902, Garrod and Bateson suggested that alkaptonuria is due to a single recessive gene, but the evidence did not seem conclusive until Garrod reported additional families in 1908. This case illustrates one of the difficulties in the study of the genetics of man, namely, the difficulty of finding an adequate number of critical families.

It is important that suspected cases of Mendelian inheritance in man should be recorded, so that they may be checked by other workers and, if valid, may be incorporated in studies of possible linkage and of anthropological questions. There is an unfortunate tendency, however, to accept

cases as established when the evidence is so weak that it would not be considered conclusive for any organism other than man. My own experience in the field may be cited as an example. About 70 percent of people of European ancestry are able to roll up the lateral edges of the tongue, while the remaining 30 percent are unable to do so. In 1940 I suggested that this difference is due to a single pair of genes (the ability being dominant), though it was clear that a few people were able to learn to do it and that there were a few discordant pedigrees. In 1952 Matlock showed such a high frequency of discordance to exist between members of pairs of identical twins that even if an inherited component is an actuality (which is not certain), there is sufficient nongenetic influence to make the character practically useless as a genetic marker. But I am still embarrassed to see it listed in some current works as an established Mendelian case.

In spite of these difficulties, a large list of more or less clear-cut Mendelian differences in man has gradually been built up, largely concerned with relatively rare defects or with less obvious biochemical variations such as blood groups, hemoglobin types, or variations in urine composition.

These cases have been important in the understanding of the genetic components of some diseases and have also been occasionally helpful in diagnosis. Mainly for these reasons, many medical schools now have departments of medical genetics and several standard books on the subject have been published. The clear-cut cases have also been of importance in physical anthropology (the beginnings of this application were described in Chapter 15).

The more obvious and familiar human differences, such as stature, hair form and color, eye color, skin color, right– vs. left-handedness, or fingerprint patterns, although obviously inherited, are difficult to analyze. In other mammals, hair color and eye color are among the best understood of the inherited characteristics, but in man there are so many intermediates that analysis is difficult. Red hair and blue eyes are often listed as due to recessive genes, which they may be, but in both cases classification is often uncertain, and if one depends on the usual popular descriptions, there will be contradictory observations.

Even more difficult to analyze are mental properties, and obviously these are the human characteristics that are of the greatest interest and importance to society. At the sensory level, there are well-established Mendelian differences that must have indirect effects on behavior—such things as taste sensitivity, night blindness, or color blindness. Since I am partially color blind, I am acutely aware of

some of the effects of my relative insensitivity to redness. Sunsets or desert colors are clearly lesser sources of esthetic satisfaction to me than they are to most people, and I am so unaware of the redness caused by inflammation that I could never have been a successful practicing physician.

At the other extreme, there are more or less clearly established Mendelian cases that involve serious mental conditions—such things as Huntington's chorea (Huntington, 1872, and many post-Mendelian references) and phenylketonuria (Fölling, 1934; Penrose, 1935; Fölling, Mohr, and Ruud, 1945).

It is the range between these extremes that is both the most interesting and the most difficult to analyze. One of the first attempts was made by Galton. He was responsible for the expression "nature vs. nurture" in the determination of human characteristics, although it is probable that he assumed his readers would recognize Shakespeare as the source of the expression (in *The Tempest,* concerning what led to Caliban's properties). Galton (1869) collected a series of pedigrees showing the concentration of particular kinds of exceptional achievements in particular families, such as musicians in the Bach family. He minimized the effect of family tradition and concluded that the results were primarily due to biological inheritance, despite one case that he pointed out but did not emphasize. In the Roman family of the Scipios there was an extraordinary concentration of generals and orators, but one of them (Scipio Aemilianus) "was not of Scipio blood" but was an adopted son, suggesting (though not to Galton) the importance of family tradition rather than genetic composition.

This same approach was later followed by Davenport *(Heredity in Relation to Eugenics,* 1911). Here there is a description of the Tuttle-Edwards family of New Haven, from whom descended two presidents and one vice-president of the United States, six college presidents, and other notables; and of the Lees of Virginia, who ran to generals and political figures. There follow accounts of the Jukes and Kallikak families, with their dreary processions of prostitutes, thieves, drunkards, and paupers. Here again was little or no recognition of the overwhelming importance of family environment and of the resulting opportunities or lack of opportunities in these examples. Surely Davenport must have understood that a potential college president, or member of the Virginia legislature, born into a Jukes family would have had no chance of realizing those potentialities—but the book does not bring out this point.

Similar views have been expressed since 1900 by other

biologists—including some who were more sophisticated than Davenport. Two examples follow:

Bateson (1912, "Biological Fact and the Structure of Society," Herbert Spencer lecture, Oxford):

> How hard it is to realize the polymorphism of man! Think of the varieties which the word denotes, merely in its application to one small society such as ours, and of the natural genetic distinctions which differentiate us into types and strains—acrobats, actors, artists, clergy, farmers, labourers, lawyers, mechanics, musicians, poets, sailors, men of science, servants, soldiers, and tradesmen. Think of the diversity of their experience of life. How few of these could have changed parts with each other. Many of these types are, even in present conditions, almost differentiated into distinct strains . . . I never cease to marvel that the more divergent castes of civilized humanity are capable of interbreeding and of producing fertile offspring from their crosses. Nothing but this paradoxical fact prevents us from regarding many classes even of Englishmen as distinct species in the full sense of the term.

Darlington (1953, *The Facts of Life):* "In England, for example, it is not lack of research which limits food production but the genetic unfitness of a large part of the tenant farmers, the legally secured occupiers who are organized to keep better men off the land."

Such extreme views have not gone unchallenged. Especially among anthropologists (largely under the influence of Boas) and among psychologists there has been a strong tendency to minimize the effects of genetic composition on human behavior. The most extreme statement of this position that I know is by Watson (1925, *Behaviorism):* "In the case of man, all healthy individuals . . . start out *equal.* Quite similar words appear in our far-famed Declaration of Independence. The signers of that document were nearer right than one might expect, considering their dense ignorance of psychology. They would have been strictly accurate had the clause 'at birth' been inserted after the word equal."

Much of the discussion of this question has been on the emotional level, because unambiguous objective evidence is so difficult to get. By and large, the extreme proponents of genetic determination have tended to be political conservatives with their views ultimately rooted in the caste system of feudalism, while the extreme advocates of environmental control have tended to represent a political philosophy derived more from the egalitarianism of the French Revolution.

As it happens, the most effective approach to this question was initiated by Galton (1883, *Inquiries into Human Faculty).* In a series of

studies on pairs of twins, he recognized that they were of two kinds, "similar" and "dissimilar," and concluded that these arose, respectively, from a single fertilized egg and from two independently fertilized eggs. This conclusion has since been confirmed by embryological evidence and by extensive genetic studies; the two types are now usually referred to as monozygotic (or identical) and dizygotic (or fraternal). Galton saw that they offered an opportunity to test the relative importance of nature and nurture, since the monozygotics should be alike in genetic makeup, whereas the dizygotics should be no more alike than ordinary brothers and sisters. He carried out a few tests on mental properties and concluded that the monozygotics were in fact more alike in behavioral attributes.

The next step was taken by Muller (1925). He found a pair of monozygotic twins who had been separated in early life and brought up in different families. He gave them a series of psychological tests, and found them to be quite similar. This method was greatly extended by Newman, Freeman, and Holzinger (1937). They found a considerable series (twenty) of such separated monozygotics and, as controls, carried out the same tests on a series of monozygotics, and also of dizygotics, reared together. The book makes fascinating reading—especially the detailed case histories—but the authors admitted to disappointment at the inconclusiveness of the results. Later series of such studies have also been rather disappointing, although there can be no question of their importance. Among the difficulties encountered may be mentioned the uncertainty as to just what the psychological tests are measuring, the varying ages at which the separations took place in the different pairs, the inaccuracy of the underlying tacit assumption that twins reared together are exposed to identical environmental effects, and the circumstance that the separated twins were usually reared in rather similar families (never was one brought up as a Lee and his twin as a Jukes). Nevertheless, these studies have convinced most unbiased students that there is an appreciable inherited component in the determination of human mental differences.

The difficulties of objective study of mental differences reach their maximum in the case of racial differences. If it be admitted that there are inherited individual differences, then on general grounds one must conclude that there are statistical differences between races. If one is inclined to look upon individual mental differences as largely genetic in origin, he then is likely to consider the observed (or imagined) cultural differences between races as being genetically determined and to conclude that some races (inevitably including the one to which he belongs) are inherently superior. The extreme examples

of this attitude have not usually been scientifically trained; the terrible example is Hitler, of course, but he was preceded by many pseudoscientific writers (such as Gobineau, Houston Chamberlain, and Madison Grant), most of whom would have been horrified by Hitler's methods. There have, however, been biologists with some background in genetics who have leaned in this direction. Since racism is a dirty word, it is perhaps kinder (and certainly more agreeable to the writer) not to name them.

Galton was one of the first to suggest the possibility of the genetic improvement of human populations; he introduced the word *eugenics* to designate this field of study and planning. There are two approaches here, which have been described as "negative" and "positive." The first proposes to decrease or eliminate the more extreme inherited defects—physical and mental—and the second proposes to increase the number of better individuals, and thereby to make possible the production of still better ones. Both approaches, especially the positive one, are based on the obvious success of animal and plant breeders in improving the populations with which they work.

It is estimated that something like 4 percent of human infants have tangible defects that can be detected in infancy—some of them very serious and others much less so, and some of them remediable and others not. It is also estimated that perhaps about half of these are largely genetic in origin. If it were possible to eliminate these by preventing their birth, this would obviously be a great advantage to society, in economic and, especially, in humanitarian terms.

In the early days of Mendelism, there were many people who felt that this objective could be rather simply achieved, but with increased knowledge this hope has been somewhat dimmed. The easiest class of defects to eliminate should be the dominant, but it has turned out that the more serious of these are apt not to appear until the normal reproductive age has largely passed (the typical example here is Huntington's chorea). Presumably those that appear earlier in life have, for the most part, been eliminated by natural selection. Any appreciable decrease in the incidence of recessive defects would depend on the identification of heterozygous carriers—which is not usually possible. There has also come to be a growing realization that, in some cases, heterozygosis for a particular gene may (at least under certain conditions) confer an advantage even when homozygosis is very disadvantageous. The best-known example here is sickle-cell anemia in man. Homozygosis for this gene causes the serious defect from which the name is derived; but it was shown by

Allison (1954) that heterozygosis for it confers considerable resistance to malaria and so is of selective advantage where malaria is prevalent. It remains uncertain how frequent this type of relation is, but the possibility suggests that caution be exercised in any attempt to eliminate undesirable recessives. A further point has been emphasized by Haldane, namely, that a recessive which interferes with the fertility of the individual must be retained in the population largely by recurrent mutation and therefore cannot be eliminated by artificial selection, although its frequency may be reduced.

Positive eugenics seems even more difficult, for several reasons. It is evident that animal breeders have, by selection from mixed populations, produced many reasonably uniform breeds, possessing desired characteristics and including many individuals more extreme in these respects than any found in the original population. There is no reason to doubt that similar results could be obtained with human populations. But there are a whole series of obvious difficulties—of which the greatest is: Who sets the goals? Who functions as the animal breeders have, in determining the basis of selection? Obviously no sane person would want a Hitler to have this power and responsibility, and most of us would agree with Bateson in mistrusting even a committee of Shakespeares.