CHAPTER VIII

HEREDITY IN MAN

In the chapters dealing with the various aspects of heredity in general, a number of instances have been given illustrating inheritance of various characters in man, and the province of this concluding chapter will be to collect and add to these cases, so as to sketch the general outlines of what is known of human inheritance. It has been seen that as man differs in no important way in his bodily characters from the other mammalia, so the laws governing the variation and transmission of those characters are the same as are found throughout the animal and vegetable kingdoms wherever they have been investigated; and further that the 'mental and moral' attributes of man, which presumably are correlated with physical structures, are inherited no less strongly than the bodily features themselves. When investigated by the biometric methods, the stature, span, length of fore-arm, eye-colour, and certain other physical characters or measurements, are found to

give a parental correlation and thus an intensity of inheritance closely similar to those obtained from the study of various animals and plants. When various non-measurable and less definite characters such as intellectual ability, hand-writing, etc. are investigated by the same methods, a similar intensity of heredity is found, and finally the same is true when the character chosen is liability to certain diseases, notably tuberculosis and insanity, or such abnormal conditions as congenital deafness. Since these latter conditions have been only briefly alluded to, and are of such fundamental importance for the well-being of mankind, the evidence may be referred to rather more fully here. The case of insanity is especially convincing, for it is not open to the objection sometimes made with regard to infectious diseases that the cause of the apparent inheritance of the condition is the exposure of the child to infection from the parent. It must be remembered that there are many kinds of insanity, in one of which at least (chorea), the inheritance appears to be Mendelian, and that of two men with equal tendency to mental aberration, one who is not exposed to strain may remain normal through life, while another under more arduous conditions may break down. But the data of occurrence of insanity among tainted stocks make it certain that 'the insane diathesis is inherited with at least as great an intensity as any physical or

mental character in man. It forms...probably no exception to an orderly system of inheritance in man, whereby *on the average* about one-half of the mean parental character, whether physical, mental or pathological, will be found in the child. It is accordingly highly probable that it is in the same manner as other physical characters capable of selection or elimination by unwise or prudential mating in the course of two or three generations.' (Heron [10]). Similarly for congenital deafness, Schuster writes '...that striking confirmation has been obtained of previous work on widely different characters, at any rate with regard to the correlation between father and children, and mother and children.' [31].

These examples, which might be added to, of results obtained by 'biometric' methods, make it sufficiently clear that a knowledge of the facts of inheritance is of importance to mankind, and that the further collection of accurate data is one of the most needed social requirements. Before passing on to other aspects of the question one other subject may be mentioned. The measure of resemblance in these characters has not only been worked out between parent and child, but between brothers and sisters, between children and grandparents and uncles and aunts, and between cousins. Some estimate can therefore be made of the probability of an individual being affected if his relatives are known,

a thing which should not only be useful to insurance offices, but to all thinking men, for it may ultimately become the basis for deciding on the propriety of marriage by members of tainted families. In general it appears that the resemblance of a child to its grandparent is rather more than half of that to its parent, and that the resemblance between uncle and nephew, or between first cousins, is very slightly less than between grandchild and grandparent.

We may now turn to definitely discontinuous characters in man, some of which are clearly Mendelian in their inheritance. One of the most interesting cases is that of eye-colour. Hurst [17] has shown that complete absence of pigment in the front of the iris is recessive to the presence of pigment; that is to say, that two pure blue-eyed people have only blue-eyed offspring, but that a blue-eyed individual married to one with any brown or yellow in the iris may have children with pigmented eyes and that two pigmented parents have pigmented children, with or without a proportion of blue-eyed in addition. Within the pigmented class there is great range of variation, from a small yellow rim round the pupil to completely dark eyes, and the relation of the various pigmented types to each other has not yet been analysed. But that the characters 'pigmented' and 'non-pigmented' are a Mendelian pair, his evidence leaves no doubt. This is thus a case in which the

occurrence of apparently continuous variation within a discontinuous category is clearly shown. Of other Mendelian characters in man, colour-blindness, complicated by its relation with sex, has already been

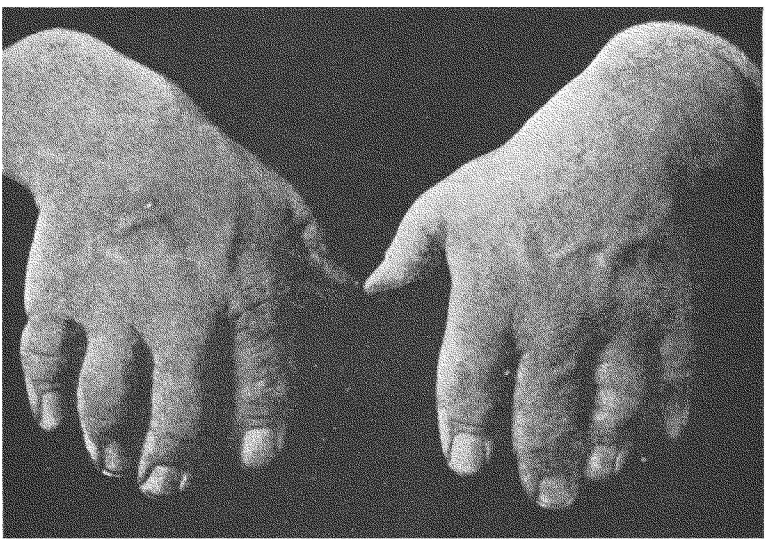
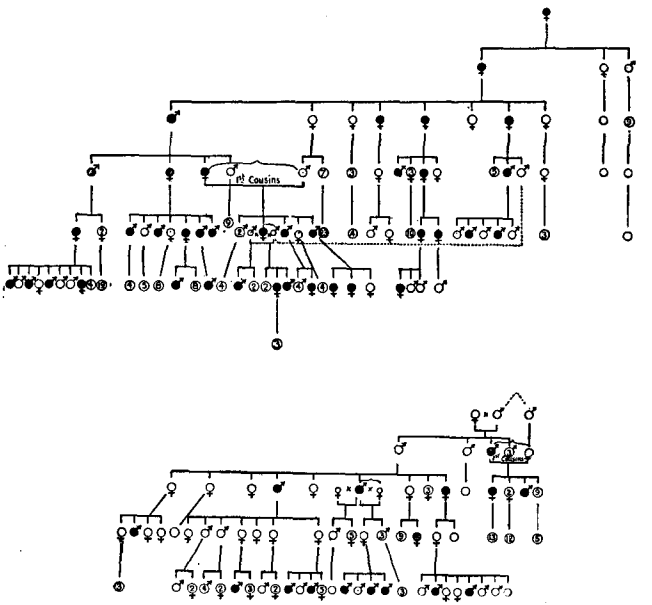


Fig. 12. Brachydactylous hands. (From Bateson, after Farabee.)

mentioned. Several cases are known in which an abnormality behaves as a simple dominant, e.g. the condition of the fingers known as 'brachydactyly,' in

which the fingers have one joint less than the normal; congenital cataract, and probably other diseases of the eye. Perhaps the most remarkable human pedigree ever collected is one of 'night-blindness,' extending through nine generations and going back to the seventeenth century, which has been published by Nettleship (see [1]). The condition is one in which the patient cannot see in dull light, and it behaves as a Mendelian dominant, probably, however, with some complication, since the numbers affected are less than the theoretical expectation. In all these cases in which the abnormality is dominant, only affected individuals can transmit it; the normal members of the family have only normal offspring, a condition which is shortly summarised as 'once free, always free.'

But the rule that the affected alone transmits will be followed only when the condition depends on a single factor; if it depends on more than one, or if its dominance is modified by sex or other conditions, then non-affected individuals may have affected offspring. This is possibly the case in many diseases in which it appears that the affection is dominant, and yet certain non-affected individuals have affected offspring, and in such examples it must also be remembered that the disease is probably not always developed in people in whom the tendency is present; the tendency may be there but the conditions required



♂ *Unaffected male*

♀ Unaffected female

♂ Affected male

♀ Affected female

♂ ♀ } Not certainly affected

♀ 3 females

⊙ 3 individuals, sex not recorded

—+— Indicates consanguinity.

to bring out the disease may be avoided, especially if it is a condition not present at birth, but appearing later in life. This kind of thing may perhaps be illustrated by the pedigrees of *Retinitis pigmentosa* taken from Nettleship (Bowman Lecture, 1909 [23]) on p. 105.

The disease is not usually present at birth, but comes on at a varying age, sometimes during or after middle life, and it will be seen that in the first pedigree it is transmitted only by affected members of the family, so behaving as a typical Mendelian dominant. In the second pedigree, however, it commonly 'skips' a generation, the parents of affected individuals usually being normal, but themselves children or sisters of those who are affected. The fact that in both families (as in most cases of this disease) males are more frequently affected than females, suggests that there is some complication, and this is perhaps connected with the fact that in one family the disease behaves as a simple dominant, while in the other it is most frequently transmitted, like colour-blindness, through normal females from affected males. These pedigrees are given as examples of the somewhat irregular inheritance of diseased conditions such as may frequently be seen in the medical journals; many of them are probably explicable in the ways suggested above.

A somewhat different group of phenomena is

illustrated by the inheritance of pigmentation in man, in skin- and hair-colour. In the case of hair-colour, Hurst has given evidence that bright red behaves as a recessive to dark-coloured hair, and that to some extent at least segregation takes place. But the shades of hair-colour graduate into one another so continuously that it is impossible to place them with confidence in Mendelian categories, and further the colour alters so greatly between infancy and maturity in many persons that classification is difficult. Many children for example have bright red hair, in whom during adolescence the colour deepens to brown, while other members of the same family, whose hair has hardly differed from the first during childhood, keep the bright red until middle life. In families with red hair we may see clear evidence of segregation between red and dark brown hair-colour, but the differences between the originally red-haired individuals show that some contain a darkening factor which is absent in the others. Probably then in human hair-colour there are a number of factors which interact upon one another in a way even more complex than in the hair-colour of mice mentioned in a previous chapter; and where rigid experiment is impossible, the analysis of these factors is almost hopeless. The same remarks perhaps apply to the various eye-colours within the class with pigmented iris, and the very frequent but

not absolutely perfect correlation between dark eye-colour and dark hair suggests that similar factors may perhaps be at work in both cases.

The inheritance of skin-colour in man is also one of the cases which has hitherto defied Mendelian analysis, and has been quoted more than once as disproving the universality of Mendelian inheritance. When a 'white' European marries a negro, the offspring are 'mulattoes,' intermediate between the parents. Mulattoes however are not all alike, some have brown skins and some yellowish. When they marry among themselves they are said never to produce full blacks or full whites, but again mulattoes, who however vary in the depth of their colour. When a mulatto marries a white, the 'quadroon' offspring are lighter than mulattoes but usually darker than Europeans; there is evidence however that they vary considerably, with possibly a certain amount of discontinuity between the darkest and lightest. Some evidence of segregation is also provided by the occasional instances of 'throw back' to very dark skin and negroid features or hair among children of apparently white people with some negro ancestry. The whole problem however is very insufficiently known, and the difficulty of obtaining reliable data is doubtless increased by race-prejudice. Taken in mass, the results of crossing white and black races seem to give a blended inheritance with continuous

variation; but as has been seen in the case of hair-colour the accurate investigation of individual families would possibly show that several factors were concerned, and that in the later generations, only when all these factors are combined in one individual would the colour be identical with that of either of the original races. In this respect crosses between different races of mankind resemble hybrids between different species of animals or plants, except that there is usually no sterility. Most of the Mendelian investigations have been made on varieties which differ in few characters, for the sake of simplicity, but when species are crossed and the offspring are fertile so many diverse characters are concerned, of which the relation to one another is not generally known, that the offspring of the hybrids may contain no individuals closely resembling either parent species. This has been explained by saying that only varietal and not specific characters segregate from one another on the Mendelian scheme, but it is not improbably due to the multiplicity of characters concerned, and their complicated interrelations, which makes analysis exceedingly difficult. It is also not impossible, when germ-cells differing very considerably in constitution combine in fertilisation, *that in the formation of the germ-cells of the next* generation the machinery for segregation is inadequate. Extreme cases of this are possibly the cause

of the frequent sterility of hybrids, but it may be that when the parental differences are insufficient to prevent the formation of fertile germ-cells, they may yet be enough to interfere with normal Mendelian segregation.

Certain aspects of inheritance in mankind have now been reviewed, and it remains briefly to indicate the lines on which our knowledge may be of practical importance. One of the things which is especially prominent when the evidence is considered as a whole is the exceeding definiteness or determinancy of the process of heredity. Given parents of certain constitution, it can be said with confidence that *on the average* a certain proportion of their offspring will have such and such characters. It matters not whether the character considered is regarded from the standpoint of the Biometrician or the Mendelian, both agree that what is present in the germ-cell will be present in the individual, and that external conditions as a rule play but a small part in determining its appearance. The Biometrician finds an average value for the intensity of inheritance, and shows that it is sensibly the same whether the character considered is stature, eye-colour, ability, or tendency to congenital disease. When the character in question is a simple case of presence or absence, the Mendelian finds that it is present in a definite proportion of the children of affected parents, so that he can say

with confidence that among the offspring of a parent who has congenital cataract or abnormally jointed fingers, about one-half will be similarly affected, and there is no hope in such a case that the severity of the affection will diminish in later generations. Where the disease depends on several factors, it may perhaps be eliminated by repeated marriage with untainted stock, but in such cases as cataract or colour-blindness there is no hope of this.

It is commonly supposed that inherited disease arises largely from the cumulative effect of bad conditions, drink and the like, but it has been seen how doubtful it is whether the effects of such things are really transmitted, and in any case it can be proved that in comparison with the germinal constitution, the effects of environment are relatively insignificant. Galton was one of the first to illustrate this by the study of twins. Human twins are of two sorts; in one case they arise by the simultaneous development of two ova, as in the litters of lower animals, and then they are no more alike than other children of the same parents, and may be of different sexes. Twins of the second kind are probably produced by division of one ovum, and are then of the same sex and so alike as to be called 'identical.' Such 'identical' twins remain through life, despite differences of environment, more like one another than successively born brothers commonly are, even

when brought up in precisely the same surroundings. The same thing has been shown by an investigation of school-children in relation to their home environment and the habits of their parents. From a study of over 70,000 children in Glasgow, classified according to the employment or non-employment of their mothers in work outside the home, it was found that the relation of their height and weight to the employment or non-employment of the mother was almost negligible compared with the relation between the physical characters of the mother and child. Still more surprising, if correct, is the observation that no regular relation could be found between drinking habits in the parents and the health, intelligence or physical development of some 1400 children in the schools of Edinburgh. [Elderton, 10[1].] Investigations of this kind are still in their infancy, and perhaps more urgently needed than any other social data—and it would be rash to make sweeping general statements from the little that has been done. Results like the examples quoted make one doubt

[1] The conclusions arrived at from this investigation have been severely criticised from both the medical and the statistical side, and it is probable that the statistical material used is not capable of yielding a decisive answer to the question whether drinking habits in the parents cause deterioration of the children or not. Nevertheless, the fact that it was not found suggests that the habits of the parents are relatively unimportant compared with the nature of the stock in determining the character of the children.

whether the generally accepted statements about the degeneration caused by unhealthy conditions or drink are really at all reliable. It is easy where insanity or other disease occurs, to say that in so many per cent. of the cases there has been alcoholism in the ancestors, and that therefore alcoholism is a cause of insanity; but in the first place it must be shown that the alcoholism is not the *result* of nervous disorder, which in the next generation appears as insanity[1]; and in the second place, in order to prove a causal connexion, in addition to this it must be shown that insanity is actually more frequent in the descendants of drunkards than in those of the sober. The undoubted evils of excessive drinking are many and obvious enough, but it does not follow that physical or mental degeneration of the descendants are among them, and it may be a false hope to suppose that these evils could be removed merely by the abolition of drink.

The same sort of argument may apply to the undoubted physical and mental inferiority of our slum population. It is not yet proved whether this is the effect of miserable surroundings, or whether the 'unfit' gravitate to the worst places because the more fit occupy the better. These are problems which society has as yet scarcely attempted to face, and yet it is clear that on their correct solution

[1] In this connexion see Barrington and Pearson [10].

depends the central question of social reform. If man is to any appreciable extent the creature of his environment, then improved conditions will improve the race. But if, as the study of heredity suggests, though it would be rash to say it is proved, man is almost entirely the product of inborn factors which are little affected by environment, then improved conditions may only encourage the propagation of the degenerate, and the race as a whole may go back rather than forward. Responsible students are not lacking who maintain that this is already taking place. It is said that the increase of insanity which is believed to have taken place in modern times is due to the provision of asylums where the insane are properly cared for and frequently discharged as 'cured.' When the insane were treated on the 'strait jacket' system no cure could be effected, and so the unfortunates could not recover to propagate their kind. But on the present system it not infrequently happens that the insane are enabled to bring into the world large families, so that it is not improbable that the increase in number may be due to this, rather than to the increased strain of modern conditions. No one would advocate a return to the old system, but some restriction on the reproduction of the mentally deficient is undoubtedly demanded by modern knowledge of heredity.

It is even said that hospitals and the feeding of destitute school-children are really working in the direction opposite to what is intended, by enabling the degenerate to live and beget families, who under harder conditions would never have survived[1]. If a child is to survive it is undoubtedly better that he should be well fed and cared for, but looking at the matter apart from all sentiment, it is quite possible that posterity will be worse rather than better as a result of such institutions. It is not improbable that future generations will find that our methods for the relief of distress are on wrong lines, and that other means must be found for dealing with the problem, which will cure the evil at its root instead of attempting to alleviate the symptoms.

Another point at which the study of heredity touches social problems is the treatment of criminals. It is becoming recognised that a large proportion of criminals are in some way abnormal, and that their crimes are due not to evil surroundings nor to wilful perversity, but to inherited defects. If this is actually the case, penal treatment of such is no less cruel than similar treatment of the insane, but in both cases efforts at reclamation or cure, followed

[1] It is of course not suggested that all or even the majority of those who receive such help are degenerate, but it can hardly be doubted that a very high proportion of the 'unfit' will take advantage of it.

by liberty and encouragement to marry, may only lead to a repetition of the same evils in the next generation. The present teaching of biology is perfectly clear, that in the case of the evils mentioned above and many others, marriage of those afflicted, and to a less extent of their near relatives, involves a grave risk of transmitting the affection to descendants, and so of inflicting serious injury upon society[1].

[1] See [43].