

APPLIED EUGENICS

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PREFACE

The science of eugenics consists of a foundation of biology and a superstructure of sociology. Galton, its founder, emphasized both parts in due proportion. Until recently, however, most sociologists have been either indifferent or hostile to eugenics, and the science has been left for the most part in the hands of biologists, who have naturally worked most on the foundations and neglected the superstructure. Although we are not disposed to minimize the importance of the biological part, we think it desirable that the means of applying the biological principles should be more carefully studied. The reader of this book will, consequently, find only a summary explanation of the mechanism of inheritance. Emphasis has rather been laid on the practical means by which society may encourage the reproduction of superior persons and discourage that of inferiors.

We assume that in general, a eugenically superior or desirable person has, to a greater degree than the average, the germinal basis for the following characteristics: to live past maturity, to reproduce adequately, to live happily and to make contributions to the productivity, happiness, and progress of society. It is desirable to discriminate as much as possible between the possession of the germinal basis and the observed achievement, since the latter consists of the former plus or minus environmental influence. But where the amount of modification is too obscure to be detected, it is advantageous to take the demonstrated achievement as a tentative measure of the germinal basis. The problem of eugenics is to make such legal, social and economic adjustments that (1) a larger proportion of superior persons will have children than at present, (2) that the average number of offspring of each superior person will be greater than at present, (3) that the most inferior persons will have no children, and finally that (4) other inferior persons will have fewer children than now. The

science of eugenics is still young and much of its program must be tentative and subject to the test of actual experiment. It is more important that the student acquire the habit of looking at society from a biological as well as a sociological point of view, than that he put his faith in the efficacy of any particular mode of procedure.

The essential points of our eugenics program were laid down by Professor Johnson in an article entitled "Human Evolution and its Control" in the *Popular Science Monthly* for January, 1910. Considerable parts of the material in the present book have appeared in the *Journal of Heredity*. Helpful suggestions and criticism have been received from several friends, in particular Sewall Wright and O. E. Baker of the United States Department of Agriculture.

PAUL POPENOE.

WASHINGTON, *June*, 1918.

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INTRODUCTION

The Great War has caused a vast destruction of the sounder portion of the belligerent peoples and it is certain that in the next generation the progeny of their weaker members will constitute a much larger proportion of the whole than would have been the case if the War had not occurred. Owing to this immeasurable calamity that has befallen the white race, the question of eugenics has ceased to be merely academic. It looms large whenever we consider the means of avoiding a stagnation or even decline of our civilization in consequence of the losses the War has inflicted upon the more valuable stocks. Eugenics is by no means tender with established customs and institutions, and once it seemed likely that its teachings would be left for our grandchildren to act on. But the plowshare of war has turned up the tough sod of custom, and now every sound new idea has a chance. Rooted prejudices have been leveled like the forests of Picardy under gun fire. The fear of racial decline provides the eugenicist with a far stronger leverage than did the hope of accelerating racial progress. It may be, then, that owing to the War eugenic policies will gain as much ground by the middle of this century as without it they would have gained by the end of the century.

This book could not have been written ten years ago because many of the data it relies on were not then in existence. In view of inquiries now going on, we may reasonably hope that ten years hence it will be possible to make a much better book on the subject. But I am sure that this book is as good a presentation as can be made of eugenics at its present stage of development. The results of all the trustworthy observations and experiments have been taken into account, and the testing of human customs and institutions in the light of biological principles tallies well with the sociology of our times.

I cannot understand how any conscientious person, dealing in a large way with human life, should have the hardihood to ignore eugenics. This book should command the attention not only of students of sociology, but, as well, of philanthropists, social workers, settlement wardens, doctors, clergymen, educators, editors, publicists, Y. M. C. A. secretaries and industrial engineers. It ought to lie at the elbow of law-makers, statesmen, poor relief officials, immigration inspectors, judges of juvenile courts, probation officers, members of state boards of control and heads of charitable and correctional institutions. Finally, the thoughtful ought to find in it guidance in their problem of mating. It will inspire the superior to rise above certain worldly ideals of life and to aim at a family success rather than an individual success.

EDWARD ALSWORTH ROSS.

The University of Wisconsin
Madison, Wisconsin
July 1918.

APPLIED EUGENICS

CHAPTER I

NATURE OR NURTURE?

At the First Race Betterment Conference held at Battle Creek, Mich., many methods were suggested by which it was believed that the people of America might be made, on the average, healthier, happier, and more efficient. One afternoon the discussion turned to the children of the slums. Their condition was pictured in dark colors. A number of eugenists remarked that they were in many cases handicapped by a poor heredity. Then Jacob Riis--a man for whom every American must feel a profound admiration--strode upon the platform, filled with indignation.

"We have heard friends here talk about heredity," he exclaimed. "The word has rung in my ears until I am sick of it. Heredity! Heredity! There is just one heredity in all the world that is ours--we are children of God, and there is nothing in the whole big world that we cannot do in His service with it."

It is probably not beyond the truth to say that in this statement Jacob Riis voiced the opinion of a majority of the social workers of this country, and likewise a majority of the people who are faithfully and with much self-sacrifice supporting charities, uplift movements, reform legislation, and philanthropic attempts at social betterment in many directions. They suppose that they are at the same time making the race better by making the conditions better in which people live.

It is widely supposed that, although nature may have distributed some handicaps at birth, they can be removed if the body is properly warmed and fed and the mind properly exercised. It is further widely supposed that this improvement in the condition of the individual will result in his production of better infants, and that thus the race, gaining a

little momentum in each generation, will gradually move on toward ultimate perfection.

There is no lack of efforts to improve the race, by this method of direct change of the environment. It involves two assumptions, which are sometimes made explicitly, sometimes merely taken for granted. These are:

1. That changes in a man's surroundings, or, to use the more technical biological term, in his nurture, will change the nature that he has inherited.
2. That such changes will further be transmitted to his children.

Any one who proposes methods of race betterment, as we do in the present book, must meet these two popular beliefs. We shall therefore examine the first of them in this chapter, and the second in Chapter II.

Galton adopted and popularized Shakespere's antithesis of *nature* and *nurture* to describe a man's inheritance and his surroundings, the two terms including everything that can pertain to a human being. The words are not wholly suitable, particularly since nature has two distinct meanings,--human nature and external nature. The first is the only one considered by Galton. Further, nurture is capable of subdivision into those environmental influences which do not undergo much change,--e.g., soil and climate,--and those forces of civilization and education which might better be described as culture. The evolutionist has really to deal with the three factors of germ-plasm, physical surroundings and culture. But Galton's phrase is so widely current that we shall continue to use it, with the implications that have just been outlined.

The antithesis of nature and nurture is not a new one; it was met long ago by biologists and settled by them to their own satisfaction. The whole body of experimental and observational evidence in biology tends to show that the characters which the individual inherits from his ancestors remain remarkably constant in all ordinary conditions to which they may be subjected. Their constancy is roughly proportionate to the

place of the animal in the scale of evolution; lower forms are more easily changed by outside influence, but as one ascends to the higher forms, which are more differentiated, it is found more and more difficult to effect any change in them. Their characters are more definitely fixed at birth.[1]

It is with the highest of all forms, Man, that we have now to deal. The student in biology is not likely to doubt that the differences in men are due much more to inherited nature than to any influences brought to bear after birth, even though these latter influences include such powerful ones as nutrition and education within ordinary limits.

But the biological evidence does not lend itself readily to summary treatment, and we shall therefore examine the question by statistical methods.[2] These have the further advantage of being more easily understood; for facts which can be measured and expressed in numbers are facts whose import the reader can usually decide for himself: he is perfectly able to determine, without any special training, whether twice two does or does not make four. One further preliminary remark: the problem of nature vs. nurture can not be solved in general terms; a moment's thought will show that it can be understood only by examining one trait at a time. The problem is to decide whether the differences between the people met in everyday life are due more to inheritance or to outside influences, and these differences must naturally be examined separately; they can not be lumped together.

To ask whether nature in general contributes more to a man than nurture is futile; but it is not at all futile to ask whether the differences in a given human trait are more affected by differences in nature than by differences in nurture. It is easy to see that a verdict may be

[1] See Woods, Frederick Adams, "Laws of Diminishing Environmental Influences," *Popular Science Monthly*, April, 1910, pp. 313-336; Huxley, J. S., *The Individual in the Animal Kingdom*, Cambridge and New York, 1912. Pike, F. H., and Scott, E. L., "The Significance of Certain Internal Conditions of the Organism in Organic Evolution," *American Naturalist*, Vol. XLIX, pp. 321-359, June, 1915.

[2] There is one line of experiment which is simple and striking enough to deserve mention--namely, ovarian transplantation. A description of this is given in Appendix A.

sometimes given to one side, sometimes to the other. Albinism in animals, for instance, is a trait which is known to be inherited, and which is very slightly affected by differences of climate, food supply, etc. On the other hand, there are factors which, although having inherited bases, owe their expression almost wholly to outside influences. Professor Morgan, for example, has found a strain of fruit flies whose offspring in cold weather are usually born with supernumerary legs. In hot weather they are practically normal. If this strain were bred only in the tropics, the abnormality would probably not be noticed; on the other hand, if it were bred only in cold regions, it would be set down as one characterized by duplication of limbs. The heredity factor would be the same in each case, the difference in appearance being due merely to temperature.

Mere inspection does not always tell whether some feature of an individual is more affected by changes in heredity or changes in

surroundings. On seeing a swarthy man, one may suppose that he comes of a swarthy race, or that he is a fair-skinned man who has lived long in the desert. In the one case the swarthyness would be inheritable, in the other not. Which explanation is correct, can only be told by examining a number of such individuals under critical conditions, or by an examination of the ancestry. A man from a dark-skinned race would become little darker by living under the desert sun, while a white man would take on a good deal of tan.

The limited effect of nurture in changing nature is in some fields a matter of common observation. The man who works in the gymnasium knows that exercise increases the strength of a given group of muscles for a while, but not indefinitely. There comes a time when the limit of a man's hereditary potentiality is reached, and no amount of exercise will add another millimeter to the circumference of his arm. Similarly the handball or tennis player some day reaches his highest point, as do runners or race horses. A trainer could bring Arthur Duffy in a few years to the point of running a hundred yards in $9\frac{3}{5}$ seconds, but no amount of training after that could clip off another fifth of a second.

A parallel case is found in the students who take a college examination. Half a dozen of them may have devoted the same amount of time to it--may have crammed to the limit--but they will still receive widely different marks. These commonplace cases show that nurture has seemingly some power to mold the individual, by giving his inborn possibilities a chance to express themselves, but that nature says the first and last word. Francis Galton, the father of eugenics, hit on an ingenious and more convincing illustration by studying the history of twins.[3]

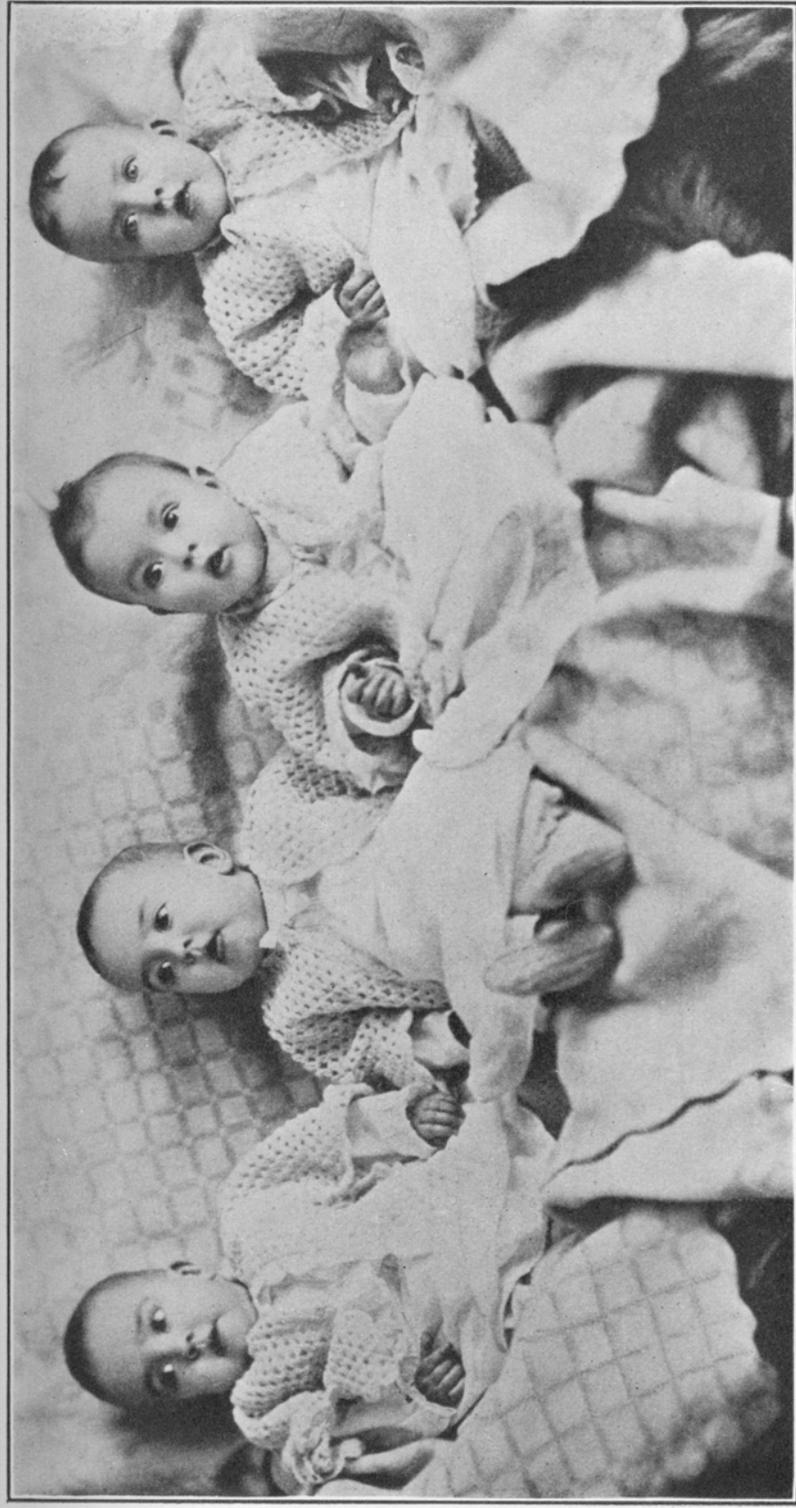
There are, everyday observation shows, two kinds of twins--ordinary twins and the so-called identical twins. Ordinary twins are merely brothers, or sisters, or brother and sister, who happen to be born two at a time, because two ova have developed simultaneously. The fact that they were born at the same time does not make them alike--they differ quite as widely from each other as ordinary brothers and sisters do. Identical twins have their origin in a different phenomenon--they are believed to be halves of the same egg-cell, in which two growing-points appeared at a very early embryonic stage, each of these developing into a separate individual. As would be expected, these identical twins are always of the same sex, and extremely like each other, so that sometimes their own mother can not tell them apart. This likeness extends to all sorts of traits:--they have lost their milk teeth on the same day in one case, they even fell ill on the same day with the same disease, even though they were in different cities.

Now Galton reasoned that if environment really changes the inborn character, then these identical twins, who start life as halves of the same whole, ought to become more unlike if they were brought up apart; and as they grew older and moved into different spheres of activity, they ought to become measurably dissimilar. On the other hand, ordinary twins, who start dissimilar, ought to become more alike when brought up

[3] Galton, Francis, *Inquiries into Human Faculty*, 1907 edition, pp. 153-173. This volume of Galton's, which was first published in 1883, has been reissued in Everyman's Library, and should be read by all eugenists.

in the same family, on the same diet, among the same friends, with the same education. If the course of years shows that identical twins remain as like as ever and ordinary twins as unlike as ever, regardless of changes in conditions, then environment will have failed to demonstrate that it has any great power to modify one's inborn nature in these traits.

With this view, Galton collected the history of eighty pairs of identical twins, thirty-five cases being accompanied by very full details, which showed that the twins were really as nearly identical, in childhood, as one could expect to find. On this point, Galton's inquiries were careful, and the replies satisfactory. They are not, however, as he remarks, much varied in character. "When the twins are children, they are usually distinguished by ribbons tied around the wrist or neck; nevertheless the one is sometimes fed, physicked, and whipped by mistake for the other, and the description of these little domestic catastrophes was usually given by the mother, in a phraseology, that is sometimes touching by reason of its seriousness. I have one case in which a doubt remains whether the children were not changed in their bath, and the presumed A is not really B, and *vice versa*. In another case, an artist was engaged on the portraits of twins who were between three and four years of age; he had to lay aside his work for three weeks, and, on resuming it, could not tell to which child the respective likeness he had in hand belonged. The mistakes become less numerous on the part of the mother during the boyhood and girlhood of the twins, but are almost as frequent as before on the part of strangers. I have many instances of tutors being unable to distinguish their twin pupils. Two girls used regularly to impose on their music teacher when one of them wanted a whole holiday; they had their lessons at separate hours, and the one girl sacrificed herself to receive two lessons on the same day, while the other one enjoyed herself from morning to evening. Here is a brief and comprehensive account: 'Exactly alike in all, their schoolmasters could never tell them apart; at dancing parties they constantly changed partners without discovery; their close resemblance is scarcely diminished by age.'



FOUR BABY GIRLS AT ONCE

FIG. 1.--These quadruplet daughters were born to Mr. and Mrs. F. M. Keys, Hollis, Okla., on July 4, 1915, and were seven months old when the photograph was taken. Up to that time they had never had any other nourishment than their mother's milk. Their weights at birth were as follows (reading from left to right): Roberta, 4 pounds; Mona, 4-1/2 pounds; Mary, 4-1/4 pounds; Leota, 3-3/4 pounds. When photographed, Roberta weighed 16 pounds and each of the others weighed 16-1/4. Their aunt vouches for the fact that the care of the four is less trouble than a single baby often makes. The mother has had no previous plural births, although she has borne four children prior to these. Her own mother had but two children, a son and a daughter, and there is no record of twins.

"The following is a typical schoolboy anecdote:

"'Two twins were fond of playing tricks, and complaints were frequently made; but the boys would never own which was the guilty one, and the complainants were never certain which of the two it was. One head master used to say he would never flog the innocent for the guilty, and the other used to flog them both.'

"No less than nine anecdotes have reached me of a twin seeing his or her reflection in the looking-glass, and addressing it in the belief that it was the other twin in person.

"Children are usually quick in distinguishing between their parent and his or her twin; but I have two cases to the contrary. Thus, the daughter of a twin says:

"'Such was the marvelous similarity of their features, voice, manner, etc., that I remember, as a child, being very much puzzled, and I think, had my aunt lived much with us, I should have ended by thinking I had two mothers!'

"In the other case, a father who was a twin, remarks of himself and his brother:

"'We were extremely alike, and are so at this moment, so much so that our children up to five and six years old did not know us apart.'

"Among my thirty-five detailed cases of close similarity, there are no less than seven in which both twins suffered from some special ailment or had some exceptional peculiarity. Both twins are apt to sicken at the same time in no less than nine out of the thirty-five cases. Either their illnesses, to which I refer, were non-contagious, or, if contagious, the twins caught them simultaneously; they did not catch them the one from the other."

Similarity in association of ideas, in tastes and habits was equally close. In short, their resemblances were not superficial, but extremely intimate, both in mind and body, while they were young; they were reared almost exactly alike up to their early manhood and womanhood.

Then they separated into different walks of life. Did this change of the environment alter their inborn character? For the detailed evidence, one should consult Galton's own account; we give only his conclusions:

In many cases the resemblance of body and mind continued unaltered up to old age, notwithstanding very different conditions of life; in others a severe disease was sufficient to account for some change noticed. Other dissimilarity that developed, Galton had reason to believe, was due to the development of inborn characters that appeared late in life. He therefore felt justified in broadly concluding "that the only circumstance, within the range of those by which persons of similar conditions of life are affected, that is capable of producing a marked effect on the character of adults, is illness or some accident which causes physical infirmity. The twins who closely resembled each other in childhood and early youth, and were reared under not very dissimilar conditions, either grow unlike through the development of natural [that is, inherited] characteristics which had lain dormant at first, or else they continue their lives, keeping time like two watches, hardly to be thrown out of accord except by some physical jar."

Here was a distinct failure of nurture to modify the inborn nature. We next consider the ordinary twins who were unlike from the start. Galton had twenty such cases, given with much detail. "It is a fact," he observes, "that extreme dissimilarity, such as existed between Jacob and Esau, is a no less marked peculiarity of twins of the same sex than extreme similarity." The character of the evidence as a whole may be fairly conveyed by a few quotations:

(1) One parent says: "They have had *exactly the same nurture* from their birth up to the present time; they are both perfectly healthy and strong, yet they are otherwise as dissimilar as two boys could be, physically, mentally, and in their emotional nature."

(2) "I can answer most decidedly that the twins have been perfectly dissimilar in character, habits, and likeness from the moment of their birth to the present time, though they were nursed by the same woman, went to school together, and were never separated until the age of thirteen."

(3) "They have never been separated, never the least differently treated in food, clothing, or education; both teething at the same time, both had measles, whooping cough, and scarlatina at the same time, and neither has had any other serious illness. Both are and have been exceedingly healthy, and have good abilities; yet they differ as much from each other in mental cast as any one of my family differs from another."

(4) "Very dissimilar in mind and body; the one is quiet, retiring, and slow but sure; good-tempered, but disposed to be sulky when provoked;--the other is quick, vivacious, forward, acquiring easily and forgetting soon; quick-tempered and choleric, but quickly forgiving and forgetting. They have been educated together and never separated."

(5) "They were never alike either in mind or body, and their dissimilarity increases daily. The external influences have been identical; they have never been separated."

(6) "The two sisters are very different in ability and disposition. The one is retiring, but firm and determined; she has no taste for music or drawing. The other is of an active, excitable temperament; she displays an unusual amount of quickness and talent, and is passionately fond of music and drawing. From infancy, they have been rarely separated even at school, and as children visiting their friends, they always went together."

And so on. Not a single case was found in which originally dissimilar characters became assimilated, although submitted to exactly the same influences. Reviewing the evidence in his usual cautious way, Galton declared, "There is no escape from the conclusion that nature prevails enormously over nurture, when the differences of nurture do not exceed what is commonly to be found among persons of the same rank in society and in the same country."

This kind of evidence was a good start for eugenics but as the science grew, it outgrew such evidence. It no longer wanted to be told, no matter how minute the details, that "nature prevails enormously over nurture." It wanted to know exactly how much. It refused to be satisfied with the statement that a certain quantity was large; it demanded that it be measured or weighed. So Galton, Karl Pearson and other

mathematicians devised means of doing this, and then Professor Edward L. Thorndike of Columbia University took up Galton's problem again, with more refined methods.

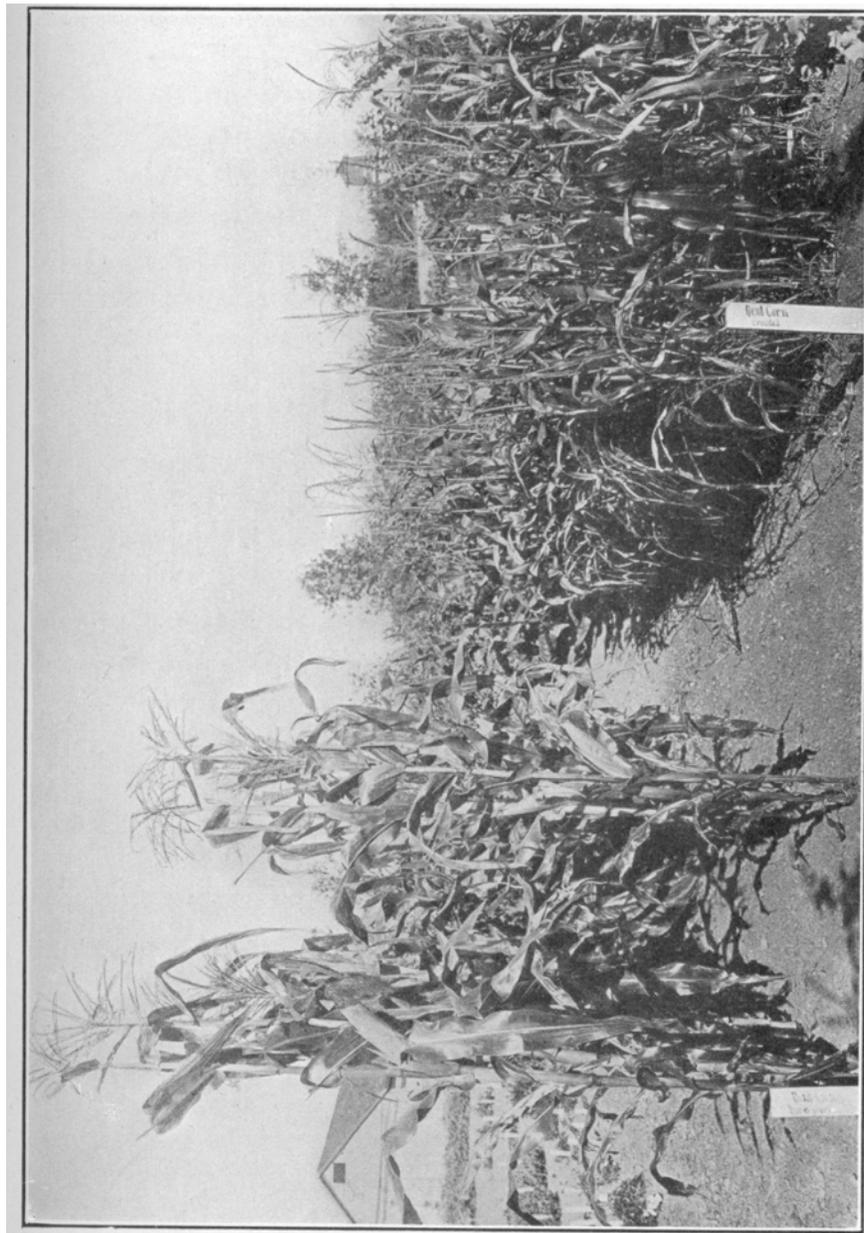
The tool used by Professor Thorndike was the coefficient of correlation, which shows the amount of resemblance or association between any two things that are capable of measurement, and is expressed in the form of a decimal fraction somewhere between 0 and the unit 1. Zero shows that there is no constant resemblance at all between the two things concerned,--that they are wholly independent of each other, while 1 shows that they are completely dependent on each other, a condition that rarely exists, of course.[4] For instance, the correlation between the right and left femur in man's legs is .98.

Professor Thorndike found in the New York City schools fifty pairs of twins of about the same age and measured the closeness of their resemblance in eight physical characters, and also in six mental characters, the latter being measured by the proficiency with which the subjects performed various tests. Then children of the same age and sex, picked at random from the same schools, were measured in the same way. It was thus possible to tell how much more alike twins were than ordinary children in the same environment.[5]

"If now these resemblances are due to the fact that the two members of any twin pair are treated alike at home, have the same parental models, attend the same school and are subject in general to closely similar environmental conditions, then (1) twins should, up to the age of

[4] What is said here refers to positive correlations, which are the only kind involved in this problem. Correlations may also be negative, lying between 0 and -1; for instance, if we measured the correlation between a man's lack of appetite and the time that had elapsed since his last meal, we would have to express it by a negative fraction, the minus sign showing that the greater his satiety, the less would be the time since his repast. The best introduction to correlations is Elderton's *Primer of Statistics* (London, 1912).

[5] Dr. Thorndike's careful measurements showed that it is impossible to draw a hard and fast line between identical twins and ordinary twins. There is no question as to the existence of the two kinds, but the ordinary twins may happen to be so nearly alike as to resemble identical twins. Accordingly, mere appearance is not a safe criterion of the identity of twins. His researches were published in the *Archives of Philosophy, Psychology and Scientific Methods*, No. 1, New York, 1905.



THE EFFECT OF NURTURE IN CHANGING NATURE

FIG. 2.--Corn of a single variety (Leaming Dent) grown in two plots: at the left spaced far apart in hills, at the right crowded. The former grows to its full potential height, the latter is stunted. The size differences in the two plots are due to differences in environment, the heredity in both cases being the same. Plants are much more susceptible to nutritional influences on size than are mammals, but to a less degree nutrition has a similar effect on man. Photograph from A. F. Blakeslee.

leaving home, grow more and more alike, and in our measurements the twins 13 and 14 years old should be much more alike than those 9 and 10 years old. Again (2) if similarity in training is the cause of similarity in mental traits, ordinary fraternal pairs not over four or five years apart in age should show a resemblance somewhat nearly as great as twin pairs, for the home and school condition of a pair of the former will not be much less similar than those of a pair of the latter. Again, (3) if training is the cause, twins should show greater resemblance in the case of traits much subject to training, such as ability in addition or multiplication, than in traits less subject to training, such as quickness in marking off the A's on a sheet of printed capitals, or in writing the opposites of words."

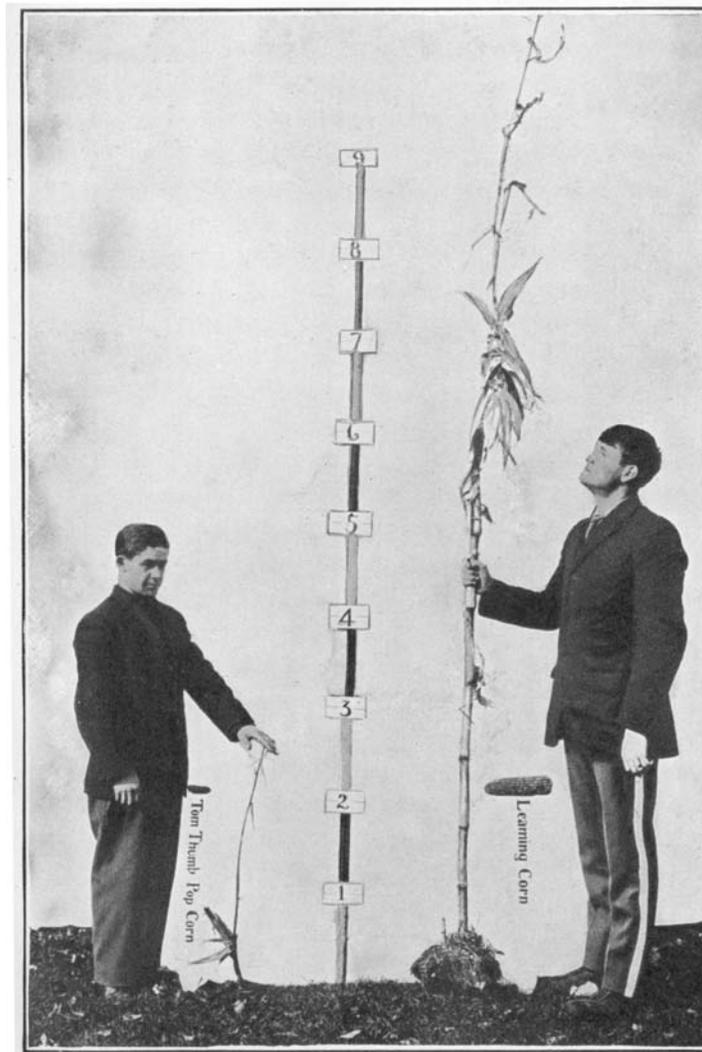
The data were elaborately analyzed from many points of view. They showed (1) that the twins 12-14 years old were not any more alike than the twins 9-11 years old, although they ought to have been, if environment has great power to mold the character during these so-called "plastic years of childhood." They showed (2) that the resemblance between twins was two or three times as great as between ordinary children of the same age and sex, brought up under similar environment. There seems to be no reason, except heredity, why twins should be more alike. The data showed (3) that the twins were no more alike in traits subject to much training than in traits subject to little or no training. Their achievement in these traits was determined by their heredity; training did not measurably alter these hereditary potentialities.

"The facts," Professor Thorndike wrote, "are easily, simply and completely explained by one simple hypothesis; namely, that the nature of the germ-cells--the conditions of conception--cause whatever similarities and differences exist in the original natures of men, that these conditions influence mind and body equally, and that in life the differences in modification of mind and body produced by such differences as obtain between the environments of present-day New York City public school children are slight."

"The inferences," he says, "with respect to the enormous importance of original nature in determining the behavior and achievements of any man in comparison with his fellows of the same period of civilization and conditions of life are obvious. All theories of human life must accept as a first principle the fact that human beings at birth differ enormously in mental capacities and that these differences are largely due to similar differences in their ancestry. All attempts to change human nature must accept as their most important condition the limits set by original nature to each individual."

Meantime other investigators, principally followers of Karl Pearson in England, were working out correlation coefficients in other lines of research for hundreds of different traits. As we show in more detail in Chapter IV, it was found, no matter what physical or mental trait was measured, that the coefficient of correlation between parent and child was a little less than .5 and that the coefficient between brother and brother, or sister and sister, or brother and sister, was a little more than .5. On the average of many cases the mean "nature" value, the coefficient of direct heredity, was placed at .51. This gave another means of measuring nurture, for it was also possible to measure the relation between any trait in the child and some factor in the environment. A specific instance will make this clearer.

Groups of school children usually show an appalling percentage of short-sightedness. Now suppose it is suggested that this is because they are allowed to learn to read at too early an age. One can find out the age at which any given child did learn to read, and work out the coefficient of correlation between this age and the child's amount of myopia. If the relation between them is very close--say .7 or .8--it will be evident that the earlier a child learns to read, the more short-sighted he is as he grows older. This will not prove a relation of cause and effect, but it will at least create a great suspicion. If on the contrary the correlation is very slight, it will be evident that early reading has little to do with the prevalence of defective vision among school children. If investigators similarly work out all the other



HEIGHT IN CORN AND MEN

FIG. 3.--An unusually short and an unusually tall man, photographed beside extreme varieties of corn which, like the men, owe their differences in height indisputably to heredity rather than to environment. No imaginable environmental differences could reverse the positions of these two men, or of these two varieties of corn, the heredity in each case being what it is. The large one might be stunted, but the small one could not be made much larger. Photograph from A. F. Blakeslee.

correlations that can be suggested, finding whether there is any regular relation between myopia and overcrowding, long hours of study, general economic conditions at home, general physical or moral conditions of parents, the time the child spends out of doors, etc., and if no important relation is found between these various factors and myopia, it will be evident that no factor of the environment which one can think of as likely to cause the trouble really accounts for the poor eyesight of school children.

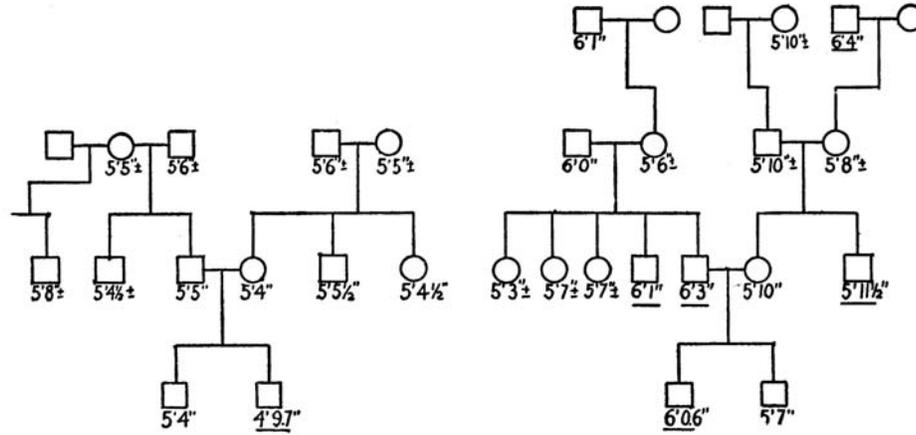
This has actually been done,[6] and none of the conditions enumerated has been found to be closely related to myopia in school children. Correlations between fifteen environmental conditions and the goodness of children's eyesight were measured, and only in one case was the correlation as high as .1. The mean of these correlations was about .04--an absolutely negligible quantity when compared with the common heredity coefficient of .51.

Does this prove that the myopia is rather due to heredity? It would, by a process of exclusion, if every conceivable environmental factor had been measured and found wanting. That point in the investigation can never be reached, but a tremendously strong suspicion is at least justified. Now if the degree of resemblance between the prevalence of myopia in parents and that in children be directly measured, and if it be found that when the parent has eye trouble the child also has it, then it seems that a general knowledge of heredity should lead to the belief that the difficulty lies there, and that an environmental cause for the poor vision of the school child was being sought, when it was all the time due almost entirely to heredity. This final step has not yet been completed in an adequate way,[7] but the evidence, partly analogical, gives every reason to believe in the soundness of the

[6] *A First Study of the Inheritance of Vision and the Relative Influence of Heredity and Environment on Sight*. By Amy Barrington and Karl Pearson. Eugenics Laboratory (London), Memoir Series V.

[7] Dr. James Alexander Wilson, assistant surgeon of the Ophthalmic Institute, Glasgow, published an analysis of 1,500 cases of myopia in the *British Medical Journal*, p. 395, August 29, 1914. His methods are not above criticism, and too much importance should not be attached to his results, which show that in 58% of the cases heredity can be credited with the myopia of the patient. In 12% of the cases it was due to inflammation of the cornea (keratitis) while in the remaining 30% no hereditary influence could be proved, but various reasons made him feel certain that in many cases it existed. The distribution of myopia by trades and professions among his patients is suggestive: 65% of the cases among school children showed myopic heredity; 63% among housewives and domestic servants; 68% among shop and factory works; 60% among clerks and typists; 60% among laborers and miners. If environment really played an active part, one would not expect to find this similarity in percentages between laborers and clerks, between housewives and schoolteachers, etc.

conclusion stated, that in most cases the schoolboy must wear glasses because of his heredity, not because of overstudy or any neglect on the part of his parents to care for his eyes properly during his childhood.



WHY MEN GROW SHORT OR TALL

FIG. 4.--Pedigree charts of the two men shown in the preceding illustration. Squares represent men and circles women; figures underlined denote measurement in stocking feet. It is obvious from a comparison of the ancestry of the two men that the short one comes from a predominantly short family, while the tall one gains his height likewise from heredity. The shortest individual in the right-hand chart would have been accounted tall in the family represented on the left. After A. F. Blakeslee.

The extent to which the intelligence of school children is dependent on defective physique and unfavorable home environment is an important practical question, which David Heron of London attacked by the methods we have outlined. He wanted to find out whether the healthy children were the most intelligent. One is constantly hearing stories of how the intelligence of school children has been improved by some treatment which improved their general health, but these stories are rarely presented in such a way as to contribute evidence of scientific value. It was desirable to know what exact measurement would show. The

intelligence of all the children in fourteen schools was measured in its correlation with weight and height, conditions of clothing and teeth, state of nutrition, cleanliness, good hearing, and the condition of the cervical glands, tonsils and adenoids. It could not be found that mental capacity was closely related to any of the characters dealt with.[8] The particular set of characters measured was taken because it happened to be furnished by data collected for another purpose; the various items are suggestive rather than directly conclusive. Here again, the correlation in most cases was less than .1, as compared with the general heredity correlation of .5.

The investigation need not be limited to problems of bad breeding. Eugenics, as its name shows, is primarily interested in "good breeding;" it is particularly worth while, therefore, to examine the relations between heredity and environment in the production of mental and moral superiority.

If success in life--the kind of success that is due to great mental and moral superiority--is due to the opportunities a man has, then it ought to be pretty evenly distributed among all persons who have had favorable opportunities, provided a large enough number of persons be taken to allow the laws of probability full play. England offers a good field to investigate this point, because Oxford and Cambridge, her two great universities, turn out most of the eminent men of the country, or at least have done so until recently. If nothing more is necessary to ensure a youth's success than to give him a first-class education and the chance to associate with superior people, then the prizes of life ought to be pretty evenly distributed among the graduates of the two universities, during a period of a century or two.

This is not the case. When we look at the history of England, as Galton did nearly half a century ago, we find success in life to an unexpected degree a family affair. The distinguished father is likely to have a distinguished son, while the son of two "nobodies" has a very small

[8] *The Influence of Unfavourable Home Environment and Defective Physique on the Intelligence of School Children*. By David Heron. Eugenics Laboratory (London), Memoir Series No. VIII.

chance of becoming distinguished. To cite one concrete case, Galton found[9] that the son of a distinguished judge had about one chance in four of becoming himself distinguished, while the son of a man picked out at random from the population had about one chance in 4,000 of becoming similarly distinguished.

The objection at once occurs that perhaps social opportunities might play the predominant part; that the son of an obscure man never gets a chance, while the son of the prominent man is pushed forward regardless of his inherent abilities. This, as Galton argued at length, can not be true of men of really eminent attainments. The true genius, he thought, frequently succeeds in rising despite great obstacles, while no amount of family pull will succeed in making a mediocrity into a genius, although it may land him in some high and very comfortable official position. Galton found a good illustration in the papacy, where during many centuries it was the custom for a pope to adopt one of his nephews as a son, and push him forward in every way. If opportunity were all that is required, these adopted sons ought to have reached eminence as often as a real son would have done; but statistics show that they reached eminence only as often as would be expected for nephews of great men, whose chance is notably less, of course, than that of sons of great men, in whom the intensity of heredity is much greater.

Transfer the inquiry to America, and it becomes even more conclusive, for this is supposed to be the country of equal opportunities, where it is a popular tradition that every boy has a chance to become president. Success may be in some degree a family affair in caste-ridden England; is it possible that the past history of the United States should show the same state of affairs?

Galton found that about half of the great men of England had distinguished close relatives. If the great men of America have fewer distinguished close relatives, environment will be able to make out a plausible case: it will be evident that in this continent of boundless

[9] *Hereditary Genius; an Inquiry into its Laws and Consequences*. London, 1869.

opportunities the boy with ambition and energy gets to the top, and that this ambition and energy do not depend on the kind of family he comes from.

Frederick Adams Woods has made precisely this investigation.[10] The first step was to find out how many eminent men there are in American history. Biographical dictionaries list about 3,500, and this number provides a sufficiently unbiased standard from which to work. Now, Dr. Woods says, if we suppose the average person to have as many as twenty close relatives--as near as an uncle or a grandson--then computation shows that only one person in 500 in the United States has a chance to be a near relative of one of the 3,500 eminent men--provided it is purely a matter of chance. As a fact, the 3,500 eminent men listed by the biographical dictionaries are related to each other not as one in 500, but as one in five. If the more celebrated men alone be considered, it is found that the percentage increases so that about one in three of them has a close relative who is also distinguished. This ratio increases to more than one in two when the families of the forty-six Americans in the Hall of Fame are made the basis of study. If all the eminent relations of those in the Hall of Fame are counted, they average more than one apiece. Therefore, they are from five hundred to a thousand times as much related to distinguished people as the ordinary mortal is.

To look at it from another point of view, something like 1% of the population of the country is as likely to produce a man of genius as is all the rest of the population put together,--the other 99%.

This might still be due in some degree to family influence, to the prestige of a famous name, or to educational advantages afforded the sons of successful men. Dr. Woods' study of the royal families of Europe is more decisive.[11]

[10] Woods, Frederick Adams, "Heredity and the Hall of Fame," *Popular Science Monthly*, May, 1913.

[11] Woods, Frederick Adams, *Mental and Moral Heredity in Royalty*, New York, 1906. See also "Sovereigns and the Supposed Influence of Opportunity," *Science*, n. s., XXXIX, No. 1016, pp. 902-905, June 19, 1914, where Dr. Woods answers some criticisms of his work.

In the latter group, the environment must be admitted--on the whole--to be uniformly favorable. It has varied, naturally, in each case, but speaking broadly it is certain that all the members of this group have had the advantage of a good education, of unusual care and attention. If such things affect achievement, then the achievements of this class ought to be pretty generally distributed among the whole class. If opportunity is the cause of a man's success, then most of the members of this class ought to have succeeded, because to every one of royal blood, the door of opportunity usually stands open. One would expect the heir to the throne to show a better record than his younger brothers, however, because his opportunity to distinguish himself is naturally greater. This last point will be discussed first.

Dr. Woods divided all the individuals in his study into ten classes for intellectuality and ten for morality, those most deficient in the qualities being put in class 1, while the men and women of preëminent intellectual and moral worth were put in class 10. Now if preëminent intellect and morality were at all linked with the better chances that an inheritor of succession has, then heirs to the throne ought to be more plentiful in the higher grades than in the lower. Actual count shows this not to be the case. A slightly larger percentage of inheritors is rather to be found in the lower grades. The younger sons have made just as good a showing as the sons who succeeded to power; as one would expect if intellect and morality are due largely to heredity, but as one would not expect if intellect and morality are due largely to outward circumstances.

Are "conditions of turmoil, stress and adversity" strong forces in the production of great men, as has often been claimed? There is no evidence from facts to support that view. In the case of a few great commanders, the times seemed particularly favorable. Napoleon, for example, could hardly have been Napoleon had it not been for the French revolution. But in general there have been wars going on during the whole period of modern European history; there have always been opportunities for a royal hero to make his appearance; but often the country has called for

many years in vain. Circumstances were powerless to produce a great man and the nation had to wait until heredity produced him. Spain has for several centuries been calling for genius in leadership in some lines; but in vain. England could not get an able man from the Stuart line, despite her need, and had to wait for William of Orange, who was a descendant of a man of genius, William the Silent. "Italy had to wait fifty years in bondage for her deliverers, Cavour, Garibaldi and Victor Emmanuel."

"The upshot of it all," Dr. Woods decides, "is that, as regards intellectual life, environment is a totally inadequate explanation. If it explains certain characters in certain instances, it always fails to explain many more, while heredity not only explains all, or at least 90%, of the intellectual side of character in practically every instance, but does so best when questions of environment are left out of discussion."

Despite the good environment almost uniformly present, the geniuses in royalty are not scattered over the surface of the pedigree chart, but form isolated little groups of closely related individuals. One centers in Frederick the Great, another in Queen Isabella of Spain, a third in William the Silent, and a fourth in Gustavus Adolphus. Furthermore, the royal personages who are conspicuously low in intellect and morality are similarly grouped. Careful study of the circumstances shows nothing in the environment that would produce this grouping of genius, while it is exactly what a knowledge of heredity leads one to expect.

In the next place, do the superior members of royalty have proportionately more superior individuals among their close relatives, as was found to be the case among the Americans in the Hall of Fame? A count shows at once that they do. The first six grades all have about an equal number of eminent relatives, but grade 7 has more while grade 8 has more than grade 7, and the geniuses of grade 10 have the highest proportion of nearer relatives of their own character. Surely it cannot be supposed that a relative of a king in grade 8 has on the average a

much less favorable environment than a relative of a king in grade 10. Is it not fair, then, to assume that this relative's greater endowment in the latter case is due to heredity?

Conditions are the same, whether males or females be considered. The royal families of Europe offer a test case because for them the environment is nearly uniformly favorable. A study of them shows great mental and moral differences between them, and critical evidence indicates that these differences are largely due to differences in heredity. Differences of opportunity do not appear to be largely responsible for the achievements of the individuals.

But, it is sometimes objected, opportunity certainly is responsible for the appearance of much talent that would otherwise never appear. Take the great increase in the number of scientific men in Germany during the last half century, for example. It can not be pretended that this is due to an increased birth-rate of such talent; it means that the growth of an appreciation of scientific work has produced an increased amount of scientific talent. J. McKeen Cattell has argued this point most carefully in his study of the families of one thousand American men of science (*Popular Science Monthly*, May, 1915). "A Darwin born in China in 1809," he says, "could not have become a Darwin, nor could a Lincoln born here on the same day have become a Lincoln had there been no Civil War. If the two infants had been exchanged there would have been no Darwin in America and no Lincoln in England." And so he continues, urging that in the production of scientific men, at least, education is more important than eugenics.

This line of argument contains a great deal of obvious truth, but is subject to a somewhat obvious objection, if it is pushed too far. It is certainly true that the exact field in which a man's activities will find play is largely determined by his surroundings and education. Young men in the United States are now becoming lawyers or men of science, who would have become ministers had they been born a century or two ago. But this environmental influence seems to us a minor one, for the man who is highly gifted in some one line is usually, as all the work of differential psychology shows, gifted more than the average in many

other lines. Opportunity decides in just what field his life work shall lie; but he would be able to make a success in a number of fields. Darwin born in America would probably not have become the Darwin we know, but it is not to be supposed that he would have died a "mute, inglorious Milton": it is not likely that he would have failed to make his mark in some line of human activity. Dr. Cattell's argument, then, while admissible, can not properly be urged against the fact that ability is mainly dependent on inheritance.

We need not stop with the conclusion that equality of training or opportunity is unable to level the inborn differences between men. We can go even farther, and produce evidence to show that equality of training *increases the differences* in results achieved.

This evidence is obtained by measuring the effects of equal amounts of exercise of a function upon individual differences in respect to efficiency in it. Suppose one should pick out, at random, eight children, and let them do problems in multiplication for 10 minutes. After a number of such trials, the three best might average 39 correct solutions in the 10 minutes, and the three poorest might average 25 examples. Then let them continue the work, until each one of them has done 700 examples. Here is equality in training; does it lead to uniform results?

Dr. Starch made the actual test which we have outlined and found that the three best pupils gained on the average 45 in the course of doing 700 examples; while the three poorest gained only 26 in the same course of time.

Similar tests have been made of school children in a number of instances, and have shown that equality of training fails to bring about equality of performance. All improve to some extent; but those who are naturally better than their comrades usually become better still, when conditions for all are the same. E. L. Thorndike gives[12] the following tabular statement of a test he conducted:

[12] *Educational Psychology*, Vol. III, p. 306. Starch's results are also quoted from Thorndike.

THE EFFECT OF EQUAL AMOUNTS OF PRACTICE UPON INDIVIDUAL DIFFERENCES
 IN THE MENTAL MULTIPLICATION OF A THREE-PLACE BY A THREE-PLACE NUMBER

	Amount done per unit of time				Percentage of correct figures in answers		
	Hours of Practice						
	First 5 Examples			First 5 Examples			
Last 5 or 10 Examples			Last 5 or 10 Examples				
Gain			Gain				
Initial highest five individuals	5.1	85	147	61	70	78	18
" next five "	5.1	56	107	51	68	78	10
" " six "	5.3	46	68	22	74	82	8
" " six "	5.4	38	46	8	58	70	12
" " five "	5.2	31	57	26	47	67	20
" " one individual	5.2	19	32	13	100	82	-18

Similar results have been obtained by half a dozen other experimenters, using the tests of mental multiplication, addition, marking A's on a printed sheet of capitals, and the like. It would be a mistake to conclude too much from experiments of such restricted scope; but they all agree in showing that if every child were given an equal training, the differences in these traits would nevertheless be very great.

And although we do not wish to strain the application of these results too far, we are at least justified in saying that they strongly indicate that inborn mediocrity can not be made into a high grade of talent by training. Not every boy has a chance to distinguish himself, even if he receives a good education.

We are driven back to the same old conclusion, that it is primarily inborn nature which causes the achievements of men and women to be what they are. Good environment, opportunity, training, will give good heredity a chance to express itself; but they can not produce greatness from bad heredity.

These conclusions are familiar to scientific sociologists, but they have not yet had the influence on social service and practical attempts at reform which they deserve. Many popular writers continue to confuse cause and effect, as for example H. Addington Bruce, who contributed an

article to the *Century Magazine*, not long ago, on "The Boy Who Goes Wrong." After alleging that the boy who goes wrong does so because he is not properly brought up, Mr. Bruce quotes with approval the following passage from Paul Dubois, "the eminent Swiss physician and philosopher:

"If you have the happiness to be a well-living man, take care not to attribute the credit of it to yourself. Remember the favorable conditions in which you have lived, surrounded by the relatives who loved you and set you a good example; do not forget the close friends who have taken you by the hand and led you away from the quagmires of evil; keep a grateful remembrance for all the teachers who have influenced you, the kind and intelligent school-master, the devoted pastor; realize all these multiple influences which have made you what you are. Then you will remember that such and such a culprit has not in his sad life met with these favorable conditions; that he had a drunken father or a foolish mother, and that he has lived without affection, exposed to all kinds of temptation. You will then take pity upon this disinherited man, whose mind has been nourished upon malformed mental images, begetting evil sentiments such as immoderate desire or social hatred."

Mr. Bruce indorses this kind of talk when he concludes, "The blame for the boy who goes wrong does not rest with the boy himself, or yet with his remote ancestors. It rests squarely with the parents who, through ignorance or neglect, have failed to mold him aright in the plastic days of childhood."

Where is the evidence of the existence of these plastic days of childhood? If they exist, why do not ordinary brothers become as much alike as identical twins? How long are we to be asked to believe, on blind faith, that the child is putty, of which the educator can make either mediocrity or genius, depending on his skill? What does the environmentalist know about these "plastic days"? If a boy has a drunken father or foolish mother, does it not suggest that there is something wrong with his pedigree? With such an ancestry, we do not expect him to turn out brilliantly, no matter in what home he is brought

up. If a boy has the kind of parents who bring him up well; if he is, as Dr. Dubois says, surrounded by relatives who love him and set him a good example, we at once have ground for a suspicion that he comes of a pretty good family, a stock characterized by a high standard of intellectuality and morality, and it would surprise us if such a boy did not turn out well. But he turns out well because what's bred in the bone will show in him, if it gets any kind of a chance. It is his nature, not his nurture, that is mainly responsible for his character.

CHAPTER II

MODIFICATION OF THE GERM-PLASM

Every living creature was at some stage of its life nothing more than a single cell. It is generally known that human beings result from the union of an egg-cell and a sperm-cell, but it is not so universally understood that these germ-cells are part of a continuous stream of germ-plasm which has been in existence ever since the appearance of life on the globe, and which is destined to continue in existence as long as life remains on the globe.

The corollaries of this fact are of great importance. Some of them will be considered in this chapter.

Early investigators tended naturally to look on the germ-cells as a product of the body. Being supposedly products of the body, it was natural to think that they would in some measure reproduce the character of the body which created them; and Darwin elaborated an ingenious hypothesis to explain how the various characters could be represented in the germ-cell. The idea held by him, in common with most other thinkers of his period, is still held more or less unconsciously by those who have not given particular attention to the subject. Generation is conceived as a direct chain: the body produces the germ-cell which produces another body which in turn produces another germ-cell, and so on.

But a generation ago this idea fell under suspicion. August Weismann, professor of zoölogy in the University of Freiburg, Germany, made himself the champion of the new idea, about 1885, and developed it so effectively that it is now a part of the creed of nearly every biologist.

Weismann caused a general abandonment of the idea that the germ-cell is produced by the body in each generation, and popularized the conception of the germ-cell as a product of a stream of undifferentiated germ-plasm, not only continuous but (potentially at least) immortal.

The body does not produce the germ-cells, he pointed out; instead, the germ-cells produce the body.

The basis of this theory can best be understood by a brief consideration of the reproduction of very simple organisms.

"Death is the end of life," is the belief of many other persons than the Lotus Eaters. It is commonly supposed that everything which lives must eventually die. But study of a one-celled animal, an Infusorian, for example, reveals that when it reaches a certain age it pinches in two, and each half becomes an Infusorian in all appearance identical with the original cell. Has the parent cell then died? It may rather be said to survive, in two parts. Each of these daughter cells will in turn go through the same process of reproduction by simple fission, and the process will be continued in their descendants. The Infusorian can be called potentially immortal, because of this method of reproduction.

The immortality, as Weismann pointed out, is not of the kind attributed by the Greeks to their gods, who could not die because no wound could destroy them. On the contrary, the Infusorian is extremely fragile, and is dying by millions at every instant; but if circumstances are favorable, it *can* live on; it is not inevitably doomed to die sooner or later, as is Man. "It dies from accident often, from old age never."

Now the single-celled Infusorian is in many respects comparable with the single-celled germ of the higher animals. The analogy has often been carried too far; yet it remains indisputable that the germ-cells of men reproduce in the same way--by simple fission--as the Infusorian and other one-celled animals and plants, and that they are organized on much the same plan. Given favorable circumstances, the germ-cell should be expected to be equally immortal. Does it ever find these favorable circumstances?

The investigations of microscopists indicate that it does--that evolution has provided it with these favorable circumstances, in the bodies of the higher animals. Let us recall in outline the early history of the fertilized germ-cell, the *zygote* formed by the union of ovum

and spermatozoön. These two unite to form a single cell, which is essentially the same, physiologically, as other germ-cells. It divides in two similar cells; these each divide; the resulting cells again divide, and so the process continues, until the whole body--a fully developed man,--has been produced by division and redivision of the one zygote.

But the germ-cell is obviously different from most of the cells that make up the finished product, the body. The latter are highly differentiated and specialized for different functions--blood cells, nerve cells, bone cells, muscle cells, and so on, each a single cell but each adapted to do a certain work, for which the original, undifferentiated germ-cell was wholly unfit. It is evident that differentiation began to take place at some point in the series of divisions, that is to say, in the development of the embryo.

Th. Boveri, studying the development of a threadworm, made the interesting discovery that this differentiation began at the first division. Of the two daughter-cells produced from the zygote, one continued dividing at a very slow rate, and without showing any specialization. Its "line of descent" produced only germ-cells. The products of division of the other daughter-cell began to differentiate, and soon formed all the necessary kinds of cells to make up the body of the mature worm. In this body, the cells from the first daughter-cell mentioned were inclosed, still undifferentiated: they formed the germ-cells of the next generation, and after maturity were ready to be ejected from the body, and to form new threadworms.

Imagine this process taking place through generation after generation of threadworms, and one will realize that the germ-plasm was passed on directly from one generation to the next; that in each generation it gave rise to body-plasm, but that it did not at any time lose its identity or continuity, a part of the germ-plasm being always set aside, undifferentiated, to be handed on to the next generation.

In the light of this example, one can better understand the definition of germ-plasm as "that part of the substance of the parents which does

not die with them, but perpetuates itself in their offspring." By bringing his imagination into play, the reader will realize that there is no limit to the backward continuity of this germ-plasm in the threadworm. Granted that each species has arisen by evolution from some other, this germ-cell which is observed in the body of the threadworm, must be regarded as part of what may well be called a stream of germ-plasm, that reaches back to the beginning of life in the world. It will be equally evident that there is no foreordained limit to the forward extension of the stream. It will continue in some branch, as long as there are any threadworms or descendants of threadworms in the world.

The reader may well express doubt as to whether what has been demonstrated for the threadworm can be demonstrated for the higher animals, including man. It must be admitted that in many of these animals conditions are too unfavorable, and the process of embryology too complicated, or too difficult to observe, to permit a distinct demonstration of this continuity of the germ-plasm, wherever it is sought. But it has been demonstrated in a great many animals; no facts which impair the theory have been discovered; and biologists therefore feel perfectly justified in generalizing and declaring the continuity of germ-plasm to be a law of the world of living things.

Focusing attention on its application to man, one sees that the race must represent an immense network of lines of descent, running back through a vast number of different forms of gradually diminishing specialization, until it comes to a point where all its threads merge in one knot--the single cell with which it may be supposed that life on this globe began. Each individual is not only figuratively, but in a very literal sense, the carrier of the heritage of the whole race--of the whole past, indeed. Each individual is temporarily the custodian of part of the "stuff of life"; from an evolutionary point of view, he may be said to have been brought into existence, primarily to pass this sacred heritage on to the next generation. From Nature's standpoint, he is of little use in the world, his existence is scarcely justified, unless he faithfully discharges this trust, passing on to the future

the "Lamp of Life" whose fire he has been created to guard for a short while.

Immortality, we may point out in passing, is thus no mere *hope* to the parent: it is a *real possibility*. The death of the huge agglomeration of highly specialized body-cells is a matter of little consequence, if the germ-plasm, with its power to reproduce not only these body-cells, but the mental traits--indeed, we may in a sense say the very soul--that inhabited them, has been passed on. The individual continues to live, in his offspring, just as the past lives in him. To the eugenicist, life everlasting is something more than a figure of speech or a theological concept--it is as much a reality as the beat of the heart, the growth of muscles or the activity of the mind.

This doctrine of the continuity of germ-plasm throws a fresh light on the nature of human relationships. It is evident that the son who resembles his father can not accurately be called a "chip off the old block." Rather, they are both chips off the same block; and aside from bringing about the fusion of two distinct strains of germ-plasm, father and mother are no more responsible for endowing the child with its characters except in the choice of mate, than is the child for "stamping his impress" on his parents. From another point of view, it has been said that father and son ought to be thought of as half-brothers by two different mothers, each being the product of the same strain of paternal germ-plasm, but not of the same strain of maternal germ-plasm. Biologically, the father or mother should not be thought of as the *producer* of a child, but as the trustee of a stream of germ-plasm which produces a child whenever the proper conditions arise. Or as Sir Michael Foster put it, "The animal body is in reality a vehicle for ova or sperm; and after the life of the parent has become potentially renewed in the offspring, the body remains as a cast-off envelope whose future is but to die." Finally to quote the metaphor of J. Arthur Thomson, one may "think for a moment of a baker who has a very precious kind of leaven; he uses much of this in baking a large loaf; but he so arranges matters by a clever contrivance that part of the original leaven is always carried on unaltered, carefully preserved for the next

baking. Nature is the baker, the loaf is the body, the leaven is the germ-plasm, and each baking is a generation."

When the respective functions and relative importance, from a genetic point of view, of germ-plasm and body-plasm are understood, it must be fairly evident that the natural point of attack for any attempt at race betterment which aims to be fundamental rather than wholly superficial, must be the germ-plasm rather than the body-plasm. The failure to hold this point of view has been responsible for the disappointing results of much of the sociological theory of the last century, and for the fact that some of the work now carried on under the name of race betterment is producing results that are of little or no significance to true race betterment.

On the other hand, it must be fairly evident, from the pains which Nature has taken to arrange for the transmission of the germ-plasm from generation to generation, that she would also protect it from injury with meticulous care. It seems hardly reasonable to suppose that a material of this sort should be exposed, in the higher animals at least, to all the vicissitudes of the environment, and to injury or change from the chance of outward circumstances.

In spite of these presumptions which the biologist would, to say the least, consider worthy of careful investigation, the world is full of well-intentioned people who are anxious to improve the race, and who in their attempts to do so, wholly ignore the germ-plasm. They see only the body-plasm. They are devoted to the dogma that if they can change the body (and what is here said of the body applies equally to the mind) in the direction they wish, this change will in some unascertainable way be reproduced in the next generation. They rarely stop to think that man is an animal, or that the science of biology might conceivably have something to say about the means by which his species can be improved; but if they do, they commonly take refuge, deliberately or unconsciously, in the biology of half a century ago, which still believed that these changes of the body could be so impressed on the germ-plasm as to be continued in the following generation.

Such an assumption is made to-day by few who have thoroughly studied the subject. Even those who still believed in what is conventionally called "the inheritance of acquired characteristics" would be quick to repudiate any such application of the doctrine as is commonly made by most of the philanthropists and social workers who are proceeding without seeking the light of biology. But the idea that these modifications are inherited is so widespread among all who have not studied biology, and is so much a part of the tradition of society, that the question must be here examined, before we can proceed confidently with our program of eugenics.

The problem is first to be defined.

It is evident that all characters which make up a man or woman, or any other organism, must be either germinal or acquired. It is impossible to conceive of any other category. But it is frequently hard to say in which class a given character falls. Worse still, many persons do not even distinguish the two categories accurately--a confusion made easier by the quibble that *all* characters must be acquired, since the organism starts from a single cell, which possesses practically none of the traits of the adult.

What we mean by an inborn character is one whose expression is due to something which is present in the germ-plasm; one which is inherent and due to heredity. An acquired character is simply a modification, due to some cause external to the germ-plasm acting on an inborn character. In looking at an individual, one can not always say with certainty which characters are which; but with a little trouble, one can usually reach a reliable decision. It is possible to measure the variation in a given character in a group of parents and their children, in a number of different environments; if the degree of resemblance between parent and offspring is about the same in each case, regardless of the different surroundings in which the children may have been brought up, the character may properly be called germinal. This is the biometric method of investigation. In practice, one can often reach a decision by much simpler means: if the character is one that appears at birth, e.g.,

skin color, it is usually safe to assume that it is a germinal character, unless there is some evident reason for deciding otherwise, as in the case of a child born with some disease from which the mother had been suffering for the previous few months. In general, it is more difficult to decide whether a mental trait is germinal, than whether a physical one is; and great care should be used in classification.

To make the distinction, one ought to be familiar with an individual from birth, and to have some knowledge of the conditions to which he was exposed, in the period between conception and birth,--for of course a modification which takes place during that time is as truly an acquired character as one that takes place after parturition. Blindness, for example, may be an inborn defect. The child from conception may have lacked the requisites for the development of sight. On the other hand, it may be an acquired character, due to an ill-advised display of patriotism on July 4, at some time during childhood; or even to infection at the moment of birth. Similarly small size may be an inborn character, due to a small-sized ancestry; but if the child comes of a normal ancestry and is stunted merely because of lack of proper care and food, the smallness is an acquired character. Deafness may be congenital and inborn, or it may be acquired as the result, say, of scarlet fever during childhood.

Now the inborn characters (excepting modifications *in utero*) are admittedly heritable, for inborn characters must exist potentially in the germ-plasm. The belief that acquired characters are also inherited, therefore, involves belief that in some way the trait acquired by the parent is incorporated in the germ-plasm of the parent, to be handed on to the child and reappear in the course of the child's development. The impress on the parental *body* must in some way be transferred to the parental *germ-plasm*; and not as a general influence, but as a specific one which can be reproduced by the germ-plasm.

This idea was held almost without question by the biologists of the past, from Aristotle on. Questionings indeed arose from time to time, but they were vague and carried no weight, until a generation ago

several able men elaborated them. For many years, it was the question of chief dispute in the study of heredity. The last word has not yet been said on it. It has theoretical bearings of immense importance; for our conception of the process of evolution will be shaped according to the belief that acquired characters are or are not inherited. Herbert Spencer went so far as to say, "Close contemplation of the facts impresses me more strongly than ever with two alternatives--either that there has been inheritance of acquired characters, or there has been no evolution." But its practical bearings are no less momentous. Again to quote Spencer: "Considering the width and depth of the effects which the acceptance or non-acceptance of one or the other of these hypotheses must have on our views of life, the question, Which of them is true? demands beyond all other questions whatever the attention of scientific men. A grave responsibility rests on biologists in respect of the general question, since wrong answers lead, among other effects, to wrong belief about social affairs and to disastrous social actions."

Biologists certainly have not shirked this "grave responsibility" during the last 30 years, and they have, in our opinion, satisfactorily answered the general question. The answer they give is not the answer Herbert Spencer gave.

But the popular mind frequently lags a generation behind, in its grasp of the work of science, and it must be said that in this case the popular mind is still largely under the influence of Herbert Spencer and his school. *Whether they know it or not*, most people who have not made a particular study of the question still tacitly assume that the acquirements of one generation form part of the inborn heritage of the next, and the present social and educational systems are founded in large part on this false foundation. Most philanthropy starts out unquestioningly with the assumption that by modifying the individual for the better, it will thereby improve the germinal quality of the race. Even a self-styled eugenist asks, "Can prospective parents who have thoroughly and systematically disciplined themselves, physically, mentally and morally, transmit to their offspring the traits or

tendencies which they have developed?" and answers the question with the astounding statement, "It seems reasonable to suppose that they have this power, it being simply a phase of heredity, the tendency of like to beget like."

The right understanding of this famous problem is therefore fraught with the most important consequences to eugenics. The huge mass of experimental evidence that has been accumulated during the last quarter of a century has, necessarily, been almost wholly based on work with plants and lower animals. Even though we can not attempt to present a general review of this evidence, for which the reader must consult one of the standard works on biology or genetics, we shall point out some of the considerations underlying the problem and its solution.

In the first place, it must be definitely understood that we are dealing only with specific, as distinguished from general, transmission. As the germ-cells derive their nourishment from the body, it is obvious that any cause profoundly affecting the latter might in that way exercise an influence on the germ-cells; that if the parent was starved, the germ-cells might be ill-nourished and the resulting offspring might be weak and puny. There is experimental evidence that this is the case; but that is not the inheritance of an acquired character. If, however, a white man tanned by long exposure to the tropical sun should have children who were brunettes, when the family stock was all blond; or if men whose legs were deformed through falls in childhood should have children whose legs, at birth, appeared deformed in the same manner; then there would be a distinct case of the transmission of an acquired characteristic. "The precise question," as Professor Thomson words it, "is this: Can a structural change in the body, induced by some change in use or disuse, or by a change in surrounding influence, affect the germ-cells in such a *specific* or representative way that the offspring will through its inheritance exhibit, even in a slight degree, the modification which the parent acquired?" He then lists a number of current misunderstandings, which are so widespread that they deserve to be considered here.

(1) It is frequently argued (as Herbert Spencer himself suggested) that

unless modifications are inherited, there could be no such thing as evolution. Such pessimism is unwarranted. There *is* abundant explanation of evolution, in the abundant supply of germinal variations which every individual presents.

(2) It is common to advance an *interpretation* of some observation, in support of the Lamarckian doctrine, as if it were a *fact*. Interpretations are not facts. What is wanted are the facts; each student has a right to interpret them as he sees fit, but not to represent his interpretation as a fact. It is easy to find structural features in Nature which *may be interpreted* as resulting from the inheritance of acquired characters; but this is not the same as to say and to prove that they *have resulted* from such inheritance.

(3) It is common to beg the question by pointing to the transmission of some character that is not proved to be a modification. Herbert Spencer cited the prevalence of short-sightedness among the "notoriously studious" Germans as a defect due to the inheritance of an acquired character. But he offered no evidence that this is an acquirement rather than a germinal character. As a fact, there is reason to believe that weakness of the eyes is one of the characteristics of that race, and existed long before the Germans ever became studious--even at a time when most of them could neither read nor write.

(4) The reappearance of a modification may be mistaken for the transmission of a modification. Thus a blond European family moves to the tropics, and the parents become tanned. The children who grow up under the tropical sun are tanned from infancy; and after the grandchildren or great-grandchildren appear, brown from childhood, some one points to the case as an instance of permanent modification of skin-color. But of course the children at the time of birth are as white as their distant cousins in Europe, and if taken back to the North to be brought up, would be no darker than their kinsmen who had never been in the tropics. Such "evidence" has often been brought forward by careless observers, but can deceive no one who inquires carefully into the facts.

(5) In the case of diseases, re-infection is often mistaken for

transmission. The father had pneumonia; the son later developed it; ergo, he must have inherited it. What evidence is there that the son in this case did not get it from an entirely different source? Medical literature is heavily burdened with such spurious evidence.

(6) Changes in the germ-cells *along with* changes in the body are not relevant to this discussion. The mother's body, for example, is poisoned with alcohol, which is present in large quantities in the blood and therefore might affect the germ-cells directly. If the children subsequently born are consistently defective it is not an inheritance of a body character but the result of a direct modification of the germ-plasm. The inheritance of an acquired modification of the body can only be proved if some particular change made in the parent is inherited as such by the child.

(7) There is often a failure to distinguish between the possible inheritance of a particular modification, and the possible inheritance of indirect results of that modification, or of changes correlated with it. This is a nice but crucial point on which most popular writers are confused. Let us examine it through a hypothetical case. A woman, not herself strong, bears a child that is weak. The woman then goes in for athletics, in order better to fit herself for motherhood; she specializes on tennis. After a few years she bears another child, which is much stronger and better developed than the first. "Look," some one will say, "how the mother has transmitted her acquirement to her offspring." We grant that her improved general health will probably result in a child that is better nourished than the first; but that is a very different thing from heredity. If, however, the mother had played tennis until her right arm was over-developed, and her spine bent; if these characteristics were nowhere present in the ancestry and not seen in the first child; but if the second child were born with a bent spine and a right arm of exaggerated musculature, we would be willing to consider the case on the basis of the inheritance of an acquired character. We are not likely to have such a case presented to us.

To put the matter more generally, it is not enough to show that *some* modification in the parent results in *some* modification in the child. For the purposes of this argument there must be a similar modification.

(8) Finally, data are frequently presented, which cover only two generations--parent and child. Indeed, almost all the data alleged to show the inheritance of acquired characteristics are of this kind. They are of little or no value as evidence. Cases covering a number of generations, where a *cumulative* change was visible, would be of weight, but on the rare occasions when they are forthcoming, they can be explained in some other way more satisfactorily than by an appeal to the theory of Lamarck.[13]

If the evidence currently offered to support a belief in the inheritance of acquired characters is tested by the application of these "misunderstandings," it will at once be found that most of it disappears; that it can be thrown out of court without further formality. The Lamarckian doctrine is now held mainly by persons who have either lacked training in the evaluation of evidence, or have never examined critically the assumptions on which they proceed. Medical men and breeders of plants or animals are to a large extent believers in Lamarckism, but the evidence (if any) on which they rely is always susceptible of explanation in a more reasonable way. It must not be forgotten that some of the ablest intellects in the world have been assiduously engaged in getting at the truth in the case, during the last half-century; and it is certainly worthy of consideration that not in a

[13] Jean Baptiste Lamarck, a French naturalist, born in 1744, was one of the pioneers in the philosophical study of evolution. The theory (published in 1809) for which he is best known is as follows: "Changes in the animal's surroundings are responded to by changes in its habits." "Any particular habit involves the regular use of some organs and the disuse of others. Those organs which are used will be developed and strengthened, those not used diminished and weakened, and the changes so produced will be transmitted to the offspring, and thus progressive development of particular organs will go on from generation to generation." His classical example is the neck of the giraffe, which he supposes to be long because, for generation after generation, the animals stretched their necks in order to get the highest leaves from the trees.

single case has the transmission of an acquired body character ever been proved beyond dispute. Those who still hold a belief in it (and it is fair to say that some men of real ability are among that number) too often do so, it is to be feared, because it is necessary for the support of some theoretical doctrine which they have formulated. Certainly there are few men who can say that they have carefully examined the evidence in the case, and accept Lamarckism because the evidence forces them to do so. It will be interesting to review the various classes of alleged evidence, though we can cite only a few cases from the great number available (most of them, however, dealing with plants or lower animals).

Nearly all the evidence adduced can be put in one of these four classes:

- (1) Mutilations.
- (2) Diseases.
- (3) Results of use or disuse.
- (4) Physico-chemical effects of environment.

The case in regard to mutilations is particularly clear cut and leaves little room for doubt. The noses and ears of oriental women have been pierced for generations without number, yet girls are still born with these parts entire. Circumcision offers another test case. The evidence of laboratory experiments (amputation of tails) shows no inheritance. It may be said without hesitation that mutilations are not heritable, no matter how many generations undergo them.

(2) The transmissibility of acquired diseases is a question involved in more of a haze of ignorance and loose thinking. It is particularly frequent to see cases of uterine infection offered as cases of the inheritance of acquired characters. To use the word "heredity" in such a case is unjustified. Uterine infection has no bearing whatever on the question.

Taking an historical view, it seems fairly evident that if diseases were really inherited, the race would have been extinct long ago. Of course there are constitutional defects or abnormalities that are in the germ-plasm and are heritable: such is the peculiar inability of the blood to coagulate, which marks "bleeders" (sufferers from hemophilia, a

highly hereditary disease). And in many cases it is difficult to distinguish between a real germinal condition of this sort, and an acquired disease.

The inheritance of an acquired disease is not only inconceivable, in the light of what is known about the germ-plasm, but there is no evidence to support it. While there is most decidedly such a thing as the inheritance of a tendency to or lack of resistance to a disease, it is not the result of incidence of the disease on the parent. It is possible to inherit a tendency to headaches or to chronic alcoholism; and it is possible to inherit a lack of resistance to common diseases such as malaria, small-pox or measles; but actually to inherit a zymotic disease as an inherent genetic trait, is impossible,--is, in fact, a contradiction of terms.

(3) When we come to the effects of use and disuse, we reach a much debated ground, and one complicated by the injection of a great deal of biological theorizing, as well as the presence of the usual large amount of faulty observation and inference.

It will be admitted by every one that a part of the body which is much used tends to increase in size, or strength, and similarly that a part which is not used tends to atrophy. It is further found that such changes are progressive in the race, in many cases. Man's brain has steadily increased in size, as he used it more and more; on the other hand, his canine teeth have grown smaller. Can this be regarded as the inheritance of a long continued process of use and disuse? Such a view is often taken, but the Lamarckian doctrine seems to us just as mystical here as anywhere else, and no more necessary. Progressive changes can be satisfactorily accounted for by natural selection; retrogressive changes are susceptible of explanation along similar lines. When an organ is no longer necessary, as the hind legs of a whale, for instance, natural selection no longer keeps it at the point of perfection. Variation, however, continues to occur in it. Since the organ is now useless, natural selection will no longer restrain variation in such an organ, and degeneracy will naturally follow, for of all the variations that occur in the organ, those tending to loss are more numerous than those

tending to addition. If the embryonic development of a whale's hind leg be compared to some complicated mechanical process, such as the manufacture of a typewriter, it will be easier to realize that a trivial variation which affected one of the first stages of the process would alter all succeeding stages and ruin the final perfection of the machine. It appears, then, that progressive degeneration of an organ can be adequately explained by variation with the removal of natural selection, and that it is not necessary or desirable to appeal to any Lamarckian factor of an unexplainable and undemonstrable nature.

The situation remains the same, when purely mental processes, such as instincts, are considered. Habit often repeated becomes instinctive, it is said; and then the instinct thus formed by the individual is passed on to his descendants and becomes in the end a racial instinct. Most psychologists have now abandoned this view, which receives no support from investigation. Such prevalence as it still retains seems to be largely due to a confusion of thought brought about by the use of the word "instinctive" in two different senses,--first literally and then figuratively.

A persistent attempt has been made in America during recent years, by C. L. Redfield, a Chicago engineer, to rehabilitate the theory of the inheritance of the effects of use and disuse. He has presented it in a way that, to one ignorant of biology, appears very exact and plausible; but his evidence is defective and his interpretation of his evidence fallacious. Because of the widespread publicity, Mr. Redfield's work has received, we discuss it further in Appendix B.

Since the importance of hormones (internal secretions) in the body became known, it has often been suggested that their action may furnish the clue to some sort of an inheritance of modifications. The hormone might conceivably modify the germ-plasm but if so, it would more likely be in some wholly different way.

In general, we may confidently say that there is neither theoretical necessity nor adequate experimental proof for belief that the results of use and disuse are inherited.

(4) When we come to consider whether the effects of the environment are inherited, we attack a stronghold of sociologists and historians. Herbert Spencer thought one of the strongest pieces of evidence in this category was to be found in the assimilation of foreigners in the United States. "The descendants of the immigrant Irish," he pointed out, "lose their Celtic aspect and become Americanised.... To say that 'spontaneous variation,' increased by natural selection, can have produced this effect, is going too far." Unfortunately for Mr. Spencer, he was basing his conclusions on guesswork. It is only within the last few months that the first trustworthy evidence on the point has appeared, in the careful measurements of Hrdlicka who has demonstrated that Spencer was quite wrong in his statement. As a fact, the original traits persist with almost incredible fidelity. (Appendix C.)

In 1911, Franz Boas of Columbia University published measurements of the head form of children of immigrants[14] which purported to show that American conditions caused in some mysterious manner a change in the shape of the head. This conclusion in itself would have been striking enough, but was made more startling when he announced that the change worked both ways: "The East European Hebrew, who has a very round head, becomes more long-headed; the south Italian, who in Italy has an exceedingly long head, becomes more short-headed"; and moreover this potent influence was alleged to be a subtle one "which does not affect the young child born abroad and growing up in American environment, but which makes itself felt among the children born in America, even a short time after the arrival of the parents in this country." Boas' work was naturally pleasing to sociologists who believe in the reality of the "melting-pot," and has obtained widespread acceptance in popular literature. It has obtained little acceptance among his fellow-anthropologists, some of whom allege that it is unsound because of the faulty methods by which the measurements were made and the incorrect standards used for comparison.

[14] Boas, F., *Changes in Body Form of Descendants of Immigrants*, 1911.

The many instances quoted by historians, where races have changed after immigration, are to be explained in most cases by natural selection under new conditions, or by interbreeding with the natives, and not as the direct result of climate. Ellsworth Huntington, the most recent and careful student of the effect of climate on man,[15] finds that climate has a great deal of influence on man's energy, but as far as inherited traits in general are concerned, he is constantly led to remark how little heredity is capable of being changed.

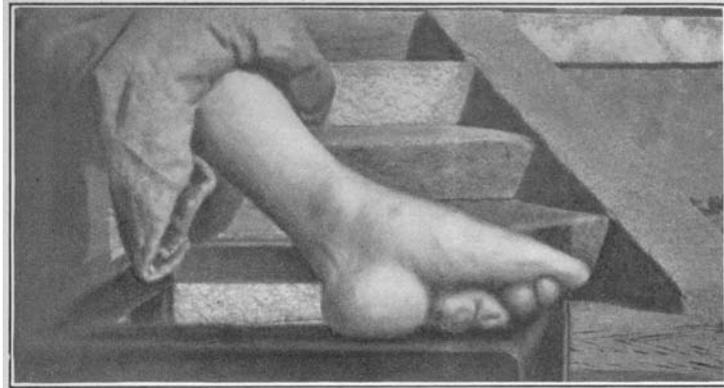
Most members of the white race have little toes that are partly atrophied, and considerably deformed. In many cases one of the joints has undergone ankylosis--that is, the bones have coalesced. It is confidently alleged that this is due to the inheritance of the effects of wearing tight shoes through many centuries. When it is found that the prehistoric Egyptians, who knew not tight shoes, suffered from the same defect in a similar degree, one's confidence in this kind of evidence is much diminished.

The retrogression of the little toe in man is probably to be explained like the degeneration of the hind leg of the whale, as a result of the excess of deteriorating variations which, when not eliminated by natural selection, lead to atrophy. Since man began to limit the use of his feet to walking on the ground, the little toe has had much less value to him.

The feet of Chinese women offer another illustration along this line. Although they have been tightly bound for many generations, no deformity is apparent in the feet of girl babies.

Breeders are generally of the opinion that good care and feed bestowed on their stock produce results in succeeding generations. This is in a way true, but it is due merely to the fact that the offspring get better nourishment and therefore a better start in life. The changes in breeds, the increase in milk yield, and similar facts, often explained as due to inheritance of acquired characters, are better explained as the results of selection, sometimes conscious, sometimes quite unconscious.

[15] *Civilization and Climate*. By Ellsworth Huntington, Yale University Press, 1916.



BOUND FOOT OF A CHINESE WOMAN

FIG. 5.--For centuries the feet of upper class women, and many lower class women, in China have been distorted in this manner; but their daughters have perfect feet when born.



DEFECTIVE LITTLE TOE OF A PREHISTORIC EGYPTIAN

FIG. 6.--The above illustration shows the foot of a prehistoric Egyptian who is estimated to have lived about 8000 B. C. The last joint of the little toe had entirely disappeared, and careful dissection leaves no doubt that it was a germinal abnormality, such as is occasionally seen to-day, and not the result of disease. It is, therefore, evident that the degeneration of man's little toe must be ascribed to some more natural cause than the wearing of shoes for many generations. Photograph from Dr. Gorgy Sobhy, School of Medicine, Cairo.

The question of inherited immunity to diseases, as the result of vaccination or actual illness from them, has appeared in the controversy in a number of forms, and is a point of much importance. It is not yet clear, partly because the doctors disagree as to what immunity is. But there is no adequate evidence that an immunity to anything can be created and transmitted through the germ-plasm to succeeding generations.

In short, no matter what evidence we examine, we must conclude that inheritance of acquired bodily characters is not a subject that need be reckoned with, in applied eugenics.

On the other hand, there is a possible indirect influence of modifications, which may have real importance in man. If the individual is modified in a certain way, in a number of generations, even though such a modification is not transmitted to his descendants, yet its continued existence may make possible, the survival of some germinal variation bearing in the same direction, which without the protecting influence of the pre-existing modification, would have been swamped or destroyed.

Finally, it should be borne in mind that even if physical and mental characters acquired during a man's lifetime are not transmitted, yet there is a sort of transmission of acquired characters which has been of immense importance to the evolution of the race. This is the so-called "inheritance" of the environment; the passing on from one generation to the next of the achievements of the race, its accumulated social experience; its civilization, in short. It is doubtful whether any useful end is gained by speaking of this continuance of the environment as "heredity;" it certainly tends to confuse many people who are not used to thinking in biological terms. Tradition is the preferable term.

There is much to be said in favor of E. B. Poulton's definition,--"Civilization in general is the sum of those contrivances which enable human beings to advance independently of heredity." Whatever wisdom, material gain, or language is acquired by one generation may be passed on to the next. As far as the environment is concerned, one generation stands on the shoulders of its predecessor.

It might simplify the task of eugenics if the same could be said of biological heredity. But it can not. Each generation must "start from scratch."

In August Weismann's words, the development of a function in offspring begins at the point where it *began* in his parents, not at the point where it *ended* in them. Biological improvement of the race (and such improvement greatly fosters all other kinds) must be made through a selective birth-rate. There is no short-cut by way of euthenics, merely.

We must now consider whether there is any direct way of impairing good heredity. It is currently believed that there are certain substances, popularly known as "racial-poisons," which are capable of affecting the germ-plasm adversely and permanently in spite of its isolation and protection. For example, the literature of alcoholism, and much of the literature of eugenics, abounds with statements to the effect that alcohol *originates* degeneracy in the human race.

The proof or disproof of this proposition must depend in the last analysis on direct observation and carefully controlled experiments. As the latter cannot be made feasibly on man, a number of students have taken up the problem by using small animals which are easily handled in laboratories. Many of these experiments are so imperfect in method that, when carefully examined, they are found to possess little or no value as evidence on the point here discussed.

Hodge, Mairet and Combemale, for example, have published data which convinced them that the germ-plasm of dogs was injured by the administration of alcohol. The test was the quality of offspring directly produced by the intoxicated animals under experiment. But the number of dogs used was too small to be conclusive, and there was no "control": hence these experiments carry little weight.

Ovize, Fêrê and Stockard have shown that the effect of alcohol on hen's eggs is to produce malformed embryos. This, however, is a case of influencing the development of the individual, rather than the germ-plasm. Evidence is abundant that individual development can be

harmd by alcohol, but the experiments with eggs are not to the point of our present purpose.

Carlo Todde and others have carried out similar experiments on cocks. The conclusions have in general been in favor of injury to the germ-plasm, but the experiments were inadequate in extent.

Laitinen experimented on rabbits and guinea pigs, but he used small doses and secured only negative results.

Several series of experiments with rats indicate that if the dosage is large enough, the offspring can be affected.

Nice, using very small numbers of white mice, subjected them not only to alcohol, but to caffeine, nicotine, and tobacco smoke. The fecundity of all these sets of mice was higher than that of the untreated ones used as control; all of them gained in weight; of 707 young, none was deformed, none stillborn, and there was only one abortion. The young of the alcoholized mice surpassed all others in growth. The dosage Nice employed was too small, however, to give his experiment great weight.

At the University of Wisconsin, Leon J. Cole has been treating male rabbits with alcohol and reports that "what appear to be decisive results have already been obtained. In the case of alcoholic poisoning of the male the most marked result has been a lessening of his efficiency as a sire, the alcohol apparently having had some effect on the vitality of his spermatozoa." His experiment is properly planned and carried out, but so far as results have been made public, they do not appear to afford conclusive evidence that alcohol originates degeneracy in offspring.

The long-continued and carefully conducted experiment of Charles R. Stockard at the Cornell Medical College is most widely quoted in this connection. He works with guinea-pigs. The animals are intoxicated daily, six days in the week, by inhaling the fumes of alcohol to the point where they show evident signs of its influence; their condition may thus be compared to that of the toper who never gets "dead drunk" but is never entirely sober. Treatment of this sort for a period as long as three years produces no apparent bad effect on the individuals; they

continue to grow and become fat and vigorous, taking plenty of food and behaving in a normal manner in every particular. Some of them have been killed from time to time, and all the tissues, including the reproductive glands, have been found perfectly normal. "The treated animals are, therefore, little changed or injured so far as their behavior and structure goes. Nevertheless, the effects of the treatment are most decidedly indicated by the type of offspring to which they give rise, whether they are mated together or with normal individuals."

Before the treatment is begun, every individual is mated at least once, to demonstrate its possibility of giving rise to sound offspring. The crucial test of the influence of alcohol on the germ-cells is, of course, the mating of a previously alcoholized male with a normal, untreated female, in a normal environment.

When the experiment was last reported,[16] it had covered five years and four generations. The records of 682 offspring produced by 571 matings were tabulated, 164 matings of alcoholized animals, in which either the father, mother, or both were alcoholic, gave 64, or almost 40%, negative results or early abortions, while only 25% of the control matings failed to give full-term litters. Of the 100 full-term litters from alcoholic parents 18% contained stillborn young and only 50% of all the matings resulted in living litters, while 47% of the individuals in the litters of living young died soon after birth. In contrast to this record 73% of the 90 control matings gave living litters and 84% of the young in these litters survived as normal, healthy animals.

"The mating records of the descendants of the alcoholized guinea pigs, although they themselves were not treated with alcohol, compare in some respects even more unfavorably with the control records than do the above data from the directly alcoholized animals." The records of the matings in the second filial generation "are still worse, higher mortality and more pronounced deformities, while the few individuals

[16] *American Naturalist*, L., pp. 65-89, 144-178, Feb. and Mar., 1916.

which have survived are generally weak and in many instances appear to be quite sterile even though paired with vigorous, prolific, normal mates."

We do not minimize the value of this experiment, when we say that too much weight has been popularly placed on its results. Compare it with the experiment with fowls at the University of Maine, which Raymond Pearl reports.[17] He treated 19 fowls with alcohol, little effect on the general health being shown, and none on egg production. From their eggs 234 chicks were produced; the average percentage of fertility of the eggs was diminished but the average percentage of hatchability of fertile eggs was increased. The infant mortality of these chicks was smaller than normal, the chicks were heavier when hatched and grew more rapidly than normal afterwards. No deformities were found. "Out of 12 different characters for which we have exact quantitative data, the offspring of treated parents taken as a group are superior to the offspring of untreated parents in 8 characters," in two characters they are inferior and in the remaining two there is no discernible difference. At this stage Dr. Pearl's experiment is admittedly too small, but he is continuing it. As far as reported, it confirms the work of Professor Nice, above mentioned, and shows that what is true for guinea pigs may not be true for other animals, and that the amount of dosage probably also makes a difference. Dr. Pearl explains his results by the hypothesis that the alcohol eliminated the weaker germs in the parents, and allowed only the stronger germs to be used for reproduction.

Despite the unsatisfactory nature of much of the alleged evidence, we must conclude that alcohol, when given in large enough doses, may sometimes affect the germ-plasm of some lower animals in such a way as to deteriorate the quality of their offspring. This effect is probably an "induction," which does not produce a permanent change in the bases of heredity, but will wear away in a generation or two of good surroundings. It must be remembered that although the second-generation

[17] *Proc. Am. Philos. Soc.* LV, pp. 243-259, 1916.

treated males of Dr. Stockard's experiment produced defective offspring when mated with females from similarly treated stock, they produced normal offspring when mated with normal females. The significance of this fact has been too little emphasized in writings on "racial poisons." If a normal mate will counteract the influence of a "poisoned" one, it is obvious that the probabilities of danger to any race from this source are much decreased, while if only a small part of the race is affected, and mates at random, the racial damage might be so small that it could hardly be detected.

There are several possible explanations of the fact that injury is found in some experiments but not in others. It may be, as Dr. Pearl thinks, that only weak germs are killed by moderate treatment, and the strong ones are uninjured. And it is probable (this applies more particularly to man) that the body can take care of a certain amount of alcohol without receiving any injury therefrom; it is only when the dosage passes the "danger point" that the possibility of injury appears. As to the location of this limit, which varies with the species, little is known. Much more work is needed before the problem will be fully cleared up.

Alcohol has been in use in parts of the world for many centuries; it was common in the Orient before the beginning of historical knowledge. Now if its use by man impairs the germ-plasm, then it seems obvious that the child of one who uses alcohol to a degree sufficient to impair his germ-plasm will tend to be born inferior to his parent. If that child himself is alcoholic, his own offspring will suffer still more, since they must carry the burden of two generations of impairment. Continuing this line of reasoning over a number of generations, in a race where alcohol is freely used by most of the population, one seems unable to escape from the conclusion that the effects of this racial poison, if it be such, must necessarily be cumulative. The damage done to the race must increase in each generation. If the deterioration of the race could be measured, it might even be found to grow in a series of figures representing arithmetical progression.

It seems impossible, with such a state of affairs, that a race in which alcohol was widely used for a long period of time, could avoid extinction. At any rate, the races which have used alcohol longest ought to show great degeneracy--unless there be some regenerative process at work constantly counteracting this cumulative effect of the racial poison in impairing the germ-plasm.

Such a proposition at once demands an appeal to history. What is found in examination of the races that have used alcohol the longest? Have they undergone a progressive physical degeneracy, as should be expected?

By no means. In this particular respect they seem to have become stronger rather than weaker, as time went on; that is, they have been less and less injured by alcohol in each century, as far as can be told. Examination of the history of nations which are now comparatively sober, although having access to unlimited quantities of alcohol, shows that at an earlier period in their history, they were notoriously drunken; and the sobriety of a race seems to be proportioned to the length of time in which it has had experience of alcohol. The Mediterranean peoples, who have had abundance of it from the earliest period recorded, are now relatively temperate. One rarely sees a drunkard among them, although many individuals in them would never think of drinking water or any other non-alcoholic beverage. In the northern nations, where the experience of alcohol has been less prolonged, there is still a good deal of drunkenness, although not so much as formerly. But among nations to whom strong alcohol has only recently been made available--the American Indian, for instance, or the Eskimo--drunkenness is frequent wherever the protecting arm of government does not interfere.

What bearing does this have on the theory of racial poisons?

Surely a consideration of the principle of natural selection will make it clear that alcohol is acting as an instrument of racial purification through the elimination of weak stocks. It is a drastic sort of purification, which one can hardly view with complacency; but the effect, nevertheless, seems clear cut.

To demonstrate the action of natural selection, we must first demonstrate the existence of variations on which it can act. This is

not difficult in the character under consideration--namely, the greater or less capacity of individuals to be attracted by alcohol, to an injurious degree.

As G. Archdall Reid has pointed out,[18] men drink for at least three different reasons: (1) to satisfy thirst. This leads to the use of a light wine or a malt liquor. (2) To gratify the palate. This again usually results in the use of drinks of low alcohol content, in which the flavor is the main consideration. (3) Finally, men drink "to induce those peculiar feelings, those peculiar frames of mind" caused by alcohol.

Although the three motives may and often do coexist in the same individual, or may animate him at different periods of life, the fact remains that they are quite distinct. Thirst and taste do not lead to excessive drinking; and there is good evidence that the degree of concentration and the dosage are important factors in the amount of harm alcohol may do to the individual. The concern of evolutionists, therefore, is with the man who is so constituted that the mental effects of alcohol acting directly on the brain are pleasing, and we must show that there is a congenital variability in this mental quality, among individuals.

Surely an appeal to personal experience will leave little room for doubt on that point. The alcohol question is so hedged about with moral and ethical issues that those who never get drunk, or who perhaps never even "take a drink," are likely to ascribe that line of conduct to superior intelligence and great self-control. As a fact, a dispassionate analysis of the case will show that why many such do not use alcoholic beverages to excess is because intoxication has no charm for them. He is so constituted that the action of alcohol on the brain is distasteful rather than pleasing to him. In other cases it is variation in controlling satisfaction of immediate pleasures for later greater good.

Some of the real inebriates have a strong will and a real desire to be

[18] Dr. Reid is the author who has most effectively called attention to this relation between alcohol and natural selection. Those interested will find a full treatment in his books, *The Present Evolution of Man*, *The Laws of Heredity*, and *The Principles of Heredity*.

sober, but have a different mental make-up, vividly described by William James:[19] "The craving for drink in real dipsomaniacs, or for opium and chloral in those subjugated, is of a strength of which normal persons can have no conception. 'Were a keg of rum in one corner of the room, and were a cannon constantly discharging balls between me and it, I could not refrain from passing before that cannon in order to get that rum. If a bottle of brandy stood on one hand, and the pit of hell yawned on the other, and I were convinced I should be pushed in as surely as I took one glass, I could not refrain.' Such statements abound in dipsomaniacs' mouths." Between this extreme, and the other of the man who is sickened by a single glass of beer, there are all intermediates.

Now, given an abundant and accessible supply of alcohol to a race, what happens? Those who are not tempted or have adequate control, do not drink to excess; those who are so constituted as to crave the effects of alcohol (once they have experienced them), and who lack the ability to deny themselves the immediate pleasure for the sake of a future gain, seek to renew these pleasures of intoxication at every opportunity; and the well attested result is that they are likely to drink themselves to a premature death.

Although it is a fact that the birth-rate in drunkard's families may be and often is larger than that of the general population,[20] it is none the less a fact that many of the worst drunkards leave no or few offspring. They die of their own excesses at an early age; or their conduct makes them unattractive as mates; or they give so little care to their children that the latter die from neglect, exposure or accident. As these drunkards would tend to hand down their own inborn peculiarity, or weakness for alcohol, to their children, it must be obvious that their death results in a smaller proportion of such persons in the next generation. In other words, natural selection is at work again here,

[19] *Principles of Psychology*, ii, p. 543.

[20] Leon J. Cole points out that this may be due in considerable part to less voluntary restriction of offspring on the part of those who are often under the influence of alcohol.

with alcohol as its agent. By killing off the worst drunkards in each generation, nature provides that the following generation shall contain fewer people who lack the power to resist the attraction of the effect of alcohol, or who have a tendency to use it to such an extent as to injure their minds and bodies. And it must be obvious that the speed and efficacy of this ruthless temperance reform movement are proportionate to the abundance and accessibility of the supply of alcohol. Where the supply is ample and available, there is certain to be a relatively high death-rate among those who find it too attractive, and the average of the race therefore is certain to become stronger in this respect with each generation. Such a conclusion can be abundantly justified by an appeal to the history of the Teutonic nations, the nations around the Mediterranean, the Jews, or any race which has been submitted to the test.

There seems hardly room for dispute on the reality of this phase of natural selection. But there is another way in which the process of strengthening the race against the attraction and effect of alcohol may be going on at the same time. If the drug does actually injure the germ-plasm, and set up a deterioration, it is obvious that natural selection is given another point at which to work. The more deteriorated would be eliminated in each generation in competition with the less deteriorated or normal; and the process of racial purification would then go on the more rapidly. The fact that races long submitted to the action of alcohol have become relatively resistant to it, therefore, does not in itself answer the question of whether alcohol injures the human germ-plasm.

The possible racial effect of alcoholization is, in short, a much more complicated problem than it appears at first sight to be. It involves the action of natural selection in several important ways, and this action might easily mask the direct action of alcohol on the germ-plasm, if there be any measurable direct result.

No longer content with a long perspective historical view, we will scrutinize the direct investigations of the problem which have been made during recent years. These investigations have in many cases been

widely advertised to the public, and their conclusions have been so much repeated that they are often taken at their face value, without critical examination.

It must be borne in mind that the solution of the problem depends on finding evidence of degeneracy or impairment in the offspring of persons who have used alcohol, and that this relation might be explainable in one or more of three ways:

(1) It may be that alcoholism is merely a symptom of a degenerate stock. In this case the children will be defective, not because their parents drank, but because their parents were defective--the parents' drinking being merely one of the symptoms of their defect.

(2) It may be that alcohol directly poisons the germ-plasm, in such a way that parents of sound stock, who drink alcoholic beverages, will have defective offspring.

(3) It may be that the degeneracy observed in the children of drunkards (for of course no one will deny that children of drunkards are frequently defective) is due solely to social and economic causes, or other causes in the environment: that the drunken parents, for instance, do not take adequate care of their children, and that this lack of care leads to the defects of the children.

The latter influence is doubtless one that is nearly always at work, but it is wholly outside the scope of the present inquiry, and we shall therefore ignore it, save as it may appear incidentally. Nor does it require emphasis here; for the disastrous social and economic effects of alcoholism are patent to every observer. We find it most convenient to concentrate our attention first on the second of the questions above enumerated: to ask whether there is any good evidence that the use of alcoholic beverages by men and women really does originate degeneracy in their offspring.

To get such evidence, one must seek an instance that will be crucial, one that will leave no room for other interpretations. One must, therefore, exclude consideration of cases where a mother drank before child birth. It is well-known that alcohol can pass through the placenta, and that if a prospective mother drinks, the percentage of alcohol in the circulation of the unborn child will very soon be nearly

equal to that in her own circulation. It is well established that such a condition is extremely injurious to the child; but it has nothing directly to do with heredity. Therefore we can not accept evidence of the supposed effect of alcohol on the fertilized egg-cell, at any stage in its development, because that is an effect on the individual, not on posterity. And the only means by which we can wholly avoid this fallacy is to give up altogether an attempt to prove our case by citing instances in which the mother was alcoholic. If this is not done, there will always be liability of mistaking an effect of prenatal nutrition for a direct injury to the germ-plasm.

But if we can find cases where the mother was of perfectly sound stock, and non-alcoholic; where the father was of sound stock, but alcoholic; and where the offspring were impaired in ways that can be plausibly attributed to an earlier injury to the germ-plasm by the father's alcohol; then we have evidence that must weigh heavily with the fair-minded.

An interesting case is the well-known one recorded by Schweighofer, which is summarized as follows: "A normal woman married a normal man and had three sound children. The husband died and the woman married a drunkard and gave birth to three other children; one of these became a drunkard; one had infantilism, while the third was a social degenerate and a drunkard. The first two of these children contracted tuberculosis, which had never before been in the family. The woman married a third time and by this sober husband again produced sound children."

Although such evidence is at first sight pertinent, it lacks much of being convincing. Much must be known about the ancestry of the drunken husband, and of the woman herself, before it can be certain that the defective children owe their defect to alcoholism rather than to heredity.

We can not undertake to review all the literature of this subject, for it fills volumes, but we shall refer to a few of the studies which are commonly cited, by the believers in the racial-poison character of alcohol, as being the most weighty.

Taav Laitinen of Helsingfors secured information from the parents of 2,125 babies, who agreed to weigh their infants once a month for the first eight months after birth, and who also furnished information about their own drinking habits. His conclusion is that the average weight of the abstainer's child is greater at birth, that these children develop more rapidly during the first eight months than do the children of the moderate drinker, and that the latter exceed in the same way the children of the heavier drinker. But a careful analysis of his work by Karl Pearson, whose great ability in handling statistics has thrown light on many dark places in the alcohol problem, shows[21] that Professor Laitinen's statistical methods were so faulty that no weight can be attached to his conclusions. Furthermore, he appears to have mixed various social classes and races together without distinction; and he has made no distinction between parents, one of whom drank, and parents, both of whom drank. Yet, this distinction, as we have pointed out, is a critical one for such inquiries. Professor Laitinen's paper, according to one believer in racial poisons, "surpasses in magnitude and precision all the many studies of this subject which have proved the relation between drink and degeneracy." As a fact, it proves nothing of the sort as to race degeneracy.

Again, T. A. MacNicholl reported on 55,000 American school children, from 20,147 of whom he secured information about the parents' attitude to alcoholic drinks. He found an extraordinarily large proportion (58%) of deficient and backward children in the group. But the mere bulk of his work, probably, has given it far more prestige than it deserves; for his methods are careless, his classifications vague, his information inadequate; he seems to have dealt with a degenerate section of the population, which does not offer suitable material for testing the question at issue; and he states that many of the children drank and

[21] For a review of the statistical problems involved, see Karl Pearson. An attempt to correct some of the misstatements made by Sir Victor Horsley, F. R. S., F. R. C. S., and Mary D. Sturge, M. D., in their criticisms of the Galton Laboratory Memoir: *First Study of the Influence of Parental Alcoholism, etc.*; and Professor Pearson's various popular lectures, also *A Second Study of the Influence of Parental Alcoholism on the Physique and Intelligence of Offspring*. By Karl Pearson and Ethel M. Elderton. Eugenics Laboratory Memoir Series XIII.

smoked,--hence, any defects found in them may be due to their own intemperance, rather than that of their parents. In short, Dr. MacNicholl's data offer no help in an attempt to decide whether alcoholism is an inheritable effect.

Another supposed piece of evidence which has deceived a great many students is the investigation of Bezzola into the distribution of the birth-rate of imbeciles in Switzerland. He announced that in wine-growing districts the number of idiots conceived at the time of the vintage and carnival is very large, while at other periods it is almost *nil*. The conclusion was that excesses of drunkenness occurring in connection with the vintage and carnival caused this production of imbeciles. But aside from the unjustified assumptions involved in his reasoning, Professor Pearson has recently gone over the data and shown the faulty statistical method; that, in fact, the number of imbeciles conceived at vintage-time, in excess of the average monthly number, was only three in spite of the large numbers! Bezzola's testimony, which has long been cited as proof of the disastrous results of the use of alcohol at the time of conception, must be discarded.

Demme's plausible investigation is also widely quoted to support the belief that alcohol poisons the germ-plasm. He studied the offspring of 10 drunken and 10 sober pairs of parents, and found that of the 61 children of the latter, 50 were normal, while of the 57 progeny of the drunkards, only nine were normal. This is a good specimen of much of the evidence cited to prove that alcohol impairs the germ-plasm; it has been widely circulated by propagandists in America during recent years. Of course, its value depends wholly on whether the 20 pairs of parents were of sound, comparable stock. Karl Pearson has pointed out that this is not the case. Demme selected his children of drunkards by selecting children who came to his hospital on account of imperfect development of speech, mental defect, imbecility or idiocy. When he found families in which such defective children occurred, he then inquired as to their ancestry. Many of these children, he found, were reduced to a condition approaching epilepsy, or actually epileptic, because they themselves

were alcoholic. Obviously such material can not legitimately be used to prove that the use of alcohol by parents injures the heredity of their children. The figures do not at all give the proof we are seeking, that alcohol can so affect sound germ-plasm as to lead to the production of defective children.

Dr. Bertholet made a microscopic examination of the reproductive glands of 75 chronic male alcoholics, and in 37 cases he found them more or less atrophied, and devoid of spermatozoa. Observing the same glands in non-alcoholics who had died of various chronic diseases, such as tuberculosis, he found no such condition. His conclusion is that the reproductive glands are more sensitive to the effects of alcohol than any other organ. So far as is known to us, his results have never been discredited; they have, on the contrary, been confirmed by other investigators. They are of great significance to eugenics, in showing how the action of natural selection to purge the race of drunkards is sometimes facilitated in a way we had not counted, through reduced fertility due to alcohol, as well as through death due to alcohol. But it should not be thought that his results are typical, and that all chronic alcoholists become sterile: every reader will know of cases in his own experience, where drunkards have large families; and the experimental work with smaller animals also shows that long-continued inebriety is compatible with great fecundity. It is probable that extreme inebriety reduces fertility, but a lesser amount increases it in the cases of many men by reducing the prudence which leads to limited families.

In 1910 appeared the investigation of Miss Ethel M. Elderton and Karl Pearson on school children in Edinburgh and Manchester.[22] Their aim was to take a population under the same environmental conditions, and with no discoverable initial differentiation, and inquire whether the

[22] *A First Study of the Influence of Parental Alcoholism on the Physique and Intelligence of Offspring*. By Ethel M. Elderton and Karl Pearson. Eugenics Laboratory Memoir Series X. Harald Westergaard, who reexamined the Elderton-Pearson data, concludes that considerable importance is to be attached to the selective action of alcohol, the weaklings in the alcoholic families having been weeded out early in life.

temperate and intemperate sections had children differing widely in physique and mentality. Handling their material with the most refined statistical methods, and in an elaborate way, they reached the conclusion that parental alcoholism does not markedly affect the physique or mentality of the offspring as children. Whether results might differ in later life, their material did not show. Their conclusions were as follows:

"(1) There is a higher death-rate among the offspring of alcoholic than among the offspring of sober parents. This appears to be more marked in the case of the mother than in the case of the father, and since it is sensibly higher in the case of the mother who has drinking bouts [periodical sprees] than of the mother who habitually drinks, it would appear to be due very considerably to accidents and gross carelessness and possibly in a minor degree to toxic effect on the offspring.

"Owing to the greater fertility of alcoholic parents, the net family of the sober is hardly larger than the net family of the alcoholic. [It should be remembered that the study did not include childless couples.]

"(2) The mean weight and height of the children of alcoholic parents are slightly greater than those of sober parents, but as the age of the former children is slightly greater, the correlations when corrected for age are slightly positive, i.e., there is slightly greater height and weight in the children of the sober."

"(3) The wages of the alcoholic as contrasted with the sober parent show a slight difference compatible with the employers' dislike for an alcoholic employee, but wholly inconsistent with a marked mental or physical inferiority in the alcoholic parent.

"(4) The general health of the children of alcoholic parents appears on the whole slightly better than that of sober parents. There are fewer delicate children, and in a most marked way cases of tuberculosis and epilepsy are less frequent than among the children of sober parents. The source of this relation may be sought in two directions; the physically strongest in the community have probably the greatest capacity and taste for alcohol. Further the higher death rate of the children of alcoholic

parents probably leaves the fittest to survive. Epilepsy and tuberculosis both depending upon inherited constitutional conditions, they will be more common in the parents of affected offspring, and probably if combined with alcohol, are incompatible with any length of life or size of family. If these views be correct, we can only say that parental alcoholism has no marked effect on filial health.

"(5) Parental alcoholism is not the source of mental defect in offspring.

"(6) The relationship, if any, between parental alcoholism and filial intelligence is so slight that even its sign can not be determined from the present material.

"(7) The normal visioned and normal refractioned offspring appear to be in rather a preponderance in the families of the drinking parents, the parents who have 'bouts' give intermediate results, but there is no substantial relationship between goodness of sight and parental alcoholism. Some explanation was sought on the basis of alcoholic homes driving the children out into the streets. This was found to be markedly the case, the children of alcoholic parents spending much more of their spare time in the streets. An examination, however, of the vision and refraction of children with regard to the time they spent in-and out-of-doors, showed no clear and definite result, the children who spent the whole or most of their spare time in the streets having the most myopia and also most normal sight. It was not possible to assert that the outdoor life was better for the sight, or that the better sight of the offspring of alcoholic parentage was due to the greater time spent outdoors.

"(8) The frequency of diseases of the eye and eyelids, which might well be attributed to parental neglect, was found to have little, if any, relation to parental alcoholism.

"To sum up, then no *marked* relation has been found between the intelligence, physique or disease of the offspring and the parental alcoholism in any of the categories mentioned. On the whole the balance turns as often in favor of the alcoholic as of the non-alcoholic parentage. It is needless to say that we do not attribute this to the

alcohol but to certain physical and possibly mental characters which appear to be associated with the tendency to alcohol."

Of the many criticisms made of this work, most are irrelevant to our present purpose, or have been satisfactorily met by the authors. It must be said, however, that as the children examined were all school children, the really degenerate offspring of alcoholics, if any such existed, would not have been found, because they would not have been admitted to the school. Further, it is not definitely known whether the parents' alcoholism dated from before or after the birth of the child examined. Then, the report did not exactly compare the offspring of drinkers and non-drinkers, but classified the parents as those who drank, and those who were sober; the latter were not, for the most part, teetotalers, but merely persons whose use of alcohol was so moderate that it exercised no visible bad influence on the health of the individual or the welfare of the home. Something can be said on both sides of all these objections; but giving them as much weight as one thinks necessary, the fact remains that the Elderton-Pearson investigation failed to demonstrate any racial poisoning due to alcohol, in the kind of cases where one would certainly have expected it to be demonstrated, if it existed.

Much more observation and measurement must be made before a generalization can be safely drawn, as to whether alcohol is or is not a racial poison, in the sense in which that expression is used by eugenists. It has been shown that the evidence which is commonly believed to prove beyond doubt that alcohol does injure the germ-plasm, is mostly worthless. But it must not be thought that the authors intend to deny that alcohol is a racial poison, where the dosage is very heavy and continuous. If we have no good evidence that it is, we equally lack evidence on the other side. We wish only to suggest caution against making rash generalizations on the subject which lack supporting evidence and therefore are a weak basis for propaganda.

So far as immediate action is concerned, eugenics must proceed on the basis that there is no proof that alcohol as ordinarily consumed will injure the human germ-plasm. To say this is not in any way to minify

the evil results which alcohol often has on the individual, or the disastrous consequences to his offspring, eugenically. But nothing is to be gained by making an assumption of "racial poisoning," and acting on that assumption, without evidence that it is true; and the temperance movement would command more respect from genetics if it ceased to allege proof that alcohol has a directly injurious effect on the race, by poisoning the human germ-plasm, when no adequate proof exists.

How, then, can one account for the immense bulk of cases, some of which come within everyone's range of vision, where alcoholism in the parent is associated with defect in the offspring? By a process of exclusion, we are driven to the explanation already indicated: that alcoholism may be a symptom, rather than a cause, of degeneracy. Some drunkards are drunkards, because they come of a stock that is, in a way, mentally defective; physical defects are frequently correlated in such stocks; naturally the children inherit part or all of the parental defects including, very likely, alcoholism; but the parent's alcoholism, we repeat, must not be considered the cause of the child's defect. The child would have been defective in the same way, regardless of the parent's beverage.

It follows, then, as a practical consequence for eugenics, that in the light of present knowledge any campaign against alcoholic liquors would be better based on the very adequate ground of physiology and economics, than on genetics. From the narrowest point of view of genetics, the way to solve the liquor problem would be, not to eliminate drink, but to eliminate the drinker: to prevent the reproduction of the degenerate stocks and the tainted strains that contribute most of the chronic alcoholics. We do not mean to advocate this as the only proper basis for the temperance campaign, because the physiological and economic aspects are of sufficient importance to keep up the campaign at twice the present intensity.[23] But it is desirable to have the eugenic aspect of the matter clearly understood, and to point out that in checking the

[23] Prohibition would have some *indirect* eugenic effects, which will be discussed in Chapter XVIII.

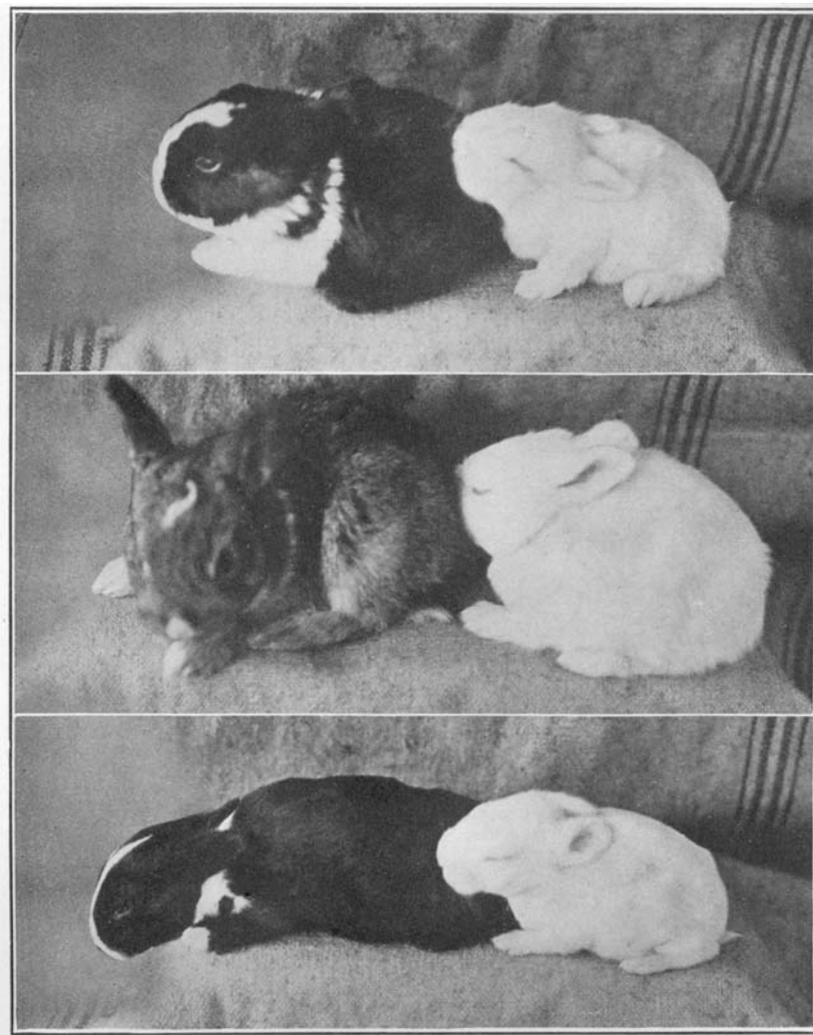
production of defectives in the United States, eugenics will do its share, and a big share, toward the solution of the drink problem, which is at the same time being attacked along other and equally praiseworthy lines by other people.

A number of other substances are sometimes credited with being racial poisons.

The poison of *Spirochæte pallida*, the microörganism which causes syphilis, has been widely credited with a directly noxious effect on the germ-plasm, and the statement has been made that this effect can be transmitted for several generations. On the other hand, healthy children are reported as being born to cured syphilitics. Further evidence is needed, taking care to eliminate cases of infection from the parents. If the alleged deterioration really occurs, it will still remain to be determined if the effect is permanent or an induction, that is, a change in the germ-cells which does not permanently alter the nature of the inherited traits, and which would disappear in a few generations under favorable conditions.

The case against lead is similar. Sir Thomas Oliver, in his *Diseases of Occupation*, sums up the evidence as follows:

"Rennert has attempted to express in statistical terms the varying degrees of gravity in the prognosis of cases in which at the moment of conception both parents are the subjects of lead poisoning, also when one alone is affected. The malign influence of lead is reflected upon the fetus and upon the continuation of the pregnancy 94 times out of 100 when both parents have been working in lead, 92 times when the mother alone is affected, and 63 times when it is the father alone who has worked in lead. Taking seven healthy women who were married to lead workers, and in whom there was a total of 32 pregnancies, Lewin (Berlin) tells us that the results were as follows: 11 miscarriages, one stillbirth, 8 children died within the first year after their birth, four in the second year, five in the third year and one subsequent to this, leaving only two children out of 32 pregnancies as likely to live to manhood. In cases where women have had a series of miscarriages so



EFFECT OF LEAD AS A "RACIAL POISON"

FIG. 7.--That lead poisoning can affect the germ plasm of rabbits is indicated by experiments conducted by Leon J. Cole at the University of Wisconsin. With reference to the above illustration, Professor Cole writes: "Each of the photographs shows two young from the same litter, in all cases the mother being a normal (nonpoisoned) albino. In each of the litters the white young is from an albino father which received the lead treatment, while the pigmented offspring is from a normal, homozygous, pigmented male. While these are, it is true, selected individuals, they represent what tend to be average, rather than extreme, conditions. The albino male was considerably larger than the pigmented male; nevertheless his young average distinctly smaller in size. Note also the brighter expression of the pigmented young."

long as their husbands worked in lead, a change of industrial occupation on the part of the husband restores to the wives normal child-bearing powers." The data of Constantin Paul, published as long ago as 1860, indicated that lead exercised an injurious effect through the male as well as the female parent. This sort of evidence is certainly weak, in that it fails to take into account the possible effects of environment; and one would do well to keep an open mind on the subject. In a recent series of careful experiments at the University of Wisconsin, Leon J. Cole has treated male rabbits with lead. He reports: "The 'leaded' males have produced as many or more offspring than normal fathers, but their young have averaged smaller in size and are of lowered vitality, so that larger numbers of them die off at an early age than is the case with those from untreated fathers."

There is, then, a suspicion that lead is a racial poison, but no evidence as yet as to whether the effect is permanent or in the nature of an induction.

This concludes the short list of substances for which there has been any plausible case made out, as racial poisons. Gonorrhoea, malaria, arsenic, tobacco, and numerous other substances have been mentioned from time to time, and even ardently contended by propagandists to be racial poisons, but in the case of none of them, so far as we know, is there any evidence to support the claim. And as has been shown, in the case of the three chief so-called racial poisons, alcohol, syphilis and lead, the evidence is not great. We are thus in a position to state that, from the eugenists' point of view, the *origination* of degeneracy, by some direct action of the germ-plasm, is a contingency that hardly needs to be reckoned with. Even in case the evidence were much stronger than it is, the damage done may only be a physiological or chemical induction, the effects of which will wear off in a few generations; rather than a radical change in the hereditary constituents of the germ-plasm. The germ-plasm is so carefully isolated and guarded that it is almost impossible to injure it, except by treatment so severe as to kill it altogether; and the degeneracy with which eugenists are called on to

deal is a degeneracy which is running along from generation to generation and which, when once stopped by the cessation of reproduction, is in little danger of being originated anew through some racial poison.

Through these facts, the problem of race betterment is not only immensely simplified, but it is clearly shown to be more a matter for treatment by the biologist, acting through eugenics, than for the optimistic improver of the environment.

There is another way in which it is widely believed that some such result as a direct influence of the germ-plasm can be produced: that is through the imaginary process known as maternal impression, prenatal influence, etc. Belief in maternal impressions is no novelty. In the book of Genesis[24] Jacob is described as making use of it to get the better of his tricky father-in-law. Some animal breeders still profess faith in it as a part of their methods of breeding: if they want a black calf, for instance, they will keep a white cow in a black stall, and express perfect confidence that her offspring will resemble midnight darkness. It is easy to see that this method, if it "works," would be a potent instrument for eugenics. And it is being recommended for that reason. Says a recent writer, who professes on the cover of her book to give a "complete and intelligent summary of all the principles of eugenics":

"Too much emphasis can not be placed upon the necessity of young people making the proper choice of mates in marriage; yet if the production of superior children were dependent upon that one factor, the outlook would be most discouraging to prospective fathers and mothers, for weak traits of character are to be found in all. But when young people learn that by a conscious endeavor to train themselves, they are thereby training their unborn children, they can feel that there is some hope and joy in

[24] Chapter XXX, verses 31-43. A knowledge of the pedigree of Laban's cattle would undoubtedly explain where the stripes came from. It is interesting to note how this idea persists: a correspondent has recently sent an account of seven striped lambs born after their mothers had seen a striped skunk. The actual explanation is doubtless that suggested by Heller in the *Journal of Heredity*, VI, 480 (October, 1915), that a stripe is part of the ancestral coat pattern of the sheep, and appears from time to time because of reversion.

parentage; that it is something to which they can look forward with delight and even rapture; then they will be inspired to work hard to attain the best and highest that there is in them, leading the lives that will not only be a blessing to themselves, but to their succeeding generation."

The author of this quotation has no difficulty in finding supporters. Many physicians and surgeons, who are supposed to be trained in scientific methods of thought, will indorse what she says. The author of one of the most recent and in many respects admirable books on the care of babies, is almost contemptuous in her disdain for those who think otherwise:

"Science wrangles over the rival importance of heredity and environment, but we women know what effects prenatal influence works on children."
"The woman who frets brings forth a nervous child. The woman who rebels generally bears a morbid child." "Self-control, cheerfulness and love for the little life breathing in unison with your own will practically insure you a child of normal physique and nerves."

Such statements, backed up by a great array of writers and speakers whom the layman supposes to be scientific, and who think themselves scientific, can not fail to influence strongly an immense number of fathers and mothers. If they are truly scientific statements, their general acceptance must be a great good.

But think of the misplaced effort if these widespread statements are false!

Is there, or is there not, a short cut to race betterment? Everyone interested in the welfare of the race must feel the necessity of getting at the truth in the case; and the truth can be found only by rigorously scientific thought.

Let us turn to the observed facts. This sample is taken from the health department of a popular magazine, quite recently issued:

"Since birth my body has been covered with scales strikingly resembling the surface of a fish. My parents and I have expended considerable money on remedies and specialists without deriving any permanent benefit. I bathe my entire body with hot water daily, using the best quality of

soap. The scales fall off continually. My brother, who is younger than myself, is afflicted with the same trouble, but in a lesser degree. My sister, the third member of the family, has been troubled only on the knees and abdomen. My mother has always been quite nervous and susceptible to any unusual mental impression. She believes that she marked me by craving fish, and preferring to clean them herself. During the prenatal life of my brother, she worried much lest she might mark him in the same way. In the case of my sister she tried to control her mind." [25]

Another is taken from a little publication which is devoted to eugenics. [26] As a "horrible example" the editor gives the case of Jesse Pomeroy, a murderer whom older readers will remember. His father, it appears, worked in a meat market. Before the birth of Jesse, his mother went daily to the shop to carry a luncheon to her husband, and her eyes naturally fell upon the bloody carcasses hung about the walls. Inevitably, the sight of such things would produce bloody thoughts in the mind of the unborn child!

These are extreme cases; we quote from a medieval medical writer another case that carries the principle to its logical conclusion: A woman saw a Negro,--at that time a rarity in Europe. She immediately had a sickening suspicion that her child would be born with a black skin. To obviate the danger, she had a happy inspiration--she hastened home and washed her body all over with warm water. When the child appeared, his skin was found to be normally white--except between the fingers and toes, where

[25] Such a skin affection, known as ichthyosis, xerosis or xeroderma, is usually due to heredity. Davenport says it "is especially apt to be found in families in which consanguineous marriages occur and this fact, together with the pedigrees [which he studied], suggests that it is due to the absence of some factor that controls the process of cornification of the skin. On this hypothesis a normal person who belongs to an affected family may marry into a normal family with impunity, but cousin marriages are to be avoided." See Davenport, C. B., *Heredity in Relation to Eugenics*, p. 134. New York, 1911.

[26] Its eugenics is to be effected through the mental exertion of mothers. And we have lately been in correspondence with a western attorney who is endeavoring to form an association of persons who will agree to be the parents of "willed" children. By this means, he has calculated (and sends a chart to prove it) that it will require only four generations to produce the Superman.

it was black. His mother had failed to wash herself thoroughly in those places!

Of course, few of the cases now credited are as gross as this, but the principle involved remains the same.

We will take a hypothetical case of a common sort for the sake of clearness: the mother receives a wound on the arm; when her child is born it is found to have a scar of some sort at about the same place on the corresponding arm. Few mothers would fail to see the result of a maternal impression here. But how could this mark have been transmitted? This is not a question of the transmission of acquired characters through the germ-plasm, or anything of that sort, for the child was already formed when the mother was injured. One is obliged, therefore, to believe that the injury was in some way transmitted through the placenta, the only connection between the mother and the unborn child; and that it was then reproduced in some way in the child.

Here is a situation which, examined in the cold light of reason, puts a heavy enough strain on the credulity. Such an influence can reach the embryo only through the blood of the mother. Is it conceivable to any rational human being, that a scar, or what not, on the mother's body can be dissolved in her blood, pass through the placenta into the child's circulation, and then gather itself together into a definite scar on the infant's arm?

There is just as much reason to expect the child to grow to resemble the cow on whose milk it is fed after birth, as to expect it to grow to resemble its mother, because of prenatal influence, as the term is customarily used, for once development has begun, the child draws nothing more than nourishment from its mother.

Of course we are accustomed to the pious rejoinder that man must not expect to understand all the mysteries of life; and to hear vague talk about the wonder of wireless telegraphy. But wireless telegraphy is something very definite and tangible--there is little mystery about it. Waves of a given frequency are sent off, and caught by an instrument attuned to the same frequency. How any rational person can support a

belief in maternal impressions by such an analogy, if he knows anything about anatomy and physiology, passes comprehension.

Now we are far from declaring that a reason can be found for everything that happens. Science does not refuse belief in an observed fact merely because it is unexplainable. But let us examine this case of maternal impressions a little further. What can be learned of the time element?

Immediately arises the significant fact that most of the marks, deformities and other effects which are credited to prenatal influence must on this hypothesis take place at a comparatively late period in the antenatal life of the child. The mother is frightened by a dog; the child is born with a dog-face. If it be asked when her fright occurred, it is usually found that it was not earlier than the third month, more likely somewhere near the sixth.

But it ought to be well known that the development of all the main parts of the body has been completed at the end of the second month. At that time, the mother rarely does more than suspect the coming of the child, and events which she believes to "mark" the child, usually occur after the fourth or fifth month, when the child is substantially formed, and it is impossible that many of the effects supposed to occur could actually occur. Indeed, it is now believed that most errors of development, such as lead to the production of great physical defects, are due to some cause within the embryo itself, and that most of them take place in the first three or four weeks, when the mother is by no means likely to influence the course of embryological development by her mental attitude toward it, for the very good reason that she knows nothing about it.

Unless she is immured or isolated from the world, nearly every expectant mother sees many sights of the kind that, according to popular tradition, cause "marks." Why is it that results are so few? Why is it that women doctors and nurses, who are constantly exposed to unpleasant sights, have children that do not differ from those of other mothers?

Darwin, who knew how to think scientifically, saw that this is the logical line of proof or disproof. When Sir Joseph Hooker, the botanist

and geologist who was his closest friend, wrote of a supposed case of maternal impression, one of his kinswomen having insisted that a mole which appeared on her child was the effect of fright upon herself for having, before the birth of the child, blotted with sepia a copy of Turner's *Liber Studiorum* that had been lent her with special injunctions to be careful, Darwin[27] replied: "I should be very much obliged, if at any future or leisure time you could tell me on what you ground your doubtful belief in imagination of a mother affecting her offspring. I have attended to the several statements scattered about, but do not believe in more than accidental coincidences. W. Hunter told my father, then in a lying-in hospital, that in many thousand cases he had asked the mother, before her confinement, whether anything had affected her imagination, and recorded the answers; and absolutely not one case came right, though, when the child was anything remarkable, they afterwards made the cap to fit."

Any doctor who has handled many maternity cases can call to mind instances where every condition was present to perfection, for the production of maternal impression, on the time-honored lines. None occurred. Most mothers can, if they give the matter careful consideration, duplicate this experience from their own. Why is it that results are so rare?

That Darwin gave the true explanation of a great many of the alleged cases is perfectly clear to us. When the child is born with any peculiar characteristic, the mother hunts for some experience in the preceding months that might explain it. If she succeeds in finding any experience of her own at all resembling in its effects the effect which the infant shows, she considers she has proved causation, has established a good case of prenatal influence.

It is not causation; it is coincidence.

If the prospective mother plays or sings a great deal, with the idea of giving her child a musical endowment, and the child actually turns out to have musical talent, the mother at once recalls her yearning that

[27] *Life and Letters of Charles Darwin*, Vol. I, p. 302, New York, 1897. The letter is dated 1844.

such might be the case; her assiduous practice which she hoped would be of benefit to her child. She immediately decides that it did benefit him, and she becomes a convinced witness to the belief in prenatal culture. Has she not herself demonstrated it?

She has not. But if she would examine the child's heredity, she would probably find a taste for music running in the germ-plasm. Her study and practice had not the slightest effect on this hereditary disposition; it is equally certain that the child would have been born with a taste for music if its mother had devoted eight hours a day for nine months to cultivating thoughts of hatred for the musical profession and repugnance for everything that possesses rhythm or harmony.

It necessarily follows, then, that attempts to influence the inherent nature of the child, physically or mentally, through "prenatal culture," are doomed to disappointment. The child develops along the lines of the potentialities which existed in the two germ-cells that united to become its origin. The course of its development can not be changed in any specific way by any corresponding act or attitude of its mother, good hygiene alone need be her concern.

It must necessarily follow that attempts to improve the race on a large scale, by the general adoption of prenatal culture as an instrument of eugenics, are useless.

Indeed, the logical implication of the teaching is the reverse of eugenic. It would give a woman reason to think she might marry a man whose heredity was most objectionable, and yet, by prenatal culture, save her children from paying the inevitable penalty of this weak heritage. The world has long shuddered over the future of the girl who marries a man to reform him; but think what it means to the future of the race if a superior girl, armed with correspondence school lessons in prenatal culture, marries a man to reform his children!

Those who practice this doctrine are doomed to disillusion. The time they spend on prenatal culture is not cultivating the child; it is merely perpetuating a fallacy. Not only is their time thus spent

wasted, but worse, for they might have employed it in ways that really would have benefited the child--in open-air exercise, for instance.

To recapitulate, the facts are:

(1) That there is, before birth, no connection between mother and child, by which impressions on the mother's mind or body could be transmitted to the child's mind or body.

(2) That in most cases the marks or defects whose origin is attributed to maternal impression, must necessarily have been complete long before the incident occurred which the mother, after the child's birth, ascribes as the cause.

(3) That these phenomena usually do not occur when they are, and by hypothesis ought to be, expected. The explanations are found after the event, and that is regarded as causation which is really coincidence.

Pre-natal care as a euthenic measure is of course not only legitimate

but urgent. The embryo derives its entire nourishment from the mother; and its development depends wholly on its supply of nourishment. Anything which affects the supply of nourishment will affect the embryo in a general, not a particular way. If the mother's mental and physical condition be good, the supply of nourishment to the embryo is likely to be good, and development will be normal. If, on the other hand, the mother is constantly harassed by fear or hatred, her physical health will suffer, she will be unable properly to nourish her developing offspring, and it may be its poor physical condition when born, indicates this.

Further, if the mother experiences a great mental or physical shock, it may so upset her health that her child is not properly nourished, its development is arrested, mentally as well as physically, and it is born defective. H. H. Goddard, for example, tells[28] of a high-grade imbecile in the Training School at Vineland, N. J. "Nancy belongs to a thoroughly normal, respectable family. There is nothing to account for the condition unless one accepts the mother's theory. While it sounds

[28] Goddard, H. H., *Feeble-mindedness*, p. 359. New York, the Macmillan Company, 1914.

somewhat like the discarded theory of maternal impression, yet it is not impossible that the fright and shock which the mother received may have interfered with the nutrition of the unborn child and resulted in the mental defect. The story in brief is as follows. Shortly before this child was born, the mother was compelled to take care of a sister-in-law who was in a similar condition and very ill with convulsions. Our child's mother was many times frightened severely as her sister-in-law was quite out of her mind."

It is easily understandable that any event which makes such an impression on the mother as to affect her health, might so disturb the normal functioning of her body that her child would be badly nourished, or even poisoned. Such facts undoubtedly form the basis on which the airy fabric of prenatal culture was reared by those who lived before the days of scientific biology.

Thus, it is easy enough to see the real explanation of such cases as those mentioned near the beginning of this discussion. The mothers who fret and rebel over their maternity, she found, are likely to bear neurotic children. It is obvious (1) that mothers who fret and rebel are quite likely themselves to be neurotic in constitution, and the child naturally gets its heredity from them: (2) that constant fretting and rebellion would so affect the mother's health that her child would not be properly nourished.

When, however, she goes on to draw the inference that "self-control, cheerfulness and love ... will practically insure you a child normal in physique and nerves," we are obliged to stop. We know that what she says is not true. If the child's heredity is bad, neither self-control, cheerfulness, love, nor anything else known to science, can make that heredity good.

At first thought, one may wish it were otherwise. There is something inspiring in the idea of a mother overcoming the effect of heredity by the sheer force of her own will-power. But perhaps in the long run it is as well; for there are advantages on the other side. It should be a satisfaction to mothers to know that their children will not be marked or injured by untoward events in the antenatal days; that if the

child's heredity can not be changed for the better, neither can it be changed for the worse.

The prenatal culturists and maternal-impressionists are trying to place on her a responsibility which she need not bear. Obviously, it is the mother who is most nearly concerned with the boggy of maternal impressions, and it should make for her peace of mind to know that it is nothing more than a boggy. It is important for the expectant mother to keep herself in as nearly perfect condition as possible, both physically and mentally. Her bodily mechanism will then run smoothly, and the child will get from her blood the nourishment needed for its development. Beyond that there is nothing the mother can do to influence the development of her child.

There is another and somewhat similar fallacy which deserves a passing word, although it is of more concern to the livestock breeder than to the eugenicist. It is called telegony and is, briefly, this: that conception by a female results in a definite modification of her germ-plasm from the influence of the male, and that this modification will be shown in the offspring she may subsequently bear to a second male. The only case where it is often invoked in the human race is in miscegenation. A white woman has been married to a Negro, for instance, and has borne one or more mulatto offspring. Subsequently, she mates with a white man; but her children by him, instead of being pure white, it is alleged, will be also mulattoes. The idea of telegony, the persistent influence of the first mating, may be invoked to explain this discrepancy.

It is a pure myth. There is no good evidence[29] to support it, and there is abundant evidence to contradict it. Telegony is still believed by many animal breeders, but it has no place in science. In such a case as the one quoted, the explanation is undoubtedly that the supposed father is not the real one; and this explanation will dispose of all other cases of telegony which can not be explained, as in most instances

[29] For a review of the evidence consult an article on "Telegony" by Dr. Etienne Rabaud in the *Journal of Heredity*, Vol. V, No. 9, pp. 389-400; September, 1914.

they can be, by the mixed ancestry of the offspring and the innate tendency of all living things to vary.

Now to sum up this long chapter. We started with a consideration of the germ-plasm, the physical basis of life; pointing out that it is continuous from generation to generation, and potentially immortal; that it is carefully isolated and guarded in the body, so that it is not likely to be injured by any ordinary means.

One of the logical results of this continuity of the germ-plasm is that modifications of the body of the parent, or acquired characters, can hardly be transferred to the germ-plasm and become a part of the inheritance. Further the experimental evidence upholds this position, and the inheritance of acquired body characters may be disregarded by eugenics, which is therefore obliged to concern itself solely with the material already in existence in the germ-plasm, except as that material may be changed by variation which can neither be predicted nor controlled.

The evidence that the germ-plasm can be permanently modified does not warrant the belief; and such results, if they exist at all, are not large enough or uniform enough to concern the eugenicist.

Pre-natal culture and telegony were found to be mere delusions. There is no justification for hoping to influence the race for good through the action of any kind of external influences; and there is not much danger of influencing it for ill through these external influences. The situation must be faced squarely then: if the race is to be improved, it must be by the use of the material already in existence; by endeavor to change the birth-and death-rates so as to alter the relative proportions of the amounts of good and bad germ-plasm in the race. This is the only road by which the goal of eugenics can be reached.