used for binding Government documents, I expressed doubts as to the buckram approved, known as No. 666, being insect-proof; and this opinion has since been confirmed by experiments made by the Philippine Bureau of Science, Dr. Stratton and myself.

My own experiments with a poison of an entirely different character gave better results. One-half of each of the various kinds of binding materials tested was treated with my preparation and the other half left untouched. They were placed in boxes and exposed to the attacks of the roaches for various periods. Upon examination, I found that while the coloring matter in certain samples had been eaten on both the treated and untreated portions, the poisoned portions of quite a number of the others were left alone. In some cases pieces of the same color, although of different manufacture as regards to one sample, were eaten and the other piece was left undisturbed. The remedy used by me did not, to my knowledge, kill any of the insects. From a comparison of the results, I arrived at the conclusion that the material used for coating the buckrams, etc., in a number of cases, had neutralized the effective action of the preparation used by me, and that in order to really obtain a material that would be insect-proof, it would be necessary to use such coloring matters as would not overcome the beneficial action of the poisons.

The fact that insects seem to show preference for certain colors used in binding materials, has already been noticed by a few of my correspondents; and also by myself while making researches in Florida last summer.

The Philippine Bureau of Science, finding that the buckram used as a standard was not insect-proof in the Islands, made another series of experiments, and have produced material which they claim is absolutely safe, but as I have not received any samples to test, although I have made request for same, I am unable to pass judgment upon it.

Although scientists have been experimenting upon binding materials in order to obtain one that would be exempt from the ravages of these little insects, little has been done toward preserving the most important part, and which, according to my investigations, receives the greatest injury, namely, the printed portion of the book. Some experiments made by J. Rodway, Esq., Secretary of the Royal Agricultural and Commercial Society of British Guiana, with papers impregnated with sulphate of cop-

per, turpentine, kerosene and corrosive sublimate, failed to stop the borings of the insects. I have sent boards and books made of different papers which I have treated with a substance to Mr. Rodway, and to other parts of the world, and the results as to the effectiveness of the remedy used should be received during the coming winter.

Arsenic in its various forms is used in large quantities in the materials used in book-making, though denied by the manufacturers; but chemical analysis will generally show the presence of this substance, which is of use to the insects. The elimination of arsenic in materials used in book-making would not only do away with a source of attraction to the insects, but save people from being poisoned, as anyone familiar with the literature of poisons knows.

Books as Disease Carriers.—Again, I speak upon the transmission of diseases by books, because the greatest disease carrier among insects that we know of to-day is the common house-fly, *Musca domestica*, which is also one of the book-destroying insects. There are a number of instances where the maggots of the fly have been found living upon paper, kept in damp places, but the damage done directly to the book is as nothing when compared to the damage done by their transferring germs, and, unless means are taken for their extermination, they will rank first among book enemies, because those who know of the fly's ability to carry disease germs, will refuse to read any book which the fly has stained. The common house-fly is only found around the habitation of man, showing that it has evolved from some other form which formerly lived in the open until it has now become thoroughly domesticated, as other forms have done, are doing, and will do in the future.

According to Dr. Howard, a single female fly in the spring might, therefore, become the progenitor of 195,312,500,000,000,000 flies by the end of the summer or mid-autumn, and allowing one million flies to a bushel makes over 193 million bushels, each one of whom is capable of spreading contagion. An investigation made at the Agricultural Experiment Station at Storrs, Connecticut, in 1908, upon 414 flies, showed that the number of bacteria on a single fly may range all the way from 550 to 6,600,000, an average of one and one-fourth millions bacteria on each, an almost incredible number to be found on such a small object. The objectionable class, coli-aerogenes type, was two and one-half times as abund-

ant as the favorable acid type. Now this only includes those on the outside, and every bacteriologist knows that large numbers are found in the intestines and expelled with the excreta. Mr. N. A. Cobb, in his article "The House-Fly,"³ states that a well-fed fly defecates 104 times in less than two hours, and that spores were found in fifty-five of the specks. These specks, containing germs, are laid upon the covers or pages of the books, and as personal observation shows that a very large portion of readers moisten their fingers in turning over the leaves of a book, it is readily seen how the fly speck upon the paper is moistened, adheres to the finger and the germs transplanted to the mouth, where they at once find the proper conditions and proceed to breed, resulting in the reader becoming afflicted with the disease, the source of which it is impossible to trace, on account of the slight consideration given by the medical world at the present time to books as a source of disease.

The danger of contracting disease by the fingers dampened with saliva in order to turn over the pages of a book is especially so in the case of persons suffering from tuberculosis, whose sputum contains millions of the bacilli. The saliva drying, the *Tubercle bacilli* cling to the fiber of the paper, and as soon as another person, who also has the vulgar habit of wetting the fingers in turning the pages, uses the book, the germs are removed to fertile soil. Many other diseases, especially skin diseases, are without doubt frequently transmitted by this means.

In conclusion, I cannot speak strongly enough on the importance of cleanliness in preventing the destruction of books by insects, and the spreading of disease. The volumes in the library should be kept thoroughly cleaned, the attendants ought to clean their hands frequently, and the patrons compelled to wash their hands before using the publications and should not be allowed to wet the fingers in turning pages. These precautions will help to decrease the spread of tuberculosis and other diseases, and do away with the grease stains on the paper, which are breeding grounds for germs and attractive feeding places for insects. Screens should be placed on all windows and doors to prevent the entrance of flies, and by these means only will the destruction of the stores of accumulated knowledge be decreased and a source of death be overcome.

³ *National Geographic Magazine*, vol. xxi., 1910, pp. 371-380.

Human Evidence of Evolution*

Is Natural Selection Dependent on Small Variations or on Large Mutations?

By A. M. Gossage, M.D.

THE problems of heredity are attracting a gratifying amount of attention from many classes—the general public, the professed biologist, the mathematician, and, of late, the medical profession. Naturally it is the inheritance of human qualities which excites the greatest interest; and there is always a desire to extend to the human race any conclusions founded on the study of animals or plants. It has been claimed by Archdall Reid that the study of human beings is as advanced, or even more advanced, than that of animals, and in itself affords sufficient evidence to decide many controversial points. In this article it is proposed to examine some of the more important evidence that can be culled from the study of human heredity, and to see what conclusions may be justified.

There are certain obvious disadvantages in the human species, as compared with animals and plants, for the investigation of the problems of heredity. To begin with, the families are small: the offspring appearing one at a time, with intervals of many months between succeeding infants. Then the period of growth is prolonged, lasting twenty to twenty-five years, and, in consequence, it is excessively rare to have more than three generations alive at the same time and available for observation. The conditions, therefore, of preceding generations can only be ascertained from the accounts, often inaccurate, of the older members of the family. It is also impossible to arrange human parentage, and the inquirer is dependent on chance marriages for the production of a particular cross which may be required to throw light on some obscure point. These objections must not, however, be taken to imply that carefully collected observations, subjected to strict criticism, may not supply very valuable facts; but at present the number of properly verified facts is not great and there is urgent need for more.

In his book on the "Laws of Heredity," Dr. Archdall Reid comes to the general conclusion that evolution takes place by the action of Natural Selection on the small differences between parents and children, insuring the continuance of the more favorable variations. It follows as a corollary of this that an unfavorable variation, or one that does not tend toward the adaptation of the individual to his environment, tends to be gradually elim-

inated. A logical deduction from this theory is, that in human beings bacterial diseases should eliminate those most susceptible to them, and that, since the more immune have the best chance of survival, and so of propagation, the immunity of a community exposed to a severe bacterial disease should gradually increase. This is a logical deduction from the theory, and, if the facts accord with it, strong favorable evidence would be afforded; but if, on the other hand, the facts are not in accord, a very cogent argument would be raised against the original theory. Since this theory of evolution by the action of Natural Selection on small continuous variations is by no means universally accepted it becomes important to ascertain accurately what are the facts with regard to the susceptibility and immunity of human beings toward the various bacterial infections. That persons differ in their susceptibility to infection seems sufficiently clear, but the knowledge of how far these degrees of susceptibility are transmitted from parents to children is decidedly hazy. Still there is definite evidence that susceptibility or immunity to rust is inherited in wheat, and in spite of the strong opposition of some authorities it is generally accepted that susceptibility to tuberculosis runs in families. Beyond these points the recorded observations are not either sufficiently numerous or accurate to warrant any really definite conclusions, though, on the whole, they seem to the writer to weigh against the theory. Measles and malaria may be taken as types of bacterial disease for consideration. Measles is a disorder which attacks nearly all European children, and after an attack the acquired immunity is very complete. The disease is, as a rule, mild in type, even in childhood, and the death rate is not high. There are, however, some countries where measles is not endemic, and where the adult inhabitants are not protected by a previous attack. In these places there has been no elimination of the susceptible in past generations, so that on the introduction of the contagium there is a virgin soil for it to work on. With the gradual spread of Europeans over the world in the last century opportunities for infection have arisen, and the results have been severe epidemics. In these, adults and children have both suffered, the case mortality has been very high, and the illness has always been much more grave than in Europe. For instance, the population of the Fiji Islands was

nearly decimated by measles on its first introduction there. As far as this goes it is in favor of Archdall Reid's conclusions, but it is possible to advance another hypothesis to explain the facts, and at present we have no means of dealing between the opposing explanations. One may suppose that the higher immunity of the European child is due to the transmission to it through the placenta, from the mother, of some of the immunity acquired by her during an attack in childhood. A similar transfer of immunity through the placenta is known to take place when a woman is vaccinated during pregnancy, her child being immune to vaccination for many months after birth.

Malaria is now mainly a disease of tropical and sub-tropical countries, and is due to infection with a special organism which is conveyed from the sick to the healthy by means of a particular kind of mosquito. As a matter of fact more than one disease is included under the term "malaria," each kind being due to a separate organism. They all occur, however, in similar places and may be considered together, since at present the knowledge concerning them is insufficient to enable us to discuss them separately. One must recognize that they differ in severity, some, e. g., the æstivo-autumnal, being much more severe than the others, and individuals may differ both in acquired and inborn immunity to the different kinds. Extended observations have conclusively shown that the adult native of India or West Africa suffers much less severely from these diseases than do such Europeans as go out to malarial districts, and it is tempting to conclude from this that the white race is naturally more susceptible to infection, and shows less resistance after infection, than the black. But it is also possible that the individual black adult may have acquired insusceptibility by reason of previous attacks or residence in the district, and that at birth there is no difference between the two races. This latter hypothesis is supported by the fact that white settlers, who do not die, get "salted" by prolonged residence in malarial climates, and that the black children suffer very severely and many of them die. If the explanation is correct, then white children born in India or Africa should suffer no more than the natives; and where the two races have been for several generations in the same locality, they should be affected equally, or rather, the white should be attacked less than

* Reprinted from *Bedrock*.

the black, because they are less exposed to infection. This point requires further careful investigation, but Leonard Rogers, in his book on "Tropical Fevers," tells us that in a particular district in India the Hindu children were found to be more severely affected than the English; and Deaderick, in his book on "Malaria," says that in the Southern States of America the black population suffers more severely than the white. Thus, as far as it goes, the evidence is against the view that there is evolution of immunity against malaria, and since, theoretically, this ought to occur, the evidence weighs for what it is worth against the view that Evolution takes place by the action of Natural Selection on small continuous variations.

The opposing view that Evolution is dependent on the action of Natural Selection on large variations or mutations, is intimately bound up with the Mendelian hypothesis. The phenomena of human inheritance have been cited both for and against these hypotheses. For the reasons already given the facts are not sufficiently definite to afford any conclusive argument on either side. What one is justified in concluding concerning human beings is that, if mutations can be proved to occur and persist in animals and plants, then they also occur in human beings; and, further, that if the Mendelian hypothesis is the correct explanation of the facts derived from experimental breeding of plants and animals, then it is also the correct explanation of numerous examples of heredity in man. Some critics of Mendelism complain that its advocates merely add other quite similar phenomena to the collection already obtained instead of breaking into fresh fields. These same critics, almost in the same breath, while acknowledging the accuracy of most of the recorded observations, claim that this Mendelian, or alternative, type of inheritance is exceptional. The multiplication of examples becomes, therefore, necessary to confute this argument, apart from the interest of the observations themselves and the fact that they frequently open up fresh problems. In this connection it may be pointed out that there are over thirty recorded abnormalities in human beings where the condition is handed down to the descendants in a manner which agrees fairly closely with what would be expected from Mendel's laws. The same may be said of some normal conditions, such as eye-color, or red hair.

The study of these abnormalities brings out a number of interesting points and justifies some important conclusions. The majority of them do not shorten life, and many interfere only slightly with the individual's capacity for earning a livelihood. In no case, however, can they be regarded as an advantage or an adaptation to the environment, and in some they prove a very distinct disability. For instance, the claw-hand and foot deformity must hamper the unfortunate possessors in the struggle for existence; and sufferers from multiple telangiectasis or angioneurotic oedema tend to die, because of their peculiarity, at an abnormally early age. Yet these conditions persist, being handed down to posterity in a certain definite proportion, and no tendency is shown for them to die out. Perhaps the most remarkable examples of this persistence of a disability through many generations of a family are afforded by the conditions known as Hæmophilia and Pseudo-hypertrophic Paralysis. The first of these causes the death of a very large proportion of the sufferers in early childhood from uncontrollable bleeding, while the second gradually cripples its unhappy victims, and nearly always renders them helpless and incapable of procreation by the time they reach adult life. In both of these conditions the affection is confined almost entirely to the male sex, and, were it handed down directly from father to son, would quickly die out. As a rule, however, it is through the female, who is herself unaffected, that the transmission takes

place, some of the sisters of affected men passing the condition to some of their sons. A woman who carries this latent abnormality may not only give it to her sons, but may hand it down through her apparently normal daughter to her grandsons, or through her granddaughter to her great-grandsons, and so on. Thus the original connection with an affected family may be lost sight of where the males in each generation have been scarce. A hæmophilic male may transmit the condition to his grandson through his unaffected daughter, but, curiously enough, seldom transmits directly to his son. The children of the normal males of these families are always normal. As one can hardly imagine this curious peculiarity as having arisen by the action of Natural Selection on small fluctuating differences, one would be tempted at first glance to suppose that here was some special device to insure the continuance of these noxious plagues of humanity, a supposition which is supported by the fact that the females from hæmophilic families have a much larger number of children than is usual. On taking a wider view, however, one finds that an exactly similar type of inheritance prevails in Daltonism, or color-blindness, a condition in which there is no injury either to the individual's health or his prospects of earning a living and begetting children.

It is claimed by Dr. Archdall Reid, that the facts on which the Mendelian hypothesis is founded can be as well explained on the supposition that reproduction is alternative in these cases as that inheritance is alternative. I do not quite understand what is meant by alternative reproduction, but the supposition seems to imply that on crossing a "dominant" with a "recessive" there is temporary patency of the dominant character in the first generation and temporary latency of the recessive, while in succeeding generations there is more perfect and permanent patency of the dominant character in the "pure dominant" and of the recessive character in the "pure recessives," while in each the opposing character becomes permanently latent. In other words, the dominant character is considered to be always latent in the pure recessive and the recessive character in the pure dominant. This supposition affords no explanation of why a particular character is sometimes patent and sometimes latent, patency and latency seeming to be purely haphazard. It assumes the presence of the other *allelomorph* in pure dominants and pure recessives, although the only evidence of this is the rare occurrence of certain exceptions to Mendel's laws, exceptions which time may clear up. It also makes no attempt to offer a reason for the remarkable and constant numerical relationship of three apparent dominants to one recessive in the offspring of two cross-bred individuals. A hypothesis which gives no explanation of the most salient facts is quite useless. On the other hand, the Mendelian hypothesis of gametic purity does explain the facts and further enables a prediction to be made as to the result of the mating of certain individuals founded on their ancestry; for instance, it is possible to predict that all the male children of a color-blind woman will be color-blind. As the explanation of these particular facts, therefore, the Mendelian hypothesis is without rival. Still it is not enough to demonstrate that no other hypothesis will explain a particular group of facts in order to establish the truth of any hypothesis, but it is necessary that all the facts should be in agreement with the explanation offered. There are, of course, apparent exceptions to the Mendelian hypothesis, exceptions which may later be found explicable on that hypothesis, or, on the other hand, may render its acceptance impossible; but that does not take away the necessity for any rival hypothesis to offer a feasible explanation of all the facts before acceptance. These points are illustrated in human beings as well as in animals and plants, but, naturally, not so

convincingly. There is plenty of evidence of the purity of recessives, and it is also found that, as would be expected, dominants of the rarer abnormalities, since they result from the union of an abnormal with a normal are always in a Mendelian sense, impure, so that half their children with a normal mate are abnormal and half normal, this relationship holding in most of these families where the numbers are sufficiently large. Difficulties and exceptions are naturally met with. For instance, dominance is, as in the case of the extra toes in fowls, sometimes incomplete, so that the abnormal condition is handed down through an apparently normal person, as occurs occasionally in Diabetes Insipidus, or Epidermolysis Bullosa. Then, again, the numbers sometimes do not correspond with expectancy.

It is of importance to note that the most striking example of blended inheritance, in spite of marked differences between the parents, is met with in human beings. It is generally acknowledged that the small continuous variations blend in the offspring while the large discontinuous variations, or mutations, do not blend and afford the examples of Mendelian "segregation." One would therefore expect that when there is interbreeding between two markedly dissimilar races, such as the European and the negro, that segregation would be found in the third generation with the production of a pure European and a pure negro. According to all the available accounts, however, not only are the children of a negro and a European a blend of the two races, but all the offspring of two half-breeds are also a blend, and there is a tendency to approach the white type when there is a further cross with a European, or the black when a person of mixed parentage mates with a negro. Genuine segregation seems to be confined to the imaginations of the novelists, who go so far as to suppose that there may be a reversion to a pure black type in the child of a pure European with a mate whose black strain is so slight that it could not be recognized on inspection (see "Senator North," by Mrs. Atherton). On the other hand, it has been stated that segregation is shown in crosses between white men and Red Indians; and recently Salaman has brought forward evidence which renders it probable that the characteristic Jewish features are recessive to the Gentile. Accurate and extended observations are much required on this question of racial admixture, and the United States of America should provide a fruitful field for such investigations, since, in addition to those already considered, some crosses between negroes and Red Indians and between negroes and Chinese and others should be found. In the first generation the children of negro and Chinese parents are said to resemble the Chinese except for woolly hair. The problem is a complex one, as there are probably several characters in which the two races differ; and while one character of one race may be dominant the others may be recessive, and the most interesting points should come out in the case of the progeny of two half-breeds.

In conclusion, attention may be drawn to the absence of any evidence of evolutionary change, either physical or mental, in the human animal during historic times. Modern man is anatomically superior to prehistoric man, but is no better equipped either with brain or muscle than the ancient Greek or Egyptian, any superiority he possesses being referable to the fact that he is able to profit easily by the hard-won acquirements of his ancestors, and, having acquired these, to pass on to fresh conquests. This emphasizes one of the mutationist's objections to the Darwinian theory of Evolution by the action of Natural Selection on small continuous variations, that it requires an infinitely longer period for the origin of species than geology is prepared to allow as the existence of a habitable Earth.

Coloring and Frosting Incandescent Lamps

By A. S. NEUMARK.

THE following lamp colors are especially adapted for stage lighting and interior decorations; if applied properly they will outlast the lamps. A clear lacquer is first made by dissolving 32 pounds of gum copal in 20 gallons of alcohol (denatured) to which has been added 4 gallons of amyl alcohol (fusel-oil). It takes quite some time for the gum to dissolve completely, and the process should be assisted by shaking. Allow to settle, then draw off or decant; strain through several layers of cloth. It is not necessary that the liquid be completely clear. In the liquid so obtained dissolve the aniline dyes as given below. To every gallon of clear lacquer:

Red.—Rhodamine B extra 2 ounces; chrysoidine E cryst. 2 ounces; methyl violet $\frac{1}{2}$ ounce.

Blue.—Blue Sp. t. 2 ounces; Victoria Blue 1 ounce.

Green.—Victoria green E 2 ounces; Methanil yellow O $\frac{7}{8}$ ounce.

Yellow.—Methanil yellow 1 ounce; Chrysoidine E cryst. $\frac{1}{2}$ ounce.

Straw.—Chrysoidine E cryst. $\frac{1}{2}$ ounce.

Amber.—Chrysoidine E cryst. 1 ounce.

Orange.—Chrysoidine E cryst. 2 ounces.

Pink.—Rhodamine B extra $1\frac{1}{2}$ ounces.

Purple.—Methyl violet $1\frac{1}{2}$ ounces.

Moonlight.—Blue S. B. $1\frac{1}{2}$ ounces; Methanil $\frac{3}{8}$ ounces.

Light Blue.—Blue S. B. $1\frac{1}{2}$ ounces.

Blue-green.—Victoria green E 2 ounces.

Not all coal-tar dyes are suitable for coloring lamps. I have found that Blue S. B. (which is usually used) soon turns green and fades quickly; but the combination of the two dyes indicated will be lasting. There is also no single red dye, which furnishes a satisfactory dark red effect. The combination of amber, pink and purple, however, results in the desired shade.

The solution is filled into a suitable cup and the hot globes, which previously have been thoroughly cleaned, are dipped into this solution. Care must be taken that the solution is free from air bubbles and that the globes do not touch the sides of the cup. Amber and yellow can be applied to the cold lamps. One dipping is sufficient in most cases, provided the globes have been cleaned carefully.

FROSTING LAMPS.

Mix 1 gallon of acetone with 3 quarts of benzol and 1 quart of turpentine. Dissolve 24 ounces gum sandarac, 8 ounces gum benzoine and 8 ounces gum

mastic. Shake well, let stand over night and strain through cheesecloth. The liquid will be perfectly clear, provided the bottles used have been perfectly dried; they should be rinsed out with alcohol before using. This solution is applied to the globes by dipping. The lamps must be cold and they should not be used before they are perfectly dry.

Both coloring and frosting liquid should be kept in glass bottles or stoneware jugs, but never in tin cans.

Frosting may be tinted with rhodamine, methanil yellow and other dyes, although some of these dyes such as chrysoidine are nearly insoluble. The colors and the frosting can easily be removed from the globes by washing with a solution of caustic soda or alcohol.

The Kinematograph as an Aid to Mathematical Instruction

We read in *Prometheus* that L. Münch, of Darmstadt, has recently employed the kinematograph for demonstrating certain properties of geometrical figures. Thus, for instance, the transition from the circle to the ellipse by the gradual spreading out of the foci from the center can be very nicely demonstrated in a way which appeals to the imagination, as yet untrained, of the novice.