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The Principles of Heredity

G. Archdall Reid

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By G. ARCHDALL REID, M.B., C.M., F.R.S.E.

Author of "The Present Evolution of Man."

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OF

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THE PRINCIPLES OF HEREDITY

"Heredity and variation. . . . Every one knows that, somewhere hidden among the phenomena denoted by these terms, there must be principles which, in ways untraced, are ordering the destinies of living beings."—BATESON.

THE
PRINCIPLES OF HEREDITY

WITH SOME APPLICATIONS

EUGENICS EDUCAT
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BY

G. ARCHDALL REID, M.B., F.R.S.E.

AUTHOR OF
'THE PRESENT EVOLUTION OF MAN,' 'ALCOHOLISM: A STUDY IN HEREDITY'
ETC.

SECOND EDITION
REVISED
AND WITH AN APPENDIX

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TO

His Author.

PREFACE

THERE is a good deal that is new—a little of which I hope will be found true—in this volume. It follows somewhat on the lines of my former work, *The Present Evolution of Man*, from which I have borrowed occasionally, especially in Chapter XI., and in the section devoted to Mind.

The evidence bearing on Heredity afforded by disease has hitherto been scarcely touched. It is utilized largely in the present work. I cannot help thinking that most students of Heredity are not aware of the value of this evidence from disease. I believe that if it had been considered in conjunction with the facts of specific adaptation to the environment a good deal of controversy concerning the transmission of acquirements and the origin of variations would not have occurred, or at any rate would not have lasted as long as it has done. So far as I am able to judge, it establishes conclusively the facts (1) that parental acquirements are never transmitted to offspring, and (2) that variations are rarely caused by the direct action of the environment on the germ-cells—so rarely that racial change is never due, directly or indirectly, to this cause. The great mass of variations have another origin which I have endeavoured to elucidate.

The function of bi-parental reproduction appears to me manifest. It is very important, but it has nothing to do with the causation of progressive variations.

In the fifth chapter I have sought to re-establish on a firm basis the doctrine that the development of the individual is a blurred recapitulation of the life-history of the race. The doctrine of recapitulation has been controverted of late; but in the whole range of biology there is nothing that is more certainly true. It follows logically and necessarily from the known fact that the child recapitulates the developmental footsteps of the parent. Unless it were true there could be no development of the individual and no evolution of the race. This fifth chapter is the crux of the whole work. If the scientific reader finds its reasoning correct and its conclusions valid, he will probably not raise much objection to the rest of the book.

I have addressed the volume mainly to medical men. The evidence relied on is drawn largely from medical sources; medical men form the largest body of scientific workers; they deal constantly with questions of Heredity, a knowledge of which is of great importance to them; but in a measure they have neglected the systematic study of the subject. Little or no direct instruction in it is given to medical students. There does not exist even a text-book to which they may refer. But a knowledge of Heredity is becoming essential to the educated doctor. I have sought to supply the want. I hope, however, the professional biologist and the general reader will not find the work devoid of interest. I have tried throughout to give prominence to broad generalizations rather than to isolated facts, to found my conclusions wholly on verified evidence, and to write in such a way that the reader's task will not be unnecessarily toilsome.

My hearty thanks are due to Dr. Gerald Leighton for "going over" the first fifteen chapters, and to the Editors of *The Monthly Review* and *The Lancet* for permission to adapt for Chapter X. matter which had appeared in their pages.

PREFACE TO THE SECOND EDITION

THE first edition of this work has been exhausted with such unexpected rapidity that I have been unable to make alterations of importance in the body of the book. A better definition, or description, of "spontaneous" variations has been introduced on page thirty-eight. Numerous typographical errors have been corrected, for the discovery of which my thanks are due to several correspondents. The main addition to the first issue consists, however, in two somewhat lengthy appendices. In the first, besides the discussion of one or two allied questions, I have endeavoured to make clearer the all-important distinction between innate and acquired characters. In the second I have dealt in some detail with the mutation theory of evolution and the phenomena of alternative inheritance. Several reviewers, notably that most indulgent of all critics, Dr. C. W. Saleeby, have expressed the opinion that the labours of Mendel and his followers have not been adequately discussed by me. I have tried to rectify the omission.

Southsea, 4th Dec., 1905.

ERRATA

Page 56, eighteenth line, *for* diseased *read* deceased.

,, 358, last line, *for* albumen *read* cotyledons.

,, 365, fourth line from bottom of text, *delete* greater.

,, 372, fifth line, *for* inter-varietal *read* intra-varietal.

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THE PRINCIPLES OF HEREDITY

CHAPTER I

THEORIES OF HEREDITY

Definition of Heredity—The multiplication of cells—The Germ-plasm—The characters of living beings—Inborn characters—Acquired characters—Modifications—Variations—The Lamarckian doctrine of Heredity.

1. HEREDITY has been variously defined. Herbert Spencer describes it as "the capacity of every plant and animal to produce other individuals of a like kind." Weismann follows Spencer very closely. According to him "the word heredity in its common acceptance means that property of an organism by which its peculiar nature is transmitted to its descendants." The science of heredity may be defined as *that science which deals with the organic relationships of progenitors with descendants.*

2. The systematic study of heredity is of very recent origin. It dates, in effect, from the publication of Darwin's great work *The Origin of Species.* No doubt many important facts were known previously; and Lamarck, Spencer, and others had formulated theories of evolution which implied theories of heredity. But so much of error was mingled with the facts, and so much of ancient superstition incorporated with the theories, that a great part of the value of both was lost. The interest aroused by Darwin's speculations gave the necessary stimulus. A body of earnest and in many cases brilliant workers strove to increase the sum-total of our accurate knowledge, to dig the truth out of the accretions of fiction which had gathered round it during the process of ages. To-day enough is known with certainty to justify the erection of heredity into a study which is by no means the least important of that group of studies which we gather

under the general name of biology. The work has been done chiefly by zoologists and botanists, but, probably, heredity concerns medical men more nearly than any other body of scientific workers. Evidence is not wanting that the period of professional neglect is drawing to a close, and that, ere long, a systematic knowledge of the laws which control the reproduction of living beings will be considered as necessary a part of the equipment for the struggle against disease as anatomy or physiology.

3. The material for the study of heredity already in the possession of medical men is so valuable that there can be little doubt that both medicine and heredity have suffered from the failure to collect and apply it in a systematic way. A knowledge of the natural history of the being to whom he devotes his life is essential to the medical worker. No zoologist or botanist can possibly have a knowledge of any animal or plant so detailed and extensive as the educated physician possesses of his own species. No experiments devised by man can rival in scope and magnitude, in duration and stringency, the many and vast experiments conducted by nature through the medium of disease. An attempt will be made in the present work to systematize and apply a portion at least of this rich mass of material. No doubt, through lack of knowledge or of judgment, the writer will frequently do less than justice to his subject. His task is one of considerable difficulty and magnitude. But his very failures may stimulate future workers to tread more successfully the path that he seeks to indicate. If he is able to preserve the interest of his readers during the first few chapters it should be possible to sustain it afterwards. There is more for medical men in the study of heredity than is commonly supposed.

4. At the present day educated men are agreed that all forms of life are related to one another through an ancestry, which, in the case of the more divergent forms, is very remote; and that all the higher and more complex forms have been evolved from lower and more simple forms.[1] The only question really in dispute among people acquainted with the facts is the method by which evolution has proceeded. The correct elucidation of that method involves the discovery of the right doctrine of heredity.

[1] Evolution within limits has been tacitly admitted by nearly all peoples and creeds. Thus it is almost universally believed that all races of mankind have sprung from a common stock. Human races are now very divergent, and each race is especially adapted to the environment in which it has spent its past.

5. The basis of all known life is the cell. The typical cell consists of a nucleus and a cell-body. It has been proved beyond reasonable doubt that the nucleus, or rather a hypothetical substance within it which has been termed the "germ-plasm," is "the bearer of heredity." Some such substance—some substance which is the bearer of heredity—there must be of necessity. Cells multiply by dividing into two or more daughter cells, the usual number being two. The lowest plants and animals are single cells. Higher organisms consist of two or more—it may be billions—of cells united for the common good. The body of a multicellular plant or animal is compounded of the cell-descendants of a unicellular organism, which is usually a fertilized ovum. Each cell of the body, though definitely related to its fellows, is, in a very real sense, a distinct and separate living entity—a unicellular organism. Blood-cells and wandering connective tissue-cells are free. Spermatozoa and ova are purely parasitic. Skin cells have been artificially transplanted. Had we the requisite skill it is possible that we could transplant every kind of cell. The death of the whole organism (somatic death) is followed, only after a measurable interval, by the death of its component cells.

6. Watching the multiplication of a somewhat highly organized unicellular animal (*Stylonychia pustulata*, an infusorian), Maupas observed that after two of these had conjugated, the resulting fertilized cell divided and re-divided many times without conjugation occurring again; but that if, after a certain fairly definite number of cell-divisions, during which millions of individuals had come into being, conjugation did not occur again, the family ultimately died out. He found, moreover, that the descendants of a conjugated pair did not conjugate among themselves, but only with the members of another family, the descendants of another conjugated pair.[1]

7. Now all this is the rule amongst higher plants and animals. The ovum and the sperm are unicellular animals of the same species. They differ in appearance, for the large and passive ovum contains much nutriment, whilst the small and active sperm carries an organ of locomotion; but in essentials they agree. Their nuclei are equivalent; that is

[1] *Arch. d. Zoöl.*, 2me série, vii. 1889. Calkins, who has repeated Maupas's experiments, disputes some of his conclusions. For example, he claims to have proved that infusorians, if properly nourished, continue to multiply indefinitely without conjugation. This point, as the reader will perceive later, is not material so far as the present work is concerned.

they are equally bearers of heredity.[1] After the conjugation of the ovum and the sperm the resulting cell divides and re-divides many times without conjugation occurring amongst the descendant cells. These, like infusorians, if they do not conjugate, ultimately die out. Most of them (the somatic or body cells) are incapable of conjugation; whilst such of them as are capable of conjugation (the germ-cells) conjugate only with cells from another body (*i.e.* cell family). There are, as is well known, exceptions to this rule. Apparently unending multiplication of cells may occur without conjugation, as among such plants as are propagated by buds, slips, and suckers; and self-fertilization also occurs; but the general rule is as stated. A multicellular plant or animal, in the successive stages of its development, is to be regarded, therefore, as the homologue, not of the remote ancestral organism, the homologue of which is the ovum or the sperm, but of all those successive generations of unicellular organisms which intervene between one act of conjugation and the next.

8. On the other hand, the cell-descendants of a pair of conjugated germs differ from the cell-descendants of a pair of conjugated unicellular organisms in that (1) they remain united and work together for the common good, (2) they undergo differentiation of form and specialization of function along certain definite lines of descent (into bone, muscle, gland and other cells), the germ-cell being specialized, for the reproduction of the complex multicellular organism, and (3) they multiply in different lines of descent at unequal, though definite, rates. Did the cell-descendants of the fertilized ovum all multiply at an equal rate, a solid spherical mass of cells would of course result; whereas, owing to differences in their rates of multiplication, the shapes of multicellular plants and animals are irregular (*i.e.* not spherical). But, though these rates of multiplication are pretty definite in every species of plant and animal, they differ widely in different species—whence arise differences in shape betwixt one species and another. An ox, for instance, differs in shape from a man because in it the

[1] The nucleus was formerly regarded as a non-essential portion of the germ-cell. It is now beyond doubt that it—or rather the chromatin contained within it—is the sole "bearer of heredity." Except that they are derived from male and female bodies there is nothing male or female in the nuclei of germ-cells. All this was decisively proved by one of Boveri's experiments. He separated by shaking the nucleus from the ovum of one species of Echinus and then fertilized the enucleated ovum with spermatozoa from another species. The larva which resulted developed the true characters of the last species only.

cells, in the different lines of descent, do not multiply at the same rate as in man.

9. All evolution consists, in essence, of a gradual change in the character of the germ-plasm contained in successive germ-cells—a change of such a nature that it is reflected in the successive individuals that spring from the cells. Thus, if, by careful breeding, we succeed in altering any plant or animal species, it is only because we have succeeded in altering to a corresponding extent the nature of the germ-plasm of that species.

10. All the *traits* or *characters* (the terms are synonymous) of every living being are separable in theory, if not always in practice, into two distinct categories. Either they are *inborn* or they are *acquired*. The first essential to a study of heredity is a clear comprehension of the distinction between inborn and acquired characters. *Inborn traits or characters are those which take origin in the germ-plasm*, which arise because the germ-plasm is so constituted that it tends, under fit conditions of shelter and nutrition, to impel or cause the germ-cell to proliferate into an individual having those characters. Thus a man's head is inborn. It arises because the germ-plasm in the fertilized ovum whence he sprang was so constituted that it impelled that germ-cell to proliferate into a being having a man's head. *Acquired characters*, on the other hand, do not take origin in the germ-plasm; *they are modifications of inborn characters caused by the play of forces from the environment on those characters after (as a rule) they have developed from the germ-cell.* Thus a man's hand is inborn. But if it be modified by use, disuse, accident, or the play of other forces from the environment the *modification* is an acquired character.[1] Inborn characters take origin in the germ; that is, they are blastogenetic in origin. They express the hereditary tendencies of the individual, and, with variations, those of the race. Acquired characters take origin (as a rule) in the cell-

[1] "All the effects of exercise are acquirements—for example, the enlargement which exercise causes in muscles. The effects of lack of exercise are also acquirements—for example, the wasting of a disused muscle. The effects of injury are acquirements—for example, the changes in a diseased lung or an injured arm. Every modification of the mind is also an acquirement—for example, everything stored within the memory. If a man be blinded by accident or disease his blindness is acquired. But if he come into the world blind, if he be blind "by nature," his blindness is inborn. If a son be naturally smaller than his father, his inferiority of size is inborn; but if his growth be stunted by ill-health or lack of nourishment or exercise, his inferiority is acquired." (*Alcoholism. A Study in Heredity*, p. 9.)

descendants of the germ-cell; that is, they are somatogenetic in origin. They express the modifications of the hereditary characters of the race which are caused *in the individual* by the play of forces from the environment.

11. The main mass of inborn or congenital characters are ancient heritages of the race. Thus head, heart, limbs, lungs, liver, the various organs of sense, etc., were possessed by the race of man even before it became human. But, since every individual differs *congenitally* somewhat from his parents, therefore every individual exhibits some *new* inborn characters. These are usually slight alterations of pre-existing inborn characters—an increased or decreased thickness or hairiness of the skin, a larger nose, a smaller mouth, a stronger heart, a weaker digestion, a broader foot, a narrower hand, a keener sight, a duller hearing, and so forth. Occasionally, however, new inborn characters are of considerable magnitude; or they may not be mere alterations of old characters, but entirely new structures. Such new excessive inborn characters are termed *abnormalities.* Thus a man may be born very much smaller or bigger, weaker or stronger, than his parents; or a child of normal parents may be born with a sixth digit on one hand, or deaf, or with a defective heart. *All new inborn characters, great or small*—all new characters which take origin in the germ-plasm, which are congenital, which come to the individual "by nature," which are inherent in him, which are expressions of his hereditary tendencies—*are technically termed "variations."* On the other hand, *all acquired characters*—all alterations in an individual caused by the play of external forces on his inborn characters, all such characters as are not congenital in him, such as do not arise in him "by nature," such as do not imply a corresponding and pre-existing trait in the germ-plasm, such as do not express his hereditary tendencies—*are technically termed "modifications" or "acquirements."*

12. The precise technical meaning of these expressions—inborn, congenital, variation, acquirement, modification—must be noted. They have not in biological literature the extended and ambiguous significations which they possess in popular literature. At any rate they are intended to have very precise and definite meanings in the present work. Formerly it is true that the term "variation" was used indifferently to indicate all differences, inborn or acquired, between parents and offspring, but of late years most authorities have agreed to limit the term to inborn differences alone. The word "congenital" is generally used as synonymous

with inborn, and will be so used in the present work; but by medical men, especially, it is sometimes applied to traits which appear before birth as distinguished from those which appear afterwards. From the point of view of heredity, however, since characters may be acquired *in utero*, the episode of birth is of no importance. It is necessary to define these terms exactly, for otherwise the most desperate confusion is apt to occur and indeed has very often arisen.[1] Their importance is due to the fact that, while it is admitted on all hands that inborn traits (including variations) tend to descend from parents to offspring and to more remote descendants, it is now denied by the vast majority of biologists that "modifications" are ever inherited. Thus, while it is admitted that if a man be blind "by nature" his blindness will very probably descend to his offspring, it is denied if he acquire blindness (as by injury, for instance) that his defect will tend to be inherited.

[1] If once we apprehend clearly the fact that the difference between the inborn and the acquired is one of *origin* we shall avoid many of the grotesque errors which vitiate the writings of some popular authors who have dealt with this subject. Even when heredity is discussed in medical meetings some one is pretty sure to remark with an air of finality, "Acquired characters must be transmissible, for every character must have had a beginning, and therefore must have been acquired originally." This sentence is such a triumph of inaccurate statement and loose thought, and within its brief limits sets forth so neatly the principal source of confusion prevalent in popular and medical terminology, that it is worth while to examine it at length. It assumes that the difference between the inborn and the acquired is not one of *origin*, but one of *age*, and that, therefore, all old characters are inborn, and all new characters are acquired. But language and bipedal locomotion are very old characters in man: yet they remain acquirements, for every man still *learns* to talk and walk. Acquired immunity against this or that disease is another old character; it also remains an acquirement, for every man who acquires immunity acquires it afresh. On the other hand, to term a new character an acquirement merely because it is new is an absurdity for more reasons than one. In the first place the words "inborn" and "acquired" are well-established technical terms with very precise and definite meanings. Biologists use them to mark the vitally important distinction between blastogenetic and somatogenetic characters. An argument which is based on a misuse of terms does not commend itself as conclusive from a scientific point of view. In the second place the distinction between the new and the old is, in this connection, a valueless one. Every character is new to the individual who has it. Thus a man's head is as new to him as a sixth digit or any other variation from the parental type. In the third place the whole argument is beside the mark, for the fact that some new characters are transmissible has never been disputed. On the contrary, the fact that they are transmissible is the corner-stone of every theory of heredity. It is admitted on all hands that new inborn characters are transmissible—new characters, that is, which take origin in the germ-plasm. All that has ever been disputed is that somatic *modifications*, whether new or old, are transmissible.

13. A variation, then, is a new inborn character. It is a new character, but it is not an acquirement. A modification is an acquirement, but it is not necessarily a new character, for many modifications have been acquired by every generation for thousands of years. Moreover, while a variation implies a difference from the parent, a modification may imply a likeness, since both the parent and the child may acquire the same modification. Modifications, as implied in the definition of them, are alterations of inborn characters caused by the play of forces from the environment on the soma of the individual that makes them.[1] The cause of variations is more obscure. Several hypotheses to account for them have been formulated, all of which are unsatisfactory as inadequate to explain all the facts, or as opposed to ascertained facts, or as founded on suppositions which cannot be verified. The whole problem of heredity centres round this question of the causation of variations. It lies at the starting-point of every conceivable doctrine of evolution; for every inborn character, as such, must have appeared in the first instance as a variation, and the evolution of every race has depended on the variations of its individual members. But it is of more than merely scientific interest. Accordingly as we take this view or that we shall form a conception of life and of certain great practical problems, which press for solution in the near future, entirely and fundamentally opposed to that which we would otherwise hold.

14. Congenital likenesses and differences between parents and offspring depend on antecedent likenesses and differences between the portions of germ-plasm contained in the germ-cells from which they arise respectively. Every theory of heredity consists in an attempt to explain why these portions of germ-plasm are somewhat alike, but not quite alike. The various explanations of the *likenesses* may be divided into two categories. One set of theories supposes that the germ-plasm contained in the germ-cells of the parent is compounded of units derived from all his parts. Thus Darwin in his theory of "Pangenesis" supposed that every cell of the body throws

[1] This statement perhaps requires qualification. As we shall see later (§ 275), there is some reason to believe that modifications may be due occasionally to the play of environmental forces, not on the soma, but on the germ-cell itself. Presumably the germ-*cell*, but not the germ-*plasm* contained within it, is then modified. Changes appear in the individual who springs from the cell, but, since the hereditary tendencies of the race are not altered, they are not transmitted to offspring.

off minute "gemmules" which are then dispersed through the body where they multiply, and whence they are collected into the germ-cells; each of the latter thus being packets of gemmules which later develop, each gemmule in its proper place, into the somatic cells of the offspring. The other set of theories supposes that the germ-plasm is not derived from the cells of the soma, but directly from pre-existing germ-plasm. Thus Weismann in his theory of the "Continuity of the Germ-plasm" supposes that, when an individual develops from a germ-cell, the germ-plasm contained in that cell divides into two portions, from one of which, after undergoing great changes and growth, is derived his soma, and from the other his germ-cells. According to the first set of theories the germ-plasm is formed anew in every individual from materials derived from his tissues. According to the second it is not formed anew, but is simply a reserved portion of the germ-plasm from which his own soma was derived.

15. None of these theories are capable of direct proof or disproof. The hereditary substance, the germ-plasm, has been identified with a high degree of probability with the chromatin of the nuclei. When cells multiply the chromatin of the parent cells is distributed to the nuclei of the daughter cells. The continuity of the germ-plasm is therefore practically certain. But it is quite beyond the powers of our microscopes to inform us whether the germ-plasm does, or does not, receive *additional* germinal elements from the soma. We know that it must receive non-living nutritive material, but that is not the same thing. The question, therefore, can be tested, only in an indirect way. If the first set of theories be true, if the soma *does* contribute germinal elements, and the various structures of the offspring *are* derived in part at least from the corresponding structures of the parent, then it follows that the child must tend to reproduce the acquirements as well as the inborn traits of the parent. On the other hand, if the structures of the child are *not* derived from the corresponding structures of the parent, then the inheritance of acquired characters is evidently highly improbable.

16. Formerly all the world believed in the transmission of acquired characters. The discovery that offspring take origin from single cells (generally fertilized ova) did not affect this belief at first. Darwin's theory of "Pangenesis," for example, expressed the popular faith in scientific terms. He tried to explain *how* acquired characters are transmitted by supposing that the hereditary substance in the germ-cells is derived

from the soma, and that as the soma undergoes modification so do the packets of gemmules in the germ-cells undergo change by the incursion of fresh gemmules. Of course, however, even were the transmission of acquirements demonstrated, it would not necessarily follow that it is achieved by means of germinal elements from the soma. Other means of transmission are conceivable. On the other hand, were the contrary demonstrated, all such theories would lose their only justification.

17. It must be noted that a character acquired by the parent can never be inherited as an *acquirement* by the offspring. For were an acquirement transmitted it would arise in the second individual in consequence of influences acting on the *germ-plasm*, whence he springs, not on his soma. The child would be *born* different from what the parent was born.[1] It would make a different start in life. The modification of the parent would therefore reappear in the child as a new inborn trait—a variation. Similarly since a variation implies a difference from the parent it can never be inherited *as such* by the offspring. If, then, the hypothesis we have under consideration be true, the modifications of the parent tend to be *transmuted* into variations in the child, and into ordinarily inborn traits in the grandchild. The theory that acquirements are transmissible to offspring is therefore nothing other than one way of accounting for the occurrence of variations, and ultimately of ordinary inborn traits. It will be necessary to discuss this theory at length, partly for the reason that, though now rejected by most students of heredity, it was, until recently, universally accepted—by all peoples during all ages—as affording a sufficient explanation of such racial changes as were not attributed to miracle, partly because it is still accepted by the majority of human beings, and partly because it will enable us to gather clearer ideas of what most serious students of the subject regard as a truer

[1] The word "born" is used here to avoid circumlocution, just as the term "inborn" is similarly used. But of course, as already indicated, birth does not divide the inborn from the acquired. The embryo and the fœtus may acquire characters (*e. g.* the effects of disease or the muscular development which probably follows intrauterine movements) just as well as the infant or adult. Again, when a child is spoken of as born different from the parent it is not necessarily meant that the difference lies in visible characters. It may consist in a *capacity* to develop differently from what the parent developed, or to react differently to similar stimuli. Were an acquired character inherited the child would differ from the parent in that it possessed the capacity to develop that trait in the absence of the force that caused the parent to develop it.

conception of heredity, and therefore of evolution, than would otherwise be possible. It will in fact serve admirably as an introduction to the whole subject. After dealing with it we shall be in a position to consider other aspects of the question with advantage.

18. Now, whether or not acquirements tend to be transmitted, one thing is certainly true—offspring often vary from their parents, are often born different from what their parents were at birth, even when no character has been transmitted. Thus, for example, the child of normal parents may have a sixth digit on one hand. But no one ever acquired a sixth digit. All our knowledge of embryology tends to show that a sixth digit, whenever it occurs, takes *origin* in the germ-plasm. It is inborn from the first; for it is wildly improbable that a structure so complex can ever have been superimposed on a normal hand by influences acting on the embryo or fœtus *after* it had developed from the germ. To take an even more convincing instance; all the members of a litter of pigs, kittens, or puppies invariably differ, not only from their parents but among themselves. It is impossible that their differences can be due to the transmission of acquirements, for in that case, since the sperms and ova were all under practically identical conditions, every suckling, kitten, or puppy would inherit nearly, if not quite, the same acquirements, and therefore all would be much alike; whereas the fact is they may differ very greatly in size, shape, colour, and a thousand other peculiarities. It is clear then that offspring frequently—we ought to say invariably—vary from their parents irrespective of the transmission of any acquirements.

19. The question we have to consider, therefore, is not whether *all* variations are due to the transmission of acquirements, but whether *any* variations are due to such transmission. The history of the question is instructive. Early in the last century the philosopher Lamarck published a theory of evolution which assumed in effect that *all* variations are due to the transmission of acquirements. His modern followers, a dwindling body, assume that *some* variations arise thus. Darwin started where the Neo-Lamarckians leave off. He assumed that, while many variations arise apart from the transmission of acquirements, some variations arise in consequence of their transmission. His modern followers, the Neo-Darwinians, who include the great majority of biologists, go a step farther. They assume that *no* acquirements are transmissible, and, therefore, that none of the variations of the child are due to the inheritance of parental modifications.

20. At first sight it would appear an easy matter to test the truth of the Lamarckian doctrine of heredity. We might, for example, amputate the tails of a pair of parent dogs, and then observe whether the puppies, subsequently born, were tailless. But the theory is not held in this crude form, at any rate by the scientific supporters of it. They assume that acquirements are only "faintly" and "fitfully"[1] transmitted, a reservation which makes any direct test extremely difficult. Decisive proof or disproof can be obtained only by observing, on the one hand, whether races or species possess characters the existence of which is explainable only on the Lamarckian doctrine of heredity; or, on the other hand, whether they possess characters the existence of which is incompatible with the truth of it—in other words, we must seek conclusive evidence in the changes undergone by races, not in those exhibited by individuals. This test, indeed, must be applied to every doctrine of heredity; for, while the variations of individuals admit, generally speaking, of explanation by a number of theories of heredity, the changes undergone by races admit of explanation, as we shall see, by only one.

21. Three well-known doctrines of racial change, or rather of evolution (adaptive racial change), have been formulated: the Lamarckian, which attributes evolution to the transmission of acquirements; the Darwinian, which attributes it to Natural Selection; and the Bathmic, which attributes it to an "inherent adaptive growth-force." Each of these doctrines of evolution is founded on a special doctrine of heredity, and, since doctrines of heredity cannot be adequately tested except by the evidence afforded by racial change, our next endeavour must be to gain a clear conception of each of these three theories of evolution.

[1] Romanes, *Darwin and After Darwin*, vol. ii., p. 152. Cf. also *An Examination of Weismannism*, p. 6.

CHAPTER II

THEORIES OF EVOLUTION

The Bathmic Theory—The Lamarckian Theory—The Neo-Darwinian Theory—The alleged inheritance of acquired characters—Mutilations—Maternal impressions—Diseases.

22. WE need not devote much space to the Bathmic theory of evolution. It has now very few followers. It supposes that evolution has occurred in obedience to, and under the immediate direction of, a Deity who has rejected both Natural Selection and the transmission of acquirements as means to His ends. It is, in effect, a theory of evolution by ever-recurring miracles. Even if we postulate a Deity as the Originator of all things, yet the whole history of science, which is that of civilization, proves that it is more profitable to seek the explanation of natural phenomena in natural laws (His laws) than in infractions of them—in miracles. Only when a natural explanation has been proved to be impossible have we an excuse for a direct appeal to the supernatural. As scientific men we may have faith in a Deity; we may suppose that the universe is one great miracle; but, except on entirely authentic and decisive evidence of a kind as yet unobtainable, we must not suppose that it is governed by discontinuous miracle.

23. Of course the theory of Bathmic evolution may be enunciated in vague terms. God and miracle need not be mentioned. We may be told that species undergo evolution, and so adapt themselves to the changing conditions of existence, not by the action of Natural Selection nor by the transmission of acquirements, but simply through the operation of an inherent adaptive "growth-force." Nevertheless the appeal to miracle is still necessary. No doubt the universal existence of variations demonstrates the existence of a growth, or rather change-force. But the difficulty which has to be surmounted by the Bathmic evolutionist arises, not

from existence of specific or racial change, but from the fact that this change (*i. e.* evolution) has led, since the beginning of life, to the close adaptation of every race of animals and plants to its own successive environments. Either the environment has acted on species, which have reacted to it, or their adaptive changes were miraculous. There is no third alternative. If the environment caused the adaptation, it must have done so by means of natural selection,[1] or by causing individuals to make adaptive acquirements which were transmitted to offspring. Again there is no real alternative. It is significant that when structures and organs, for example the limbs of snakes, lose their utility—that is when they are no longer used nor selected—they undergo degeneration, not growth.

24. The Bathmic theory of heredity and evolution may, then, be ruled out of court. We are left with the Lamarckian and Neo-Darwinian doctrines. One, or the other, or both combined must furnish the true explanation of evolution.

25. If we believe with Lamarck that acquirements are transmissible, we find ourselves committed at once to a theory of evolution. In the face of common experience, we need not believe that acquirements tend to be transmitted in their entirety,—that a dog which has lost its tail tends to have tailless puppies, or that a man who has made great mental acquirements tends to have children endowed at birth with *all* that he achieved with pain and toil. But we are committed to the doctrine that the dog's loss and the man's gain will be inherited to *some* extent, however slight, and that, if many successive generations of dogs and men make similar acquirements, the race of dogs will ultimately become tailless and that of men highly endowed mentally. In brief, the Lamarckian doctrine supposes that the effects of everything that benefits or injures the individual, including the effects of all use and disuse, are to some extent transmitted to offspring, and that evolution or degeneration results from the accumulation during generations of these transmitted effects. It supposes, for example, that certain antelopes run swiftly because *ancestral* antelopes, in their efforts to escape enemies, developed the structures which subserve speed. It supposes that stags have antlers, because originally their hornless ancestors developed the habit of

[1] "Germinal Selection" and other similar hypotheses may be considered as coming under the category of Natural Selection.—See §§ 158–9.

butting; which irritated the periosteum on certain portions of the frontal bone; which produced bosses of bone on the irritated spots; which, by the accumulation of effects during generations, evolved at last into the great branching structures we know. It supposes that the ox and the rhinoceros have horns and the cock and the crested screamer (*Palamedea cornuta*) have spurs because analogous causes irritated certain portions, not of the periosteum, but of the epidermis. It supposes that the descendant of many generations of blacksmiths will be stronger physically but weaker mentally than the descendant of many generations of students. It supposes that the conditions which produce health and strength in a succession of parents—absence of pathogenic agencies, sufficient exercise, abundance of suitable food and fresh air, the right degree of moisture and temperature, and so forth—will ultimately render the race strong, hardy, and vigorous; whereas contrary conditions will render it feeble.

26. We need not multiply instances; the Lamarckian doctrine should now be plain to the reader. It is necessary however to note a few additional points:—(*a*) Just as the doctrine of the transmission of acquirements is not adequate to explain all the facts of heredity, so, also, it is not adequate to explain all the facts of evolution; for example, while it is perhaps competent to explain man's intellectual powers or the antelope's speed, it cannot explain why man has long hair on his face, which is lacking in woman, or why the colours of one species of antelope differ from those of another. Neither man nor antelopes make acquirements with respect to hair or colour except such as lead to the loss of them. It cannot explain the differences in integuments of the different species of fish. It can explain hardly a single fact in the whole world of plants. In fact, however simple and fascinating the Lamarckian doctrine may appear at first sight, however well it may seem to explain certain phenomena, it is quite insufficient to explain the totality of phenomena. It may possibly be accepted as a partial explanation of evolution; it cannot be accepted as a complete explanation. (*b*) Again it must be noted that the Lamarckian hypothesis is not only a doctrine of evolution but also one of degeneration; it supposes that all beneficial agencies which act on a species are causes of evolution, whereas all injurious agencies are causes of degeneration. In this, as we shall see presently, it is in violent and fundamental opposition to the Darwinian explanation. (*c*) Yet again it must be noted that, if the

Lamarckian hypothesis be true, then, even if it be only a partial explanation of the facts, the evolution and degeneration of many living races, especially of the higher animals, must be proceeding on lines of enormous complexity. All the immense variety of influences acting on them must be producing slow changes in all the huge complex of their multitudinous structures. Here also the Lamarckian doctrine is in fundamental opposition to its rival.

27. The Darwinian, or rather the Neo-Darwinian theory of evolution by Natural Selection, does not possess the fascinating simplicity and obviousness of the Lamarckian doctrine. It is founded on two ascertained facts, and two inferences which its supporters maintain are legitimate:—(*a*) It insists on the universal occurrence of variations as a law of nature. But, except that it rejects the Lamarckian explanation of variations, it does not—at least as held by the majority of its supporters—necessarily concern itself with the question of their causation. It is sufficient for its purpose that variations do occur in every organ and structure of every living being. (*b*) It asserts that the number of individuals in any species which survive and beget a full quota of offspring is not the same as the number that come into being. Immense numbers perish before reaching old age or even maturity. (*c*) It infers that, *as a rule*, the individuals who survive and have offspring, are those which are better fitted to the environment in which they are placed than those which perish. (*d*) Lastly it infers that by this survival of the fittest and elimination of the unfittest the "specific mean"—the average of the race—is raised in successive generations, whereby evolution results. Nature in fact is supposed by it to act on precisely the same plan as a breeder who wishes to improve his stock of plants and animals.[1] She permits, on the whole, only a certain type of individuals to have offspring—those the best suited to their environments. In the case of antelopes, for example, she has eliminated with greater or lesser certainty all individuals incapable of withstanding want, hardship, or disease, or who are deficient

[1] It is curious that during every age men have accepted as a belief the method of evolution laid down by Lamarck, but have followed as a practice that laid down by Darwin. In other words they have believed that races change in the manner described by Lamarck, but have sought to improve their own plants and animals in the manner described by Darwin. The reader will note that Neo-Darwinians necessarily reject Darwin's theory of Pangenesis, since that hypothesis assumes the transmission of acquirements.

in endurance, speed, sight, scent, hearing, taste, digestion, and so forth.

28. As in the case of the Lamarckian doctrine it will be useful to note a few points in reference to the Darwinian theory. As already mentioned, variations are seldom great abnormalities, but, as a rule, small deviations from the parental type. Thus a man's hand may differ from his father's hand in having a sixth digit; but more commonly it is merely larger or smaller, stronger or weaker, finer or coarser. By shape and texture it may be more or less fitted to a particular kind of work; or it may be more or less capable of adapting itself to new conditions—*e. g.* by acquiring protective callosities of the skin when a change is made from light use to heavy manual labour. The various structures of living beings are so nicely adapted to one another, and living beings themselves are so closely fitted to their environments that a great variation (*i. e.* abnormality) can very seldom if ever be other than harmful. Indeed it is probable that no instance of an abnormality useful to a plant or animal in a state of nature has been recorded. It was assumed by Darwin, therefore, and in this his modern followers as a rule agree with him, that evolution through the agency of Natural Selection proceeds on lines of small variations, not on lines of great abnormalities. They suppose that all structures, no matter how large and complex, began originally as small variations of pre-existing structures, and that they were evolved in succeeding generations by the continued addition of small variations. Thus they suppose that, when the hornless ancestors of deer began to push one another with their foreheads, the animals with the thicker and stronger frontal bones were, other things equal, the more successful in the struggle for mates. Next through the survival of the fittest, by the accumulation of normal variations, small bosses of bone were gradually evolved on the thickened skulls. Lastly, still by the accumulation of normal variations, antlers appeared and increased in size till their further enlargement was no longer useful.

29. To take another extreme case:—According to Neo-Darwinians it is not necessary to postulate a great abnormality as the starting-point of wings. The fins of flying-fish, which may easily have evolved without the aid of abnormalities from smaller organs, have reached a stage from which, still without abnormalities, they may as readily evolve into organs for more sustained flight. And did this happen, and were it accompanied by equally gradual changes in other structures, the species would ultimately become adapted to an

aërial and perhaps even to a terrestrial life. The human fore-limb affords another example. It differs greatly from an organ of mere progression as in the horse; yet all the stages by which the arm of the man and the fore-leg of the horse have diverged from a common ancestral type may be traced with considerable clearness. It is still an organ of progression in the infant. In this case, as in all others, Darwinians—at any rate most of them—suppose, not that an entirely new structure has been suddenly developed, but an old structure has been gradually adapted by a change of shape to a new function.[1]

30. The rapidity of evolution, other things being equal, varies with the stringency of the selection. It follows—and the deduction is confirmed by our experience of artificial selection—that, when the stringency of selection as regards any character falls below a certain point, evolution ceases. If it falls yet lower, particularly if there be complete cessation of selection, the character in question undergoes deterioration. Thus the speed of thoroughbred horses has been evolved by stringent selection; if we cease to breed with care the race would no longer evolve; if we permitted indiscriminate breeding—*panmixia* as it is called—the race would deteriorate. There is however a limit to the stringency of selection, and therefore to the rapidity of evolution. The death-rate must not exceed the birth-rate, or the race suffers ultimate extinction. It follows again, since few individuals are pre-eminent in many qualities and none in all qualities, and since different qualities demand for their evolution different sets of eliminating agencies, that a race of complex plants or animals cannot undergo evolution in all its parts at once; for then the birth-rate would fall below the death-rate. The environments in which all races live change slowly, and with each change of environment occurs a gradual change

[1] It is often said by its opponents that Natural Selection is able to improve, but cannot create a structure. Thus we are told that the electric organ of the *torpedo* cannot have been created by Natural Selection, since in its feeble beginnings the organ cannot have been so useful as to influence the survival rate. But its adherents reply that whenever this objection is raised we may be sure it refers to some case concerning which our knowledge, especially our historical knowledge, is defective. Almost always it refers to some soft structure which has left no fossilized remains from which the past may be traced. But whenever our historical knowledge is sufficiently full we are able to perceive that Natural Selection, through its power of modifying useful structures to different but still more useful functions, may be an all-sufficient cause for the creation of entirely new organs. It is claimed therefore that the Darwinian, unlike the Lamarckian doctrine, affords a complete explanation of all evolution.

in the conditions of selection, and therefore in the direction of evolution. New qualities become essential and are evolved by stringent selection; other qualities which were formerly stringently selected are now merely preserved or undergo deterioration. Civilized man, for example, is to-day being stringently selected by certain forms of disease, and is undergoing evolution against them. But his feet, his hands, his heart, his lungs, his liver, have not changed apparently for thousands of years. Sight, hearing, smell, teeth, etc. are said to be deteriorating. They were evolved during different but overlapping periods of a long-extended past. It follows that though organisms are seldom in anything like perfect adaptation to their surroundings, organs very frequently are more nearly so. It further follows, if the Neo-Darwinian doctrine be wholly true, that the evolution of all races proceeds during any epoch on lines of comparative simplicity.

31. All causes of death are not causes of evolution, since they may be neither selective nor stringent. Thus deaths by fire and water do not cause evolution in England. Thus also modern weapons of war do not discriminate in battle.

32. The Darwinian, unlike the Lamarckian doctrine, attributes evolution to injurious agencies. According to it the specific mean is raised by the elimination of the unfit. Occasionally the two doctrines are seemingly compatible, more often they are in violent opposition. The speed of antelopes may, conceivably, have been evolved both by the transmission of acquirements and the survival of the fittest. But their powers of resisting privation and disease cannot have been so evolved. Both privation and disease cause deterioration in the individual, and should therefore, if acquirements be transmitted, cause deterioration of the race. If acquirements be not transmissible they should cause evolution by the survival of the fittest. Since powers of resisting privation and disease have undoubtedly arisen, it is clear, in this case at least, either that acquirements have not been transmitted, or that the tendency to transmission has been so feeble as to be easily overcome by Natural Selection.

33. However much the transmission of acquirements among multicellular forms may have been questioned, no doubts seem to have arisen hitherto in medical circles as to their transmission among unicellular organisms. Biologists have discussed the question to some extent; but they have merely discussed it.[1] Little or no attempt has been made

[1] Weismann formerly attributed the variations of higher animals and plants entirely to amphimixis—to the mixture of dissimilar germ-plasms

to settle it by direct observation. Yet it has great importance. If acquirements were shown to be inheritable among these lowly forms, no proof, of course, would be afforded of their inheritability higher in the scale, where the probability of transmission is infinitely less. But, if they were shown not to be transmissible among unicellular forms, an overwhelming presumption would be raised against their transmission among multicellular plants and animals.

34. It is a well-known fact that diseases are apt to change their type when the environment, in which the pathogenic organisms exists, is changed. Thus small-pox when removed to the calf is altered to cow-pox. It becomes a purely local and contagious, not a general and air-borne malady. The organisms of rabies, passed through a succession of monkeys, grow milder in type; passed through a succession of dogs, they grow more virulent; passed through a succession of rabbits, still more virulent. The organisms of anthrax may be attenuated by heat; those of diphtheria and tuberculosis by cultivation in artificial media. Numerous similar examples may be instanced. It is supposed by bacteriologists that all these organisms become individually modified by their altered surroundings, and that their "modifications" are transmitted to descendants. But the belief does not appear to be founded on anything more than an assumption. Unicellular forms, especially the organisms of disease, multiply with extreme rapidity, and therefore are exceptionally fitted to undergo swift racial change through the survival of the fittest—through the accentuation of "spontaneous" variations. They

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in bi-parental reproduction—denying all influence to the environment. But the dissimilarity between germ-plasms must have arisen in some way. He derived it, therefore, from the remote unicellular ancestors of multicellular forms. He supposed that unicellular organisms, among whom, as he then supposed, there was no amphimixis, underwent racial change solely through the transmission of modifications caused by the action of the environment. But amphimixis among infusorians was subsequently proved by Maupas. (*Le réjeunissement kalyogamique chez les Ciliés.* Arch. d. Zoöl., 2me série, vii. 1889.) Thereupon Weismann concluded that even these unicellular organisms must have arisen through the Natural Selection of congenital variations, and therefore that the source of variation "must be dismissed to some stage less distant from the origin of life"—to "those lowest of all beings which are entirely formless, and have no fixed size,—beings which we must regard, little as we know about them, as crossing the very threshold of organic life." (*Essays*, vol. ii., pp. 193-4). His latest opinion, like that of most biologists, is that the environment, acting on the germ-plasm, may, on rare occasions and to a small extent, cause variations even in the highest multicellular forms. (*The Germ-plasm*, p. 418.)

are extremely variable as is shown by numerous changes of form under conditions which preclude the possibilities of these alterations in shape and size being mere modifications. Thus the descendants of a single diphtheria bacillus, grown in broth, may be comparatively large or small; straight, clubbed, or branched; or the descendants of a single vibrio, grown under similar conditions, may be spirillar or S-shaped. By judicious management purely parasitic organisms may be rendered saprophytic, and *vice versâ*. As parasites they gradually become resistant to the germicidal action of the tissues; as saprophytes they slowly grow resistant to the germicidal action of the outer environment. If quickly transferred from one environment to the other, they tend to perish. If slowly transferred to a non-living medium, parasitic organisms tend to lose their virulence; whereas the virulence of saprophytic organisms may be enormously exalted by passage through a series of animal hosts, as in the case of streptococci. In some cases they cannot be passed from one medium to another except by way of a third. In all these examples the time occupied by the change is ample for the operation of Natural Selection.[1] Consequently the changes, which bacteriologists have attributed entirely to the transmission of acquirements, may be due altogether to Natural Selection.

35. Indeed in many cases it is practically certain that Natural Selection is the God in the machine. Thus toxins, extremely complex chemical compounds, are defensive weapons which protect the organisms producing them from their enemies, the phagocytes of the blood and tissues. It is possible to imagine that the evolution of the power of producing toxins is due to the survival in comparative numbers of those individuals who happen to produce the more poisonous secretions; but it is difficult to imagine its evolution through the transmission of acquirements. How could such remarkable acquirements be made? Why are the poisons specific, and not of a type common to all the species? Why do they arise only in species exposed to particular dangers, and not in the others? Through the effects of use! But what kind of use? A bacillus is not an experimental laboratory which conducts improvements

[1] Organisms (*e. g.* bacillus typhosus) which normally alternate between a parasitic and saprophytic existence, must not, of course, be confused with the cases given above. The alternation here is comparable to the alternation of generations in higher forms, and probably, like it, has been evolved by Natural Selection.

under expert management. Why is it possible to increase the virulence of bacilli only by passage through a living host in which their enemies the phagocytes are present, and not by passage through non-living media from which they are absent? It is perhaps conceivable that the transmission of acquirements may cause the *weakening* of a toxin by bringing about defects in the producing apparatus; but to me, at least, it seems wildly improbable that such a process can cause the *strengthening* of a toxin. Moreover, we shall see presently that there are cogent reasons for believing that modifications made under the influence of use and disuse are limited to organisms immensely higher in the scale than the microbes of disease.

36. We may conclude therefore that there is as yet little or no evidence to justify the belief that acquirements are transmissible among unicellular forms. We are not, indeed, in a position to declare they are never transmitted. The matter is still *sub judice.* Presumably it might be settled by the success or failure of attempts to produce racial change so rapidly that the influence of Natural Selection could reasonably be held as excluded. But already, as regards many important characters of unicellular forms, we are in a position to declare that it is highly improbable they can have arisen under any influence save only that of Natural Selection. All size and complexity is relative. Medical men have realized how little and simple these organisms are; but they have not realized how large and complex they are, how far removed from the beginnings of life.

37. We may now turn to multicellular plants and animals. As regards them at any rate we are in possession of an immense mass of evidence. After a unicellular organism conjugates it divides and re-divides many times, and the resulting millions or billions of cells separate, each cell "ganging its ain gait." A fertilized ovum also divides and re-divides many times, but the resulting cells adhere together and form a cell-community, in which to the germ-cells, as to the queens and drones of a hive, is delegated the function of continuing the race. Now, when a unicellular organism makes an acquirement, it is supposed to bequeath it to its own offspring and descendants. *A priori* transmission here seems probable; "the child is a part and usually a half of its parent." But the case as regards multicellular organisms is very different. One set of cells, the somatic cells, acquire modifications; the descendants of quite another set of cells, the germs, are supposed to reproduce them. It is as though

the descendants of the queen bee were supposed to reproduce the modifications of the workers associated with her. It is as though the offspring of Brown were supposed to reproduce the acquired peculiarities of Jones and Robinson. A modification of a man's thumb (*e. g.* an effect of use) is supposed to affect his germ-cells, situated far distant, in such a peculiar manner that the modification tends to be reproduced as an inborn trait by his offspring. A different modification of his thumb (*e. g.* an effect of injury) is supposed to affect the germ-cell differently, but also in such a precise way that it likewise tends to be reproduced. A similar change (*e. g.* an effect of injury) in the great toe is supposed to affect the germ in a manner so profoundly different, that the peculiarity is reproduced, not in the thumb, but in the great toe of the offspring—and so on *ad infinitum.*

38. It will be seen at once that this power of transmitting acquirements which multicellular organisms are said to possess is—if it exists—a very remarkable thing. A high organism may make a million different acquirements—in mind, brain, gland, muscle, bone, skin—in every structure. Each of them is supposed to affect the germ-plasm in which there is neither mind nor brain nor skin, nor any other specialized tissue, in such a very special and peculiar way that the extremely remote cell-descendants of that germ will reproduce the change, not as an acquirement, but as something very different, as a variation. We must therefore ask ourselves three questions. How did this remarkable power, or rather infinity of powers, arise in nature? What is the machinery by which it works? What evidence is there of its existence?

39. How did it arise? Nothing like it exists, of course, among unicellular forms, which, since they separate, are unable to influence one another. It must have arisen, if at all, *de novo* amongst multicellular organisms. What then caused the evolution of it? What preserves it? If we rule out miracle there remains only Natural Selection. But we have already seen that Natural Selection and the transmission of acquirements are frequently not compatible. Since the one works by injurious and the other by beneficial agencies, they pull in opposite directions. Suppose for the moment we accept both doctrines as true. Then, when Natural Selection is causing evolution by the elimination of the unfit, the transmission of acquirements is causing degeneration by the inherited effects of injuries (*e. g.* the effects of want and disease). Or when the transmission

of acquirements is causing evolution through inherited benefits (plentiful food, etc.), cessation of Natural Selection is resulting in degeneration. We saw that the only instances in which the two doctrines are seemingly compatible are when (as in the cases of antelopes hunted by carnivora) Natural Selection causes elimination of the unfit by violent death, while at the same time transmission of acquirements is causing evolution among the survivors by the inherited effects of use. But, as a matter of fact we are in possession of conclusive evidence that the effects of use (and presumably also of disease) are never transmitted. We shall deal with that evidence presently. Meanwhile it follows that Natural Selection and the transmission of acquirements, if they both exist in nature, are, not only sometimes, but always at war. They invariably act in opposition. Must we, then, conclude that Natural Selection has called into existence a power which tends to stultify its own operations?

40. As long as we think of inheritance among multicellular creatures in terms of the whole organism, just so long does the transmission of acquirements seem natural and probable. Thus, if we think vaguely, as we are apt to do, that a man's head is derived from his parent's head, his limbs from his parent's limbs, his lungs from his parent's lungs, we see nothing incredible in the belief that changes occurring in the parent tend to be reproduced in the child. But the moment we descend to accurate details and think in terms of the germ-cell, immediately we see that the transmission, if it occurs, is very wonderful. We are then forced to ask ourselves how this amazing power arose. Natural Selection *could* not have evolved a power which renders its own operations nugatory. How then did it arise? The only alternative is an appeal to miracle.

41. What is the machinery by which it works? By what means do different acquirements so affect the germ-plasm, so change it, as to cause their own reproduction in the offspring? It has been maintained that the multicellular body is not really multicellular, but in a true sense unicellular. The separation between the various fixed cells of the organism is said to be incomplete; they are connected by protoplasmic bridges. But, even supposing we agree to regard the multicellular body, not as a community of adherent cells, but as a sort of gigantic unicellular organism, our difficulties do not diminish. It still remains true that the offspring is derived from a minute fraction of this body, and it is just as hard to believe that the fraction is influenced in millions of precise

directions by acquirements occurring elsewhere, as to believe that the adherent cell is so influenced. It is sometimes argued that, since the different parts of the body influence one another, there is no reason why they should not influence the germ-cells. This is quite true; but the fact that A influences B is no proof that C influences D. The various co-ordinations of the body, such as the influence which the nervous system exercises over muscles and glands, or the influence which the primary sexual characters exercise over the secondary sexual characters, are limited in number, have been evolved through a slow and difficult process, and have appeared only because they are highly useful. But acquired characters are limitless in number, they are often injurious, and frequently they are new to the race. In the one case there is a reason why the correlations should occur, but in the other very cogent reasons why they should not.

42. What evidence is there that acquired characters are acquired by offspring? Though for many years biologists have ransacked the plant and animal kingdoms, no single indubitable instance of the transmission of an acquirement has yet been proved. It is not necessary to review at length the immense mass of negative testimony. In the course of this work we shall have to deal incidentally with evidence which it is believed the reader will consider conclusive. Meanwhile, before taking leave of this part of our subject, it will be well to take note of one or two fallacies which are current in popular and medical literature, though happily, in the latter case, to a much less extent than formerly.

43. Mutilations are still cited as evidence of the transmission of acquirements, though the belief in their inheritance has long been abandoned by all, or nearly all biologists. But mutilations are so very many and the instances of their transmission so very few that all such instances may be dismissed as mere coincidences, as examples of confusion between *post hoc* and *propter hoc*. Terriers still retain their tails, after many generations of mutilation. The use of ear- and nose-rings during centuries has left no trace on certain sections of the human race. How often do medical men see the mutilations caused by disease or the surgeon's knife reproduced? The parent acquires a mutilation, and the child in very rare cases happens to vary from the parent in such a way that the acquirement is apparently reproduced; but only apparently. One swallow does not make a summer. Were mutilations transmissible, then, not in one apparent instance out of a million, but in all or most instances, would

the acquired peculiarity be reproduced by the child. There is one test, and one only, by which the transmissibility of a mutilation can be proved—the test of experiment, the test of its constant reproduction under given conditions. Under that test the hypothesis that mutilations are transmissible is easily proved to be without foundation.[1]

44. Maternal impressions and telegony are supposed to supply evidence, A pregnant female sees a deformity or something else which powerfully impresses her. Her child when born is thought to reproduce the deformity. Thus a Kerry cow chased by a bull-dog is said to have borne a calf extremely like her persecutor. Telegony is a phenomenon of much the same order. A mother, who has borne offspring to one sire, is supposed to so influence offspring borne to subsequent sires that the latter reproduce the peculiarities of her first mate; thus a white woman who has borne a child to a negro is supposed ever after to bear dark children to white men; a mare who bore a foal to a quagga is said to have borne, subsequently, striped offspring to a thoroughbred horse. In the one case the mother's mind is thought to be impressed; in the other her body. Both hypotheses furnish examples of the amazing looseness of thought which occasionally prevails in biological writing. Neither the transmission of maternal impressions nor telegony has stood the test of accurate observation; they are popular superstitions. But suppose they had been demonstrated up to the hilt; even in that case the transmission of acquirements would not have been proved; for by the transmission of acquirements we mean, or ought to mean, that the precise thing the parent acquired, or something very like it, is transmitted to offspring. But a mother who gets a mental impression does not transmit that mental impression to her child; on the contrary, the child is supposed to develop something quite different, a physical malformation. So, also, did the white mother of a half-breed bear dark chil-

[1] In this, as in all similar instances, the onus of proof rests with the party making the positive assertion, not with those who deny it. If mutilations were transmissible the fact could easily be proved. If they are not transmissible it is logically impossible to furnish formal proof for the simple reason that it is impossible to prove a universal negative. Thus, if a Lamarckian declared that mutilation A was transmissible and his assertion were disproved, he could still declare that mutilation B was transmissible; if that also were disproved he could declare that mutilation C was transmissible; and so on, *ad infinitum*, through the entire range of mutilations, actual or possible, past, present, or future. Or if it were proved that a given acquirement was not transmissible in this individual, the Lamarckian could declare it *might* be transmissible in some other individual.

dren to a white father, she would not transmit anything *she* acquired, for intercourse with a negro does not make *her* dark. Telegony and the transmission of maternal impressions therefore cannot furnish argument for the Lamarckian doctrine. Were they true, which they are not, they would merely furnish arguments for the much more reasonable doctrine that changes in the parental mind or body may, in this or that *other* way, affect children subsequently born—a very different thing from the doctrine which affirms the transmission of acquired characters.[1]

45. The effects of various diseases are supposed to supply evidence. Heredity in relation to disease will be one of the principal topics of this work; but there are one or two points which may be conveniently dealt with here. Gout is constantly instanced in medical works as affording evidence. The sins of the father are thought to be visited on the heads of the children. Here diathesis—*i.e.* predisposition, tendency—an inborn trait, is confused with disease, an acquirement. Some men are so constituted that, under fit conditions, they tend to develop gout; the children inherit the inborn trait, the diathesis, and under like conditions tend in turn to develop the same disease. But there is no evidence that parental high living influences, in the slightest degree, the liability of the child to gout, nor even that generations of high living tend to evolve the gouty diathesis in a self-indulgent race. The children of poor Irish peasants, when removed from their normally miserable surroundings into a more comfortable environment, are as liable to gout as the scions of the British aristocracy. In fact, judging by the analogy of other diseases, it is probable that, were gout very prevalent and a considerable cause of death or serious disablement, the race that was most afflicted by it would, by the weeding out of the unfit, become in time the most resistant to it, the least liable under given conditions to contract it.

[1] Professor J. Cosser Ewart's classic Penicuik experiments are conclusive against telegony. (Vide *The Penicuik Experiments*, A. and C. Black. London: 1899.) It has been alleged by no one that the children of lady doctors and hospital nurses are particularly liable to malformations. "Dr. William Hunter, in the last century, told my father that during many years every woman in a large lying-in hospital was asked before her confinement whether anything had especially affected her mind, and the answer was written down; and it so happened that in no instance could a coincidence be detected between the woman's answer and any abnormal structure; but when she knew the nature of the structure she frequently suggested a fresh cause." (*Animals and Plants*, Darwin, vol. ii., pp. 251–2.)

46. Syphilis and tuberculosis have been instanced. But syphilis and tuberculosis are never inborn. Presumably they both depend on the presence of particular species of pathogenetic organisms. The child acquires the disease as much as the parent. No acquirement is transmuted into a variation. It would be as reasonable to speak of *ophthalmia neonatarum*, or of a bullet which had passed through a mother and lodged in her fœtus, as instances of the transmission of acquirements.

47. Hæmophilia has been instanced. But hæmophilia is never acquired. It appears in the first instance as a variation, and for that reason is transmissible. Here the new is confused with the acquired.

48. Speaking practically, the few surviving scientific upholders of the Lamarckian doctrine now limit themselves to the contention that the effects of use and disuse are transmissible. This was the great thesis of Lamarck himself. They admit, since acquirements are, at most, only "faintly and fitfully" inherited, that mutilations and the like, which, as a rule, are acquired by only a few individuals in a generation, and which do not greatly affect the rest of the body, can have little or no influence on the race. But they contend that the effects of use and disuse, which are acquired by every individual during thousands of years and which may profoundly affect the whole body, tend ultimately to become "organized" into inborn characters; the word "organized" being a vague word used to indicate a particular and inexplicable change in the germ-plasm. Thus hares are supposed to have become swift because their ancestors practised swift running. The giraffe is supposed to have a long neck because its ancestors stretched upwards for food. The elephant is supposed to have a short neck and a long proboscis because its ancestors stretched their upper lips rather than their necks. Similarly the snake is supposed to have lost his limbs through the transmitted effects of disuse.

CHAPTER III

USE AND DISUSE

Regeneration—Adaptive acquirements—The co-ordination of animal parts—The effects of use and disuse—The evolution of the power of making adaptive acquirements.

49. It is admitted very generally by the followers of the Lamarckian doctrine that Natural Selection must have played a great part in the evolution of living beings, especially in the evolution of plants and the lower races of animals; but they insist strongly that many characters, particularly in the higher races of animals, are such that they can have arisen only through the inheritance of the effects of use and disuse. It is well, therefore, to test the Lamarckian doctrine of heredity by the known facts of evolution. The test is a decisive one.

50. When multicellular organisms were first evolved from unicellular types, it is extremely probable that all the cells constituting the mass were similar in form and function; and that, therefore, like the ancestral unicellular organism, every cell was capable of performing all the functions of life, namely, nutrition, reproduction, locomotion, and the like. Later, presumably as a result of Natural Selection, differentiations gradually appeared among the adherent cells of the community, some taking on, more and more, one special function, and some another, till at length a high degree of differentiation resulted. Reproduction of the race was then delegated to the germ-cells, while all the other cells also devoted themselves to particular functions.

51. Among unicellular organisms every cell is a germ-cell, and as such is capable of continuing the race. Among low multicellular types the power persists in many cells, and the environment decides whether it shall be exercised or not; thus, if almost any fragment of a sponge be bedded out, it will

proliferate into a complete individual. The power persists longer in plants than in animals; from a fragment of a begonia leaf may arise an entire individual capable of continuing the race, the cells being turned from their original destiny by a change in the environment. But among the higher plants this power of reproducing the entire individual by means of cells other than germ-cells, or what may normally proliferate into germ-cells, is, as a rule, less complete.[1] Often all that appears to persist is the power of reproducing from such fragments of the complete organism as contain cells which might normally proliferate into germ-cells, the parts wanting to render the fragments complete organisms. Thus a geranium slip, for instance, contains cells which normally (*i. e.* when the branch remains a part of the plant) proliferate into germ-cells. If this branch be bedded out as a slip, it produces the roots which are needed to convert it into a complete organism of its species. Here germ-cells are not produced from cells not destined to that purpose as in the begonia leaf, but lost parts are reproduced by what may be termed, and in fact is, an exaggerated process of healing. In other plants the power of reproducing lost parts seems to be on an even smaller scale, and only comparatively trifling injuries are healed—*i. e.* a small fragment does not reproduce the whole, though the whole may reproduce small fragments.

52. Among animals, owing to the greater specialization of the cells, and the more complex conditions under which they live, this power of reproducing lost parts is present, in general, to a much less extent than among plants. At least it is present to a much less extent in the adult. In the embryo,

[1] This statement has been disputed. "We have no means of estimating exactly the proportional number of cases in which this is possible, either among the lower or the higher plants, but it is certainly much greater than Weismann supposes. 'How is it that all plants cannot be reproduced in this way?' he asks—and then adds: 'No one has ever grown a tree from the leaf of a lime or an oak, or a flowering plant from the leaf of the tulip or the convolvulus.' But I am told by botanists that the only reason why the phenomenon thus appears to be a rare one, is because it is not worth any one's while to grow plants in this way at a necessarily unsuitable season of the year. Thus, the Rev. George Henslow writes me: 'The fact is that any plant will reproduce itself by its leaves, provided the cells be "embryonic" (*i. e.* the leaf not too near its complete development), and that it be not too thin, so as to provide nutriment for the bud to form till it has roots.'" (*Weismannism*, by Professor G. Romanes, pp. 52–3.) However, even if Mr. Henslow's statement be correct, the statement in the text is not affected, since the fragments of some species of plants give origin to new individuals much more readily than the fragments of other species.

especially the very young embryo, it persists in a greater degree. Thus, if one of the two cells into which the frog's ovum first divides be destroyed, the remaining cell may reproduce the whole tadpole, though of a half-size. Later in development the tadpole is able to reproduce an amputated tail, a power of regeneration much greater than any possessed by the adult frog. Low in the scale of life, in the adult, as we have just seen, a fragment of sponge, for instance, is able to reproduce the whole; higher in the scale, a star-fish can reproduce a ray, a lobster a claw, and so forth; but none of these parts can reproduce the whole; that is done solely by germ-cells. Higher yet, as among birds and mammals, the power of reproducing lost parts is comparatively very trifling. Important and complex parts cannot be restored. Wounds and mutilations are healed; but, if important, very imperfectly, for mere scar tissues replace the tissues that were lost.[1]

53. It is clear, then, the reproduction of lost parts, whether it be on a very great and perfect scale, as when a fragment reproduces a whole, as in a sponge, or whether it be on a very small or imperfect scale, as when a wound is healed in one of the higher animals, is a process of the same order. It is, in fact, a process of the same order as the reproduction of an entire organism from a germ-cell. Now we speak of a scar, in a man for example, as an acquired character; but who would dream of speaking of all that is reproduced by a fragment of a sponge or a begonia leaf, or indeed by a fertilized germ-cell, as a character acquired by the fragment or the germ-cell? Moreover, when one of the higher animals is mutilated, as when a dog loses his tail, we lump together both the mutila-

[1] The above, however, expresses only a part of the truth, and probably only a small part of it. It is true that the power of regeneration is very generally lost to the highly specialized tissues of the higher animals, but apparently it is not lost solely (if to any extent) on account of the high exaltation of one special function in each cell. This exaltation of one function does not appear necessarily to entail the loss of other functions. On the contrary, the principal, if not the sole, reason of the loss appears to be that the retention of the power of regeneration is no longer very useful. For obvious reasons the fragment of an antelope could not maintain existence while it was regenerating the whole animal; even the loss of a limb entails inevitable destruction of the whole. Even among allied species of animals the power of regeneration varies in proportion to its usefulness. Thus terrestrial salamanders have little power of regeneration, "whilst another species of the same genus, the aquatic salamander, has extraordinary powers of re-growth . . . this animal is eminently liable to have its limbs, tail, eyes and jaws bitten off by other Tritons." (Darwin, *Plants and Animals*, vol. ii., pp. 358-9. Compare Weismann, *The Germ-plasm*, p. 114.)

tion and the tissue by which the lost part is replaced (*i. e.* the scar) as a single acquired character. But surely the mutilation ought not to be so designated. It should rather receive some such distinctive name as an *enforced* character. We see also that the power of regenerating lost parts to a greater or lesser extent persists throughout organic nature, but that this power is vastly greater in low than in higher animals. In other words, if we agree to regard such regenerations as acquirements, observation proves that the power of acquiring them is very much greater lower in the scale (*e. g.* sponge) than it is higher (*e. g.* man). The power in fact undergoes diminution (regression) as it grows of less and less importance in the struggle for survival, and other faculties take its place. The term "acquired" is now, however, so well established in reference to mutilations, that it is hopeless to expect a change to a more accurate and scientific nomenclature. Unfortunately just as a lack of clarity in thought frequently results in a lack of clarity in terms, so a lack of definiteness in terms frequently leads to a lack of accuracy in thought.

54. On the other hand, there is another class of acquired characters—perhaps the only class to which the term should be applied—the power of acquiring which is greatest among the highest animals, and, apparently, is little or not at all present among the lower animals nor in the plant world. These are such characters as arise as a result of exercise and use, and which from their nature we may term *adaptive* acquirements; for instance, the increased muscular power of an athlete. In the plant world such characters cannot be acquired to any extent, for vegetables do not "use" their parts in the sense that animals do. Plants, therefore, of necessity, attain their full development in the absence of almost all stimulation other than that supplied by sufficient food, light, and warmth.[1] Of such plant-like animals as sponges the same is true. It is true to some extent, and with many exceptions, even of such active animals as insects. Thus a pupa may develop into a perfect insect while lying quiescent. The lower vertebrates, such as fish and reptiles, also have little power of developing in response to the stimulation of exercise

[1] No doubt, to a limited extent some use-acquirements are made by plants. Thus the Kauri pines of New Zealand, when taken from exposed hillsides, yield timber much tougher and more durable, and therefore more valuable though less easily sawn, than timber taken from sheltered valleys. The ingenious timber merchant endeavours on occasion to sell his valley planks as the product of the hillside. Climbing plants also "use" their tendrils.

and use; apparently they are able to grow into normal adult animals in its absence. Thus, if a tadpole finds its way through a crevice into a small cavity, and is able to obtain sufficient food, it may develop into a normal frog though it leads a purely vegetative life. Fish are said to possess a similar power. Higher in the scale, in a continuously increasing degree, among birds and mammals, and most of all in the highest mammals, the animal attains its full devolopment, as regards many structures, only in response to the stimulation of exercise and use; thus, for instance, if the limb of an infant be locked by paralysis or by a joint disease, so that it cannot be used, it does not develop into an adult limb.[1]

55. Now, if a "normal" man takes a more than normal amount of exercise, he gets a more than ordinary development of various structures, as happens in the case of the blacksmith's arm. This additional development is regarded as "abnormal," and is rightly termed "acquired." But, as we see, the "normal" degree of development is attained only as a response to stimulation (exercise) similar in kind though less in amount. *Therefore it is clear that the full development of the normal arm, as well as many other important structures,* is acquired, differing in this from hair, nose, eyes, ears, teeth, nails, sexual organs, etc., which are wholly inborn, and apparently do not owe their development in the least to use and exercise. In fact, on consideration, I think it will be found that adult man differs physically from the infant almost wholly in characters which are acquired through use, not in those which are inborn. In the features of his face, in primary and secondary sexual organs, and in some other respects, he differs from the infant largely in inborn characters; but as regards nearly all the structures of the trunk and limbs as well as most of those of the head (*e. g.* brain), the difference lies in characters which have been acquired by the adult in response to the stimulation of exercise and use. Thus, the limbs develop almost wholly in response to use; the heart and blood-vessels develop in proportion to the strain put on them; as also do the lungs and their accessory muscles, as well as the bony attachments of the latter. The muscles, arteries, nerves, bones, ligaments, and other structures of the head and neck develop in response to similar stimulation. Moreover the normal standard of

[1] The effects of use and disuse in relation to heredity have been discussed at greater length in my book *The Present Evolution of Man*. It it now admitted, probably on all hands, that higher animals are more "plastic" than lower animals. See in particular *Development and Evolution* by Professor Mark Baldwin.

development is maintained only as a response to this stimulation (*i. e.* use, exercise); for example, when not used, the muscles and their co-ordinated structures atrophy and tend to disappear, as in the case of a paralyzed limb. It may be added that it is probable that even the infantile standard of development is to some extent acquired under the stimulus of fœtal movements in utero.[1] Adult man consists therefore of a huge superstructure of use-acquirements, built on a comparatively slender foundation of inborn traits.

56. In upholding the doctrine of the transmissibility of acquired modifications, much stress has been laid by Mr. Herbert Spencer and others on the exquisite co-ordination of the multitudinous parts of the high animal organism. They maintain that this co-ordination affords decisive proof of the Lamarckian doctrine, the line of argument being as follows: It is not probable that the many structures of a high animal can ever have varied favourably together (as compared to the parent) in any individual animal. It is unbelievable that they can all have varied favourably together, generation after generation, in a line of individuals. A chain is only as strong as its weakest link. A favourable variation, say a large horn in the elk, if unaccompanied by corresponding variations in all the thousand parts (in head, neck, trunk, limbs) co-ordinated with it, would be useless and even burdensome. In other words, if a single structure (muscle, bone, ligament, blood-vessel) of all those associated with the large horn, failed to bear the strain, the larger horn would not favour survival; but, on the contrary, would be a cause of elimination. Therefore, say these thinkers, the evolution of high multicellular animals cannot be attributed to the accumulation during generations of "spontaneous" variations only, but must, in part at least, be attributed to the inheritance and accumulation, during generations, of the effects of use and disuse.

57. But modifications, acquired as a result of use and disuse, are clearly never transmitted. Thus, an infant's limb never attains to the adult standard except in response to stimulation similar to that which developed the parent's limb. The same is true of all the other structures which in the parent underwent development as a result of use. These, like the limbs, do not develop in the infant, except as a result of similar causes. Yet all such characters must have

[1] The fœtus, especially when nearing maturity, doubtless possesses the power of making use-acquirements; but probably not the embryo. The latter represents a stage too early in the life history.

been acquired by every individual of the race during hundreds of thousands of generations. *Plainly then that which is transmitted to the infant is not the modification, but only the power of acquiring the modification under similar circumstances*—a power which has undergone such an evolution in high animal organisms that, in man, for instance, nearly all the developmental changes which occur between infancy and manhood are attributable to it. It follows, therefore, that the exquisite co-ordination of all the parts of a high animal is not due to the inherited effects of use and disuse, but to this great power of acquiring use-modifications along certain definite lines; so that if an animal varies in such a way as to have one of its structures (*e. g.* horn, which is wholly inborn) larger than it was in the parent, then all the other structures associated with it, owing to the increased strain (*i. e.* the increased stimulation) put on them, undergo a corresponding modification, and thus preserve the harmony of all the parts of the whole. So also if the horn be smaller than in the parent, the lesser strain placed by it on the associated structures causes them to develop less than in the parent, whereby again the harmony of the whole is preserved.

58. The power of acquiring fit modifications in response to appropriate stimulation is that which specially differentiates very high animal organisms from lower types. It enables the animal possessing it to closely adapt itself to all sorts of varying circumstances and environments—to acquire, for example, additional muscular powers under the stress of need, or get rid by atrophy of the burdensome addition when the need is past. It provides, in fact, a short-cut by means of which qualities too numerous to be evolved and maintained as inborn traits by Natural Selection (owing to the immense mortality which would be involved) are evoked at need. Without this power and the plasticity which results from it, the multitudinous parts of high animals could not well be co-ordinated, and, therefore, without it the evolution of the higher animals could scarcely have been possible. Indeed it is not too much to say, so vitally important is this power to the higher animals, that, as regards them, the chief aim (if we may use the expression) of Natural Selection has been to evolve it. We shall see this very clearly when we come to the study of Mind. But since this power of developing in response to the stimulation of use operates mainly along certain definite lines which are not quite the same in every species—since Nature has endowed animals with the power of making, not all possible acquirements, but only certain fixed

acquirements that are commonly useful to the species—the different species differ, as regards size and shape, and capacity for action, not only in characters which are inborn, but also in those which are acquired. Thus an ox differs in size and shape from a man not alone in inborn characters, but also in the characters which are acquired as a result of exercise and use. The structures of both ox and man develop in response to use, but not quite in the same direction, nor in the same proportion, nor to the same degree; hence to some extent the differences in size and shape betwixt the two animals. For instance, the fore limbs of both the ox and man grow greatly in response to use, but the lines of growth are very different.

59. Adaptive acquirements may involve not only quantitative changes, but qualitative changes also. For example, in man exercise does not merely cause a muscle to increase in size; it occasions besides, as in athletes after training, an increase in efficiency (*i. e.* in the power and duration of contraction) which is greatly out of proportion to the increase of size. Intermittent friction, or heat, or other irritant (*e. g.* chemical) not merely causes the skin to thicken, as in corns and callosities; it renders it denser also. Again, stimulation (that is, use) may result in change that is apparently wholly qualitative. Thus eyes, which, when unaccustomed to the task, are rendered sore by the continual scrutiny of small objects (*e. g.* print in the case of an adult learner) may by practice be trained, without apparent physical change, to endure the labour without damage.

60. Since the power of profiting physically by experience, of developing individually in response to use, is an enormously important faculty which is observable mainly in the higher animals, it is, speaking comparatively, quite a recent product of evolution. So much is certain.

61. Now we may summarize our facts, and see how they bear on the problem of the transmission of use-acquirements. Plants and plant-like animals if they "use" their parts do so only to a small extent; and therefore amongst them there can be little or no "use-inheritance." Higher in the scale (*e. g.* most insects and the lower vertebrates) animals use their parts, but still make few use-acquirements, therefore few use-acquirements can be transmitted. Yet higher in the scale animals use their parts and make use-acquirements, but, since every animal has to make the whole of these acquirements afresh, none of them are transmitted. Were use-acquirements transmitted, a child, for example, would

grow into the possession of full adult size and power in the total absence of all exercise. We know that it cannot do so. In the human being, especially civilized human being, the latest product of evolution, the descendant of thousands of generations during which acquirements were constantly made to a larger extent than by any other animal, we should find the largest number of acquirements crystallized into inborn traits. The exact contrary is the fact. Owing to evolution of man's great power of making acquirements, his inborn traits have actually undergone regression. He attains maturity only by making afresh the same acquirements his near and remote ancestors made. Without them he is incapable of independent existence.

62. It may be argued that amongst the higher animals use increases, not only the number of acquirements, but the power of making them as well, and that it is the latter acquirement that is transmitted. But this view likewise is plainly erroneous. In the human being, for instance, the power of making acquirements, mental and physical, is greatest in infancy, and it is mainly by virtue of it that the infant develops into adult man. But the power constantly declines during the passage from infancy to old age, till it almost disappears in the old man, who can grow neither physically nor mentally. Here again, since nothing is acquired, nothing can be transmitted.

63. Moreover, it is to be noted that this power of developing, of growing in response to the stimulation of use and exercise, is not equally distributed to all parts of the body. By labour almost any man may, if he chooses, increase the size of his muscles or the thickness and density of his skin (*e. g.* on his hands), but, though no parts are more used than the joints, the teeth, and the tongue, no man can by exercise increase their size. The power of growth in response to exercise resides, therefore, not especially in the parts which are most used, but in the parts in which it is most useful—in other words, in those parts where it has been evolved, not by use, but by Natural Selection.

63*a*. Very clearly the appeal to evolution affords no support to the Lamarckian doctrine of heredity. The Bathmic doctrine we have already rejected. There remains only the Neo-Darwinian doctrine. It has been declared inadequate by its opponents. Whether or not it accords with, and is capable of explaining, all the facts of evolution, may next be examined.

CHAPTER IV

SPONTANEOUS VARIATIONS

Variations attributed to the direct action of the environment—Some variations at least arise otherwise—The evidence that variations are caused by external influences—Reasons for believing they are not so caused—Variations said to be caused by bi-parental reproduction—The principal forms of bi-parental inheritance—Evidence that bi-parental reproduction is a cause of variations.

64. THE Theory of Natural Selection as propounded by Darwin is not a theory of heredity, but one of evolution only. As a doctrine of heredity he propounded the hypothesis of Pangenesis. But the two do not stand or fall together. On the contrary, Pangenesis, since it implies the transmission of acquirements, is distinctly incompatible with Natural Selection, and is moreover quite irreconcilable with the facts of modern embryology. His modern followers have accepted Natural Selection while they have rejected Pangenesis, as they have the Lamarckian and Bathmic doctrines of heredity. Instead they have propounded several theories of heredity all of which—as must every theory of heredity—centre round the question of the causation of variations.

65. These theories fall naturally into two categories. On the one hand, it is supposed that all, or nearly all, variations are due to the direct and immediate action of the environment on the germ-plasm. On the other hand, it is supposed that all, or nearly all, variations arise "spontaneously" or "fortuitously." By the word "spontaneous" it is of course not intended to imply that variations arise without cause, but only that the cause or causes of them do not proceed from the environment, but are inherent in the germ-plasm itself. In other words, it is supposed that just as the somatic descendants of the fertilised ovum vary amongst themselves, some becoming nerve-, others skin-cells, and so forth, so the germinal descendants vary, but not in the same regular manner. Spontaneous variations, according to this hypothesis, occur in a "haphazard" manner all round the specific

mean, "like bullet-marks round a bull's-eye." If we reject the Bathmic doctrine of heredity, spontaneous variations may for the present be taken as meaning all those variations which arise independently of any direct[1] and immediate action of the environment. Presently we shall be in a position to give them a narrower signification. We have, then, these two theories of heredity:—the doctrine that variations are due, as a general rule, to the immediate and direct action of the environment on the germ-plasm, and the doctrine that they are not so due, but arise, as a rule, "spontaneously." The two doctrines, as commonly formulated, are not entirely exclusive. Most biologists admit the existence both of spontaneous variations and of variations caused by the immediate and direct action of the environment. But biologists differ greatly in the relative importance they attach to the two factors.

66. Now it is certain that some variations, at least, arise spontaneously. The same phenomena which enabled us to prove that all variations are not due to the transmission of acquirements enable us to demonstrate, also, that they are not all due to the influence of the environment. For example, the germ-cells from which a litter of puppies, kittens, or pigs arise are all exposed to practically the same environmental influences, yet the germ-plasms contained in them often differ immensely in hereditary tendencies, as is proved by the great range of variations which may occur among the different members of the same litter. It may be maintained of course that germs vary because, being differently situated in the reproductive organs, they are differently acted on by the play of forces from the environment. But when we remember how thoroughly the reproductive organs are protected, how completely they are permeated by blood and lymph channels, and how small, therefore, the differences of nutrition and environment must be, this hypothesis appears very far-fetched. It is incredible, for example, that one child should inherit exclusively paternal characters while another inherits exclusively from the mother, or that one child should have five digits on a limb while another has six or seven, or that one puppy of a litter should be big and brown and rough-

[1] Direct as opposed to the indirect influence of Natural Selection. Thus if the toxins of malaria were to injure the germ-plasm (and therefore, the offspring) of those individuals who suffered from that disease their action would be spoken of as direct. But, if they merely altered the germ-plasm of the race, by weeding out the unfit, their action would be indirect. The word "immediate" is used in opposition to "remote." Some biologists believe that the environment does not now influence the germ-plasm, but that it did so in a very distant past.

haired while another is small and black and smooth-haired, or that one should present characters entirely new to the race whilst another harks back to a remote ancestor, merely because of excessively minute differences of nutrition and the like.

67. Some authors, writing vaguely, appear to believe that a given influence does not necessarily exert a given effect on the germ-plasm, but may cause it to vary in all sorts of different ways, thus producing an "epidemic of variations." But a given influence must produce precisely similar effects on substances which are precisely similar. It is only when the influences differ in quality or quantity that the effect can be different. Such influences as normally act on the germ-cells of the same parent cannot differ so greatly as to be the cause of many of the variations which distinguish the offspring of the same parents. Moreover, to say that influences from the environment produce "crops of variations all about the specific mean" is to put all influences on a par. It is equivalent to a declaration that heat produces the same effect as cold, want the same effect as plenty, health the same effect as disease—an improbable and indeed unreasonable hypothesis. It is not unreasonable to suppose that a given influence, say a certain food or a toxin, may cause a certain variation or type of variation; it is unreasonable to suppose it is capable of causing any and every type of variation in substances which were originally alike. The differences which cause variations must lie, therefore, in the germ-cells themselves. Consequently we have no choice but to believe that some variations arise spontaneously, and our task, therefore, is not to determine whether *all* variations are due to the direct and immediate action of the environment, but whether *any* variations arise thus.

68. Now there is a certain amount of evidence which appears to indicate that influences from the environment may to some extent influence the germ-plasm contained in the germ-cells of the parent, and so produce variations in the offspring. For instance, Hoffman sowed wild plants very thickly in pots. After several generations they produced, in some cases, double flowers such as had never been observed before. A species of butterfly is bright coloured in Germany, but of a more dusky hue in Italy. Weismann reared the German variety in a high and the Italian in a low temperature. The former became darker than the normal, but not so dark as the Italian variety. Contrariwise the latter became brighter than the normal, but not so bright as the German variety.

He concluded, therefore, that the temperature, acting directly, caused a change not only in the individual but in the species. The horse is said to decrease rapidly in size in the Falkland Islands, and European dogs to deteriorate in India. Many similar examples have been recorded.[1] Medical men are familiar with statements declaring that offspring are affected by various pathological conditions in the parent—gout, plumbism, alcoholism, phthisis and the like. Bud variations—*e. g.* the appearance on a peach tree of a branch bearing nectarines —have also been instanced.

69. But, though all this evidence appears at first sight very strong, it becomes less convincing after careful examination. Hoffman's double flowers may not have arisen through the direct action of the changed environment. Under the greatly altered conditions the fit that survive were probably not the same as would have survived under normal conditions. Possibly, therefore, the double flowers were correlated to some unperceived but important character, which underwent concomitant evolution. It is doubtful if Weismann's experiments fulfilled all the necessary conditions. For example, he does appear to have paid due attention to light.[2] Colour is affected

[1] *Animals and Plants*, vol. ii., p. 260 *et seq.*

[2] I must admit, however, that this is a pure guess on my part. But in the only account accessible to me (*The Germ-plasm*, p. 399) Weismann does not mention that he provided for the influence of light. He appears also to have reared only one generation of butterflies, and, therefore, we do not know whether the alterations of colours were transmissible. White men who have spent the major portion of their lives in India, but whose families have resided in England, do not appear to have children darker than those who have always dwelt at home. But, since exposure to strong light tends to produce pigmentation in the skin of human beings, the presumption is that this effect of use is beneficial. Fair skins certainly blister very readily. It follows that people with naturally dark skins must, in the tropics, have a considerable advantage in the struggle for existence, and therefore Natural Selection alone should be able to cause the evolution of a black race. Judging by the colour of the new-born babies, the negro-race was not originally black. Terra-del-Fuegians who live in a cold climate are dark; Esquimaux and Samoydes who live farthest from the equator are yellow; American Indians are copper-coloured; Scandinavians are white. It would seem, then, that exposure to light tends to evolve a dark colour in the naked skin of man, and therefore in the tropics, where this form of selection is most stringent, all races are dark. But nearer the poles sexual selection evolves a variety of colours. In the extreme north no doubt the blistering glare from the snow has an important influence. If, then, light so strongly affects the races of man we may suppose it has some influence on butterflies; though in view of the facts that so many brilliantly coloured species inhabit the tropics, and that the skin of butterflies is not naked, the influence is doubtless much weaker.

more by light than by temperature. Thus animals and plants which live in darkness are colourless, and white men become bronzed under a fierce sun.

70. A constant source of error arises from the practical difficulty of distinguishing between modifications and variations. Thus when Nägeli removed Alpine plants from their natural habitat into the botanical gardens at Munich the "species were so altered that they could scarcely be recognized . . . but when such plants or even their descendants were removed to a poor gravelly soil the new characters entirely disappeared. . . . The retransformation was always complete even when the species had been cultivated in rich garden soil for several generations."[1] This difference in individual acquirements, combined with a difference in the individuals who survive under the altered conditions, may easily account for very many of the changes which have been attributed to variations directly caused by climatic influences. It is difficult to understand how bud variations can be due to the influence of the environment. Apparently they do not regularly occur under given climatic or other environmental conditions. In the case of the nectarine, for instance, one bud out of the millions in an orchard of peach trees may vary in such an extreme and definite manner as to bear nectarines. It is at least highly unlikely that the external influences acting on that one bud can have differed so marvellously from the influences acting on all the other buds as to produce the change. On the contrary, it is more probable that a bud variation, however striking, is nothing more than an ordinary variation which appears rather late in the life of the individual. Some plants grown from slips have not altered under the influence of the environment, though separated from the parent stem by centuries of time and great expanses of space. One writer has published observations which indicate great degeneration and a high rate of mortality among the children of lead-workers. But his observations were not sufficiently extensive to be conclusive, nor, apparently, have they been corroborated. If correct they are very remarkable. It would seem, then, that lead does not destroy the spermatozoa exposed to its direct influence, but only their very remote cell-descendants in the children's bodies, and that only long after the direct influence of the lead has ceased.[2]

71. On the whole the evidence collected by biologists is neither large in amount nor conclusive in character. Many of the phenomena instanced by them are evidently capable of

[1] *Weismann's Essays*, vol. i., p. 276. [2] See Appendix A.

more than one interpretation. The problem, in fact, is too complex and difficult to be solved by observing differences between parents and children, and then trying to trace them to forces from the environment acting on the former. We cannot solve it even by observing a short line of individuals. We must turn as usual to the evidence afforded by evolution.

72. All the processes of adaptive racial change may be classed under one of two categories. Either they are progressive, or else they are regressive. Progressive evolution depends on progressive variations, and leads to increased magnitude or complexity of structure (and function) or both. Regressive evolution depends on regressive variations, and leads to decreased magnitude or complexity.[1] Now it must be noted that no influence from the environment of any sort, however effective as a cause of variations, can, by itself, be a cause of evolution, except as a rare coincidence. It might by acting on a succession of generations lead to great racial changes; it could not lead to *adaptive* racial change. Indeed if we reject the Lamarckian doctrine and suppose that evolution is due to Natural Selection, such an influence would prevent adaptation.

73. Suppose the influence were one which affected the whole species for a prolonged period and which acted beneficially on the individual (*e.g.* good and plentiful food), then, presumably, the germ-plasm, *if it underwent any change at all*, would share in the good fortune of the rest of the parent's body, and the variations of the child would be of a progressive nature—for example, increased size and vigour. But increased size or vigour or any other progressive change, even if it were a general change and not one confined to particular structures or organs, would but rarely be of advantage to the species. It would throw the race out of harmony with its environment, as by rendering necessary a larger supply of food. In considering these problems the close, the extraordinarily close, adaptation of every species in all its organs and powers to its whole environment must constantly be borne in mind. Consider, for instance, how wonderfully the various species of insects are adapted to their several environments, and how utterly unsuited any species is to the environment of any other. They fill particular niches in nature to which they are closely fitted by all their characters. Species undergo evolution because the environment undergoes change; because step by step, by slow adaptive alterations of

[1] See § 97.

particular structures, the race follows the gradual transformation in its surroundings. Always there is minute adaptation. If the progressive change (*e. g.* increased size and vigour), instead of affecting the whole organism, affected only particular organs, the species would not only be thrown out of harmony with its environment, but the different structures of the body would be thrown out of harmony with each other. In either case Natural Selection could not remedy the defect, for if the whole species were acted on there could be no regressive variations by the selection of which the specific mean could be restored. If the whole species were not acted on Natural Selection could only destroy the individuals that were affected. In the former case there would be no adaptive change ; in the latter no specific change whatever.

74. On the other hand, if the agency were an injurious one, one which caused regressive variations, for example a virulent toxin like that of malaria which circulates for prolonged periods in the blood of almost every individual within certain areas, then the race would helplessly degenerate, for here there would by no progressive variations by means of which Natural Selection could restore the balance.

75. If we conceive the species as exposed to a number of influences, part of which produced progressive and part regressive changes, exactly the same results would follow. The species would still drift helplessly in the direction of the sum of these changes. Once again Natural Selection could not possibly act. Again there could be no adaptation to the environment.

76. *Very clearly, then, the doctrine that variations are commonly caused by the action of the environment on the germ-plasm is incompatible with the doctrine of Natural Selection. Indeed it is incompatible with every conceivable theory of evolution. Adaptation to the environment by Natural Selection can proceed only when the environment has little or no part in the causation of variations, when variations are wholly or almost wholly spontaneous.* The Lamarckian doctrine is nothing more than a special application of the doctrine that variations are caused by the action of the environment. In multicellular organisms the immediate environment of the germ-plasm is the soma. Lamarck imagined that adaptive changes in the soma so affects the germ-plasm that they are reproduced as variations in the offspring. He forgot that all changes in the soma are not adaptive, and that adaptive changes would be of little avail if the rest were non-adaptive. Nevertheless

he formulated an intelligible hypothesis of heredity, which seemed to surmount some of the difficulties and explain a moiety of the facts of evolution. But the hypothesis we are considering surmounts none of the difficulties. It explains none of the facts. It renders an intelligible theory of evolution impossible. It is held as a rule by the followers of Darwin: apparently they do not perceive that it is even less in accord with their chosen faith than the teachings of Lamarck which they so strenuously reject. If variations are commonly caused by the action of the environment the theory of Natural Selection is certainly false.

77. If confirmation were wanted of the truth that the environment has little or no influence in the causation of variations, we may find it in the fact that species, instead of progressing, degenerate in all their parts when the environment is entirely favourable, that is when there is entire cessation of selection. Thus internal parasites tend to become mere bags of eggs when only the reproductive functions are selected. So also, no matter how favourable the environment, choice breeds of plants and animals tend to degenerate when no longer selected with care. If any particular structure (*e. g.* the limbs of the ancestors of snakes) become useless (*i. e.* not subjected to selection), they also degenerate. Evolution occurs only when the conditions are unfavourable to the individual, when there is a need for specific adaptation. Thus negroes, presumably by the weeding out of the unfit, have undergone great evolution against malaria. Unless, then, we pin our faith to a kind of topsy-turvy Lamarckian doctrine, unless we suppose that influences, which injure parents, cause variations *of a directly opposite kind* in offspring, it is evident that the facts of evolution tell decisively against the hypothesis that the environment is commonly the *direct* cause of variations.

78. All species must be in close adaptation to their environment or perish; but no species can remain adapted to a constant environment, or undergo adaptive change in a changing environment unless it is highly insusceptible to the direct action of the forces to which it is exposed. To secure adaptation the members of a species must vary spontaneously in every direction about the specific mean, and so present material for the work of Natural Selection. Suppose, now, there existed a species the germ-plasm of which was to some degree susceptible to direct alteration. Then, following the rule, the germ-plasm in some germ-cells would vary so as to be more susceptible than the germ-plasm in other germ-cells.

The individuals that sprang from the more susceptible germ-plasm would be less in harmony with the environment than the others, and would be weeded out in greater numbers. The conditions of life, therefore, are such that Natural Selection invariably tends to establish in the germ-plasm a high degree of insusceptibility to the direct action of the environment. It is not necessary to believe, however, that the insusceptibility is absolute. Evolution is never perfect. It is necessary to believe only that a very high degree of insusceptibility has been evolved in all races, a degree of insusceptibility so high that only under very exceptional circumstances, or in very exceptional germ-cells, does the environment cause any change, a degree of insusceptibility so high that the exceptions may be treated as negligible.

79. To sum up:—Influences from the environment acting on the germ-plasm are causes of variations, or they are not. If they are causes of variations, then every influence produces a definite type of variation, or it does not. If it produces a definite type of variation then Natural Selection is rendered nugatory; for, since the variations of the individuals exposed to the influences would be in one direction, there would be no scope for selection as regards that character. The species would drift helplessly to destruction. There would remain, besides, the difficulty, insurmountable under this hypothesis, that the children of the same parents, not only vary amongst themselves, but may vary in *all* directions from the parents. Moreover, since definite variations caused by influences from the environment can rarely be adaptive, it is evident that Natural Selection must tend to eliminate from the species that type of germ-plasm which is susceptible to such influences, and so bring about a high degree of insusceptibility. The fact that some species, which are closely adapted to an environment that has altered little, have existed almost unchanged for enormous epochs of time is proof that the germ-plasm actually does possess a high degree of insusceptibility. These species are still acted on by potent influences, but they are not changed by them. The work of Natural Selection is not rendered nugatory, and therefore they are kept stable. On the other hand, if we suppose that given influences cause variations, but not variations of a definite type, then we must admit that the germ-cells must differ amongst themselves, apart from any changes caused by the action of the environment; and, if we admit this, we admit the existence of a sufficient cause for variations. If we seek a further cause we violate the scientific principle of par-

simony. "Neither more, nor more onerous causes are to be assumed, than are necessary to account for the phenomena."

80. We leave this very important subject for the present. At this stage it cannot receive adequate treatment, for, until we have considered disease, we shall not be in possession of all our evidence. Moreover, there is testimony that a change of environment does really result in an "epidemic" of variations. It is assumed, very generally, that such epidemics are due to the direct action of the environment on the germ-plasm. The facts, however, admit of an explanation more in accordance with probability, but with which, also, we are not in a position to deal at present.[1] Enough has been said, however, to justify the conclusion that, except perhaps in very rare instances, no variations arise through the direct and immediate action of the environment.

81. Bi-parental reproduction—the intermixture of somewhat dissimilar germ-plasms—has been alleged as a cause of "fortuitous" variations. Professor Weismann and his followers formerly supposed that it was the sole cause of variability in all organisms except the very lowest. More recently the influence of sexual reproduction as a cause of variability has been denied altogether.[2] The truth undoubtedly lies between these two opinions. Sexual reproduction is a cause of many variations, but it is not the cause of all variations.

(*a*) In *blended inheritance* the characters of the parents appear to unite in such a manner that the offspring is more or less intermediate between the two. Thus the child of a white man and a black woman usually blends the colour and many other peculiarities of his parents in himself. If he resembles one parent more than the other, then the former is said to be *prepotent*. Thus "mules sometimes resemble donkeys, at other times they resemble ponies." [3]

(*b*) In *exclusive inheritance*, one parent appears to transmit his or her characters to the exclusion of the other, and, therefore, is entirely prepotent. Thus when black or albino quadrupeds mate with individuals of another colour, the offspring often follow, in colour at least, exclusively after one or other parent. A blue pigeon is prepotent over one of any

[1] See §§ 143 and 163.

[2] "Variability is not a product of bi-parental inheritance. . . What-ever be the physiological function of sex in evolution, it is not the production of greater variability." (Pearson's *Grammar of Science*, pp. 473–4 ; ed. 1900.)

[3] *The Penicuik Experiments*, p. 10.

other colour. "In breeding Game-fowls . . . if you cross a black with a white game, you get birds of both breeds of the clearest colour . . . when turnspit dogs and Ancon sheep, both of which have dwarfed limbs, are crossed with common breeds, the offspring are not intermediate in structure but take after either parent."[1] Long-established races such as natural varieties are usually prepotent, though seldom entirely so over newer races such as domestic varieties. Thus the ass is usually prepotent over the horse, and the jackall over the dog. Very inbred stock are also said to be prepotent over less inbred stock.[2] When varieties are crossed there is a tendency for descendants to take exclusively after one or the other form. But subsequent descendants occasionally revert from one to the other parent variety.

(*c*) In *particulate inheritance* there is exclusive inheritance not as regards the whole organism, but as regards particular characters. Thus a child may inherit the mother's eyes, but the father's nose. Thus also a horse may not blend the colours of its parents, or inherit exclusively the colour of one of them; he may be a piebald, and display both colours unblended in patches. It is conceivable that all blended inheritance is only a form of particulate inheritance in which the patches are invisibly small.

82. Now sexual reproduction is plainly a cause of variations, since in blended and particulate inheritance the offspring varies from both parents, and since in exclusive inheritance he varies from one of them. Even if, bearing in mind the conception of the mid-parent[3] we agree not to regard blended inheritance as a variation, yet exclusive inheritance is certainly a variation from one parent, and particulate inheritance is a variation from both. If of several offspring one exhibits blended inheritance, a second inclusive inheritance, and a third particulate inheritance, they vary amongst themselves, and it is difficult to understand how they can do this without

[1] *Animals and Plants*, vol. ii., p. 70.

[2] *The Penicuik Experiments*, p. xlix.

[3] "The word 'Mid-Parent' . . . expresses an ideal person of composite sex, whose stature is half-way between the stature of the father and the transmuted stature of the mother." (*Natural Inheritance*, p. 87. See also *The Grammar of Science*, p. 470.) Similarly a mid-grandparent is a conception obtained by striking an average between the characters of the four grandparents, and a mid-ancestor of any generation by striking an average between all the ancestors of that generation. The expression is a useful one as saving much circumlocution. Except when otherwise indicated by the context the terms parent, grandparent, and ancestor are always intended by the present writer to imply mid-parent, mid-grandparent, and mid-ancestor.

at the same time varying from the parents. The occasional occurrence of female plumage on a male bird is certainly a variation due to sexual reproduction. Even if we cede the point at issue and agree to restrict the term to characters which neither parent possesses and which are not blends of the characters they do possess, we still have ample evidence that bi-parental reproduction is a cause of variation. For example, if we mate a Burchell zebra which has very broad conspicuous stripes with a pony which has no stripes, the offspring is born with twice as many stripes as the zebra.[1] Again, if we cross-breed two perfectly distinct varieties of domestic pigeons—for example a pouter and a fantail—neither of which has a trace of blue about it—we are apt to obtain as offspring a bird which closely resembles the ancestral wild blue rock. In all cross-breeding between allied varieties and species the ancestral type is apt to appear. In all these cases bi-parental reproduction is the necessary antecedent to the appearance of traits in the offspring which neither parent exhibited. Clearly, then, it is a cause of variation. It is true that here we have no evidence of *progressive* variation; that is, of variation on which a divergence and an advance on the ancestral type may be founded. But no one has as yet suggested that the term should be so used as to exclude regressive changes.

83. On the other hand we have now ample evidence that sexual reproduction is not the sole cause of variations. This fact was long ago demonstrated conclusively by Professor Vines. Writing of the *Basidiomycetes* he stated—

"These Fungi are not only entirely asexual, but it would appear that they have been evolved in a purely asexual manner from asexual ascomycetous or æcidiomycetous ancestors. The Basidiomycetes, in fact, afford an example of a vast family of plants, of the most varied form and habit, including hundreds of genera and species, in which, so far as minute and long-continued investigation has shown, there is not, and probably never has been, any trace of a sexual process." [2]

84. The Basidiomycetes could not have undergone differentiation without the occurrence of variations. More recently Professor Weismann himself discovered evidence of variations occurring in the absence of sexual reproduction. "Two varieties of a small Ostracod (*Cypris reptans*), possessing a very marked coloration, occur in certain ponds in the

[1] See *The Penicuik Experiments.*

[2] *Nature*, vol. xl., p. 626.

neighbourhood of Freiburg. The colour of one variety, A, is light yellow-ochre, five green spots being present on either side of the shell ; the other variety, B, appears dark green, owing to the yellow-ochre ground-colour being reduced in extent by the presence of six large green patches. . . . In 1887 some individuals of the dark green variety, B, appeared for the first time in an aquarium containing the typical yellow-ochre-coloured variety, A ; and since I have observed a similar occurrence in other broods of A. . . In the winter of 1890-91 a colony of B appeared in which a few typical individuals of the variety A were found together with typical specimens of B which had been bred in this aquarium for years." [1]

85. Still more recently Dr. E. Warren has published careful measurements made on Daphnia Magna. "From twenty-three Daphnia (themselves originated by parthenogesis) broods were produced consisting of three to six individuals. The parents were measured and the offspring allowed to grow up. On measuring the offspring it was obvious that the children of the same brood exhibited very considerable variability. . . . Among my notes are recorded the measurements of twenty-six grandchildren, the offspring of seven grandparents. With these the co-efficients of correlation and regression were calculated. On account of the altogether insufficient number of individuals, the results were bound to be very uncertain, but they appear to favour the view that inheritance in parthenogenetic generation resembles that from mid-grandparents to grandchildren." [2]

86. The belief that variations are due solely, or almost solely, to bi-parental reproduction was, therefore, a pure guess, which subsequent observation has proved entirely erroneous. Since the offspring of asexual reproduction exhibit variations in abundance, we have every reason to suppose that some at least of the variations that occur among races that reproduce sexually are not due to the intermixture of dissimilar germ-plasms. On the other hand bi-parental reproduction is undoubtedly a cause of variations. Our endeavour, therefore, must now be to dissociate the variations due to bi-parental reproduction from those due to other cause or causes. The task will not be very difficult, but it will be somewhat lengthy and roundabout. We shall have to consider first the *mode* in which the offspring develop. In the end we shall find that sexual reproduction, though a cause of variations, is not a cause of "spontaneous" variations. The variations due to it

[1] *The Germ-plasm*, pp. 344-6.
[2] *Proceedings of the Royal Society*, 1889, vol. lxii., p. 154.

do not occur in a haphazard manner all round the specific mean, but trend in a perfectly definite direction. If we know the parents we are able to predict with tolerable accuracy the kind of variations to which the union of their dissimilar germ-plasms will give rise. It follows, contrary to the doctrine so widely held by Weismann and his followers, that bi-parental reproduction cannot provide materials for the work of Natural Selection. Nevertheless we shall see that it plays a great part in adapting complex species to their environments.

CHAPTER V

RECAPITULATION

The recapitulation of the parental development—The consequent recapitulation of the life-history of the race—Neglect of the doctrine of recapitulation by students of heredity—Regressive and progressive variations—Reversion the same thing as regression—Dormant traits—Reversed Selection.

87. EVERY individual who completes the span of days allotted to his kind follows in the footsteps of his parent. He begins life as a unicellular organism, the fertilized ovum; then, step by step, in orderly succession, he recapitulates the processes by which his parent passed from ovum to embryo, to fœtus, to infancy, to adult life. *But the recapitulation is never very exact.* The child varies from the parent. All this is true in essence of every species of plant and animal, and as far as we know has always been so. Apparent anomalies occur, it is true, but they are anomalies in appearance only, not in reality. Thus among certain lower animals there is alternation of generations, and a plant which has arisen from seed may be propagated for many generations by means of slips and suckers. But whenever the germ-cell recurs, the recapitulation recurs also. In a very real sense the "persons" that arise from the individual which sprang from the germ-cell may be regarded as detached portions, capable of separate existences, of one and the same individual.

88. But, if the son recapitulates the development of the parent, the latter also recapitulated that of the grandparent, who in turn recapitulated that of the great-grandparent—and so on in unending procession. No other method of development is known to us in Nature. A man's child grows into another man because he follows in the developmental footsteps of his father. Did he develop in any other way he would not be a man. For the moment consider only progressive evolution. We shall see presently that progressive evolution never occurs

unattended by regressive evolution, but, for the sake of simplicity, we may first of all imagine an organ which has evolved towards perfection by the uninterrupted accumulation during generations of only such progressive variations as have favoured evolution in a given direction. In other words, we are imagining an organ which was a little better developed in the son than in the father, in the father than in the grandfather, and so on, in an uninterrupted series, right up to the ancestor in whom the organ had its beginnings. We are supposing that, all through the long line, no individual occurred who had not the organ a little better developed than his predecessor. Now, since each individual of the line has recapitulated the development of his predecessor, and at the end of the recapitulation made a small addition of his own, which in turn was recapitulated by his successor with yet another small addition, it is clear that the last descendant must recapitulate the organ as it was in each ancestor in turn,[1] beginning with the first in whom the organ commenced, and ending with his own addition to the organ as it was in his parent. By such means, and such means only, can the organ develop in him. In this way only, apart from acquirement, is growth possible. Apply this reasoning to every organ in the body and we see why the development of the individual is a recapitulation of the life-history of the race.

89. But every organ is made up of inter-dependent parts, just as every individual is made up of inter-dependent parts or organs; and therefore an organ usually undergoes evolution in several directions at once. Thus it may grow broader and thicker as well as longer; new structures may appear on or in it; the relationships and comparative sizes of its parts may be altered. Regressive changes may occur which may coincide with, and be correlated to progressive changes in other directions. Thus, while the penguin's fore-limb was being altered from an organ of locomotion in the air to one of locomotion in the water, much was being lost to the wing at the same time that something was being gained.

90. But through all these permutations and combinations, through the apparent confusion of these progressions and

[1] This statement is liable to be misunderstood. At any rate it has been misunderstood. It is not meant of course that an individual, when he has finished the recapitulation of one ancestor, begins again at the germ-cell and recapitulates the whole of the development of the next ancestor. It is only meant that he recapitulates in orderly succession the *persistent* additions made to the development by each successive ancestor.

regressions, recapitulation, no matter how obscured to our eyes by the complexity of the process, must still have occurred. Those biologists who, deceived by the unlikeness of the embryo during the different stages of its development to the lower animals which were its prototypes in the life-history, have declared that the development of the individual is not a recapitulation of the life-history of the race, can have never adequately considered the problem, or else are guilty of excessively careless and inaccurate language. If evolution has been an actuality, as we know it has, and if each individual during growth follows in the developmental footsteps of his parent, then the recapitulation of the life-history of the race in the development of every individual belonging to it is inevitable. Otherwise we must suppose that at some period of the life-history a break occurred, an individual, or rather a whole generation of individuals, gave origin to monstrous and even miraculous offspring. The parent did not reproduce his like; the child did not follow in the developmental footsteps of the parent; but an individual of one species reproduced an individual of quite another species. It is as if a fish had given birth to a dog, or a bird to a man. Monstrous births are not unknown to medical men, but none so monstrous as this. Moreover the monsters we know perish. They are not adapted to their environment. Adaptation arises only through a gradual process of evolution. But this monster who is supposed to have broken the orderly recapitulation of the life-history must necessarily have been adapted to his environment since he survived and begat descendants—descendants who, it is to be presumed, did not follow his example, but, taking up the ancient tradition, recapitulated *his* development. We have no choice, no alternative, but to believe in a miraculous monster—many miraculous monsters—or to believe that the development of every individual is a recapitulation of the life-history of the race. "Under a scientific point of view, and as leading to further investigation, but little advantage is gained by believing that new forms are suddenly developed in an inexplicable manner from old and widely different forms, over the old belief in the creation of species from the dust of the earth."[1]

91. But to say that there is recapitulation is one thing. To say that there is accurate and complete recapitulation is quite another thing. It is obvious that in no instance is the recapitulation accurate and complete. In no instance does an individual reproduce all his ancestors exactly. Thus presum-

[1] *The Origin of Species*, p. 662.

ably man has descended from a water-breathing animal; yet his embryo never very closely resembles one. It has changed from its prototypes of the life-history. Incapable of a separate existence, it is adapted to live only as a parasite in its own special environment. Its prototypes, on the other hand, could not have existed thus. Immense changes have taken place. *The explanation lies in the fact that variations occur, not only at the end of development, but during the course of it.* The child differs from the parent as a germ, an embryo, and a fœtus, as well as during adult life. During every stage evolution is at work, preserving useful variations and eliminating harmful structures. When the environment changes for the adults of the species it changes for the embryos also. Step by step the race in all its developmental stages follows the change in the environment. To-day, for example, mammals retain their young within their bodies for prolonged periods. The whole structure of the embryo has altered in consequence. Thus the gills have almost disappeared and a placenta has undertaken their function. Among the medusæ there is alternation of generations. The egg gives rise to a larva, the larva to a polype, the polype to more polypes by budding, each of these to many jelly-fish, the jelly-fish to many eggs. In some species one or other stage is now omitted. "In the life-history of the Hydroidæ any phase, planuloid, polypoid, or medusoid, may be absent."[1] Thus the nauplius stage has been suppressed among nearly all malacostracan crustaceans. Doubtless these changes did not occur in monstrous forms; for example, a larva whose ancestors had given rise to polypes did not suddenly omit the polype stage and give origin to a jelly-fish. On the contrary, all our knowledge of Nature leads us to believe that the alteration occurred gradually during many generations. The polype stage was slowly shortened till at length it disappeared. In this instance whole chapters, or volumes rather, have been omitted from the life-history. If a plant, for instance a strawberry, propagated unendingly by means of runners only, all the earlier volumes of the life-history of its race would be lost. In fact budding may be regarded generally as a device to get rid of unnecessary chapters—to avoid unnecessary recapitulation.

92. We see then that there is recapitulation, but not exact or complete recapitulation. The development of every individual, except for his own variations, is a complete recapitulation of the parent's development, but it is not a complete

[1] Dr. Strethill Wright, quoted by Darwin, *Animals and Plants*, vol. ii., p. 364.

recapitulation of the life-history of the race. No child could develop unless there were recapitulation; but no race could undergo extensive evolution unless the recapitulation were incomplete and inexact. Shortened and emended, a life-history is like some toilsome work begun by an inexperienced author on insufficient knowledge and with half-formed plans. As his knowledge grows and his plans take shape, every page is altered. Almost every line is written over or erased. Passages or chapters which were formerly important become irrelevant and are omitted. New passages carry on the continuity of the narrative. The finished work leaves few traces of its life-history; yet not so few but that a skilful student may detect here and there, by passages not quite in keeping with the rest, traces of the method by which the author worked.

93. The mode of development of every individual makes recapitulation certain.

> " There is a history in all men's lives
> Figuring the nature of the times diseased."[1] deceased

They are unskilful students who deny its existence. Its very incompleteness is due to the recapitulation by descendants of the regressive variations[2] of the ancestors. Naturally the most ancient parts of the history are most incomplete and most inexact, for on them variation has longest been at work. Even if existing plant and animal forms had arisen by special creation, there would still have been recapitulation. But in that case it would have been recapitulation without variations. There would have been no history; or it would have been history in a sentence. As it is, the dim and fleeting resemblances to lower animals, displayed by the embryos of all higher types, present the strongest evidence of the truth of the doctrine of evolution that exists in the whole range of science.[3] We have here a real history retold in every generation with the additions and omissions made by the preceding generation—a history which ever grows longer with the lapse of years, and ever more and more inaccurate and incomplete in its earlier parts.

94. We know that children follow in the developmental footsteps of their parents. We know that they do so with variations. We know there has been evolution. We know that monsters are rarely produced, and that they perish whenever produced, and so leave no descendants. These facts being known to be true, the truth of the doctrine of recapitulation follows as certainly as if it had been mathematically

[1] *Henry IV.*, III. i. [2] See § 97.
[3] See *Darwin and After Darwin*, Romanes, vol. i., pp. 98–155.

demonstrated. It "may be maintained with the same degree of certainty as that with which astronomy asserts that the earth moves round the sun, for a conclusion may be arrived at as safely by other methods as by mathematical calculations." There is no need to appeal to embryology for confirmation. Essentially the problem is one for the thinker, not for the embryologist. If, however, we do appeal to embryology we find the evidence exactly such as might have been expected. A history is plainly revealed by every embryo; but, as I say, it is a history with great inaccuracies, with vast omissions and some additions, both omissions and additions being greatest in the earlier stages. We do not find, nor should we expect to find, in the embryo, in a state of potentially functional perfection, those organs by means of which, at a period immensely remote, lowly types maintained their existences. Their organs, having lost their functions, have disappeared or are disappearing, or remain merely as foundations on which the functional structures of the fœtus and adult are built. Thus in man the vermiform appendix is disappearing. Thus, also, the branchial arch no longer conveys blood to functional gills; it serves merely as a foundation to the vascular system which is developed later. On the other hand we never find lowly forms swimming about attached to umbilical cords and placentæ. These are late additions superimposed on an earlier stage.

95. Some such theory of development as that outlined above is held by the great majority of biologists. It is a remarkable fact, therefore, that the doctrine of recapitulation is almost completely ignored in every formal theory of heredity that is at all well known. Such theories are usually attempts to explain the facts of development on morphological grounds. The "architecture" and composition of the germ-cell, the derivation and destination of its various "units," are the principal objects of study. Darwin has his gemmules, Spencer his physiological units, Galton his stirps, Haeckel his plasidules, Weismann his biophors, Nägeli his micella, De Vries his pangenes. The theory of recapitulation, on the other hand, is essentially physiological. It supposes that the germ-cell is of such a "nature," or has such a "function," that under fit conditions it tends to develop by repeating the life-history of the race, thus growing into an organism much like the parent form. No attempt, impossible of verification in the present state of our knowledge, is made to pry into the morphological details of the germ-plasm. The germ-plasm is conceived merely as having certain

tendencies the nature of which has been ascertained by direct observation.

96. All the organs and tissues of which an individual is compounded possess the power of independent variation. Even single cells may possess this power. One hand may vary in a particular way, but not the other. A foot may vary, but not the hand. One or more nails out of the twenty may vary but the others not. All evolution in shape and function depends on this power of independent variation. Without it descendants might become larger or smaller than ancestors, but otherwise would remain exact copies. In studying heredity our attention is apt to be distracted by the multitude of variations, and the consequent complexity of the subject, from the main fact of development, viz., the recapitulation of the parent by the child, and, consequently, of the life-history of the race by the individual. In every normal individual—in every individual who survives—the variations from the parent are as but a drop in the ocean compared to the likenesses. Were it otherwise no organism would reproduce its kind.

97. In order to get rid of as much as possible of the confusion we may begin by imagining a case of extreme simplicity. We may think again of a structure which began as a variation in an individual, whom we name A.; a structure which was evolved by means of an uninterrupted series of favourable variations in a line of descendants whom we may name B., C., D. . . . L., M. Suppose M. has a child named N. Then, as regards the structure we are speaking of, N. exactly resembles M.; or he does not. In the former case he has recapitulated M.'s development without additions or subtractions. In the latter case he has made additions or subtractions or both: in other words he has varied. The additions are termed *progressive* variations; the subtractions are termed *regressive* variations. Variations may occur during any stage of the development; that is, N. may vary from M. as embryo, as fœtus, or as adult.

98. Consider the regressive variations first. *Obviously a regressive variation is a failure to recapitulate the whole of M.'s development.* In other words it is a failure to recapitulate the whole of the life-history as presented by M. N. stops short at a point reached by some ancestor—say H. That is, he reverts to H. He recapitulates the development without the additions made by the descendants of H. If *his* descendants recapitulate *his* variation, it is evident that I., J., K., L., and M. disappear from the series, which becomes A., B. . . .

H., N., or rather, since N.'s development is the same as that of H., it becomes A., B. . . . H. The fact that regression is only another name for reversion is not clearly recognized in biological literature. But if development is by recapitulation —as it certainly is—it is difficult to imagine what else it can be. *It is in fact impossible to conceive of a case of regression which is not one of reversion, or vice versâ.*[1] No doubt it is often not easy to recognize regression as reversion, but that is only because our vision is obscured by the complex conditions under which the problem is usually presented to us. When reversion occurs on a great scale, when the whole organism or a considerable part of it reverts to the ancestral type, and what is known as atavism occurs, we recognize the

[1] The fact that regression is identical with reversion is the main contention of the present and the three succeeding chapters. In the discussion of details the central truth is apt to be lost to sight. It is needful, therefore, even at the cost of tedious repetition, to give it all possible emphasis at the outset. It would be well if the reader now paused awhile and tried to imagine an instance of regression which is not also an instance of reversion. He will find it impossible. Every instance of regression is a failure to recapitulate part of the parent's development, and, consequently, part of the life-history. It is therefore, of logical necessity, an instance of reversion. We may illustrate the argument by taking an extreme example. The first digit on a limb has been evolved by the superimposition of progressive variation on progressive variation in an immensely long series during an immense number of generations. Suppose, now, a child of normal parents is born lacking the first digit. Then his variation— if not an example of latency (see §§ 101—106), which properly speaking is not regression— is a regressive variation. It is also an act of reversion. As regards *this one character* he has lapsed the whole of the progressive variations made by millions of his ancestors. He has reverted *in this one particular* to that remote ancestral condition which existed previously to the evolution of the digit (or even of the limb). It matters not that very probably no ancestor ever existed who had four perfectly developed digits, and only four. It is not contended that the child has reverted as regards the whole hand; it is only contended that he has reverted as regards the first digit. Suppose again instead of completely lacking the first digit the child were born with a malformed rudimentary digit, a mere stump. Here, again, we should have reversion and regression, though in a form less complete. The digit may not, and probably would not, closely resemble anything which existed in the ancestry; but that would only mean that different parts of the digit had reverted unequally. A digit like an entire limb is made up of parts, and it does not necessarily or usually revert in all its parts equally. The reason why regression so seldom presents the appearance of reversion will be more fully discussed presently (see §§ 132 and 148); but meanwhile, since development is by recapitulation, there is no escape from the conclusion that every act of regression *must* be an act of reversion. It should be noted, however, that when a child lacks a digit this variation is much more probably due to latency than to reversion. Reversion to an ancestor so extremely remote is usually a slow process. (See § 139.)

reversion but not the regression. When the reversion affects only part of a structure, and is disguised by progressive changes in other parts, we recognize the regression, but not the reversion. When, however, it appears in a simple form—as when the descendant of a line of individuals, each of whom had six digits on one hand, reverts to a remoter ancestor who had only five—we see clearly that regression and reversion are identical.

99. Progressive variations, also, may occur at any stage of the development. N., after recapitulating the whole of M.'s development of the structure, may add to it. His variation may then be compared to an increase of growth at the *point* of a twig. Or the variation may not appear at the end of his development, but during the course of it like a lateral bud. Thus it may appear at the point H. reached at the end of his development, not at the point M. reached. In other words it appears during embryonic life at that stage which represents H. It is these variations which occur during development that have rendered plants and animals complex, and the study of heredity difficult and obscure. In the illustration we considered just now we studied a structure which we imagined as evolving in a series of individuals, A. . . . M. in one direction only—as it were in a line. But every structure has breadth and thickness as well as length. During development a thousand, or a million, variations may appear on the surface or in the substance of the structure. Any one of these, if favoured by Natural Selection, may grow to a size and importance far exceeding that of the parent and structure—just as a twig, if favoured by sunshine, may eventually exceed the rest of the branch on which it grows. Every variation, when once it has started, may be looked upon as a structure capable of independent variation in an almost infinite number of directions, regressive and progressive. As a consequence every species of plant and animal is in a condition of continual flux and change. As a whole the likeness to the parent is well preserved. But in minutiæ there is an immense amount of variation.

100. If we think of a complex plant or animal or even of a single structure as a whole we are unable, as a rule, to reason clearly. We then see progressive and regressive variations occurring in multitudes, and we become confused by the immense mass of details. We may perhaps be able to say that the organism, or organ, as compared to the parent, has progressed or regressed in the *sum* of its characters; but we cannot distinguish the nature, the meaning of progression

and regression. But, if we think of some new and simple structure, or better still of a single quality (say colour) of this structure, we are able to see clearly their exact signification. We see, then, that *progression implies a divergence from the ancestral type, a complete recapitulation plus an addition ; whereas regression always implies a reversion towards the ancestral type, an incomplete recapitulation.* In other words, every congenital deviation from the parent is either a prolongation or an abbreviation of the life-history, or, in the case of complex variations, it may be a combination of both.

101. All the inborn characters of an individual take origin in the germ-plasm whence he sprang. They arise because the germ-plasm was so constituted that it tended, under fit conditions of shelter and nutrition, to give rise to an organism having those characters. A principal source of confusion in the study of heredity arises from the fact that the germ-plasm may be so constituted that it tends to give origin to two characters, one of which is incompatible with the other. The tendencies are not incompatible, but the characters are. Only one character will then develop. The other becomes "dormant" or "latent"; but the tendency, to which it is due, persists, and may become active in some subsequent generation. To take an illustration: suppose a blue colour has been evolved in a line of pigeons A. . . . M. Suppose N. varies from M. in such a manner as regards a particular feather that he not only has a tendency to develop the blue colour, but a new and stronger tendency to develop a white colour. Then the blue colour becomes dormant and the white appears. If O. recapitulates his parent N. he will reproduce the white colour in the corresponding feather. Suppose in addition he varies in such a manner as to render the blue colour dormant in other feathers. Suppose this process is repeated in subsequent generations till Y. develops wholly white feathers. Then, though Y. recapitulates all his ancestors, no blue colour will appear in him; it will be dormant. If, however, Z. reverts to M. or a remoter ancestor he will be entirely blue without a trace of white. His descendants also will have no white unless they happen to vary as N. did, thus beginning the process again, or unless the white has disappeared through the occurrence of a fresh progressive variation which has rendered the white dormant in turn. If Z. reverts to an ancestor less remote than M. he will be mingled blue and white, the one colour or the other predominating according to the remoteness of the ancestor.

102. We have described no merely imaginary process;

there is unlimited evidence of the existence of dormant tendencies. "Besides the visible changes that it (the germ) undergoes, we must believe that it is crowded with invisible characters proper to both sexes, to both the right and left sides of the body, and to a long line of male and female ancestors separated by hundreds and even thousands of generations from the present time; and these characters, like those written on a paper with invisible ink, lie ready to be evolved whenever the organism is disturbed by certain known or unknown conditions."[1]

103. Thus all domesticated races of pigeons have been evolved under stringent artificial selection from the wild blue rock. Every one of these varieties, no matter how purely bred, occasionally produces an individual with the blue ground-colour and the other special markings of the wild ancestor.[2] Purely bred domesticated fowls show a similar tendency by reverting in plumage to the wild *Gallus bankiva*.[3] Horses are sometimes faintly striped. Numerous similar examples may be found among animals. Amongst many varieties of cultivated plants reversion is more the rule than the exception. The latency of certain inborn characters is quite normal. The sexual characters are transmissible through children of an opposite sex to grandchildren of the same sex, and an old bantam hen, whose ovaria were diseased, has been known not only to develop the warlike disposition of a cock, but also to display in her tail the sickle-shaped feathers of remote male ancestors. Hæmophilia may be transmitted through mothers who display no trace of it. The tendency to gout and polydactylism may skip a generation. In cross-breeding the appearance of latent ancestral

[1] *Animals and Plants*, vol. ii., pp. 35–6.

[2] See *Animals and Plants*, vol. i., p. 216. So far as the present writer is aware no record exists of these reverted birds, when paired together, reproducing the coloration of the domestic variety or varieties from which they were derived. On the contrary, "When a blue, or a blue and chequered bird, having black wing-bars, once reappears in any race and is allowed to breed, these characters are so strongly transmitted that it is extremely difficult to eradicate them." (*Plants and Animals*, vol. i., p. 210.) In other words the white or black of the domesticated variety is not rendered latent in the reverted descendant. If, however, the hypothetical "ancestral units" concerning which so much has been written had any real existence, the domesticated variety should reappear almost infallibly, since the ancestors of the reverted bird must have been red, white or black for, perhaps, hundreds of generations. Several breeds of domesticated pigeons are known to have been in existence three hundred years ago. Doubtless their real antiquity is much greater.

[3] *Animals and Plants*, vol. ii., p. 251.

characters is so common that "we must conclude that a tendency to this peculiar form of transmission is an integral part of the general law of inheritance."[1] The transmission of ancestral characters in a latent condition through a long series of generations is therefore of frequent and undoubted occurrence. The only questions we have to consider are, (*a*) Under what conditions do characters become latent? and (*b*) Under what conditions do latent characters reappear?

104. Morphological theories of inheritance usually explain the latency and reappearance of ancestral characters by supposing that discrete "ancestral units" pass in a dormant condition through any number of ancestors till in the fulness of time they become active in some descendant. Thus Darwin speaks of "dormant gemmules derived . . . from some remote progenitor."[2] Weismann's "ancestral ids" struggle together.[3] Galton supposes that of its total heritage the child derives a half from its two parents, a quarter from its four grandparents, an eighth from its eight great-grandparents, and so forth.[4] In all these theories each of the ancestors—or many of them—are supposed to be represented by discrete active or dormant "units" which are present during every stage of development. All these theories are therefore, as regards reversion at least, in sharp opposition to the theory of recapitulation, which supposes that the ancestors (*i. e.* mid-ancestors) are represented, not *en masse*, but in orderly succession, beginning with the first and ending with the last. If the one theory is true the other cannot be true. The theory of recapitulation is so certainly true that the theory of discrete ancestral units is quite certainly erroneous.[5] The

[1] *Animals and Plants*, vol. ii., p. 31.
[2] *Op. cit.* ii., p. 395.
[3] *The Germ-plasm*, p. 260.
[4] *Proceedings of the Royal Society*, vol. lxi., p. 402.
[5] When varieties are crossed there is sometimes exclusive inheritance as regards some particular character in which they have become divergent. But, as Mendel found, the suppressed ancestral trait tends to reappear as an exclusive character in a definite proportion of grandchildren. Even the grandchildren who do not revert tend to have offspring and descendants who do—also in a definite proportion of cases. The reversion to the second variety is however final. There is no return to the first variety. The Mendelian law would appear to lend colour at first sight to the hypothesis of discrete ancestral units, since the two ancestral strains do not mingle. But ancestral strains which are incompatible in some particular, and which ultimately separate as regards that particular, are very different from units representing various ancestors belonging to the same strain, which keep together, but remain discrete. (See § 128, footnote.) When dealing with

existence of dormant tendencies enables us to explain the fact, otherwise inexplicable by the theory of recapitulation, that individuals who revert to a remote ancestor may reproduce traits that individuals who do not revert do not recapitulate. When the white pigeon was evolved from the blue pigeon a new chapter was added to the life-history, but not in prolongation of it. To use a somewhat clumsy illustration, it was pasted over the last leaves of the volume. In this case therefore reversion means not a shortening of the volume, but a stripping away of the superimposed pages.

105. The frequency with which characters become dormant demonstrates that latency is one of the means by which species are adapted to their environments. Useless, or rather injurious, characters are sometimes eliminated thus. Generally speaking latency seems to occur only when evolution is rapid—when some character, long and strongly established, has become injurious and must be quickly replaced by one more useful. Thus various wild characters in many domesticated animals and plants have become latent under stringent artificial selection.

106. It is of course possible that characters may sometimes become dormant for reasons other than because they are incompatible with newer and more useful characters which replace them. Without being replaced by anything they may be suppressed by Natural Selection merely because they have become injurious to the species.

107. A character, then, may disappear from a line of individuals in two distinct ways. It may be *quite* eliminated from the race by simple reversion to ancestors more and more remote till at last, as regards this character, that ancestor is approximated to one who existed at a time anterior to its first appearance. In this case it will never appear again except as a result of a fresh series of *progressive* variations. Or it may become dormant, in which case it will reappear only as a result of *regressive* variations.

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problems of heredity we must always bear in mind that the germ-plasm, not the individual, is the real subject of discussion. The germ-plasm undergoes gradual changes ; the individual enables us to ascertain and indicate those changes. We have no reason to suppose that the germ-plasm is divided into and is compounded of particles representing separate individuals. On the contrary it is probable that there is continuity of the germ-plasm, and therefore that the individual is nothing more than an incident in its career,—a dwelling-place where shelter and nutrition are obtained. We judge of the nature of the germ-plasm and of the changes it undergoes by the characters of the houses which it builds and temporarily inhabits.

108. The regression and ultimate disappearance of structures, especially large and important structures, has often been attributed to that form of Natural Selection which is known as *reversed selection*, "the selection which affects not increase of an organ, but decrease of it." No doubt reversed selection does to some extent hasten the elimination of burdensome and injurious structures by selecting for survival individuals in whom as a consequence of reversion the structure is poorly developed, but we shall see presently that other selective means have been provided by nature so efficient that reversed selection has little scope to act in such cases. It plays a great part nevertheless. Imagine again our series of individuals A. . . . M. who have evolved a certain structure in a certain direction by an uninterrupted series of progressive variations. If N. completely recapitulates M., he may afterwards vary in an endless number of different ways. Amongst others he may double back, as it were, on his own development, so that in him the structure is less perfect at the end of his development than it was immediately earlier. If this process be continued in subsequent generations, then in the remote descendants the structure will be less perfect in the adult than in the immature individual. Indeed it may be quite absent in the adult. Numerous examples of this process may be found in nature. For instance, the caudal appendage is better developed in the human embryo than in the adult. Still better illustrations are afforded by the disappearance in adult life of the larval or embryonic structures of numerous animals, for example, frog, ascidian, and many insects. In all these instances, as in cases of latency, there is no real regression in the sense in which we have used the term. The individual does not regress as compared to his progenitors, but only as compared to his younger self. The germ-plasm does not lose a tendency. Even the individual, if his development be considered as a whole, loses nothing. On the contrary, his development gains a prolongation.

109. The nature of the work done by reversed selection will be rendered clearer if we examine a couple of well-known and oft-quoted examples. Eyes have been evolved through the action of Natural Selection. In animals living in total darkness, in certain cave-dwellers, for example, the eye has become, not only useless, but worse than useless, since it is an extremely prominent and tender, and therefore vulnerable part of the organism. In some of these animals the eye is better developed in the immature than in the

adult organism. The animal in its development seems to retrace some of the steps it has already made. It is clear the retracement was made in the life-history as well. The horse presents us with another striking example. The remote ancestor of the modern horse, the Hipparion, had three functional toes. The embryo of the horse has also three toes of considerable size. But the two outer toes in each limb, which in the embryo are nearly as well developed as in the Hipparion, degenerate partially during development, so that the horse is born with only one functional toe. "Occasionally a foal is born with two hoofs on one or more of its limbs; at very long intervals a foal appears with three hoofs on one or more of its limbs." Now when the outer toes persist in the individual we have plainly, in a real sense, an arrest of development. The toes remain in the embryonic, the ancestral condition; the whole life-history is not recapitulated. But in the normal horse there is no arrest of development; the recapitulation is carried out to its full extent, though, in the later stages, in a reversed direction.

110. As in the case of other forms of Natural Selection, the principal, if not the sole, effect of reversed selection, therefore, appears to be a prolongation, not an abbreviation of the life-history. It causes in the more mature individual a deterioration of organs which have become injurious to it, but which, during a former period of the life-history, were useful, or which are still useful, or at any rate comparatively harmless, to the less mature individual. When, therefore, we see a structure or an organ better developed in the embryo than in the adult, in the larva than in the imago, we must conclude that reversed selection has been at work.

CHAPTER VI

BI-PARENTAL REPRODUCTION

Bi-parental reproduction said to be a cause of progressive variations—A complete error—Evidence from the common experiences of life—The scientific evidence—Equidæ—Pigs—Goats—Rabbits—Sheep—Pigeons—Fowls—Ducks—Plants—Reversion seldom observable under conditions of Natural Selection—Often observable under conditions of artificial selection—Reversion the cause of the deterioration of useless parts—The function of bi-parental reproduction in evolution.

111. WE are now in a position to consider the part played in nature by sexual or bi-parental reproduction. Though nearly all biologists have supposed that progressive variation, and therefore evolution, is largely due to bi-parental reproduction, there is, in fact, in the whole range of biological literature not one iota of evidence which supports that view. Men, as in so many instances, have accepted a dogma without proof, and have held it without inquiry. There is no veil like the veil of familiarity. The misleading analogy, so frequently made, that two dissimilar germ-plasms are like an acid and a base, the union of which results in a product which is dissimilar from both, has often warped their judgments. The common experiences of life and the massive and precise testimony accumulated by science have been ignored under the influence of what is plainly an obsession.

112. Take a few of the common experiences of life. Suppose a man and a woman vary from their parents and from the specific type, the one by being unusually tall and dark, and the other by being unusually short and fair; and suppose they have offspring. Of what type should we expect the offspring to be? Should we expect some unusual progressive variation to result from this union of comparatively dissimilar germ-plasms? Assuredly not. Our common experience is that, though exceptionally the child of such a couple may be as tall and dark as the father or as short and fair as

the mother, in the great majority of instances the children will be more like ordinary men and women of their race than either parent. In other words, there may be exclusive inheritance, but more often there will be particulate, and especially blended, inheritance. Only very exceptionally will the child of such parents display a progressive variation—that is, be taller or darker than the father or shorter or fairer than the mother.

113. In this case, then, the combination of dissimilar germ-plasms commonly results, not in *progressive* variations, but in a regression towards the parental, and therefore the specific, mean. *But a regression towards the specific mean implies a lapsing of progressive variations, and a lapsing of progressive variations implies a failure in recapitulation, a reversion to the ancestral type.* Suppose, again, a man with a short thick nose mates with a woman with a high thin nose; do we commonly get a new and extraordinary type of nose as the result—a nose such as the current theory of the origin of progressive variations would lead us to expect? No. Again there is reversion. The exceptional peculiarities of the parents tend to disappear. Suppose, yet again, that a man with a sixth digit mates with a normal woman. Do the offspring usually have a seventh digit or any other exceptional peculiarity? Assuredly not. Once again the general tendency is towards a return to the specific, the ancestral type; in one or more generations the sixth digit tends to disappear. We may run through the whole gamut of progressive variations and we shall constantly get the same result. In every instance there is a tendency to reversion, which is generally to the immediate ancestors, but which may be to remoter ancestors, as when a bird resembling *Columba livia* arises in the dovecot, or when pure white sheep have dark-coloured offspring, or when a cultivated plant reverts to the wild type.

114. But now suppose two people mate who have the *same* progressive variations—who, for example, are *both* tall and dark or short and fair, or who both have noses of the same peculiar shape, or who have each a sixth digit—what then is the *usual* result? *Universal experience tells us that in such cases the children tend to inherit the progressive variations which the parents possess in common.* They tend to be tall and dark, or short and fair, and so forth. *So that we may lay it down as a general rule that bi-parental reproduction tends to eliminate the characters in which parents differ, and to leave unaffected those in which they agree.* It follows that we have every reason to believe that *whenever bi-parental reproduction acts*

at all, it is a case of regressive, not of progressive, variations. No doubt progressive variations occur in abundance under bi-parental reproduction,—a tall dark pair may even have children taller and darker than themselves; but the point I wish to emphasize is this—that *there is not an iota of evidence that bi-parental reproduction is connected with progressive variations as cause and effect.* On the contrary, we have every reason to believe, on the authority of recent exact measurements,[1] that progressive variations occur quite as commonly among parthenogenetic species as among forms sexually reproduced.

115. It cannot, indeed, be too clearly recognized that no form of bi-parental inheritance—exclusive, particulate, or blended—is an example of progressive variation.[2] In exclusive inheritance the peculiarities of one parent are rendered latent, while the peculiarities of the other are not increased. In particulate and blended inheritance the peculiarities of both parents are to some extent lost or rendered latent. No doubt, occasionally, a blended individual is better adapted to his surroundings than either parent, or than the ancestral type. Thus an animal with blended colours may be more in harmony with the environment than his very dark father or his very light mother; thus, also, by intercrossing, man has obtained several breeds of domestic animals useful to him (*e. g.* sheep). But in all these cases the better adaptation to the environment is not due to *progressive* variations. It is due to *regressive* variations.

116. Leaving common experience, we may turn to the scientific evidence. This is even more decisive, inasmuch as it is more striking; for now, as a rule, we see reversion, not to the immediate ancestry, but to the remote ancestral form. *If we cross varieties or species the general tendency is ever towards great reversion.* All that distinguishes the one variety or species from the other, all the special characters

[1] See § 85.

[2] Professor Cossar Ewart insists (Address to Zoological Section, British Association, 1901) that the relative maturity of parents and the degree of ripeness of the germ-cells are causes of variations. Thus he found that, if very young pigeons and rabbits were crossed with more mature animals, the latter were prepotent. He found also, if a doe rabbit were mated some time before ovulation is due, that the offspring resembled the sire; but if she were mated thirty hours after her proper pairing period, the offspring resembled the mother. Evidently he believes that his experiments furnish evidence of the causation of that kind of variability on which evolution—progressive evolution—is founded But plainly there is no evidence of progressive variation here. We have evidence only of some of the conditions which determine prepotency.

which have arisen along the diverging lines of evolution, tend to disappear. The ancestral form common to both varieties, even if it be separated from the crossed descendants by thousands of generations, tends to reappear. Sometimes the reversion is direct; the ancestral form reappears immediately in the offspring of the cross. At other times the offspring blends in the first generation, but reverts in subsequent generations. Or the descendants of the blend may revert, not to the remote common ancestor, but to one or other of the crossed varieties; the inheritance in this case being exclusive. Now if bi-parental evolution were a cause of progressive variations we ought to find that great progressive variations commonly result from cross-breeding; for here the germ-plasms are extremely dissimilar. Instead, we find evidence of great regressive variations only. In no case is there the least evidence that bi-parental reproduction is the cause of progressive variations. We may quote a few examples.

117. If we mate a Burchell zebra with a horse, "some of the hybrids in make and disposition strongly suggest their zebra sire, others their respective dams; but even the most zebra-like in form are utterly unlike their sire in their markings. It is not a matter of taking after a grandparent, but after an ancestor thousands of generations removed, an ancestor probably far more like the Somali than any of the Burchell zebras; . . . even when the hybrids are distinctly horse-like they never repeat recently acquired peculiarities, such as a blaze or short ears, high withers, or a small head and long neck." [1]

118. "Although mules are not nearly so numerous in England as asses, I have seen a much greater number with striped legs, and with the stripes far more conspicuous than in either parent form. . . . In South America, according to Roulin, such stripes are more frequent and conspicuous in the mule than in the ass. In the United States, Mr. Gosse, speaking of these animals, says, 'that in a great number, perhaps in nine out of ten, the legs are banded with transverse dark stripes.'" [2]

119 "Professor Jaeger has given a good case with pigs. He crossed the Japanese or masked breed with the common German breed, and the offspring were intermediate in character. He then re-crossed one of these mongrels with the pure Japanese, and in the litter thus produced one of the young resembled in all its characters the wild pig; it had a

[1] *The Penicuik Experiments*, p. xii.
[2] *Animals and Plants*, vol. ii., p. 16.

long snout and upright ears, and was striped on the back. It should be borne in mind that the young of the Japanese breed are not striped, and that they have a short muzzle and ears remarkably dependent."[1] "The European wild boar and the Chinese domesticated pig are almost certainly specifically distinct. Sir F. Darwin crossed a sow of the latter breed with a wild Alpine boar which had become extremely tame, but the young, though having half-domesticated blood in their veins, were extremely wild in confinement, and would not eat swill like common English pigs."[2]

120. "Captain Hutton, in India, crossed a tame goat with a wild one from the Himalayas, and he remarked to me how surprisingly wild the offspring were."[3]

121. "The Earl of Powis formerly imported some thoroughly domesticated humped cattle from India, and crossed them with English breeds, which belong to a distinct species; and his agent remarked to me, without any question having being asked, how oddly wild the cross-bred animals were."[4]

122. "I crossed a Dalmatian . . . with a well-bred sable collie, and obtained three pups. . . . The pups neither resemble young collies nor young Dalmatians, but rather suggest young pointers or foxhounds. The ground-colour is nearly white in all three; in two there are five large dark brown blotches, in one four lemon-coloured patches. This seems to be a case of reversion towards the mediæval ancestors of the Dalmatian."[5]

123. "We have seen in the fourth chapter that the so-called Himalayan rabbit, with its snow-white body, black ears, nose, tail and feet, breeds perfectly true. The race is known to have been formed by the union of two varieties of silver-grey rabbits. Now, when a Himalayan doe was crossed by a sandy-coloured buck, a silver-grey rabbit was produced; and this is evidently reversion to one of the parent varieties."[6]

124. "There is reason to believe that sheep in their early domesticated conditions were 'brown or dingy black, but even in the time of David certain flocks were spoken of as white as snow. During the classical period the sheep of Spain are described by ancient authors as being black, red, or tawny. . . . The Rev. W. D. Fox was informed that seven white Southdown ewes were put to a so-called Spanish ram which had two small black spots on his sides, and they

[1] *Animals and Plants*, vol. ii., pp. 17, 18.
[2] *Op. cit.*, p. 19.
[3] *Op. cit.*, p. 19.
[4] *Op. cit.*, p. 19.
[5] *The Penicuik Experiments*, p. xxxi.
[6] *Animals and Plants*, vol. ii., p. 15.

produced thirteen lambs, all perfectly black. Mr. Fox believes that this ram belonged to a breed which he has himself kept, and which is always spotted with black and white; and he finds that Leicester sheep crossed by rams of this breed always produce black lambs; and he has gone on re-crossing these crossed sheep with pure white Leicesters during three successive generations, but always with the same result. Mr. Fox was also told by the friend from whom the spotted breed was procured, that he had likewise gone on for six or seven generations crossing with white sheep, but still black lambs were invariably produced."[1]

125. "My attention was first called to this subject, and I was led to make numerous experiments, by MM. Boitard and Corbié having stated that, when they crossed certain breeds of pigeons, birds coloured like the wild *Columba livia*, or the common dove—namely slaty-blue, with double black wing-bars, sometimes chequered with black, white loins, the tail barred with black, with the outer feathers edged with white—were almost invariably produced. . . . I selected pigeons belonging to true and ancient breeds, which had not a trace of blue or any of the above specified marks; but when crossed, and their mongrels re-crossed, young birds were often produced, more or less plainly coloured slaty-blue, with some or all of the proper characteristic marks. I may recall to the reader's memory one case, namely, that of a pigeon hardly distinguishable from the wild Shetland species, the grandchild of a red spot, white fantail, and two black barbs, from any of which, when purely bred, the production of a pigeon coloured like the wild *C. livia* would have been almost a prodigy."[2]

126. "I was thus led to make the experiments recorded in the seventh chapter on fowls. I selected long-established pure breeds in which there was not a trace of red, yet in several of these mongrels feathers of this colour appeared; and one magnificent bird, the offspring of a black Spanish cock and white Silk hen, was coloured almost exactly like the wild *Gallus bankiva*. All who know anything of the breeding of poultry will admit that tens of thousands of pure Spanish and of pure white Silk fowls might have been reared without the appearance of a red feather. The fact, given on the authority of Mr. Tegetmeier, of the frequent appearance in mongrel fowls of pencilled or transversely-barred feathers, like those common to many gallinaceous birds, is likewise

[1] *Animals and Plants*, vol. ii., pp. 3, 4.
[2] *Op. cit.*, p. 14.

apparently a case of reversion to a character formerly possessed by some ancient progenitor of the family."[1]

127. "I have been informed by Mr. B. P. Brent, that he crossed a white Aylesbury drake and a black so-called Labrador duck, both of which are true breeds, and he obtained a young drake closely like the Mallard (*A. boschas*). Of the Musk-duck (*A. moschata*, Linn.) there are two sub-breeds, namely, white and slate-coloured; and these I am informed breed true. But the Rev. W. D. Fox tells me that by putting a white drake to a slate-coloured duck, black birds, pied with white like the wild musk-duck, were always produced."[2]

128. "When flowers which have normally an irregular structure become regular or peloric, the change is generally looked at by botanists as a return to the primitive state. But Dr. Maxwell Masters, who has ably discussed this subject, remarks that when, for instance, all the sepals of a Tropæolum become green, and of the same shape, instead of being coloured with one prolonged into a spur, or when all the petals of a Linaria become simple and regular, such cases may be due merely to an arrest of development;[3] for in these flowers the organs in their earliest conditions are symmetrical, and if arrested at this stage of their growth, they would not become irregular. If, moreover, the arrest were to take place at a still earlier period of development, the result would be a simple tuft of green leaves; and no one would probably call this a case of reversion.[4] . . . On the doctrine that peloria is simply the result of an arrest of development, it is difficult to understand how an organ arrested at a very early period of growth should acquire its full functional perfection;—how a petal supposed to be thus arrested should acquire its brilliant colours, and serve as an envelope to the flower, or a stamen produce sufficient pollen; yet this occurs with many peloric flowers.[5] That pelorism is not due to mere chance variability, but either to an arrest of development or to reversion, we may infer from an observation made by Ch. Morren, namely, that families that have irregular flowers often return by these monstrous growths to their regular form; whilst we

[1] *Animals and Plants*, vol. ii., p. 14. [2] *Op. cit.*, pp. 14, 15.

[3] According to the doctrine the present writer is striving to make clear, all reversion is an arrest of development, inasmuch as it is a failure in recapitulation.

[4] But this is just what it is.

[5] The difficulty disappears when we remember that reversion does not necessarily include all characters. A flower may revert in shape while it remains true in colour.

never see a regular flower realize the structure of an irregular one."[1]

129. "Striped flowers, though they can be propagated truly by seed, have a latent tendency to become uniformly coloured, but when once crossed by a uniformly coloured variety, they ever afterwards fail to produce striped seedlings."[2]

[1] *Animals and Plants*, vol. ii., pp. 32–33.

[2] *Op. cit.*, pp. 45–6. Recent research renders it very probable that some of the experiments on cross-breeding quoted above are incomplete. They tell us of the reappearance of the common ancestral type; but they do not record the results of continued breeding from the reverted individuals. It has been shown by de Vries, Bateson, and other followers of Mendel, that, even when the offspring of crossed varieties revert to the common ancestral form, there is a strong tendency towards the reappearance of the differentiated types among subsequent descendants. Thus "the first cross of albino mice with black-and-white Japanese waltzing mice gave grey house-mice resembling in size, colour, and wildness the wild house-mouse. The first crosses, bred together, gave albinos, grey mice, black-and-white, grey-and-white, and black mice." (Von Guita, quoted by Mr. Bateson and Miss Sanders—*Report to Evolution Committee of the Royal Society*, 1903, p. 145.) In the present state of the inquiry it is difficult to estimate to what extent particulate and exclusive inheritance prevails among the offspring of crossed forms; but it appears that complete and permanent reversion to the common ancestral type is by no means unusual. At any rate, it is certain that while cross-breeding is frequently a cause of reversion, it is never a cause of progression. The work done by Mendel and his followers is of the highest interest and importance. Very probably it will shed a clear light on some of the phenomena of heredity. But it must be constantly borne in mind that the mating of distinct varieties is not the same thing as breeding within the same variety. The former must occur so very rarely in nature, that it can play no part in the adaptation of species to their environments. In Mr. Bateson's words, "the central phenomenon in Mendelian heredity is segregation." (*Proceedings of the Zoological Society of London*, 1903, vol. ii., p. 85.) "The germ-cells or gametes produced by cross-bred organisms may in respect of given characters be of the pure parental types, and consequently incapable of transmitting the opposite character." (*Report of the Evolution Committee of the Royal Society*, 1902.) In the case of abnormalities also (*e. g.* a sixth digit) the inheritance tends to be exclusive; indeed an abnormal individual is in effect one who belongs to a new variety. As already indicated, an abnormality (*i. e.* a deformity) can seldom increase the adaptation to the environment. Even when not injurious (*e. g.* sixth digit) it is apt to be bred out in the course of generations. The central fact of normal breeding, that is, breeding between members of the same variety, is blended inheritance, not segregation of the parental characters. It is from the effects of normal breeding that we must endeavour to ascertain the function of bi-parental reproduction in nature; and very certainly that function is to produce, not progressive but regressive variations.

When two individuals of the same race vary somewhat as regards any character differently from one another, the chances on the whole are that both their variations are useless. It is therefore an advantage to the offspring that both variations should be eliminated by the regressive action

130. It is unnecessary to multiply examples. "Reversion is not a rare event, depending on some unusual or favourable combination of circumstances, but occurs so regularly with crossed animals and plants, and so frequently with uncrossed breeds, that it is evidently an essential part of the principles of inheritance."[1] The variability of crossed breeds, on which so many writers have commented, will in almost all instances be found to be of a regressive nature.[2] A little thought will show that the "regression towards mediocrity" which occurs when individuals of the same variety breed is a phenomenon of the same kind—that it is reversion towards the ancestry. It matters not that in uncrossed species the reversion is generally to the immediate ancestry. If unchecked by selection it will be towards a remoter ancestry in succeeding generations. Nothing in nature is more certain than that the function of the bi-parental reproduction is to produce regressive variation; and nothing in science is more remark-

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of bi-parental reproduction. But when individuals of different varieties interbreed, the characters in which they differ are useful, since they have been evolved by Natural Selection from the ancestral type. It is therefore an advantage that they should be both preserved by segregation in the offspring. Varieties so seldom interbreed in nature that this tendency to segregation as regards varietal characters can hardly have arisen through the operation of Natural Selection. On the other hand, if an individual varies greatly from the rest of his kind he constitutes a variety by himself. If he survives his variation is probably useful. It would be an advantage to preserve it. When one individual is a sport (*e. g.* Ancon and Manchamp sheep, albinos) the offspring tend to inherit from one or other parent exclusively. It is possible, then, that this tendency to exclusive inheritance in the descendants of sports is a product of Natural Selection, a real phase of evolution. Herein perhaps we have the explanation of the fact that varietal characters tend to segregate in the descendants of cross-breeds. In view, however, of the rarity of great and useful variations even this explanation appears far-fetched. That very dissimilar parents tend to have offspring in whom the inheritance is exclusive is, therefore, probably no more than an accidental result of conditions in the germ-plasm which are unknown to us.

To sum up;—the unions of very dissimilar individuals (*e. g.* those belonging to separate genera) are usually sterile; the unions of less dissimilar individuals (*e. g.* those belonging to separate varieties) usually result in exclusive inheritance or reversion to the ancestral type; the unions of still less dissimilar individuals (*e. g.* those within the same variety) usually result in blended inheritance, when there is generally regression towards the common varietal type—that is regression to mediocrity. (See Appendix B.)

[1] *Animals and Plants*, vol. ii., p. 368.

[2] There are some apparent exceptions. (See §§ 162-3.) Moreover when there is exclusive inheritance, or when this or that character is identical in both crossed species, progressive variations are possible.

able than that, in spite of plain, abundant, and conclusive evidence, it should so long have been regarded as the cause of progressive variations.

131. Before attempting to estimate the function of bi-parental reproduction in evolution it is necessary to return for a space to the general subject of regressive variations. Reversion can seldom be observed in such of the higher plants and animals as have been slowly evolved under Natural Selection; not because it does not occur, but because it is usually masked and slight. It is masked because such complex beings seldom or never regress in all their characters at once, and therefore such reversion as may occur in this or that particular is associated with progressive variations in other particulars. It is slight because, since such species have evolved but slowly, reversion to a not very remote ancestor does not usually result in any very appreciable change of type. Thus, if, as regards any character, a man reverted to his "mid-ancestor," or, in cases of exclusive inheritance, to any particular ancestor, of a thousand years ago, no one would be able to recognize to what the change of type was due. Not only would the changes, as a rule, be too small to be noticed, but the observer would need to have an impossibly exact knowledge of the ancestral form.

132. Sometimes, however, recognizable reversion does occur in such beings. Thus a man may resemble the portrait of some far-away ancestor, or the progeny of a pair of ordinary horses may exhibit the zebra-like stripes of the ancestral form. In other words, the progressive variations made during hundreds or thousands of generations may be lapsed in a single generation. It is not however among complex beings, slowly evolved in every particular, that we shall find the most convincing evidence. We must turn to animals and plants that have undergone swift evolution in one or two particulars, and this occurs, speaking generally, only under stringent artificial selection. For Natural Selection, having care for many characters, results in comparatively slow evolution; but artificial selection, having care for only one, or only a few characters, results in much swifter evolution. Domesticated plants and animals, as we have just seen, frequently revert to or far towards the wild type. Again, if we take any prize breed of domesticated animals or plants, and, after choosing the finest specimens, henceforward breed indiscriminately from their descendants, the cessation of selection is invariably marked by a reversion towards the ancestral type which is swift in proportion to the swiftness of the antecedent evolu-

tion. In other words, reversion towards the ancestral type is swift in inverse proportion to the number of generations that intervene between the prize variety and the type whence it was derived. Thus, without stringent selection, the speed of race-horses, which depends on structural peculiarities, cannot be maintained. They tend to lose their special characters and to revert towards the ordinary horse. The same is true of all the prize breeds.[1] Thus large prize dogs tend to produce smaller offspring, while small breeds are with difficulty kept small. Again, careful breeding from ordinary horses readily evolves a speedier race, for the offspring of ordinary horses in many instances surpass the parents. But, in proportion to the success of the breeder, further improvement grows continually more and more difficult, till at length evolution practically reaches a standstill. For this reason it is now very difficult to improve our breed of race-horses. The offspring of a pair of the finest animals are, in the great majority of instances, inferior to their parents, and consequently the most, or almost the most, that stringent selection is now able to achieve is the preservation, not the improvement, of the race.[2] It is plain, therefore, that, owing to the increasing tendency towards reversion, rapid evolution quickly slows down, till, even in the presence of stringent selection, it practically ceases.

134. But perhaps the most striking evidence is furnished by certain cultivated plants (for instance the apple), which are usually propagated by means of slips or suckers, that is, by detached portions of the individual. In effect the most favourable individual of a species is chosen and multiplied by means of slips, the rest of the species being eliminated;

[1] "If a considerable number of improved cattle, sheep, or other animals of the same race were allowed to breed freely together, with no selection, but with no change in their conditions of life, there can be no doubt that after a score or a hundred generations they would be very far from excellent of their kind." (*Animals and Plants*, vol. ii., p. 225.) "When selection is suspended rapid deterioration (from the fancier's standpoint) is the inevitable result. If, *e. g.*, a number of pigeons, good specimens of a distinct breed, are isolated and left unmolested for a few years, they rapidly degenerate, *i.e.* they lose their show points (be they freaks, frills, ruffs or metallic tints) and re-assume the more fixed ancestral characters." (Professor J. Cossar Ewart. Presidential address to the Zoological Section of the British Association, 1901.)

[2] "Two years ago thirty-two yearlings were sold for 51,250 guineas. These thirty-two yearlings are represented by two winners of five races, Florio Rubbatino, and La Reine, who have contributed about £2000 to the total cost; and there is not, as far as can be known, a single one of the remaining thirty with any prospect of making a race-horse." (Quoted from *The Times*, December 27th, 1897, by Sir Walter Gilbey. *Race-horses*, p. 6.)

and in each new seminal generation the process is repeated. Moreover, as plants produce many more offspring than mammals or birds, the gardener's area of choice in each seminal generation is much wider than the breeder's. Such plants, therefore, have been evolved by a tremendously severe process of selection, resulting in an evolution much more rapid than is possible among the higher animals, or even annual plants.

135. Now suppose we chose any one of these highly divergent varieties, and, without any selection, bred from seed alone, what again would happen? There is ample evidence that in the vast majority of instances the variety would swiftly (that is, in a few generations) revert to something very like the wild stock from which it originally descended, but not to the wild stock precisely; for while the cultivated variety was undergoing progressive evolution in one direction, it was apt under the changed conditions of selection to undergo regression in other particulars, and in these the reverted varieties would differ from the wild stock.

136. Here, again, the rapidity and completeness of the reversion is proportionate to the rapidity of the previous evolution. It is greater in the case of many cultivated plants than in the case of any domesticated animals. It is greatest in the case of plants most recently cultivated and stringently selected. The peach, which has been cultivated for more than 2000 years, generally comes true by seed.[1] Apples have also been cultivated from antiquity, but there are a great number of recent varieties which, like all recent varieties, are especially liable to reversion. "No one can raise, for instance, from the seed of the Ribstone Pippin, a tree of the same kind. . . . Yet it was a mistake to suppose that with most varieties the characters are not to a certain extent inherited. In two lots of seedlings raised from two well-marked kinds, many worthless crab-like seedlings will appear, but it is now known that the two lots not only usually differ from each other, but resemble to a certain extent their parents."[2] "In a treatise published in Amsterdam in 1768 it was stated that nearly 2000 varieties of hyacinth were known. A century later only 700 varieties could be found in the largest garden in Haarlem. In this treatise it was said not an instance is known of any one variety producing itself truly by seed; the white kinds, however, now almost always yield white hyacinths, the yellow kinds also come true."[3]

[1] *Animals and Plants*, vol. i., p. 361.
[2] *Op. cit.*, p. 372.
[3] *Op. cit.*, p. 395.

Presumably the white and yellow kinds have now been fixed by careful and long-continued selection; and, as a consequence, when recapitulation is incomplete the ancestor reverted to is not necessarily one of another colour. In 1810–14 Lady Monk and Lord Gambier collected some plants of the wild heartsease, and thus began the cultivation of the modern pansy. Twenty years after "a book entirely devoted to this flower was published, and 400 named varieties were on sale."[1] Half-a-century later Darwin wrote, "Cultivators speak of this or that kind as being remarkably constant and true; but by this they do not mean, as in other cases, that the kind transmits its character by seed, but that the individual plant does not change much under culture. The principle of inheritance, however, does hold good to a certain extent, even with fleeting varieties of the heartsease, for to gain good sorts it is indispensable to sow the seeds of good sorts. Nevertheless, in almost every large seed-bed a few almost wild seedlings reappear through reversion."[2] At the present time the seed of the pansy is "of such a quality, and is saved in so many distinct colours, that for all ordinary purposes the trouble of striking cuttings and keeping stocks in pots all the winter through is mere waste of time and pit-room."[3]

137. An almost endless number of similar examples may be culled from the literature of the subject. It may be accepted as a general rule, therefore, that every variation is unstable in proportion to its newness. It can be "fixed" only by such long-continued selection as makes it occupy a considerable period of the life-history. Otherwise it is apt to be lost altogether through incomplete recapitulation.

138. In a great number of cases the young plants, grown from the seed of garden plants which have undergone rapid evolution, revert towards the ancestral type. But the recorded instances of the seeds of such reverted plants, or any of their descendants, reproducing the cultivated type are very few—if indeed there are any.[4] This must mean that

[1] *Animals and Plants*, vol. i., p. 392. [2] *Op. cit.*, p. 393.

[3] *The Culture of Vegetables and Flowers from Seeds and Roots*, issued by Sutton and Co., the seed merchants. Messrs. Sutton claim, "In no one department of floriculture has there been accomplished a more remarkable advance, or one tending more directly to the public advantage, than in the improvement of the strains and races and stocks of the seeds of Florists' flowers" (p. 195). They give examples of flowers the varieties of which have been recently more or less fixed by selection carried through many generations.

[4] Darwin mentions (*Animals and Plants*, vol. ii., p. 247) that "in

the cultivated type disappears absolutely from the series. It does not become latent. It can never again be represented in the life-history. It could only reappear as a consequence of fresh progressive evolution resulting from selection similar to that by which it was originally evolved.

139. Two things, then, are evident from the foregoing. First, that there is, on the average, a greater tendency towards reversion than towards progression, a greater tendency to vary towards the ancestry than away from it. In other words there is a greater tendency to let the last steps made in the life-history lapse in the development than to add other steps to them. Secondly, the strength of the tendency towards reversion is proportionate to the swiftness of the antecedent evolution, and therefore species which have been quickly evolved tend to regress gradually. For this reason it is that characters long established in the species are much more stable than more recent characters. In the former case, reversion, to be appreciable, must be to an extremely remote ancestor, whereas in the latter reversion to a much less remote ancestor results in appreciable regression. For example, the cultivated pansy, which was quickly evolved under Natural Selection, reverts quickly to the heartsease; but because the heartsease was very slowly evolved under Natural Selection, subsequent reversion in the absence of

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France a considerable number of the best pears have been discovered in woods, and this has occurred so frequently that Piteau asserts that improved varieties of our cultivated fruits rarely originate with nurserymen. In England, on the other hand, no instance of a good pear having been found is recorded; and Mr. Rivers informs me that he knows of only one instance with apples, namely the Bess Poole, which was discovered in a wood in Nottinghamshire." Piteau's statement is certainly incorrect, the vast majority of improved plants having originated under artificial selection. Darwin also mentions one improved variety of peach as discovered in a wild place and two varieties of wheat. Wheat, which is grown from seed, is of course as likely to produce a good variety when it has run wild as when it is cultivated. The apple and peach have been cultivated for many centuries and are apt to breed true, and we do not know that the improved apple and the pears found wild in woods were the offspring of reverted plants. Their parents may have been, like themselves, of the cultivated type. It is conceivable that the cultivated type may on rare occasions become latent in reverted plants. This would mean of course that the dormant and the active tendencies in the germ-plasm had changed functions, the former becoming active and the latter dormant. But, so far as the present writer is aware, there is no well-authenticated instance of such an occurrence. It would seem that only those characters which have been long established, and are therefore strongly established, tend to become latent. Characters less strongly established tend to disappear through mere regression.

selection must be very slow, so slow as to be inappreciable to us. *It follows also that the magnitude of any act of reversion tends always to be greater than the magnitude of the corresponding act of evolution.* Thus many seminal generations must have intervened between the crab and the cultivated apple, but, in a single generation, the cultivated apple may, and often does, revert far towards the crab. Therefore it is that, in the absence of selection, species invariably undergo regression. In this manner do parts long useless become mere vestigial remains or disappear absolutely by reversion to that ancestral condition in which they did not exist. Thus have disappeared, for instance, the limbs of snakes, the eyes of some cave-dwelling animals, and the many useless parts of internal parasites. Thus have vanished utterly innumerable useless parts in every species of plant and animal.

140. Return now to bi-parental reproduction. An example taken from disease will make its function clear to the reader. Suppose any deadly malady, for instance malaria, is prevalent in a country; the men and women who survive and have offspring will in general be those who have varied favourably as regards it. The children, therefore, will inherit the variation undiminished by sexual reproduction and continued selection will result in evolution. But we know, also, that people vary in their powers of resistance to tuberculosis. Suppose, in the country we are speaking of, tuberculosis is not prevalent. Then people who vary favourably as regards it will not survive in greater numbers than people who do not so vary. The two types will survive equally and will mate together; the older type will tend to be prepotent, and this variation, useless under the circumstances, will be planed away continually by reversion to the ancestral type. The species will not become burdened with it. If, however, tuberculosis be now introduced, the situation is changed. Only those individuals will survive that are resistant to the disease, and therefore evolution against it will proceed unchecked by sexual reproduction. If, next, malaria be banished by improved sanitation, the power, now useless, of resisting it will begin immediately to undergo regression. The many individuals who revert towards the more ancient and therefore the more prepotent type in which it did not exist, will survive and have offspring. What biologists call the "constitution of the race" will be broken. It will become, to all appearance, much more variable.

141. Indeed a little thought will render it evident that the above considerations afford an explanation, at once probable and in accord with the doctrine of Natural Selection, of the

fact that species removed to new environments tend to become more variable in every way. Consider a plant growing wild in a wood. It fills a particular niche in nature, which if it alter much it will not fit. Working together for ages, Natural Selection and sexual reproduction, progressive and regressive evolution, have closely adapted it in all its parts to the environment. Natural Selection has met every gradual increase of stringency in the conditions under which the species lives by slowly evolving new structures, or much more often by modifying old structures. Sexual reproduction has met every decrease of stringency by planing away all redundancies. When the adaptation to the little-changing environment has nearly approached perfection and excessive variation has become disadvantageous, the two forces have united to preserve the stability of the type; Natural Selection by eliminating regressive variations, and sexual reproduction by eliminating excessive progressive variation. Since the environment in wild nature changes very slowly, an appearance of great stability and uniformity in all the individuals of the species is thus produced. And not only an appearance. It is plain, whenever the adaptation to the environment is close, that Natural Selection and sexual reproduction will combine to limit the tendency to vary; Natural Selection by destroying individuals that tend to vary greatly, sexual reproduction by reducing this tendency in any offspring such individuals may chance to have towards the specific mean. *It must be remembered that an unusual tendency to vary is itself a variation*, for, judging by analogy, it is not at all probable that all individuals tend to vary to exactly the same extent; and if they do not vary to the same extent, Natural Selection must work on these variations just as it does on any other, and so exalt or reduce the tendency according to the needs of the time. Every species fills a particular niche in nature. But that niche changes its shape, at times with comparative quickness, at times very slowly. The species follows suit. When the niche is changing rapidly great variations are advantageous, and Natural Selection therefore chooses for survival those individuals who vary greatly (and favourably). When the niche is nearly stable great variations are disadvantageous. They do not, then, increase the adaptation; they merely increase the elimination. At such times, therefore, Natural Selection chooses for survival those individuals that tend to vary but little. These restrictions on the tendency to vary are probably of great importance, but have not received the attention they deserve.

143. But now suppose the plant we are considering is removed to entirely new surroundings, to a garden, for instance. The conditions of survival are immensely altered. Selection ceases, or, as artificial selection, changes its direction. Unrestrained by Natural Selection, sexual reproduction causes, in many parts, rapid regression, which, in a few generations, becomes easily appreciable. Restrictions on that very ancient heritage of the race,[1] the tendency to vary, are thus removed. Not only regressive, *but progressive*, variations make their appearance, if not in increased numbers, at least in forms of such magnitude as to be noticeable. The cultivator, not realizing that his hypothesis controverts the doctrine of Natural Selection, leaps, of course, to the conclusion that the alteration has been produced by the direct action of the altered environment on the germ-plasm. He is in error. One truth cannot contradict another. Species are closely adapted to their environments; the only possible cause of adaptation known to scientific men is Natural Selection. Natural Selection could not bring about adaptation if the environment, acting directly on the germ-plasm, were more than a very insignificant cause of variations.[2]

144. In exactly the same way as sexual reproduction planes away useless variations against tuberculosis or malaria, so it eliminates every other kind of useless variation or organ in every species of plant and animal in which the reproduction is bi-parental; whereas useful variations are left unaffected. At any rate all useful variations which are of common occurrence, such as those of an established structure, are unaffected. Great abnormalities, or "sports" as they are termed, though said by some biologists often to be prepotent, tend to disappear, even if useful.[3] They are sometimes pre-

[1] See §§ 160 and 163. [2] See §§ 72–9.

[3] Of course, owing to blended inheritance, a great abnormality is liable to persist for more generations than a smaller variation. Moreover, in the case of great abnormalities, owing, presumably, to incompatibility in the germ-plasm, the inheritance is often exclusive. Thus the offspring of Ancon sheep, inherited exclusively from one parent or the other. (*Animals and Plants*, vol. ii., p. 70.) Conceivably a great abnormality might be of such a kind as to be useful. But this is highly unlikely. No doubt man has found one or two which are useful to *him*, as in the case of the short-legged Ancon sheep above cited, which could not leap fences; but, as far as I am aware, no instance is known of such an abnormality being useful in a state of nature to the organism that produced it. The chances are almost infinity to nothing against a large and elaborate new structure, a deformity, increasing the adaptation to the environment. Apart from tumours most abnormalities are examples of regression, not of progression. Probably even tumours

served by artificial selection, as in the case of Ancon and Manchamp sheep.[1] But the selection is then extraordinarily severe. The breeder endeavours by closer interbreeding to protect his chosen abnormality from the regressive action of sexual reproduction, and only thus can succeed in preserving it. *Under conditions of Natural Selection, bi-parental reproduction insures that all evolution shall be on lines of small variations, not on lines of great abnormalities.*

145. We have now conclusive evidence that parthenogenetic species vary; but, though the contrary has been too hastily inferred, it is extremely probable that they do not vary to very much more than half the extent that is normal in bi-parental reproduction. It is likely that their progressive variations are as numerous as in the latter case, but all the scanty evidence available points to a comparative lack of regressive variations. Thus the *receptacula seminis* of various parthenogenetic species (e. g. *Cypris reptans*) appear to have undergone no regression, though in some cases innumerable generations have elapsed since they were functional; whereas in other cases (e. g. *Aphides*) when sexual reproduction alternates with parthenogenesis the *receptacula* have degenerated in the parthenogenetic females. It is not to be supposed that there is no reversion in the absence of bi-parental reproduction. The fact that development is by recapitulation insures a certain amount of it. Nevertheless it is reduced to a minimum. Indeed, considering the evident lack of reversion among asexual forms, it is probable that bi-parental reproduction plays a part in the causation of reversion greater than is apparent on the surface. When two individuals who differ obviously in certain characters mate, and bear offspring in whom the characters are diminished or lost to the extent of the parental differences, the reason for the regression seems clear to us. But we are apt to be puzzled when characters are lost or diminished in offspring the parents of which resembled each other. In such instances the resemblances may have been only apparent; differences important from a developmental standpoint may have existed, and yet have passed unnoticed, or they may even have been qualitative and inappreciable. As is well known, we are apt to overlook considerable differences, especially in unfamiliar forms, unless our powers of observation have been trained

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should be placed in the same category. (See Appendix B, also *The Present Evolution of Man*, p. 49.)

[1] *Animals and Plants*, vol. i., p. 104.

by experience. Thus, though we are able to detect vast differences between the people of our own race, Chinamen seem much alike to us. The ordinary man hardly knows one sheep from another; the shepherd knows every member of his flock. A famous old Dutch gardener was said to have been able to distinguish all the hundreds of varieties of hyacinth by their dried bulbs.[1] Moreover the germ-cells of the same individual vary among themselves, and thus may give rise to regression in this or that character in the offspring of individuals who apparently are not unlike.

146. Bi-parental reproduction occurs invariably in all large and complex organisms; that is, in all organisms that are apt to vary uselessly in a great number of ways.[2] It occurs periodically at any rate in most parthenogenetic species; and is periodically prevalent also in many if not all unicellular forms. *It is an exceedingly effective device to assist and direct the regression which is the necessary result of development by recapitulation; for, unlike the latter, it is selective in action.* It eliminates as a rule only useless variations. It plays exactly the same part in selecting regressive variations that Natural Selection plays in selecting progressive variations. Bi-parental reproduction, indeed, is only another name for bi-parental selection. It is almost as important a factor in evolution as Natural Selection.[3]

[1] *Animals and Plants*, vol. i., p. 384.

[2] Animals are more complex than plants, and, therefore, have a greater need for regressive variations. Though the germs of the same individuals differ among themselves, the germs of separate individuals differ more. Consequently plants are sometimes self-fertilized, animals are not. "As yet I have not found a single terrestrial animal which fertilizes itself. This remarkable fact which offers so strong a contrast with terrestrial plants . . ." (*The Origin of Species*, p. 123.) Self-fertilization occurs, however, among certain more or less vegetative marine animals.

[3] It must be noted, however, that bi-parental reproduction itself must have arisen through the survival of those organisms that were capable of this mode of reproduction. Ultimately, therefore, all the phenomena of evolution must be referred to Natural Selection. Even reversion due to failure to recapitulate the life-history must be so referred, for reversion depends on antecedent progression, and there can be no progression in the absence of Natural Selection. Since bi-parental reproduction planes away the vast multitude of useless variations, it is evident that it must contribute, on the whole, to the stability of the species. Weismann is mistaken, therefore, in supposing that parthenogenetic species are particularly stable. No doubt bi-parental reproduction contributes to the instability of species by aiding in the elimination of *organs* which have become useless, but its major function is the elimination of those useless *variations* which arise in one generation and are lost in the next.

CHAPTER VII

REGRESSION

Summary—The function of regression in evolution—Development in ancient environments—Development in new environments—The evolution of man's higher faculties—The "inadequacy of Natural Selection"—The unknown factor—Theories of regression—Germinal selection.

147. THE last three chapters are so important for a right understanding of what I conceive to be the true principles of heredity that it will be well to sum up and emphasize their main contentions briefly. Since every individual follows (with variations) in the developmental footsteps of his predecessors, the recapitulation (with inaccuracies corresponding to ancestral variations) of the life-history of his race is inevitable in his own development—unless indeed he happens to be an extraordinary and incredible sort of monster. No such monsters can have occurred in his ancestry, for monsters, lacking adaptation to the environment, invariably perish. While it is obviously impossible for any *individual* to so vary from his immediate predecessors as to recapitulate the later stages of development without first substantially recapitulating the earlier stages, it is of course quite possible for the converse to happen. Thus a human being cannot become an adult without first passing through the embryonic and fœtal stages; but it is quite possible for him to cease developing at any point. When this happens, when there is an omission of the later stages, we have an instance of reversion, of regression. It is customary to regard reversion as due to the sudden activity of hitherto "latent ancestral units," but it is infinitely more probable that it is due to incomplete recapitulation. Since organisms vary in all possible directions, there is no conceivable reason why they should not vary in this particular direction. Indeed they are more likely to vary in this direction than in any other; for every variation must be

regressive or progressive, and as far as we know the chances of its being the one or the other are equal. But while all regressive variations trend in one direction, a progressive variation may trend in any one of an infinite number of directions. It need not necessarily constitute an extension of the previous evolution; it may even constitute a reversal of it, as in those cases of which reversed selection takes advantage.[1] It is, of course, conceivable that the germ-plasm contains ancestral units—discrete particles which "struggle" together during the development of the individual, and are suppressed, in which case they are rendered latent, or are victorious, in which case they are expressed in his characters. But it is always dangerous and unscientific to seek to explain by unknown forces phenomena which can be sufficiently explained by forces already known. All the phenomena of reversion are explainable by failure of recapitulation. All the phenomena of regressive evolution are explainable by the selective action of bi-parental reproduction.

148. Every complex individual, as we know, varies in a thousand ways, great and small, from its parent; but only here and there is a variation useful. The useful variations, in proportion to their usefulness, are preserved and, in succeeding generations, are accentuated by Natural Selection. Of the useless variations some may be rendered latent, but the vast majority are immediately planed away by reversion directed by bi-parental reproduction. Most of them, being minute, disappear in the next succeeding generation; but even when they are comparatively large, a few generations suffice to procure their disappearance. Even should a series of individuals, having a useless variation in common, happen to mate and have offspring who vary so that the character is more and more accentuated, yet since the tendency towards reversion is greater than towards progression, a time surely comes when, perhaps in a single generation, the whole of the

[1] The fact that regressive variations are all in one direction, whereas a progressive variation may trend in any one of an infinite number of directions, would seem to indicate that regression is inevitable in the mere absence of Natural or Artificial Selection. But this contention, which has frequently been used by the present writer, will not bear close examination. A progressive variation, no matter in what direction, is still a progressive variation. A corresponding act of regression of no greater magnitude will do no more than eliminate it. What does render regression inevitable in the absence of Natural or Artificial Selection is, first, the fact that regressive variations tend to be of greater magnitude than progressive variations, and, second, the fact that ancient characters are prepotent over less ancient characters.

progressive variations lapse, and the character vanishes never to reappear, except in the improbable event of a fresh series of matings and variations of a like nature. Again, it sometimes happens that a change of environment renders useless a structure which was formerly useful. Here also reversion steps in and procures its elimination. Such a structure—say the wing of a bird whose habits have ceased to be aërial—was evolved by the superimposition in a long line of individuals of progressive variation on progressive variation. These, when the character becomes useless, are lapsed in orderly succession, the most modern first and more ancient later,[1] till, at last, the structure reverts to that most ancient condition when it did not exist. In this manner it approximates continually to more and more ancient forms, but only approximates. It never reproduces its prototypes of the life-history exactly; for, during the whole course of evolution, reversion was at work, planing away everything which was originally useless, or which became useless as the organ evolved. A complex organ such as a wing is, therefore, even during its progression, a product, not only of progression, but also of regression. Evolution rough-hews the organ, but reversion chisels its finer lines. What is true of a complex organ is true in a yet greater degree of every complex animal and plant. Such a being is a product, not only of progressive evolution, but also of regressive evolution. In it many structures, useful during a remote period of the life-history, but useless later, have returned to that yet more ancient condition when they did not exist. Others, in which reversion is as yet incomplete, still persist, and are known to us as vestigial remains. It should, however, be noted clearly that, when a vestigial structure is more developed earlier in the development of the individual than later, this indicates that its apparent regression is due not wholly to regression the result of reversion, but partly or wholly to progression the result of reversed selection. Such a structure must have become not only useless, but harmful during the life-history.

149. Every complex animal, therefore, in the successive stages of its development does not represent exactly the corresponding successive stages in the evolution of the race. At each stage of the development are present useless structures,

[1] By this it is meant, of course, only that variations which were *superimposed* on one another are lapsed in orderly succession. It is not meant that characters in different parts of the wing necessarily disappear in the reverse order of their appearance. Doubtless such characters do often disappear in this order, but they do not necessarily do so.

which have regressed towards a more ancient order of things; and at every stage of development structures are absent which were present in the life-history, because they were then useful, but which since underwent complete regression. Doubtless if a higher animal, a man for instance, lived during his development in a succession of environments similar to those in which his race was evolved, his development would much more exactly recapitulate the life-history than it actually does; for in that case structures which had been useful during the life-history would continue to be so during the development, and so would be preserved.

150. Instances of this are common enough in nature. Thus a butterfly, in its development from the egg forwards, lives, during part of its development, in environments which must correspond pretty closely to the environments in which its race underwent this or that part of the evolution. The caterpillar, therefore, must represent its prototype in the corresponding stage of the life-history much more closely than does the human embryo at any stage. The caterpillar stage is therefore greatly prolonged, as compared to the other stages, and, during it, the animal probably very closely resembles its remote ancestor.[1] But during the other stages, in which the environment differs greatly from the ancient environments—for instance, the stage during which the ovum develops into the caterpillar, and in the chrysalis stage when the caterpillar develops into the butterfly—the environments differ greatly from those which anciently prevailed. In these stages, therefore, much regression is possible, for many parts become useless which were formerly useful. The development is then only a vague recapitulation of the life-history, and consequently is much shortened and condensed. In these respects it resembles the whole development of man.

151. Consider how vastly different is the environment, in which the embryo of man develops, from the environments in which his race evolved. The embryo develops in the uterus, but its prototypes of the life-history struggled each for itself in a world full of enemies and dangers. How many parts, therefore, have become useless to the embryo, which were useful to the prototypes! How vast is the field in

[1] This is no doubt true in a general sense. But Lord Avebury has shown that larvæ of insects belonging to very different orders may be closely similar if of similar habits, but that they may be very unlike, even when belonging to the same order, if their habits and therefore environments be dissimilar. In the latter case progressive evolution has occurred in the larval stage.

which regression has worked! Is it any wonder that the development of man is only a vague recapitulation of his life-history? In plants, which, since they are stationary, live under practically the same conditions from embryonic to adult life, the development of the individual has been even more emended and condensed. It presents, therefore, scarcely a trace of the life-history.

152. Regression, then, is the necessary complement of progressive evolution. Without regression due to reversion there could be no evolution, except of the simplest kind. Without it there could be no planing away of the numberless useless variations which occur during, and especially at the end of the development, nor of all those structures which, though useful in some part of the life-history, became useless later. Without regression, therefore, a species would become so burdened with useless variation and structures as to be incapable of existence. Reversed selection could not cause the elimination of all these burdensome and useless characters; for no matter how burdensome, and worse than useless, they might be in the aggregate, separately they are so little burdensome that reversed selection could not act. It could not act on them in the aggregate, for this would mean that in some individuals they would be present *en masse*, whereas they would be absent *en masse* in others—a conjunction improbable, or rather impossible. Moreover, reversed selection usually causes a lengthening, not a shortening of the development.

153. Again, without regression, the recapitulation of the life-history would be impossible in the development; and for this reason, once again, evolution would be impossible. For were there no regression, the prototypes of the life-history, with all their useless variations, would necessarily be reproduced exactly in the development of the individual; and then the development would be as elaborate, and almost as lengthy as regards time, as evolution. Moreover, the prototypes could not exist in the enormously changed environment. How, for instance, could a gill-breathing animal, or any of the higher forms which intervened between it and man, exist in the uterus, in which can exist only those dim representations of the life-history which constitute man's development?

154. It is this great change of environment, this close protection of the individual in the uterus and afterwards, that has rendered possible the evolution of man and the higher animals. Opportunity has been afforded for regression to plane away innumerable characters that had become useless.

The development has thereby been straightened, shortened, and simplified; and the evolution of new characters, useful in the new environment, has become possible. Thus, for instance, have been rendered possible the higher characters of man; for even after birth he is closely protected, and therefore, even in that portion of the development which intervenes between the infant and the adult there has been regression. Consider how feeble and helpless the infant is after birth; but its prototypes of the life-history fought each for its own existence. The infant can digest scarcely anything but milk, and its jaws are very feeble. Its prototypes must have had different and wider powers of assimilation. Perhaps more remarkable than anything is the regression of instinct in man. We shall have to deal with this when we consider Mind, but reflect, meanwhile, how extremely incapable, as compared with young insects for instance, the infant at birth is of adapting itself of its own initiative to the environment. Later, it *acquires* all kinds of knowledge and ways of thinking and acting, which serve as a superior substitute for instinct. But meanwhile the mother's protection, which renders possible the acquirement, renders useless the instincts of its prototypes, which, therefore, have lapsed. Hence the regression of instinct in man. By it his mental development is shortened and simplified, just as by the regression of bodily parts his physical development is shortened.[1]

155. Biologists—at any rate many biologists—have fully recognized that development is a recapitulation of the life-history. They have noted the constant tendency towards reversion. They have observed the gradual disappearance of useless organs. They have realized that useless variations, if transmitted, must ultimately render a race incapable of existence. They have recognized that bi-parental reproduction must have some very highly important function. All these things they have noted, and many of them have declared rightly that Natural Selection, as ordinarily understood, is by itself totally inadequate to explain all the

[1] In the foregoing mention has constantly been made of characters lapsed in orderly succession, the last first, the earlier later. But, as already indicated (*e.g.* among the medusæ), earlier characters may sometimes lapse before the later. This may happen especially when some parts of the life-history are not direct, but form, so to speak, a loop —for example, when evolution, and consequently development, have been rendered indirect by the action of reversed selection. The omission of the loop would straighten and therefore shorten the development. Considering how condensed the development is, it is probable that this has occurred not infrequently.

phenomena of evolution. "If acquired variations are transmitted, there must be some unknown principle in heredity; if they are not transmitted, there must be some unknown factor in evolution."[1] "Something is wanting to the selection of Darwin and Wallace, which it is obligatory on us to discover if we can, and without which selection as yet offers no complete explanation of the phyletic processes of transformation."[2] But biologists have failed to realize that recapitulation, variation, and bi-parental reproduction combined render reversion inevitable, which in turn renders the deterioration and final disappearance of useless organs and variations—*i. e.* organs and variations not preserved by Natural Selection—equally inevitable.

156. This, then, is the unknown factor in evolution. Not one, but two forces are continually at work in nature—Natural Selection and Reversion. The former causes progressive evolution, the latter regressive evolution. They are opposed, but one would be quite inadequate without the other. They are warring forces, but their resultant is a near approach to perfection. Between them they tend to bring every species into exquisite harmony with its environment. The parts they play in evolution may be compared to those played by assimilation and waste in the growth of the individual. Not substance alone, but waste of substance, renders an individual efficient.

157. Some biologists, perceiving the inadequacy of Natural Selection, have attributed regression to transmission of acquirements—in this case to the transmission of the effects of disuse. Others, perceiving the inadequacy of Natural Selection and the impossibility of the transmission of acquirements, have appealed to the supernatural—to miracle. Others, forgetting that mere cessation of selection is sufficient to cause regression, have declared that useless parts are injurious, inasmuch as they are burdensome and absorb nutriment, and that, therefore, Natural Selection (in this case Reversed Selection) is an all-sufficient cause. Others have attributed regression to the struggle of parts, alleging that the more active, the more used parts, absorb the most nutriment. But this implies the transmission of acquirements. Moreover, there is no real struggle of parts. Plants and animals are not always on the verge of starvation; the roe of the herring does not struggle, but it absorbs a

[1] Osborn.

[2] Weismann. *Germinal Selection*, English translation, p. 15. Compare also Romanes' *Darwin and After Darwin*, vol. ii., p. 154.

monstrous quantity of nutriment; the parts of plants do not struggle, yet they develop according to the needs of the organisms.

158. Weismann, perceiving all these difficulties and having no faith in miracles, formulated a theory of "Germinal Selection" in which he transfers the struggle for nutriment from the parts of the organism to the "determinants" of the germ-plasm. According to him the body arises from determinants in the germ-plasm. A weak determinant produces a minus (regressive) variation. Being weak, it is vanquished in the struggle for food by stronger determinants and so grows weaker. If the part it produces is useful, the individual who has the minus variation perishes by Natural Selection; the race being continued by individuals in whom the part is better developed. If it is useless he survives. Since there is continuity of the germ-plasm, the process of weakening continues with added force in successive generations till at length the determinant perishes and the part disappears. In the total absence of all evidence of real existence of determinants it is, of course, impossible to deal with the hypothesis with profit. It is the airiest pinnacle on a very airy edifice of speculation. Moreover, it is quite unnecessary as an explanation of regression. All the phenomena of regression are sufficiently explained by known facts. Furthermore, Weismann's theory of regression is founded on his theory of heredity, which, in turn, is founded on the supposition that the progressive variations are due to bi-parental reproduction. Since it is evident that they are not, his whole hypothesis collapses.

159. Somewhat similar or analogous to the views of Weismann are those of Dr. J. Beard of Edinburgh.[1] Dr. Beard is an acute and accurate observer, but his reasoning is by no means easy to follow. He appears to maintain that in bi-parental reproduction the (potential) characters of the parents are mingled, not combined, in the germ-tract till "the epoch of the formation of the primary germ-cells," much as two differently coloured packs of cards may be mingled. "There will be in every cell two representatives of each character or quality." In the primary germ-cells one representative of each character or quality is eliminated or rendered latent in the process of "reduction," *the one best suited to the environment being preserved or rendered active.* Selection, therefore, occurs within the germ-cells, and as a consequence individuals generally tend, as regards any character, to resemble the superior more

[1] *Review of Neurology and Psychiatry*, March 1904, p. 184, *et seq.*

than the inferior parent. This form of germinal selection, according to Dr. Beard, is much more powerful in adapting species to their environments than that Natural Selection of individuals which Darwin outlined. "What it (*i. e.* Natural Selection) would do, that, and far more than that, Nature brings about in a more efficient way by selecting in the germ-cell which of two characters or qualities, the greater or lesser, shall be taken." The assumption, apparently made by Dr. Beard—that the environment is the same for the germ-plasm as it is for the species, and that it selects biophors or pangenes (representing qualities) in a way similar to, but more certain, than the way in which Darwin supposed it selects individuals—is, to say the least, tremendously improbable. He gives no concrete examples, but let us take one. Suppose antelopes are preyed upon by lions; then certain qualities depending on a multitude of structures—speed, wariness, etc.—will undergo evolution in the species. According to Darwin this will result from the elimination of unfit individuals. According to Dr. Beard, it will result from the elimination of unfit biophors in the germ-cells of those individuals which are not captured by the lions (*i. e.* those who have offspring), and which are, therefore, not affected by this element in the environment. But why the fit biophors rather than the unfit are chosen is not explained. Even were this theory of germinal selection true, it would not, by itself, suffice to explain progressive evolution. The child would not progress beyond the most favoured parent. Dr. Beard surmounts the difficulty by supposing that the environment acting directly on the biophors is the cause of variations. "As living entities they must be influenced by the total environment, nutrition, climate, disease, toxins, etc. To all these influences they will react. The effect of all the factors will be a different one on the differently constituted characters. Some it will favour, and these will flourish and increase in importance. Others will be unfavourably influenced or neglected, and these will diminish." It is evident that every objection raised in the present work against the hypothesis that variations are due to the direct action of the environment applies in full to Dr. Beard's theory.[1]

[1] See Chapters IV. and XII.

CHAPTER VIII

THE CAUSE OF SPONTANEOUS VARIATIONS

The inherent tendency to vary—Galton's Law of Inheritance—In-breeding and cross-breeding—Fertility and sterility—The effects of domestication on fertility—The geographical distribution of species—Summary.

160. If spontaneous variations are not due to the transmission of acquirements, nor to the direct action of the environment on the germ-plasm, nor to bi-parental reproduction, to what then are they due? Undoubtedly to an inborn tendency to vary, a tendency that is inherent in the germ-plasm of every species of plant and animal. But whence this tendency? In the present state of our knowledge—in the total lack of all evidence—we can only speculate vaguely. To me it seems probable that, in that distant past when life was near its origins, all living beings were homogeneous in structure, and that they produced offspring by fission, or rather fragmentation, similar to themselves; but that, amongst these homogeneous organisms, there arose beings which had a tendency to be heterogeneous in structure, and the fragmentation of which therefore produced offspring that varied among themselves. The question as to the steps by which this departure from homogeneity was achieved is interesting, but it is not material to the matter in hand. Very plainly it did occur somehow. By some means or other it came about that organisms produced offspring that varied spontaneously amongst themselves. Possibly or probably the result was brought about by the environment acting directly on the individual, but affecting his different parts (*e. g.* outer and inner parts) differently. The moment differentiation among offspring occurred a great advantage in the struggle for existence was conferred. Natural Selection came into being and evolution followed. Natural Selection could then fix two vitally important laws of heredity, two hereditary tendencies

which were immensely advantageous to the races that possessed them. The first was this tendency which causes parents to reproduce their like *with variations.*[1] The second was the tendency which causes the reproductive elements to be more or less completely indifferent to the action of the environment so far as their hereditary tendencies were concerned. These two tendencies would enable races to adapt themselves to adverse circumstances, instead of undergoing degeneration. More or less complex organisms would arise, which, in order to live in the environment in which they were produced, would have to be very similar to the parents, and which could not be similar unless they followed nearly the same developmental footsteps. Recapitulation would thus provide for adaptation to the parental environment, and variability would provide for adaptation to changes in the environment. An inevitable corollary to recapitulation and the tendency to vary about a mean would be the occurrence of regressive variations. Regressive variation would then render the evolution of still more complex beings possible. An even greater degree of complexity would demand a special selective means of eliminating useless structures and variations. Bi-parental reproduction would then be established, its actual origin being due, perhaps, to attempts at cannibalism amongst unicellular organisms.

161. It will be interesting to note some phenomena on which the theory of regression set forth in these pages has a bearing. Mr. Galton's Law of Inheritance, which attributes an average of one-quarter of the total heritage of the child to each parent, one-eighth to each grand-parent, and so forth, may be true as regards the particular species investigated by him, if we suppose that by the "contribution" of an ancestor to the heritage is meant reversion to (*i. e.* failure to recapitulate beyond) that ancestor. But the law is manifestly untrue as regards other species that have been evolved at a different rate. The parents of the pansy, for example, contributed, as a rule, in Darwin's time, nothing to the heritage. They contribute somewhat more now. The average amount of

[1] As to the intracellular mechanism by means of which the offspring are rendered variable, I do not venture to offer an opinion. Certainly, judging from the evidence, the transmission of acquirements, the direct action of the environment, and bi-parental reproduction have nothing to do with it. From a germ-cell, whether fertilized or not (as in parthenogenesis), arise somatic cells of many different varieties. There is no reason to doubt that the same process of evolution, which caused the somatic descendants of the germ-cell to differ among themselves, has caused the germinal descendants to differ also.

reversion in any species as regards any particular character depends mainly on two factors, (*a*) reversion towards the ancestry caused by defective recapitulation, and (*b*) reversion towards the specific mean caused by regression to the parental mean. The former is an instance of normal regressive variation; the latter is a necessary consequence of bi-parental reproduction; the extent of the former depends usually on the speed of the antecedent evolution; the extent of the latter on the amount of the difference between the parents.

162. Darwin showed that, in many instances, in-breeding is injurious and cross-breeding beneficial, the former causing a lack of health and vigour, the latter an increase of it.[1] The elaborate devices evolved by many plants to secure cross-fertilization lend strong support to his contention. If the views set forth in the present work are correct, it follows that the benefits of cross-breeding are due to the rapid elimination of useless and injurious characters, which often accumulate as a result of too close in-breeding. These characters may not be tangible or visible, but may be mere tendencies and predispositions, which act as checks to healthy development. The worst effects of in-breeding are observed under artificial selection, not only because the in-breeding is generally closer than under natural conditions, but also because man is unable to detect and eliminate many injurious variations which nature would infallibly eliminate. Occasionally the increase of vigour which follows crossing results in an improvement in some particular character of such a kind that it is apt to be mistaken for a progressive variation. For instance, Darwin mentions instances of the fruit of melons and apples as improved by crossing varieties.[2] But the massive nature of the evidence pointing to the regressive action of bi-parental reproduction renders it more than probable that the improvement is due rather to the improved health of the plants, combined possibly with exclusive inheritance, or with progressive variations in characters in which the crossed species agree. Certain domesticated

[1] *Animals and Plants*, chap. xviii.

[2] *Ibid.*, vol. ii., p. 110. Many years ago I grew several varieties of melons in a small garden in New Zealand. There was of course extensive cross-fertilization through the agency of insects. The fruit from the hybrid plants was always quite worthless, having apparently lost every quality which renders a melon agreeable. Every year it was necessary to procure fresh seed from gardens in which one variety only was grown. When seed was required it was the practice in the country to grow the varieties separately.

animals, sheep for instance, have been improved by crossing.[1] Two breeds, each having *in excelsis* the qualities desired by the breeder, are chosen and mated. The desired qualities are not diminished, while the general vigour of the stock is increased.[2] Or a breed having the desired qualities is crossed once or twice with a breed which has them not, and whatever reversion occurs in the desired qualities is eliminated in subsequent generations by careful selection.[3]

163. Professor J. Cosser Ewart, also, while declaring that "intercrossing . . . never, so far as I have seen, results in the appearance of characters absolutely new to the species," insists that "though intercrossing usually results in retrogressive variation, it is indirectly an extremely potent cause of progressive variations,"[4] owing to the increased vigour of the stock. Now, of course, it is conceivable that vigour is a variation which is the cause of other variations. Probably, however, it is nothing other than a manifestation of good health due to the presence of certain characters and qualities and the absence of certain others. Professor Ewart maintains in effect—indeed he does so formally—that the environments of the germ-cells is a cause of variation. We have already seen that there are weighty reasons for believing that he is mistaken. The fact that it is easy to evolve new varieties from the cross-bred descendants of choice cultivated plants and domesticated animals is no evidence that crossing is in itself a cause of progressive variations. For not only is it more easy to breed from vigorous stock, but there is no reason why cross-bred stock should not produce just as many progressive variations as ordinary stock in all characters except those in which the parent varieties differed. Thus supposing, from a plant having a flower of a certain colour, two varieties were evolved by careful selection which differed from the parent type and from each other only in the colours of the flowers. If these varieties were crossed we should certainly get no progression in colour. On the contrary, we should get reversion. But there is no reason why we should not get progression in shape and size. Moreover, breeders of choice stock are very careful to eliminate all variations except the very few they desire. In other words they endeavour to suppress or eliminate variability. In this they are probably successful, for, in Professor Ewart's own words, "In in-bred

[1] *Animals and Plants*, vol. ii., p. 73. [2] *Ibid.*, chap. ii., p. 73.

[3] *Op. cit.*, p. 157.

[4] *Presidential Address to the Zoological Section*, British Association, 1901.

herds, *e. g.*, the males and females are so like each other that the offspring, were it possible, might almost as well be raised by buds or cuttings."[1] If this be so, crossing such types would cause a reversion to the ancestral condition of greater variability.[2]

164. Varieties of the same species, when evolved by artificial selection, are generally very fertile when crossed, no matter how divergent they may be in structure. But varieties evolved under Natural Selection are generally much less fertile even when the divergence in structure is apparently slight.[3] Distinct species tend to be inter-sterile; distinct genera are nearly always so. Natural varieties are evolved much more slowly than artificial varieties. It is evident, therefore, that time rather than apparent divergence of structure is the principal factor in the causation of specific and varietal inter-sterility, a hypothesis which is confirmed by the fact that species inhabiting distinct regions tend to be sterile when crossed.[4] The explanation seems to lie in the fact that, as regards domesticated varieties man has sought to cause differences, not in the embryo, but in the adult forms. His varieties develop from egg to fœtus along parallel lines, and on that account are inter-fertile. But, as we know, variation, regressive and progressive, is at work on the embryo as well as on the adult. It slowly brings about changes in the embryonic development, so that in time the embryonic development of two long-separated forms proceeds on lines more or less divergent, or at any rate not parallel. When two domesticated varieties mate we tend to get reversion; that is, the last, the divergent, links in the chain of development are dropped. Presumably the same thing occurs when the divergence occurs early in embryonic life, but then the links are dropped in the beginning or middle of the chain and further development becomes impossible. Hence, probably, the reason why long-separated species are inter-sterile. Of course changes may occur so early as in the germs. Thus the chromosomes may not be of an equal number. When the germs are incompatible we get complete sterility. When the developmental tendencies are incompatible the embryo perishes at

[1] *The Penicuik Experiments*, p. xlvi. [2] See §§ 142–3.

[3] "With respect to sterility from the crossing of domestic races, I know of no well-ascertained cases with animals. This fact, seeing the great difference in structure between some breeds of pigeons, fowls, pigs, dogs, etc., is extraordinarily in contrast with the sterility of many closely-allied natural species when crossed." (*Animals and Plants*, vol. ii., p. 81.)

[4] *Origin of Species*, p. 384.

a more or less early stage.[1] But now arises the question, What originally caused two branches of the same race to separate and so cease to interbreed? Probably the initial cause was always geographical: one branch took to the mountain, the other to the valley; one to the forest, the other to the swamp; one to the island, the other to the continent; one to one side of a mountain-chain, the other to the opposite; one to one end of a continent, the other to the other end; and so forth. Doubtless in many cases much intercrossing occurred between the two diverging branches at first; but, as the divergence grew greater, the intercrossing became less. Suppose for instance a species inhabited the whole of a large tract of land which interposed no obstacle to free intercourse except distance. Then though there were free intercrossing between contiguous sections of the species, there would be none between distant sections. Two or more increasingly divergent types might arise, as we know they have arisen between continental races of mankind in hundreds of instances. In the course of geological time mutual sterility would supervene, though intermediate types, *did they survive,* might long furnish a chain of fertility uniting the most separated groups. If subsequent migrations mingled the two newly-established varieties, mutual disinclination, combined with comparative or complete infertility, would keep them from interbreeding.[2] Probably, therefore, mere lapse of time is sufficient in all cases to cause mutual infertility. Professor Romanes sought to attribute specific differentiation in some cases to accidental infertility; he supposed that certain individuals in a race might vary so as to be fertile amongst themselves, but, from physiological causes, infertile with the rest of the race. The sections, separated by function but not by space, would then evolve on diverging lines.[3] But "this seems putting the cart before the horse; we require to seek why infertility accompanies differentiation of type, and we are told that infertility may be the source of differentiation of type; but why then should it be correlated with advantageous rather than disadvantageous differences? Why are not the chance reproductive variations distributed between the two types?"[4]

[1] *Origin of Species*, pp. 387–8. Sterility is sometimes caused otherwise than by incompatibility in the germs and embryos. Thus a big dog could not easily mate with a little dog. But these causes of sterility do not concern us here.

[2] *Animals and Plants*, vol. ii., p. 80 *et seq.*

[3] *Darwin and After Darwin*, vol. iii.

[4] Pearson, *The Grammar of Science*, p. 417.

165. Darwin, following Pallas, maintained that "domestication eliminates the tendency to sterility which is general in species when crossed."[1] Doubtless he was right. When species are partially infertile, when their respective developmental tendencies run on nearly but not quite parallel lines, it is evidently probable that some sperms and ova may vary so that the parallelism is more complete in their cases than in those of others. They are therefore able to unite and develop into individuals, whereas the others are not. Crossing partially infertile varieties consists in nothing more than a process of selection of such sperms and ova. When varieties are crossed the offspring are said to resemble one or other parent type more often than when species are crossed.[2] In the latter case they are said more often to be intermediate in character. This is what might be expected. Exclusive inheritance, like blended or particulate inheritance, is possible when the two parents are not very widely separated by descent. When they are widely separated there is more often reversion to the common ancestral type, which in many respects appears intermediate between the two.

166. We have now finished the first section of our work. Before proceeding to the study of disease, which will form the next section, it will be useful to summarize in a convenient form the conclusions at which we have already arrived.

I. All the characters of living beings, mental or physical, are either *inborn* or *acquired*.

II. An inborn character is one which takes origin in the germ-plasm.

III. A *variation* is an inborn deviation from the parental type. It is therefore a new inborn character, and as such takes origin in the germ-plasm. It may be progressive or regressive in type.

IV. A progressive variation constitutes a deviation from the parental *and* ancestral type, which speaking generally is in the direction of increased magnitude and complexity. It results from the complete recapitulation of the parental development *plus* an addition.

V. A regressive variation constitutes a deviation from the parental *towards* the ancestral type. As a rule it is in the direction of diminished magnitude and complexity. It results from an incomplete recapitulation of the parental development. The only occasions when it is in the direction of increased magnitude and complexity are when it has been

[1] *Animals and Plants*, vol. ii., pp. 88–9.
[2] *Origin of Species*, p. 407.

preceded by reversed selection, or when it brings into activity some dormant trait.

VI. Among the most considerable and important of the inborn characters possessed by the higher animals are various *capabilities* of developing in certain fixed directions, that is of making various definite acquirements in response to fixed stimuli—usually those resulting from use. Man's body develops mainly in this way and his mind almost entirely so.

VII. Evolution is *adaptive* racial change. A theory of evolution seeks to account for such changes. Every theory of evolution is founded on a corresponding theory of heredity. A theory of heredity seeks to account for inborn likenesses and differences between parents and offspring. The only theory of evolution which is in accord with the facts of Nature is the theory of the Natural Selection of favourable variations. The only theory of heredity which is in accord with the doctrine of Natural Selection is the theory that the likenesses between parents and offspring are due to the recapitulation by each of the life-history of the species, and that variations arise "spontaneously."

VIII. The tendency to vary spontaneously has been evolved by Natural Selection. Like any other character it may be increased or diminished by the same agency, or by reversion to a more or less variable ancestral type. Whenever an hitherto stable environment changes, the tendency is increased. If the stringency of selection is increased, the tendency to vary is exalted by Natural Selection. If the stringency is diminished, the tendency is exalted by reversion. In both cases adaptation to the changing environment is hastened.

IX. An "acquirement" is a modification of an inborn character due, speaking generally, to the action of the environment on the soma. It is not necessarily a new character. Acquirements, therefore, differ *toto cælo* from variations.

X. Only inborn characters are transmissible to offspring.

XI. Evolution, therefore, proceeds solely on lines of inborn characters.

XII. Every individual in his development follows (with variations) in the footsteps of his predecessors.

XIII. The development of every individual is, therefore, a recapitulation (with inaccuracies, with omissions and additions) of the life-history of his race.

XIV. Since regressive variations tend to be of greater magnitude and prepotency than progressive variations, the tendency to regression is always greater than the tendency to progression. Consequently progressive evolution can occur only when selection is somewhat stringent, and this is especially the case when a character has been recently and quickly evolved. It follows that, whenever the stringency of selection is relaxed, a character which has undergone evolution tends to regress.

XV. Regressive variations are absolutely necessary to the existence of complex and variable types. During the development of every individual many useless variations arise. If these were transmitted and multiplied during subsequent generations, they would render the existence of the species increasingly difficult, and at length impossible. During the evolution of the species many parts become useless. If these were preserved they would render the development of the individual increasingly difficult, and at length impossible. But obviously indiscriminate regression would act as an obstacle to adaptation. Natural Selection, therefore, has evolved bi-parental reproduction, which regulates the tendency to reversion in a very beautiful, effective, and discriminating manner. It aids Natural Selection to preserve structures and variations when they are useful, and assists regression to eliminate them when they are useless. It is a selective source of regressive variations in offspring; never a cause of any sort of progressive variations.

XVI. Natural Selection seizing on progressive variations causes progressive evolution. Bi-parental reproduction seizing on regressive variations causes regressive evolution. The latter is a necessary accompaniment of the former. No doubt Natural Selection may sometimes seize on large and favourable regressive variations, but this can but seldom happen. Natural Selection as commonly understood, therefore, explains only half the facts of evolution.

XVII. When Natural Selection is stringent it overcomes the tendency to regression, and progressive evolution ensues. When it is less stringent it merely maintains the structure. When it is still less stringent, and even more when it has been completely abolished, the tendency to reversion comes into play and causes regressive evolution. Natural Selection may be compared to a sculptor who designs and roughly prepares a statue; reversion, to a colleague, more skilful mechanically, who chisels out its finer lines.

XVIII. Development is a dim, blurred, and inaccurate recapitulation of the life-history, because (1) many characters have disappeared or are disappearing through reversion, (2) because many characters have been rendered latent, and (3) because many characters which were originally absent have been interpolated in the course of the life-history.

XIX. The environment acting on, or through, the parent has little or no effect on offspring subsequently born. But some of the evidence on this point has yet to be considered. Acting in this way it has certainly no influence on racial change. Racial change, as shown by the close adaptation of every species to its environment, is due to evolution—progressive and regressive. Progressive evolution is due directly to Natural Selection, which acts only when the environment is injurious. Regressive evolution is due to reversion, which affects a race or character only when the environment is beneficial—that is when Natural Selection, as regards the race or character, is more or less in abeyance. In both cases the racial changes are of an adaptive nature exactly opposite to those which might be expected if the environment directly influenced the germ-plasm. Probably Natural Selection evolved this indifference of the germ-plasm to the direct influence of the environment very early in the history of life by selecting for survival the offspring of those individuals whose germ-plasm was most indifferent. Only thus could a race be rendered capable of evolving under deteriorating conditions. But progressive evolution is never complete or perfect, since, the moment it approaches perfection, selection ceases and reversion steps in. It is probable, therefore, that some offspring are still affected to some extent by powerful influences acting from the environment. But, since a change caused by the direct action of the environment can rarely be beneficial (*i. e.* adaptive), such individuals, or their descendants, must as a rule be eliminated sooner or later. As a consequence the course of evolution is not affected by the direct action of the environment.

XX. Evolution is due solely to Natural Selection. But besides the simple and direct elimination of the unfittest which Darwin described, species are adapted to their environments by other means more subtle and exact. Natural Selection has evolved in all plants and animals a tendency to vary which decreases or increases automatically accordingly as the adaptation to the environment is more or less exact. The materials for the work of Natural Selection are thus provided in greater or lesser abundance according to the needs, for the time being, of the species. Natural Selection has also evolved bi-parental reproduction which automatically eliminates useless variations and structures.

XXI. For some years past Darwin's theory of Natural

Selection has been regarded as under a cloud. We are told that it is inadequate to explain all the facts of evolution. The theory of recapitulation, also, has been under a cloud. We are told that it is opposed to the facts. But if the child recapitulates the development of his parent there can be no more doubt of the recapitulation of the life-history than there can be of the truth of a proposition which has been demonstrated mathematically. The inability of embryologists to trace the life-history in the development merely demonstrates the fact that there have been variations in the past, and that *these* have been recapitulated. The neglect of the doctrine of recapitulation by students of heredity has led directly to the prevailing disbelief in the adequacy of Natural Selection and to the formulation of a number of impossible morphological hypotheses. But the one truth is the complement of the other. If Nature be scrutinized by the aid of both we gain a wonderful clearness of vision. It is as if, standing on a hill and peering into a mist-hidden valley, we put on magic glasses. The mists vanish. Things erstwhile dim and mysterious become in a moment plain and consistent. The great scheme of Nature spreads like a map at our feet.

CHAPTER IX

NATURAL SELECTION AMONG CIVILIZED MEN

The alleged Cessation of Selection among civilized peoples—Civilized man is stringently selected—A problem for medical men—Inborn and acquired immunity—Doctrines of heredity as applied to problems of disease.

167. We are told by many biologists that man's evolution has ceased. He has become civilized, and has obtained a mastery over the forces of Nature so great that he is no longer stringently selected. Hunger and thirst seldom afflict him. He has made himself secure against cold. Wild beasts do not wait for him in the forest, nor do his enemies watch by the path. Wives are no longer fought for nor captured by the swift and strong. Neither courage nor intelligence reward men with long life and many offspring. The handicap of life is arranged with extravagant unfairness; the competitors do not all start from the scratch. Moreover, the weakling and the fool rear as numerous a progeny in the hovel and the workhouse as stronger and wiser men do in better homes.

168. In proof of their deductions these writers tell us that in size of body and brain the moderns were equalled or surpassed by some peoples who lived during the Stone Age, and were certainly surpassed in intellect by the Greeks who lived two thousand years ago. They tell us also that man's sight, hearing, and teeth have plainly degenerated, and invite us to believe that the rest of his faculties are on the same downward path.

169. Doubtless to a certain extent they are right. It is possible that some regression is occurring. But man, when judged by historical and even by palæolithic standards, is a very ancient animal. Most of his structures and faculties—his muscles, bones, and viscera, all his five senses—must have been derived with little essential change from pre-human ancestors. Even his specially human attributes, his erect

bearing, his hands, his large brain, and his intelligence, are of enormous antiquity. On the other hand, our civilized social organism which preserves the unfit, and our weapons of war which destroy the fit and unfit alike, are modern inventions. Not long ago prince and slave fought side-by-side and hand-to-hand in savage and continuous warfare. Even to-day a bent back, a defective hand, or a low grade of intelligence is a draw-back in the struggle for descendants.

170. It is unlikely, therefore, that there has been much regression as yet, at any rate as regards the characters on which biological and philosophical writers have fixed their attention. The time has been too short. Indeed there is evidence of some progression, for the armour of our not very remote ancestors must have belonged to quite small men, and it is said that modern Norwegians are able to introduce one hand only into the two-handed sword-hilts of their ancestors. Probably the defective sight, hearing, and teeth of civilized men are attributable largely to the effect of disuse on the individual. Boers and Australian Bushmen appear to have senses as keen as those of savages, and Negroes dwelling in the Northern States of the American Union are said to suffer as much from caries of the teeth and defective sight as white men. The intellectual achievements of the ancient Greeks were very splendid, but there are strong reasons to believe that their superiority was due more to the excellence of their mental training than to the greatness of their natural powers.

171. Other writers maintain that man is undergoing, not regression, but great and rapid evolution. They point, as proof, to his recent wonderful advance in civilization. But here the word evolution is not used in its biological sense. The existence of the steam-engine and the electric telegraph do not imply an intrinsic change in mind and body. They belong not to human evolution, but to what has been termed "evolution in the environment."

172. The truth appears to be that the gradual cessation of the old causes of elimination has caused or is causing human evolution on ancient lines to cease; but as yet the time has not been sufficient to permit appreciable regression. Just as hands and feet ceased to evolve hundreds of thousands of years ago, just as heart and lungs ceased to evolve at a period still more remote, so the evolution of size, strength, and intelligence has probably reached its term. In all these particulars the race is so well adapted to the environment that the amount of elimination which now obtains merely sustains, but does not add to, the antecedent evolution. But

if, in the future, as modern socialistic tendencies seem to indicate, the labourer receives not according to the result achieved, but according to the labour expended, if the weak in muscle and brain survive and have offspring equally with the strong, very slow regression will follow, no doubt; unless indeed, in an era more enlightened than our own, Artificial Selection takes up the task which Natural Selection has laid down, and, by a careful selection of parents, raises mankind to a pinnacle of strength and intelligence as yet undreamed of.

173. Nevertheless, though it may be true that Man's evolution on the ancestral lines is nearing its term, it is not true that he has ceased to evolve altogether. The direction of his evolution has changed, but the speed of it has not slackened. On the contrary, it is probably greater to-day than at any former period of his life-history. Biologists, who are occupied chiefly with visible physical characters or with mental traits, have not noted this change of direction; but it is none the less real. The study of it lies within the special province of the medical man.

174. If human evolution has ceased, if Natural Selection no longer eliminates the unfit among civilized peoples, it is evident that most people must die of old age, or else that the elimination is not selective. But, as a fact, millions of people perish, even in England which is highly civilized, before or during the child-bearing age, nearly all of whom are eliminated because they are constitutionally incapable of surviving under the ordinary conditions of the environment in which they find themselves.

175. If we wish to ascertain the direction in which any species is evolving, it is a good plan to note which members of it survive and which perish. We shall thus, by observing the difference in qualities between the fit and unfit, be able to discover which traits favour survival, and, therefore, which traits are undergoing evolution by the accumulation of inborn variations. As a rule, it is impossible to apply this method to plants and animals "in a state of nature." We do not know enough about them. A dead bird or insect, or a withered shrub in the thicket does not give us sufficient information. It may have perished through the agency of any one of a hundred different causes, to which an unascertainable deficiency in any one of a hundred different qualities may have exposed it. Or its death may have been due to pure mischance. The great majority of plants and animals are destroyed before reaching maturity. Only the fit survive, and, even of the fit, only a small minority. The adaptation

of wild species to their environments is so close, the number of the survivors compared with the total number of the offspring is so small, that probably the great majority of deaths among them are entirely "haphazard." It was this fact that caused Weismann to declare that no man had seen Natural Selection at work, and the late Lord Salisbury, incited thereto by theological preconceptions, to insist that Natural Selection was never at work.[1] It is this that has moved several distinguished men of science to undertake prolonged and laborious experiments to prove that Natural Selection is ever at work.[2]

176. But we know man much better than any other animal or plant. The peculiarities of every human being are, of necessity, noted before his death by some of his contemporaries. His offspring and descendants are also under close observation. For some thousands of years the chief causes of mortality among his races have been studied with anxious attention. During recent years very precise scientific methods have been adopted. An army of trained and experienced medical workers has delved in almost every nook and cranny of the world, and in all civilized countries a government department has tabulated the results of their labours. We now know precisely the causes from which men die; we know approximately the number of deaths due to each cause, and the average ages at which men die from this or that cause. We have therefore ample materials on which to found a judgment as to the effects produced on descendants, and therefore on the race, by these precisely ascertained and tabulated causes of elimination.

177. *In the great majority of instances men, especially civilized men, perish of disease.* Haphazard deaths, comparatively speaking, are very rare. Moreover, where, as in all civilized communities, men live in dense and settled masses, and so can take disease from one another, the great majority of deaths are due to zymotic diseases—to diseases caused by minute living beings belonging to various plant and animal species.

A mass of sorely neglected material for the study of heredity has been accumulated by medical workers, which, for volume and detailed accuracy, transcends by far anything within the reach of zoologists and botanists. The medical man spends his life in the study of parent and descendant.

[1] *Presidential Address*, British Association, 1894.

[2] For example, Professor Weldon's experiments on crabs, and Professor Poulton's experiments on chrysalises.

The surgeon sees mutilations every day, both those due to accident and his own knife and those which occur in many successive generations, such as pierced ears. He is constantly employed in remedying great variations, progressive and regressive, as tumours, cleft palates, and hernias. The physician notes the effects of diet and of various conditions of life. He watches maladies which affect only part of the body, as many skin complaints; or which, from a focus, flood the system with virulent toxins, as diphtheria and tetanus; or of which the microbes as well as the toxins invade every part of the body, as syphilis. Some of these maladies are short and sharp in action, as chicken-pox and influenza. In others the period of suffering may be very prolonged, as tuberculosis and leprosy. Many diseases, which have afflicted certain races for hundreds, perhaps thousands of generations, have only recently been introduced to other races. Biologists have performed many experiments on animals and plants; but no experiments conducted by man can rival in duration, magnitude, scope, and stringency these vast experiments conducted by Nature.

178. Speaking practically all this opulent field of labour has been allowed to lie fallow. The problems of heredity and evolution have not greatly interested the mass of medical men, and disease lies outside the spheres of botanists and zoologists. No doubt there has been much mention of heredity by medical men, and much mention of disease by naturalists; but medical men have not as a rule bestowed that close attention on heredity which they have devoted to disease, and naturalists have certainly not applied to disease those exact methods of research which they have applied to other problems of heredity. The two great sections of biological workers, medical men and naturalists, have lived, as it were, in separate compartments, and, like the adherents of different religious systems, have abjured the works of one another. Yet in this great field of labour might have been found the answers to more than one important problem, the means of settling more than one long-enduring controversy. If acquired characters are transmissible, no matter how "faintly and fitfully," the traits impressed on many successive generations by disease should become observable in the race. If ever external influences affect the germ-plasm, the descendants of those races which have been long affected by such diseases as bathe the germ-cells with toxins or invade them with micro-organisms should show the trace. If ever Natural Selection has been at work we should see its processes de-

monstrated by the familiar causes of death among the living beings we know best. Moreover, apart from its practical and scientific importance, the study of heredity in connection with diseases is of incalculable interest from political, social, and historical standpoints. If at this stage I declared that disease has so influenced the evolution of certain races of mankind that they alone are capable of undergoing civilization, and therefore that nearly half the races of the world are doomed to early extinction, no doubt I shall be thought guilty of extravagance. The impression will be deepened if I add that disease has so dealt with one race, recently of insignificant numbers, that its future world-predominance is assured. Nevertheless all this is true and capable of clear demonstration.

179. When a zymotic disease, such as measles, is very prevalent in any area, experience teaches that the inhabitants may be divided, roughly, into three categories. There are those who, under the circumstances, are totally immune to the disease;[1] there are those who take the disease, but are sufficiently resistant to recover; and lastly, there are those who take it and die. The three categories, however, shade into one another. In the first are individuals who, though immune under ordinary conditions of health and environment, may take the disease, and even perish of it, under worse conditions; in the second are people who may be immune under exceptionally good conditions, but who may perish under exceptionally bad conditions; while in the third are individuals who under good conditions may survive, and even not take the disease at all.

180. It is universally admitted that men differ greatly in their susceptibility to infection and in their powers of subsequent resistance. If, then, a lethal disease be very prevalent it is evident that it presents a very stringent form of Natural Selection. In England, for example, hardly any one escapes measles, whooping-cough, or tuberculosis unless he be immune, or death unless he be resistant. In other parts of the world no one weak against malaria, typhoid fever, or dysentery is able to survive. Whenever any form of selection is stringent, it is accompanied by an evolution of those

[1] Inborn immunity is probably never absolute, but it is an error to state, as is sometimes done, that there is no such thing as absolute immunity. Acquired immunity is absolute, at any rate for some time; otherwise there could be no recovery from a general infection. Worse conditions could not well be produced than occur at the height of such an infection. Yet the sufferer recovers. Such recovery, therefore, implies absolute immunity.

qualities which enable the survivors to escape. It follows, in the case of disease, that selection should cause an evolution of an inborn power of *resisting* infection, or of an inborn power of *recovering* from infection. The two qualities are quite distinct, and are generally useful against quite distinct diseases. Thus only inborn immunity, inborn power of *resisting* infection, is of avail against tuberculosis. As is well known, experience of and recovery from tuberculosis does not confer increased resisting power. In other words, when a person, who has suffered and recovered from tuberculosis, has increased resisting power, we have every reason to believe that his added security is due solely to improved conditions of general health and surroundings, not to any benefit conferred by the disease. The case is quite different as regards some other maladies. Thus almost every one is capable of being infected by measles—that is, scarcely any one has inborn immunity against it. But most people are capable of recovering from it after a short illness of pretty definite length. They *acquire* an immunity, which is generally persistent, even under the worst conditions, throughout life. Indeed, were the acquired immunity, which arises during recovery from measles, whooping-cough, and the like, not more or less permanent, life would be difficult or impossible in all countries where these diseases are prevalent. In the case of some diseases, then, illness and recovery confer a distinct benefit; that is to say, an immunity which is acquired through the existence of an inborn power of making this acquirement, which may be enduring, as against measles or chicken-pox, or more or less transient, as against diphtheria or common cold, and which, as we know, is protective only against the particular disease which causes its development in the individual.[1]

181. Now, since tuberculosis, as a rule, weeds out those who cannot *resist* infection by it, whereas measles, as a rule, weeds out those who cannot *recover* from infection, it is evident, if Natural Selection acts at all, that these diseases, which are types of many others, should cause the evolution of entirely

[1] It must not be supposed, however, that there is a hard-and-fast line of demarcation between the diseases against which immunity may be acquired, and those against which the only kind of immunity possible is the inborn. Some people seem congenitally immune to measles. Many people appear congenitally immune to scarlatina; but many others, though susceptible to infection, are capable of acquiring immunity against it. The fact remains, however, that the two kinds of immunity are quite distinct, and that, as a general rule, they afford protection against distinct diseases.

different qualities. Tuberculosis should cause an evolution of what we know as inborn immunity, while measles should cause an evolution of something quite distinct—the inborn *power* of *acquiring* immunity. Moreover, since immunity against any one disease does not imply immunity against any other, we should find that evolution against any one malady does not imply evolution against any other.

182. On the other hand, if acquired characters are transmissible, we should have different and exceedingly curious results. Tuberculosis tends always to injure and weaken the individual afflicted by it. Seemingly it never confers any sort of benefit. Consequently, if acquirements are inherited, a race afflicted by tuberculosis should, through the accumulation of injuries during generations, become more and more injured, feeble, and degenerate, more and more unfit for existence, till at last it becomes extinct. But measles generally confers a distinct benefit on the individual; he acquires immunity. If this were transmitted it would, of course, appear as inborn immunity in the next generation. If, then, acquirements are transmissible, no matter how "faintly and fitfully," a race afflicted by measles should become in time quite immune to it, quite incapable of being infected by it.

183. Lastly, if acquired characters are not transmissible, but if influences from the environment tend, with more or less readiness, to affect the germ-plasm, we should again get definite results in the case of each disease, though in each instance it would not be possible to forecast, on logical grounds, the nature of the changes in the race. Presumably they would always be in the direction of degeneracy. Certainly they would be in this direction in the case of such diseases as tuberculosis, in which the influences are always harmful. Even in the case of measles and kindred disorders the changes should also probably be in the direction of degeneracy, since, for a period at least, the germ-plasm is subjected to acute poisoning.

184. It is evident, therefore, that disease affords ideal material for testing the truth of the three principal doctrines of heredity. All these doctrines suppose that offspring tend, with variations, to reproduce the inborn characters of their parents. But they differ in the way in which they account for the variations. The first doctrine, the Neo-Darwinian, supposes that practically all variations arise "spontaneously"; the second, the Lamarckian, supposes that some variations at least are due to the transmission of acquirements; the

third, an unnamed doctrine, supposes that variations are due to influences from the environment acting on the germ-plasm. Whichever doctrine be true, it is plain that a race long afflicted by any prevalent and lethal or serious disease must undergo change. All the races of mankind sprang from a common stock, as is proved by the fact that they are able to interbreed. They were, therefore, once alike. By comparing races which have been afflicted for hundreds or thousands of generations by a given disease with races which have had little or no experience of it, we should be able to ascertain the kind of racial change caused by the disease, and so be able to judge of the correctness of one or other theory. Thus if long experience of tuberculosis has rendered a race highly resistant, we must suppose that variations arise "spontaneously." But if it renders the race feeble and degenerate, or less resistant, it is plain we must reject the Neo-Darwinian theory and accept one of the other two.

185. The doctrine of Natural Selection has rarely been applied by medical men to the study of disease. The Lamarckian doctrine has been, and is still, very widely held. The doctrine that parental disease acting directly on the germ-plasm tends to render offspring subsequently born degenerate is practically universal,[1] not only among medical men, but even amongst biologists, who in this particular have naturally accepted medical opinion. Enormous confusion has arisen in medical literature by the loose use of the terms "acquired" and "congenital." Before attempting to analyze and estimate the racial effects of disease, it is necessary, therefore, to gather ideas as clear as possible respecting the exact nature of certain effects of disease on the individual, especially the nature of that most important effect of all—acquired immunity.

[1] Witness the prevalent notion of the causation of gout in offspring, and the equally prevalent belief that races have grown resistant to disease through the transmission of acquirements.

CHAPTER X

ACQUIRED IMMUNITY

Theories of immunity—The kind of diseases against which immunity may be acquired—Pasteur's theory—Chauveau's theory—The theory of chemical neutralization—The theory of habituation—Rabies—Small-pox—Anthrax—Snake-venom—The rationale of acquired immunity—Syphilis.

186. THE literature of immunity is so large, and still increases with such bewildering swiftness, that it is not easy for any one outside the ranks of professional bacteriologists to keep in touch with it. Owing, doubtless, to the novelty, magnitude, and difficulty of the subject, the multitude of the workers, and the keenness of their competition for success and fame, observations and deductions, which later research proves erroneous, are published with unusual frequency in this branch of science. The task of the learner, however willing, is thereby rendered doubly difficult. I approach this part of my subject, therefore, with the greatest diffidence. An amazing number of theories concerning the nature of acquired immunity have been propounded, most of which have already crumbled under the assaults of facts subsequently discovered. One or two recent morphological or chemical hypotheses depend on surmises which cannot be tested by an appeal to ascertained facts, and, therefore, like theories of ancestral units, are incapable of direct proof or disproof.

187. Presumably acquired immunity against a disease, since it is a beneficial development arising as a regular consequence of experience, is comparable to, is of the same nature as, other acquirements which arise in the individual as a regular result of use. In other words, presumably it arises because and when the organism " gets used " to that particular disease. Presumably also the inborn power of acquiring

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immunity under the stimulus of disease has been evolved in the species by the same means as the power of making other "use-acquirements" has been evolved—for instance, the power that a muscle possesses of getting used to fatigue, or the power which tendons, glands, and other structures possess of developing in response to the stimulus of increased use. In all these instances the organism (or given parts of it) reacts in a definite and highly beneficial way to given stimuli. But most well-known theories assign an almost magical origin to immunity. We are expected to believe that it arises through processes which have no known analogy in nature. It will be instructive to note a few of these theories, and then make an attempt to bring this particular class of acquirements into line with other adaptive acquirements. Such an attempt, however great, through lack of knowledge or discernment, the ultimate failure, has at any rate the merit of seeking to unify our knowledge.

188. Some zymotic diseases, as compared to others, are short and sharp. The sufferer perishes or recovers from the actual disease within well-defined time-limits, though he may suffer from certain after-effects—the sequelæ—for a longer period. Before he falls ill of any of these diseases he is free from the specific pathogenetic micro-organisms of it, as is obvious from the fact that he does not infect his fellows. During his illness he swarms with them, since he is then infective. During or after recovery he rids himself of his enemies, since he is no longer infective. Something banishes or destroys the parasites in his system. Recovery implies, in fact, their banishment. A profound change befalls the sufferer. From being a soil on which parasites flourish, his body becomes poisonous to them. At the least it becomes a soil in which they cannot exist easily. *He acquires immunity.* Other diseases run a prolonged indefinite course. Immunity cannot be acquired against them.

189. Now it is very noteworthy that it is only against diseases the micro-organisms of which produce more or less powerful toxins—as judged by the systemic effects—that immunity can be acquired. When the toxins are feeble or non-existent—*e.g.* in tuberculosis and leprosy—when the onset of the disease is unmarked by symptoms of poisoning, when the pathogenetic organisms, instead of engaging at a long range, enter at the outset into what may be termed an actual physical struggle with the phagocytes, which, undeterred by toxins, at once attack the disease germs, and taking them into their substance attempt to destroy them, then immunity

cannot be acquired. Evidently, therefore, toxins and immunity are related, more or less immediately as cause and effect.[1] The quickness and completeness with which immunity may be produced against any disease seems, generally speaking, in direct relation to the quickness with which the toxins are produced and their degree of virulence. Thus immunity is quickly acquired against such diseases as measles and small-pox, but more slowly against enteric fever or syphilis. Malaria and relapsing fever are apparent exceptions to this rule, for though their toxins are powerful and quickly produced, yet these diseases are of long duration. It is possible, however, that the periods of intermission which distinguish these maladies are really periods of acquired immunity—an immunity which is lapsed very soon after it is acquired. The parasites are then absent from the blood, or occur in a highly-resistant but non-virulent form.[2] The duration of immunity bears some relation to the virulence, or at any rate to the abundance of the toxins, for a severe attack of small-pox protects for a longer time than an attack of modified small-pox (vaccinia). But this, while it may be true of attacks of the same disease, is not true of attacks of different diseases. Thus, chicken-pox, a comparatively mild disease, usually confers lasting immunity, while diphtheria, a much severer disease, does not.

190. What is the nature of acquired immunity? What precisely are the effects of the change which a man under-

[1] If the above be correct, the antitoxic treatment of tuberculosis attempted by Koch and others—in effect an attempt to procure acquired immunity—is, from the nature of the case, doomed to failure. Apparently the bacillus tuberculosis produces no powerful toxins against which immunity may be acquired. An individual may suffer for any number of years from a pure tuberculosis, as of joints and glands, without becoming in the least immune. A toxic intercellular substance has been extracted from the bacillus which is useful for diagnostic purposes, but, evidently, it is of a nature quite different from the true toxins which are secreted into the surrounding medium by such micro-organisms as those of diphtheria and tetanus. For the same reason an antitoxic treatment of leprosy and cancer—supposing it to have a microbic origin, which is extremely doubtful—should be impossible.

[2] In malaria the period of intermission is produced not so much by the absence of the parasites as by the absence of the toxins. The reader can hardly have realized as yet the part that Natural Selection has played in the evolution of these low forms; but it is not impossible that the non-virulent stage—the period of the formation of resistant spores—is entered upon by the protozoon as a means of protecting itself against phagocytes which have acquired the temporary power of tolerating the toxins and attacking the microbes. A more permanent immunity is certainly very slowly acquired.

goes when, after being susceptible to disease, he becomes, through illness and recovery, highly resistant to it? Pasteur supposed that the parasites of each disease against which immunity may be acquired find, every species of them, some special pabulum in the body on which they subsist, but on which no other species can subsist, and that when this special pabulum is exhausted they perish from starvation. In diseases against which acquired immunity is, as a rule, permanent—*e. g.* small-pox—this pabulum, he supposed, is, as a rule, not renewed; but when immunity is not permanent—*e. g.* in diphtheria—it is renewed, whereby the individual again becomes susceptible. Chauveau, on the other hand, supposed that acquired immunity arises because the waste products of the microbes are inimical to their own existence, just as alcohol, for instance, is inimical to the yeast microbes that produce it from solutions of sugar; and, therefore, that when the waste products reach a certain percentage in the fluids of the infected person, the microbes perish, as yeast perishes when alcohol reaches a certain percentage in a fermenting fluid. In diseases in which acquired immunity is permanent he supposed that the waste products are bottled up within the infected person, but that they are eliminated after a time in diseases against which acquired immunity is not permanent. Both these theories are negatived by the fact that the parasites of certain diseases—*e. g.* anthrax—are able to flourish in blood drawn from animals that have acquired immunity against them.

191. Pasteur's theory is, probably, abandoned by every one. Chauveau's theory is still supposed by some bacteriologists to offer a partial explanation of acquired immunity. But probably even this modified belief should be abandoned. Waste products are much less inimical to the organisms which produce, and are therefore inured to them, than they are to the cells of the body. Thus alcohol may attain a percentage of fourteen in a fermenting fluid, but no man could exist if alcohol formed anything like that proportion of his total volume. It is only reasonable to suppose that his resisting powers are lowered by the waste products of pathogenetic germs more than the vital powers of the parasites themselves.

192. A doctrine widely held, even at the present day, is to the effect that acquired immunity is due to the production within the infected person of substances which chemically antagonize or otherwise neutralize the toxins, and which, for that reason, have been termed antitoxins. By one set of

authorities antitoxins are supposed to be elaborated by the infected person, by another set they are supposed to be produced by the parasites. Many facts have been thought to furnish evidence of the truth of the neutralization theory. Some parasites, the diphtheria bacilli, for example, can be cultivated outside the body in broth or other nutrient media, which then becomes intensely poisonous from the presence of toxins. A horse can be gradually habituated to having large quantities of this poisoned broth injected into him. Thereafter his serum possesses remarkable properties. It is no longer poisonous, at any rate it is not poisonous if withdrawn from the horse after a sufficient interval of time. On the contrary, it possesses curative powers. If mixed with a given proportion of the toxin it renders the latter harmless. If the toxin and the antitoxin are injected simultaneously into different parts of an animal, the same result follows, though in this case somewhat larger doses of antitoxin are needed. Even when injected into an animal already diseased, and in which, therefore, the toxins are already present, it greatly tends to promote recovery. On this latter discovery is founded the celebrated serum treatment of diphtheria which has saved so many lives.

193. The doctrine of chemical neutralization has been very fruitful from a practical point of view. The men who formulated it and worked under its guidance are those who have built up our present splendid system of serum therapy, and who have thus robbed some death-dealing complaints of half their terrors. But a working hypothesis, untrue in itself, may occasionally lead to important practical results. There are apparently insuperable objections to the theory of neutralization.

194. Antitoxins have been detected in the blood of an animal a few minutes after the injection of toxins. Evidently they are specific substances, since immunity conferred by them against one disease does not protect against any other. It is improbable in the last degree that the animal body is a species of magic bottle, instantly capable of producing at need highly complex chemical substances, the antitoxins, which exactly neutralize other equally complex substances, the toxins, the right antitoxin at the right time; or that each toxin contains, or is capable of being converted into, substances chemically antagonistic to itself, and to no other toxin. If this happens it is a fact unique in nature. Nothing else like it is known to occur. It is possible perhaps to formulate an hypothesis which is at once more probable and more in accordance with the rest of our experience.

195. The various vegetable poisons are in a real sense toxins. Like the microbic poisons they protect the organisms producing them from other organisms to which they are liable to fall a prey. A tobacco-smoker or an opium-eater, if he begins with small doses, is able to inure himself to immensely larger doses—to doses great enough to be fatal many times over to a beginner. At any rate, though sequelæ occur, as in the case of disease, from smoking tobacco and opium, he is able to inure himself against the immediate effects of the poison. No one will venture to suggest that he owes his immunity to the formation of antitoxins which chemically neutralize nicotine and opium. The case of arsenic, a mineral poison, is similar. In each instance the individual simply becomes habituated to the poison. It is not necessary to explain, indeed it is beyond our power to explain, how this habituation is brought about. We know only that it does occur, and we have no more reason to suppose that it is due to the formation of a substance chemically antagonistic to the poison than we have to suppose that the habituation of the muscles of a trained athlete is due to the formation of a substance chemically antagonistic to fatigue. We can only say, in a very vague way, that it is due to vital changes in the cells, that it is part of that general capacity for undergoing beneficial change by means of which the higher animals adapt themselves to changes of circumstances. Now we have incontrovertible evidence that acquired immunity to diseases is due, to some extent at least, to a similar habituation to the toxins. If we inject doses of toxin into a horse at a certain very rapid rate, we are able to render his blood very poisonous to other animals. At the same time he retains his own health. Clearly, then, in this case, since the toxins are not neutralized, he owes his immunity to habituation.

196. However, it may be argued: "All this does not impugn the doctrine of neutralization. Habituation is possibly part of the phenomenon. It is true that an individual may become habituated to opium, nicotine, arsenic, or to a toxin, by the use of gradually increased doses. But the question of antitoxin stands on a different plane. If we mix a small dose of opium or nicotine with a large dose, the latter is not thereby rendered less poisonous. We cannot cure a person poisoned by opium or nicotine by giving him additional small doses. But, if we mix sufficient antitoxin with toxin, we render it harmless, and a dose of antitoxin tends to cure a person suffering from the corresponding toxins. Clearly an antitoxin is not a small dose of a toxin, but quite a different thing."

197. But let us go a little deeper. Pasteur killed rabbits suffering from rabies and dried their spinal cords. His treatment for the cure of an infected person began by the injection into him of an emulsion prepared from a cord which had been dried for fourteen or fifteen days. This cord was quite incapable of causing disease; presumably the pathogenetic organisms had perished. The treatment was continued by injections from fresher and fresher cords, and ended by the injection of material from a cord that was absolutely fresh and intensely virulent. By this method he enabled many individuals who had been infected and who would otherwise have perished to acquire immunity. It is clear, since the antitoxin is procurable from old and dried cords, not from those which are absolutely fresh and virulent, that the immunizing substance is here produced in the dead and drying cords in the presence of dead or dying micro-organisms, not in the living and virulently infected animals from which the cords are taken. Moreover, did the living infected animal produce the antitoxin it would survive, whereas it invariably perishes. In this case then the antitoxin is not produced by the vital action of the cells of the rabbit, but arises in the absence of their vital action in a dead thing. It is wildly improbable that the pathogenetic organisms produce toxins when in health, and substances which chemically neutralize the toxins when dying or dead. No doubt chemical changes do occur in a cord, but it would be equally strange if these resulted in the formation of substances antagonistic to this particular toxin and no other.

198. Again, the parasites of some diseases are capable of infecting more than one species of animal. Under the changed conditions they generally, if not always, vary the virulence of their toxins. Thus rabies in dogs is a very deadly disease. If passed through a series of rabbits its severity is still more exalted, and it is even more quickly fatal. If passed through a series of monkeys it becomes so mild as to be no longer fatal. Indeed Pasteur originally procured immunity against rabies by inoculating dogs from a series of monkeys and rabbits, beginning with the monkey in which it was weakest, and ending with the rabbit in which it was strongest. Human small-pox when passed through the calf becomes cow-pox, and when returned to man as vaccinia it protects against the deadly variety of the disease. It is incredible that, while unmodified rabies and small-pox produce toxins which cause death, modified rabies and small-pox produce, or cause to be produced, substances which are chemically

antagonistic to the toxins, and so bring about immunity. The theory of chemical neutralization is plainly at fault.

199. Another of Pasteur's experiments may afford some light. He submitted the bacilli of anthrax to an abnormal degree of heat, and found that they generally lost their virulence. Ordinary anthrax bacilli are very fatal to sheep, but Pasteur made the highly important discovery that if the sheep were inoculated first with bacilli of little virulence, next with those of greater virulence, and lastly with those of great virulence, the animals could be rendered immune to bacilli of the greatest virulence. This result could be obtained only by observing the steps of the process; an immediate passage from very weak to very virulent bacilli resulted in the death of the sheep. Here again the theory of chemical neutralization breaks down entirely. The anthrax bacilli are introduced alone or with an insignificant quantity of toxin. The antitoxins, whatever they may be, are elaborated within the sheep, and it is difficult to understand, if they are substances chemically antagonistic to the toxins, why they should be elaborated only when the animal has undergone Pasteur's treatment, and not at other times. The truth appears to be, that, just as heating the bacilli of anthrax progressively weakens their toxins, so drying the cords of infected rabbits weakens the toxins contained in the cords. It is not that the toxins are diminished in quantity, but that they are altered in quality. Habituation to a weaker toxin places the individual in a position of advantage, from which he is able to become habituated to a stronger toxin more easily than he could otherwise have done. Progressive treatment enables him to resist the strongest toxins and recover from a disease which, without it, would have been inevitably fatal.

200. Snake-venom (a toxin) may be swallowed in enormous quantities, not only without ill effects, but with the remarkable result that the individual is rendered immune to venom injected under the skin. The Bushmen of South Africa make a practice of eating the poison-glands of snakes, and are thus rendered immune to the bite.[1] In this case the swallowed venom enters the blood in a digested condition, and thus supplies the stepping-stones. It has been found, that if venom be altered by artificial means outside the body, the antivenene when injected under the skin of a person suffering from snake-bite may actually effect his recovery.

201. *Now, the presumption is that all the so-called antitoxins are weakened toxins.* A phagocyte does not kill a micro-

[1] Fraser, *Address at the Royal Institution*, March 30, 1896.

organism by tearing it to pieces or crushing it. It takes the parasite into its own substance and digests it. Digestion implies a digestive substance. During recovery from some diseases (*e.g.* diphtheria and pneumonia the parasites begin to perish and disintegrate even before the phagocytes reach them. Something kills them—presumably the same, or a similar digestive substance as kills the parasites which the phagocytes actually ingest. This substance is secreted by the phagocytes and the other cells concerned just as pepsin is secreted by the stomach-cells. But pepsin, which leaves uninjured the cells of the stomach, digests not only snake-venom, but also the poison-glands which produce the venom. In like manner it is probable that the digestive substances, enzymes, secreted by the phagocytes, cause the gradual weakening and ultimate destruction of the toxins as well as the gradual disintegration of the parasites. It follows, if this view be true, that when an animal is recovering from disease in which toxins are abundant, or when repeated doses of toxin are injected into him, *there must be present in his serum—when drawn off—first, the digestive substances, and, secondly, toxins in all stages of digestion and disintegration.*

202. Pasteur's treatment of rabies proves that a weakened toxin (*i. e.* antitoxin) may enable an animal to recover, may furnish a stepping-stone towards immunity, even when the animal is already diseased; that is, even when virulent toxins are present in him. Here, then, is the explanation of the fact that while diphtheria antitoxin may enable a man to recover when poisoned by the virulent toxins of the disease, a small dose of opium or arsenic does not help a man when poisoned by a large dose. A small dose of arsenic or opium merely adds to the effect of a large dose. It does not differ in kind from the latter. The two doses are merely different amounts of the same thing. But weaker toxins differ somewhat in kind from stronger toxins, and unless the latter are already so concentrated as to have destroyed the vitality of the cells (*e. g.* in the later stages of fatal disease), the antitoxins serve as stepping-stones towards habituation and recovery.

203. To sum up,—acquired immunity to any disease is due to an habituation to the toxins of that disease. This result is brought about by the digestion of the toxins, so that there are present in the animal's blood toxins in all stages of attenuation, from those newly produced by the parasites and extremely virulent, to those produced in the beginning of the disease, and now in a state of great enfeeblement.

Up that graduated scale the cells of the animal react till complete immunity is attained. The serum treatment artificially supplies digestive substances, and, what is even more important, a scale of attenuated toxins.

204. Various other considerations lend strength to the belief that acquired immunity against any disease depends essentially on a gradual habituation to its toxins, on an increased power of *physiological resistance*, as a result of which cells are enabled to perform their functions in spite of the presence of toxins (which indeed do then but stimulate the cells especially concerned—those which produce the enzymes), not on the production of chemically antagonistic substances, whether chemical (in the narrow sense) or digestive. Thus it was found by Buckner that a mixture of toxin and antitoxin—*e. g.* that of tetanus—in a proportion harmless to an animal of one susceptible species—*e. g.* a mouse—is still toxic to a weaker animal of the same species or to an animal of a more susceptible species—*e.g.* guinea-pig—which could not be the case did the antitoxin contain substances which neutralized the toxin. Whereas if immunity depends immediately on a physiological, not a chemical reaction, even an attenuated toxin may be fatal to a very susceptible animal; an inference corroborated by the fact that a non-susceptible animal may be rendered susceptible by influences—*e. g.* cold and starvation—which lower the vitality. Again, there is a sharp distinction between the "active" immunity which is procured by experience of actual disease, and "passive" immunity which results from the injection of antitoxic sera. The former is enduring, the latter is fleeting. If the sera contain substances which chemically neutralize the toxins it is impossible to explain the difference; for the diseased person can do no more than produce these substances himself. But, if acquired immunity be a vital reaction, the difference is easily explained on the hypothesis that the attenuated toxins in the sera are so mild that they cannot cause a permanent reaction, though they do cause a temporary reaction which enables the person to resist immediate infection. The case is exactly parallelled by the comparatively fleeting immunity to small-pox conferred by one vaccination mark, and by the fleeting immunity to yellow fever which residents in countries where it is prevalent acquire without actual illness—presumably because they are frequently infected by small doses of parasites. Yet again, Roux found it possible to obtain from a prepared horse two lots of sera of equal antitoxic value, even though no intermediate injection of

toxin had been made. He argued thence that antitoxin must be a substance produced by the horse, and not merely an altered toxin, for were it the latter the second lot of serum, as containing less antitoxin, should be weaker than the first. But as a fact his observations tell against the theory of chemical neutralization, not against that of a vital reaction. Definite quantities of chemicals are required for the neutralization of other chemicals. But for the purpose of a vital reaction the quality of the reagent is, within limits, of more importance that the quantity—as in the case just cited of antitoxin from a single vaccination mark, which confers complete, though not lasting, immunity.

204 (*a*). The theory of immunity at present most in favour is Ehrlich's "side-chain" hypothesis, a chemico-physiological attempt to explain the facts. Ehrlich supposes that the cells of the body have certain "outlying" groups of molecules, which he terms side-chains or receptors, and which are capable of union with various substances which may be present in the blood; for example, food or toxin molecules. By means of these side-chains, therefore, cells are nourished or on occasion poisoned. If a toxin be very abundant, in the circulation, its molecules, seizing on many side-chains, may become part of the cell and so cause its death. If less abundant it causes the death of some of the side-chains merely. Each of these, forming a compound with a now inert toxin molecule, is shed from the cell and undergoes disintegration. This is the chemical part of the theory. The physiological part is that toxins, if they do not destroy the cells, stimulate them to produce many side-chains, which are shed in an active condition and serve to neutralize the toxins when free in the lymph. For this reason the serum of an individual who has had experience of the toxins possesses antitoxic powers. When immunity is inborn it is supposed that the cells possess no side-chains capable of uniting with the toxins. They are therefore uninjured, a wonderful difference thus existing between species of animals, and, since some individuals possess inborn immunity to diseases to which other individuals of the same species are susceptible, even between individuals of the same race.

204 (*b*). It is evident, if Ehrlich's hypothesis be correct, that it does not controvert the explanation upheld by the present writer. It merely attempts to go much deeper. For digestion by enzymes it substitutes neutralization with subsequent digestion. It explains "habituation" by supposing that the cells acquire the power of producing side-chains

in greater abundance. But the central mystery as to how this power arises remains unexplained. The hypothesis is founded, unfortunately, on data which cannot be verified, and it is opposed to the facts of evolution—to the known parsimony of Nature. The primary function of the side-chains is supposed to be nutrition. But in a man there must be as many varieties of these side-chains as there are separate diseases against which he is able to acquire immunity; for immunity to any one disease does not protect against any other. Even races which are susceptible against this or that disease, but which have had no previous experience of it, must possess the whole budget of side-chains, since all races are capable of acquiring immunity against all diseases in which toxins are abundant. Moreover antitoxin may be obtained from the dead and drying cord of a rabbit which would infallibly have perished of rabies—that is, though the side-chains are not produced in sufficient abundance to neutralize the toxins in the living animal, and though they cannot, of course, be produced by the dead cells of the drying cord, yet antitoxin is present in abundance. Clearly the hypothesis breaks down in this instance. It is possible to understand the evolution of a general power of resisting or recovering from infection in the higher animals, surrounded as these are by unicellular beings which would otherwise flourish within them. It is easy to understand in the case of races exposed to particular diseases how this power may be accentuated in particular directions by Natural Selection. But it is not possible to understand how a race which has not had previous experience of measles, for instance, should have evolved side-chains capable of neutralizing the toxins of that disease. It is improbable in the last degree that side-chains evolved primarily for nutritive functions should so exactly hit off all the toxins on earth.

204 (*c*). Contrast Ehrlich's hypothesis with the simple explanation of immunity set forth in the present work. The latter makes no assumptions except such as can be verified, or such as analogy renders extremely probable. It is in accord with the facts of evolution. It supposes that inborn *racial* immunity is not due as a rule to any special resisting power on the part of the attacked species, but to lack of adaptation to that particular environment on the part of the attacking micro-organism; that the inborn immunity occasionally displayed by certain individuals of a susceptible race (*e. g.* man in the case of scarlet fever) is due to a resisting power so high that the disease germs are unable to establish

themselves under normal conditions of health; that acquired immunity is part of that general power of making useful acquirements in particular directions which is possessed by all the higher animals; that the habituation is by way of weak toxins to stronger toxins; that the progressive weakening of the toxins is brought about by enzymes secreted by certain cells as a normal part of their function. The last is the principal assumption made, but the existence of digestive ferments in the lymph has been proved beyond all doubt, as has also the fact that snake-toxin digested and weakened by the enzyme secreted by the stomach-cells causes, when it enters the blood-stream, immunity against that poison in the individual who has swallowed it. Finally, it supposes that the reason why antitoxins are possible in the case of bacterial and animal poisons as well as such vegetable poisons as abrin and ricin, but not possible in the case of mineral poisons, is due to the fact that the latter are of very simple composition and cannot be altered without undergoing complete destruction as poisons, whereas the former, being immensely more complex chemically, can be digested in such a manner that they are not destroyed as poisons, but merely weakened.

205. But perhaps the most beautiful and, as it seems to me, most convincing proof of the theory of habituation is supplied by the phenomena of syphilis, a disease against which immunity may be acquired, but which, owing to the feebleness of its toxins (in this approaching leprosy and tuberculosis), yet persists long enough in a woman to cover the entire period of several pregnancies. This evidence, notwithstanding its interesting nature, has been curiously neglected by bacteriologists. Normally, as we know, there is no connection between the placental blood-vessels of a mother and those of her fœtus. But they are in close apposition, and are very thin-walled, so that while solids (*e. g.* the parasites of disease) are normally stopped, fluids, gases, and solids (*e. g.* toxins) in solution pass from one to the other by diffusions. Under abnormal circumstances (*e. g.* during disease) the continuity of the vessel-walls may be broken, and then the solids as well as the fluids pass from one to the other. It can hardly be doubted that this is what commonly happens in syphilis; and therefore a syphilitic mother very generally bears a syphilitic child. But when, in rarer cases, the continuity of the vessel-walls is not broken, when a syphilitic mother has a healthy child, or when, as more commonly happens, the healthy partner of a syphilitic father is delivered of an infected child, then is seen a most instructive pheno-

menon—the healthy individual is found to be immune to the disease; for such an infant does not acquire the disease when suckled by his infected mother, nor, on the other hand, as Colles proved, does such a healthy mother contract the disease when suckling her infected child, though other non-infected women may. Here, during gestation, toxins passing from the infected to the non-infected individual inure the cells of the latter to resistance, as a result of which they destroy the micro-organisms if at any future time, in the act of sucking or giving suck, they find entrance. But children born of a mother who has recovered from syphilis, and who is immune, are not themselves immune like the healthy children born to her during her illness. Whence it follows that her continued immunity is not due to the presence of chemical antidotes or digestive bodies; for if it were her offspring would continue to be born immune, just as they did (if not infected) when she was ill. Her continued immunity, therefore, is plainly due to the fact that her cells do not lapse the training they received when she was suffering from the disease.

206. In connection with syphilis it would be interesting to seek the explanation of some instructive phenomena which occur in the inherited form of that disease. If a man contract syphilis, then, after a certain number of years, of which the limit has been set at five, he ceases as a rule to be infective to a woman, but for very long after he may have offspring who exhibit the signs of very virulent infection. If a woman contract syphilis, then, like a man, she also ceases after a limited time to be infective to another adult, and not only this, but, unlike the man, she ceases also to be infective to her children (Diday's law of decrease). A woman's power of infecting her children is, therefore, of a much shorter duration than that of a man. Speaking only in general terms and without regard to the numerous exceptions, which doubtless depend on variations in resisting power in the offspring, the children earliest born to her after infection suffer, in the absence of treatment, most severely from the disease; those later born less severely; till, at length, if she continue to bear children, the latest born do not suffer at all. Her disease tends at first to result in abortions and miscarriages; then in the birth at term of one or more dead children; then in one or more children who survive birth for a space; next in children who survive, but show signs of disease; and lastly in children who show no sign of infection. If such a woman mate with an infected man, this law still holds, for which

reason the children of a married couple who have the disease, as a rule, even in the absence of treatment, show less and less signs of it; whereas a woman not previously infected may have grievously diseased children to a father who has long ceased to exhibit signs of the disease. Moreover, if a non-infected mother bear infected children, who live, to a diseased father, her children also show less and less signs of it, until, at length, they show no signs at all.

207. If we are right in the foregoing portion of this chapter, acquired immunity to syphilis, like acquired immunity to other diseases, must depend on acquired power of tolerating the toxins; the cells concerned (especially those concerned in the elaboration of the digestive bodies) being able to perform their functions in spite of the presence of the toxins; in consequence of which the micro-organisms must gradually be destroyed; or, if some of them survive, they must survive in the unfavourable environment in a highly resistant, and, therefore, judged by analogy, a very harmless form—*e.g.* as resting spores. Now we have evidence that pathogenetic organisms do not induce disease in susceptible organisms when the number in which they find entrance sinks below a certain minimum—a minimum which varies with the species of the invading parasites, with the species of the animals attacked, and with each individual of the latter. Thus it has been found that to kill a rabbit by artificial infection at least sixteen thousand virulent anthrax bacilli must be introduced, a lesser number perishing and conferring on the rabbit increased resisting powers. (Lubarsch.) Again, one cubic centimetre of a fresh broth culture of bacillus pyocyaneus will infallibly cause fatal disease in a rabbit, which, however, will survive and acquire increased resisting power from the injection of a quarter of that quantity. But immature animals are less resistant than adult animals of the same species; for instance, young guinea-pigs succumb more easily to attenuated anthrax bacilli than do older animals. Young animals, therefore, are capable of being infected by a smaller quantity of microbes than adults; and for this reason it probably is that a father may infect his offspring with syphilis at a time when few microbes survive in him, and long after he has ceased to be infective to a woman; and this readier infectibility of the young suffices also to explain the fact that while it is rare for a diseased woman to bear a non-infected child, it is much more common for a diseased child to be born of a healthy mother. Moreover, both ovum and spermatozoon are unicellular animals; in them there is no

differentiation of tissue for the performance of different functions; in them therefore there are no cells which can react to the toxins; and therefore neither ovum nor spermatozoon has the power of resisting the parasites, or, in other words, of acquiring immunity. This power, like the power of acquiring all other use-acquirements arises much later in their cell-descendants, when these have undergone morphological and physiological specialization and differentiation into skin, muscle, gland, nerve, phagocyte and other cells. Hence it follows that a man can never confer immunity on his children; for though his spermatozoa be steeped in toxins they cannot react, since the necessary machinery is wanting. So also, a woman, who has recovered from syphilis or any other disease, cannot then confer immunity on her non-infected children; for, though during her illness her ova are steeped in toxins, yet in them also the machinery for reaction is wanting. But if a woman become pregnant during her illness, then in her fœtus, if it be not too immature, there are present differentiated and specialized cells, which like those of her own body have the power of acquiring various traits, among others the power of reacting to the toxins of this or that disease. And, therefore, while a man can never confer immunity on his children or a woman on children born to her before infection or after recovery (unless they be themselves infected), a woman can confer immunity on offspring of which she is pregnant during her illness, for in the latter case the machinery for acquiring immunity is present—that is, the toxins passing from the mother to the embryo, may produce a protective reaction in the cells of the latter, especially those concerned in the elaboration of the digestive bodies.

208. But syphilis is a disease of long duration; in other words, immunity against it is only very slowly acquired; the cells only very slowly acquire the power of tolerating the toxins, and of producing the digestive bodies undeterred by their presence. It follows that if a woman become pregnant during the earlier stage of her illness, even if the microbes be stopped in the placenta and the child is not infected, there will pass from her to the embryo toxins which are little if at all attenuated; and, therefore, since young individuals are, in general, less capable of resisting zymotic diseases than the older members of their species, the embryo perishes, and the mother aborts or miscarries. But as her disease progresses the mother gradually acquires more resisting power; her cells become more and more tolerant of the toxins, and, therefore,

more and more capable of producing the digestive substances which attenuate and destroy the toxins; and, therefore, up to the time of her recovery, she becomes more and more capable of conferring immunity on her offspring; for, as time lapses, there pass from her to the child toxins in a greater and greater state of attenuation. Then, if the child be infected (as usually occurs), the digestive substances he receives through the placenta tend to destroy the micro-organisms and attenuate the toxins produced in him. At length, before recovery and immunity are achieved, a time arrives, the advent of which varies in different individuals, when the digestive substances produced in the infected mother are of such potency or in such abundance that the toxins are so much attenuated as not to destroy the child, who is then born alive, and it may be of a fat and healthy appearance.[1] In him are present digestive substances, and the micro-organisms of the disease. Frequently in such a child the disease reasserts itself after birth; the child begins to pine and ere long perishes. The only possible explanation of this phenomena appears to be the following: the digestive bodies from the mother attenuate the toxins sufficiently to protect the child from injury while he remains in the uterus, but not sufficient to bring about in the young individual a protective reaction. Therefore after birth, when the digestive bodies derived from the mother are exhausted, the toxins produced by the parasites within the child, and not now altered, cause his death. But at a still later stage in the mother's disease the toxins are so much attenuated that the cells of the child are able to react, and, therefore, though after birth the signs of the disease may be seen, he recovers and is afterwards immune. Still later, when the mother has recovered, when her cells have acquired the power of resisting the toxins and she is immune, the child can acquire from her neither the disease nor the immunity, since the toxins, attenuated or otherwise, no longer pass from one to the other.[2]

[1] Be it remembered that here we speak in general terms only. As is well known living children may be born to a mother during all stages of her disease; but abortions and miscarriages are most frequent during the earlier stages, and of such children as are born alive the great majority perish. It is very significant, moreover, that hand-fed syphilitic children are more liable than those who are breast-fed to marasmus. (Coutts.) It is known that antitoxins are secreted in the milk, and Ehrlich believes that the "congenital" transmission of acquired immunity is due in part at least to the presence of large quantities of antitoxins in the milk.

[2] We cannot set forth positive evidence proving that the children born of a mother recovered from syphilis and immune to it are not themselves

209. On the other hand, if a *healthy* mother bear diseased children to an infected father we should, if our theory be correct, expect to find (and actually we do find) that each succeeding infant exhibits less and less signs of the disease; and this notwithstanding the fact, other things being equal, that the last child infected by a diseased father, tends, when born to a different woman who has not previously suffered from the disease or borne infected children, to have the complaint as deeply as the first; in other words, a woman, who has once borne an infected child, tends to endow succeeding infected children with greater and greater powers of resistance; the increased powers of resistance being clearly derived from her and not from the father, since the women, who have not been themselves infected nor borne infected children, may bear deeply diseased children to the same father. Here, in the case of the former woman, toxins from each infected child pass into the circulation of the non-infected mother, inducing a more and more perfect reaction in each succeeding pregnancy; and, therefore, in each succeeding pregnancy there are elaborated by her more and more digestive bodies, which at length attenuate the toxins so thoroughly that the cells of the child are able to react and the child survives, instead of perishing like its predecessors. In this case toxins pass from the child to the mother, while from the mother to the child pass attenuated toxins and digestive substances.

210. It follows as a corollary, if a mother, who has acquired immunity either by personal disease or by bearing infected children, become pregnant of an infected embryo, she will tend to confer immunity on it, since the elaboration of toxins in the latter will tend to call forth the elaboration of digestive bodies in her; but, if the embryo be not infected, then immunity will not be conferred; for in such a case no toxins from the child will call forth the digestive bodies from the mother; and these, as we have seen, do not persist in the body in the absence of appropriate stimulation—*i. e.* in the

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immune, for no observations bearing on the subject appear to have been published. Nevertheless, reasoning from the analogy of other diseases we may be sure they are not. It is a matter of common knowledge that the children of mothers recovered from and immune to whooping-cough, measles, scarlatina, small-pox, and other diseases, are not immune. On the other hand, the children of mothers who, during pregnancy, have suffered from small-pox have been found immune; and Chauveau claims to have proved that the offspring of sheep suffering from anthrax, have, under similar circumstances, exhibited immunity against that disease.

absence of toxins—but after a space disappear, leaving behind only the power of tolerating the toxins, only the power of readily producing digestive bodies when stimulated by toxins.

211. The serum treatment, whether employed by nature, as in syphilis, or by man, as in diphtheria, supplies digestive substances, and attenuated toxins. In the hands of nature the digestive substances are probably of primary importance, as there is then an unlimited supply of them from the mother on the one hand, and on the other a weak capacity for producing them in the infant. When, however, man seeks to secure acquired immunity artificially the digestive substances in the antitoxin are doubtless of comparatively little importance. They are limited in quantity and are soon exhausted. The attenuated toxins, not only when the serum treatment is employed, but also in protective vaccination against small-pox, rabies, and anthrax, are then of primary importance.

212. The foregoing theory of immunity carries us a very little way. It merely supposes that acquired immunity is a physiological reaction,[1] a use-acquirement of the same nature as other use-acquirements. Some of these use-acquirements are quantitive; the organs or tissues acquiring them increase in size. Others are qualitative; the organs or tissues increase in power. Many are both quantitive and qualitative; as when a muscle not only increases in size, but to a disproportionate extent in capacity for doing work. No doubt in the last analysis most qualitative changes are, to some extent at least, quantitive;[2] this or that constituent of the part which has undergone change is increased or diminished in amount. But as yet we are far from being able to determine the quantitive changes, if any, which occur when a nerve cell becomes used to nicotine or even to such a simple substance as alcohol. And we are just as far, I imagine, from being able to determine the precise changes which occur when phagocytes and other cells become used to this or that toxin.

[1] It is hardly necessary to state that the writer claims no originality for the hypothesis that acquired immunity is a physiological reaction. It has been a commonplace in bacteriological literature (see, for instance, the most admirable article by Dr. Kanthack in Professor Clifford Allbutt's *System of Medicine*).

[2] They cannot always be merely quantitive as stated by Weismann (*The Germ-plasm*). Thus when a cell dies the change is qualitative but can hardly be said to be quantitive.

CHAPTER XI

EVOLUTION AGAINST DISEASE[1]

The decisive evidence afforded by disease—Malaria—Tuberculosis—Measles—Whooping-cough—Small-pox — Dysentery — Diarrhœa — Enteric fever.

213. We may now resume the main thread of our argument. The discussion in the last chapter will have had the effect of clearing away some confusions as regards terms. Probably, for instance, we are now agreed that "congenital" syphilis and "congenital immunity to syphilis" are not, as is so often implied in medical literature, true inborn characters, but merely acquirements made *in utero* of exactly the same kind as the mother's acquirements. We saw that diseases afford a means of testing the three principal doctrines of heredity. On any doctrine of heredity some changes they must produce in races that have been long and severely afflicted by them. What doctrines of heredity, then, does that change confirm?

214. Is the doctrine of the spontaneous origin of variations (and, therefore, the doctrine of evolution by Natural Selection) the true doctrine? Do all *lethal* and prevalent diseases cause, through the survival of the fittest, an evolution of immunity in the race—the diseases against which immunity *cannot* be acquired, an evolution of *inborn* immunity; the diseases against which immunity *can* be acquired an evolution of the *power of acquiring immunity?* Do *non-lethal* diseases produce no effect whatever on the race?

215. Or is the doctrine of the causation of variations by the transmission of acquirements the true doctrine? Do all prevalent diseases, *lethal or non-lethal*, against which immunity *cannot be acquired* produce racial degeneration? Do all diseases, *lethal or non-lethal*, against which immunity *can* be acquired, produce an evolution of *inborn* immunity?

[1] The bulk of this chapter has been taken with some modification from the Author's work, *The Present Evolution of Man.*

216. Or is the doctrine of the causation of variations by the direct action of the environment on the germ-plasm the true doctrine? Do all diseases, *lethal or non-lethal*, produce racial degeneration?

217. The evidence is decisive. The doctrine of spontaneous variations, and therefore of evolution by the agency of Natural Selection, is beyond doubt the true doctrine. There is not an iota of evidence that any race whatsoever has undergone degeneration through the action of any disease, nor that the acquirement of immunity during any number of generations has resulted in an evolution of inborn immunity. On the contrary, every race, that has been exposed to a lethal disease, is resistant to that particular disease precisely in proportion to its past experience of it. When the disease is one against which immunity *cannot* be acquired, the race has undergone an evolution of *inborn* immunity; thus Europeans who have suffered severely from tuberculosis for thousands of years, resist infection by it, or when infected recover from it more easily than African Negroes who have suffered less, and much more easily than American Indians, who until lately had no experience of the disease. When the disease is one against which immunity *can* be acquired, the race has undergone an evolution of the *power of acquiring* immunity, never of inborn immunity; thus English children, whose race has long been afflicted by measles and whooping-cough, contract those maladies as easily as Polynesians to whom they were familiarized only during the last century. But, whereas English children, as a rule, recover readily, Polynesians perish in great numbers. When the disease is non-lethal no effect on the race can be observed. Thus Polynesians are infected as easily and recover as easily, but not more nor less easily, than Englishmen from chicken-pox.

218. It is easy to give chapter and verse. We have only to glance at the evidence relating to a few of the more important diseases. *Malaria.*—Man's evolution against malaria is more striking and conspicuous than that occasioned by any other disease, and that for two reasons. First, because, in many districts infested by its microbes, it is so prevalent and virulent that no man resident in them escapes infection unless he is immune nor death unless he is resistant. The elimination of the unfit therefore has been very thorough, and presumably it has been very prolonged, since in such districts the inhabitants, however much they may have warred among themselves, have dwelt secure, protected by their deadly climate from the fate that has befallen

so many aboriginal tribes—for example, the Lowland Celts and before them their predecessors in Great Britain—extermination by immigrant hordes. Evolution against malaria, therefore, has been very considerable. Secondly, the illness occasioned by the disease is of a very sudden and marked character; and, therefore, observers are easily able to contrast its effects on individuals of different races, and to perceive how much more resistant are those races which have had prolonged experience of it than those to which it is strange.

219. So considerable has evolution against malaria been in various parts of the world that it is scarcely necessary to bring forward evidence in proof of it. Nothing indeed can be plainer than that different races of mankind differ vastly in their powers of resisting the disease, and that those races that have had extended and disastrous experience of it are much more resistant than those who have had little or no experience of it. Even people who, on doctrinal grounds, strenuously repudiate the idea of evolution in general, must admit that in this case evolution has certainly occurred; for if, as they usually believe, all the races of mankind had a common origin, then in no other way is explicable the difference which now exists between one race and another, not only as regards disease, but also as regards size, shape, colour and so forth—for example, between Englishmen and West African Negroes.

220. But while this evolution, when once attention is drawn to it, becomes so manifest that it is unnecessary to waste time in marshalling in proof of it facts that are notorious, we shall nevertheless find it interesting to note how exactly the degree of evolution undergone by any race coincides with the virulence of the disease to which it has been subjected. This fact is admirably brought out in the following table:—

"In Ceylon there died of malaria fevers per 1,000 of the population—

Negroes	1·1
Natives of India	4·5
Malays	6·7
Natives of Ceylon	7·0
Europeans (English)	24·6"[1]

221. The above table is even more significant than it

[1] Hirsch, *Geographical and Historical Pathology* (New Sydenham Society, 1883), vol. i., p. 245.

appears. Had the habits and customs of the Europeans been the same as those of the Asiatics and Negroes, without doubt their death-rate would have been higher than it was, as may be judged by the following extract:—

"It has been stated over and over again that Negroes and natives of the countries where malarial fevers are endemic are themselves immune to the poison of malaria.

"This is too sweeping a statement to make, certainly as far as regards British Guiana, and I believe other tropical countries as well.

"It is quite true, that the Negroes and Creoles of this colony do not suffer to nearly so great an extent as foreigners, a very marked difference in this respect being evidently noticeable in the numbers of the coolies attacked compared with those of the Negroes and Creoles. Coolies all suffer to a very great degree, and are probably the class of foreigners most subject to malarial poison.

"On the other hand, we must take into account in dealing with the question of immunity in the natives of tropical countries the various conditions under which they live as compared with those of foreigners. Now, unfortunately, the natives of this country live under the most insanitary conditions—conditions which would soon be fatal to Europeans unaccustomed to tropical life. Yet their death-rate would probably compare very favourably with that of foreigners.

"Again, the reason why the coolie suffers so terribly from malaria as compared with other foreigners is obviously due to the conditions under which he lives, and doubtless partly also to his occupation. The coolies, as we know, live in huts built on the ground, in many cases no attempt being made to raise the floor, the latter as often as not being mother earth; so that they may be said to be literally grovelling in malarial dust. Their occupation being mainly that of agriculturalists again only serves to keep them saturated with earth poison.[1]

"It would not have been unreasonable to suppose that the coolies, coming from an evidently malarious country, would have acquired a high degree of immunity to the malarial poison; unfortunately such is very far from being the case, and that this is true is entirely due to the causes mentioned above. Were the coolies to live under conditions more sanitary than the present one, it is probable that they would show a certain amount of immunity. There can, I

[1] In other words, the coolies are particularly exposed to the attacks of the mosquito.

think, be no doubt therefore that, given a little sanitation, as regards the coolies living on estates, a very sensible decrease in their mortality would at once take place, and there would be far fewer cases utterly broken down in health, with sallow, earthy complexions unfit to work for a few hours together."[1]

222. The difference in habits between Europeans and Asiatics explains why in India the former appear sometimes to suffer less than the latter. "The following is a table compiled by Waring of the malarial sickness during ten years among the troops in the Madras Presidency:—

	Total Strength.	Admissions for Intermittent.	Admissions for Remittent.	Percentage of the Troops.	
				Intermittent.	Remittent.
European Troops	103,431	13,264	4,336	12·8	4·2
Native Troops	568,403	95,354	8,046	16·8	1·4

"The native troops accordingly suffered from simple malarial fever to a greater extent than even the Europeans, but the number of cases of remittent fever observed was three times less among the former than among the latter."[2]

223. In other words, Europeans, to whose race the disease was strange but who were less exposed to infection, suffered three times as much from the disease in its severer forms as the natives to whose race it was familiar—a fact to which many parallels may be found. Thus Professor Hirsch remarks—

"In the malarious regions of the tropics the natives take the milder forms of the fever, while the foreigner, and particularly those not acclimatized, take the disease in its severer forms; and in accordance with that fact, the types with the longer intervals occur in the former, and those with the shorter intervals in the latter."[3]

"Just as the history of malarial disease shows it to have been a malady of all times, so the inquiry into its geography leads us to recognize in it a disease of all races and nationalities. This predisposition to malarious sickness is developed in the highest degree among all peoples belonging to the Caucasian stock, not only on European soil, but also among the Arab population of the Barbary States, and in the malari-

[1] Ozzard, *British Guiana Medical Annual and Hospital Report*, 1893, p. 91.

[2] Hirsch, vol. i., p. 244–5. [3] *Ibid.*, vol. i., p. 241.

ous districts of India, where the Mahomedan and Hindoo population suffer in the same degree as foreigners. This is not the less true for the Malay and Mongol stocks, and for the native (Indian) population of North and South America. The predisposition is least for the Ethiopian race, which, though it by no means enjoys an absolute immunity from the disease, is still affected by it, *ceteris paribus*, less frequently, less readily, and less severely than other races; and to this many experiences have unquestionably testified, not only in Senegambia, the West Coast of Africa, Nubia, and other parts of its native habitat, but also in the malarious regions of the tropics, whither they have emigrated. This relative immunity from malarial fever on the part of the Negro race, is an acquired, not a congenital one, as we may learn from the frequent cases of sickness and death from this disease among the children of the Negroes in Senegambia. But the same immunity is enjoyed by the natives of all malarial regions, so far as concerns their native home, and such other localities as are affected by malaria less severely than it; so that one might almost formulate a general rule that the predisposition to malarial sickness becomes weaker in proportion as the individual has been continuously exposed, from birth to maturity, to more or less severe malarial influences, without suffering from them to any considerable extent."[1]

224. The passage last quoted furnishes an example of facts which may be accepted, but inferences which must be disputed. The sweeping generalization that the "relative immunity from malarial fever on the part of Negroes is an acquired not a congenital one" is certainly not correct. Characters which appear late in the development of the individual are not necessarily acquired. The superior immunity, or much of it, exhibited by adult Negroes may be, and probably is, as truly congenital as are their permanent teeth or their beards. That some increase of resisting power may be acquired against malaria by continual residence in its presence is rendered certain by the fact that natives of countries infested by it exhibit greater susceptibility when returning from a residence abroad than do their compatriots, or than they themselves exhibited before they left their homes; but even this acquired character, like all use-acquirements, depends on an inborn trait developed by Natural Selection, for Negroes whose race has long been exposed to malaria exhibit greater powers of acquiring it than Europeans.[2]

225. *Tuberculosis.*—Man's evolution against tuberculosis is

[1] Hirsch, vol. i., 243–4. [2] See § 290 (footnote).

not less marked than his evolution against malaria, but owing to the insidious nature of the former disease, the gradual character of the attack, and the slowness with which symptoms supervene, it is not so striking to the casual observer. In malaria toxins are present in abundance, and are of great virulence, and therefore the person attacked passes in a few hours from apparent health to extreme illness. Within twenty-four hours of entering an infected country he may manifest the symptoms of a virulent seizure. Ships navigated by men of a race which has undergone no evolution against the disease, may have the whole crew stricken down on entering a malarious port, while the natives around retain their health. Invading armies from beyond the borders of malaria have been decimated, and rendered useless as fighting forces, while the inhabitants of the land were able to pursue their ordinary avocations. Moreover, in malarious countries, the pathogenetic micro-organisms are everywhere present, and therefore no susceptible person escapes infection.

226. But in tuberculosis the toxins are conspicuously feeble. Infection is not marked by sudden and manifest illness. A slow, long-continued "personal" struggle between the phagocytes and the pathogenetic micro-organisms, which, however, is shorter in the less resistant than in the more resistant, in, generally speaking, the men of a race to which the disease is strange, than in those of a race to which it is familiar. Even in countries where the pathogenetic organisms are most abundant they are not everywhere present, but are more or less limited to crowded and ill-ventilated domiciles to which infected persons have access. Individual powers of resistance, even among peoples to which the disease is quite strange, vary very largely. Parties of strangers from beyond the infected areas are, therefore, never stricken down *en masse*, but one by one, at different intervals; and the symptoms noticeable in the sufferers are such as are referable by unskilled observers to other diseases—coughs, colds, and so forth. Last, but not least—among the races which are least resistant to malaria is our own; on the other hand, our race is among the most resistant to tuberculosis; and therefore our attention is not drawn, in the same marked manner, to racial differences in relation to the latter disease as it is to differences in relation to the former. We have all heard, for instance, of the sufferings from malaria of our compatriots in India and on the West Coast of Africa, and that in the year 1809 a British army was destroyed as a fighting force by the same cause in the Island of Walcheren, but few of us know "that of 9,000 Kaffirs

(Negroes from the East Coast of Africa) who had been imported at various times by the Dutch Government into Ceylon, and had been drafted into regiments, scarcely a trace of their descendants remains; they would certainly not be recognized at all among the present population of the island. In the years 1803 and 1810 the British Government imported three or four thousand Negroes from Mozambique into Ceylon to form into regiments, and of these in December 1820 there were left just 440, including the male descendants." [1] All the rest had perished mainly from tuberculosis, and in a country where the disease is not nearly so prevalent as in England.

227. We habitually speak of the fatal "climate" of the West Coast of Africa or of the Terai; but we are usually unaware that our own "climate" at the present day is nearly, if not quite, as fatal to the native inhabitants of much the greater part of the world—of all the New World and of Africa, a considerable portion of Asia, and part of Europe—and that, therefore, our race, which is able to persist under such adverse conditions, has undergone evolution in relation to tuberculosis fully equal to the evolution against malaria undergone by the West Africans.

The micro-organisms of tuberculosis, since they are essentially earth-borne and entirely parasitic, and since strong sunlight is highly inimical to them, are unable to persist except under given conditions, which are best satisfied in the crowded, badly-ventilated and ill-lighted houses of civilized people—particularly those that dwell in the cities of cold and temperate climates. That the environment is yearly growing more favourable to the bacilli in the world at large, especially in newly colonized areas, in consequence of the increase of population, cannot be doubted, and this in spite of the greater attention which is now-a-days paid, in some places, to light and ventilation. It is calculated that at the present time at least one-seventh or one-eighth of the total number of deaths is due to its agency. But it is death-dealing to a vastly greater extent under circumstances which are even more favourable to it than such as normally obtain. For instance, in prisons, barracks, convents and the like, the death-rate is apt to be enormous, as may be judged from the following:—

228. "*Phthisis in prisons.*—Consumption prevails in prisons to a truly disastrous extent. I take the following statistical data from an excellent article on the subject by Baer. In the United States prisons, from 1829 to 1845, the mortality from

[1] Hirsch, vol. iii., p. 226.

phthisis was 12·82 per 1,000 prisoners of Philadelphia, and at Auburn and Boston 8·89 and 10·78 respectively; in Baltimore prison it was 61 per cent. of the mortality from all causes. In the French prisons, particularly those in which long terms of penal servitude are worked out, the death-rate from phthisis amounts to between 30 and 50 per cent. of the mortality from all causes. In the Dutch prisons it reaches the same height; in the Danish convict prisons it amounted in 1863–9 to 38 per cent. of all deaths; over the whole of the prisons of the Austrian Empire in 1877–80 it was 61·3 per cent.; and in the nine large convict prisons in Bavaria from 1868 to 1875 it was 38·2 per cent. In the present establishments of Wurtemburg, according to Cless, the yearly average of deaths from phthisis from 1850 to 1858 was 24 per 1,000; while from 1858 to 1876, in consequence of the improved diet, it fell as we have seen to 8 per 1,000, although it still remains two or three times greater than among the people at large. During a period of eleven years (1869–79) the mortality in the prisons of Prussia was 42·87 per cent. of the deaths from all causes, and 12·32 per 1,000 prisoners.

229. "For England we have Baley's report on the prevalence of phthisis from 1825 to 1842 among the convicts at Milbank Penitentiary, where 31 out of 205 deaths were due to cholera, and 75 of the remaining 174, or 43 per cent., were due to phthisis; while of 355 prisoners discharged during the same period on account of ill-health, 90 were phthisical, and of these quite three-fifths according to precedent would have died of that disease if they had been left to complete their term. In that way we may bring the annual mortality from phthisis at Milbank up to 13 per 1,000, or more than three times that of the London population at large. Pietra Santa gives the following facts for the prisons of Algeria:—Of 23 natives who died in the public prisons of Alger, 17 succumbed to phthisis; in the central prison of l'Harrach there were 57 deaths from phthisis in a total of 153, or 37·2 per cent. The important influence of imprisonment on the occurrence of this disease is very clearly brought out by its prevalence in those regions in which phthisis is in general a rare thing, as, for example, in Lower Bengal. Webb quotes the following remarks by Green with reference to the commonness of the disease among the natives in the prison of Midnapore: 'After a careful examination into the early history and origin of the cases of this disease as they have occurred, I have been led to the conclusion that many of the men thus affected were previously hale, and capable of earning their livelihood, and

were not subject to cough before imprisonment. I find that after they have been working a few weeks or months on the roads here, and inhabiting the gaol, they have become subject to attacks of inflammation of the lungs, and from time to time to frequent repetitions of these attacks, which have ended in some cases . . . in death in the acute stage, in others in a prostrate sinking state with a gradual wasting away of the body, and all the symptoms and ultimately all the post-mortem morbid appearances of tubercular disease of the lungs.' Next to the hard labour Green lays most stress on the bad ventilation of the cells, and on the highly defective construction of the prison in other respects.

230. "The great frequency of consumption in prison may seem to be due to the prisoners bringing the disease with them; but that such is not the case follows from the well-authenticated fact that most of the deaths from phthisis among prisoners do not occur until the later years of the term of their confinement. At Milbank Penitentiary signs of a pulmonary affection on admission could be made out, as Baley tell us, in only 12 among 1,502 prisoners who entered in 1842, and in only 15 among 3,249 who were received in 1844. Among the convicts of 1842 there were 510 women sentenced to transportation who remained at Milbank not longer than three months, and of these two fell ill of phthisis or scrofula during that time; whereas of the remaining prisoners admitted no fewer than 47 became consumptive before the completion of their term of two or two-and-a-half years. It is further to be kept in mind that most of the convicts sent to Milbank had already served longer or shorter terms of imprisonment elsewhere, and not a few of them more than one term; so that in a certain proportion of those who were found phthisical on admission to the central prison the seeds of the disease might have been implanted while they were undergoing sentence previously.

231. "There is no doubt that prisoners are exposed to a large number of noxious influences capable of affecting their health or of creating more or less of predisposition to take phthisis, or of augmenting a predisposition already there, and among these a bad or insufficient diet, as we have already seen, might play a not unimportant part. But even under these circumstances it is evident that the real factor is a protracted detention, with brief remissions, in crowded and ill-ventilated work-rooms and sleeping-places. That is the one detrimental thing which obtains with more or less uniformity in all penal establishments, whatever difference

there may be among them in their other arrangements, such as the very various kinds of discipline and occupation.

232. "The same hygienic disadvantages arising out of the manner of living among confined bodies of people, which we have just been considering, contribute not a little to the prevalence of consumption, be it more or less, among the population living at large; and that holds good equally for the well-to-do classes and for the poor. Here, again, there is no mistaking the drawbacks in the mode of life which has come along with the progress of modern civilization. 'The prevalence of consumption among the families of our villagers and farmers,' says an American writer, 'can be shown, we believe, to have kept step with the deviation of these families from their former frugal, active, and industrious manners of life, and their adoption of the absurd practices which characterize the mode of our fashionable classes in the large cities.' Once more, I think, the stress should be laid on spending the time amidst bad ventilation indoors, in living-rooms, but more particularly in bedrooms. In the latter the human being spends nearly half of his existence; and the rooms assigned as bedrooms by the better classes are too often chosen not on considerations of health, but out of a device to have the greatest amount of comfort in the public rooms of the house.

233. "But the dark side of civilization nowhere shows its influence for spreading consumption more decidedly than in those disastrous outbreaks of disease among peoples who were wont to live perfectly free from all restraint and conventionality, but now have come into contact with Europeans, and have adopted European manners and vices. Of that we have sad examples in the ravages of consumption among certain tribes of North American Indians, among the natives of several groups of islands in the Pacific, among the Maoris of New Zealand, and in Algiers.[1]

234. "The same circumstances serve to account for the strikingly common occurrence of phthisis in nunneries, seminaries and such-like institutions, in evidence whereof a number of observations have been brought forward by Fourcault, also in the Oriental harems, not only among the women but among little children also; again among badly-lodged troops, of which we have evidence from England, France, Turkey, and India; and above all in prisons.

235. "Among many surgeons there is complete agreement that cases of phthisis are least common in soldiers when they

[1] Hirsch, vol. iii., pp. 222–5.

are leading an active life in the open air, on the march, or in manœuvres and campaigns; that the cases mount up as soon as the troops enter on their garrison life, as, for example, in winter, and spend their time in ill-constructed, crowded, filthy, and badly-ventilated barracks. Welch, who treats of this matter with reference to the British Army, says that 'nearly half of army consumption is connected with vitiated barrack atmosphere,' a similar conclusion having been expressed by earlier writers, as Tulloch and Maclean, the latter including in his statement the British and native troops in India. With respect to its frequency in the French army we find a similar reading of the facts in the papers by Champpouillon, Tholozan, Viry, Lausies, and others."[1]

236. The conditions under which we live are such that, normally, every individual amongst us is exposed to infection —that is, we all at one time or another enter the rooms inhabited by tuberculous sufferers; but such has been the evolution of resisting power in our race that only about one-eighth of us perish from consumption, while seven-eighths of us live immune to the disease, or recover from it and die from other causes. A notable fact in this connection is the often evenly-balanced nature of the struggle between the microbes and phagocytes. Many of us are resistant under almost any circumstances; but many others exist in the border space between immunity and susceptibility. Such people when their vitality is lowered, or under other circumstances favourable to the bacilli, contract the disease, but when their vitality is raised, or when the environment becomes less favourable to the pathogenetic micro-organisms, defy it, and, if they are already diseased, recover. Even when they do not recover the disease usually runs a prolonged course in them; there is a lengthened struggle between the parasites and the phagocytes, and we then behold the phenomena of chronic phthisis. Laennec said that a patient does not die of his first attack of tuberculosis; that is, a patient of the highly-resistant type which is normal in our race. Less resistant individuals, who have lapsed back to the ancestral condition of greater susceptibility, undoubtedly do often perish of their first attack; as, for instance, of acute phthisis (galloping consumption) or tubercular meningitis; but the very general prevalence of more resistant individuals, who, as regards their powers of defence against the bacilli correspond to a far later stage of the life-history, justifies Laennec's dictum.

[1] Hirsch, vol. iii., pp. 221–2.

237. It is clear, therefore, that the individuals of our race are very generally so resistant to tuberculosis that even after infection their phagocytes, under slightly improved conditions, are able to wage successful war against the microbes. It is clear also that no immunity can be acquired against the disease, since those who have recovered may, under worse conditions, take it again and again. Their only safety lies in the absence of the pathogenetic micro-organisms. Thousands of our race who are unable to resist the attacks of tuberculosis in their native land, and on that account are obliged to leave it, are able to maintain a healthy existence under conditions that yet prevail in all such parts of the New World as have not long been settled by us—in certain parts of America, in Australia, in New Zealand, in the Pacific Islands, and also in South Africa. But in these very lands, where the less resistant among us recover from previous infection tuberculosis is causing the extermination of the natives. This one fact throws the greatness of our evolution into startling relief, for the natives usually live under hygienic conditions that are far better as regards the disease than do the settlers. The latter endeavour to reproduce their home life as nearly as possible; they gather themselves into urban communities, and build much the same kind of houses as those in which they contracted the disease; whereas the natives dwell scattered, or at worst in small communities, and in dwellings more wind-swept than the shanties of the Hebridean fisher-folk. Nevertheless they perish and their races are becoming extinct: for so susceptible are they that they take the disease in circumstances in which the most susceptible Europeans live immune; and they are so little resistant that they take it in its most virulent form. The microbes, unchecked by the phagocytes, multiply within them at a rapid rate, they exhibit all the phenomena of galloping consumption; and even in their draughty wigwams and whares they infect their fellows. To infect a normal European a considerable dose of the virus seems necessary, since so many of the parasites succumb in the struggle with the phagocytes; to infect a Red Indian or a Maori the smallest possible dose seems sufficient, since the phagocytes seem to have no power of destroying the bacilli.

238. "Consumption is prevalent to a most disastrous extent among the races of the Southern Pacific. We have more particular accounts for Fiji and Tonga, Samoa, Tahiti, the Marquesas and Hawaii (Honolulu). In New Caledonia the death-rate from consumption among the Kanakas is estimated

at two-fifths of the mortality from all causes. Almost all the authorities are of the opinion that the great prevalence of the malady in these islands dates from the time when the natives began to come into more intimate relations with European immigrants, and therewith to make considerable changes in their mode of life; and that opinion is borne out by the fact, that in the Hawaian Islands, where phthisis at the present time creates great ravages among the natives, it was of rare occurrence forty or fifty years ago. On the other hand, it follows from Wilson's account (1806) of the state of health in Tahiti, that phthisis has been widely prevalent in that group as early as the beginning of the century; and there are accounts to the same effect from the Tonga group, New Caledonia, and other of the Archipelagoes of Polynesia." [1]

239. "In New Zealand phthisis has made frightful ravages among the natives, and has been one of the chief causes of the gradual extinction of that race." [2]

240. "On Nossi Be also the malady is not uncommon among the coloured races, particularly the Kaffirs. In Madagascar and Mayotte it is as common as in Europe, and rapidly fatal, as it mostly is in the tropics. In Zanzibar, Lostalot did not happen to see many cases, but it is said to be especially common among the Arabian women of the higher classes." [3]

241. "In Cape Colony phthisis is oftenest met with among the Hottentots inhabiting the plains nearest the coast; in other classes of the population it is much rarer than in the East African islands within the tropics just spoken of; while on the interior plateau of South Africa it hardly occurs at all. There is a lack of information of a trustworthy kind as to the state of health on the southern part of the West Coast of Africa—the coast of Lower Guinea. Around the Bights of Benin and Biafer (country of the Cameroons and the Gaboon), as well as in the adjoining island of St. Thomas, it appears from the entirely trustworthy writings of Daniel, that phthisis is widely prevalent and very malignant amongst the Negroes. As regards the French settlements on the Gaboon Coast, that statement is fully borne out by the French medical practitioners; and we have an account to the same effect regarding its occurrence in the island of Fernando Po." [4]

242. "In the Western Hemisphere the inhabited regions within northern latitudes and with an Arctic climate, offer a marked contrast to the corresponding territories of Europe in

[1] Hirsch, vol. iii., p. 587.
[2] *Op. cit.*, p. 189.
[3] *Op. cit.*, p. 189.
[4] *Op. cit.*, pp. 189–90.

respect to the great frequency of phthisis among them. In Northern Greenland that disease is one of the commonest causes of death. At a trading station on the northern shore of Hudson's Bay phthisis is prevalent among the scanty population to an enormous extent, according to the evidence of a practitioner who had been five years on the station, and there are reports to the same effect from New Archangel and the Aleutian Islands (Alaska). It is common also in Newfoundland, New Brunswick, and Canada, and in the last particularly among the native Indians (Stretton)."[1]

243. Just as regards malaria, so as regards tuberculosis, the resisting power of any race is precisely in proportion to its past familiarity with the disease.[2] Many writers lay stress on the susceptibility of Africans, as may be seen from the following:—"No race or nationality enjoys a decided immunity from consumption; but in respect to the frequency of its incidence, the Negro race takes the first place. Proof of this is furnished by the medical reports from all those parts of the world to which the Negro has migrated, and in the mixed populations of which he forms a large ingredient: such as the United States, the West Indies, the Mosquito Coast, Brazil, the Argentine Republic, Peru and Bolivia, Algiers, Egypt, the West African Islands, Ceylon and the East Indies.

244. "In the convict prison of the United States, from 1828 to 1845, the average mortality among the prisoners of the whites was 11·16 per 1,000; but among the Negroes confined in the Eastern Penitentiary of Pennsylvania it was

[1] Hirsch, vol. iii., pp. 182–3.

[2] It has been said that blonde people are particularly susceptible to tuberculosis. This may be true of our race, though that is more than doubtful. The notion may have arisen from the fact that fair skins show a hectic flush very plainly. It is certainly not true of mankind at large. Some of the darkest races of the world are very susceptible. Colour, in fact, appears not to be correlated in any way to susceptibility. Had it been so all races which have been much afflicted by phthisis would now present a particular shade of colour. It is probable, therefore, that the so-called "phthisical facies" is a consequent not a precedent of the disease. Again, it has been said that vulnerability to phthisis "resides in the epithetal coverings of the body being too little resistant, too easily stimulated by external agencies, too readily penetrated by the parasites of the disease." But this is a manifest error. It is not probable that all the races of the New World are weaker as regards the epithetal coverings than, for example, Englishmen. Moreover, when the parasite gets past the epithetal coverings of Englishmen the disease very often takes on a chronic form and the sufferer may recover. Acute phthisis usually supervenes in Polynesians and Red Indians, and they seldom recover.

40·74, and in the Maryland Penitentiary 28·49, while among the coloured population living at large in New York it was 11 per 1,000. At Wilmington, N.C., 0·9 of the whites died of phthisis in 1880, and of the blacks 2·6 (Wood). 'It is a remarkable fact,' says Bartolacci in his work on Ceylon, 'that of 9,000 Kaffirs (Negroes from the East Coast of Africa) who had been imported at various times by the Dutch Government into Ceylon, and had been drafted into regiments, scarcely a trace of their descendants remains; and they would certainly not be recognized at all among the present population of the island. In the years 1813 and 1810 the British Government imported three or four thousand Negroes from Mozambique into Ceylon to form into regiments; of these in December 1820 there were left just 440, including male descendants.'

245. "Whether this preponderance of phthisis among Negroes is an affair of physiological predisposition due to their nationality, or to what extent it may be so due, we are unable to decide. It is certain, however, that the amount of disease increases considerably among Negroes away from their native countries, an increase that depends in part upon the manner of living. The extent to which a change of climate may operate in that direction will appear from the phthisis mortality among Negro troops in the British service at certain military stations.

COMPARATIVE TABLE OF PHTHISIS AMONG BRITISH AND NEGRO TROOPS.

Station.	Deaths per 1,000 British.	Deaths per 1,000 Negro.
Jamaica	6·2	7·5
Lesser Antilles	7·1	9·8
Mauritius	3·9	6·4
Bahamas	2·0	7·0
Gibraltar	6·1	33·5

246. "Here we have confirmation of the well-known fact that the migration of the Negro to a colder climate is accompanied by a rise in the phthisical average; but it is obvious that we should make an allowance for the changed habits of living as weighing not less in the scale. Prunel calls attention to a fact that has a bearing on the question, namely, that at Khartoum, in latitude 17° N., with a temperature not lower than that of the mountains around, consumption ensues among the Negro captives as well as among the Arabs of the desert, whenever they give up their

nomadic life to live under a roof, even if it be in a warmer region.

247. "Here also an important part among the disease factors is played without doubt by bad food, insufficient clothing, and confinement in crowded, filthy, and badly-ventilated huts; and there is nothing to surprise us in the experience that consumption has increased to an alarming extent among the Negroes of Arkansas of late, or since their emancipation, the result being due, as the authority adds, to the carelessness and shiftlessness of a class of people who have been suddenly thrown upon their resources, and have been withdrawn from the protection and consideration of a race more intelligent than themselves."[1]

248. The comparatively high mortality of Negroes from phthisis demonstrates their extreme susceptibility. But Professor Hirsch is mistaken in supposing that of all races they are the most susceptible. In Cape Colony and elsewhere they are able to multiply in contact with European civilization. Under similar conditions the natives of the Western Hemisphere perish from tuberculosis. Negroes are, therefore, not nearly so susceptible to the disease as American, Polynesian and Australian aborigines.[2] Natives of the crowded city-settled peninsula of India, though less resistant than the inhabitants of equally crowded but much colder Europe, are more resistant than the Negroes, as the following paragraph proves:—

249. "I pass now to another disease, phthisis, of which the increase in this colony is undoubted, and so far progressive. This increase has received notice more than once, and very fully in a paper by Dr. Fergusson in the hospital reports. I wish to direct attention especially to a phase of its local development which is also noted by Dr. Fergusson—the different clinical history which the disease presents as it occurs in the two races forming the largest proportion of our very mixed populations. Amongst the blacks the disease, considered from its clinical side, is generally of the rapid, acute form known as 'galloping consumption,' or, looking at it from a pathological point of view, it presents in that race the form of tubercular caseous pneumonia. The phthisical East Indian, on the other hand, presents the clinical characteristics of the slower and more variable forms, or, speaking pathologically, suffers most commonly from tubercular interstitial pneumonia or peri-bronchitis. Now, why this difference? We have as

[1] Hirsch, vol. iii., pp. 225–8.
[2] See § 306.

yet no reason to doubt that the bacillus of the disease is in both instances alike, but this is a matter which it would be interesting to have settled by direct observation.

250. "The conditions under which the individuals live are in both cases practically the same. The difference, therefore, does not appear to arise from any factor acting immediately and directly on the individuals, but to be connected with something more remote. To me there appears to be but one solution of the matter; the peculiarity depends on inherited differences, in fact on racial characteristics." [1]

251. I have been unable to gather anything very definite concerning the Chinese in their relation to tuberculosis; but considering how large and numerous their cities are, how ancient their civilization, how filthy their habits, and how crowded their dwellings, especially the sleeping apartments, they should be of all races of the world the most resistant, if not to tuberculosis, which infests in particular houses of the European type, yet against many other non-malarial zymotic diseases.

252. *Measles, whooping-cough and small-pox* fall with such frightful severity on races which have had little or no previous experience of them, that it is clear that the resisting power of such races is very low. It is difficult, however, to draw exact comparisons. As in the case of other diseases, the problem has not been studied hitherto from a biological standpoint. No works on the subject have been compiled, and one is able to form an opinion only on isolated references scattered through medical literature. The problem is complicated, moreover, by the fact that in countries new to them air-borne diseases usually prevail in an epidemic form when first introduced. So large a part of the community is stricken down, that the sick are apt to receive insufficient attention. The death-rate becomes high even out of proportion to the relative weakness of the resisting power. Nevertheless, though epidemics of air-borne diseases occasionally occur in the Eastern Hemisphere of such severity that almost every member of the community is attacked, yet the mortality never reaches the enormous proportions it does in the Western World. "We know the story of measles in Fiji, how in 1876 it swept away forty thousand out of the population of one hundred and fifty thousand. Measles when it attacks the Polynesians is no longer the infantile malady we know of. It becomes a devastating plague. The Tongans with the experience of Fiji in their memories, took, it is true, some

[1] Grieve, *British Guiana Medical Annual*, March 1, 1890.

precautions against the after effects of the disease; but nevertheless one twentieth of the population was carried off and the remainder was so demoralized that it was threatened with famine."[1]

253. Many Polynesians are able to recover from an attack of measles if properly tended. The disease, in itself, is so mild that it is not necessarily fatal even to individuals of a race which has undergone no evolution against it. But Polynesians suffer even when well tended to a disproportionate extent from various after effects. Thus Davis writing of the Samoan epidemic of 1893 writes:—"Until a few months ago measles had not entered this group (Samoa). It was conveyed to Tonga 500 miles south of us by the New Zealand steamer *Upolo* in June last, and from all accounts we have received it nearly decimated that group. The same steamer brought the contagion to our group nearly three months afterwards. Here, as in Tonga, the epidemic was at first mild. Comparatively few died at Samoa during the period of fever and rash. The sequelæ and complications have caused the mortality. I have not been able to obtain accurate statistics of the deaths from this recent epidemic throughout Samoa, as the ten inhabited islands of this volcanic and tropical group lie between five parallels of latitude, or, with intervening straits, cover nearly 270 miles; but judging from the accurate returns obtained here, and also from reports obtained from missionaries and others, no fewer than 1,000 of the entire population of 31,500 died from measles up to the end of December 1883, and nearly half of these adults. Since then there have probably been a few hundreds more.

254. "The epidemic was not malignant. Our mortality has arisen principally from gastritis, enteritis, diarrhœa, and dysentery. A few died from suppressed measles. The craving the natives manifest for raw fish, unripe or over-ripe fruit, and especially half-cooked fresh pork, became morbid during the period of convalescence. Many, lest they should be told to avoid these, abstained from procuring foreign medicine. Nine-tenths of the deaths could have been prevented by care in diet. The worst cases of diarrhœa and dysentery brought to me yielded to treatment. Cases under one's own personal supervision, and where instructions were followed, recovered. With the common strumous diathesis it has excited no surprise to see so many adults as well as children suffering from enlarged suppurating glands in the

[1] Thomson, *The Diversions of a Prime Minister*.

cervical and submaxillary regions, and in the groin, etc., not a few had parotid abscess with suppuration. Numerous abortions and cases of premature labour occurred, but none died with ordinary treatment. Single and multiple abscesses are an every-day occurrence here, but these have multiplied almost tenfold since the advent of measles. Before the rash had disappeared a large number of adults passed intestinal worms by the mouth.

"Now that nearly two months have elapsed since the last case of fever and rash, a mild persistent form of intermittent fever is prevailing. This with glandular and respiratory affections are the most common ailments at this season.

"In the missionary dispensary I am daily seeing cases of sickness the starting point of which was measles. The two epidemics of influenza at the end of 1891 and January 1893 increased the tendency of Samoans to chest affections. Measles will be found to have still further intensified their tendency to respiratory diseases; and the frequent deaths as well as the many debilitated natives one daily meets with, give evidence that we have not as yet reached the end of the measles epidemic—an epidemic which will long be remembered, as not one of the entire population seems to have escaped."[1]

255. Dr. Davis is doubtless right in attributing a great proportion of the deaths in the Samoan epidemic to improper treatment, but the conditions in that benign climate can hardly be worse than those to which little children are exposed by the ignorant inhabitants of our slums. Nevertheless the latter do not suffer from sequelæ to anything like the same extent.

256. Many epidemics of whooping-cough have occurred in the New World.[2] Last year (1903) it was said to be depopulating New Guinea. The disease is not very amenable to treatment, but as seen in adult Europeans it is not one which, especially in a warm climate, entirely incapacitates the sufferer from the ordinary duties of life. A widespread epidemic in an English colony, for example, would hardly result in decimation.

257. Small-pox also makes frightful ravages in communities that have had no previous experience of it, but, here again, the high mortality is undoubtedly due in part to the universal nature of the epidemic. The sick are left unattended. But, as in the case of measles, though many widespread epi-

[1] Davis, *British Medical Journal*, May 18, 1894.
[2] Hirsch, vol. iii., pp. 28–44.

demics are known to have occurred in the Old World, none were so terrible as those recorded in the New. Perhaps nothing demonstrates the low resisting power of races that have undergone no evolution against small-pox so clearly as the fact that a party of Esquimaux, who were taken to Berlin and vaccinated there, perished of the attenuated form of the disease.[1] Most even of our little children are able to recover from the unmodified form.

258. *Dysentery, Diarrhœa, Enteric Fever, etc.*—Malaria, tuberculosis, measles, whooping-cough, and small-pox afford ample proof that man's present evolution is mainly against disease; and moreover, that in different countries the direction of the evolution is different because different diseases differently determine it. Similar evidence is afforded by the study of a host of other diseases, for these like malaria and tuberculosis are invariably more fatal to strangers from beyond their areas of distribution, than to races that have long dwelt within the districts they infest. But, since few diseases are so prevalent within their areas of distribution, or so fatal as malaria or tuberculosis, evolution against few others is so clearly marked as against them. Moreover most other very prevalent and fatal diseases against which considerable evolution has occurred are those affecting the alimentary tract—that is, are those in which, generally speaking, infection depends on the character of the food and water-supply, especially the latter; and, therefore, as regards them, since strangers who enter the infected districts are usually Europeans, more careful as to their food and water than the natives of Africa and Asia, where these diseases chiefly prevail, they usually suffer from them less in proportion to their susceptibility than the natives. For instance, Europeans actually suffer less from cholera in India than do the natives, though their great susceptibility is proved by the history of the various pandemics during which the disease has overpassed its normal boundaries and ravaged Europe. It is therefore difficult to estimate with any degree of accuracy the extent of the evolution undergone by races that have had extended and disastrous experience of these diseases, for we cannot with accuracy contrast them with races that have had little or no experience of them, and, therefore, have undergone little or no evolution in relation to them. Nevertheless in all publications in which the subject is alluded to—official reports, medical works, travels, and so forth—we continually meet statements, collectively so

[1] *The Scottish Medical and Surgical Journal*, April 1900, p. 330.

numerous that volumes might be filled with them, that tend to show that the evolution has been considerable. Thus we read that, owing to malaria and dysentery Muscat is uninhabitable by Europeans during the summer months;[1] that in the districts infested by yellow fever strangers are vastly more liable to attack than natives;[2] that in Ceylon the mortality from dysentery among the troops reached the rate of 230 per 1,000;[3] and so forth. The following table extracted from the official *Report on Sanitary Measures in India* in 1892-3, exhibits the difference between the European and native troops in relation to the sum-total of the diseases prevalent in that country. In contrasting the two races it should, however, be borne in mind, that, while the whites, on the one hand, since they are mostly unmarried, suffer more from the venereal diseases than the natives, whereby their sick and death-rates are unduly raised, the natives, on the other hand, are more exposed to infection by other diseases. It should be noted, also, that many of the whites who were invalided home would have died had they remained in India, and, therefore, that the total death-rate of the Europeans should be calculated rather on the basis of "total loss" than of "deaths" when comparing it to the "mortality including absent deaths" of the natives.

ABSTRACT OF STATISTICS OF EUROPEAN TROOPS IN INDIA.

Year.	Average Annual Strength.	Ratio per 1000 of Strength.				
		Admissions.	Constantly Sick.	Deaths.	Invaliding.	Total Loss.
1870–79	57,742	1475	60	19·34	43	62
1881–90	61,399	1471	73	14·24	27	42
1882–91	62,229	1448	74	14·17	26	40
1891	67,030	1379	79	15·89	27	43
1892	68,137	1517	84	17·07	24	41

ABSTRACT OF STATISTICS OF NATIVE TROOPS IN INDIA.

Year.	Average Annual Strength Present.	Ratio per 1000.				
		Admissions into Hospital.	Constantly Sick.	Deaths from		Mortality including absent Deaths.
				Cholera.	All Causes.	
1877–81	118,669	1422	48	1·94	24·90	27·40
1881–90	116,712	1054	35	1·28	13·44	16 91
1882–91	118,111	1020	34	1·45	13·09	16·61
1891	128,600	972	35	2·64	15·44	18·34
1892	127,355	1092	37	2·14	14·97	18·67

[1] Hirsch, vol. iii., p. 283. [2] *Op. cit.*, vol. i., p. 340.
[3] *Op. cit.*, vol. iii., p. 296.

259. The following table shows the amount of child sickness and mortality among the whites in India:—

STRENGTH, SICKNESS, AND MORTALITY OF CHILDREN IN THE ARMY OF INDIA.

Year.	Average Strength.	Admission-rate per 1000.	Constantly sick-rate per 1000.	Death-rate per 1000.
1881–90	6286	633·5	23·4	50·22
1882–91	6220	609·4	22·2	50·63
1891	5886	509·0	19·2	49·27
1892	5762	564·6	22·0	48·59

260. It is not necessary to pursue this subject any farther. The facts are indisputable. No one doubts that races which dwell within the area infested by any prevalent and death-dealing disease are more resistant to it than races from beyond the area. The only possible question is as to how this difference in resisting-power arose. It is commonly said to be due to "acclimatization," a word which, when applied to races, even by the ignorant, is practically a synonym for evolution. A *race* that has undergone acclimatization is of course one that has undergone evolution. But this acclimatization, this evolution, is popularly supposed to result from the accumulation of acquired traits. It is now sufficiently clear that this is not the case. On the contrary, it is due solely to Natural Selection. We have already maintained that Natural Selection can act only when variations are spontaneous—that is when they are not caused by the influence of the environment. The study of disease, as we shall now proceed to show, demonstrates this point very clearly.

CHAPTER XII

THE ARGUMENT FROM DISEASE

The Lamarckian doctrine is certainly untrue—It is equally untrue that hereditary tendencies may be easily changed by the direct action of external forces—Professor Cossar Ewart's observations.

261. JUDGED, then, by the test of racial change in relation to disease, both the Lamarckian doctrine and the belief that the environment acting directly on the germ-plasm is the cause of variation would seem mistaken. The Lamarckian doctrine, indeed, is certainly and obviously erroneous. The very clinical evidence on which it is supposed to rest is founded partly on a misuse of terms and partly on an abuse of logic. Diseases *acquired* by the fœtus *in utero* are spoken of as congenital with the meaning implied that they are inborn. *Post hoc* is confused with *propter hoc*. The exception is supposed to prove the rule. Common experience is ignored, and rare coincidences are given the evidential rank of regular consequences. But the plain fact that diseases like tuberculosis do not render races degenerate, nor diseases like measles render races immune, is decisive testimony that acquirements are not even faintly and fitfully transmitted. [1]

262. The Lamarckian doctrine is not only untrue, it is inherently improbable. But the doctrine that variations

[1] Formerly all the world believed in the transmission of acquirements, and consequently all the world was constantly finding "conclusive" evidence of its constant occurrence. To-day there is hardly a rag of that evidence left; and, with rare exceptions, only certain French medical observers are able to discover fresh evidence. It is a remarkable fact, however, that the problem of evolution—of adaptation—has excited singularly little interest in France, and it is equally curious that these French observations relate almost entirely to laboratory work which it is not easy to repeat. In Great Britain or Germany, you may cut off the tails of a thousand dogs, or amputate the limbs of a thousand men, or observe the non-infected offspring of a thousand tuberculous patients, and get no evidence of transmission.

result from the play of environmental forces on the germ-plasm stands on a different basis. It is inherently probable. *À priori* it seems only reasonable to suppose that nutriment or toxins or similar powerful influences persistently applied must tend to cause radical changes in the germ-plasm exposed to them. But when we remember that species undergo evolution only under adverse conditions, and "degeneration" only under beneficial conditions; when we consider the facts of adaptation, and the impossibility of adaptation occurring except through the agency of unfettered selection, we are forced to the conclusion that the survival of the fittest must have rendered the germ-plasm nearly, if not quite, insusceptible to external influences, so far *at least as its hereditary tendencies are concerned.*

263. It is often argued that, since the somatic cells of the body are easily injured or benefited by influences from the environment, it is absurd to suppose that the germ-cells are inviolate. But this reason is founded on a double misapprehension. It has been asserted by no one that germ-cells are inviolate. It has been proved by no one that somatic cells are easily altered in their hereditary tendencies. On the contrary, we know that germ-cells may be readily injured and killed, and that somatic cells are particularly stable in their hereditary tendencies. Were these tendencies easily changeable in somatic cells, there could be no recovery from disease. During the whole period of life somatic cells proliferate, and so carry on the processes of growth, repair, and regeneration. Their multiplication is especially rapid under adverse conditions, as when a lymphatic gland is inflamed by the presence of toxic substances. But, though such a gland as a whole may be permanently altered by severe and prolonged inflammation, yet the lymphatic cells if they survive exhibit no hereditary change. Removal of the irritant causes immediate return to the ancestral type. A month or a year or twenty years after an histologist does not find a new variety of cells.[1] The same is true of all the other cells of

[1] Young cells, it is true, may be altered into more mature cells, thus skin cells may become horny. But no change is thereby made in their hereditary tendencies. The change is one for which their hereditary tendencies have prepared them. Whatever its subsequent alterations the descendant of a skin or connective tissue cell is always an ordinary skin or connective tissue cell to begin with. It may be that a real alteration of hereditary tendencies occurs during tumour formation. But even so the change is merely a reversion to a remote ancestral type, which external influences may call into activity but cannot create. (See *The Present Evolution of Man*, p. 49.)

the body. The truth appears to be, then, that both germ-cells and somatic cells, however capable of injury in other particulars, are exceedingly stable in their hereditary tendencies. Were the germ-cells not stable the species could not persist; were the somatic cells not stable the individual could not persist. Even when cells are exposed to injury so severe that many perish, the survivors still retain their ancestral traits.

264. It is widely believed by alienists, that various diseased conditions, especially phthisis, are causes of "mental instability" in offspring. It is possible of course that phthisical people may have an undue proportion of mentally unstable children, but even so it would not necessarily follow that parental phthisis is the *cause* of filial instability. The weakness against phthisis is specific, but it is well known that all causes which physically depress the individual increase the liability to infection. It is known also that similar causes tend to create mental instability. Parents tend to transmit inborn characters to offspring. A defective constitution, therefore, might expose one generation to phthisis and result in the next in mental instability. But in that case the filial instability would not be due to the parental phthisis. It does not appear, however, that statistics have been published which demonstrate that the children of the phthisical are more liable to mental instability than the children of the non-phthisical. Alienists have noted merely that many of the inmates of lunatic asylums, who, speaking generally, are drawn from a very poor class much exposed to disease, have a phthisical ancestry, a fact which may be noted of many people, especially those of the same class, outside the walls. Nor has it been shown that races which have been longest and most afflicted by phthisis, for example the English and the Lowland Scots, are mentally less stable than races that have been less afflicted, for example the Terra del Fuegians and the Highland Scots. *Moreover of late years the prevalence of phthisis has greatly decreased, whereas that of insanity has enormously increased.* Were the former the cause of the latter the exact opposite should be the case.

265. In his very interesting and valuable address to the Zoological Section of the British Association, Professor J. Cossar Ewart insisted that "there is a considerable amount of evidence in support of the view that changes in any part of the body or soma which affect the general welfare influence the germ-cells." He added—

266. "It may first be asked, Does disease, in as far as it

reduces the general vigour or interferes with the nutrition of the germ-cells, act as a cause of variation? I recently received a number of blue-rock pigeons from India infected with a blood parasite (*Halteridium*) not unlike the organism now so generally associated with malaria. In some pigeons the parasites were very few in number, in others they were extremely numerous. The eggs of a pair of these Indian birds with numerous parasites in the blood proved infertile. Eggs of a hen-bird with numerous parasites fertilized by a male with few parasites proved fertile, but the young died before ready to leave the nest. An old Indian bird, however, with comparatively few parasites, mated with a half-bred English turbit produced a single bird. The half-bred turbit has reddish wings and shoulders, but is otherwise white. The young bird by the Indian blue-rock is of a reddish colour nearly all over, but in make not unlike the cross-bred turbit hen.

267. "Some time before the second pair of eggs was laid, the parasites had completely disappeared from the Indian bird, and he looked as if he had quite recovered from his long journey as well as from the fever. In due time a pair of young were hatched from the second eggs, and as they approached maturity it became more and more evident that they would eventually present all the distinctive points of the wild rock pigeon. The striking difference between the first birds paired and the birds of the second nest might, however, be due not to the malaria parasites but to the change of habitat.

268. "Against this view, however, is the fact that another Indian bird infected to about the same extent as the mate of the half-bred turbit counted for little when mated with a second half-bred turbit; while two Indian birds in which extremely few parasites were found at once produced blue-rock-like birds when bred—one with a fantail and the other with a tumbler.

269. "Another possible explanation of the difference between the bird of the first and the birds of the second nest, is that the germ-cells were for a time infected by the minute protozoon *Halteridium* in very much the same way as the germ-cells of ticks are infected by the parasite of Texas fever. But of this there is no evidence, for even in the half-grown birds hatched by the pure-bred malarious Indian rocks the most careful examination failed to detect any parasites in the blood. In all probability *Halteridium* can only be conveyed from one pigeon to another by Culex or some other gnat.

270. "These results from pigeons suffering from malaria seem to indicate that the germ-cells are liable to be influenced by fevers and other forms of disease that for the time being diminish the vitality of the parents. Further experiments may show that the germ-cells are influenced in different ways by different diseases.

271. "Sometimes the germ-cells suffer from the direct action of their immediate environment, from disturbance in or around the germ-glands. If, for example, inflammation by the ducts or other channels reaches the germ-glands, the vitality of the germ-cells may be considerably diminished ; if serious or prolonged, the germ-cells may be as effectively sterilized as are the bacteria of milk by boiling.

272. "In 1900 two mares produced foals to a bay Arab which had previously suffered from a somewhat serious illness involving the germ-glands. The foals in no way suggest their sire. This year I have three foals from the same Arab after he had quite recovered ; one promises to be the image of his sire, and the other two are decidedly Arab-like both in make and action.

273. "While all the germ-cells are liable to suffer when the soma is the subject of disease, there is no evidence that they are capable of being so influenced that they transmit definite or particular modifications (unless directly infected by bacteria or other minute organisms); that, *e.g.*, the germ-cells of gouty subjects necessarily give rise to gouty offspring. Doubtless if the germ-cells, because of their unfavourable immediate surroundings, suffer in vigour or vitality, the offspring derived from them are likely to be less vigorous, and hence more likely than their immediate ancestors to suffer from gout and other disease."

274. The foregoing passages are quoted in full, since they contain evidence which is, probably, more conclusive, or at any rate more easy to handle, than any in medical literature. Owing to the less complex conditions, the danger of confusing *post hoc* with *propter hoc* is smaller. It must be admitted that Professor Ewart has proved that, for the time being, prepotency is affected by the condition of the germ-cells. But, though lack of health and vigour in the germ-cells of one parent may cause the characters of the other parent to preponderate in the offspring, yet no traits new to both parents arise in the offspring. Moreover, the suppressed traits are not necessarily lost to the species. It is very probable that they are rendered merely latent, and that they

will appear in subsequent generations.[1] The fact that the sick birds were more or less sterile does not bear on the point at issue. No doubt, when the birds are ill, the germ-cells, like the rest of the cells, are incapable, in a greater or lesser degree, of fulfilling their functions. It has long been known that ill-health is a cause of sterility. But the statement that the offspring were feeble is a very remarkable one. It would seem, if Professor Ewart's conclusions be accepted as embodying a general truth, that spermatozoa, which leave the male during his illness, are so weakened that even within the healthy female body, and after union with healthy ova, they produce debilitated offspring. In other words, such cells produce weakened cell-descendants. Neither in themselves nor in their descendants do they tend to recover. But if these same sperms reside for a longer time within the unhealthy body of the male, they can, in common with all the rest of his cells, recover perfectly and produce normal offspring when he recovers. So that the conclusion we are driven to is this, that the only cells in the whole body incapable of recovery are those *ripe* germ-cells which happen to pass to a healthy environment (the female body), and which enter into union with healthy cells. Professor Ewart himself believes that ripe germ-cells are specially liable to alterations which change their hereditary tendencies. He does not tell us what proportion of his Indian birds were ill, but apparently all, or nearly all, were infected. One, at least, was an old bird. It appears, then, that the disease is widely prevalent among pigeons in India, and that immunity is not easily acquired against it, any more than it is against malaria. How, if the disease is very prevalent, if it is of long duration, if infected birds tend to be sterile, if such offspring as they produce are enfeebled, and if these enfeebled offspring are exposed to the attacks of the parasite, the species continues to exist in its native habitat is a mystery. As a fact, however, of all Professor Ewart's observations only a single one lends support to his belief that offspring are enfeebled by parental disease. In this case two Indian birds, of which the male was much diseased and the female little affected, were mated. The union proved fertile, but the offspring perished, a circumstance which is obviously susceptible of several explanations more probable than the one Professor Ewart has given.

[1] Their reappearance is rendered probable by the experiments of Mendel (see notes to §§ 104 and 129), Darwin (*Animals and Plants*, vol. ii., p. 46), and other observers.

275. But now, supposing his explanations were confirmed, supposing it were proved by extended experiments that parental disease does commonly affect offspring, then another point would arise. What is the nature of the enfeeblement? Is it a true variation, a true alteration of hereditary tendencies? Or is it merely an acquirement, a mere temporary alteration of the germ-cell, which affects the individual which arises from it, but not his descendants? Professor Ewart regards it as a variation; but he does not appear to have confirmed his hypothesis by experiments on the descendants. If he is correct, then the mystery of the persistence of the species in India is deepened. It becomes still more difficult to understand why it was not exterminated long ago.

276. In view, however, of this persistence of the species we cannot avoid the conclusion that, however valuable Professor Ewart's observations may be as elucidating questions of prepotency and sterility, they do not, at any rate as yet, clear up the problem of the origin of variations.

277. It has been argued that an agency which enfeebles offspring need not necessarily cause enfeeblement of the race. Its effects might be counteracted by Natural Selection, which, by the elimination of the unfit, might raise the specific mean more than the enfeeblement of the offspring depressed it. But this line of reasoning is clearly invalid. It confuses two entirely distinct things, general vigour and specific resisting power. To take a concrete example;—malaria causes a general enfeeblement of those whom it afflicts. Presumably, if offspring are affected, they also suffer a general enfeeblement. But the individuals who survive exposure to malaria are not necessarily the strongest and most vigorous in a general sense. They are merely those who possess the specific power of making resistance to the protozoon and its toxins—a power which may occur in people who are otherwise weak. Thus big, strong, and vigorous Englishmen do not, apparently, resist malaria better than smaller and weaker men. That evolution against disease is entirely specific is shown by such a fact as that malaria has long afflicted races of very different physiques, and that the most finely-developed Polynesian is weaker against tuberculosis than the puniest Londoner. If then malaria eliminated the unfit against itself and *at the same time* enfeebled offspring, the one process would not counteract the other. On the contrary, the race would lose its general vigour at the same time as it increased its power of resisting the disease. Evolution is never perfect. Even Africans still suffer severely from malaria, almost every individual on the West

Coast being attacked, and many children perishing. Presumably they will continue to suffer to the end, since whenever evolution approaches perfection, reversion steps in. It follows that if malaria enfeebles offspring it must enfeeble and ultimately exterminate the race *notwithstanding the elimination of the unfit.* But there is not an iota of evidence that any race has been enfeebled by experience of any disease even when experience of the disease has extended over hundreds, perhaps thousands, of successive generations.

278. Again, it has been argued that, though malaria or other causes of enfeeblement may as a rule leave most offspring unaffected, it may yet affect a considerable number of offspring. These, being enfeebled, would be eliminated, and thus the race would still undergo evolution. It is difficult to meet arguments which depend wholly on a series of unproved hypotheses, but it is obvious that such a process would eliminate from the race a particular type of germ-plasm—the type that was capable of being altered in its hereditary tendencies. Natural Selection would therefore render the germ-plasm very stable. We have maintained nothing more than that the germ-plasm is stable, and that its stability has been evolved and is still being maintained by Natural Selection.

279. All evolution is a process of adaptation to the environment. The more complex the environment, the more complex must be the species that dwells therein. Its structures and faculties must be numerous and efficient in proportion to the diversity and magnitude of the contingencies it has to meet. For this reason a "higher" animal is more complex than a "lower." If the environment grows more complex the species must follow suit or suffer extinction. New structures and faculties must be evolved to meet new dangers, or old structures and faculties must be rendered more efficient to meet greater dangers. If the environment grows less complex the species must still follow suit. It must become less complex, or, overburdened with useless structures and faculties, it will no longer be adapted to the conditions of its existence. We know that both these reactions occur in nature. Every species undergoes progressive evolution under adverse conditions; that is, when the complexity of the environment increases. Every species undergoes regressive evolution (*i.e.* degeneration) under beneficial conditions; that is, when the complexity of the environment decreases.[1] But all evolution,

[1] The environment is never entirely beneficial. Under every known condition there are always some unfit who are eliminated. Thus civilized men, as a rule, have plenty of food, and among them the weak are

progressive and regressive, is founded on variations in individuals; and it is popularly believed that variations in individuals are caused or at any rate influenced by external agencies acting on the germ-plasm.

280. In the present state of our knowledge every theory of heredity which rightly aspires to be anything more than a mere working hypothesis is in effect a theory of the origin of variations. And every theory which seeks to account for variations has, as a necessary corollary, a theory of racial change. Setting aside miracle, there are only two ways possible of accounting for variations. First, we have the supposition that variations arise through the action of the environment on the germ-plasm, secondly, we have the supposition that variations arise spontaneously.[1] To me at least the theory of spontaneous variations does not imply mere "blind chance." It implies that variations arise through the action of a highly advantageous tendency to vary in all directions about the specific mean, which was evolved very early in the history of all life by Natural Selection, and which was a necessary antecedent to all other evolution.[2] The Lamarckian doctrine is no more than a particular application

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assisted by the strong. Nevertheless disease takes its toll and eliminates large numbers. But suppose a race existed in which every form of elimination except death from old age were suddenly abolished, so that even the weakest individuals had their full quota of offspring; then, in the fulness of time, the race would infallibly press on its food supply to such an extent as to check its increase. The survival of the fittest would again obtain; and under such conditions (*i. e.* if there were no struggle—an actually impossible condition) the fittest would be the smallest, the least complex, the most degenerate individuals—the individuals that required the least food.

[1] Weismann's hypothesis ingeniously combines both these hypotheses. He believes that variations are caused *in the first instance* by influences from the environment, but that they are subsequently shuffled and re-shuffled during the repeated acts of sexual reproduction. They are thus presented to nature for selection in the guise of spontaneous variations.

[2] To state the case in brief terms:—If variations are caused by external influences, then, though we are able to account for the variations of individuals, yet the species is evidently exposed to blind chance. It deteriorates helplessly under adverse influences. But if variations arise spontaneously, then, though the individual is exposed to blind chance, the species is not. Moulded by Natural Selection it meets every change in the environment, beneficial or adverse, with an appropriate reaction. Under the first hypothesis the evolution and persistence of species is inexplicable. Under the second we are able to understand how species not only persist, but, as a condition of persistence, adjust themselves with the greatest nicety to every change in the environment.

of the first theory. It supposes that particular external influences affect the germ-plasm in particular ways.

281. We have insisted, perhaps with wearisome reiteration, that the doctrine of Natural Selection is quite incompatible with the hypothesis that variations are caused by the direct action of the environment. If the one is true the other cannot be true. But the incompatibility has not been sufficiently recognized by biological thinkers. Probably this confusion of really opposed ideas would never have arisen if students of evolution had studied disease as closely as they have studied heredity, or, on the other hand, if students of medicine had devoted as much attention to the facts of adaptation as they have devoted to disease. The naturalist and botanist notes the close adaptation of every species to its place in nature, and perceives that the adaptation can have been brought about only through Natural Selection, or, in some cases, through the transmission of acquirements. As a rule, observation forces him to reject the Lamarckian doctrine. But to his mind Natural Selection generally presents itself as the sudden elimination of the unfittest by violent death. The antelope is slain by the lion, or escapes by the exercise of faculties which develop with use and so increase the general strength and vigour. The tree is uprooted by the storm, or develops a tougher fibre and sends its roots deeper. Seeing only one aspect of the problem he perceives nothing incompatible in the belief that adaptation is due to Natural Selection, and the belief that variations are caused by the direct action of the environment on the germ-plasm. He forgets that there are instances of adaptation other than against the causes of violent death. The medical man, on the other hand, studies the individual rather than the race ; and is preoccupied more with disease and other causes of slow decay than with the sudden death of healthy and vigorous individuals. Likewise perceiving only one aspect of the problem, he ignores the facts of adaptation, and very naturally concludes that causes which enfeeble the individual must tend to cause deterioration of the race. But if the causes of the slow deterioration of individuals be studied in conjunction with the facts of adaptation, it becomes impossible to doubt that Natural Selection must long ago—near the beginnings of life—have reduced the influence of the environment on the hereditary tendencies of the germ-plasm to a minimum.

282. It is quite possible, indeed it is more than probable, that even amongst the highest animals, individuals occur whose germ-plasm is more or less easily altered by external

influences; but under the normal conditions of existence such a type is among the most unfit, and, therefore, Natural Selection must tend constantly to purge the race of it.

283. Many readers may have found the foregoing discussion of the causes of variations very tedious. But the subject is of surpassing importance. Except we have clear and correct ideas concerning it we must go astray in our whole conception of life. Only by means of such a discussion was it possible to justify the position we have taken—the negative position that variations are not normally caused by the direct influence of the environment. A negative position even when founded on truth is always difficult and sometimes impossible to establish. Had we maintained that external influences do cause variations, we could easily have proved our case — if correct — by instancing a few incontrovertible examples; and this is what those who disagree with us should do. All nature is a field in which they may delve. Adopting the opposite conclusion, a like course is not open to us. Had we proved that this or that agency did not cause a change in the germ-plasm in this or that instance, we should have been told we were reasoning from the particular to the general. What did not occur in one instance might occur in other instances. Our only course, therefore, was to demonstrate that under the conditions in which life exists it is impossible that variations can be due, except only very rarely, to the direct action of environment. The fact that species undergo progressive evolution, not degeneration, when exposed to influences which poison or otherwise enfeeble the soma and the germ-cells is decisive.

284. Of this at least we may be sure, that, if external influences acting on the germ-plasm do alter offspring, then, in the immense majority of instances, the change is not a true variation, a true alteration of hereditary tendencies, but merely an acquirement which affects the individual, but not his offspring and descendants.

CHAPTER XIII

THE ORIGINS OF ZYMOTIC DISEASES

The microbes of disease are an infinitesimal portion of the total number of bacteria—Men acquire microbic diseases as a rule only from other men—The conditions necessary for the evolution of a microbic disease—The antiquity of microbic diseases—Their first origin—Their spread—Earth-, air-, and water-borne diseases—Epidemic and endemic disease—Epidemics in the ancient and modern worlds.

285. WHEN we attempt to solve the problem of the origin and evolution of zymotic diseases we are lost at once in a sea of conjecture. It is possible, however, to draw certain deductions which are not devoid of a high degree of probability. The pathogenetic microbes form an infinitesimal fraction of the total number of bacterial species. In nature it is not easy to find a speck of soil or a drop of water that is entirely sterile. Most species of bacteria are innocuous; that is, they are capable of a saprophytic existence only. It is a safe assumption that all parasitic forms are derived from saprophytic ancestors; otherwise we should have to uphold the belief, now very generally abandoned, that the highly specialized bacteria of human diseases arose by spontaneous generation after the evolution of the higher animals. It would be vain to speculate on the steps by which this or that species of pathogenetic microbe passed from a saprophytic to a parasitic mode of life. Possibly in some cases the passage was from dead organic material to healthy living beings by way of feeble or dying individuals in whom the power of resistance had been lowered, perhaps by famine. Whatever the steps of the transition, each species that became parasitic evolved special means of offence and defence, and special means of passing from host to host, and so securing the persistence of the species. Presumably all these changes were brought about by the agency of Natural Selection.

286. With few exceptions, certainly with few if any important exceptions, man cannot acquire zymotic disease except, directly or indirectly, through the medium of other men. Travellers in mountain or Arctic solitudes, in deserts or uninhabited islands, are never infected. Even malaria, which was long supposed to be an emanation from the soil, is not contracted, as Manson, Ross and others have demonstrated, except in the neighbourhood of other and previously infected human beings. Many diseases are strictly limited to man, as, for example, measles, scarlatina, and chicken-pox. Even when the same species of microbe (*e. g.* those of tuberculosis or malaria) infests both man and some other species of animal, the varieties differ, and, speaking generally, do not pass easily from man to the lower animals, or *vice versâ*. It follows that the microbes of man's more important diseases are, directly or indirectly, dependent on him for subsistence. Some of them, as those of syphilis, cannot maintain existence outside the human body. Others, as those of measles, are capable of maintaining existence for a limited time outside the body, but seemingly cannot multiply outside it. Their nutritive supply, their means of increase, lies wholly within the living tissues of man. Yet others, as those of cholera and enteric fever, which derive their nutritive supply from the contents of his alimentary canal as well as from his living tissues, are able, not only to exist in the external world, but to multiply there, provided that the medium in which they find themselves be contaminated with human excreta. Though in a true sense saprophytic, they are in a sense as true really parasitic on man.[1]

287. Since the pathogenetic micro-organisms of human diseases draw their nutritive supplies from man, obviously no disease can persist except among populations so

[1] That they are truly parasitic is proved by the fact that they are capable of invading the living tissues, *e. g.* the wall of the intestines. It has been said that the mass of decaying vegetation in the delta of the Ganges is the natural home of cholera. But, no matter how abundant the vegetation, cholera does not persist in streams on the banks of which the population is sparse, as, for example, the rivers of Africa and South America. It would seem, therefore, that the Ganges is the home of cholera, not because it contains much vegetable matter, but because it is an infected sewer, the most gigantic on earth. It is possible, of course, indeed it is probable, that the micro-organisms of cholera and other water-borne diseases may persist for an indefinite time in water in which there is much vegetable matter in solution, but in that case it appears evident that they persist as saprophytes that cannot re-acquire the parasitic habit. Otherwise it is difficult to understand why all the streams of the tropics are not now the homes of cholera.

crowded that the microbes are able to pass from one individual to another in unending succession. When the succession fails the disease dies out and is not renewed again except from foreign sources. Even in modern times microbic disease is comparatively rare among nomadic tribes, and, seemingly, was quite unknown in Arctic regions and in many Pacific islands before its introduction by Europeans. It follows that these maladies, in their modern well-defined forms, must have made their appearance only after men had peopled certain regions in considerable numbers. Bacteria, which had previously subsisted on decaying organic material or on lower animals, must then have changed their habits and gradually adapted themselves to the new and increasing supply of food. Since the microbic diseases of man are generally quite distinct from those of lower animals, and since probably they are more numerous, it is likely that in the majority of instances the passage was directly from a saprophytic life to an existence parasitic on man. The conditions for the evolution, persistence, and spread of disease are less favourable among lower animals. Men have not only lived in vast and settled communities from remote antiquity, but there has been more or less constant intercourse between their different communities. Many lower animals lead solitary lives. Many gregarious species wander from place to place in search of food and leave the sick behind to perish. Even when species are gregarious and inhabit fixed dwelling-places the spread and persistence of disease amongst them is checked by lack of intercourse between the different communities of the same species. Men, therefore, because they have presented a more constant and abundant supply of food, have suffered probably more from microbic disease than lower animals.

288. We have historical evidence of the antiquity of many diseases. Leprosy is mentioned in the book of Exodus as prevalent in Egypt. By other accounts we learn that it was prevalent in India, China, and Japan about the same time.[1] The fact that it had spread so widely argues an immensely greater antiquity. Venereal diseases are mentioned by Greek and Roman writers,[2] as is diphtheria.[3] "Consumption of the lungs may be traced with certainty in the writings of every period as far back as the earliest attempts of the ancient world to deal with medicine according to a

[1] Hirsch's *Handbook of Geographical and Historical Pathology*, vol. ii., p. 2 (New Sydenham Society).

[2] *Op. cit.*, p. 60. [3] *Op. cit.*, p. 73.

method."[1] The histories of dysentery,[2] cholera,[3] small-pox,[4] and other complaints are almost as old. But, while we have evidence of the extreme antiquity of many diseases, we have no clear account of the origin of any one disease. All the world over men are still brought into contact with saprophytic organisms; the total number of men has increased; their means of intercommunication, and therefore of spreading disease, has increased; yet still we never receive authentic accounts of a new disease. A new disease, in fact, appears always to be a disease newly noted, not one newly evolved. No sooner do we hear of an hitherto unknown malady than we begin to hear of its prevalence in past times. It seems probable, therefore, that the human race has not only undergone particular phases of evolution against particular diseases, but that it has undergone a general evolution against all bacterial infection. In that case saprophytic organisms have a greater gulf to bridge to-day than formerly. No doubt, under exceptional circumstances, the gulf is sometimes bridged, as in the septic infection of wounds. But even so the disease never spreads to normal healthy individuals. For obvious reasons, unless capable of infecting healthy individuals under normal conditions of life, a disease cannot persist.

289. It would appear, indeed, that saprophytic organisms are able to assume, with comparative ease, parasitic habits under special circumstances.[5] The main obstacle to the evolution of a new disease lies, therefore, not in the assumption of parasitic habits, but in the evolution of the means of passing in sufficient numbers from one healthy individual to another. Unless such individuals are very susceptible (*i. e.* susceptible to very small doses of bacteria), this evolution is difficult, the bacteria perishing before it is complete. Were the passage from a saprophytic to a parasitic existence easy, we would, considering the number of saprophytic forms with which we are surrounded, hear of a new disease every day. Indeed the persistence of the higher plants and animals would be impossible.

290. Confirmation of the above conjecture is afforded by the fact that children are less resistant than adults to diseases against which their race has undergone little or no evolution. They represent a stage in the life-history of the race when

[1] Hirsch, vol. iii., p. 169.
[2] *Op. cit.*, p. 285.
[3] *Op. cit.*, vol. i., p. 432.
[4] *Op. cit.*, p. 123.
[5] Possibly typhus and relapsing fever are examples. But they appear only under special circumstances, and disappear when these are removed.

the general evolution against disease was not so advanced.[1] Thus, while many adult Englishmen are able to resist

[1] Of course what is true of disease in general is even more true of disease in particular. Young individuals are much less resistant to a disease against which their race has undergone evolution than older people. This is notoriously true of phthisis in England. Many West African children perish of malaria, but, speaking comparatively, very few adults. The high proportionate death-rate from malaria of native children, and the fact that West Indian Negro soldiers suffer more at the beginning of their residence in Africa than later, has led Koch and other writers to suppose that no race is more resistant to malaria than any other race; that resisting power to malaria is purely an acquirement; and, therefore, that malarious countries are as suitable for residence to properly "seasoned" Europeans as to the natives. The real truth is, however, that individuals of races that have been long and severely afflicted by malaria are able to acquire immunity much more easily than individuals of races that have been less, or not at all, afflicted. Malaria occupies a position midway between such diseases as tuberculosis and such diseases as measles. Because permanent immunity against malaria is only slowly and partially acquired, races afflicted by the disease have undergone an evolution of inborn resisting power; but because it is possible to acquire a considerable degree of immunity there has been an evolution of the power of acquiring immunity as well. It is an undoubted fact that white people find it difficult, even under the best conditions obtainable, to rear families on the West Coast. The writer has in his possession a letter from Captain Henry Eckersley, who died from malaria after three seasons on the West Coast. In it that very brilliant soldier, whose death was so great a loss to his profession, states that when his regiment of West Indian Negroes first arrived on the Coast, both the white officers and the men suffered greatly; but that, after a single season, the men acquired immunity, whereas the officers continued to suffer as much as ever. The following from Miss Mary Kingsley is very much to the point:—

"Yet remember, before you elect to cast your lot with the West Coasters, that 85 per cent. of them die of fever, or return home with their health permanently wrecked. Also remember that there is no getting acclimatized to the Coast. There are, it is true, a few men out there who, although they have been resident in West Africa for years, have never had fever, but you can count them upon the fingers of one hand. There is another class who have been out twelve months at a time and have not had a touch of fever; these you want the fingers of your two hands to count, but no more. By far the largest class is the third, which is made up of those who have had a slight dose of fever once a fortnight, and some day, apparently for no extra reason, get a heavy dose and die of it. A very considerable class is the fourth—those who die within a month or a fortnight of going ashore.

"The fate of a man depends solely on his power of resisting the so-called malaria, not in his system becoming immuned to it. The first class of men I have cited have some unknown element in their constitutions that renders them immune. With the second class the power of resistance is great, and can be renewed from time to time by a spell home in a European climate. In the third class the state is that of cumulative poisoning; in the fourth of acute poisoning." (*Travels in West Africa*, pp. 526–7. Macmillan and Co.) Natives in countries in malaria in India and West Africa, it has been found difficult to rear English families in the former country and practically impossible in the latter. Young English soldiers perish more readily of cholera and dysentery than older men. The same is true of Polynesians and others when exposed to tuberculosis.

291. On the other hand we have no certain evidence that any parasitic disease has ever died out. The chances are all against such an occurrence. When once established as parasites the microbes, owing to the continual growth of human populations, would find a constantly augmented food supply, and constantly increased opportunities of reaching fresh fields of conquest. Preventive measures or other agencies have caused the partial disappearance of leprosy from several countries, but it is still very prevalent in many quarters of the globe. Contagious diseases have spread very widely. Air-borne diseases have become endemic instead of merely epidemic, and almost every child now suffers from measles, chicken-pox, whooping-cough, and small-pox, modified or unmodified. Sanitary science, which has left unaffected the air-borne maladies, has recently diminished earth- and water-borne diseases in some of the more highly civilized countries; but in the rest of the world they are, apparently, as prevalent as ever. We must conclude, therefore, that both the total disappearance of old diseases and the appearance of new diseases are events of the greatest rarity in the modern world, if indeed they ever occur.

292. The analogy of other forms of life renders it tolerably certain that the microbes of each disease, no matter how widely diffused at the present time, originated, each species of them, in a single centre from a single ancestral type of saprophytic organism. It is very improbable, for example, that types so highly specialized as the microbes of syphilis or rabies or measles had multiple origins. The constant tendency in nature is towards differentiation in type, not towards approximation. No one supposes, for example, that the varieties of apples or those of peaches have descended from two or more species which have become alike. On the contrary, our whole evolutionary conception of life leads us

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which malaria and yellow fever are prevalent tend to lose their immunity if they sojourn abroad, and then are apt to contract the disease on their return. Doubtless, when living within the area infected by the pathogenetic organisms they are often infected. A "passive" immunity results, which, however, is not permanent like the "active" immunity which follows actual illness and recovery from some diseases.

to suppose that the different varieties in each type had a common origin in one species from which they differentiated in various directions. Thus we attribute to cattle or dogs a common origin in a single centre from a single ancestral type. We do not suppose that they originated in diverse centres from diverse types which afterwards fused more or less.[1] The mere fact that the varieties are able to interbreed shows the community of origin. Indeed, while all nature affords evidence of the constant tendency towards differentiation, we know no instance of real approximation between diverse forms,[2] nor do we know of a single instance of the same form originating in diverse centres. We must conclude, therefore, that it is in the highest degree probable that each disease arose in a single centre, whence it spread till it reached its present limits.

293. As in the case of other forms of life, we have every reason to suppose that the human race arose in a single centre from a single ancestral type. All our information indicates the Eastern Hemisphere as the place of origin. Parts of it have been inhabited by a dense and settled population from a time immensely remote. "Behind dim empires ghosts of dimmer empires loom." Beyond the traces of the oldest empires we find traces of primitive agricultural communities, and far beyond these the remains of the cave-men and hunters of the Stone Age. Even a race of hunters tends to increase faster than the food supply. Doubtless the pressure of population in the Old World led to the colonization of the New. But even in the New World there are signs of a civilization so ancient that some authorities have placed its beginnings as far back as a score or more of thousands of years. Now, with the exception of malaria, it is extremely doubtful whether any zymotic disease existed in the whole of the New World at the time of its discovery by

[1] It is very probable, as Darwin supposed (*Animals and Plants*, vol. i., pp. 34–85), that domesticated dogs and cattle have descended from several wild varieties, but his own labours have rendered it clear that all the wild varieties were descended from a common ancestral form. Moreover, among them, even under domestication, there has been much more differentiation than approximation. It is possible, of course, for closely-related varieties to interbreed and so fuse into a single variety, but this rarely if ever happens except in the case of domesticated animals. No one has ever maintained that unrelated forms of micro-organisms interbreed.

[2] Thus, though the whale has mimicked the fish, though certain species of insects have mimicked other species, the resemblance is in outward form only. The internal structural differences remain as great as ever.

Columbus. The subject is involved in obscurity, but, while it is evident that the European adventurers introduced many diseases, there is no clear indication that they found and brought back one. Apparently all the diseases which have been prevalent in Europe and America during the last four hundred years were prevalent in the former continent before the fifteenth century. Syphilis and yellow fever have sometimes been regarded as exceptions. But syphilis was well known to the Roman physicians and was common during the Middle Ages.[1] Moreover, the inhabitants of the New World take the disease in a very acute form, and it is not found in remote communities to which Europeans have had no access. Yellow fever was first noted with certainty in the West Indies in the middle of the seventeenth century. The records of the time "tell of the importation of the disease from place to place, and from island to island."[2] Not till more than a century later was it observed on the West Coast of Africa. There can be no doubt that the earlier observers confused yellow fever with bilious malaria, and that it was present both in the West Indies and Africa long before a differential diagnosis was made.[3] The fact that of all races Negroes are most resistant to the disease would seem to indicate West Africa as the place of origin. In any case it is certain that with the exception of malaria, zymotic disease, if not entirely absent, was extremely rare in the New World. That fact is of high significance. It demonstrates the extreme difficulty with which saprophytic organisms evolve parasitic habits, and the extreme improbability of the hypothesis that any disease has had multiple origins in more than one centre.

294. We have no means of judging whether the enormously prolonged separation between the inhabitants of the Old and the New Worlds occurred before or after the evolution of zymotic disease among the former. Even if it had occurred before the separation, zymotic disease could hardly have persisted among the isolated bands of roving hunters, who penetrated into lands where there were no other human beings. Even contagious disease could hardly have persisted under conditions so adverse. The fact that malaria was found on both sides of the Atlantic and the Pacific is very remarkable. It indicates, perhaps, that some at least of the human invasions of America occurred otherwise than by way of the Arctic Zone. Since men have drifted in boats to

[1] Hirsch, vol. ii., p. 60. [2] *Op. cit.*, vol. i., pl. 317–18.
[3] *Op. cit.*, p. 317.

every island of the Pacific, it is not impossible that malaria was thus introduced. The only alternative is that infected mosquitoes, borne on driftwood or driven on tempests, crossed separately.

295. Pathogenetic organisms are exposed to climatic and other influences external to the body only during their passage from one human being to another. It is this that bestows on the mode of infection its importance. The parasites of contagious diseases, passing directly from one person to another, are thoroughly protected from external influences, and, therefore, are capable of existing in, or of travelling to, every part of the habitable globe. They may afflict nomadic peoples or small isolated communities almost equally with large and populous centres. At the other extreme the microbes of malaria, which are conveyed from person to person by means of a particular species of mosquito, are infective only within the area frequented by the mosquito. As, with the possible exception of certain islands, the mosquito is already present in nearly every region suitable to its existence, malaria is now almost incapable of extending its boundaries. Anciently, no doubt, owing to the long duration of the disease, it spread with extraordinary rapidity. Air-borne diseases (measles, chicken-pox, small-pox, whooping-cough, influenza and the like) are almost as well able to travel as contagious diseases. Conveyed to long distances by a succession of infected individuals, or by infected clothing, they spread with extraordinary rapidity on reaching new ground. They quickly infect the whole population, but for that very reason, and because immunity is quickly acquired against them, they soon exhaust the food supply, and, therefore, are apt to die out among nomadic tribes, or in small and isolated communities.

296. Of all diseases except those carried by insects, the water- and earth-borne maladies are most under the influence of conditions external to the human body. Cholera and dysentery are natives of warm climates, and seldom, and then only under especially favourable conditions, make incursions into colder regions. A high temperature is favourable also to typhoid. All water-borne maladies are, moreover, essentially crowd and filth diseases. A settled population and a continuously infected water supply are necessary conditions of their permanence. When spreading beyond the areas in which they are endemic, they usually travel along the great trade routes, and, therefore, more rarely than the air-borne diseases afflict nomadic peoples and small isolated communities. In

effect a house disease which is seldom if ever contracted outside the walls of a building, tuberculosis, also, is a malady of settled and more or less crowded populations. Nomadic peoples never acquire it except by intercourse with settled populations. Like malaria, or such contagious diseases as are of long duration, it is pre-eminently capable of journeying to the most distant parts of the globe.

297. Zymotic disease, then, arose originally among the slowly-growing populations of the Old World. Air-borne diseases and diseases borne by lower animals may have arisen among the early hunters and nomads. Similar forms of disease, for example, distemper, rinderpest, the horse-sickness in South Africa, the rabbit plague in Northern Canada and the cattle-fever in Texas, occur among lower animals, when these are present in considerable numbers. With the exception of tuberculosis and leprosy endemic disease was probably almost unknown in the sparsely-peopled ancient world. The facts that air- and water-borne diseases spread very rapidly, that the illnesses caused by them are comparatively short and sharp, and that recovery is followed by immunity must have caused rapid exhaustion of the food supply of the microbes. Under such conditions the persistence of the pathogenetic species was maintained among the scanty populations by a passage to new and perhaps very distant sources of supply. Introduced by travellers or spreading from tribe to tribe, they appeared suddenly in epidemic form as plagues and pestilences, and, disappearing as suddenly, were not known again till a fresh generation furnished a fresh supply of food. When, however, in spite of war, famine, and pestilence, the human race increased to such an extent that the number of fresh births furnished a perennial supply of food, while at the same time a rising civilization and improved means of communication lessened the isolation of various communities, then many diseases slowly passed from an epidemic to an endemic form. Pestilence grew less, but every individual was exposed to infection, and, during youth, either perished from or acquired immunity against the more prevalent forms of disease.[1]

[1] At the present day air-borne diseases are endemic in England. But they are epidemic in places where the population is more sparse and intercourse between separate communities less frequent, as in Tropical Africa and Northern Asia and America. An epidemic occurs when a great many members of the community are susceptible. It ceases when all or most of the surviving members are immune—that is after the disease has attacked a very susceptible community. The disease, especially if it be one which confers permanent immunity, is then apt

298. Zymotic disease—at any rate disease against which immunity can be acquired—when endemic is far less terrible than when epidemic. Modern examples of ancient epidemics may be seen in isolated regions. In Pacific islands, for example, air-borne disease spreads like a flame. The whole community is stricken down. The sick are left untended and perish in multitudes. The fields, the entire business of the community, is neglected, and famine frequently follows. Under such conditions measles or whooping-cough, diseases which we in England are accustomed to regard as scarcely more than nuisances, may rise to the level of a great national disaster. Thus in 1749 thirty thousand natives perished of measles on the banks of the Amazon.[1] In 1829 half the population died in Astoria.[2] In 1846 it committed frightful ravages in the Hudson Bay Territory.[3] More recently a quarter of the total inhabitants was swept away in the Fiji group.[4]

299. At the dawn of history, long after the evolution of zymotic disease, the population of the Eastern Hemisphere was still sparse and scattered. Even as late as the Norman Conquest that of England was barely two millions—about one-third of the number now present in London. Means of

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to disappear for a considerable time—until the number of new births provides a fresh supply of food. Consequently severe, and therefore rare, epidemics occur more especially in small and isolated communities. Large and less isolated communities provide a perennial supply of food, and maintain or receive a perennial supply of microbes. Amongst them, therefore, the disease tends to be endemic. Of course if the microbe is of a kind which is much exposed and very susceptible to conditions external to the human body (*e.g.* the bacillus of cholera), epidemics tend to recur only when these conditions also are favourable. If they are seldom satisfied, the disease will seldom occur except in an epidemic form. It will be endemic only in favourable localities in which the population is large. When a disease is endemic the elimination of the unfit is very thorough. Almost every individual who is weak against the disease perishes, but hardly any individual dies through mere lack of attendance or from famine caused by the disease. But when the disease is epidemic many of the unfit may survive and have offspring during the long intervals which, perhaps, intervene between one visitation and the next. Moreover, during the visitation many individuals who are fairly resistant may perish from mere lack of attendance or from famine. An endemic disease therefore does its work of elimination more "cleanly" and completely than an epidemic disease. It follows that races that have suffered from endemic disease should be—as they are—more resistant than those who have suffered merely from epidemic disease.

[1] Hirsch, vol. i., p. 167.
[2] *Op. cit.*, p. 167.
[3] *Op. cit.*, p. 158.
[4] *Op. cit.*, 167.

communication were poor and beset by dangers. A journey from York to London was then a more serious affair than a journey from London to San Francisco is to-day. As in Pacific islands, water- and especially air-borne diseases were, therefore, absent during long periods of time. When they came they spread as epidemics. Accordingly we read of plague and pestilence; of diseases suddenly becoming epidemic and sweeping away a fourth or a half of entire communities. Historians are apt to attribute these immense catastrophes partly to the bad sanitation of the period and partly to diseases which have died out of the world, or at any rate out of Europe. Doubtless they are right in a few instances. But, apart from diseases which spread under special circumstances from tropical centres, bad sanitation, under modern conditions of intercommunication and crowding, tends to render water-borne disease endemic, not epidemic. Over air-borne disease it has no effect. Measles, whooping-cough, chicken-pox, influenza, common cold, and small-pox (in a modified form) are as common as ever.[1] The character of these ancient epidemics, their special symptoms as indicated in old literature, their sudden and portentous appearance

[1] The foregoing has an interesting bearing on the vaccination controversy. It is abundantly evident that sanitation has not banished small-pox. We owe much to modern sanitation. It has immensely reduced the water-borne diseases. It has to some extent diminished the earth-borne diseases. But it has failed totally against air-borne diseases. It is possible to keep untainted our water supply, and to clean and disinfect our houses. But we can neither keep untainted nor disinfect the air. Its volume is too vast, its flow too swift. A great many people contend that vaccination has not banished small-pox. Let us for a moment, and for the sake of argument, grant that contention. It follows, since immunity against small-pox is acquired, not inborn, and since so few of us have suffered from the disease, that practically the whole community is susceptible. Under these circumstances what has caused the almost complete disappearance of a disease which until lately was endemic and almost universal among us? We are told isolation. The answer indicates surprising confusion of thought. We cannot isolate any one when every one is susceptible—at any rate, in the case of air-borne disease. The attendants of the sick themselves fall ill and spread the infection. Isolation is possible only when the great mass of the community is immune, when only the exceptional individual is capable of taking the disease. Under opposite conditions the pestilence spreads like a prairie fire. By itself isolation has no greater power of controlling small-pox than the historic old lady with a broom had of sweeping back the Atlantic. In the absence of vaccination it would be worse than useless. Better it were a thousand times that small-pox should be endemic amongst us than it should be epidemic. In the former case many people would lose their lives, and practically the whole community would be disfigured. In the latter case the very existence of the race would be menaced.

which men attributed to the wrath of God, their tremendous infectivity and rapid spread, their equally sudden and complete departure as of Divine anger assuaged, point rather to air- and water-borne diseases of the types now endemic and comparatively harmless among us; but still so fearful in their effects on isolated communities. Like the light flashed from a child's mirror on a darkened wall, so they flickered and swept forwards and backwards from end to end of the Old World—from the Malay Peninsula to the North Cape of Norway, from Kamschatka to the South point of Africa. A parallel may be found in the recent epidemic of rinderpest amongst the herbivorous animals of Africa. Years might pass, old men might remember, the peoples might sacrifice to their gods; but when a fresh generation of those who knew not the disease had arisen, when the harvest of the non-immune was ripe and ready, the diseases would return to the dreadful reaping. Behind them the earth was heaped with the dead, and the few and stricken survivors grubbed for roots to satisfy their hunger. To-day sanitation has nearly abolished water-borne disease; and, in a population largely immune, epidemics of air-borne disease, like a light thrown on a sun-lit wall, are but faint simulacra of that which they were in their old days of awful power.

300. The progress of consumption was different. It was never truly epidemic. Owing to its low infectivity, to its lingering nature, to the fact that no immunity could be acquired against it, it did not spread suddenly when first introduced, but when once established its virulence did not abate within measurable time. In other words, it was endemic from the beginning. It made its home in the hovels of the early settlers on the land. In such situations—as in Polynesian villages—modern Englishmen do not take the disease. But their remote ancestors were more susceptible; they could be infected by a smaller dose of bacilli. Gradually as civilization advanced the conditions grew more stringent. Men gathered into larger and denser communities, into hamlets and villages in which they built houses ill-lighted and worse ventilated.

301. With the rise of towns, and ultimately of great cities, the stringency of selection continually increased; and, with it, step by step, the resisting power of the race. To-day Englishmen dwell under conditions as impossible to their remote ancestors as to the modern Red Indians. In fact, no race, especially in cold and temperate climates, is now able to achieve civilization, to dwell in dense communities, unless it

has previously undergone evolution against tuberculosis. But of this more anon.

302. So during the long sweep of the ages microbic diseases strengthened their hold on the inhabitants of the Eastern Hemisphere, who, in turn, slowly evolved powers of resistance. In like manner antelopes grow swift and wild sheep active when persecuted by beasts of prey. Then, when the germs of disease were rife in every home and thick on the garments of every man, there occurred the greatest event in human history, the vastest tragedy. Columbus, sailing across an untracked ocean, discovered the Western Hemisphere. The long separation between the inhabitants of the East and the West ended. The diseases of the Old World burst with cataclysmal results on the New.

CHAPTER XIV

BACTERIA AS EMPIRE BUILDERS

Air- and water-borne diseases in the Western Hemisphere—Tuberculosis—The extinction of the natives—The colonization of the New World by European nations—The causes of success or failure—The foundations of empire—The cessation of the great migrations.

303. THE ancient condition of the Old World was reproduced in the New. Again we read of plague and pestilence, of water- and air-borne diseases coming and going in great epidemics, and of the famines that followed. Measles and, in later times, cholera piled the earth with the dead. The part played by small-pox was even greater. When taken to the West Indies in 1507 whole tribes were exterminated.[1] A few years later it quite depopulated San Domingo. In Mexico it destroyed three and a half millions of people.[2] Prescott describes this first great epidemic as "sweeping over the land like fire over the prairies, smiting down prince and peasant; and leaving its path strewn with the dead bodies of the natives, who (in the strong language of a contemporary) perished in heaps like cattle stricken with murrain." In 1841 Catlin wrote of the United States, "Thirty millions of white men are now scuffling for the goods and luxuries of life over the bones of twelve millions of red men, six millions of whom have fallen victims to small-pox."

304. But the principal part was played by tuberculosis. Air- and water-borne diseases generally left an immune remnant, but against tuberculosis no immunity could be acquired. Red Indians and Caribs could not in a few generations achieve an evolution which the inhabitants of the Old World had accomplished only after thousands of years and at the cost of hundreds of millions of lives. Civilization, which implies a dense and settled community with cities and towns, had suddenly become a necessity, but remained an impossibility to all the inhabitants of the temperate parts of the

[1] Hirsch, vol. i., p. 136. [2] *Ibid.*, vol. i., p. 137.

West. It is a highly significant fact that throughout the New World no city or town has its native quarter, whereas every European settlement in Asia and Africa has its native suburbs. The aborigines of the New World are now found only in remote or more or less inaccessible parts. The following is an example of the manner in which tuberculosis went to work: "The tribe of Hapaa is said to have numbered some four hundred when the small-pox came and reduced them by one fourth. Six months later a woman developed tubercular consumption; the disease spread like fire about the valley, and in less than a year two survivors, a man and a woman, fled from the newly-created solitude. . . . Early in the year of my visit, for example, or late the year before, a first case of phthisis appeared in a household of seventeen persons, and by the end of August, when the tale was told me, one soul survived, a boy who had been absent at his schooling." [1]

305. The Caribs of the West Indies are almost extinct. The Red Indians are going fast, as are the aborigines of cold and temperate South America. The Tasmanians have gone. The Australians and the Maoris are but a dwindling remnant. As surely as the trader with his clothes or the missionary with his church and school-room appears the work of extermination begins on Polynesian islands. Throughout the whole vast extent of the New World the only pure aborigines who seem destined to persist are those which live remote in mountains or in the depths of fever-haunted forests, where the white man is unable to build the towns and cities with which he has studded the cooler and more "healthy" regions of the North and South. Many explanations, or pseudo-explanations, have been offered to account for the disappearance of the natives. We are told that they cannot endure "domestication," that they "pine like caged eagles" in confinement, that the change produced by civilization makes them infertile as the change produced by captivity makes some wild animals infertile, and so forth. But the only peoples who are disappearing are those of the New World, some of whom were by no means savage. In Asia and Africa are many tribes far lower in the scale of civilization who have persisted in constant communication with dense and settled communities from time immemorial. Notwithstanding all that has been written the people of the New World do not wither away mysteriously when brought into contact with the white man. They die as other men do

[1] *In the South Seas*, p. 27 (R. L. Stevenson).

of violence, or famine, or old age, or disease. But deaths from all these causes, except the last, are now comparatively rare amongst them—much rarer than formerly during the time of their perpetual wars. The vast majority die of imported diseases—exactly the same diseases as white men die of. But their mortality is invariably much higher than that of white men; they perish on an average at a younger age. All this is not mere hypothesis. It can be proved by reference to carefully collected and tabulated statistics published by every Department of Public Health in America, Australasia and Polynesia. The cause of the sterility cannot be demonstrated with the same precision; but it is hardly necessary to invent fanciful causes, when a reasonable one is to hand. The high mortality indicates a high sick-rate, and presumably illness is as much a cause of sterility in the New World as in the Old, and among savages as among civilized people.

306. The Spanish Conquest of the West Indies was followed by the swift disappearance of the natives. To that end the Spanish unconsciously adopted the most effective means possible. They satisfied their greed by forcing the natives to labour in plantations and in mines, and their religious enthusiasm by compelling attendance in churches and cathedrals. In other words, they placed the natives under conditions the most favourable for acquiring the diseases which they imported by every vessel. When the native population dwindled it was replaced by Negro slaves from West Africa. The case of the latter is extremely interesting. No colony of Africans has ever succeeded in Europe or Asia, where the mortality from tuberculosis grows so great that the immigrants soon become extinct.[1] Nevertheless even in West African forests Negroes have undergone some evolution against tuberculosis.[2] It was not enough to enable them to persist in the densely-peopled parts of Europe and Asia, but it was enough to enable them to persist under the conditions they found in the islands and on the mainland of America. In America tuberculosis, as compared to its prevalence in Southern Europe and Asia, had as yet spread but little. The slaves were taken to the warmer parts of the country and employed mainly in agriculture. They had a special start and were placed under conditions that grew worse

[1] A stream of African slaves was poured into parts of Europe and Asia for many years. They have left no trace on the population.

[2] Many accounts have been published of the prevalence of tuberculosis in Africa. See Hirsch, vol. iii., pp. 189–92.

only very slowly as the density of the population slowly increased. As a result they underwent evolution, and are now able to persist even in the towns and cities of the United States, though, as their high mortality shows, with difficulty. Judging from the fate of Negro colonies in Europe and Asia there can be but little doubt that a new immigration of Africans into America would now have a speedy and disastrous termination.

307. After the discovery of America the principal maritime races of Western Europe competed for its possession. Spain and Portugal, then powerful nations, had the first start in the race, and chose the seemingly richer tropics. But the forests of the centre and South were defended by malaria, which raised a barrier against immigration, and by heat and light, which raised a barrier against tuberculosis. Moreover, the Spaniards and the Portuguese intermarried freely with the aborigines, and the mixed race which resulted inherits in half measure the resisting power of both stocks. At the present day this mixed race, with a leavening of mulattoes and of pure Spaniards, Portuguese, and Negroes, inhabits the cities and more civilized parts. Even in tropical America the pure aborigines are found, speaking generally, only beyond the verge of civilization. Farther South the disappearance of the natives has been more complete, and the cooler, healthier, and more open pampas are settled by a race more purely European.

308. The weaker British and French were shouldered into the seemingly inhospitable North. But the British won the battle of Quebec and the French immigration soon ceased. That little fight is half forgotten, but it is doubtful if any battle in all history had results half so important. It placed all North America in the grasp of the Anglo-Saxon, and gave his race enormous space for expansion. Unchecked by malaria the new-comers gathered into communities and built towns and cities such as those which across the Atlantic were the homes of tuberculosis. The cold forced them to admit little air and light into their dwellings. The aborigines melted away from the borders of the settlements. Under the conditions there was little intermarriage. In that climate Indian women and even half-caste children could not exist within stone walls. The few white men who took native wives preserved them only while living a wild life remote from their kin.

309. The British conquest of North America and Australasia resembles the Saxon conquest of Great Britain. The

natives have been exterminated within the area of settlement. It is in sharp contrast to their conquests in Asia and Africa. Both in the Old World and in the New the subjugation of the natives was accompanied by many wars and much bloodshed, and probably the conflicts in the former were more prolonged and destructive than those in the latter. But in no part of the Old World have the British exterminated the natives. They do not supplant them, they merely govern them. Southern Asia and East and West Africa are defended by malaria. The British cannot colonize them, and the natives have undergone such evolution against tuberculosis, that they are capable, under favourable conditions, like the American slaves, of resisting the hard conditions imposed by modern civilization. In South Africa, where there is little malaria, Europeans share the land with the natives, but the latter are likely to remain in an overwhelming majority.

310. If history teaches any lesson with clearness it is this, that conquest to be permanent must be accompanied with extermination; otherwise in the fulness of time the natives expel or absorb the conquerors. The Saxon conquest of England was permanent; of the Norman conquest there remains scarcely a trace. The Huns and the Franks founded permanent empires in Europe; the Roman Empire and that of the Saracens in Spain soon tumbled into ruins. It is highly improbable, therefore, that the British will retain their hold on their Old World dependencies. A handful of aliens cannot forever keep in subjugation large and increasing races that yearly become more intelligent and insistant in their demands for self-government. But no probable conjunction of circumstances can be thought of that will uproot the Anglo-Saxons from their wide possession in the New World. The wars of extermination are ceasing with the spread of civilization. We have ransacked the world and now know every important disease. Diseases cannot come to us as they came to our forefathers and to the Red Indians, like visitations from on high. All the diseases that are very capable of travelling have nearly reached their limits, the rest we are able to check. Even in the unlikely event of a new disease arising it would affect other races equally. Canada and Australasia like the United States may separate from the parent stem, but the race will persist. If ever a New Zealander broods over the ruin of London he will be a New Zealander of British descent.

311. The Natural History of Man is, in effect, a history of his evolution against disease. The story unfolded by it is

of greater proportions than all the mass of trivial gossip about kings and queens and the accounts of futile dynastic wars and stupid religious controversies which fill so large a space in his written political history. In the latter as told by historians, groping in obscurity and blinded by their own preconceptions, men and events are often distorted out of all proportions. A clever but prejudiced writer may pass base metal into perpetual circulation as gold. Luther and the Reformation are accepted as Divine by many people; they are reviled as diabolical by more. Cromwell was long regarded as accursed; to-day he is half deified. How many of us are able to decide on grounds of fact, not of fiction, whether the Roman Empire perished because the Romans, becoming luxurious, sinned against our moral code, as ecclesiastic historians would have us believe, or because a disease of monkish bigotry and stupidity clouded the clear Roman brain and enfeebled the strong Roman hand, as Gibbon would have us think. But the Natural History of Man deals without obscurity and without uncertainty with greater matters. Study it, and the mists clear away from much even of political history. We see clearly how little the conscious efforts of man have influenced his destiny. We see forces, unrecognized, enormous, irresistible, unchanging, working slowly towards tremendous conclusions—forces so irresistible and unchanging that watching them we are able even to forecast something of the future.

312. The mere political results of Man's evolution against disease are of almost incalculable magnitude. The human races of one half of the world are dying, and are being replaced by races from the other half. Not all the wars during all time taken together constitute so great a tragedy. A quite disproportionate part in this great movement has been borne by our own race. It has seized on the larger part of those regions in which the aborigines were incapable of civilization and were undefended by malaria. In the great void created by disease it has more room wherein to spread and multiply than any other race. The world-predominance of the future, therefore, seems assured to it. Our birth-rate, it is true, is falling, and is likely to fall still more. It is lower than that of many other peoples. But medical men know that the fall is due to no loss of natural fecundity; but merely to the inevitable spread of physiological knowledge—a knowledge which is being gradually acquired and used by all civilized races. Other nations may dream of foreign conquest, but the time for founding permanent

empires is past. There remains for them only temporary conquest in a few malarious parts of the world in which European nations cannot flourish and supplant the natives. Spain and Portugal lost their opportunity when they turned from the temperate regions and chose the tropics. France lost her opportunity on the heights of Abraham. Germany is more than a century too late in the start. Russia can conquer only hardy aliens, who will multiply under her rule and ultimately assert their supremacy.

313. In times now far remote in the history of civilized peoples, the sword was the principal means for digging deep the foundations of permanent empires. Its place was taken by a more efficient instrument. A migrating race, armed with a new and deadly disease and with high powers of resisting it, possesses a terrible weapon of offence. But now disease has spread over the whole world and so is losing its power of building empires. The long era of the great migrations of the human race, of the great conquests, is closing fast.

CHAPTER XV

NARCOTICS

A mental problem—The elimination due to alcohol—The reasons why men drink—Self-control—Will-power—Variations amongst drinkers—Alcoholic selection—Racial differences—Alcoholic evolution—Is parental intemperance the cause of filial degeneration?—Opium—The sobriety of South Europeans—The comparative drunkenness of North Europeans—The excessive drunkenness of some savages—The sobriety of others—Intemperance in the ancient world—Climate—Potency of beverages—Environment—The memory of past disasters—Civilization—Education—The parallel between diseases and narcotics.

314. Zymotic disease is not the only selective agent of elimination among civilized men. Certain narcotics are causes of an elimination quite as great and every whit as selective as that caused by any disease. Like diseases narcotics choose for elimination individuals of a certain type, and for survival individuals of the opposite type. But the choice made by narcotics is determined primarily not by the physical but by the mental characters of the person selected. The man who dies of alcohol or opium is not necessarily one who is especially liable to be injured physically by excessive indulgence. He is always one to whom the sensations produced by excessive drinking are especially delightful. His drinking habits and, therefore, his elimination, are determined, not by peculiarities of body, but by peculiarities of mind. Strictly speaking, therefore, the study of the effects produced by narcotics should be deferred till we have considered the phenomena of mind. But from the point of view of heredity the analogy between narcotics and diseases is so close that it is more convenient to deal with them at once, especially as narcotics usually kill by producing disease.

315. It is hardly worth while, indeed it is hardly possible to produce direct evidence of the precise magnitude of the mortality caused by alcohol, the most widely used of all

narcotics.[1] The Registrar-General announces it as ·26 per cent. of the total number of deaths in England. But, in this particular, his returns are worthless. For very obvious reasons "alcoholism" is very seldom introduced into a British death certificate. Physicians generally prefer to mention the immediate cause of death—cirrhosis of the liver or kidney, or disease of the nervous or vascular system, or what not. In Switzerland where the death certificate is a secret official document handed by the medical attendant, not to the friends of the deceased, but to the registrar, the deaths directly due to alcohol are announced as 2·47 per cent.—that is nearly ten times as many as in England. Taken in conjunction with deaths indirectly due to alcohol (from cirrhosis, etc.) they are announced as 10 per cent.[2]—that is nearly fifty times as many. Even 10 per cent. hardly conveys an adequate idea of the truth. In many cases when death has been accelerated by alcohol the medical attendant can have no suspicion of the fact. It is notorious that indulgence in alcohol weakens the general powers of resisting disease and injury. The statistics of insurance and friendly societies clearly demonstrate that abstainers on the average live longer and have less sickness than non-abstainers. British and Russian soldiers succumb to wounds more readily than Afridis and Turks who are much more temperate. Moreover, drunkards are frequently physically and mentally unattractive to people of the opposite sex, who object from prudential motives, as well, to marry them. They are often sterile through ill-health. Male drunkards are apt to satisfy their sexual cravings by intercourse with an unfortunate class of women, who are often sterile because unfortunate, and unfortunate because drunken. Owing to ill-treatment the mortality among the children of drunkards, who tend to inherit the parental predisposition, is high.

316. Evidently therefore the elimination caused by alcohol is immense—greater even than that caused by tuberculosis. Moreover, the elimination is stringently selective. If we carefully analyze the motives which induce men to drink we shall find that they are three in number. In the first place men drink to satisfy thirst. When the percentage of water, an organic constituent of their bodies, falls below the normal,

[1] A good deal of statistical evidence is given in my volume *Alcoholism: A Study of Heredity* (London, Fisher Unwin), in which the whole subject is more fully dealt with than is possible in the present work.

[2] From 10 to 10·15 per cent. of the total number of deaths. See Mulhall's *Dictionary of Statistics*.

they seek instinctively to supply the deficiency. When possible they flavour the water in various ways as by tea, coffee, or alcohol. Secondly, men drink to gratify taste. They seek to produce a pleasant sensation by exciting the peripheral nerve-endings in the mouth. Their motives are then precisely the same as those which animate a girl who consumes a chocolate-cream. Thirdly, men drink to induce those peculiar feelings, those peculiar frames of mind, which arise when alcohol, circulating in greater or lesser quantities in the blood, acts directly on the central nervous system.

317. Clearly these three motives are entirely distinct; and, upon examination it will be found that they impel to the consumption of three distinct classes of beverages by three distinct classes of individuals. The heated athlete, who gulps down a quantity of light beer at a wayside inn and departs satisfied, is evidently influenced by a desire different from that which sets the connoisseur sipping his choice wines, and both desires are different from the motives which cause the toper to drink even methylated spirit when he can get nothing more palatable. For the thirsty man the water is the main consideration; he takes the alcohol merely to improve the taste of his drink. For the connoisseur the flavour is the main consideration; the water and alcohol are used merely to improve the flavour. For the toper the cerebral effect is the main object; so long as his beverage contains alcohol he will drink even when he is not thirsty, and when the flavour of his beverage is disagreeable.

318. Of course the three motives may, and often do co-exist in the same individual. A man may seek at one and the same time to satisfy his thirst, to gratify his taste, and to become drunk. Or in the beginning of his drinking career he may drink alcoholic beverages mainly to satisfy his thirst, later to gratify his palate, and lastly for the sake of intoxication. But the fact remains that the three motives are quite distinct, and that in the mind of any given drinker one or other of them usually predominates, and impels him, when he has a choice, to choose a certain class of beverage. The thirsty man chooses dilute beverages. The man, who seeks to gratify his palate, chooses especially well-flavoured beverages. The toper, when he has a choice, chooses sufficiently strong beverages, though of course he prefers them well-flavoured if possible. By themselves thirst and taste are never the causes of excessive drinking. Instinct warns the thirsty man when he has had a sufficiency of water. It takes from him his desire. A glass or two of wine, like

an ounce or two of chocolate, tends, also, to cloy the palate of the connoisseur. In effect, the drunkard is always one to whom the mental effects of alcohol acting directly on the brain is delightful. Our concern is with him alone.

319. This mental effect varies in quantity and quality with the amount of alcohol drunk, and with the individual who drinks it. A given amount of alcohol, which produces deep intoxication in one individual, may leave another comparatively unaffected, or it may render one person morose, a second genial, a third merely stupid and sleepy, and so forth. Probably most people are capable of enjoying some quantity of alcohol; that is, some quantity of alcohol, when circulating in the blood, awakens pleasant sensations in the minds of most people. But, just as people vary as regards every other physical and mental character, so they vary as regards the quantity of alcohol they enjoy most, and in the degree of their enjoyment of it. A very little alcohol easily satisfies some people, and their craving for even that small quantity may be very weak. Others desire a large quantity, and their longing for it may be the strongest emotion of which they are capable.

320. It is necessary to insist on this distinction. In most writings on the subject it is assumed that drunkards and temperate men differ mainly as regards their powers of self-control. The assumption is very flattering to the self-esteem of those who make it, but it is certainly erroneous, as any moderate drinker may ascertain at the cost of a little observation and introspection. What is it that keeps him temperate? Self-control! But self-control implies something controlled in the self—the craving for drunkenness. All drunkards have the craving very strongly developed. If, then, the mental difference between the drunkard and the moderate man lies mainly in their powers of self-control, we must assume that all moderate men pass through life vehemently longing for intoxication, but strenuously resisting the craving for it. The assumption is a monstrous one. Let the reader, if he be a moderate drinker, judge from his own case. Is he the victim of this tremendous craving? Do the majority of his intimates manifest it?

321. Many drunkards are men of strong wills, and many of them have a strong desire to be sober. They fail because their craving for intoxication is yet stronger. On the other hand, many sober men are of weak will-power. They are temperate because their desire for excessive indulgence is yet weaker. Many men—"men of pleasure" for instance—

devote their lives to self-indulgence; but this form of self-indulgence does not appeal to them. It is unbelievable that such people spend their lives valiantly resisting exceedingly urgent temptation. No doubt many moderate men exercise a certain amount of self-control. Warned by unpleasant experience they drink less than they would otherwise do. They are easily able to exercise the necessary restraint because they are not driven by their desires as by a tempest. It is this comparatively small amount of self-control exercised by people of this class that has given rise to the fiction that a man is sober or drunken mainly because he does, or does not, exercise self-control.

322. The truth is that most men and women who drink at all and can afford it take alcohol more in proportion to their desires than in proportion to their lack of self-control. One may observe this every day at dinner. As a rule the people one meets there are manifestly not under the influence of strong temptation. They take as much alcohol as they are inclined for. More would be unpleasant, or at least not very pleasant, to them. Indeed it is hardly possible for a man who is strongly tempted by alcohol to be a moderate drinker. The human will is not strong enough to resist a passion so overmastering when it is continually fed by small indulgences. Such men must, as a rule, be drunkards or total abstainers.

323. It is not intended to deny the merits of self-control. Beyond doubt many a man is now an abstainer because he had the resolution and courage to exercise self-control. Indeed it is probable that most men, even habitual drunkards, exercise some restraint and drink less than they otherwise would. The essential thing is, not that men do not exercise restraint, but that different men are so constituted mentally that they differ vastly in the strength of their desires, in the strength of their cravings for intoxication, and that, as a rule, drinkers are drunken or temperate, not *mainly* because they exercise less or more self-control, but mainly because they are more or less tempted. Abstainers form a class by themselves; they are not exposed to the same extent to what may become very urgent temptation. Of drinkers it is certain that most if not all moderate men are so constituted that their desires are comparatively weak. It is equally certain that all drunkards are so constituted that their desires are very strong. No man unless he were strongly tempted would systematically and regularly take doses of poison which, besides entailing on him a multitude of other

evil consequences, make him feel very ill a few hours afterwards.

324. Within limits the passion for alcohol grows with indulgence. But here again men vary. The growth is more rapid and extensive in some individuals than in others. A course of indulgence, which leaves one man almost indifferent to the charm of drink, will fill another with furious desires. After a more or less prolonged experience of alcohol many men learn fairly accurately the amount of alcohol which will produce the mental state that is most pleasant to them—just as after a certain amount of smoking they learn the amount of tobacco which is most pleasant to them. With such men, who constitute the great majority of moderate drinkers, the growth of the craving does not continue indefinitely. Having learned the limit they are able to stay within it without much effort or difficulty. Other men never reach the limit of growth. Their tendency is always to drink to deep intoxication; to drink to the point of coma. Between the two extremes lie all shades of drinkers.

325. Men differ, therefore, in their susceptibility to the charm of alcohol, and as a rule indulge in it in proportion to their desires. As might reasonably be expected, those who are most tempted succumb, on the average, most and oftenest to temptation. At any rate it is certain that all drunkards are so constituted that they are greatly tempted, whereas all or nearly all moderate men are so constituted that they are comparatively little tempted. Judging from the diverse effects of alcohol on different men, it is probable that it does not awaken sensations or emotions of precisely the same kind in all minds. It is very probable, therefore, that all men are not tempted in identically the same way. For example, one man may drink to procure a sense of exhilaration, whilst another may drink to allay nervousness, irritability, or insomnia. Some men are drunken during prosperity; others only after they have fallen into misfortune. But all these roads lead to the same goal. The fact remains that some men are so constituted that they succumb much more quickly and completely to the charm of alcohol than others. They acquire the habit and the craving for intoxication with much greater ease. Even if, ignoring obvious facts, we attribute differences in drinking habits solely to differences in powers of self-control, and insist that all men are equal as regards their susceptibility, that central fact would still remain.

326. Now, we have just seen that alcohol, when taken to

excess, is a poison and the cause of a great mortality. It is, therefore, an agent of elimination at once selective and very stringent. It weeds out great numbers of individuals of a particular type—those most susceptible to its charm. It follows that alcohol like disease should be a cause of protective evolution. A race afflicted by it should grow more and more resistant, less and less prone to excessive indulgence. If the principles of heredity we have laid down are correct, this increase of resisting power, this lessened susceptibility, should be the sole change caused by alcohol in the hereditary tendencies of the race. Alcohol should not render the race using it degenerate, nor affect its hereditary tendencies in any other way.

327. On the other hand, alcohol does immense injury to the *individual who takes it to excess.* Judging by the statistics of insurance companies and friendly societies, it does harm even to those who take it in moderation. If, therefore, the rival theory of heredity is correct, if variations are caused through the action of the environment, then, as in the case of malaria and other diseases, alcohol should be a cause, not of evolution, but of degeneration.

328. It is widely believed that the use or abuse of alcohol does tend to alter the hereditary tendencies of the race. It is supposed that alcohol, circulating in the blood of the parent, so injures the germ-plasm that offspring and descendants are rendered degenerate. This hypothesis is held by many medical men, and finds constant expression in lectures and in letters to professional journals, and occasionally in a "manifesto" which is popularly supposed to be the fruit of ripe knowledge and thought. Unfortunately the races that have been rendered degenerate are never specified.

329. Here again we light on the perpetual antagonisms between the theory that variations arise spontaneously and the theory that they are caused by the action of the environment. No better test could be imagined. Alcohol like a toxin permeates the whole system and bathes the germ-cells with poison. It has been used during many thousands of years, by almost every individual of many races, often to great excess. On either theory great changes should be apparent. Other races that have had, practically, no experience of alcohol offer themselves for comparison.

330. The races inhabiting the northern shore of the Mediterranean Sea have used alcohol continuously as long, probably, as any peoples in the world. Certainly they have possessed a more abundant supply of it. We have docu-

mentary evidence that alcohol was used in Egypt 7,000 years ago. As Egypt was even then highly civilized it is probable that its use dates back to a period much more remote. The Mahomedan conquest imposed restrictions on its manufacture, which, nevertheless, were by no means complete, as may be judged from a perusal of such Moslem classics as the *Arabian Nights*. The records of the races dwelling in the south of Europe—Portuguese, Spaniards, South Frenchmen, Italians, Greeks, to whom may be added the Jews—though less ancient than those of the Egyptians, yet carry us back to a period of very great antiquity. Their oldest histories, even their oldest myths, tell of a state of society in which the use of wine was well established. The West Africans of the forest region, also, have used alcohol in the shape of palm-wine from time immemorial. The races inhabiting Northern Europe have used it, probably, for a period shorter than their Southern neighbours, and we have every reason to believe that their supplies of it have always been comparatively scanty. In the south of Europe it was manufactured from the grape; in the north it was derived from corn, honey, and other food-stuffs of which savages in cold and temperate climates have seldom a more than sufficient supply. Wine is easily made; brewing requires greater skill and knowledge. Probably the North Europeans were still in their Stone Age when the South Europeans were building theatres and temples. Most savages are able to manufacture alcohol in very dilute solution only. The abundance of alcohol in Italy was a principal cause of the Gothic invasion. Many races, principally those inhabiting the New World, have had little or no experience of alcohol.

331. How then has alcohol affected the races that have used it? Are the Jews and the races inhabiting the south of Europe the most degenerate on earth? Are North Europeans only less degenerate? Are the races that have never used alcohol, the Terra del Fuegians, the Esquimaux, and the Australian blacks, for instance, mentally and physically the finest in the world? We have only to state the proposition to see its absurdity. There is no evidence that the hereditary tendencies of any race have been altered by alcohol circulating in the blood and acting directly on the germ-plasm. Once again the sufferings of the peoples have produced no effect, but the deaths among the peoples have produced an immense effect. Every race that has had experience of alcohol is temperate in the presence of an abundant supply in proportion to the length and severity of

its past experience of the poison. The South Europeans and the Jews are the most temperate peoples in the world. West Africans also are very temperate.[1] North Europeans are more drunken. Those savages, and those only, who have had little or no experience of alcohol—Esquimaux, Red Indians, Patagonians, Terra del Fuegians, Australian blacks—are beyond all the peoples the most drunken on earth.

332. Stated in this brief and direct way the thesis is apt to excite incredulity. It is sharply opposed to popular beliefs, though that need not trouble us. Popular notions on abstruse points of science are occasionally erroneous. Of more importance is the fact that a mass of statistics purporting to prove that the children of drunkards tend to be degenerate has been compiled, especially by medical men in charge of lunatic asylums. But no "control" observations appear to have been made. We know that many drunken parents have normal children; certainly, therefore, parental drunkenness is not invariably a cause of filial degeneration. We know also that many temperate parents have defective children. There is nothing to show that the proportion is greater in the one case than in the other. Even were it established that the proportion of defective children is higher in the case of drunken parents it would still have to be proved that the relation is one of cause and effect. People who have an inborn tendency to mental defect, who are abnormally depressed, nervous, restless, or irritable, are often so constituted as to find solace in drink. Their children are liable to inherit their inborn mental defects with spontaneous variations;—that is, to inherit the defect to a greater or lesser extent. The unborn child of a drunken and pregnant mother is practically another drunken person, as liable, or more liable, to suffer from the effects of drink; but in such a case the resulting defect, though a mere acquirement, is tolerably certain to be regarded as a congenital (*i. e.* inborn) defect by the medical man who sees it. Mere acquirements, also, are the defects due to the ill-treatment, want and neglect to which the children of drunken parents are particularly exposed. Indeed, were it fully established that drunken parents, other than pregnant mothers, tend to have an excessive number of their children "congenitally defective," it would still be a question whether the filial defects were not mere acquirements. Professor Cossar Ewart's observations on diseased pigeons render this not unlikely. All

[1] See *Alcoholism*, pp. 258–62.

these sources of error render the success of a statistical inquiry peculiarly difficult, if not impossible, but there is no indication that they ever occurred to the minds of the compilers.

333. On the other hand, we have the fact that there is less intemperance to-day than in the times when men got "drunk for a penny" and "dead drunk for twopence," yet the lunacy rate has enormously increased. Even if it be maintained that there is more drunkenness to-day than formerly, it must be admitted that the increase of mental defectiveness is out of all proportion. Plainly, therefore, some cause or causes other than alcohol have been at work. We shall attempt to elucidate them in a future chapter. Meanwhile, on all counts, we are driven to the conclusion that a statistical line of inquiry does not promise success. The subject is too complex. The sources of error are too numerous and too difficult to surmount. Nevertheless, if it be true that the use or abuse of alcohol is a cause of degeneration, we have a plain and easy way of ascertaining the fact. We have only to compare races that have long used alcohol with races that have had little or no experience of it. So many races have used and abused the narcotic during so many ages and under so many different conditions that all sources of error should be eliminated, and the effect, if any, should be clear. What, then, do we find when we make this comparison? Most certainly we find no evidence that any race had undergone any kind of degeneration which can be traced to the use of alcohol. Judged from the disinterred remains of their ancestors, neither the Jews nor the South Europeans have deteriorated physically. No one has accused the Jews of mental inferiority. No one doubts that, given a proper system of education, South Europeans are still capable of great intellectual brilliancy. Englishmen, Frenchmen, Germans, Chinamen, and Japanese are certainly not inferior physically or mentally to the lowest New World savages.

334. Other external influences—use and disuse, heat, cold, want, disease—many of them extremely powerful, do not directly influence the hereditary tendencies of the race. It would be an extraordinary circumstance if alcohol were unique in this respect. *À priori*, therefore, we have the strongest reasons for believing that it cannot be a cause of degeneration, except, perhaps, in the case of very exceptional individuals. On the other hand, it would be extravagant to suppose that, though men differ innately and widely in every other character, they are yet exactly alike in their inborn

susceptibility to the charm of alcohol, to suppose that the huge mortality that is caused by it is an affair of pure chance, to suppose that the inborn predilections of individuals have no part in distributing the mortality. Doubtless chance does play a considerable part; many men are unable to procure as much alcohol as they desire; others are exposed to exceptionally good or bad influences. The ordinary costermonger is less likely to exercise self-restraint than a man reared in the normal environment of a clergyman. But all this only proves that alcohol as a selective agent is more stringent under some conditions than under others. Under every condition it is still an agent of selection. We are driven thence to the expectation that it is a cause of evolution. It follows, since only those individuals are eliminated by alcohol who enjoy the intoxicating effects of it, we should expect to find those races least inclined to excessive indulgence which have been longest and most severely afflicted. This, as a fact, is exactly what we do find. It is an absolute rule to which there is no exception, that, given an abundant supply of alcohol, every race is temperate strictly in proportion to its past experience of the poison. When our deductions are confirmed so conclusively by an appeal to facts they can no longer be regarded as mere hypotheses. They become certainties.

335. The facts concerning opium are very similar. That narcotic has been used extensively in India for several centuries. It was introduced by the English into China about two centuries ago. Quite recently the Chinese have taken it to Burma, to various Polynesian islands, and to Australia. There is no evidence that the use of opium has caused any race to deteriorate. Indeed it happens that the finest races in India are the most addicted to its use. According to the evidence given before the late Royal Commission on Opium, the natives of India never or very rarely take it to excess. When first introduced into China it was the cause of a large mortality; but to-day most Chinamen, especially in the littoral provinces, take it in great moderation. On the other hand, Burmans, Polynesians, and Australian natives take opium in such excess and perish of it in such numbers that their European governors are obliged to forbid the drug to them, though the use of it is permitted to foreign immigrants to their countries. In exactly the same way alcohol is forbidden to Australasians and Red Indians in places where it is permitted to white men.

336. Until recently it was agreed on all hands that South Europeans, notwithstanding the possession of a more abundant supply of alcohol, were more temperate than North Europeans, and North Europeans than most savages. But since I first attributed racial sobriety to evolution,[1] some authorities have made the surprising discovery that South Europeans are the most drunken people on earth. It seems that the consumption of alcohol *per capita* is greater in the south of Europe than in the north, and very much greater than in Greenland, Terra del Fuego, Central Australia, or amongst the Red Indians. But a high consumption *per capita* does not necessarily indicate a high rate of drunkenness. Imagine two parties of twenty men each. Suppose every man of the first party drank one glass of alcohol; while, of the second party, one man drank nineteen glasses, and the rest none at all. The consumption *per capita* of the first party would be the higher, but most people would agree that the amount of drunkenness in the second party would be the greater. Red Indians, Englishmen, and Italians do not drink after the same fashion. They do not seek the same sensations nor feel the same emotions. Given a sufficient supply of the concentrated solutions of alcohol which civilized men have invented, Red Indians are soon exterminated. They drink furiously, and are furious in their drink. They become "fighting mad." Englishmen possess considerable quantities of alcohol, but the consumption of it is very unequally distributed. Comparatively few women and children use it. Many men abstain. Many more take it in great moderation. A large minority are intemperate; but among them the homicidal, the immediately lethal form of drunkenness has become less common than among Red Indians. They are more apt to be sleepy, genial, or stupid. Moreover the homicidal form of drunkenness is least common among the higher classes, who have been most thoroughly weeded out. In Italy almost every man, woman, and child takes alcohol; but, though very abundant and palatable, it is drunk almost exclusively to gratify thirst or taste. Drunkenness is very rare. Formerly it was the custom among the Italian peasantry to purchase an hour's drinking in a tavern on payment of a very trifling sum. A similar custom would result in the ruin of a landlord in England, and the murder of him and half his customers in Dacota. The following extract, written by a close and accurate medical observer resident in Italy, illus-

[1] In 1896. See *The Present Evolution of Men.*

trates very vividly the difference between British and Italian drinking:—

337. "I see here in Italy a nation whose ancestors are known by every school-boy to have been an awful example of intemperance, living amidst abundance of wine a life of sobriety. When I return to my own country I find myself among a people surpassed by none in the virtue of self-control, but whose alcoholic habits are notorious all the world over.

338. "I have met time after time Italians who confess without shame that they have never drunk anything but wine; they are never drunken. Drunkenness upon Italian wine I have seen, but only amongst my fellow-countrymen and women. Amongst my own servants I find that water as a drink is considered bad for the stomach, and is feared just as water as a bath is feared as a peril and a danger. A male servant, whom I have never detected under the influence of alcohol, drinks a flask of Chianti (containing 10 per cent. of alcohol) daily, and each female servant drinks about half a flask (the flask contains about two and a half English bottles). This is the custom of Tuscany, and on inquiry from old residents in the country districts I learn that however abundant the vintage the *contadini* preserve always their temperate habits, drinking their fill, but never becoming drunken. Drunkenness in the British sense is so rare as to be a matter of great interest and discussion when it occurs.

339. "It is surely likely that in a country where every peasant has access to as much wine as he likes, there would be much drunkenness if self-control were the only restraining influence. The peasants (*contadini*) receive a half of every product of the farm, including the wine; they have it always beside them, and can drink how and when they please. Now-a-days wine is grown especially for export and for consumption in the rapidly growing towns; but even thirty years ago, when the export trade was practically *nil*, and there was a great excess of production over consumption, there was no drunkenness. In those days, I am told, wine was given to horses, and whole barrels would be poured out in the road to make way for the new vintage, when the price was only a few coppers per flask. Even now, when the price is about one frank a flask, and much is said to find its way to Bordeaux to be re-labelled as cheap French wine, there is ample wine in the country to permit drunkenness in presence of the desire. But no; it is given to infants, children drink

it regularly, and babies are bathed in it, but drunkenness in the English sense does not exist."[1]

340. If we may trust somewhat scanty historical records, every race which is now temperate was anciently drunken. The Jews were a drunken people till, and long after they settled in the Promised Land, in which every man dwelt beside his own vineyard. Examples of drunkenness and exhortations to sobriety are common in the older scriptures. They occur less often in the New Testament, in which the exhortations are addressed chiefly to the Gentiles. At the present day, though a Jewish abstainer is seldom seen, yet a Jewish drunkard is as rare as a native of India who takes opium to excess. The sobriety of the Jews as compared to that of Anglo-Saxons may be judged from the following passage :—

341. "Among the Jews it (alcoholism) is an almost unknown affection. Their sobriety is proverbial; and the experience among Jewish medical practitioners is unanimously to the effect that occasion to observe the disease in the person of a Jew is an excessive rarity. Statistics confirm the general opinion of Jewish sobriety. Selecting two typical hospitals as possessing the most trustworthy records, a comparative investigation may be made as to the prevalence of alcoholism among their patients. The Boston City Hospital has a general *clientèle* in a town that does not contain a disproportionately large number of Hebrews. In 1899 there were 7,104 cases treated there, and of these 226—a little over 3 per cent.—were admitted for alcoholism. The Beth Israel Hospital of New York City has an entirely Jewish *clientèle*, the proportion of non-Jews treated there being a negligible quantity—not one-fourth of one per cent. Its records show four cases of alcoholism, or diseases directly attributable to it, in 3,000 cases that applied for admission during the last few years—that is, a little over one-tenth of one per cent. Hence the records show that alcoholism is, at least, thirty times as prevalent among the general community, including the Jews, as in that race itself."[2]

342. Classical literature supplies abundant evidence of the ancient insobriety of the Greeks and Romans as well as of the ancestors of the modern Germans and French. The Spartans made drunken helots serve as "awful examples" to their youth. Lycurgus cut off the legs of drunkards and destroyed the vines. Pittacus inflicted double punishment

[1] Dr. H. Laing-Gordon, *British Journal of Inebriety*, Jan. 1904.

[2] *Jewish Encyclopædia.*

for crimes committed in drink. Alexander died drunk. So intemperate was his court that it is almost a matter of surprise that any members of it survived. The Romans were as drunken as the Greeks. The intemperance of the Gauls and Germans was a by-word in the ancient world. It increased to a frightful extent when the monks added to the alcoholic supply by planting vines for sacramental purposes round the monasteries, and so introduced the culture of the grape. To-day the average Frenchman or German of the vine regions is as temperate as an average Jew or Italian. England has always been comparatively drunken. Since the supply of alcohol has never been so plentiful as on parts of the Continent, the elimination of the unfit has been less thorough, and the evolution less complete. Nevertheless, though the purchasing power of the nation has increased out of all proportion to any rise in the price of alcohol, we do not, at the present day, witness the tremendous orgies which were common in former times. With every opportunity to be drunken the great majority of Englishmen are now temperate.

343. In the history of most nations have happened occasional outbursts of intemperance due to increased facilities for procuring alcohol, or to a loosening of the general moral tone. The fact has caused some critics to argue that there is no such thing as evolution against alcohol. It is hardly necessary to deal with this objection at length. To ascertain the existence of evolution we must not compare decade with decade, but century with century, and we must not neglect to assign the proper value to collateral circumstances. The strength of the predisposition to intemperance is not the only thing which determines the amount of the consumption of alcohol. Many causes other than evolution have been assigned for the comparative drunkenness or sobriety of different races.

344. *Climate.*—Since the South Europeans dwell in a warm-temperate climate, extremes of heat and cold have been supposed to predispose to drunkenness. But a hundred savage races, whose ancestral supplies of alcohol were scanty, are drunken in much the same kind of climate as that in which the South Europeans are now temperate. Jews and South Europeans were formerly drunken in their present environment. They are now temperate in every climate to which they travel. West Africans are temperate under the equator.

345. *Potency of the national beverages.*—Strong solutions of

alcohol are supposed to conduce to drunkenness. No doubt, if a man wishes to get drunk he will, as a rule, if he have the opportunity, choose a strong solution without being very particular as to the taste of it. But if he have not the opportunity he will get just as drunk on a weak solution. Many savages are extremely intemperate on the very weak solutions which alone they are able to manufacture. The English consume three-quarters of their alcohol as beer and less than one-quarter of it as spirits. They are much more drunken than South Europeans, whose beverage is, on the average, twice as strong.

346. *Environment.*—Wretched surroundings are supposed to conduce to intemperance, and, to some extent, no doubt they do. But the surroundings of Englishmen are not worse on the average than those of South Europeans. Italians and Jews are temperate under shocking conditions in the East End of London.

347. *The memory of past disasters.*—South Europeans are supposed to be temperate because they have much knowledge, derived from old experience, of the evils of intemperance. Englishmen and savages are supposed to be less temperate because they have less knowledge. In other words, South Europeans, whose evil experiences occurred chiefly more than two thousand years ago, are supposed to have a more vivid recollection of their misfortunes than Englishmen, whose evil experiences have lasted through many centuries down to the present day. They are supposed to have a more vivid recollection than savages who actually see their own generation melting away. The existence of numerous temperance societies in the north of Europe, and the almost complete lack of them in the south, is a striking commentary on this hypothesis.

348. *Civilization is supposed to conduce to sobriety.*—Undoubtedly it does do so, but hardly in the sense intended. All highly-civilized races are able to provide themselves with great quantities of alcohol, and, on that account, have been more or less thoroughly purged of the craving for intoxication. But North Europeans, who are more civilized than South Europeans and West Africans, are more drunken. They have been less able to supply themselves with abundant supplies. We shall see later that it is impossible to exclude alcohol from peoples living under civilized conditions of life. It follows that no race is capable of achieving civilization which has not previously undergone this particular phase of evolution. When savages, who have had no experience of

alcohol, are brought into contact with strong modern solutions they are exterminated as quickly as when introduced to tuberculosis under modern conditions. When the savage ancestors of civilized peoples discovered alcohol they were unable, like the most modern savages, to manufacture it except in small quantities and in very dilute solutions. As a consequence only those individuals who had the best opportunities of obtaining alcohol could take lethal quantities, and only those who had the strongest cravings did take them. Evolution was thus possible. The primitive conditions are illustrated by those which recently obtained among the natives of Guiana, who manufactured a cassava intoxicant, of which a debauch of three days was necessary before intoxication supervened.

349. *Education.*—What is there in the education of Jews, South Europeans, and West Africans that should render them more temperate than North Europeans? The upper classes of England are said to be better educated than the lower. Certainly they spend more time at their books. They are less drunken. But it must be remembered that the upper classes are, in general, derived from the upper classes of former times. Their purchasing power has been greater; they have been more completely weeded out. Moreover, sober families from the lower classes have constantly displaced drunken families in the upper. No doubt habits of self-restraint may be taught and have some influence, and beyond doubt fashion has very considerable influence. It is very probable, indeed, that the upper classes on the whole exercise more self-restraint as regards alcohol than the lower. The improvement in the habits of the former which occurred during the last century was far too rapid to be attributed wholly to evolution. Granting all this, it must be remembered, nevertheless, that indulgence in alcohol produces in people who are susceptible to its charms a particular feeling, a sensation, a set of emotions which to them is very delightful. Education cannot alter sensations. Just as it leaves unaffected the sensations produced by heat, or cold, or mutton, or tobacco, so it leaves unaffected the sensations produced by alcohol. It may, indeed, induce a moral abhorrence, but that is altogether a different matter. As we have already seen, it is not a moral abhorrence, not a strenuous resistance to temptation, which restrains the majority of the upper classes, who seek pleasure quite as eagerly and recklessly as the members of the lower. They are temperate, but seldom, if ever, at the cost of great

self-restraint. Their feelings are not of that kind which ruined a clergyman of the writer's acquaintance. This unfortunate being, who had been an abstainer all his life, was medically advised to take alcohol during an attack of influenza. He went like a stone to the depths—went in despair, weeping and praying for Divine aid. Nor are they of the kind that possessed a tippler who, as related by Dr. Mussey of Cincinnati—" A few years ago . . . was put into an almshouse in this State. Within a few days he had devised various expedients to procure rum, but had failed. At length he hit on one which was successful. He went into the wood-yard of the establishment, placed one hand upon the block, and with an axe in the other struck it off at a single blow. With the stump raised and streaming he ran into the house and cried, 'Get some rum. Get some rum. My hand is off.' In the confusion and bustle of the occasion a bowl of rum was brought, in which he plunged the bleeding member of his body, then raising the bowl to his mouth, drank freely, and exultingly exclaimed, 'Now I am satisfied.'[1]

350. " The craving for drink in real dipsomaniacs, or for opium or 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 a 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 sure as I took one glass, I could not refrain.' Such statements abound in dipsomaniacs' mouths."[2]

351. It is evident that we can in no way account for the difference between races with respect to alcohol except by supposing that some races have undergone evolution—an evolution which, in every way, is as important to humanity as that caused by disease, and which supplies evidence as conclusive that variations arise spontaneously, and not through the action of the environment on the germ-plasm.

352. An interesting parallel obtains between diseases and narcotics. Against some diseases, for example tuberculosis, immunity cannot be acquired by the individual. Against others, for example chicken-pox, it can be acquired with great ease. Between the two extremes lie all other diseases. The power of acquiring immunity is a short cut by means of which the more tedious process of evolving inborn immunity

[1] Professor William James, *Principles of Psychology*, vol. ii., p. 543.
[2] *Ibid.*

is avoided. By a single process of evolution provision has been made against many maladies. The most death-dealing diseases are those against which immunity cannot be acquired, or can be acquired only slowly and with difficulty (*e. g.* malaria). Alcohol resembles tuberculosis in that little immunity can be acquired against it by the individual. Without very greatly increasing the dose, the drinker is able to reproduce the immediately poisonous effects (intoxication) which he felt on the first occasion of using the poison. It is just these poisonous effects that he seeks to renew. The mortality caused by alcohol in a race new to it is very great, and tends to produce inborn immunity—that is, to evolve a race which does not desire the immediately poisonous effects, and which, therefore, drinks in moderation. Against tobacco complete immunity may be acquired. Nicotine is very poisonous to the beginner, but not only does the habitual smoker acquire the power of tolerating immensely increased doses, but he never craves to renew the immediately poisonous effects which he felt when he first used the poison. In other words all smokers smoke in "moderation"; that is, they do not seek to intoxicate, to immediately poison themselves with nicotine. The mortality caused by tobacco is so small as to be negligible. As a consequence—and in this it resembles chicken-pox—no evolution results from racial experience of it. Races who have long used it desire it in quantities as large as races that have had no previous experience of it. Opium lies midway between alcohol and tobacco. Immensely increased doses can be tolerated by the habitual user, but, if he belong to a race which has had no previous experience of opium, he generally desires to reproduce the intoxication he felt on the first occasion of using it. Opium, like measles, is therefore the cause of a large mortality. The resulting evolution tends to render the race "immune," so that it no longer desires opium in such quantities as to produce intoxication. It would appear, therefore, that the power of tolerating increased quantities is a great advantage. The race does not start from the scratch. It evolves immunity much more quickly and easily than in the case of alcohol. After an experience of a few hundred years the natives of India appear quite "immune." After two centuries the Chinese have evolved far towards immunity. But a disastrous experience of thousands of years has not rendered North Europeans fully "immune" to alcohol.

353. If this parallel between diseases and narcotics holds

good, it must follow that the process of evolving powers of resistance against measles must be much less tedious and difficult than that of evolving powers of resistance against malaria. Since it is more easy for the *individual* to acquire permanent immunity against measles than against malaria, the race starts from a position of comparative advantage. On the other hand, since no immunity can be acquired by the individual against tuberculosis, the race starts here from a position of great disadvantage, and the process of evolving powers of resistance must be very long and tedious. We know indeed, as a fact, that races that have been greatly afflicted by tuberculosis for thousands of years still suffer grievously, and that when endemic it exterminates, in spite of the utmost care, the races of the New World. We know as a fact also, that endemic measles does not exterminate New World peoples. Careful attendance on the sick reduces the death-rate from it below the birth-rate. These two diseases, therefore, confirm our hypothesis. Of malaria it is not possible to speak positively, but the parallel appears to hold good as regards it also. It is impossible, at any rate it is very difficult, for Europeans, who have had little or no experience of the disease, to colonize West Africa, where it is most virulent; but Spaniards and Portuguese have succeeded to some extent in colonizing tropical America, where it is very virulent. The Creoles already display great powers of resistance, as do also the descendants of the Portuguese in India.

354. It seems then, both as regards narcotics and diseases, that the ease with which the race evolves resisting power bears a close relation to the ease with which the individual is able to acquire personal immunity.

CHAPTER XVI

REFLEX ACTION

Mental symbols—The origin and evolution of mind—Sense-impressions —Feelings—Pleasure and pain—The will.

355. THE study of the comparative rudimentary minds of lower animals and of the developing minds of children sheds a very clear light on some of the problems of heredity, a knowledge of which in turn helps us greatly to understand many of the phenomena of psychology. Mind presents peculiar difficulties and offers particular advantages to the student of heredity. He deals here with an immaterial something, the workings of which in other living beings he is able to infer only through their actions. On the other hand, he knows nothing so well as his own mind, his sensations, emotions, and thoughts. All knowledge of everything else comes to him through the medium of his mind. Whatever else he may doubt, he cannot doubt the existence, the reality of his own feelings and thoughts.

356. As I sit here I hold in my hand a pen. I am aware of it, and can be aware of it only through my senses. At the moment three senses are giving me information—the sense of sight, the sense of touch, and the muscular sense.[1] I know that the thing I hold is a pen, and possibly therefore these sensations are awaking in me other very faint unnoticed representations, from which my conception of a pen is drawn and which, when my attention is called to them, I call memories of other pens. At any rate, the pen appears to me a *familiar* thing. At the present moment, however, I am clearly conscious only of the vivid sensations aroused by this particular pen. For the sake of simplicity, and for the moment, we may disregard all sensations save those now coming to me through sight. Rays of light are

[1] Or more probably the feelings in my joints. (See James, *Principles of Psychology*, vol. ii., 189 *et seq.*)

supposed to pass from the pen to my retina, where presumably they set up chemical and molecular changes; these in turn set up similar changes in my optic nerve; which again set agoing other like changes in my brain. Thereupon dawns in my mind a sensation which I call the "sight of the pen"—a sensation which *is* the pen to me, but which my reflecting nature tells me cannot even resemble the pen. The undulations of light cannot of course resemble it; neither can molecular changes in the retina, the optic nerve, nor the brain. Least of all can the sensations which are correlated with the nervous changes that occur in the darkness within my skull resemble it. A sensation is a mental phenomenon; a pen I suppose is a material object. No two things can be more dissimilar, more utterly unlike in every way than immaterial sensations and material objects. They have absolutely nothing in common. I am really conscious, therefore, not of the actual pen, but of something very different, of a sensation which, *as I suppose*, is awakened in me by a material object outside and beyond my mind, of the real nature of which I can never by any possibility know anything.

357. I write the word "pen," and it stands to me for a sign and a symbol of the spoken word "pen." But it is only a sign. It does not in the least resemble the spoken word. On the other hand, the spoken word is quite unlike the "seen object," of which again it is only a sign. So also the sensation of sight, "the thing I see," is at most only a mental symbol of a material something outside my mind, a something of a nature entirely different from my mind, and which I can "know" only through sensations which are part of *me* and not of the thing they symbolize. Indeed the very existence of that "real" thing is doubtful, for I can test it only by sensations with which I am encompassed as by a wall, beyond which I cannot pass to the real thing, and which may not, indeed cannot, tell the truth. For example, I touch the pen and say it feels smooth and hard. But when I mention these "qualities of the pen," I am still speaking only of my own sensations, not of anything that actually belongs to the pen. These qualities, these sensations are just as much a part of me, and as little a part of the pen as the pain which is awakened if the point be driven into my finger. Sometimes I know my sensations play me false and symbolize things that have no real existence, as when I see or touch a pen in a dream.

358. To take another example; I look out of my window

and say, "I see a mountain in the distance." But it is absurd to think that my sensation of sight, my feeling, can resemble a huge material mass many miles away If I journey towards the mountain till I pass over or round it my sensations constantly change. The "real thing" presumably does not change. Evidently here also I am dealing with a succession of mental symbols. At best, therefore, I live in a symbolic world, which my mind has constructed for me, and into which no "real" thing nor the likeness of any real thing can enter. If any real thing there be, it is more unlike the mental symbols than the spoken word is unlike the written word. Both the latter are sensations, the one of hearing, the other of sight, and so can, in some sort, be compared. But the real thing is not a sensation, and can in no way be compared to one. The symbolic world constructed for me by my mind, however, is "good enough" for me. It fills me with interest, and with a mental reservation I accept it as real.

359. It is peopled by men and women who are certainly as real as my own body, which, like them, I know only through my senses. They have bodies much like mine, and from their actions I infer that their minds, also, are much like mine. A variety of reasons leads me to believe that our minds are associated in some way, which I do not in the least understand, with our brains. Since the brains are alike and the minds are alike, I infer that the association is probably one of cause and effect. That is, I suppose our minds are alike because our brains are alike—or *vice versâ*. The brains and the minds of children are somewhat unlike mine. But the difference between our brains is not very great, and I am able to remember my own childhood and so can form a fairly clear idea of the mind of at least one child. The difference between the brains of lower animals and my own, however, is considerable; presumably the difference between our minds is correspondingly great. Indeed I infer by our actions that this is certainly so.

360. Not only the brains but the sense organs of some lower animals are very different from mine. For example, our eyes may be constructed on unlike plans. Probably, therefore, the world as symbolized to them by their senses is different from the world as symbolized to me. In some cases their sense organs appear more, and in other cases less, perfect than mine. I have strong reason to suppose that the information given to me by my senses is incomplete and fragmentary. For instance, my sense of sight is able to avail

itself of the information supplied through the medium of only those rays of light which lie within that part of the spectrum visible to me. Slower or faster undulations tell me nothing; but there are grounds for believing that they tell a good deal to some animals. All my information comes to me through a very limited number of senses, but, conceivably, I might have many more, in which case my information would be more complete. Some lower animals appear to have senses of which I have no more conception than a man born blind can have of sight Thus, apparently through the exercise of senses unknown to me, a bat seems able to avoid obstacles when flying in absolute darkness. Various other animals do not appear to possess all, or many, or any of the senses I possess. Clearly, therefore, I must be very cautious when I try to infer the mental processes of lower animals from my own mental processes. The most I can do with a reasonable degree of safety is to infer (1) sense-impressions, and therefore a stream of sensations and some sort of a mind, when I perceive structures which are probably organs of sense, (2) to infer sense-impressions somewhat like mine when the sense organs and the nervous structures connected with them resemble mine, and (3) to infer a mind somewhat like mine when the brain associated with it is somewhat like mine. If the animal I am considering belongs to a species that is closely related to my own, I can of course draw my inferences with a proportionate degree of confidence and safety.

361. All my experience tells me that feeling, and therefore mind, is associated only with nervous tissue. Other sorts of tissue, so far as I know, fulfil quite different functions. I have no right, therefore, to infer the presence of mind in an individual unless I know that the species to which it belongs possesses a nervous system, however rudimentary. Accordingly I do not suppose that plants and the lowest sorts of animals are capable of feeling, much less of thinking. On the other hand, the presence of nervous tissue does not necessarily imply the presence of mind. For example, I have no reason to suppose that consciousness is associated with any of the nerve ganglia of my body except my brain. It appears, therefore, that only certain more or less highly evolved masses of nervous tissue are associated with mind.

362. In common with other structures, nervous tissue, and therefore mind, has been evolved by Natural Selection. Like the physical structures, the mental faculties adapt the individual to his surroundings. Mind is quite useless to

any individual unless his feelings and thoughts result in action or the inhibition of action. It owes its existence, therefore, to movement—to the necessity of co-ordinated movement between the various parts of the complex cell-community which we call a multicellular animal. In its lowest manifestations it directs and co-ordinates movements of a comparatively simple sort. In its highest manifestations it directs and co-ordinates movements which may be exceedingly complex and multitudinous, as when a man in early youth forms a plan in the execution of which he spends a long life.

363. Since mind is quite useless without the power of making movements, it is evident that this power, in its beginnings at least, must have been evolved before mind. At the present day movements occur in many plants and animals (*e. g.* unicellular animals) in which there are apparently no sense organs nor nervous tissue. Their environments are so simple, their ranges of action so limited that sensation and thought would be of as little use to them as to the individual cells of higher animals. Presumably therefore Nature, with her usual parsimony, has not endowed them with a superfluous possession. In my own body occur movements, for example in the intestines, of which I am quite unconscious. All movement, therefore, is not associated with mental phenomena. All the movements in my body which are unconnected with sensation are known as reflex movements. But clearly it would not be correct to define reflex action as action which is not associated with sensation, for many reflexes in my body are associated with a great deal of it—for example, the reflex of coughing, the convulsions associated with tickling, and the painful movements in the hollow viscera. It would not even be correct to define reflexes as actions which are not initiated by sensation, for the convulsions of tickling and several other reflexes do not occur in the absence of sensation, for example under chloroform.

364. Feelings are sometimes defined as sensations into which have entered the elements of pleasure or pain.[1] More frequently the term is used in a wider sense, but the ability to distinguish without circumlocution between sensations which have the peculiar tone imparted by pleasure or pain

[1] It may be said that thoughts may be pleasurable or painful, and that thoughts are not sensation. There is strong evidence, however, that thoughts never have this emotional element unless they first give rise to certain physical changes to which is due, directly, the pleasure or pain. (See *The Principles of Psychology*, by Professor William James, vol. ii., p. 449.)

and those which have it not is certainly useful. When feelings include pleasure or pain, or the promise of them, they give rise to *emotions*. They then supply particular motives for action. Many sense-impressions are neither pleasurable nor painful; or at least the pleasure or pain in them is so faint as not to supply efficient motives for action. If I pass along the street, many objects impress my sense of sight, but to most of these impressions I am quite indifferent. For instance, a scrap of paper drifting on the pavement may be seen but not noticed. But some of the things I see awaken *interest*. They give immediate pleasure or pain, or the promise of one or other in the future. I note them, and, if the emotion they awaken be strong enough, I feel a *desire* to take action, which may or may not be balanced by opposing desires. If I act or abstain from acting on that desire my *will* comes into operation. The action, or the inhibition of it, which follows is *voluntary*. Now all my actions may be divided into those which are initiated by my will and those which are not initiated by it. The latter are reflex actions, the former are not.[1] The same action at different times may be reflex or voluntary. Thus if I cough or wink because, owing to the presence of an irritant, I am obliged to do so, the action is clearly reflex. But if I cough or wink because I wish to do so, the action is just as clearly not reflex, but voluntary. *Reflex Action, therefore, may be defined as action which is not initiated by the will.* It is involuntary action, which under normal circumstances invariably follows the application of given stimuli. As we see it may or may not be associated with sensation.

365. It is difficult to imagine that the convulsions of tickling can serve any function useful to the organism that suffers from them. Probably like the tendon reflexes they are mere by-products of evolution. But the function of the vast majority of reflexes is clear. They have been evolved by Natural Selection to provide useful reactions to simple, but important and generally oft-recurring events—events of such a nature that the given reflex reaction to any one of them is, for practical purposes, always the right reaction. Obviously all reflexes, for example those associated with the circulatory, the respiratory, and the alimentary systems are inborn and transmissible. None of them are acquired. Since

[1] Instinctive and automatic actions are usually regarded as involuntary. According, however, to the definition in the text they are voluntary. This departure from established custom will be justified later.

the power of co-ordinating the movements of the cells of multicellular animals must have arisen before the evolution of consciousness, and since many reflexes are not associated with feeling, it is certain that reflex action in its beginnings was evolved before mind. The term "reflex," as the derivation implies, is usually limited to actions which occur through the medium of a more or less differentiated nervous system, by means of which "afferent" or in-going impulses pass to, and "efferent" or out-going impulses pass from a central nervous mass. Movements which occur in the absence of a differentiated nervous system, as in very low animals, have been termed "protoplasmic," though the term "reflex" is occasionally applied to them also. Accepting the limitation, it is evident that mind was a new faculty, the evolution of which was rendered possible by the antecedent evolution of a differentiated nervous system—a nervous system that near its beginnings was devoted exclusively to reflex action. It is very probable, therefore, that the first function performed by mind in its most primitive form of sense-impressions, was to initiate certain reflexes. As animals grew complex and the reflexes numerous, definite sense-impressions served as delicately discriminating, but potent stimuli to given reflexes—sparks which fatally exploded given stores of energy.[1]

366. None of the reflex actions of the individual are initiated by his will. But many of them may, to a greater or lesser extent, be inhibited by it. Thus power of voluntary inhibition, whenever it occurs, is invariably associated with pain, which with pleasure furnishes the springs of desire, of will, of voluntary action. It is present only where it is useful to the individual. Thus a man is quite unable to control the movements of his heart, or the peristaltic movements of his stomach and intestines. Under normal circumstances he would derive no benefit from such control. Certainly his remote unintelligent ancestors would have derived none. But he is able to inhibit to a greater or lesser extent, especially when the reflex impulse is somewhat weak, the movements of certain other portions of his alimentary canal, as well as such reflexes as breathing, coughing, and winking. In such cases the exercise of inhibition is associated with increasing pain or discomfort

[1] An attempt to associate mind in its beginnings with reflex action is one thing. Quite a different thing would be an attempt to trace the evolution of mind from that which was non-mental. The latter is not attempted here. If we were able to trace mind from non-mental beginnings we should know the exact nature of the connection between mind and matter.

which impels to the removal of it; and always, in a shorter or longer time, the voluntary impulse tends to be overpowered by the involuntary reaction. The duration of the voluntary control over a reflex act is determined by its usefulness. Thus it is short in the case of breathing, coughing, and sneezing—for here, as a rule, it is needed only during the act of swallowing or other occasions of short duration. It is much longer in the case of the reflexes of the bladder and the lower intestines, which it is often useful to control for a more lengthened period.

367. An irritant in the larynx, or on the conjunctiva, is painful and the cause of reflex action. But here again the true function of the feeling is to impel to voluntary action. Not only do we wink or cough, but we take additional measures. We rub our eyes or hold our breath, or move away from a dust or smoke-laden atmosphere. Were there no incitement to voluntary action the feeling, in such cases, would be a useless epi-phenomenon. A mere sense-impression or a stimulus devoid of consciousness would serve as well—as indeed it does in the case of all those internal reflexes which are not controllable by voluntary effort. Sometimes under abnormal conditions pain does not precede but accompanies the performance of a reflex action. But here again its function is to initiate voluntary action. Thus when we experience angina pectoris, we relieve the labouring heart by keeping still. When we have pain in the intestines we seek to empty them. Indigestion tends to cause us to abstain from food.

368. Pleasure also is experienced during the actual performance of some reflexes, but, as in the case of pain, its function is then not to bring about directly the reflex act, but, by the promise of it, to initiate definite voluntary actions, which in turn supply the stimulus for the reflex. Thus the pleasure which is experienced during the performance of the sexual act prompts to the voluntary actions which necessarily precede it. Thus, again, the pleasure derived from satisfying hunger prompts to the performance of the often very complex voluntary actions which precede the swallowing of food.

369. All the actions of living beings are voluntary, reflex, or protoplasmic. Not a muscle contracts, not a gland secretes but the action comes under one or the other category; and always voluntary actions, unlike reflexes, are directly initiated by desires, wishes, wills, which in turn are awakened by the actual existence of, or the prospect of future pleasures or

pains. But the voluntary actions which we have just considered, which depend directly on the pleasures or pains which precede, accompany, or follow reflex actions, comprise in the higher animals but a small proportion of the total number. For example, the complex mass of actions by means of which a man earns his livelihood have no immediate connection with any reflexes. There is, however, great confusion in the use of the terms reflex, involuntary, and voluntary. Popularly and scientifically the words have not always the same meanings. Often the latter term is restricted to deliberate actions. Thus we are told that when a man snatches his finger from a flame, into which he has inadvertently introduced it, his action is involuntary (*i.e.* reflex); whereas if he wilfully introduces it and keeps it there his action is voluntary. Now no man wilfully (*i.e.* deliberately) burns his finger unless his desire to burn it is greater than his desire to preserve it—unless he thinks that the burning will ultimately lead to benefits which will outweigh the immediate suffering. He "chooses" the greater of two desires, and in this case prefers remoter happiness to present pain. We have only to examine the operations of our own minds to be convinced of the reality of the truth that when there is a conflict of desires, we are always actuated by our stronger desires, the relative strength of them being determined by the relative strength of the corresponding pleasures or pains. When did any man ever seek pain or avoid pleasure except to avert sharper pain or to obtain greater pleasure? The martyr suffers for the sake of deeper and more lasting joys. The patriot risks danger and death for his country, the parent toils for his child only because his mind is so constituted that an opposite course would be more painful. Our *interest* is awakened only through the medium of our own pleasures and pains. For example, did we not feel pain at the sight of another man's sorrow, we should be quite indifferent to it. Prompted, however, by our personal pain, we often stretch a helping hand even when the action entails suffering on ourselves. Invariably, even when our desires are most altruistic or whimsical, we choose what is, or appears at the moment to be, the lesser suffering or the greater pleasure. If, for instance, in an endeavour to disprove this pleasure and pain theory of voluntary action, a man bit his finger and then declared that he had acted contrary to the dictates of pleasure and pain, it would only be necessary to reply that his pleasure in disproving the theory transcended in his mind the pain of the bite. We are helpless in the grip of our desires. We follow unopposed desires, or the stronger of two conflicting desires implicitly. But even after "decision" an opposing desire may rise up in the court of our minds, and, by appealing strongly for reversal of judgment, cause us to falter and hesitate. Happy is he whose desires, once rejected, cease their clamour. Him we term a resolute man.

370. If then a man deliberately decides to burn his finger he follows a course dictated by the stronger of two desires. His action, therefore, is certainly voluntary in the only right sense of the term. *It is not contrary to his desires, nor does it occur in the absence of desire.* But he feels continually the strong pull of the rejected desire; hence his sense of hesitancy, of doubt, of effort. But when he has only one motive for action, and when, therefore, he acts instantly without hesitation or apparent effort, his act is none the less voluntary. An act of deliberation is one thing; a voluntary act is quite another thing. It is not necessarily a resultant of opposing desires, but may result from only one. An act of deliberation invariably occupies an appreciable interval of time; a voluntary action may be "as quick as thought"; so quick that the man is hardly conscious of his pain and his desire to end it before his finger is out of the flame. In a future chapter we shall be in a position to set forth all this more fully and convincingly than we are able to do at present.

371. In a being mentally so complex as man it is not always very easy to trace the connection between his voluntary actions and his desire for pleasure or his aversion to pain. In lower animals in proportion to the simplicity of their mental operations, the connection is more easily perceived. Thus, when a religious enthusiast deprives himself of luxuries in order that he may support a missionary enterprise, the connection between pleasure and pain and the voluntary act is less obvious than when the tiger stalks his prey, or even when a bird deprives herself to feed her nestling. It is evident, however, that in all these instances again the individual is so constituted that an opposite course would give more pain or less pleasure. To the tiger's desire nothing is opposed, and therefore he acts without hesitation. The bird and the man derive greater satisfaction, or suffer less pain from the deprivation than they would have done from the indulgence. But they feel the strong desire for immediate pleasure. Hence the sense of hesitation, and of what we call effort.

372. We may then, provisionally at least, divide all the actions of living beings into, on the one hand, those which are voluntary, and on the other, those which are reflex. To sum up; voluntary actions originate in the immediate presence or the prospect of future pleasures and pains. From pleasure or pain, or the prospect of it, arise desire or aversion, which in turn awakens the will. The voluntary action follows. Reflex action may be associated with pleasure or pain. It may even be initiated by one or the other. When this occurs the feeling is always a spur to useful voluntary actions as well—as in the case of tickling when the feeling causes the individual to take measures to protect himself;—the necessity for the voluntary action being the true reason for the presence of the feeling. Reflex actions are never initiated by the will, though they may be inhibited by it.

CHAPTER XVII

VOLUNTARY ACTION

Instinct—Reason—Memory—*Sitaris*—Dragon-fly—The instincts of Man —The evolution of Memory and Reason—Animals that tend their young—Social animals—The ant—Traditional knowledge in the lower animals—Comparison of the frog with the human being.

373. VOLUNTARY actions may be divided into those which result from inborn mental impulses (*i. e.* desires) and those which result from acquired mental impulses. The former are termed instinctive, the latter, for the want of a better word, we may term "rational."[1] Rational actions, at any rate all deliberate rational actions, are admittedly voluntary.

[1] Generally, especially by technical writers, the term reason is used in a sense much more restricted than in the present work. Thus some authors draw a distinction between intelligence and reason, the former being defined as the faculty by which we draw "perceptual inferences," the latter as the faculty by which we draw "conceptual inferences." In an elaborate discussion of the subject it may be convenient for the purpose of clear definition to so limit the meaning of the word, but then no term remains by which the entire faculty of drawing inferences may be noted—a faculty which obviously depends on the association of ideas, on memory. By common acceptance the power of drawing inferences, the power of using past experiences as guides to future conduct, has been termed reason. Certainly no other word in the language has been used so widely to designate this power. "All the higher animals manifest in various degrees the faculty of inferring. *Now, this is the faculty of reason*, properly so-called." (Romanes, *Mental Evolution in Man*, p. 12. See also *The Descent of Man*, p. 114.) Conception has been described as "the sense of sameness." We get our conceptions by not only knowing things, but by knowing more or less *about* them. As a rule, we know much more about things than lower animals, and therefore our powers of conception show a corresponding superiority. The beginnings, however, of the power are, I think, observable in the more intelligent brutes. When present in a drawing-room I was once bitten by the house-dog. The bite was not severe, I did not start nor exclaim, and the affair passed unnoticed. Later I said to my hostess, "Does your dog bite people?" "No," she replied. "At least not unless they are badly-dressed tramps and that kind of people." Apparently that dog had a rudimentary sense of sameness.

Most authorities, however, place instinctive actions in the involuntary or reflex category. Presently we shall be in a position to discuss this question with advantage, and shall then see that there are good grounds for holding that instinctive (as also automatic) acts are voluntary in a very real sense.

374. Not only the instinctive impulse (the instinct properly so called), but also the power of performing the instinctive action which results from the impulse, is usually inborn; whereas, not only the rational impulse, but the power of giving effect to it is acquired. For example, the caterpillar builds as a place of shelter a cocoon, and a man a house. The caterpillar acts on an inborn mental impulse. He has had no previous experience of cocoons and can have no idea of the purposes they serve. Very probably he has never seen one before. But he acts as if he knew all about the uses of cocoons and the proper method of building them. Driven by his inborn impulse he sets to work at the fit time and place. Notwithstanding the total lack of all practice, his bodily parts act in exact co-ordination. Apparently his work in its beginnings is as perfect as in its endings. Unaided by memory, by learning, by practice, by acquired mental and physical traits, he rears an elaborate structure precisely suited to his needs. The man builds his house in quite a different fashion. He has no instinctive impulse to build, and no inborn dexterity; but he has a clear idea of what he wants. Memory furnishes him with his impulse and his knowledge; practice confers on him his dexterity. If a caterpillar observed other caterpillars working, and noted how, and inferred why they builded, and concluded finally that it would be beneficial if he did the like, his action would be rational. He would depend on his memory, on his acquired mental traits, on his power of using past experience for the guidance of future conduct. In effect, he would think "Such and such actions were beneficial for such and such *reasons* to other caterpillars; let me therefore imitate them." Such a caterpillar would work clumsily at first, but with greater skill later. If the man, on the other hand, were impelled to build his house by an inborn mental impulse, and wrought perfectly without previous knowledge, practice, and forethought, both his impulse and his power of giving effect to it would be instinctive. The distinction between instinct and what we have termed reason, then, is clear. The one depends on inborn mental traits, the other on acquired mental characters. INSTINCT, *therefore, may be*

defined as that faculty which is concerned in the adaptation of means to ends by virtue of inborn inherited mental impulses and capacities for action. REASON *may be defined as the faculty which is concerned in the adaptation of means to ends by virtue of acquired non-inherited mental impulses and capacities for action.*

375. The lowest animals are without power of movement; or at least we must suppose that the earliest animals had not this power since it implies some degree of evolution. Higher in the scale of animal life protoplasmic and reflex action appears. Yet higher instincts are mingled with reflexes, and in insects especially reach great perfection. Still higher reason appears, and in the highest animal of all, man, attains a position of commanding importance.

376. Some instincts of animals are very remarkable. "Let us follow the somewhat complex life-history of a beetle of the family of the Blister-beetles or Cantharides, as we learnt it first from Fabre. The female of the red-shouldered bee-beetle (*Sitaris humeralis*) lays its eggs on the ground in the neighbourhood of the underground nest of a honey-gathering burrowing-bee (*Anthophora*). The larvæ, when they emerge, are agile, six-legged, and furnished with a horny head and biting mouth-parts, as well as with a tail-fork for springing. The little animals have at first no food-instinct, or at least none manifests itself, but they run about, and as soon as they see a bee of the genus *Anthophora* they spring upon it and hide themselves in its thick, hairy coat. If they have been fortunate the bee is a female, who founds a new colony and builds cells, in each of which she deposits some honey and lays an egg upon it. As soon as this has been done the *Sitaris* larva leaves its hiding-place, bites the egg of the bee open, and gradually eats up the contents. Then it moults, and takes the form of a grub with minute feet and imperfect masticating organs; the tail-fork, too, is lost, for all these parts now are useless, since it can obtain liquid nourishment without further change of place, from the honey in the cell, in exactly the quantity necessary to its growth. Then it spends the winter in a hardened pupa-like skin, and it is not till the next year (the third), after another short larval stage and subsequent true pupahood, that the fully-formed beetle emerges. This again possesses biting mouth-parts, and eats leaves, and has legs to run with and wings to fly with.

377. "In this beetle, then, the food-instinct changes three times in the course of its life; first the egg of the bee is the liberating stimulus, then the honey, and finally leaves. The

instinct of moving varies likewise, expressing itself first in running and jumping and in catching on, then in lying within the cell, and, lastly, in flying about on bushes and trees."[1]

378. Manifestly during the whole of this complicated proceeding the beetle is quite independent of experience, of memory. He does each action once and never repeats it. From the nature of the case he can never have seen similar actions done by other beetles. Instinct guides and keeps him to a narrow, rigid line of life, for which it is all sufficient, and from which if he strays he perishes. In accordance with Nature's law of parsimony, therefore, the power of making mental acquirements, the power of using past experiences as guides to future conduct cannot exist to any extent in him. Even if he possessed an extended memory, it would undergo regression in his descendants. It is conceivable that the beginnings of memory are present in him. In a form so rudimentary as to be unobservable by us, he may need it and perhaps does use it for some of the smaller actions of his life; but his main line of conduct is predetermined by instinct.[2]

[1] Weismann, *The Evolution Theory*, vol. i., pp. 150–1.

[2] Professor Richet (*Revue Philosophique*, XXI. 570, quoted by James) insists that "Without memory no conscious sensation, without memory no consciousness." But clearly he is mistaken. The act of feeling a sensation is quite distinct from the act of remembering it, and there is no conceivable reason why the former should not occur without the latter. "All he is entitled to say is that without memory no consciousness known outside of itself." Professor Romanes declares that "Memory must be, and is, a faculty which appears very early in the development of mind. *A priori*, this must be so because consciousness without memory would be useless to the animal possessing it." But we have not the least evidence of memory in *Sitaris*, and it is hard to imagine of what use it would be to her. Before a sensation can be remembered it must be felt; but, if felt, it need not necessarily be remembered. All the evidence points to the conclusion that the faculty of feeling was evolved long before the faculty of remembering. That a sensation may be useful to an individual it is not necessary that he should remember the circumstances under which he felt it before; it is only necessary that it should be a spark which explodes an appropriate reflex or instinctive action. Remembrance is useful only to those animals in whom the action is not reflex or instinctive, and in whom, therefore, it is initiated, not by the sensation alone, but by the sensation *plus the memory of a past event*. Professor Romanes' own experiments provide some excellent examples of lack of memory in low animals. "For instance, I have taken a hermit crab, put it into a tank filled with water, and when he had protruded his head from the shell of the whelk in which he was residing, I gently moved towards him a pair of open scissors, and gave him plenty of time to see the glistening object. Then, slowly including the tip of one of his tentacles between one of the open

379. The dragon-fly furnishes another example:

> "To-day I saw the dragon-fly
> Come from the wells where he did lie.
> An inner impulse rent the veil
> Of his old husk. From head to tail
> Came out clear plates of sapphire mail.
> He dried his wings; like gauze they grew.
> O'er crofts and pastures, wet with dew
> A living flash of light he flew."

380. The dragon-fly begins his conscious life in the water. Emerged from the egg, he knows his food and where to seek it; his enemies and how to shelter from them. At the fit time, prompted by his instinct, he leaves the water and climbs into an entirely new world. As a perfect insect he rests till his wings are fit for use and then launches himself into the air. Again he knows his prey and his enemies. He knows his mate and how to deal with her, and she knows the fit time and place wherein to lay her eggs. From first to last he furnishes no evidence of memory. Like *Sitaris* he seems to live the narrow round of his life unaided by experience. Both *Sitaris* and the dragon-fly have exactly the same instincts as their predecessors, from whom as we see they can have had no opportunities of learning. Instinct, therefore, like all inborn characters, is transmissible from parent to child.

381. In man several very highly important instincts survive; for example, the sexual and parental instincts, the instinctive recognition of and delight in food, the sporting instinct, the impulse to rest when tired, and the periodic impulse to sleep. He is a very abnormal man in whom the sight of a beautiful woman arouses no emotions. She is a very abnormal woman who has no love for her child. Most of us are capable of recognizing and enjoying food when it is placed in our mouths.[1] Almost every child delights in play.

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blades, I suddenly cut off the tip. Of course the animal immediately drew back into the shell, and remained there for a considerable time. When he came out again I repeated the operation as before, and so on for a great number of times, till all the tentacles had been progressively cut away little by little. Yet the animal never learnt to associate the scissors with the effect which always followed it, and so never drew in until the snip had been given." (*Mental Evolution in Animals*, pp. 122–6.) Here memory of former sensations and events gave no help to the crab; but sensation alone was useful, for it caused him to withdraw instinctively into his shelter.

[1] Practically speaking innutritious substances are generally disagreeable. We are apt to take them only when they are combined with and concealed by food.

Every man enjoys rest when wearied. On every one comes the periodic craving for sleep. Examining our own minds we see that an instinct is an emotion, a desire, an impulse to action, aroused in us by a given stimulus and prompting us to definite acts—the instinctive acts by which the desire is gratified. Since we have inherited our instincts from pre-human ancestors, we shall not be very wrong if we suppose that the instincts of lower animals are of much the same nature as our own—that they are emotions and desires, having their springs in present or prospective pleasures and pains. In all probability, therefore, the feelings of sexual and parental love, for example, do not differ altogether in the human being, the tiger, and the spider.

382. Clearly it is the presence of this prompting emotion, this desire to achieve pleasure or avoid pain, that distinguishes an instinctive act from a mere reflex. Very low animals may possess reflexes; but the existence of the emotion marks an advanced stage in evolution. Before it can be felt and gratified the animal must have a comparatively highly-developed nervous system, connected with organs of sense and movement. Instinctive actions, besides, are usually very much more complex than reflex actions. They are directed to ends that are often immensely more distant. Compare, for instance, any of the reflexes in the body of the spider or the dragon-fly with the long series of instinctive movements which the one makes in spinning a web and the other in seeking his prey. A reflex may be, and often is, quite unaccompanied by any manifestation of mind. But mind, often highly developed, must be present during every performance of an instinctive act. Imagine, for instance, a dragon-fly darting hither and thither in a wood, keenly observant of obstacles, of enemies, of possible food, and possible mates. A flood of sense-impressions must pour on his mind, and awaken a constantly changing stream of emotions. Imagine a spider approaching a huge wasp entangled in his web, or his equally formidable mate. As desire and fear, hope and apprehension, chase each other through his mind and contend for mastery he hesitates, advances, and retreats. Amid the conflict of emotions something very like what we term intelligence is born. He chooses his line of action in a sense as real as a man would do under similar circumstances.

383. It is impossible of course to indicate the precise stage of evolution—the particular kind of animals—in which instinct first arose. We can only say that it must have

arisen in connection with a highly-developed nervous system, which owed its existence to the evolution of many reflexes within the same complex organism. Sensation, as we have already surmised, must probably have preceded instinct as an accompaniment of elaborate reflex action. When during the course of subsequent evolution sensation took on particular tones or qualities—those of pleasure and pain, the inciters of desire—instinct made its appearance. It is equally difficult to indicate the earliest appearance of reason—of memory and its corollary, the power of applying the contents of memory to the guidance of future conduct. A rudimentary power of making mental acquirements seems to exist even so low in the scale as the lower mollusca. "Even the headless oyster seems to profit from experience, for Dicquemase (*Journal de Physique*, vol. xxviii., p. 244) asserts that oysters taken from a depth never uncovered by the sea, open their shells, loose the water within, and perish; but oysters taken from the same place and depth, if kept in the reservoirs, where they are occasionally left uncovered for a short time, and are otherwise incommoded, learn to keep their shells shut, and then live for a much longer time when taken out of the water."[1]

384. Accordingly as animals are more and more highly placed in the scale of life their power of making mental acquirements, and therefore of profiting by experience, increases. Without exception it is small in the case of all animals that are not tended during at least a part of their conscious life by the parents. Such animals, cast adrift, must necessarily arrive in a hostile world with their faculties fully developed. From the beginning they must be capable of fighting their own battles. They have little time to learn, and therefore little capacity for learning. If they had, since they generally die after depositing their eggs, they would have no opportunity of imparting anything they had learnt to the next generation. They must come, therefore, armed *cap-à-pie* with instinct for the fray. Some of these animals, however, display distinct though very limited capabilities for making mental acquirements. Thus trout in a much-fished stream grow shy of moving objects on the bank, and carp confined in monastic ponds are said to have learned to recognize the sound of a bell as a signal for food. Amphibians and reptiles have been tamed and have even learned to distinguish their masters from other people.

385. In the case of animals that tend their young the

[1] Romanes, *Animal Intelligence*, p. 25.

power of making mental acquirements is much greater. The young individual does not begin existence in an entirely hostile world. He need not, therefore, be so well equipped mentally and physically as, for instance, the young dragon-fly, or as he himself must be later when the parental protection is withdrawn. Opportunity is thus afforded for supplying deficiencies of instinct by the exercise of such powers of making useful mental acquirements as he may possess. This power of learning, of profiting by experience, is what we term intelligence and reason. In the higher animals the equipment of intelligence is always in inverse proportion to the equipment of instinct. It is, therefore, proportionate, as a rule, to the helplessness of the individual at the beginning of conscious life, and consequently to the amount and duration of the care which must be lavished on him by the parent.[1] A chicken who knows how to run, and peck, and hide from danger as soon as it is out of the egg is less intelligent than a parrot or a jackdaw; a lamb is less intelligent than a dog or a monkey. A human infant, whose subsequent acquirements will be immense and whose mother's care is strenuous and prolonged, is so helpless that it cannot even seek the breast.

386. When animals are social, and so have the opportunity of learning not only from their parents but from other

[1] This statement requires qualification, or rather expansion. Comparative deficiency of instinct is not the only cause of the helplessness of young animals. Thus a young pigeon is very helpless at birth, but ultimately it does not become more intelligent, if so intelligent as an adult domestic fowl. Much depends on the manner in which the food is collected by the parents. All animals that tend their young, but go far afield for food, have helpless offspring. The lioness leaves her cubs in the lair; the pigeon, the seagull, and the hawk leave their fledglings in the nest. But the young deer and the young pheasant from the first wander with their parents. For obvious reasons, in the one case helplessness is an advantage, in the other activity. Instinct, however, is not really lacking to helpless young animals of this class. Its development is merely deferred to a time when it is useful. The instinct of flight, for example, is developed in the young pigeon as soon as the growth of the wings renders flight possible. The helplessness of the carnivorous mammals, however, seems due, in part at least, to a real lack of instinct. The clumsy young puppy, for instance, appears distinctly to *acquire* strength of muscle and freedom of movement. His playfulness is clear evidence that his powers of making physical and mental acquirements are great. (See §§ 400–2.) It should be noted also that the family life, especially when animals of the same species mix together, depends entirely on the power of making mental acquirements. The parents and child, the husband and wife, must *learn* to recognize each other. They cannot, from the nature of the case, recognize one another instinctively. Family life, therefore, is developed in proportion to the development of the power of making mental acquirements.

members of the species, the power of making useful mental acquirements is correspondingly great. It reaches a remarkable development even among insects some species of which live together in great communities. Young ants, for example, are tended with anxious care. It is said that they are led about the nest by older individuals and taught their duties. They are said to be playful.[1] Most significant of all is the fact that some species have the habit of capturing slaves belonging to other species. These they take as pupæ, never as adult ants. "When the pupæ hatch out in the nests of their captors, the young slaves begin their life of work, and seem to regard their masters' home as their own; for they never attempt to escape, and they fight no less keenly than their masters in defence of the nest. *F. sanguinea* content themselves with fewer slaves than *F. rufescens:* and the work that devolves upon the slaves differs according to the species which has enslaved them. In the nest of *F. sanguinea* the comparatively few captives are kept as household slaves; they never enter or leave the nest, and so are never seen unless the nest is opened. They are then very conspicuous from the contrast which their black colour and small size presents to the red colour and the much larger size of *F. sanguinea*. As the slaves are by this species kept strictly indoors, all the outdoor work of foraging, slave-capturing, etc. is performed by the masters; and when, for any reason, a nest has to migrate, the masters carry their slaves in their jaws. *F. rufescens*, on the other hand, assign a much larger share of the labour to the slaves, which, as we have already seen, are present in much larger numbers to take it. In this species the males and fertile females do no work of any kind; and the workers, or sterile females, though most energetic in capturing slaves, do no other kind of work. Therefore the whole community is absolutely dependent upon the slaves. The masters are not able to make their own nests or to feed their own larvæ. When they migrate, it is the slaves that determine the migration, and, reversing the order of things that obtains in *F. sanguinea*, carry the masters in their jaws. Huber shut up thirty masters without a slave and with abundance of their favourite food, and also with their own larvæ and pupæ for a stimulus to work; but they could not feed themselves and many died of hunger. He then introduced a single slave and she set to work at once, fed the surviving masters, attended to the larvæ and made some cells.

[1] Huber, confirmed by Fabre, *Les fourmis de la Suisse*, 1874.

387. "In order to confirm this observation Lespés placed a piece of sugar near a nest of slave-makers. It was soon found by one of the slaves, which gorged itself and returned to the nest. Other slaves then came out and did likewise. Then some of the masters came out, and, by pulling the legs of the feeding slaves, reminded them that they were neglecting their duty. The slaves immediately began to serve their masters with the sugar."[1]

388. The slaves are neuter individuals and have no offspring, the supply being maintained by fresh captures. Consequently they can have had no ancestors that performed servile duties. It follows that the slaves must *learn* their work, and, therefore, that the performance of it is not instinctive but intelligent and "rational." It is evident, therefore, since ants are able to adapt themselves to an environment and to duties so entirely novel, that at least some species of them are capable of making great mental acquirements. It is a fair inference that many of the other so-called instincts of ants—for example, the habit of keeping plant-bugs as beasts of burden to carry leaves, of keeping pets, of rearing aphides for the sake of their sweet secretions, of cultivating plants and storing the seeds, of nipping the rootlets of the seeds to prevent germination, and so forth—are really acquired habits, bits of knowledge and ways of thinking and acting which are handed down from one generation to the next, not by actual inheritance, but traditionally and educationally, just as our children acquire from us language, or religion, or a trade. There is indeed considerable reason to believe that the power of making mental acquirements has evolved to a greater degree in the favourable environment of the ant-nest than among any other species of animal except man.

389. Traditional knowledge is common enough among the higher animals, and forms no inconsiderable part of their mental equipment. For instance, birds and mammals inhabiting desert islands appear to have no instinctive fear of man. Darwin relates how in the Galapagos group he pushed a hawk from its perch with the muzzle of his gun. Seals and birds in the Antarctic show only indifference or anger at the presence of human visitors. A short acquaintance with man, however, instils a dread which soon becomes traditional. Doubtless animals which have escaped attempted destruction at his hands, or who have witnessed the actual destruction or capture of their kind, become alarmed and by their demeanour communicate the alarm to their fellows. No increase of alarm

[1] Romanes, *Animal Intelligence*, p. 656.

is observable, however, among yet lower animals, for example, insects, even if destroyed in large numbers. As the destruction is not selective a new instinct is not evolved, and such animals are incapable of acquiring and communicating alarm. Since the advent of sheep the Kea parrots, and in some districts the descendants of the tame pigs of New Zealand, have become predatory. The American bison and the wild Lapland reindeer when much persecuted abandoned the open plain for the forest. Sparrows in New Zealand have taken to burrowing in cliffs like sand-martins, whereas the cliff-swallow of the Eastern States of America has abandoned the cliffs and now resorts to the eaves of houses. Beavers in Europe no longer build huts and dams. Gulls, which are among the wildest of wild birds on the sea-coast, where they are persecuted, are almost as tame as domestic fowls at London Bridge, where they are fed. Innumerable similar examples might be instanced. All the higher animals may be observed imparting traditional knowledge to their offspring; thus predatory animals, every species in its own way, teach their young to hunt.

390. In order to obtain a clear conception of the distinction between instinct and what we have termed reason, it is useful to contrast the development of an animal whose mind is almost purely instinctive with the development of one whose mind is largely rational. Occasionally the newspaper press makes an announcement which is generally received with—perhaps—undeserved incredulity. It is stated that, on a lump of chalk or coal being struck and shattered, there has leaped from amongst the fragments a frog, perfectly developed and in full possession of its faculties. It is popularly assumed that the frog is coeval with the chalk or coal. The assumption is, of course, nonsense. No frog ever lived for millions of years. Moreover the frog is an air-breathing animal. On the other hand it is just possible that on very rare occasions a frog may inhabit such a prison-house. If the lump had a cavity in the heart of it, and if, after removal of the lump from, or disturbance in its place of formation, water laden with nutriment flowed into the cavity by one crevice and out by another, a tadpole might make its dwelling in the cavity, till too big to leave it; and if there were air in the cavity as well as water the tadpole might develop into a perfect frog. It is difficult to decide what amount of truth there is in these newspaper announcements. Probably, since they are so frequently repeated and with so much circumstantial detail, they are not wholly false. The

truth of them is not essential to the argument, but since the frog in the lump of chalk or coal furnishes an excellent illustration, we will for the moment assume them to be true. At any rate, even if no frog has actually inhabited a cavity in chalk or coal, it is tolerably certain that a tadpole so placed would develop into a perfect animal; for if we capture a tadpole, and, supplying it with proper food, rear it in a vessel in our own houses, it also develops into a frog perfect in body and mind. In all respects the animal is as active and his faculties are as keen as those of a frog born in the marshes. If released he is ready to take his place with, and battle for existence against his fellows of the pond. Like the dragon-fly, he knows his proper food and how to seek it; he knows his enemies and how to avoid them; he will search for his mate and will know her when they meet. Neither the aquarium nor the narrow walls of chalk or coal cramp body and mind such as they are. His physical and mental development depends solely, or almost solely, on the amount of food he is able to secure. But he is practically incapable of learning. People who have kept frogs know them as the stupidest of pets. If now and then a frog learns or appears to learn, the amount of his acquired knowledge is certainly infinitesimal.[1]

391. But suppose we took a baby at birth and, were it possible, confined it in a narrow chamber so contrived that growth but not movement was permitted, and in which neither light nor sound nor other messages from the outer world reached it. Suppose by some means we kept it alive, cramped and in the still darkness, for twenty or thirty years, and then opened the chamber. We should find a creature scarcely human. Certainly all that distinguishes man from the brutes would be absent. The creature would have the hair and teeth and some other structures of the adult man. The rest of its body would be little bigger than an infant; for, as is well known, the trunk, limbs, and brain of man, though not his hair nor teeth, develop mainly as a result of use and exercise.[2] Thus a limb, completely paralyzed during infancy, grows little if at all. Possibly the bones of the imprisoned baby would grow somewhat; but the voluntary muscles, except the breathing muscles, would disappear.

[1] The most learned frog of which I have knowledge is one mentioned by the late Professor George Romanes (*Animal Intelligence*, p. 255). It is possible his correspondent was not a very accurate observer. Nevertheless frogs are so high in the scale of life that it is tolerably certain that they are able to learn a little, if a very little.

[2] See § 438, footnote.

The strange inhabitant of the prison would be a mere bag of bones. A feeble heart would beat between feeble lungs. Big teeth would overcrowd its baby jaws, and long hair from its head would cover its body as with a garment. Its mind, like that of a new-born baby, would be almost a perfect blank. Light and sound and its other sensations would convey no meanings to it. Moreover, unlike the baby, at its age it would have lost, in great measure, the power of making acquirements, physical and mental. It could, therefore, no longer grow as a result of use and exercise. It would remain helpless, inert, crippled, a hopeless imbecile.

392. The frog's body, then, gains almost nothing from use and his mind almost nothing from experience. They develop much as man's sexual organs and instincts develop. On the other hand man depends, as regards body and mind, very largely on use and experience. The frog's notion of the surrounding world is inborn and instinctive, and descends by actual inheritance from parent to offspring. But the individual frog is unable to add materially to that knowledge. In other words, the frog, as we have the strongest reasons to believe, has little memory. As a consequence he has little idea of the past and therefore of the future. He lives almost wholly in the present.[1] His actions, therefore, are not due

[1] That is, he lives almost wholly in what has been called the "specious present." The real present is an instant, a knife-edge of time; "the practically cognized present is no knife-edge, but with a certain breadth of its own on which we sit perched, and from which we look in two directions into time. The unit of composition of time is a *duration*, with a bow and a stern as it were—a rearward- and a forward-looking end. . . . The specious present has, in addition, a vaguely vanishing backward and forward fringe; but its nucleus is probably the dozen seconds or less that have just elapsed." (James, *Principles of Psychology*, vol. i., pp. 609 and 613.) "All the notes of a bar of a song seem to the listener to be contained in the present. All the changes of place of a meteor seem to the beholder to be contained in the present. At the instant of the termination of such series no part of the time measured by them seems to be a past. Time, then, considered relatively to human apprehension, consists of four parts, viz. the obvious past, the specious present, the real present, and the future. Omitting the specious present it consists of three . . . nonentities—the past, which does not exist, the future, which does not exist, and their conterminons, the present; the faculty from which it proceeds lies to us in the fiction of the specious present." (G. R. Clay, *The Alternative*, p. 167. Quoted by James.)

In human beings the specious present is of short duration. It may be shorter or much longer in various lower animals. An Egyptian fly is back on one's face the moment it has dodged the hand. Apparently the deadly peril has already passed from its mind. A wasp is a stupid animal, though, as Lord Avebury has shown, somewhat capable of to forethought or calculation or inference, but solely to impulse. With the man it is different. His notion of the

learning (*Ants, Bees, and Wasps*, chap. xi.). Yet she knows her way back to the nest. Does she do it by the exercise of a true memory? Is she able to *recall* ideas and events that have passed from her mind? Or does she merely live in a specious present of long duration, during which the way to the nest is always dimly present in her mind? Considering how low is her capacity for making mental acquirements, it is possible that her specious present is long of duration and rich of contents, and that she finds her way by virtue of it. This, however, would imply a prodigious extension of the specious present. It is much more probable that she is really able to recall past experiences—but only a certain set of past experiences which she can utilize only in a certain way. Man's mind, on the other hand, is capable of much more varied acquirement, which can be utilized in an infinitely greater diversity of ways.

Possibly by studying our dreams we may be able to get some notion of the mental processes of purely instinctive animals. So far as my own experience enables me to judge, we dream even during the soundest sleep. As a medical man I am frequently rung up. I appear always to awaken from the midst of a dream, which I remember if I think of it at the time, but which otherwise I soon forget. When dreaming during fairly sound sleep we seem to live entirely in the present. At least this is the case with me and nearly all whom I have questioned. There is little or no casting of our thoughts backward to the past or forward over the future. When we see an individual in a dream we know him at once, as it were by instinct, to be a friend or an enemy. Or we judge him to be one by his immediate conduct. The state of mind is entirely different from that which obtains in our "waking dreams," when we are pre-occupied exclusively with the past or the future. Thus one of my most common dream-enemies is a schoolmaster whom I detested as a boy. When this person appears he does not come surrounded by an aura of recollections. He is greeted with aversion which he proceeds to justify; but his past hostilities, his cruelties, stupidities, and injustices, are never recalled except perhaps in very light sleep. He is an enemy in the "specious present," beyond which my dream-mind does not wander; and he is then to me an enemy just solely because he is an enemy, because I know intuitively that he is going to act as an enemy, not because I *remember* him as an enemy. I never say to him, "You *did* this or that iniquitous thing." He is perceived, not conceived, as an enemy. Nothing he does surprises me. Indeed no situation, however absurd, ever does surprise a dreaming person. How could it if real memory be abolished? We are surprised in our waking hours only at phenomena that contradict past experience. If we cease to draw inferences from our past we cannot be surprised. A young baby would be no more surprised at flying than at being carried, at seeing a dragon than at seeing its own nurse, at observing a stone rise to the ceiling than at observing one fall to the ground. Last year in the character of Father Christmas I carried some toys to my boy's bedroom. The only surprise he expressed subsequently was that "Father Christmas did not look quite so nice" as he had expected. In lighter sleep, when the waking and the dreaming consciousness are merged, particularly when we are just dropping off or rousing naturally, our powers of recollection appear less in abeyance. We seem to have world is only to a small extent inborn and instinctive. He inherits comparatively little of that sort from his parent, and transmits little of the kind to his child. But he is preeminently capable of learning. Though his mind is almost a blank at birth, yet every sight and sound, every sensation and experience, adds to the store of knowledge piled up in his immense memory. One frog is mentally almost similar to any other frog. Under given conditions all frogs act much alike. They move in a narrow instinctive groove. But because man depends so greatly on experience, and since the experiences of different men may differ very widely, it follows that men may differ very greatly in mind from one another. Under given circumstances men who have not had the same training do not act in the same way. Their actions are controlled by their acquirements; they do not move in a narrow instinctive groove. One man acquires Spanish, another English; one man becomes a hunter, another a statesman; one becomes a priest, another studies science; one is civilized, another is savage. The differences are endless.

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some notion, however small, of the past, and some conception, however confused, of the future.

As I greet my old school-master in my dreams, so, presumably, does a frog greet a snake or a rival. If a fly that he was about to eat were turned into a snake about to eat him, he would feel alarm doubtless, but probably no surprise. It is true, of course, that I really got my knowledge of my school-master through experience, and that in this I differ from the frog, who gets his knowledge of the snake through instinct. But in my dreams my acquired knowledge seems to take on the type of instinct. It appears innate, as if the physical characters in my brain, with which it is correlated, had developed otherwise than through use and experience; as if they had developed as Adam's navel is said by theologians to have developed.

CHAPTER XVIII

THE INSTINCTS AND THE ACQUIREMENTS OF MAN

The essential difference between Man and the brutes—Reason in the brutes—The substitution of reason for instinct—The instincts of Man—The sexual instinct—The parental instinct—The instinct for food — Imitativeness — The sporting instinct — The stereotyping of mental acquirements—Its advantages and disadvantages.

393. MAN'S splendid power of learning through experience, and of applying the contents of his memory to forecast and mould the future is his peculiar glory. It is this that distinguishes him from and raises him above all other animals. This it is that makes him man. This it is that has enabled him to conquer the whole world and adapt himself to a million conditions of life. Consider how immense are his mental acquirements during his long passage from infancy to old age. A language alone needs a vast memory, to communicate by language a vast development of reason. With the exception of the evolution of life and consciousness, this evolution of the power of making mental acquirements is the most important phase of evolution in the whole history of life. It alone renders all the stages of intellectuality possible. Memory, forethought, induction, deduction, reason in all its grades and in every sense, imagination, conception, discrimination, comparison, association, habit, all depend on it.

394. Reason is a word which has been used with many meanings. Various writers, giving this or that signification to the term, have maintained that man alone, of all animals, possesses reason. We have used it as synonymous with the general power of drawing inferences, a faculty which clearly depends on memory. Obviously all animals that have the power of making mental acquirements, of storing data in their memories, must possess the power of drawing inferences from them; otherwise their stores of experience would be useless, and the power of making them would not have been evolved.

If a bird, for instance, attacked by a man, escaped, and subsequently fled on sight of the man without waiting to be attacked, it must draw a real inference. It must conclude, in a dim way at least, that the man is dangerous. If reason is used with this meaning it is certainly incorrect to say that men alone possess it. If, however, we limit the term to some particular manifestation, or phase of the faculty of drawing inferences, it may be correct to say that man is the only rational animal. Owing to his immense memory and his vast powers of using the contents of his memory, he is, of course, able to perform feats of thinking, abstraction, for example, far beyond the powers of lower animals. But even in its highest manifestations the faculty differs in degree, not in kind, from that displayed by the oyster, which learns by experience to close its shell when uncovered by water. The oyster draws a kind of inference, however dimly and unconsciously; in it, as in a baby lately born, is present the beginnings of that faculty which attains to such splendour in adult man. The baby is as incapable as the oyster of the higher phases of reasoning, but as he grows, as he recapitulates the life-history of his race, the development of the faculty in him proceeds without stop or break, from the lowest phases of perceptual inference to the highest flights of conceptual or abstract thought, and thus affords a representation of the manner of its evolution.[1]

[1] Many writers, especially when animated by theological zeal, have declared that the possession of reason fixes an impassable gulf between man and the lower animals. Thus Father Maher (*Fortnightly Review*, Feb. 1902, p. 222), who defines reason as "the faculty, the essential character of which consists in the apprehension of the universal," insists that "the lower animals do not show that individual free variation in method and plan of action, and that intellectual progress which ought to mark the presence of personal intelligence. Thus, animals of the same species when in similar circumstances exhibit a striking uniformity in their operations. They will seek their prey, build their nests, and foster their young in the same way. Amongst rational beings, on the contrary, we find in everything the signs of individual personality. The ants and bees in the time of Moses or of Aristotle worked as perfectly as their descendants of to-day, and geese and sheep acted not more awkwardly. There is no evidence that during all the time brutes existed upon the earth they have invented a single mechanical instrument, lit a fire, or intelligently transmitted a useful piece of information from one generation to another. . . . The difference which separates the simplest exercises of reason from the highest forms of animal intelligence is thus found to be impassable."

But, as we see, reason, even as defined by Father Maher, is plainly nothing more than a particular development of the faculty for making and using mental acquirements. In man alone this faculty has grown so great that he is able to apprehend universals. It would be as reason-

395. Man, pre-eminently the rational animal, is proportionately helpless at birth. His helplessness diminishes as a result of the physical and mental acquirements he makes. In this he differs from the young pigeon, which is capable of making some acquirements, but which is helpless chiefly because its instincts are deferred. In man, therefore, the power of making acquirements has done more than supplement instinct. In a large measure it has supplanted it. In a lesser degree the same is true of all the highest animals. Why has the power of making mental acquirements replaced instincts? The explanation is twofold. In the first place, reason confers adaptability, a faculty of enormous importance. Secondly, as a single thing it is more easy of evolution than a great number of instincts. Reason is a substitute for millions of instincts, each of which would need for its evolution and maintenance a separate process of Natural Selection. Reason for its evolution and maintenance needs only one process of Natural Selection. Natural Selection implies

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able to declare that an impassable difference separates the elephant from other animals merely because his nose is transcendentally long and can be used for seizing objects. In man only the power of making and using acquirements predominates greatly over instinct. Men, therefore, have marked individualities, and human societies are changeful because human character depends mainly, not on scarcely varying instincts, but on mental acquirements which differ immensely in different individuals, and from generation to generation. Lower animals lack individuality, and their states of society are comparatively changeless, they are unable to invent mechanical instruments, light fires, or transmit abstruse information, for an opposite reason. But very plainly the difference is merely one of degree. Since the gulf is passable during development (*i. e.* recapitulation), it is passable, and has been passed during evolution.

Mr. A. R. Wallace argues (*Darwinism*, p. 474) that, since the mathematical, musical, artistic, and moral faculties can have been of no assistance in the struggle for existence to the savage or brute progenitors of modern man, their existence affords evidence that the evolution of his mind has not been due solely to "the blind, eternal forces of the universe" (*i. e.* Natural Selection), ... "but must have had another origin, and for this origin we can only find an adequate cause in the unseen universe of spirit." Mr. Wallace's reasoning is an interesting application of the great maxim, "Whatever you are totally ignorant of assert to be the explanation of everything else." The mathematical faculty is merely a particular manifestation of the general faculty of making acquirements. The fact that it can be more highly developed by training in some individuals than in others is no more a proof of supernatural origin than the fact that a great capacity for distinguishing between different kinds of tea is a proof of such origin. The moral faculties are not instinctive, as Mr. Wallace implies, but mere acquirements. The artistic and musical faculties, like the capacity for enjoying narcotics, are obviously explainable as by-products of mental evolution. (See Romanes, *Darwin and After Darwin*, vol. ii., pp. 25–35.)

elimination of the unfittest. To be an effective cause of evolution it must be stringent. Many stringent processes of elimination, each the cause of a high rate of mortality, necessarily cause the extinction, not the evolution, of the species subjected to them. There is, therefore, a natural limit to the number of instincts that may be evolved at one time in a species.[1] Nature, then, by evolving memory and its corollary reason, has discovered a way out of the difficulty; and, by supplying that which is a substitute for an infinite number of instincts, has enabled animals to adapt themselves to the increasing complexity of their environments, and thus to achieve a higher evolution. She "is frugal in her operations, and will not be at the expense of a particular instinct to give us that knowledge which experience and habit will soon produce."

396. But even in man, the least instinctive animal, a

[1] It is possible that an indefinite number of instincts might be evolved in a species provided the conditions were not very onerous, that is, provided the instincts were evolved in succession one by one, or only a few at a time, so that Natural Selection could establish thoroughly each instinct or set of instincts before elimination for the next set began. A well-established instinct (*e. g.* the sexual instinct), like a well-established physical structure, would have a comparatively slight tendency to regression, and therefore would be maintained by a relatively small amount of elimination. But obviously the evolution of a number of instincts by this process would be very slow. Much swifter and more easy of evolution would be the single power of making mental acquirements by means of which each individual in turn could acquire efficient substitutes for a multitude of instincts. We have already noted how there has been amongst the higher animals an evolution of a general power of acquiring immunity against disease, combined with a particular power of acquiring immunity against particular diseases. Similarly, while there has been among animals an evolution of the general power of making mental acquirements, there has been in different species an evolution of particular powers of making mental acquirements in fixed directions. Thus, the capacity of cats for being tamed, for becoming adapted to a novel environment, is a manifestation of the general power, whereas the innate tendency to learn to hunt small animals is an instance of the evolution of the power of making acquirements in a particular direction. Darwin and other writers consider the ability to breed in captivity as the first condition to domestication. But, as regards the higher animals, even more important is the power of making mental acquirements. Otherwise the animal cannot be tamed. We are able to domesticate elephants though they rarely breed in captivity. If they remained as shy and savage as wild elephants we should have to shoot them at sight. They could be then no more domesticated than tigers, much less intelligent animals whose instincts cannot be overpowered by mental acquirements. The only animals that lack great powers of making mental acquirements, which we are able "to domesticate," are certain insects — *e. g.* silk-worms — and these are merely kept, not domesticated in any real sense.

certain number of instincts persist in full force. Without them the continued existence of the individual and the species would be impossible. Such are the instinctive delight in food with its corollary the instinctive recognition of food as food, the instinct of curiosity, the imitative, the sporting, the sexual, and the parental instincts.

397. Of the parental and sexual instincts we need say little. The necessity for their persistence is obvious. The sexual instinct is usually stronger in men than in women. If only for physical reasons no man can procreate offspring unless he has the instinct. In past ages, other things equal, the man who had the instinct best developed had the most offspring. Accordingly it has suffered no regression in him. But women have often been slaves, entirely subject to the will of their masters. They are quite capable of having offspring even when the instinct is weak or absent. Hence the difference in this respect between the sexes. The parental instinct is, on the other hand, usually stronger in women than in men. The woman who had the instinct weakly developed took, other things equal, comparatively little care of her offspring, and handed on her peculiarity to comparatively few daughters. The man's parental affection was of less importance. Hence again the cause of the difference.

398. Of the instinctive delight in and recognition of food, also, we need say little. The capacity for recognizing food is least developed in the helpless infant, who is preserved by its mother from errors. In the young of lower animals the recognition is perfect in proportion to their activity at or soon after birth. Sight, scent, and especially taste supply information. Insects, reptiles, and birds are probably seldom in error; even the young puppy rarely makes a mistake. As the human being becomes capable of finding and placing objects in its mouth its discrimination becomes keener. This is due in some measure to acquirement, but certainly more to the development of a deferred instinct. A savage who has never seen some odd-looking articles of civilized diet will instantly recognize it as a food when it is placed in his mouth. The child will seldom swallow anything but food; it will crave for a sufficient quantity, and will rarely swallow an excessive quantity unless starving for some particular constituent of which it has been unduly deprived. Like all inborn traits, the power of discrimination varies in different individuals, and like all products of evolution it is not absolutely perfect. Thus poison concealed in a nutritious substance may not be detected. Nevertheless, considering the great complexity of

the instinct it is wonderfully exact. Normally adults trust exclusively to it. Guided by the instinct they eat and drink of the things they enjoy to the extent of their desires. Man is an omnivorous animal. No one food contains all the constituents necessary to him in exactly the right proportions, though many foods contain all the constituents in wrong proportions. If, then, he is restricted to one article of diet, he eats largely and wastefully; he must devour too much of some constituents that are in excess to get sufficiency of those that are in deficiency. Hence the huge meals of meat made by the carnivorous Esquimaux, or of rice made by the vegetarian Hindoos. When a varied diet is adopted the meals are smaller, because instinct so directs the choice that the different constituents are combined in the right proportion. Except when our instincts are perverted by disease or acquired characters, we delight in dishes that have in excess the constituents in which we are deficient, and we tire of those which have in excess constituents that have become superfluous to us.[1]

399. The instincts of curiosity and imitativeness are of the highest importance. In every species of animal they are developed in direct proportion to the power of making mental acquirements. They are the principal vehicles by means of

[1] I have had the temerity to put this theory into practice. With one exception, almost from babyhood my child has been allowed to eat exactly what he wished and to any extent that he wished. He was not made to eat anything he did not like. The exception was vinegar, for which he had a fad, and as to which he was checked. He has shown no inclination to excess in any other particular. His desire proved to be chiefly for farinaceous foods. His appetite, as was expected, is small, but from the first he has been very active and free from ailments. It is probable that so-called greedy children are merely starved children—starved of some necessary constituent of diet, which in England is usually sugar. Such children, like famished men, generally eat to excess. Greediness is less common among adults, who have the power of choosing and combining their own diets. No doubt the appetites of children like those of adults vary with the individual. But, proportionately to the sizes of children, their appetites are often larger than those of older people. This is usually attributed to the demands of growth. But a minute quantity of food should be sufficient to supply the microscopic amount of daily growth made by a child. Though growth is very rapid during intra-uterine life, pregnant women have not noticeably larger appetites than non-pregnant women. The larger appetites of children, therefore, are probably due to the fact that they are seldom allowed to select their own diet. Modern men are larger and presumably stronger and more robust than their ancestors of four or five hundred years ago. Presumably the increase of size is due to more and better food, especially to that very concentrated and nourishing food, sugar.

which useful mental acquirements are made. The young caterpillar, which is almost if not quite incapable of making mental acquirements, is neither curious nor imitative. The young monkey is both, as is the young human being to a yet greater extent. The instinct of curiosity impels the individual to acquire a knowledge of the world round him as a remedy for his deficiencies of instinct. The imitative instinct impels him to copy his elders and so acquire useful traits. This instinct lies at the foundation of all animal society which is not on a purely instinctive basis. The young human being not only learns to walk and speak by imitation, but acquires in a general way the whole tone of the society in which he is reared. Hence the importance of a right choice of companions for him. Adults are less curious and imitative than children; for, as development nears completion, and a sufficient number of useful mental traits, and an adequate working knowledge of the environment has been acquired, these instincts become of less and less value, and undergo atrophy. Human environment is so complex and variable, however, and man's power of making mental acquirements is so great, that they do not lose all value. They persist to some extent even in the oldest individual. Hence the gossip's inquisitiveness and the scholar's industry. Hence the sway of fashion, and the spreading infection of enthusiasm. All research too is prompted by the instinct of curiosity, all sympathy by the imitative instinct.

400. Among man's surviving instincts none is more important nor presents features of greater interest than the love of play. Young animals of a purely instinctive species, most insects for example, never sport. Their lives are entirely business-like. Play would be useless to them, since their bodies develop without exercise and their minds without experience. Young ants are said to play, and the statement is very probable, for their power of making mental acquirements is very great. But as regards most other insects, particularly those which in youth lead solitary lives, only the adults indulge in a sort of play, or rather dance, while displaying their sexual attractions. Thus during the late summer we see the love-dance of gnats; and often house-flies from the same cause sport in the centre of a room. The young of the higher animals, however, are full of play. The kid, the kitten, the puppy, the young monkey, and the young elephant spend their lives in eating, sleeping, and especially in sporting. The higher the animal the more capable of making physical and mental acquirements, the more sportive

it is. Man, unlike most animals, loves sport even in extreme old age, because even in old age he is somewhat capable of learning. It is a significant fact that the sport that every animal loves and follows in youth is such as exactly fits it for the future business of its life. The kid delights in climbing steep places. The kitten goes elaborately into ambush and stalks and pounces just as the old cat does later in life. The puppy sports in quite a different fashion. His play is a pretence at furious pursuit and fighting—but only a pretence; his instinct prevents the infliction of injuries on his companions. The young monkey delights in climbing trees. His eager curiosity, his very mischievousness, are due to instinct, and are indications of his high powers of making mental acquirements. Similarly games that children delight in are all educational. The very young child is content with play that involves mere "physical" activity. When the baby moves his limbs aimlessly, he is learning to move them purposefully. When he crawls on hands and knees or totters on uncertain feet he is learning to co-ordinate his muscles that he may be active; he is supplying them with the stimulus necessary for growth that he may be strong. The little girl dandles her doll as later she will dandle her baby. The little boy for ever pits his strength and skill against the skill and strength of his childish companions, as later he will pit them against the skill and strength of adult competitors and as his savage ancestors pitted them against the competitors and the wild beasts with which they contended. The games of older children especially those of boys almost always involve a contest. Not only do they tend to increase strength and activity, but the intellectual faculties are brought into play and developed. This intellectual element in sport increases as the individual approaches maturity, since long after his body has ceased to grow, his mind is still capable of some increase. After maturity active sports do no more than maintain the previously acquired physical development, or supply temporary additions to it.

401. Play is in fact educational. Without it the higher animals could not reach their full development; the stimuli necessary for the growth of their bodies and minds would be lacking. The first and by far the most important part of a child's education, therefore, is achieved by itself through the medium of sport aided by the instincts of imitation and curiosity. On the foundation thus laid it is possible for the parent or teacher to build. Without that foundation all formal education would be impossible; for nothing the parent

could do or say would convey any meaning to the blank mind of a baby; by no imaginable means could the child be taught to co-ordinate its muscles or think rationally. Play, a new instinct, which has been evolved in the higher animals, therefore, brings into effective operation the new power of making physical and mental acquirements. It is often regarded by stupid parents as a sign of the child's inherent frivolity and silliness; it is permitted only as a concession to weakness, as a thing to be checked within the narrowest possible limits, not one to be extended within the widest possible bounds. The instinctive, unconscious, but purposeful wisdom of the child's behaviour is hidden from them. In reality the play of a child is the most beautiful, the most wonderful, the most suggestive phenomenon in nature.[1] If older people showed as much energy and wisdom in improving and preserving their minds and bodies the sage would never have said that the human population of the world consisted principally of fools.

402. The fact that children at play have no real notion of the end to which their actions tend, raises a strong presumption that animals actuated by instinct are equally ignorant. To say the least, therefore, it is widely improbable that the spider, for example, spins his web with the conscious idea of capturing prey, or the caterpillar his cocoon to obtain future shelter. The actions in themselves are pleasurable; the ultimate end is unthought of.[2]

[1] This morning, for example, my little child told me with evident delight a fairy tale in the invention of which he had exercised his imagination. Soon after I saw him in the wintry garden, net in hand, pursuing imaginary butterflies. At present he is seated in an arm-chair. Two stools are before him and two behind. He supposes himself in a boat. In either hand is a mop, and he is rowing vigorously. Not one movement does he make, not one thought does he think but serves to develop body or mind. Driven by his instinct he works as busily and as wisely as a caterpillar spinning its cocoon or a spider its web. The energy of a boy at play is proverbial.

[2] Mr. Herbert Spencer and several other writers have attributed the impulse to play to the presence of superfluous energy. It is not to them an instinct which impels to useful actions. The higher animals, having "better nutrition, gained by superiority," are supposed to expend it in sport. The extreme parsimony of nature, the constant tendency of all useless parts and faculties to regression was as little realized by them as by Mr. A. R. Wallace, when he attributed the splendid plumage of many male birds, not to sexual selection, but to this curious notion of superfluous vigour. The true theory of sport was not enunciated till Professor Karl Groos published his fascinating work, *The Play of Animals*, in 1895. As far as I am aware, the first attempt to sketch the evolution of the power of making acquirements was made in my own book, *The Present Evolution of Man*. This power has been termed

403. Almost as beautiful as the child's instinct to play is the mother's instinct to play with her child. This instinct, also, is only seen in the higher animals, and in its greatest development only in the highest. Sports the mother has long abandoned now give her renewed pleasure. When we watch any mother, brute or human, playing with her offspring, we see how perfectly all her actions are adapted to develop just such traits in her offspring as will fit it for the future battle of existence. The "wisdom," the "forethought," of the brutes guided as it is by instinct seldom goes astray. The wisdom of the woman so long as it is guided by pure instinct is equally sure. It is only when she relies on her own acquirements, which perhaps include many foolish traditions, that she is apt to do wrong.

404. The power of making mental acquirements is, then, a substitute in the higher animals, especially in man, for many instincts, but an immensely superior substitute. And when I use the word substitute I do not mean, merely that in the higher animals reason has replaced instinct to a greater or lesser extent. I mean more than this. I mean the things we learn, and the peculiarities of character we acquire during youth, become in time so stereotyped in us, that did we not know their origin, we could not distinguish them from true instincts. Thus though we learn to read, to write, to knit, to sew, to carpenter, to lay bricks, and so forth, with infinite difficulty, yet time and constant practice render all these complicated actions so automatic that they *seem* instinctive. No word is more abused than the word instinct. We are told, for instance, that such and such a man instinctively dodged a blow. He does not dodge it instinctively. But the "human boy" when sporting has so practised the dodging of blows that the action becomes automatic in him, and remains so in the man. Again, people say they liked or disliked some other person instinctively. They are wrong. Even in the young child vague recollections influence likes and dislikes. We hear of the instincts of modesty, of morality, of altruism, of devotion, of patriotism, and so forth. We shall see that there are no such instincts. All these characters depend on something higher—on the

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"plasticity" by Professor Mark Baldwin and others. But obviously an animal that responds to the stimulus of use and experience by *growing* actively in body and mind in directions that have been more or less definitely fixed by Natural Selection, is something more than merely plastic. I have thought it better, therefore, to adhere in the present work to the more accurate if more clumsy expression.

power of making acquirements. This power is a substitute for instinct in yet another way. Instinct descends from parent to offspring through thousands of generations. But some acquired mental characters, bits of knowledge, ideas, belief, habits, ways of thinking and acting are almost as permanent. Language, cooking, the wearing of garments, and religions are examples.

405. All things tend to become automatic in us as we grow older. Not only our actions, but our habits, our ways of thinking and acting, our beliefs, our whole nature gradually become stereotyped, and approximate, as I say, in effect, though not in fact, to the instinctive type of mind. A great advantage is thereby gained and a great advantage lost. The advantage is that we are able to act quickly and without mental toil in the common affairs of life. Cycling is an example. It is learnt with labour and difficulty, but practice renders balancing and pedalling automatic and extremely easy. It becomes an exact substitute for an instinct. Arithmetic is another example. Practice so much facilitates calculation that, did we not remember the learning and the practice, we should think our powers instinctive. It is true that cycling and arithmetic come more easily to some men than to others, but that only means that the former have a greater power of making these acquirements, that they have a greater capacity, not that they are born with a greater knowledge. Their powers of learning may, or may not, be applied to cycling or arithmetic. They may be applied to other things, or left dormant.

406. The disadvantage, the tremendous disadvantage, is that, as our actions become automatic and our beliefs and thoughts stereotyped, we gradually lose our splendid human power of learning, of profiting physically and mentally from experience. Physically we cease to grow, both in body and brain. Mentally we become less and less receptive. It is interesting to ponder on the intellectual differences between a little child and a grown man. Adults are apt to regard the intellectual powers of children with amused contempt. But when we compare ourselves with little children, when we consider what we were and what we are, we should feel humble enough. We cannot learn as a child learns. We are not open in anything like the same degree to conviction when faced with fresh evidence. We are less credulous than children, not only because we know more, but because we can learn less. When a child enters the world its mind is almost a blank. Light reflected from various objects, now

brighter, now darker, reaches it, and conveys no meaning. Sounds, smells, the feelings of touch, and the joint or muscular sensations from various parts of its body convey no definite meanings. Pain causes the child to raise an instinctive cry, unmeaning to itself, for help. If it knows enough to wish to move its arms it is just as likely to move its leg; if it seeks to touch its toe, it is just as likely to touch its head. But in a few weeks it evolves order out of chaos. Soon sight, hearing, touch, and other sensations convey definite meanings. It moves its limbs in a definite way. It comprehends to a wonderful degree the world around it. No grown man could do the like.

407. In a year or two the child learns to walk and speak a language and a vast deal besides. The real intellectual giants are the little children. Adults are dwarfs standing on the shoulders of giants, on the shoulders of their former selves. They make use of the knowledge, the data, the reasoning powers they acquired as little children. The world would be different and infinitely better if grown people in addition to their stored knowledge could retain the child's power of learning, of changing, of growing mentally in response to fresh experience. There would, then, for example, be only one religion left in the world—the true religion, whichever that may be. Men would not adhere blindly to untruths which the progress of knowledge has rendered obvious. They would never have been martyred for saying that the world was round, nor trembled to declare that it was more than six thousand years old. No Milton of science, mute now and inglorious for ever, would have preached to deaf and hostile ears. The material and intellectual stagnation, the stupid insect-like incapacity to learn, which the people of so many countries exhibit, and which hamper even the most enlightened nations, would fade like a dream. The wheels of progress would move smooth and fast. There would be no poverty and no crime.

408. The organ of man's mind, the physical concomitant of his consciousness and intellect, is his brain. For a limited time after birth his brain increases very rapidly in size; but the rate of growth diminishes gradually till it ceases when adult life is reached. The brain is contained in a box consisting of a number of bones, which in early life grow by spreading at their edges, thus permitting the expansion of the brain. Later the bones coalesce into one mass, and the expansion of the brain is checked. The physical conditions thus afford an explanation of the mental phenomena. The

growth of mind is exactly parallel to that of its organ. At first, as we see, the mind grows very rapidly. But its rate of increase becomes slower, and at length in old age there is regression. In that last stage, though the quantity of brain is the same as in early manhood, the quality is inferior. There is less nervous, and more fibrous tissue. Besides learning man has also the fortunate capacity for forgetting. His brain, enclosed in a box which ceases to grow, has "room" for a limited quantity of mind only. Consequently he remembers, as a rule, important and forgets unimportant things. The things which are important to him are those which impress him deeply, either because they are intrinsically important and impressive, or because they are very frequently repeated. In the beginning the power of learning predominates, and more enters the mind than leaves it; but later the capacity for forgetting is greater. In extreme old age man is said to reach second childhood. But this second childhood is woefully different from the first. The aged man resembles the child only because his acquirements have become small. He differs from the child because he has lost his splendid instincts for making and his wondrous powers for retaining acquirements.

"For this losing is true dying,
This is lordly man's down-lying,
This his slow but sure reclining,
Star by star his world resigning."

CHAPTER XIX

AUTOMATIC ACTION

All "inborn" characters are in reality acquirements—All automatic actions are voluntary—They result from "diffused" not concentrated attention.

409. In the first chapter of this work we defined an acquired character as a modification of an inborn character which results from the action of forces from the environment on that inborn character. As a fact, however, all the inborn characters of the individual develop from the germ-cell in response to stimuli applied to the germ from the environment —fit and sufficient nutriment, a right degree of heat, moisture, conjugation with another germ-cell, and so forth. In reality, therefore, only the structures of the germ-cell and the tendencies resident within them—structures and tendencies which are passed, unchanged by stimuli (except conjugation), by each germ-cell to its successors—are inborn. All the characters of the individual which arise from them are acquired. But this has not been generally recognized, and in practice the term "acquirement" is restricted to characters which arise in response to forces (stimuli or not) *other* than those we have mentioned above—for example, the characters which result from use and those which result from injury.

410. The acquirements which result from use occur only in the higher animals. At any rate, they occur to the greatest extent only in the highest animals. There is every reason to believe, therefore, that the power of making them is a late product of evolution, and that it has undergone more or less rapid increase through Natural Selection, for example in certain insects (*e.g.* ants) and mammals (*e. g.* man).[1]

[1] In precisely the same way the tendency in the germ-cells to develop the so-called inborn characters is a product of evolution. Unicellular organisms, as we know, tend under the influence of fit stimuli to grow, and divide, and so multiply—these hereditary

We do not know how the case may be among invertebrates, but among vertebrates the evolution of the power of developing in response to the stimulus of use has been accompanied

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tendencies being products of evolution. In remote times the tendencies resident in the germ-plasm of one or more species of unicellular organisms underwent such changes as a result of evolution that the products of division (the offspring) did not separate, but remained adherent. Multicellular organisms thus came into being, and, as a further result of evolution, underwent differentiation into innumerable species. Plainly the changes throughout were in essence changes in the germ-plasm. It so evolved, so changed its tendencies, that fit stimuli caused it to produce, not comparatively simple unicellular organisms, but more or less complex multicellular organisms. Lastly, as a further result of evolution, the nature of the germ-plasm was so changed that from it arose organisms the "inborn" characters of which were capable of further development in fixed directions as a response to the stimulus of use. These extensions of "inborn" characters which result from use and which we term "acquirements," however, are acquirements in a sense not more real than "inborn" traits are acquirements. Both sets of traits are acquirements since both result from stimuli; "inborn" traits develop from the germ-cell and continue to grow under the stimulus of nutrition; in the case of certain of the characters of certain of the higher organisms nutrition at a certain stage of development ceases to be the stimulus for growth, and use takes up the task. When considering questions of evolution and heredity we must for ever keep our attention fixed on the germ-plasm. It is evident that two of the principal events which have occurred during the history of life have been—(1) that change in the germ-plasm which caused it to produce the "inborn" structures (physical and mental) of multicellular organisms, and (2) that change which caused it to produce "inborn" structures which possessed the power of undergoing further development under the influence of use. The non-recognition of the fact that the latter change in the germ-plasm is a high and a late product of evolution has involved biology in endless confusion, and has led to the formulation of several extremely erroneous hypotheses; for example, the Lamarckian doctrine and the subsidiary doctrines of mental evolution enunciated by Spencer, Lewes, and Romanes. (See §§ 431–6.) The main error underlying all these hypotheses is the assumption that the power of making use-acquirements is a property possessed by all living beings. As we see, it is a property possessed only by some of the structures of some living beings, and these the highest.

Before a structure can be used it must exist and be capable of being used. Therefore, in every individual all structures must develop up to a certain stage without the influence of use. Thus, for example, all the structures of the human embryo necessarily develop without use. Later, after birth, use takes up the task for which nutrition is now insufficient, and the continued development of most of the structures is due to its stimulation. The development of the individual is a recapitulation of the life-history. During the evolution of the race, structures capable of being used must have been evolved before the evolution of the power of developing still further under the influence of use was possible. The new power was obviously of immense importance; for structures that possessed it became endowed with a species of unconscious intelligence by a concurrent regression of the power of developing in response to other stimuli—nutrition, heat, moisture, and even injury. Thus the human being, who of all animals has the greatest capacity for making use-acquirements, has the least power of reaching full development of body and mind without the aid of use and experience. In the higher animals, therefore, use has replaced, to a great extent, other stimuli (except conjugation) as an incentive to development. Probably this is true as regards the invertebrates also.[1]

411. The acquirements which result from the stimulus of use are mere extensions of those which result from nutrition and the other stimuli which early affect the germ and the tissues that develop from it. In other words, the acquirements which result from use are mere extensions of those which are technically termed "inborn" characters. Natural Selection has so dealt with germs and the tissues which arise from them that they respond to given stimuli by developing in definite ways. At first in all animals, in response to nutrition, are developed structures capable of being used. Later in some animals the structures develop farther in response to being used. In other words, at given stages of the development of the higher animals, use takes up the task for which nutrition alone has become inadequate. Use plays a great part in the development of man, and, therefore, very much of the subsequent development of the helpless baby results from it; it plays a lesser part in the development of the horse, and, therefore, comparatively little of the more active foal's development depends on it, it hardly plays any part in the development of the frog, and probably none at all in that of the dragon-fly.

412. Since acquirements are mere extensions of inborn characters (so-called) we are often unable to distinguish between the two—to say where the inborn character ends

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that caused them to grow to a closer adaptation to the changes in the environment than was possible had they developed solely under the blind influence of nutrition and the other stimuli which develop the "inborn" characters.

[1] Scratching an itching spot furnishes an instance of an acquirement replacing an instinct. Normally we itch when some small object rests on or moves over the skin, and especially when we get a minute bite. Scratching gives relief, and is exactly adapted to dig out or tear away the object. Probably it was even more useful to our remote ancestors than to us. The action is certainly instinctive in some if not all birds, and in the lower mammals. Equally certainly it is not instinctive in man, for the baby does not scratch itself, till it has *learned* how, and when, and where to scratch.

and the acquirement begins. The two are joined at an invisible line. For example, we cannot tell merely by examining an adult human limb which acquirements have been made as a result of use. We know that the greater part of its bulk is due to use only because we have previously learned that human limbs develop very little after birth without that stimulus. Precisely the same is true of mental characters. The foal, for instance, is born with some instinctive knowledge[1] of how to co-ordinate its limbs for locomotion, avoid obstacles, seek its mother's breast, and so forth. Experience adds to this knowledge; presently it learns better how to co-ordinate its limbs, and avoid obstacles. Here again we cannot distinguish the extension from the thing extended. If a being, who had never before seen or heard of a man, suddenly met one, he could not tell what part of the man's

[1] The use of the word knowledge with reference to the foal's instinct may be thought objectionable. Some authors, apparently, would limit the term to the products of experience garnered in the memory. There is, however, plenty of warrant for its use in this connection. "Has the bird a gland for the secretion of oil? She knows how to press the oil from the gland, and apply it to the feather. Has the rattle-snake the grooved tooth and gland of poison? He knows without instruction how to make both structure and function most effective against his enemies. Has the silk-worm the function of secreting the fluid silk? At the proper time she winds the cocoon such as she has never seen, as thousands before have done, and thus without instruction, pattern or experience, forms a safe abode for herself in the period of transformation. Has the hawk talons? She knows by instinct how to wield them effectively against the helpless quarry." (A. Chadbourne, *Instinct*, p. 28. Quoted by Professor W. James.) "The ichneumon which deposits its eggs in the body of a larva hidden between the scales of fir-cone, which it can never have seen, and yet knows where to seek." (Romanes, *Mental Evolution in Animals*, p. 166.)

Is it correct to say that a man "knows" how to walk? Yes. Then it is certainly correct to say that the insect "knows" how to walk. The man acquires through practice the ability to make the muscular co-ordinations which result in walking, and this ability is what we term "knowledge of *how* to walk." In the insect the ability is inborn. One class of stimuli develops it in man; another class in the insect. The final result is the same. The use of the word knowledge in this connection is sanctioned by universal custom; but it must be remembered that such knowledge differs very widely from that other kind of knowledge which can be represented in consciousness, and which the man (especially the anatomist), but not the insect, can acquire—the knowledge *about* walking. It should be noted that, in a sense, the insect is as dependent on experience as the man. Unless he experiences a given stimulus he does not walk. But experience in him merely awakens an impulse; it merely puts pre-existing machinery into action. In the man it does more; in part at least, it creates the machinery. The experience does not add to the insect's knowledge, for it fades from his mind immediately. It leaves its impress on the man's mind.

mental traits were instinctive, and what part acquired as a result of experience. During my passage through life I have acquired certain mental characters—a certain amount of miscellaneous information, certain likings and aversions, certain ways of thinking and acting. It is quite conceivable that I might have been born with all these, just as, without experience, a dragon-fly becomes a perfect insect with all his mental traits complete; in which case they would have been instinctive in me. It was formerly believed by most biologists, and is still believed by the general public, that acquired mental characters are transmissible to offspring. In other words, they believed that characters, which in the parent arise through the stimulus of use and experience, tend to arise in the child through the stimulus of nutrition alone. Nothing in the characters is supposed to be changed except the kind of stimulus that caused them to develop. If then my mental acquirements were transmitted to my child, if they arose in him through the stimulus of nutrition unaided by the experience that developed them in me, they would be instinctive in him. But nobody, again, could distinguish them when inborn from acquirements, except by knowing the mode of origin—by knowing the kind of stimulus that developed them. The kind of stimulus alone makes the difference. We see, therefore, more clearly than ever that "acquired" mental traits are mere substitutes for instincts, just as acquired physical characters are mere substitutes for inborn physical characters. Instincts themselves are acquirements which are distinguished from the mental acquirements usually so-called by being developed under the influence of different stimuli. All the pother we made in the first and subsequent chapters about the absolute necessity of clearly distinguishing between inborn and acquired characters issues then in this—the whole of the traits of an individual are acquirements; but custom prescribes that the term shall be limited to those characters which result from certain stimuli (injury and use), whereas the term inborn is restricted to characters which result from other forms of stimuli (*e.g.* nutrition). The reader will have realized, however, that this nomenclature, even if inaccurate, is convenient, and marks a distinction of vital importance.

413. The particular class of acquired movements which most nearly resemble instinctive and reflex actions are the "automatic" actions. Suppose a woman learns to knit; then at first all her movements are deliberate—involving concentrated thought. She works slowly and with hesitation,

making many mistakes. In the end, though she gives only passing attention to her knitting, she works at speed and rarely makes mistakes. Her actions have become automatic. In a similar way we learn to walk, to write, to cycle, to play the piano, and so forth. It is a main business of our lives to make as many actions automatic as possible. Only thus are we enabled to move with comfort and success in our world, doing automatically many useful things at the same time that our thoughts are busied mainly with actions that we are unable to perform in this easy way. Now the question we have to decide, and which, up to now, we have left in abeyance, is whether an action ceases to be voluntary when it becomes automatic.

414. It should be noted (1) that every automatic action was once voluntary and has passed only by slow gradations from one category to another; (2) that every automatic action becomes voluntary whenever we concentrate our thoughts on it; and (3) that every voluntary action has in grown people an automatic element, for grown people co-ordinate their muscles with comparative ease, swiftness, and lack of thought even when doing unusual actions; whereas the infant does so only after long practice. If, then, we decide that automatic actions are non-volitional, we must conclude that only those actions are volitional on the doing of which we concentrate our thoughts; whereas if an action is so easy, because habitual, that when doing it we are able to let our thoughts wander, then immediately it becomes involuntary. So that if a woman decides to knit, and then while knitting lets her thoughts wander, the beginning of her action is voluntary, but the rest of it involuntary.

415. Dr. Carpenter writes—"In this familiar experience [walking] we can clearly trace three distinct modes of action —the Automatic, the Voluntary, and the Volitional. While we are all unconscious of the movements our legs are executing for us those movements are purely *automatic*. When our attention is not so completely engrossed elsewhere, but that we know where we are, and what we are doing, the movements of locomotion are not only *permitted* by the will, but may be guided by it into some unusual direction; such movements are *voluntary*. But when the sense of fatigue attending each movement makes it necessary that a distinct effort of Will shall be exerted for its repetition, the act comes to be *volitional*." . . . "There may still be metaphysicians who maintain that actions which were originally prompted by the Will with a distinct intention, and which are still

entirely under its control, can never cease to be volitional; and that either an infinitesimally small amount of Will is required to maintain them when they have been once set going, or that the Will is a sort of pendulum-like oscillation between two actions,—the maintenance of the train of *thought*, and the maintenance of the train of *movement*. But if only an infinitesimally small amount of Will is necessary to maintain them, is not that tantamount to saying that they go on by a force of their own? And does not the experience of the *perfect continuity* of our trains of thought during the performance of movements that have become habitual entirely negative the hypothesis of oscillation? Besides, if such an oscillation existed, there must be *intervals*, in which such an action would go on of *itself*; so that its essentially automatic character is virtually admitted. The physiological explanation, that the Mechanism of Locomotion, as of other habitual movements, *grows* to the mode in which it is early exercised, and that it then works automatically under the general control and direction of the Will, can scarcely be put down by the assumption of a hypothetical necessity, which rests only on the basis of ignorance of our composite nature." [1]

416. Dr. Carpenter, however, has not exhausted the whole of the possibilities.[2] The real gist of the question whether, or not, automatic actions are voluntary, lies in the further question whether our attention ever *completely* wanders from an automatic action *while* we are doing it. Judging from my own mental experience it appears to me that it never does so wander. At the present moment I am looking at a point of light reflected from a gilded knob. My attention is concentrated on it, but not the *whole* of my attention. I am conscious also, though much more vaguely, of the rest of the knob, of the piece of furniture to which it belongs, of the wall against which it rests, of all the objects in the room

[1] *Mental Physiology*, pp. 19, 20.

[2] "There is more than one alternative explanation in accordance with larger bodies of facts. One is that the perceptions and volitions in habitual actions may be performed consciously, only so quickly and inattentively that no *memory* of them remains. Another is that the consciousness of these actions exists, but is *split* off from the consciousness of the rest of the hemispheres. We shall find in Chapter X. numerous proofs of this split-off condition of portions of the consciousness. Since in man the hemispheres indubitably co-operate in the secondary automatic acts, it will not do to say either that they occur without consciousness or that their consciousness is that of the lower centres, which we know nothing about. But either lack of memory or split-off cortical consciousness will certainly account for all the facts" (James' *Principles of Psychology*, vol. i., p. 165.)

within my area of sight. In just the same way, it seems to me, we are able to do many things at one time, and attend to them all, though at any given moment the *most* of our attention is concentrated on one or other of them only. This action is always the most interesting for the time being to us, and it is non-automatic, not because it receives the *whole* of our attention, but because is receives the *greater part* of it; whereas the other actions are automatic, not because they receive *no* attention, but because they receive comparatively little. As I gazed at the knob I was smoking, but I am sure I was not wholly unconscious of the latter action. Now, that I am thinking chiefly of it, it has ceased to be automatic, whereas my gaze at the point has become so. Had I been quite unconscious, quite inattentive of my pipe, it would have dropped from my mouth. Were I quite inattentive to the point of light, I should in effect be blind. When I lean automatically against a structure which I have supposed to be stable, but which presently gives way, I am instantly conscious of the change of position which follows. But I am sure I do not know how I could have been conscious of it unless my attention had been to some degree occupied with the sensations that are changed. Indeed if our attention is always wholly concentrated on one object, I do not understand how we can change it to another. If, when engaged in deep thought and walking automatically, I avoid obstacles, I must have given them *some* attention. I take it, in fact, that no single sensation ever reaches us but receives some part of our attention, but that at any given time only one, if any, of the whole complex receives the concentrated part of our attention.

417. When we speak to a friend we are not conscious only of the words we are uttering; we are automatically observing also the play of expression on his features. When a lover pays court to his mistress his attention is not wholly occupied with informing her that he had the happiness of meeting her uncle a week ago. He is conscious also of the girl's charm, of the graceful turn of her head, of the bloom on her cheeks, of the movements of her pretty hands; he is conscious even of the bore in the distance who may interrupt the conversation. So long as he devotes his *main* attention to what he is saying, his speech is not automatic and remains coherent; but the moment his main attention wanders to the lady's perfections or to the bore his speech tends to become automatic, and therefore, because the choice of words requires concentrated attention, it tends to become incoherent

or stammering. Who is there that can by concentrating his attention on something else forget great physical pain?

> "There never was yet philosopher
> That could endure the toothache patiently."

418. "Which of all of us alas! has not experienced a bitter and profound grief, the immense laceration caused by the death of some cherished fellow-being? Well, in these great griefs the present endures neither for a minute, for an hour, nor for a day, but for weeks and months. The memory of that cruel moment will not efface itself from consciousness. It disappears not but remains, living, present, co-existing with the multitude of other sensations which are juxtaposed in consciousness alongside of this one persistent emotion which is always felt in the present tense. A long time is needed ere we can attain to forgetting it, ere we can make it enter the past. *Haeret lateri letalis arundo.*"[1] While such a great grief lasts we are *distracted*. We cannot *wholly* concentrate our attention on the common affairs of life.

419. The truth that automatic actions always receive a part of our attention during their performance is proved by such facts as that a woman who is able to knit uninterruptedly during a quiet gossip, or while reading a book, will cease knitting the moment a topic of unusual interest presents itself—that is, the instant so much of her attention is concentrated on the topic, that there is not enough to spare for the knitting. So, also, at dinner we are able automatically to use our knives and forks, and choose and combine our morsels of food, while conversing; but, if one of our companions makes a remark that strongly attracts the attention, the play of every knife and fork, and even of every jaw ceases. We have all seen a street musician performing on several instruments at once. In what light are we to regard his actions? They cannot all be involuntary, for obviously the man's will and attention are strongly engaged. If one action only is voluntary, then which one? To me, at least, it is unbelievable that he is conscious of, and is willing only one of his actions, and is quite oblivious of the rest. The man himself would say that he has to attend to all of them at the same time—*i.e.* that his attention and will are diffused over them all; which is the same thing as saying that practice has made all his actions more or less automatic, but that they still remain voluntary. A chemist, who at first must give his whole attention to the wrapping and

[1] Richet, *L'Homme et l'Intelligence*, p. 583. (Quoted by James.)

sealing of bottles, is able at length to do his work neatly while conversing with his customers. Must we suppose that his actions are perfectly voluntary only as long as they are entirely clumsy? A first-class cricketer automatically makes the right movements with the bat; he has no time for deliberate thought. Is his swift dexterity a sign that his will is in abeyance? Suppose a servant allowed the contents of a jug of hot water to pour over her master's feet when receiving orders; would he not blame her rightly? And would not the blame imply that she should have kept part of her attention fixed on the jug? When a smoker collects tobacco, places it in a paper, and twists and lights a cigarette, his hands, and even each separate digit, perform unlike movements. Are we to suppose that the movements of only one hand or of one digit are voluntary? No one will maintain this. It will be admitted that the movements of all the digits on both hands are voluntary. It must then be admitted that the attention is not concentrated on the movements of any one digit, but is diffused over them all. And if it be capable of being diffused over the movements of two limbs, what reason is there why it should not be capable of being diffused over the movements of four? In other words, what reason is there why we should regard the movements of a walker, who is thinking of his hands, or the stars, or his banking account, as reflex? A well-drilled soldier obeys the least word or gesture; as well might we suppose, from the absence of fuss, that he is not under the control of his commander, as suppose, from a similar absence of fuss, that automatic actions are not under the control of the will. As a fact, of all actions, automatic actions are most under control of the will, since only a minimum (but a sufficient minimum) of will, of attention, of fuss is needed for their control. In this they differ radically from reflex actions, with which they are so often confounded, but which are seldom controlled by the will, and are never initiated by it. It is probable, indeed, that the whole of this dire confusion has arisen, or at least been perpetuated, by the use of the inappropriate word automatic. An automaton is a creature without will. An automatic action, so called, in a living being is one in which the will works smoothly and easily, without hesitation, without sense of effort. Owing to this ease and lack of effort the superficial assumption has been made that it is a kind of reflex action.

420. Sometimes when we concentrate our attention on an act, which we are accustomed to perform automatically, we

make an increased number of mistakes; but this is not because we have converted an involuntary act into a voluntary one. It is only because we are trying to do the act in an unaccustomed way—by means of our concentrated attention, instead of by means of our peripheral attention aided by the associations the various movements comprising the act have formed among themselves. Thus when a woman is knitting automatically the feeling of one movement supplies through association the tendency to start the next. When she concentrates her attention she abandons to some extent the aid of these associations and tries to do the knitting in the way it was done when she was learning it. Just so might a soldier, well-drilled in a complicated manœuvre, be confused by a number of unnecessary commands issued by a fussy officer. The existence of the acquired associations no more converts an automatic action into a reflex action, than the existence of an acquired desire converts "rational" action into an instinctive one. Their presence does not imply an absence of will; it implies merely that the will has established aids to enable itself to work swiftly and easily. The fact that automatic actions are acquirements, and that they are initiated, directed, and controlled throughout by the will, sets them poles apart from reflexes. They are, however, admirable *substitutes* for reflex actions—just as rational actions are admirable substitutes for instinctive actions. They are the analogues, not the homologues, of reflexes. They are functions of the cerebrum, not of lower nervous centres.

421. It seems certain, then, that automatic actions do not retire altogether out of our minds during their performance; they merely pass into the background. They receive our attention, but not the concentrated part of our attention. They are directed by our wills, but not by the concentrated part of our wills. They occupy not the *fovea centralis* of our mental retina, but the peripheral surface. Our memory of doing them, like our memory of the images that fall on the peripheral portion of the retina, is faint or non-existent because memory stores with care only things on which we concentrate our attention. The more completely we are habituated to any action, the more completely automatic it has become, the farther it is possible to push it into the background during efficient performance. Thus walking has become very automatic, and therefore we are able to walk even while our attention, and therefore our will, is *almost* wholly concentrated on some other subject. Even when

walking, however, we are apt to stop if our attention be strongly arrested, as by a loud and sudden noise. On the other hand, the process of peeling potatoes never becomes so automatic in a cook as walking. Peeling is less habitually practised, and potatoes are of irregular shapes, to which the movements of the knife must be adapted. No cook, therefore, can peel potatoes uninterruptedly while engaged in an animated conversation.

422. The fundamental error underlying Dr. Carpenter's reasoning is the assumption that we can attend to and will only one thing at a time. It is certain that we are able to attend to and will many things at one time. Were it otherwise our complex life would be as impossible as the complex image which falls on the retina would be useless were we able to attend to only that part which impinges on the *fovea centralis*. Automatic actions, therefore, are performed, not in the complete absence of will, nor in response to an infinitesimal amount of will, nor because the will oscillates to and from them, but always under the influence of a small but sufficient amount of will. They differ from non-automatic voluntary actions only because the attention, and therefore the will, is *less* concentrated on them. They are, therefore, distinctly voluntary, and, therefore, in a category altogether apart from that occupied by reflex actions. As we see, however, they are almost perfect substitutes for reflexes.[1]

423. A principal function, then, of our faculty of making mental acquirements, of our conscious and unconscious memories, is to supply us with substitutes for instincts and reflexes. Our conscious memories supply us with our stereotyped mental attitudes—desires, beliefs, ways of thinking, and so forth. Our unconscious memories supply us with our stereotyped ways of acting—the automatic ways of acting we have just considered. As we grow older these imitation instincts and reflexes increase in number and importance; they form a larger and a larger portion of our total reaction to the environment. Beyond the verge of them spreads a domain, very wide in the infant but narrowing as we pass

[1] Instincts also may be substitutes for reflex actions. When an irritant is applied to a man's side he removes it by a "rational" action. When it is applied to a frog's side it is removed by an action which is probably instinctive. When, however, the frog is pithed and can feel nothing, and when, therefore, the action cannot be instinctive, he still removes the irritant. Probably in the comparatively rudimentary nervous system of the frog, instinct is replacing, but as yet has only partially replaced, certain reflexes.

towards old age, which is the real realm of the active intellect. Here, where thoughts and actions are not yet stereotyped, memory gathers fresh harvests, imagination plays, and reason ponders. Here man is a rational being in the strict sense of the word.

CHAPTER XX

THEORIES OF MENTAL EVOLUTION

All instinctive actions are voluntary—They differ from rational actions only in that the tendency, and (as a rule) the capacity to perform them is inborn—Lewes—Spencer—Romanes—Mental acquirements are not transmissible—Offspring are not affected mentally by the action of the environment on the parental germ-plasm.

424. Contrary to accepted doctrine, I have maintained in the foregoing pages that an instinctive action is of the voluntary, not the reflex type, since it is prompted by an emotion, a desire. No one will quarrel with the use of the word emotion, for an instinct *is* an emotion—an emotion which prompts to certain definite acts, the instinctive acts. Objection will certainly be taken, however, to the use of the word desire. It will be argued :—If an instinctive animal has no memory, if, therefore, he has no conception of the past and consequently can gather no idea of the future, if he lives entirely in the present, how can he be influenced by *prospective* pleasures or pains ? How can he desire a thing of which he has no conception ? Everything depends on the meaning we give to the words present, future, and prospective. Doubtless a spider when he approaches his mate does not desire posterity. Very probably he has not even an idea of the sexual act nor the pleasure he will derive from it. But he lives in a "specious present," which has in it an immediate past, and, therefore, may be said to have an immediate future. His instinct, his emotion, prompts him to *approach* the female in this immediate future, and then, as the specious present drifts on, it prompts in succession to that series of actions which culminate in the sexual act. I am sure I do not know by what name to distinguish this prompting emotion if not by the term "desire." Presumably the spider finds a pleasure in performing the instinctive acts, and would find a pain or discomfort in not performing them.

I find it difficult to imagine the existence of pleasure or pain without the presence of a corresponding desire to do or not to do. If no desire is present, then the pleasure and pain are useless epiphenomena, the existence of which the known parsimony of nature should cause us to deny. But, if pleasure or pain are absent, then the instincts of lower animals differ so much from our own that they should not be included under a common designation. Moreover, in that case, our instincts—hunger, sexual and parental love, and so forth—cannot have been derived from the instincts, so called, of our remote ancestors.[1] If, on the other hand, it be maintained that desire is not present during the first performance of the instinctive act, but only during subsequent performances of the same act, then the desire is due to the memory of the pleasure or pain, and is once more a useless epiphenomenon, since the perfect performance of the instinctive act was possible without it. In that case such an animal as sitaris, which performs a series of instinctive acts only once, is an automaton burdened with an unnecessary memory;—a hypothesis which involves the further hypothesis that memory, which appears always to be correlated with a relatively large amount of nervous tissue, was, with the

[1] Descartes held that the lower animals are pure automata—without feelings, desires, fears, hopes, passions, thoughts. Modern authors, however, generally admit the presence of pleasure or pain and desire as essential factors of instinct. "If we analyze the propensity of storing we find it consists of three impulses. First, an impulse to *pick up* the nutritious object, due to perception; second, an impulse to *carry it off* into the dwelling-place, due to the idea of this latter; third, an impulse to *lay it down* there, due to the sight of the place. It lies in the nature of the hamster that it should never see a full ear of corn without feeling a desire to strip it; it lies in its nature to feel, as soon as its cheek pouches are filled, an irresistible desire to hurry to its home; and finally it lies in its nature that the sight of the store-house should awaken the impulse to empty its cheeks." (Schneider, *Der Thierische Wille*, p. 208. Quoted by James.)

"And so, probably, does each animal feel about the particular things that it tends to do in the presence of particular objects. They, too, are *à priori* syntheses. To the lion it is the lioness that is made to be loved; to the bear, the she-bear. To the broody hen the notion would probably seem monstrous that there should be a creature in the world to whom a nestful of eggs was not the utterly fascinating and precious and never-to-be-too-much-sat-upon object which it is to her." (James, *Principles of Psychology*, vol. ii., p. 387.)

"What voluptuous thrill may not shake a fly, when at last she discovers the one particular leaf, or carrion, or bit of dung that out of all the world can stimulate her ovipositor to its discharge! Does not the discharge then seem to her the only fitting thing? And need she care or know anything about the future maggot and its food?" (*Op. cit.*, p. 388.)

nervous tissue, mysteriously evolved without the aid of Natural Selection.

425. So when the dragon-fly launches himself in flight it is very probable he has no conscious design of seeking food, however hungry he may be. Doubtless his immediate impulse, his immediate desire, is to perform certain actions which, as it happens, result in flight. The sight of prey awakens in succession the impulse to pursue, to seize, and ultimately to eat. Again, I cannot distinguish his successive emotions from desires. I have no means of judging his instincts, of imagining his emotions, except by referring them to my own, which they probably resemble to some extent. I note that no instinct ever moves within me, but there awakens with it a desire, which to me is indistinguishable from the instinct. Thus as a child the sporting instinct was to me nothing other than a desire to sport. When I was older a pretty face awakened in me emotions which were certainly desires. At the present day when I am hungry the smell of food awakens an emotion which I cannot separate from a desire to eat. The sight of my child is apt to awaken other emotions which I cannot separate from a desire to perform various acts of tenderness.[1]

426. According to most authorities instinctive movements should be placed in the category of reflex actions, because they follow fatally the application of given stimuli. "*The actions we call instinctive all conform to the general reflex type;* they are called forth by determinate sensory stimuli in contact with the animal's body, or at a distance in his environment. The cat runs after the mouse, runs or shows fight before the dog, avoids falling from walls and trees, shuns fire and water, etc., not because he has any notion of life, or of death, or of self, or of preservation. He has probably attained no one of these conceptions in such a way as to react definitely upon it. He acts in each case separately, and simply because he cannot help it; being so framed that when that particular running thing called a mouse appears in his field of vision he *must* pursue; that when that particular barking and obstreperous thing called a dog appears there, he *must* retire if at a distance, and scratch if close by; that he *must* withdraw his feet from water and his face from flame, etc. His nervous system is to a great

[1] It is very doubtful whether the parental impulse is really inborn in the male human being. (See § 442.) But this only demonstrates how extremely difficult it is to distinguish an instinct from an acquired desire, and, therefore, what a perfect substitute the latter is for instinct.

extent a pre-organized bundle of such reactions—they are as fatal as sneezing and as exactly correlated to their special excitants as it is to its own. Although the naturalist may, for his own convenience, class these reactions under general heads, he must not forget that in the animal it is a particular sensation or perception or image that calls them forth." [1]

427. But reactions which, admittedly, are neither instinctive nor reflex were called forth just as fatally by given stimuli,—provided always that they are the only stimuli in operation, or the strongest stimuli of those in operation. The desires we "acquire," however, are so multitudinous, their operations consequently are so complicated, they vary so in combination from day to day, that the appearance, the mere appearance, of fatality is not so obvious. When our instincts are opposed by our acquired incentives they do not necessarily compel us fatally to the instinctive course of action. A mother puts her child out to nurse; a hungry man abstains from eating his friend's dinner; a lover abstains from caressing his mistress in public. When two of our instincts are opposed we do not, we cannot, fatally follow both; one or the other conquers. Precisely the same is true of the lower animals. Their instinctive desires impel them just as fatally, but not more fatally. The lion and the lamb, the cat and the mouse, have lain down together in many a "happy family." The dog may be taught to abstain from the pursuit of the cat. Indeed, the house-dog is often the loving friend of his hereditary enemy. When attacked the cat "chooses" [2] between her rival impulses, the impulse to fly and the impulse to defend herself. She always reacts to the stronger. The spider hesitates before his gigantic mate. Like automatic movements, therefore, instinctive actions are poles apart from reflexes.

428. We are compelled, then, I think, to place instinctive actions in the voluntary category, or to place all actions in the reflex category. To sum up:—Instinctive actions resemble rational actions in that they are always prompted by desire,

[1] James, *Principles of Psychology*, vol. ii., p. 384.

[2] Again I would impress on the reader that an action resulting from choice is nothing other than a reaction to the stronger impulse. At the present moment the idea of writing is hateful to me, and the idea of reading a certain book delightful. I choose to continue writing only because certain motives which impel me to the task are stronger than those which impel me to idleness. All the moral education of our children is nothing other than an attempt to supply them with impulses (*i. e.* desires) that shall impel them to good rather than to evil.

and, therefore, by the will. They differ from rational actions in that the capacity to feel the instinctive desire is always inborn, as is also, as a rule, the capacity to perform the instinctive action by which the desire is gratified;[1] whereas the capacity to feel the "rational" desire and the ability to gratify it are always acquired. On the other hand, reflexes resemble instincts in that they develop in the individual under the influence of the same class of stimuli (nutrition, etc.); they differ from instincts in that they are not discharged by the same class of stimuli—that is, they are not discharged by desires acting through the will.

429. Professor James insists that all actions in man are originally reflex. But, if the foot of a child of two be pinched, it is snatched away. The newborn baby, similarly maltreated, merely shrieks. Clearly the action of the elder child is not reflex, though it may be automatic, for the capacity to co-ordinate the muscles for its performance has been acquired. The shriek of the baby, if our definitions are correct, is instinctive, not reflex. It is prompted by pain. It is reflex only in the sense that any rational action is reflex.

430. In defining reflex actions as purely involuntary, and instinctive and "rational" actions as purely voluntary, we have sharply marked off the former from the latter. Similarly, by showing that instinct arises in the individual under one kind of stimulus, and reason under quite another kind of stimulus, we have sharply separated instinct from reason, leaving no border space where the one merges into the other. Throughout we have proceeded on the assumption that all these faculties have arisen solely through the Natural Selection of favourable spontaneous variations. We have supposed, also, that reflex action, strictly so called,[2] appeared when the nervous system had reached a somewhat advanced stage of evolution; that later, at a stage still more advanced, instinct appeared; and that yet later, at a stage even more advanced, reason appeared; the three faculties not being derived the one from the others, but appearing like branches on a common stem.

431. Until recently, however, psychologists, who treated the subject from the standpoint of evolution, believed in the transmission of acquirements and derived the faculties

[1] The capacity to perform the instinctive action is not always inborn. Thus a man cannot gratify his sporting and sexual instincts without the aid of his acquired powers of co-ordinating his muscles.

[2] See § 365.

from one another. They supposed, therefore, that there were border spaces where they merged. Thus "Spencer regards instinct as compound reflex action and the precursor of intelligence, while Lewes regards it as lapsed intelligence, and therefore necessarily the successor of intelligence. Thus, while Lewes maintains that all instincts must originally have been intelligent, Spencer maintains that no instinct need ever have been intelligent."[1] Professor Romanes, from whom I have quoted, is in partial agreement and disagreement with both Mr. Lewes and Mr. Spencer, thinking that in some cases the one is right and in some cases the other.[2]

[1] *Mental Evolution in Animals*, p. 256.

[2] Romanes gives a condensed but clear account of Mr. Spencer's theory of the origin of reflex action and its concomitant nervous tissue. "The following is the theory whereby Mr. Herbert Spencer seeks to answer this question, and in order fully to understand it we must begin by noticing the effects of stimulation upon undifferentiated protoplasm. A stimulus, then, applied to homogeneous protoplasm, which is everywhere contractile and nowhere presents nerves, has the effect of giving rise to a visible wave of contraction, which spreads in all directions from the seat of stimulation as from a centre. A nerve, on the other hand, conducts a stimulus without undergoing any contraction, or change of shape. Nerves, then, are functionally distinguished from undifferentiated protoplasm by the property of conducting invisible or molecular waves of stimulation from one part of an organism to another, and so establishing physiological continuity between such parts without the necessary passage of visible waves of contraction.

"Now, beginning with the case of undifferentiated protoplasm, Mr. Spencer starts from the fact that every portion of the colloidal mass is equally excitable and equally contractile. But soon after protoplasm begins to assume definite shapes, recognized by us as specific forms of life, some of its parts are habitually exposed to the action of forces different from those to which other of its parts are exposed. Consequently, as protoplasm continues to assume more and more varied forms, in some cases it must happen that parts thus peculiarly situated with reference to external forces will be more frequently stimulated to contract than are other parts of the mass. Now in such cases the relative frequency with which waves of stimulation radiate from the more exposed parts, will probably have the effect of creating a sort of polar arrangement of the protoplasmic molecules lying in the line through which these waves pass, and for other reasons also will tend ever more and more to convert these lines into passages offering less and less resistance to the flow of such molecular waves—*i. e.* waves of stimulation as distinguished from waves of contraction. And lastly, when lines offering a comparatively low resistance to the passage of molecular impulses have thus been organically established, they must then continue to grow more and more definite by constant use, until eventually they become the habitual channels of communication between the parts of the contractile mass through which they pass. Thus, for instance, if such a line has been established between the points A and B of a contractile mass of protoplasm, when a stimulus falls upon A, a molecular wave of stimulation will course through that line to B, so

All three authors base their theories on the assumption that acquired mental characters are capable of transmission, and therefore of accumulation in subsequent generations.

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causing the tissue of B to contract—and this even though no wave of contraction has passed through the tissue from A to B. Such is a very meagre epitome of Mr. Spencer's theory, the most vivid conception of which may be conveyed in a few words by employing his own illustration, viz. that just as water continually widens and deepens the channel through which it flows, so molecular waves of the kind we are considering, by always flowing in the same tissue tracts, tend ever more and more to excavate for themselves differentiated lines of passage. When such a line of passage becomes fully developed, it is a nerve-fibre, distinguishable as such by the histologist; but before it arrives at this its completed stage, *i. e.* before it is observable as a distinct structure, Mr. Spencer calls it a line of discharge.

"Such being the manner in which Mr. Spencer supposes nerve-fibres to be evolved, he further supposes nerve-cells to arise in positions where a crossing or confluence of fibres gives rise to a conflict of molecular disturbances; but it is unnecessary for present purposes to enter upon this more elaborate and less satisfactory part of his theory. Less satisfactory not only because more speculative, but because the whole weight of embryological and histological evidence appears to me to be opposed to the speculation. For the whole weight of this evidence goes to show that nerve-cells are the result of the specialization of epithelial or epidermal cells—that is, that they arise, not out of undifferentiated protoplasm, but by way of a further differentiation of a particular kind of already differentiated tissue, where this is exposed to particular kinds of stimulation." All I desire now to point out is the *à priori* probability that nervous channels become developed where they are required simply from the fact of their being required—that is by use.

"And this *à priori* probability derives so much confirmation from the fact that it is scarcely possible to refrain from accepting it as an answer to the question above propounded, namely, How are we to explain the fact that the anatomical plan of a ganglion with its attached nerves comes to be that which is needed to direct the nervous tremors into the particular channels required? It is a matter of daily observation that 'practice makes perfect,' and this only means that the co-ordinations of muscular movement which are presided over by this or that nerve-centre admit of more ready performance the more frequently they have been previously performed—which, in turn, only means that the discharges taking place in the nerve-centre travel more and more readily through the channels or nerve-fibres which are being rendered more and more permeable by use. So much, indeed, is this the case, that when an associated muscular movement takes place with sufficient frequency, it cannot by any effort of the will become again dissociated; as is the case, for instance, with the associated movement of the eyeballs, which does not begin to obtain till some days after birth, but which then becomes as closely organized as any of the associated movements in the muscles of the limbs.

"And if this is the case even in the lifetime of individuals, we can scarcely wonder that in the lifetime of species heredity with natural selection should still more completely adapt the anatomical plan of ganglia, with their attached nerves, to the performance of the most

432. We have just seen that the performance of any complex action becomes more easy by frequent repetition, till, if the action be repeated frequently enough, the performance of it becomes automatic. In common but erroneous parlance it becomes instinctive. Mr. Lewes supposed that some of this acquired facility in performance is bequeathed by successive parents to successive offspring, whereby it is accumulated during generations to such an extent that the remote descendant has inborn the facility which the remote ancestor acquired only with effort and difficulty;—which is the same thing as saying that the character that arose in the ancestor under one form of stimulation, arises in the descendant under quite another. In this manner, according to Lewes, do actions at first intelligent and accompanied by a sense of mental effort become mechanical and instinctive, passing first through a border-space where they are neither quite intelligent nor altogether instinctive, but partake of the nature of both.

433. But setting aside for the moment the conclusion we

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useful—*i.e.* the most habitual—actions. Thus we may see in a general way how such nervous machinery may at last come to be differentiated into specially distributed anatomical structures, which, on account of their special distribution, are adapted to minister only to particular co-ordinations of muscular movements. That is to say, we are thus able to understand the rise and development of Reflex Action." (*Mental Evolution in Animals*, pp. 30–3.)

Mr. Spencer's theory appears plausible at first sight. Examined closely it is found to consist of a tissue of vague assumptions, many of which are opposed to known facts. A mass of undifferentiated protoplasm is assumed. Such a mass exists nowhere in nature except *perhaps* among the lowest unicellular organisms in whom nerves never arise. It is assumed that stimuli applied to a given point will at first be diffused through the mass, but that, presently, channels (*i. e.* nerves) will be established through which the stimuli will pass to definite points. The very vague analogy of flowing water is given. But water does not wear out channels in a perfectly level and homogeneous surface. Without initial differentiation in the protoplasm the stimuli would continue to be diffused through the mass. It is lightly assumed that the changes which stimuli cause in one individual (the parent) will reappear in quite another individual (the offspring) in the absence of the stimuli. Lastly, the power of developing under the influence of use, which is possessed only by certain of the structures of the highest animals, is supposed to be a property common to all protoplasm. The fact that actions tend to become automatic in the highest animals is no evidence that channels for the discharge of stimuli are readily established by use in *all* nervous tissue. It is evidence only that *certain* channels are readily established in a *particular* class of nervous tissue which a very prolonged course of evolution has adapted to that special function.

have already arrived at, that acquired traits are not transmissible, this hypothesis totally fails to account for the formation of many important instincts. For instance, many insects at the end of their lives lay their eggs in a particular place and in a particular way. The action is performed only once and at a time when the eggs have ceased, in any true sense, to be portions of the parent organism. Under the circumstances, not only can no facility in performance be acquired by the individual, but even were it acquired, none could be transmitted. Yet Mr. Lewes' hypothesis of the genesis of instinct pre-supposes both the acquirement of facility and the transmission of it. Therefore, while it is conceivable that this instinct arose by the survival of the fittest during a severe process of Natural Selection, it is inconceivable that it should have arisen through a lapsing of intelligence. All this is equally true of the mating instinct. If Mr. Lewes be right, the ancestors of lowly animals that reproduce bi-parentally must have possessed extraordinary intelligence. Moreover, were it true that instincts had such origins as he supposes, they would be most numerous and best developed in higher animals, and intelligence in the lower, whereas the reverse is the case; for in the highest animals—*e. g.* man—intelligence predominates and instinct is at a minimum, while in lower animals—*e. g.* fish—instinct predominates and intelligence is at a minimum. Very plainly, therefore, in the higher animals there has, on the whole, been regression, not evolution, as regards instinct. Again, instinct and reason do not merge at any point, as they would were one derived from the other. The fact that one is "inborn" and the other "acquired" separates them sharply; and if in the case of any given action, which is the outcome of both instinct and intelligence, as for instance a man's choice of a wife, we are unable to say how much of it is instinctive and how much intelligent, our difficulty is due to our ignorance, not to there being no dividing line but a border space.

434. According to Mr. Spencer, "rational action arises out of instinctive action when the latter grows too complex to be perfectly automatic."[1] His hypothesis, like Mr. Lewes', necessarily involves the supposition that there is a border space where the instinctive and the intelligent merge. We have seen that he describes instinct as compound reflex action. In his view, therefore, intelligent action is reflex still more compounded. Concerning instinct he says: "In its

[1] *The Principles of Psychology*, vol. i., p. 458.

higher forms instinct is probably accompanied by a rudimentary consciousness. There cannot be co-ordination of many stimuli without some ganglion through which they are all brought into relation. In the process of bringing them into relation this ganglion must be subject to the influence of each—must undergo many changes. And the quick succession of changes in the ganglion, implying as it does perpetual experiences of differences and likenesses, constitutes the raw material of consciousness. The implication is, that as instincts developed, some kind of consciousness must have become nascent."[1]

435. It seems, then, that Mr. Spencer regards consciousness as an accidental accompaniment of instinct (and presumably of intelligence also), not as an essential part of it. But some instinctive (and intelligent) actions, such as winking the eye when in fear of injury, are exceedingly simple, whereas some reflex actions are highly complex. "No one thinks of sneezing, or the convulsions produced by tickling, as examples of instinctive actions. Yet they are compound reflex actions to a degree of compounding not easily paralleled, and certainly much more so than any of the psychical adjustments which are given by Mr. Spencer as illustrations of instinct."[2] So also some intelligent actions are very simple, whereas some instinctive actions are highly complex; for example, web-spinning by spiders. Intelligent action, therefore, cannot be correctly described as arising out of "instinctive action which has grown too highly complex to be perfectly instinctive." Moreover, as I say, instinct does not merge into intelligence and reason, but is sharply divided from it. There is, therefore, no more reason to suppose, as Mr. Spencer does, that intelligence arises out of instinct than for supposing, as Mr. Lewes does, that instinct arises out of intelligence.

436. Mental acquirements are clearly not transmissible. Having arisen in the parent through the stimulus of use, they do not arise in the offspring through the stimulus of nutrition. All the objections to the Lamarckian doctrine which we found so decisive when discussing physical characters retain their full force when applied to mental characters. Indeed they are even more decisive as more patently opposed to the facts. Mr. Spencer's hypothesis is not only controverted by the evidence, it is actually unintelligible. It is impossible to understand why the mere co-ordination

[1] *The Principles of Psychology*, vol. i., pp. 434, 435.
[2] Romanes, *Mental Evolution in Animals*, p. 258.

in a ganglion of purely physical stimuli should result in consciousness. It is equally difficult to understand why the mere compounding of reflexes should necessarily result in desire, memory, reason. His statement is a signal instance of that "scandalous vagueness" which Professor James has so feelingly denounced.[1] Mr. Lewes' alternative hypothesis is intelligible, but is quite as opposed to the evidence. Were acquired mental characters transmissible the human race would long ago have lost, indeed would never have achieved, that mental "plasticity" which is its special endowment. The stereotyped knowledge, beliefs, prejudices, sentiments of the adult would appear in a stereotyped form in the child. A race that had long followed Mumbo-Jumbo would be born with a faith in him innate and ineradicable within measurable time. A race that had long spoken a given language would speak it instinctively, though the children were reared by people who spoke another tongue. There would be no deaf mutes, for, however deaf, the mutes would still talk instinctively. A race that lived under conditions (*e. g.* the presence of alcohol or opium) that adversely affected the mind would deteriorate till it perished.

437. Since mental characters are correlated to physical characters in the brain, every reason that tells against the hypothesis that physical variations are commonly due to the direct action of the environment on the germ-plasm tells equally against the hypothesis that mental variations are so produced.

[1] *The Principles of Psychology*, vol. i., p. 149.

CHAPTER XXI

THE MIND OF MAN

The basis of man's mind—The physical changes which have accompanied the evolution of memory—Speech—The substitution of acquirements for instincts—Sexual and parental love—Modesty—Morality—Comparison between physical and mental traits—Mental acquirements that are due to physical conditions—The influence of the environment—Man the educable animal—The opinions of scientific men.

438. At the basis of all the physical structures of Man lie his "inborn" physical characters. Some of his physical characters develop to the fullest extent without the aid of use-acquirements, which would be useless to them, and which therefore they are incapable of making; for example, his hair which is never "used," his sexual organs which are used to advantage only when fully developed, and his teeth which are so constantly and equably used that Natural Selection has been able to fix a right standard without an unnecessary resort to use-acquirements. All his other structures, for example his heart, his lungs, his limbs, his brain, develop after birth chiefly if not exclusively as a reaction to use.[1] Nutrition now supplies the material, not the

[1] We cannot say positively that the growth of these structures after birth is due *exclusively* to use. The data for making a positive statement are not available. But we know that a muscle completely paralyzed tends to atrophy completely, and it is reasonable to suppose that, if a muscle owes its preservation to use, it must owe its growth to still more use. The paralyzed limbs of children remain diminutive; but I am not aware that anything has been published that demonstrates whether or not a paralyzed limb on which no strain is placed increases at all in size. The effect of use on the heart may be estimated by its enormous hypertrophy in diseased conditions that place it under great strain. The training of athletes renders their lungs very capacious. It is hardly possible to doubt that man's brain owes its development to use as much as any other structure. It is correlated to his mind, which certainly grows under the influence of experience. The cerebral hemispheres especially, the organ of his memory and all that flows from memory, must depend on use for their increase after birth. If the

stimulus for growth. At the basis of man's mental acquirements lie his memory and his instincts—his capacity for making acquirements and his incitements to making them. But instinct has so shrunken in him that, unaided by acquirements, it cannot prolong his life nor enable him to perpetuate his race. At birth he cries when in pain and sucks when hungry, but there is little besides that he can do. His deferred instincts—the sporting, the sexual, the parental—though they incite him to necessary actions, are dependent for usefulness on previous acquirements, without which they would prompt in vain. In effect he has become a creature with a vast memory and with incitements to use his memory in such definite ways that presently, when grown, he shall in body and mind fit his environment whatever that may be. The rest of his physical and mental characters are as much overshadowed by his memory and its corollary intelligence as the structures of some internal parasites are dominated by their reproductive organs. The parasite has become a mere bag of eggs; man has become almost as completely a manufactory of thought, owing his persistence as much to his intelligence as the parasite to its fecundity.

439. His bodily structures have been modified in accordance with this dominant character. The great hemispheres of his brain, to which consciousness has transferred its seat from lower centres, have arisen. His hands have become the strong but delicate instruments of his intelligence. To free his hands for their peculiar functions he has assumed the erect attitude. As a consequence his whole skeleton has undergone a change. Structures and capabilities, a high development of which was formerly essential to the survival of his less intelligent ancestors, have become less essential and have undergone regression. Thus his senses of smell and hearing are now less keen than those of the animals nearest to him. Intelligence enabled him to discover and perpetuate the art of making fire, and so of warming himself, and of cooking, softening, and partially predigesting his food; but, as a consequence, his jaws have

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brain be mechanically prevented from growing, as by an early coalescence of the cranial bones, the mental development is checked, and idiotcy results. The individual is unable to make those mental acquirements which would enable him to move "rationally" through his world. Idiotcy also follows a lack of opportunity to make acquirements, as in the case of prisoners closely confined from infancy in Eastern prisons. Races that make comparatively few mental acquirements (*i. e.* the lower savages) are usually small-brained.

become feeble, his teeth liable to decay, and his stomach incapable of assimilating the raw coarse food on which his ancestors flourished.

440. It would be difficult to indicate the most important physical change which accompanied the evolution of man's memory, but certainly none has had results more far-reaching than that which has occurred in his organ of speech, and rendered articulate language possible. Three things must have undergone concurrent evolution, the evolution of any one being impossible without the others—the hemispheres of the brain, the organs of speech, and language. The first two are natural endowments of the species, actual physical parts of the individual, wholly inborn in the infant, but with acquirements superadded in the adult. The third is a mere system of signs which man has invented. Almost as complex in its way as the brain, its elaboration must have been nearly as slow as the evolution of the hemispheres. But this system of signs enables him to communicate, and so in succeeding generations to accumulate knowledge abstruse, varied, voluminous, complex to a degree immensely beyond anything that could have been achieved without its aid. Lacking it, his great brain, his great power of making mental acquirements, would be useless. The knowledge of this great system of signs is in effect, though not in fact, an instinct, since, as an absolute condition of *human* survival, it has been handed without break by every generation to the next from that remote past when man first emerged from the brute. A single acquirement, it is a superior substitute for many instincts. Owing to the unfailing possession of it by an endless succession of generations, man has regressed so far in structures and instincts that but for language, and all that is communicated by language, he is as unfit for existence as a military ant without its slaves. If for a single generation this all-important system of signs were lost, and man, were it possible, survived, he would at once be reduced to the condition of a brute, and, his equipment of instinct being small, a very helpless brute. His highest faculty, his enormous power of making and using mental acquirements, of profiting by experience, would be rendered nugatory. Under the new conditions the fit who survived would not be the same as heretofore. And since the power of acquiring the higher mental faculties would be no longer a principal factor in survival, that power would necessarily regress, and man would degenerate towards that ancestral form in which it did not exist.

441. The slow evolution of speech, and the slow concurrent evolution of the structures which subserve speech during innumerable generations, the one generation transmitting that which it acquired from the preceding generation, with slight improvements, to succeeding generations, which, by the survival of the fittest, were able not only to acquire the speech with the improvements, but to make further improvements, all in like manner to be transmitted to descendants of slightly larger powers, the constant repetition of this process till speech as we know it was evolved, furnishes us with the means of learning by analogy the process by which some of the more complex acquired traits of man and the lower animals have been developed. Like language, these are individually acquired by each generation, but have been developed and perfected during many generations, and this especially when the trait is one which is only acquirable slowly and with difficulty as speech is. The development of speech in the individual, beginning with the inarticulate cries of the infant and ending with the wide and accurate power of expression possessed by the adult, is accompanied by growth in the brain and the vocal organs. Probably the infant, not only does not know how to speak, but is physically incapable of speech. And, as we may dimly trace the life-history of the race in the development of bodily structure, so in the halting efforts of the child we are able to detect something of the way in which this great system of verbal signs was painfully evolved by primitive man.

442. The extent to which mental acquirements have replaced instincts in man is seldom if ever realized. With the exception of the desire for rest and sleep when wearied, nearly all his remaining instincts are mere incitements to make acquirements. Even sexual and parental love incite thereto. Men and women endeavour by acquirements to increase their powers of fascination. The mother learns to tend her offspring. Moreover, to an extent difficult to determine accurately, but certainly very large, both sexual and parental love, or, to speak more correctly, the capacity to feel them, are acquirements. It is very doubtful whether the human male has any "natural affection" for his children. There are indications that he acquires his love for them, as he may acquire a love of country or of a particular religious system, through the incitements of his imitative instincts. It is notorious that the custom or fashion prevailing in any race or class largely determines whether the men and the women composing it shall be good or bad parents, whether

they shall tend with care or neglect their children. Many races, ancient and modern, savage and civilized, have practised infanticide apparently without pain or compunction. If it be argued that paternal affection is a deferred instinct which is awakened only by association with the child, then it must be admitted that it must be a very feeble instinct, very unequally distributed, evidently undergoing regression, easily overcome by acquirements, and hard to distinguish from passion, which is based wholly on acquirement.

443. Sexual love for a particular object, like love for a particular child, is of course an acquirement, though equally of course with an instinctive basis. It is because human beings are capable of making acquirements that love for a particular man or woman or child is possible to them. Purely instinctive animals are incapable of recognizing their mates or their offspring. But the instinctive basis itself appears absent in those women who have no sexual appetites. La Rochefoucauld said truly that to some people love is an affair of fashion. Sexual jealousy is always regarded as instinctive in man. In our country it is a very dominant passion; but even among us the lover is not usually jealous of the legitimate mate as he would be had the passion an inborn basis as among certain lower animals, for example the stag. On the other hand, a husband or wife may combine aversion to the legitimate mate with extreme jealousy. Abroad, in polyandrous lands, men amicably share a common wife, and in polygamous countries women a common husband. It would appear, therefore, that sexual jealousy is little if at all inborn. It seems we feel it, as we feel jealousy for our country, or our religion, because we have acquired it by imitation from other people. The love of property is certainly an acquirement; we feel just as great or almost as great a jealousy for our houses, lands, or money as for our mates. Sexual love as idealized among modern Western nations is plainly an acquirement. It is quite a recent character—an invention of mediæval chivalry, and especially of the troubadours. Ancient communities showed no trace of it, and many modern communities show none. An appreciation of sexual beauty is supposed to be instinctive in human beings; but in great measure it, also, is plainly a matter of acquirement. The great mane of man, his long hair and beard, is a sexual feature, and probably was his principal means of fascinating the opposite sex when he was becoming human. But women in England would be as much repelled by long locks and an untrimmed beard, as men would by a shaven female head.

Female heads devoid of hair are much admired in parts of Africa, as are shaven male heads in some other lands. The Hottentots admire and have developed by selection features in their women which appear monstrous to us. Tattooed skins are regarded with delight in many parts of the world, but are horrifying to strangers. Fatness is considered an important factor of beauty in some places.[1] In a district of East Africa women bore their lower lips and stretch them round large rings of wood. The lower teeth are knocked away. The men behold with sexual transports the exposed tongue ineffectually striving to achieve articulate language—"spluttering through a hedge of broken teeth." Elsewhere women bore their ears and noses. Almost as hideous as the East African custom were the crinoline and chignon of the nineteenth century, that era of transcendent bad taste. Presumably our fathers admired them. As one vagary succeeds another we think no one looks "nice" who is not attired in the latest fashion. Clearly, then, sexual love with its accessories, jealousy and admiration of beauty in the opposite sex, is much overlaid and extended by manifest acquirements.

444. Modesty is supposed to be an instinct, and much has been written on that assumption even in scientific works. But the baby has no trace of it, and apparently would not develop an iota but for his imitative faculty. Various savages have no more modesty than a lower animal. Only those races that wear clothes are modest, at any rate in the Christian or Mahomedan sense. Doubtless clothes were used originally for warmth or ornament. But in time constant concealment of parts of the body led some races to the notion that it was wrong to expose them—some races but not all, for the Esquimaux, who wear clothes, freely expose their bodies in their huts. To-day in England many a woman, who perhaps neglects her child or is indifferent to her lover, would rather die than appear naked in public. A manifest tradition, a mere acquirement, modesty has become

[1] As a child I told a native in India that Queen Victoria was extremely beautiful. "Is she very fat?" said the man with interest. In Honolulu a Kanaka told me that the native queen was most lovely—she weighed two hundred pounds. In New Zealand I saw much of a tribe of natives. At first the tattooed faces of the chiefs were displeasing. Later, when I had caught the infection of the fashion, an untattooed native face seemed mean and common. I must confess that no fashion in women's clothes appears in England but for the time being I think it pretty. I have learned to distrust my taste and try to correct it by imagining women, dressed in the fashion, as marble statues. Then the real hideousness of some fashions become apparent.

as strong or stronger than any instinct. Formerly it was carried to such extremes that monks and nuns refused to view their own bodies, and so to wash. The Turkish woman is modest about her face: the English woman delights in displaying it. The women of our lower orders conceal their shoulders, as do the women of the upper classes in the morning. In the evening the latter would consider covered shoulders unseemly. The children of savages removed from the ancestral environment have been taught extreme modesty by missionaries. We have no reason to suppose that the child of Quakers reared by savages would instinctively desire the concealment of even a fig-leaf.

445. Morality is said to be an instinct. But there is no evidence that any human individual or race ever possessed any morality except such as was acquired through the imitative faculty, or, in rarer cases, through reasoned thought. The extraordinary diversity of moral systems in time and space, the sharp contrasts that exist between race and race, the swift transitions which have occurred during history, is conclusive evidence that morality is no other than an acquirement. Moreover, if morality (as also modesty) be an inborn character, an instinct, it must have arisen through a direct process of Natural Selection. A process of Natural Selection, by which in the remote past immodest and immoral savages were eliminated, is hardly conceivable. It is sometimes maintained that modesty and morality were evolved by the elimination, not of immodest and immoral individuals, but of communities. This contention, however, is founded on a confusion of thought. No evolution can result from the elimination of communities unless all the members of each community are the offspring of a single individual (*e. g.* queen-bee), in which case it is the parent, the individual, that is really selected. Otherwise any evolution that occurs must result from selective elimination within the community. A community which merely displaced another would spread, but undergo no racial change. Thus Irish sexual morality is said to be greater than the sexual morality of the English. If the English perished the Irish might swarm across the Channel, but it is difficult to perceive how their alleged moral instinct would be increased thereby.

446. Fear and hate are said to be instincts. As a fact, in man they are acquired emotions. The adult fears or hates nothing except that which he has learned to fear or hate. Unlike the frog in his fear of the snake, or the stag in his hate of a rival, he gains these impulses to action through

previous experience of injury. The new-born infant neither fears nor hates anything. An ability to track game, and other like characters, are said to be instinctive in some savages. But this is much the same as saying that an ability to read and write is instinctive in Englishmen. Presumably the Australian native, for instance, is not born with a knowledge of the appearance, habits, and tracks of the emu or the kangaroo. There is not any evidence even that he is more capable than the child of civilized parents of acquiring the knowledge. It is natural, however, since he has been trained under the best tuition from infancy to tracking, that he should be more proficient than the European who attempts to acquire proficiency much later and under much less favourable auspices.

447. The kind of stimulus (use) that causes any physical structure to develop is always much the same for that structure. Thus the human hand is employed mainly in grasping, pushing, and otherwise manipulating objects. It is subjected to pressures and strains that vary somewhat in degree, but little in kind, with the occupation of the individual. Subjected to great and constant pressures and strains it tends to grow relatively large, strong, and coarse; subjected to lesser pressures and strains it tends to be relatively smaller, weaker, and more delicate. But the tendencies to growth in it are such that a comparatively limited amount of use is sufficient to develop it into a normal adult hand. A greater amount of use results only in minor differences. Probably the amount of stimulus received by the hand, in different members of the community, varies more than that received by any other structure—for example, eyes, tongue, lungs, heart, legs. Nevertheless the individual members of a community, even when reared under almost identical conditions, may differ greatly in their physical characters. Thus one person may be tall, strong, and dark, while another is short, weak, and fair. It is evident, therefore, that the physical differences are, to a very large extent, due to germinal variations. We see the truth of this yet more plainly when we contrast individuals of different races. No one will doubt that a Scandinavian and an African Bushman reared as members of the same household, and therefore under very similar conditions, would present immense physical contrasts. The structures of both would grow under the influence of use, and all this growth would be an acquirement; but the direction of the growth and the extent of it would be rightly limited by their inborn tendencies.

448. But while the kind and the amount of development which may result from use in the hand or other physical structures is rigidly limited, a man is capable of learning to use his hand in any one of a thousand or million different ways. Thus he may acquire dexterity as an etcher, a painter, a writer, a watch-maker, a marksman, a blacksmith, a surgeon, and so on in endless variety. But all these acquirements are mental, not physical. We see, then, by contrasting the range of acquirements which use may produce in a hand with the range of acquirements which experience in using a hand may produce in the mind, how immensely greater is the power of making acquirements possessed by the latter. Moreover manual dexterities form only a microscopical part of the total that a man's mind may, and always does, acquire. The artist's skill in guiding his hand is as naught compared to the rest of his mental achievements. As naught to the rest is the skilful penmanship of the historian, the poet, or the philosopher. Who, in estimating the greatness of the architect or the engineer, even thinks of the skill with which he moves the pencil or the ruler? Who can even name a manual dexterity which underlies the success of the statesman or the general? The real adaptability, the real plasticity of man, therefore, lies in his mind, not in his body. It is in the former that he is pre-eminent above lower animals. His body is like a fragment of flint which some rude savage may chip and change a little. His mind is like a mass of clay or metal which a skilful workman may mould into ten thousand shapes. Mentally, much more than physically, man is the product of his immediate surroundings; whereas physically, much more than mentally, he is the product of a long-extended past.

449. It is often argued that since men differ greatly as regards their innate physical characters, they must differ as greatly as regards their inborn mental characters. Doubtless this is true. We know, for instance, that of two men similarly trained, one may vastly excel the other as mathematician, musician, poet, artist, philosopher, or as commander. But, when it is further argued that the mental differences which we perceive in men are commonly innate in the same sense as their physical differences, the error is obvious. The narrowness of the range of possible physical acquirements and the width of the range of possibile mental acquirements are not taken into account. The extreme ductility of the mind as compared to the body is forgotten. Beyond a few

deferred instincts which have been evolved by Natural Selection by reason of their utility, and which therefore are common to the whole species, the entire mental difference between the infant and the adult is due to the acquirements made by the latter. One man may have more of this or that instinct; but, since instincts have been evolved, he cannot have different instincts, at any rate if he has not varied very greatly—that is, if he is a sane person. On the whole instinct makes the individuals of a species alike, not different. The mental differences between adults, then, are due, first to differences in innate capacity, in innate power of making and utilizing acquirements, and secondly, and to a much greater extent, to differences in the acquirements that are made by virtue of this capacity. This is true also as regards physical structures, but whereas, as we have just seen, use causes physical structures to develop along lines that are rigidly fixed and limited as regards direction and extent, experience may cause the mind to develop to an almost unlimited extent in any one of a million possible directions. The nature of the mental acquirements depends almost wholly on the individual's peculiar environment—on his experiences, his opportunities for learning. And, since a difference in acquirement constitutes the main part of the mental difference between the infant and the adult, since the experiences of individuals are never alike and may differ extremely, it is evident that the environment must be a very potent factor in the causation of mental differences. This is obviously true as regards knowledge, for no two men know exactly the same things. It is less obvious, but probably no less true, as regards more subtle mental differences. We often say, when speaking of this or that man, that he is by nature resolute or weak, proud or servile, brave or cowardly, honest or knavish, moral or immoral, merciful or cruel, just or unjust, gentle or violent, morose or genial, buoyant or depressed, sanguine or despondent, intelligent or stupid, broad-minded or bigoted, and so on. We are probably mistaken. There is abundant evidence that characters such as these are dependent mainly, not on germinal differences, but on acquirements.

450. Mental acquirements may be due to the individual's physical condition. Good health tends to render him buoyant, ill-health to depress him. Gout predisposes people to irritability, chronic liver complaint to despondency. The dyspeptic is often morose. An odd cheerfulness is often shown by the consumptive. Exophthalmic goitre is a cause

of nervousness, myxœdema of lethargy. Brain disease may lead to positive lunacy and mania. An early union of the cranial bones is a constant source of idiotcy; the growth of the brain and mind being checked, the microcephalic idiot, unable to make those acquirements by means of which rational people balance and direct their instincts, behaves like a lower animal. He follows his instincts. Physical strength and activity predispose to arrogance and courage; physical weakness to timidity and meekness.

451. But apart from the mental acquirements due to bodily conditions are those due to the world outside the individual. To take an illustration. Imagine twin infants in a cot, one awake and the other asleep; suppose an event happens that alarms the waking child, but leaves the other unaffected; suppose again that subsequently another event, observed by both children, occurs, which, owing to the apprehension and nervous irritability engendered by the previous event, again alarms the first child and thus increases its irritability, but, because of the previously undisturbed equanimity, again leaves the second unaffected by fear; imagine this process repeated; then, though the original cause of fear were quite forgotten, the one child might well grow up of a much more timid and nervous disposition than the other. In which case every one would speak of the former as naturally (*i.e.* innately, instinctively) more timid than his brother, though in fact his timidity would be acquired. So might many peculiarities of mental character arise. I have taken an hypothetical case; but most of us can remember experiences, unimportant in themselves and occurring later in life, when the individual is much less impressionable, which have been so accentuated and magnified by subsequent occurrences as to change the whole character, and with it the career, of some person.[1]

452. To take another illustration. Identical twins are extremely alike physically. Presumably, since mental characters are correlated to cerebral structures, they are as much alike as regards innate mental traits—instincts and capabilities. Suppose such a pair were separated in infancy, one being placed in a ploughman's hut, the other being given a career in a good school and university. Presently they would differ mentally *in toto cœlo*. Physically they would develop much alike. The ploughboy's hands would be a little rougher and his skin a little more tanned. The main

[1] In my own case five minutes' careless conversation when a boy led to a gradual but profound change in my entire character and career.

physical differences from his brother—the more unkempt aspect, the clumsier gait, the uncouth gestures—would, however, be an expression of mental differences. To take yet another illustration. The child of English parents, reared by African savages, would remain an Englishman in body. Not so in mind. His sexual and parental instincts, such as they are, would remain, though some of their manifestations might be different. But his instincts of curiosity and imitativeness would confer on him a set of mental acquirements—ideas of religion, morals, modesty, language, ways of thinking and acting, knowledge in general—wholly different from those which distinguished his progenitors. An utter savage, mentally he would be the child of his immediate surroundings. All that a thousand generations had slowly acquired would be exchanged for what a thousand others had accumulated. Outside the imagination of a follower of Lamarck no Rev. John Creedys ever existed. In real life we read of white children captured by Red Indians becoming as cruel and treacherous, as inimical to their kindred as their captors; of English children in India acquiring all the "che-che" characteristics; of savages civilized in a single generation. Man, intellectually the highest animal, is not less malleable than a slave ant.

453. Man has been termed the educable animal. But only a part of his education is achieved in the school-room or under the influence of grown people. During infancy he educates himself, and, under often incalculable influences, many of his merits and demerits are acquired even so early. In childhood and boyhood he is educated very largely by companions only a little older than himself. When people declare that they do not know whence this or that individual derives this or that peculiarity of disposition in which he differs from his parents, they forget these early influences. Parental traits which are inborn are transmissible; they appear almost inevitably in the offspring.[1]

[1] The fact that children often offer startling mental contrasts to their parents is presumptive evidence that neither the parental nor the filial traits are inborn. The remark that the children of clergymen are apt to be "wild" is so common as to be almost proverbial. Children derive their acquired mental traits by imitation, not only from their parents, but from their companions. Extremely austere people are often not on intimate terms with their children. They govern more by fear than by love, through authority than through confidence. That child is always in peril whose parents are not his closest friends and companions, who is obliged to carry his hopes and fears, his impulses and temptations to chance associates. He who is reared in a very austere household has a wide region wherein to go astray. Other people may not necessarily be more wicked than his parents, but at least they think fewer things

454. Certain homes, certain stages of society, certain environments undoubtedly tend to endow the individuals exposed to them with definite mental characters. In one environment they grow up morose and irritable. In another they imbibe the spirit of the Greek mariners, who

> "With a frolic welcome took
> The sunshine and the storm."

Under some circumstances they become timid and effeminate; under others brave and hardy. Apart from conditions of health, happiness and despondency are habits. A joyous childhood is usually a prelude to a buoyant manhood; while, conversely, a miserable childhood is often the precursor of a manhood of despondency. The common-sense of mankind has recognized the extreme importance of education. For this reason do we so carefully train our children, seeking to realize in them our ideals of character and conduct. For this reason have Governments endowed great educational establishments, and Churches for centuries striven to bring the world to their ways of thinking.

455. To sum up: Man is mentally a bundle of capacities for making acquirements, actual acquirements, and instincts which are mainly incitements to make acquirements. In the case of any given man it is hard to distinguish the inborn from the acquired. It is hard even to estimate his true capacity for making acquirements, for this faculty may be largely increased or diminished by acquirement.[1] Nevertheless we are entitled to declare that in the mental characters he exhibits acquirements enormously predominate over inborn traits. "We often hear of hereditary talents, hereditary vices, and hereditary virtues; but whoever will critically examine the evidence will find that we have no proof of their existence. The way in which they are commonly proved is in the highest degree illogical; the usual course being for writers to collect instances of some mental peculiarity found in a parent and in his child, and then to infer that the peculiarity was bequeathed. By this mode of reasoning we might demonstrate any proposition; since in all large fields of inquiry there are a sufficient number of empirical coin-

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wicked. Whenever such a one makes a downward step he is liable to make many more. Extreme austerity of principle and conduct in parents may, therefore, be positive evils to the child unless accompanied by as marked a tenderness and cordiality of feeling and manner. If the reader will consult his own experience, he will perceive how rarely a child, who is the intimate friend of both his parents, "goes wrong."

[1] See Chapter XXIII.

cidences to make a plausible case in favour of whatever view a man chooses to advocate. But this is not the way in which the truth is discovered; and we ought to inquire not only how many instances there are of hereditary talents, etc., but how many instances there are of such qualities not being hereditary. Until something of this sort is attempted we can know nothing about the matter deductively; while until physiology and chemistry are much more advanced, we can know nothing about it inductively."[1]

456. As a general rule, however, most scientific men appear to hold a contrary opinion. Thus Mr. Francis Galton says: "The long period of the Dark Ages under which Europe has lain is due, I believe, in a very considerable degree, to the celibacy enjoined by religious orders on their votaries. Whenever a man or a woman was possessed of a gentle nature that fitted him or her to deeds of charity, to meditation, to literature, or to art, the social conditions of the time were such that they had no refuge elsewhere except in the bosom of the Church. But the Church chose to preach and exact celibacy. The consequence was that these gentle natures had no continuance, and thus, by a policy so singularly unwise and suicidal that I am hardly able to speak of it without impatience, the Church brutalized the breed of our forefathers. She acted precisely as if she aimed at selecting the rudest portion of the community to be, alone, the parents of future generations. She practised the arts which breeders would use, who aimed at creating ferocious, currish, and stupid natures. No wonder that club law prevailed for centuries over Europe; the wonder is that enough good remained in the veins of Europeans to enable their race to rise to its present very moderate level of natural morality."[2] Investigation has proved that mediæval monks had, on an average, larger brains than the laity. If, as Mr. Galton implies, gentle natures are inborn, then the Church certainly did her best to brutalize the breed of our ancestors; but if gentleness is a character which almost any one may acquire, but which only a few people in the mediæval environment did acquire, then the Church can have exercised no real selection. Women are not, perhaps, especially distinguished by a love of meditation or literature, but all the world over they have been regarded as the gentler sex. When, however, women are emancipated from ancestral tradition, when they acquire new traits by imitation, they are apt to be as fierce

[1] Buckle, *History of Civilization*, vol. i., p. 177.

[2] Galton, *Hereditary Genius*, pp. 343–4.

and violent as men. Witness the women of more than one French revolution and the black Amazons of West Africa. If brains grow in size by use, there is a strong probability that the superior cranial development of the monks was due not to germinal peculiarities but to the more intellectual nature of their pursuits.

457. Again, Professor Karl Pearson declares: "The upper middle class is the backbone of a nation, it depends on it for its thinkers, readers, and organizers. This class is not a mushroom growth, but the result of a long process of selecting the intellectually able and fitter members of society; roughly speaking, its members marry within the caste, they form opinion and think for a nation. We want every possible ladder for attracting to that class able members of the hand-working class; but with very considerable experience of those who have climbed those ladders, and some of them are brilliant men, or were brilliant lads at least, I am prepared to maintain that the middle classes (owing to their long period of selection and selective mating) produce relatively to the working classes a vastly greater proportion of ability; it is not the want of education, it is the want of stock which is at the basis of this difference. . . . The population of France is becoming more and more Celtic because the Bretons are the one element in the population which does not limit the family. Who can affirm that this is for the benefit of France, or that her national character will not change with this predominance?"[1]

458. The opinions of such keen thinkers as Mr. Galton

[1] *The Grammar of Science*, ed. 1900, pp. 466–7. See also Pearson's Huxley Lecture (*Times*, Oct. 17, 1903). "We inherited our parents' tempers, conscientiousness, shyness, ability, even as we inherited their stature, fore-arm, and span. Again, within broad lines, physical characters were inherited at the same rate in man and the lower forms of life. The irresistible conclusion was, that if man's physical characters were inherited even as those of the horse, the greyhound, and the water-flea, what reason was there for demanding a special evolution for man's mental and moral side? If the relation of the psychical characters to the physical characters was established, what was its lesson? Simply that geniality and probity and ability might be fostered by home environment, and by provision of good schools and well-equipped institutions for research, but that their origin, like health and muscle, was deeper down than those things. They were bred, and not created." There can be no doubt that we tend to inherit our parents' ability—their powers of making mental acquirements *plus* their powers of learning to utilize these acquirements to advantage. But would any man be "able" if reared among fools, or genial if trained by ill-tempered people or dour fanatics, or upright if taught by thieves? Under what process of Natural Selection was "probity" evolved?

and Professor Pearson are entitled to respect, but the environments in which the infancy and childhood of the middle and lower classes are passed are so different that it is not possible to form a safe opinion by comparing adults or even lads. The little children of the lower classes appear to me, as a rule, more intelligent than those of the upper, a result due, no doubt, to the rough-and-tumble of the streets, which in some respects compares favourably with the coddling and the often dull seclusion of a nursery. So also city children are generally more intelligent than country children. When the lower classes have favourable opportunities they have produced many distinguished men, as in France during the great Revolution, and in America. In Russia and other conservative and aristocratic countries, where their opportunities for acquiring and utilizing mental traits are more restricted, they rarely produce distinguished men, and are always regarded with contempt as innately inferior. No doubt middle-class people have married mainly amongst themselves, a fact that is proved by their greater sobriety as compared with the hand-workers.[1] But, except as regards alcohol, the stringency of selection was greater in former times amongst the latter. The unintelligent were weeded out more thoroughly. On the other hand, the most able, or at least successful, of the hand-workers have often reinforced with their strength and intellect the class above. On the whole, therefore, while it is certain that the two classes differ much in their acquirements, it is probable that they differ little, if at all, in their germinal peculiarities. At any rate if they differ, yet, so greatly do man's acquirements outweigh his inborn traits, and so completely are the two intermingled, that we have no means of ascertaining it.

459. The Celtic element in France, as elsewhere, is certainly less intelligent and progressive than the non-Celtic; but here again it is a question of germinal *versus* acquired peculiarities. The whole problem of racial characteristics, however, is so interesting and important that we must

[1] The reader may be reminded that alcohol, like opium, tobacco, food, warmth, sexual intercourse, and the like, is a cause of pleasant sensations, and that sensations cannot be altered by education. Experience of alcohol awakens in some men a craving for deep indulgence, no matter how they have been educated. They may acquire a moral abhorrence of drunkenness, and may abstain from it, but they still remain capable of enjoying the sensations. An acquired love for drinking, therefore, differs *in toto cœlo* from the acquirements we are considering. No man is depressed or nervous, for instance, for the sake of the pleasant sensations those frames of mind awaken.

reserve its treatment for a separate chapter. We shall then be in a better position to judge how far the mental peculiarities of individuals and classes deserve to be regarded as innate. Since individuals have only one life each, we cannot test our theories by rearing the same people first in one environment and then in another. But races have sometimes changed their mental environments very rapidly. Under these conditions whatever psychical alterations occur must be considered, not as innate, but as acquired.

CHAPTER XXII

RACIAL MENTAL DIFFERENCES

Mainly acquired—Differences in instinct must be slight—Shapes and sizes of brains in relation to intelligence—The stability of inborn characters—Most racial characters cannot be inborn since they are liable to too rapid alteration—The evidence from religion.

460. No opinion is more universally entertained than the one that races of mankind differ mentally, each from all others, by reason of inborn traits. Though opinions differ as to the mental peculiarities of this or that race, though each race has usually a very flattering opinion of its own mental proclivities and capabilities, and a very unflattering opinion of the proclivities and capabilities of other races, yet it is seldom doubted that such proclivities and capabilities are inborn. For instance, to take the English point of view, few Englishmen doubt that their own race has "by nature" a genius for empire and colonization, is brave, resolute, cool-headed, law-abiding, liberty-loving, industrious, enterprising, and so on; that "by nature" Frenchmen are fickle, frivolous, ardent, and logical; that, for the same reason, Germans and Dutchmen are phlegmatic and thoughtful; Russians dull and barbarous; Japanese brave and enterprising; Spaniards proud, intolerant, and superstitious; Italians musical, excitable, and prone to violence; Bengalese cowardly, servile, and subtle; Afghans fanatical, fierce, and treacherous; Chinese in some things abnormally clever, in others abnormally stupid; West Africans, almost beyond belief, foolish and cruel; Fingoes braggart and timid; Zulus brave and honest; that this race has great artistic tendencies and that race none at all; that this race has considerable capacity for civilization, that race less, and that other none at all; that the Irish have "by nature" one kind of temperament and the Scotch another.

461. Almost alone among historians Buckle has questioned whether races differ inherently as regards their mental

peculiarities. He says: "I cordially subscribe to the remark of one of the greatest thinkers of our time who says of the supposed differences of race, 'Of all vulgar methods of escaping from the effects of social and moral influences on the mind, the most vulgar is that of attributing the diversities of conduct and character to inherent natural differences.'" (Mill's *Principles of Political Economy*, vol. i., p. 389.) Ordinary writers are constantly falling into the error of assuming the existence of this difference, which may or may not exist, but which assuredly has never been proved. Some singular instances of this will be found in Alison's *History of Europe*, vol. ii., p. 336; vol. vi., p. 138; vol. viii., pp. 525, 526; vol. xiii., p. 347, where the historian thinks that by a few strokes of his pen he can settle a question of the greatest difficulty connected with some of the most intricate problems of physiology.[1]

462. "Whatever therefore the moral and intellectual progress of men may be, it resolves itself not into a progress of natural capacity, but into a progress, if I can say so, of opportunity, that is, an improvement of the circumstances under which that capacity after birth comes into play. Here, then, lies the gist of the whole matter. The progress is one, not of internal power, but of external advantage. The child born in a civilized land is not likely as such to be superior to one born among barbarians; and the difference which ensues between the acts of the two children will be caused, so far as we know, solely by the pressure of external circumstances; by which I mean the surrounding opinions, knowledge, associations, in a word, the entire mental atmosphere, in which the two children are respectively nurtured."[2]

463. Now, since so little in man that is mental is inborn, and so much is acquired deductively, it seems probable that Buckle is right. An attempt to judge the innate ability or other mental characters of a family, class, or race simply by counting distinguished heads or estimating the general culture is on a level with an attempt to estimate the amount of water in a river by measuring its width while ignoring its depth. Our chances of success are best when we deal with members of the same family or class, because here, within wide limits, the general training, the sum-total of the experience of individuals is somewhat similar. But, when we attempt by such means to compare classes and races, the sources of error are so numerous and great that our conclusions are

[1] Buckle's *History of Civilization*, vol. i., p. 40.
[2] *Op. cit.*, p. 178.

practically certain to be erroneous. Perhaps the most extreme instances of this fallacious method of reasoning is furnished by those travellers who conclude that the inability of savages to count is due to an innate lack of mathematical ability instead of to a mere lack of mathematical knowledge. As well might they conclude, because a man has no knowledge of Hebrew, that, therefore, he is innately incapable of acquiring it. The considerable success of aboriginal children in Australian schools affords a fit commentary.

464. It is often maintained that, since (as in the case already discussed of individuals) nature has caused, in different environments, the various races of mankind to differ as regards their innate physical characters, it is highly likely that it has caused them to differ as regards their innate mental characters also. But here crops up again that old and fertile source of error, the idea that the human mind is a bundle of "faculties" and "proclivities" as rigidly fixed as to the degree and direction of their growth as the various structures of a physical organ. The mind is not the homologue of an organ; it is the correlate of the functional activity of an organ, the cerebrum—an organ, which, like other organs, is limited as to its growth, but which is distinguished from all others except perhaps the hand by the enormous range and diversity of its functioning. We may compare the human mind, therefore, not to a material thing like the hand, but rather to all the movements of which the hand is capable. The whole "purpose," if I may use the term, of the evolution of the human mind has been to enable a race which lives in a very complex environment to make suitable adjustments "under circumstances novel alike to the experience of the individual and to that of the species." The brains of various races differ in size and shape, and may differ structurally in many other respects, not as yet observed by us; and these differences have possibly or probably for their concomitants mental differences of more or less importance, but it is very doubtful that these latter are of the kind commonly supposed. The mind of every man, not a microcephalic idiot, is as we have seen, much more entirely a product of his own individual past than his body.

465. I have written in vain if the reader is still unconvinced that the whole trend of man's mental evolution has been towards the creation of a great memory and of great powers of utilizing the contents of memory—of an immense faculty for recalling past events and objects, and so, by means of association, comparison, discrimination, abstraction, induction,

deduction, reaching reasoned conclusions. In vain have I laboured if I have failed to convince him that almost all man's inborn impulses to action, his instincts, have undergone regression, or have become subservient to this one great faculty. But if he is convinced, as I think he must be, for the evidence is overwhelming, then he must believe also that the different races of mankind cannot differ greatly as regards their inborn impulses. They can differ greatly only as regards their capacities for making and utilizing acquirements, and more particularly as regards the acquirements they actually do make. Possibly this or that instinct, for example, the sexual or the parental, has undergone more regression in one race than in another. Possibly this or that instinct, for example the sportive or imitative, has reached a higher stage of evolution in this race than in that. But so entirely dependent for survival during untold centuries has man been on his memory and its corollary, intelligence, that it is incredible that there can be surviving any great racial differences in instincts. Whatever instincts any race possesses are useful to every other race to a nearly equal degree. Whatever instincts any race has lost must long have been useless to every race, and therefore must have been almost, if not quite, lost by all. As a matter of fact no inborn impulse to act, nor inborn power of co-ordinating muscles for action, can be named concerning which there is clear evidence that any race surpasses any other. The infants of all races are born equally helpless, and they all develop the same instincts, apparently to the same extent. Everything, therefore, which has been written, for instance, about the wonderful instincts of the savage as compared to the civilized man has been founded on a misuse of the term instinct, on a misunderstanding of comparative psychology.

466. The brains of some races are relatively long and narrow; those of the others are shorter and wider. We are unable to say for certain what these inborn differences of shape imply mentally. Probably they imply no more than similar peculiarities of the hand imply as regards its function. A man with a relatively short hand is able to use it to much the same effect as a man with a long hand. There is no real evidence proving that short-headed men have, on that account, mental characters different from long-headed men.[1] As a

[1] A tribe of American Indians were accustomed to flatten the foreheads of their children by pressure. There is no evidence that any mental alteration resulted. Probably the shape of the brain, a soft organ, is determined by the shape of the skull, and not *vice versâ*. In

general rule the size of the brain varies directly with the intellectual power of the individual. Thus men have greater intellectual powers than lower animals, and the more intellectual races of men have usually larger brains than the less intellectual. Reasoning from the analogy of other structures of which man makes a variable amount of use, the size of the brain depends on two separate factors; first, on the amount of growth which is achieved under the influence of nutrition, a growth that occurs mainly, if not entirely, before birth; and second, on the amount of growth which results from nutrition *plus* use, a growth which occurs entirely after birth. Now man may vary innately as regards both factors; given an equal amount of nutrition, one child may be born with a larger brain than another; or given an equal amount of use one child's brain may grow more rapidly than another's. If the intellectual powers are proportionate to the size of the brain, as we must suppose they usually are, then the individual whose brain grows the more rapidly under either kind of stimulus will generally be of greater innate mental capacity than the other. But, while it is probable that the amount of nutrition which is supplied to children *in utero* is, under normal circumstances, very much the same, the amount of use to which individuals as compared to other individuals, and races as compared to other races, put their brains varies very much. Presumably, therefore, a representative Australian aborigine, educated in England, would have a larger brain than most of his compatriots; whereas an Englishman reared by Blacks would have a smaller brain than most Englishmen. It follows, since brains grow under the influence of use, and since the amount of use varies, we cannot accurately determine the innate mental capacities of the various races by comparing the sizes of their brains. However, since Englishmen long lived and were selected under conditions which more stringently demanded a high degree of intelligence than the conditions under which the Australian Blacks evolved, it is probable that under identical conditions the former would develop larger brains and greater intelligence than the latter, and that the average Chinaman would surpass both.

467. Yet another factor must be considered when we attempt to estimate the relationship which exists between

all likelihood it has no more to do with determining mental characters than the bumps on the bony surface have. On the other hand, the size of the skull is probably determined largely by the size of the brain—by the amount of growth made by the brain before the sutures close.

the size of the brain and the degree of intelligence. Brains may be developed under various forms of use. For example, a man may acquire a knowledge of classics, or mathematics, science, commerce, and so on. Presumably the most severe study would tend to develop the brain most; but the effect on the intelligence might not be commensurate. Thus Chinese statesmen are all literati; their studies are extremely arduous; their brains are large; but they are not especially renowned for wisdom. In brief terms stupidity may be acquired as well as intelligence; and it may be acquired at the cost of much labour.

468. Apart, however, from this innate capacity to make acquirements, are the acquirements actually made by virtue of it? We cannot doubt that an English child reared by Australian Blacks would make acquirements very similar to those of his educators. Indeed he could make no other. There does not perhaps exist a potential senior wrangler among the Blacks, but judging from such children of savage parentage as have been reared in civilized communities, the average Bushman can be brought under fit training to resemble closely in his mental traits the average Englishman. Except in relation to narcotics, the incapacity to become civilized is physical, not mental. It follows that by far the greater part of the mental differences between races, probably all that is observable, is due, not to innate mental peculiarities (instinct and capacity), but purely to acquirements. We have noted the extreme parsimony of Nature. Except as regards a few bi-products (*e. g.* the delight in narcotics) she evolves only those traits which are useful to the race, while she steadily eliminates all those which are useless. It is not believable, therefore, that Natural Selection can have produced such inborn mental differences between races as are meant when it is said that the Englishman is "by nature" resolute, the Frenchman mercurial, the Italian excitable, the Dutchman phlegmatic, the West African cruel, and so forth. For it can hardly be that the environment in which the English evolved has so differed from the environments in which the French, the Italians, the Dutch, and the West Africans have evolved, that survival of the fittest in the case of Englishmen has caused in them a greater evolution of resolution and the nervous structures which in that case must be correlated to resolution than it has caused in the other nations named. It can hardly be that the Frenchman is inherently mercurial because the environment of his ancestry was such that superior vivacity

caused a lesser elimination than it caused in other nations. There is no conceivable reason why phlegm in Dutch surroundings should have conduced to survival more than in West African surroundings; or why cruelty should have been more beneficial or less deleterious to the ancestors of West Africans than it was to the ancestors of Dutchmen.

469. Inborn characters evolved by Natural Selection are usually very stable; for, since they are common to the whole race, they are generally very ancient. During the course of many generations they may undergo slow evolution or regression, but they are never suddenly changed. Acquired racial peculiarities, also, may be very stable; thus language has persisted for thousands of generations, and some forms of religion for thousands of years. But acquired peculiarities differ from inborn characters in that they are *liable* to be changed for the whole race in a single generation. The best evidence, therefore, that the racial peculiarities which are commonly regarded as inborn are in truth acquired, is furnished by the fact that many races have altered their mental characters with great swiftness. Almost all civilized races have emerged from comparative barbarism too rapidly to permit of the racial change being accounted for in any other way. In a single generation the Japanese have become progressive, and the Maoris of New Zealand orderly and intellectual. In a scarcely longer period the Highlanders of Scotland underwent similar changes. For two or three centuries the Greeks were one of the most splendid races of which history holds record; within a century or two later they ranked amongst the most degraded of peoples. Much the same is true of the Chaldeans, the Assyrians, and the Romans. The Egyptians, once so great, have long been a wretched people, cowardly, effeminate, untrustworthy. Under British tuition they have again begun to show some martial capabilities. The Arabs, after an unmeasured past of stagnation, quite suddenly displayed great qualities. They overran much of the known world, founded the highest and most liberal civilization of the Middle Ages, produced a literature of considerable merit, and made very important mathematical, astronomical, and other scientific discoveries. They have since lapsed into comparative barbarism.

His facts are correct: his interpretation erroneous.

470. The clearest evidence, however, is afforded by the history of religions. A religion is, of course, a pure acquirement. Any traits that arise under its influence are also pure acquirements. For good or evil every religion is a most potent educational factor, especially if it limits the

acquisition of mental traits foreign to its own system. It covers or tinges with its influence practically the whole field of human knowledge, thought, and endeavour. In inculcates peculiar beliefs concerning the universe around, sets up a peculiar standard of right and wrong and of morals and conduct, indicates peculiar means, and sanctifies peculiar ends. Even the instincts come within its purview. The instincts for food, rest, and sleep have been the occasions of many curious *tapus*. Many religions tend to restrain the sportive instinct. In Scotland, for instance, it is considered sinful for children to develop their minds and bodies on Sunday. Almost without exception religions have restrained the instinct of curiosity,—hence the prolonged intellectual and social stagnation in which so many races have sunk. All religions have used the imitative instinct, on which all man's civilization and all his barbarism are dependent, as a means of insuring their own continuance;—hence their endeavours to direct the education of children. The sexual instinct, especially, has been under their control. A few religions have encouraged it; many have in part encouraged and in part restrained it; a few have held it in abhorrence;[1]—

[1] To "cut down by the axe of Virginity the wood of Marriage" was an ideal amongst the early Christians. Even the parental instinct was held by them in no great esteem; some saints were highly lauded for deserting their children as were others for deserting their aged parents. The suppression of almost every instinct, the destruction of human happiness and well-being on earth, and ultimately the extinction of the human race appears, in effect, to have been the principal aim of our ancestors in religion. Nothing, in fact, shows more clearly the greatness of the part played by acquirement in the human mind than the amazing and seemingly fundamental differences in mental traits between the clear-headed denizens of the Roman Republic and their near descendants, the early Christians;—unless indeed it be the mental differences between an age that revered Saint Simeon Stylites, of whom an admiring biographer recorded that "a horrible stench, intolerable to the bystanders, exuded from his body, and worms dropped from him whenever he moved, and they filled his bed," or Saint Antony who was never guilty of washing his feet, or Saint Euphrasia who joined a community of one hundred and thirty nuns all of whom shuddered at the thought of a bath, or that austere virgin Silvia who at sixty years of age, though suffering from a sickness caused by her habits, refused on religious principles to bathe any part of her body except her fingers, and an age that reveres Galileo, Newton, and Darwin, believes on the whole that cleanliness is next to godliness, and treats religious mania in a mad-house. The decline of Greece and Rome has been attributed by those writers who are inclined to believe almost every human characteristic is inborn to an inrush of mentally inferior aliens. It would almost seem as if they thought that the Greeks and Romans had left no descendants. But even if it be admitted that the classic races were swamped, the mystery is, if anything, deepened. If their peculiar

hence the extraordinary variety of sexual customs in the past and the present. The parental instinct, also, has often been under the direction of religion.

471. The special advantages which a comparative study of religions offers to an inquirer in heredity arise, first from the fact that in past times many races have very rapidly changed their religions; second, from the fact that in several instances many diverse races follow the same religion; and, third, from the fact that sections of the same race sometimes follow diverse religions. One outstanding fact greets us at the beginning of our inquiry;—all communities that have any given religion in common have also mental characteristics so much in common that the resulting state of society in any one of the communities is such as is more or less common to all the other communities;—in other words, they have a nearly similar civilization, attain to a nearly similar level of prosperity and enlightenment, exhibit a nearly similar degree of respect for law and order, are nearly equally progressive, and so on. Of the truth of this there is unlimited evidence; for throughout the world whatever community of whatever race in whatever climate professes a given religion, it has invariably a state of society nearly similar to that of all the other communities professing the same religion. Other educational influences, of course, may modify the civilization which is associated with any religion, but so great, so dominant, is the influence of the latter that in all cases the modification is surprisingly slight.

472. The example of modern Mahomedans, since they include within their ranks a great number of races, dwelling in a variety of climates, under very diverse physical conditions, admirably illustrates the argument. It is manifest that the Mahomedan civilization, the Mahomedan mind, is

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characteristics were inborn, what process of Natural Selection had previously caused, in quite a short period, the inhabitants of a few small towns in Greece and Italy to evolve mentally so far beyond the people of the surrounding areas? What process of Natural Selection has caused the modern descendants of the stupid aliens to become mentally so superior to their forefathers of the Dark Ages? In the time of Queen Elizabeth the superiority was a very sudden and recent affair in England. It is still a somewhat recent affair in some of the awakening communities in the South of Europe. Who can doubt that the change is dawning in the East of the Continent? A few generations more and when we scratch the Russian we shall no longer find the Tartar. The philosophy which attributes the mass of racial peculiarities to innate qualities, and not to mere acquirement, is, in effect, a philosophy which attributes evolution to miracle and not to orderly processes of Natural Selection.

everywhere much the same. The Malay of the Eastern Archipelago is about as high in the scale of civilization, but no higher than the Moor of Fez, the Turcoman raider in Siberia, or the Arab slave-dealer on the Congo. All these widely-separated peoples of such diverse races have much the same degree of prosperity and enlightenment, and practically they all think alike. Being under the influence of a dominant educational factor, their acquired knowledge and acquired impulses, their modes of thought and motives for action, and the state of society resulting therefrom are much the same. The Turks alone have received a thin veneer of the civilization of the Christians. Forced by the exigencies of their position, they have adopted the quick-firing rifles, the big guns and the ironclad ships of their Western neighbours. But everything they have in excess of other Mahomedans is imported, purchased by the superior command of money, which the extent and populous condition of their territories bestows. At the bottom the Turks remain the men that Mahomet made them; and if the pressure of Christian civilization were removed they would lapse back to what they were in the days of Osman. All the swarming millions of the Buddhists think and act much alike to one another, but differently from the peoples of other religions. Their strange civilization is unlike all other civilizations, and their various communities have about an equal degree of prosperity. The same is true of the Hindoos, and the adherents of all other religions.

473. We have here a law of civilization so uniform in action that it has all the force of a natural law; namely, that a civilization or state of society invariably conforms to the religion with which it is associated, and that quite irrespective of race. The degree of civilization achieved is, in fact, the sum-total of the progress permitted by the associated religion, which, in most cases, sets such limits to further progress as cannot be passed unless the religion first be abandoned or modified. Thus a believer in Fetishism cannot be other than savage; he cannot achieve a higher civilization unless he first eliminates the principal cause of his degradation, his beliefs with their associated moral and social codes. No doubt just as the action of a natural law is modified by external causes, as, for instance, the action of the law of the expansion of gases may be modified by pressure, so the action of a law which connects a civilization with a religion may be modified by the pressure of other civilizations. In all cases, however, the change is more

apparent than real. It consists rather in the acceptance of the material products of the modifying civilization than an acceptance of the civilization itself. Thus the Turks borrow our big guns, but not our ideals; our ironclad ships but not our enlightenment. A change from a lower to a higher civilization consists in fact and in essence of a mental not a material change. There must be an increase of knowledge, and not only that, but, more especially, a modification in the mental *tone*.

474. The supreme importance of the mental tones acquired under the influence of religion is extremely well shown in the case of conquered nations. To take again the example of the Mahomedans: all those nations, which were conquered by them and which adopted the Mahomedan religion, now possess the Mahomedan type of mind, and with it the Mahomedan civilization; but those which did not adopt the religion remain mentally distinct—for example the Armenians, most of the Hellenes, the Bulgarians, Servians, and Roumanians. In India, Mahomedans contrast sharply with Hindoos, and in Central Asia with Buddhists.

475. Many Teutonic invasions, Norse, Danish, Saxon, English, have penetrated Ireland. A large portion of the aboriginal Celts were displaced or exterminated. The earlier invaders adopted the Roman Catholic religion. They cannot now be distinguished from the natives in common with whom they have the so-called Celtic temperament. The last invaders were Protestants. They are easily distinguishable, being eminently "Teutonic" in mind. Indeed, in journeying through Ireland a glance from a carriage-window is almost sufficient to discover, by the evidence of material prosperity, whether the district is orthodox or heretical. Much the same is observable in Switzerland. In Russia the neatness and prosperity of the Lutheran villages as compared with the poverty and neglect which characterize the Greek Church communities affords plain and striking evidence of mental differences. The departure of the industrious and progressive Huguenots to England seriously crippled France in her struggle with the rival power. It left her poorer by the loss of wealth-giving resource and energy.

476. History affords numerous examples of races changing their characteristics, and with them their civilization. In almost every case the change was associated with a change in religion; in the remaining cases it was associated with a change in mental training which was equivalent to a

change in religion. For instance, much of Asia Minor and Northern Africa anciently held the pagan Roman religion, and possessed the splendid, tolerant, enlightened, extremely material Roman civilization. Subsequently the inhabitants became Christians in the primitive sense of the word, producing vast numbers of hermits and other ascetics, and such celebrated saints as Athanasius and Augustine of Hippo, all of whom taught the scorn of earthly happiness. Their civilization became typical of the early Christians. Lastly, they were converted to Mahomedanism; and since then their civilization has been typically Mahomedan. We have here an example of many races being forced into a uniformity of mental characteristics, and, therefore, of civilization, progress, wealth and enlightenment by a religion held in common. The Negroes of the present day furnish us with an example of a single race professing several religions, and possessing many different civilizations. Allowing for other educational influences, such as comparative freedom, prevailing superstitions, and social standing, the black Methodists and Baptists of America differ remarkably little mentally from their white co-religionists, but markedly from the Catholic Negroes of San Domingo, who resemble in many of their characteristics the whites of South America; while the Mahomedan Negroes of Africa are typical Mahomedans—fierce, fanatical, predatory, jealous of their women, non-progressive as compared with Christians—differing greatly in turn from their neighbours, the pagan Negroes, whom they easily subdue.

CHAPTER XXIII

METHODS OF RELIGIOUS TEACHING

The ways in which religions mould character—Dogmatic and rational teaching—The mental uniformities and divergencies caused by religious sects—The mental characteristics of the Greeks and Romans—Of the Early Christians—Of Christians during the Dark Ages—Of Heretics—Progress—Enlightenment—The proportion of great men.

477. A RELIGION exerts its mental influence in two ways. First, it teaches certain doctrines—certain beliefs concerning the environment, a code of morals as a guide to conduct, a ritual, and so on. Secondly, it teaches its doctrines in a certain way. The doctrines of all religions differ more or less; but all religions have this in common—they are never founded on data which are known to be true (*i. e.* on verifiable evidence). This does not imply necessarily that the doctrines they teach are untrue. It implies only that the moment a fact has been verified it passes from the category of "religious truth" into that of ordinary secular knowledge, which, when systematized, we designate science. For its acceptance an "act of faith" is then no longer needed. If the doctrines of a religion are true, they *may* be no bar to the advancement of knowledge. If they are false they may be terrible obstacles. It is because the adherents of every religion have, at one time or another, strenuously upheld untrue beliefs that the world has seen the conflict so prolonged and discreditable between religion and science. As already noted, a man who believes in such doctrines as those of Fetishism, upheld in the way such doctrines generally are, must be a savage. His mind is so filled with the untrue, so fortified against the true, that there is no room for the latter unless the first be ejected.

478. But, from the standpoint of progress and civilization, the doctrines of a religion, whether true or false, weigh in

the balance as nothing compared to the way in which they are taught, for it is possible so to teach true doctrines as to make them intellectually disastrous to the recipient; and so to teach false doctrines as to render them intellectually beneficial—or, at any rate, not nearly so disastrous as the truth may be made. Suppose I tell my child that the earth is flat, and succeed in surrounding him with influences which raise in his mind a prejudice in favour of that belief so strong that he will ever after be impervious to rebutting evidence, and will, in fact, regard all such evidence with abhorrence. The thing has been done, and may be done again. Then all people, who have been trained similarly and who, therefore, agree with him, will describe his frame of mind as one of "simple faith" or "steadfast faith," or by some such eulogistic expression. People trained according to the same method, but in a different though perhaps equally absurd belief, will be less complimentary, as will be those who know on positive evidence that the world is round. Now since in this particular I shall have abolished the child's splendid human power of learning and thinking, since I shall have rendered him as incapable of profiting from experience as a purely instinctive animal, his mental condition will evidently be one of extreme stupidity. A human being cannot be made stupid in compartments. If he acquires a vicious habit of thought in one thing, he is liable to apply it to other things. The main injury that I shall have done my child, will be due, therefore, not to the untrue doctrine, but to the way in which I taught it. Had he been educated by a better method, he would soon have discovered and repudiated the untruth. His mind will have been more than burdened by an untruth. It will have been enfeebled and shackled.

479. But now, suppose I taught him that the world is round, but still by the old vicious method. Then I shall not have loaded his mind with an untruth; but I shall put chains on it nevertheless. I shall have equally limited his power of learning and thinking. He will hold the truth as he held the falsehood, as a mere superstition, a prejudice. I take it that a superstition is not necessarily an untrue belief. It is a belief, true or false, held in a certain unreasoning, unintelligent way. So far as any man holds a belief in this unreasoning way he limits his power of learning and thinking. If his mind be loaded and limited on all sides by a multitude of superstitions and prejudices he will of necessity be very stupid, very incapable of learning and thinking. The epithet is opprobrious; but I do not know how else to describe an

incapacity to revise erroneous beliefs and opinions by the light of fresh and perhaps conclusive evidence. A man can seldom be made stupid without being made brutal also. When masses of men are stupid they are invariably brutal. On the other hand, if I teach my child that the world is of this or that shape, giving data and conclusions in such a way as to leave his mind capable of future acquisition and thought, I shall have greatly enhanced the intellectual value of the truth or greatly minimized the evil of the falsehood. His belief, true or false, will no longer be a superstition, a prejudice, but an intelligent conviction, capable of revision, and worthy of the wonderful human intellect. He will not only have acquired knowledge, but also that without which knowledge is useless, the power of drawing rational inferences, from data which he verifies habitually.

480. The question whether the doctrines of any religion are true or false lies outside the scope of our discussion. We are endeavouring merely to ascertain the origin of racial differences. The method by which any religion is taught, of necessity a human invention, lies within its scope. Judged from the intellectual standpoint, it may be a good or bad method. By means of it are produced in a great measure those mental uniformities which the adherents of any given religion display when compared with another, and those mental divergencies which they display when compared with the adherents of other religions—mental uniformities and divergencies which are commonly supposed to be innate, but which in fact are acquired. If a religion be taught in such a way as to leave the minds of its adherents ductile to fresh experience, then that religion, however false, will be, at any rate, no permanent instrument of human degradation. Its false doctrine will presently be discovered and repudiated. Its true doctrine will not any the more be denied because held by an intelligent race; and the advance of knowledge, possible under such conditions, may ultimately confer on them the high distinction of removal from the category of things *believed* to be true to the category of things *known* to be true. A religion taught in this way will be associated with a changeful and progressive civilization in which many great men arise, for supreme intellect will have scope and ordinary minds will be receptive. If, on the other hand, a religion be so taught that its doctrines are held as mere superstitions, then, whether true or false, it will become an instrument, the most potent conceivable, of human degradation. It will surround and limit the minds of its adherents by an

almost impenetrable wall of prejudice. It will inflict on them premature mental senility, for in all things which fall within its range the minds of the young will be rendered almost as incapable of acquirement as those of the aged. It will be associated with a state of society stagnant and inefficient, and because inefficient, corrupt. Few great men will arise under its influence, for genius, having little scope, will be stunted, and ordinary men will be nearly as non-receptive as insects. To be great in any useful sense it is not enough that the worker should possess great powers which he uses greatly. It is necessary also that his great achievements should be recognized and appreciated by his compatriots. Newton would have been ignored during the Dark Ages, Darwin would have been burnt.

481. The incalculable stupidity which may result from vicious methods of teaching is well illustrated by the fact that for ten or twenty centuries the adherents of two rival religions, only one of which can be true, will dwell side by side, and dispute acrimoniously the whole time, and yet be unable to come to a common understanding by the mutual elimination of error. I imagine that no sincerely religious man will deny the existence of this excessive mental inertia. If he will not admit it as regards the members of his own sect, he will at least admit it as regards other sects, the adherents of which, as he conceives, are prevented only by lack of intelligence from perceiving the truth which to him is so clear. The ecclesiastics of every religion hold the same beliefs as the laity; but they are much more thoroughly trained dogmatically. They are supposed to be learned and wise, and to have the best intentions. Yet notoriously of all men they are the least open to the influence of fresh evidence no matter how conclusive it may be. For instance, it was not till the truth had been known for centuries that the majority of European ecclesiastics admitted the spherical shape of the world. Here, therefore, it was not the doctrines, but the way in which they were held, that was the principal obstacle to the advancement of knowledge.

482. For the purpose of our discussion we will assume that all the doctrines held at the present day by reasonably cultured Christians are true. It follows that there should be much truth in the kindred religions of Judaism and Mahomedanism, and even some truth in Buddhism. But in the ancient Pagan religion there can have been little truth. It is agreed, indeed, on all hands, that the doctrines of the latter were false. Its gods were merely mythical human

beings of exaggerated proportions and powers, endowed with immortality, but cursed also with human lusts and weaknesses. Its doctrines, therefore, can have had no very elevating influence on its adherents. Nevertheless in conjunction with it arose, in quite a short time, civilizations memorable for the splendour of their achievements in almost every branch of human endeavour, for a lofty and unselfish patriotism, a noble literature, a profound philosophy, a wonderful practical genius and enterprise; memorable for ever also for multitudes of great men who were rewarded with a quick and generous appreciation, so that even in early manhood they obtained influence and were able to devote their powers when at the best to the service of the State.

483. Now the splendour of the Greek and Roman civilizations cannot have been due to innate racial qualities, for both the rise and decline of the classic races was much too rapid to permit of this explanation. Besides, we are able to think of no process of Natural Selection which could have differentiated the Greeks and Romans of the classic period from their predecessors, contemporaries, and successors. It cannot have been due to the doctrines of the Pagan religion, for, as we see, there was nothing especially stimulating about them. The doctrines, indeed, resulted from the spirit, the "genius," *the acquired mental traits* of the people. It can have been due, therefore, only to the fact that, by a fortunate accident, the Pagan religion permitted a magnificent system of mental training to its adherents. With the limited knowledge of the environment possessed by the ancients the explanation of natural phenomena offered by their religion was as good as any other, and for that reason, since there was no rejection of verifiable evidence, it did no great intellectual harm. No doubt, as in the conspicuous case of Socrates, its doctrines were sometimes employed as weapons against the full exercise of the human understanding, but, as compared to most other religious systems, to a minimal extent.[1] The decline of the Greeks and Romans was no

[1] "Among the ancients, although the methods of inquiry were often very faulty and generalizations very hasty, the respect for the honest search after truth was widely diffused. There were, as we have already seen, instances in which certain religious practices which were regarded as attestations of loyalty, or as necessary to propitiate the gods in favour of the State, were enforced by law; there were even a few instances of philosophies, which were believed to lead directly to immoral results or social convulsions, being suppressed; but, as a general rule, speculation was untrammelled, the notion of there being any necessary guilt in erroneous opinions was unknown, and the boldest inquirers were

doubt due to the influx of aliens; not, however, because the aliens brought an infusion of inferior blood, but solely because their presence resulted in a change for the worse in the mental training of the youth. The scanty scientific knowledge of the time left the great Pagans, as in the case of ignorant people at the present day, susceptible to the influence of superstition. With the aliens from the East came a multitude of creeds of which the most conspicuous features were mystery not explanation, superstition not reason and clear thought; creeds that had associated with them, therefore, a system of mental training that left the mind cribbed, cabined, and confined, walled about by beliefs held as unintelligent prejudices. This process of mental degradation may be clearly traced in the history of the declining Greeks. It may be traced even more clearly in the latter pages of Roman history, for here we have very copious evidence. It began, in the latter case, before the advent of the Christians with the worship of the Egyptian deities Isis and Serapis, and the wide spread of other mystic religions. But it cannot be doubted that the form taken by early Christianity, the mental atmosphere in which it trained the youth, was largely responsible for the downfall of the highest civilization the world had yet seen.

484. "The energies of Christendom were diverted from all useful and progressive studies, and were wholly expended on theological disquisitions. A crowd of superstitions attributed to infallible wisdom, barred the path of knowledge, and the charge of magic, or the charge of heresy, crushed every bold inquiry in the sphere of physical nature or of opinions. Above all, the conditions of true inquiry had been crushed by the Church. A blind, unquestioning credulity was inculcated as the first of duties, and the habit of doubt, the impartiality of a suspended judgment, the desire to hear both sides of a disputed question, and to emancipate the judgment

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regarded with honour and admiration. The religious theory of Paganism had in this respect some influence. It was eminently poetical, eminently patriotic, and eminently tolerant . . . the notion of many distinct groups of gods led men to tolerate many forms of worship and great varieties of creeds. In that colossal amalgam of nations of which Rome became the metropolis, intellectual liberty still further advanced; the vast variety of philosophies and beliefs expatiated unmolested; the search for truth was regarded as an important element of virtue, and the relentless and most sceptical criticism which Socrates had applied in turn to all the fundamental propositions of popular belief remained as an example to his successors." (Lecky, *History of European Morals*, vol. ii., pp. 189–90.)

from unreasoning prejudice, were all in consequence condemned. The belief in the guilt of error and doubt became universal, and that belief may confidently be pronounced to be the most pernicious superstition that has ever been accredited among mankind. Mistaken facts are rectified by inquiry. Mistaken methods of research, though far more inveterate, are gradually altered; but that spirit which shrinks from inquiry as sinful, and deems a state of doubt a state of guilt, is the most enduring disease that can afflict the mind of man. Not till the education of Europe had passed from the monasteries to the universities, not till Mahomedan science, and classical freethought, and industrial independence, broke the sceptre of the Church, did the intellectual revival of Europe begin."[1]

485. The idea that Christianity, or rather that Christians, should have ever played a part so degrading intellectually is repugnant to the sentiments of most modern votaries of the faith—as repugnant as a similar charge against their religious systems would be to Buddhists or Mahomedans. But it is not realized by them that a constant struggle is being waged at the present day by all the most enlightened and progressive of societies against the very tendencies that were most conspicuous in the mental training of the early Christians. A mental atmosphere which produced in immense numbers people of the type of St. Simeon Stylites, could not otherwise than result in the state of society which then prevailed. A wave of real insanity spread over the ancient world, and so affected the minds of its inhabitants, that a modern physician could not have distinguished mania due to inborn mental defect from that which resulted from the ordinary training of the day. But that this insanity was not a necessary accompaniment of Christian doctrines is evident from the fact that some modern Christian communities equal and even surpass in many respects the Greek and Roman. The minds of most moderns, it is true, are not as yet so well trained as those of our wonderful predecessors, and therefore, in proportion to population, we produce fewer great men, and are much more tardy and grudging in our recognition of them. In other words, our training leaves us less receptive. On the other hand, knowledge of physical science has advanced so far that we are much less open to the assaults of alien superstitions; while the industrial nature of our civilization has enabled us to invent invincible weapons of war which can be manufactured and used with

[1] Lecky, *History of European Morals*, vol. ii., p. 206.

the greatest effect only by the most enlightened societies. Our civilization and progress, therefore, have elements of stability which were lacking in the ancient world. Our less enlightened societies are compelled to take their tone from the more enlightened. Paradoxical as it may sound, so long as there is danger of war so long must our progress be maintained.

486. Under quite different religious systems the effects of mental training similar to that which the early Christians received may be seen in many modern lands. They are conspicuous in Thibet. Witness the prolonged stagnation, the intense stupidity which arises from an almost brute imperviousness to new ideas, the extreme credulity as regards matters of mystery, the foolish scepticism as regards matters of fact, the resulting low standard of efficiency, the lack of great thinkers and men of action, the widespread degradation of public morals, the brigandage and general lawlessness. In states of society similar to that in which arose St. Simeon Stylites, arise the mad ascetics of India and Arabia, and the ferocious fanatics of Afghanistan, Morocco and the Soudan.

487. The final overthrow of Rome was due to foreign conquest; but the decline of Rome had set in long before, and without that decline the fall would not have occurred. The barbarian conquerors were all converted to the prevalent form of Christianity; whereupon they lost, so far as we are able to distinguish, the most of their own characteristics and adopted those of the early Christians. A drear uniformity of mental type spread all over Europe. Frantic asceticism was mingled with savage indulgence. Superstitious reverence of ecclesiastical power was mitigated only by the occasional murder of ecclesiastics. War was the normal condition of every nation. Civil strife was seldom, and brigandage never, absent from any Christian country. Millions of heretics who advocated the doctrines we now maintain perished by the sword, and thousands more by torture. Untold numbers of helpless and feeble-minded old women were burnt as witches. A religion which had become a sheer superstition entered into and restricted every field of thought. No man could have new opinions in faith but he was denounced as unorthodox. No one could make new discoveries in many branches of science but he was condemned as a heretic. No one could invent in mechanics or investigate in chemistry but he was liable to be tortured as a magician. All science, all accurate scientific habits of thought were rendered impossible.

488. At length after this prolonged period of intellectual

darkness and degradation the bonds on the human mind slowly loosened. Men began to read again the long-neglected works of the Greek thinkers, and thereupon a new life stirred in the ashes of civilization. Wycliffe, Luther and others appealed from the Church to the Bible. No event in the history of the human intellect had results more momentous. It conferred on every man the right and the possibility of private judgment. The old stagnant atmosphere gradually disappeared. Men began to think otherwise than by rule like so many beetles. At first the reformers, as yet unreformed, were as intolerant as the orthodox. Witness Luther's denunciation of Aristotle—" truly a devil, a horrid calumniator, a wicked sycophant, a prince of darkness, a real Apollyon, a beast, a most horrid impostor on mankind, one in whom there is scarcely any philosophy, a public and professed liar, a goat, a complete epicure, this thrice execrable Aristotle." Witness the murder of Servetus by Calvin. Witness the persecutions of Catholics and rival Protestant sects. But the power, and with it, the habit, the tradition of being intolerant, soon passed from the Reformers. Since many divergent minds studied a book in which there were numerous obscure passages, many divergent sects arose. Where all were at variance none could be persecuted. In the clash of opposing sects religious persecution and a uniformity of prejudice became impossible. Thus a new mental atmosphere developed. Man now approached religion with something of the spirit of the old Greeks. Fundamental and unambiguous doctrines were not repudiated by the mass of the people, any more than they had been by the Greek populace; but every man thought more and more for himself. The real change, therefore, was in the mental training. At length it had become possible for Christianity to associate itself with a high and progressive civilization. At last a year of Europe had become better than a cycle of Cathay.

489. We are told sometimes that the Church, which insisted on a uniformity of prejudice, exercised a softening and civilizing influence during the Dark Ages. The intense rancour, the constant mendacity and unfairness, the often insane ferocity of ecclesiastical contention is a sardonic commentary on this humorous statement. Probably in all history there is no instance of a society in which ecclesiastical power was dominant which was not at once stagnant, corrupt, and brutal. At the present day every community and every section of a community is lawless and non-progressive in exact proportion to the intellectual authority—not

influence—exercised by its Church. The phenomenon is a universal one, and may be observed equally amongst the adherents of non-Christian religions. Moral precepts, however excellent, are seldom effective and never long effective, when opposed to the deeper influence of a limitation of thought. The type of mind created wages successful war against them. Those apologists who attribute the violence and cruelty of mediæval churchmen to the spirit of the age do not realize that the spirit of every age is always largely the product of the contemporary religious teaching.

490. Immediately after the Reformation every heretical nation began to surpass its orthodox rivals. Of professedly orthodox communities the most progressive were, as they are still, those which contained the largest leaven of heretics. Multitudes of great men arose among the unorthodox, especially at first when the activity of thought was greatest, as in our own Elizabethan age. Internal peace and order were evolved out of the original chaos; civil wars and conspiracies grew rare. Political liberty widened, not only because the growing intelligence of the people demanded power, but because their greater reasonableness, their lessened savagery, rendered the possession of power no longer a signal for rapine.[1] A community such as that which now inhabits the United States of America would not for a week endure the autocratic government of Russia; but the danger to the rulers of surrendering power would be infinitely less in America than in Russia. In the former they would, probably, be pensioned, in the latter murdered. An autocratic government is a natural and practically inevitable accompaniment of orthodoxy; democratic government of heresy.

491. If the reader even now thinks that the distinctive facial characters which we commonly observe are mainly inborn, not acquired, let him consider the present situation in Christendom. Christendom is divided between three great sects, two of which are orthodox, the third heretical—that is, in two the Church maintains its authority over the minds of its adherents, whereas, in the third, authority of the Church, or rather of the multitude of Churches, has been transferred to a book on which each man exercises his intelligence. During the last century almost every orthodox

[1] Our laws, too, have grown milder. Formerly men were executed for many trivial offences; now even the convicted murderer is sometimes permitted to escape death. It is commonly assumed that legislators have become less ferocious. But this is not the whole truth; criminals have become more amenable to mild laws.

community has suffered from frequent civil war. Russia, with its Polish rebellion, is the principal exception, but there the power, not the will has been wanting; for conspiracies against the government are more common in Russia than elsewhere. Civil wars have become extremely rare in heretical countries. As regards foreign war heretical nations have almost invariably vanquished orthodox nations. Almost every orthodox community is ruled by a police, organized and armed on a military basis; heretical communities generally by one on a civil basis. The amount of violent crime, especially murder, is much greater in all orthodox than in any heretical communities. It is greatest among the most orthodox. Where the orthodox mingle with the heretical the same proportion of crime is maintained. Under such conditions, moreover, as a rule which has few exceptions, the heretical, owing to their greater efficiency, are the more successful in the battle of life. They occupy the more lucrative and authoritative positions, the orthodox becoming the hewers of wood and drawers of water. In every great city, whether in the Old World or the New, where the orthodox and the heretical mingle, the former comprise the poorest class. Until very lately, when heresy has spread widely in orthodox lands, and the pressure of heretical civilization is universally felt, almost every mountain range and forest tract in orthodox Europe had its band or bands of brigands. Brigandage has been very rare among settled heretical communities. Orthodox parliaments generally present scenes of violence and disorder; the proceedings of heretical parliaments, on the other hand, are generally orderly except when disturbed by a band of the orthodox; in which case the latter usually quarrel fiercely among themselves. The dying and dead nations of Europe are all orthodox; the rising nations are all heretical. The education of the youth in schools is more thorough and rational among the heretical. During the last century and a half the progress of the civilized world has been very rapid. This period, which has been that of the greatest heresy, of the greatest intellectual freedom, has been unusually prolific in great men—men, good or bad, who have towered over their contemporaries and achieved world-wide fame—statesmen, naval and military heroes, scientific men, philosophers, historians, poets, novelists, explorers, engineers, inventors, accumulators of wealth, thinkers and men of action of all sorts. If the reader will put down this volume for a few minutes and try to recall to mind as many as possible of the men of transcendent achievements, who during the last four or five generations have won enduring fame by virtue of genius, not by mere possession of place, he will find that, with hardly an exception, they have been heretics—either members of regular heretical communities or seceders, declared or actual, from orthodoxy. Amongst the latter have been Voltaire, the men of the French Revolution, Napoleon and his marshals, Cavour, Garibaldi, Gambetta, Renan, Zola, de Lesseps, Tolstoy. Evidently, therefore, while genius is not confined to any race, its manifestation is almost exclusively restricted to the heretical. Amongst Buddhists, Mahomedans, and Hindoos, whose intellectual freedom is even less at the present day than that of any Christian community, great men in any real sense of the word are practically unknown, Their prominent men are generally fanatics—brutal leaders of a brutal and foolish crowd. Japan is an apparent exception. But, with her awakening Japan became intensely heretical, as may be judged from the fact that she sent a commission round the world to discover the best form of religion. In their newly-acquired mental daring, enterprise, originality and activity, the Japanese resemble the Pagan Greeks much more than do other Eastern peoples or the nations of mediæval Europe.

492. We have attributed the mental differences shown by the followers of different religions largely to methods of mental training. This explanation will be very unpalatable to many people. The only alternatives, however, will be more unpalatable still. These alternatives, as we have seen, are the hypotheses that the mental differences are due (1) to differences in doctrines, or (2) to inborn racial differences. The first presupposes that the doctrines of orthodox sects are inferior (*i. e.* less true, and therefore less adaptive) to those of heretical sects. But on this hypothesis the Christian religion must be more untrue than the Pagan; and since the mental differences between heretical and orthodox Christians is very great, the difference between their doctrines should also be very great. This is patently not the case; the doctrines professed by all Christians are fundamentally alike. I for one cannot believe that the South Irishmen and Spaniards are less law-abiding, enterprising and progressive than Scotchmen or Germans, merely because the former believe in such things as purgatory, whereas the latter do not. The second hypothesis presupposes that innately inferior races choose orthodox religions. The difficulty then arises of explaining why races, which are now heretical and superior, were formerly orthodox and no whit superior. Moreover, as

already indicated, the changes in mental characters were too rapid to be innate.[1]

493. Clearly, then, racial mental characteristics are determined much more largely by training than by inheritance. Races are merely aggregates of individuals. It follows that individual characteristics are as largely determined by training. Religion plays a very important part in training, but not, of course, an exclusive part. The educational influences operating on the youth of every race are multitudinous in number, and differ with every country, even with every district and class. But, for reasons already given, we are able to judge the effects of religion more easily than that of other educational influences. From the fact that this one educational factor exercises an influence so far-reaching on the mental characters of the race and of the individual, we may judge how profound must be the influence of the sum-total of educational influences. In the human being education counts for very much; race counts for comparatively little. But this does not imply that individuals and races do not differ in innate peculiarities. It implies only that innate peculiarities are so dominated and concealed by acquirements that their detection, with any degree of certainty, is almost impossible.

[1] It is a misfortune of all religions that their authoritative exponents are, with few exceptions, old men, comparatively incapable of mental acquisition, and, therefore, of change. Consequently during times of intellectual advance all religions tend to succumb to a disease of senility. The methods of exclusive intellectual training adopted by orthodox sects help in this, and are intended to keep their adherents within the fold. Amongst barbarous and illiterate peoples such methods may be very effective. They are disastrous to the sect when applied to more civilized communities. "Infidelity" is comparatively rare amongst heretics, as in Great Britain and America. It is now almost the normal condition of educated men in the majority of orthodox communities. Where heretics and orthodox Christians are mingled together the rate of increase of the former is usually the greater. The quite fatal weakness of extreme orthodoxy in these stirring days is the low grade of intelligence it develops or permits. Intelligent men tend to desert it, not necessarily because its doctrines are demonstrably untrue, but because they cannot breathe the mental atmosphere which its authorities with characteristic crassness insist on creating.

CHAPTER XXIV

METHODS OF SCHOLASTIC TEACHING

The evolution of the hunting instinct—The reason why labour is unpleasant—The formal education of the lower classes—That of the higher classes—Classical teaching—The decay of the patrician classes—Scientific teaching—Artificial aids to memory and the reasoning faculty—The teachings of the principles of heredity—The training of medical men.

494. SCHOLASTIC as well as religious methods of teaching may confer on races and classes mental characteristics which have all the appearance of being inborn. We have seen how the infant instinctively trains himself physically and mentally, and how, when older, the child continues this process. His imitative instinct having come into play, he "forms" himself on the model of his companions, juvenile and adult. Later his parents, taking advantage of his vast receptive powers, begin his formal education. The first, the instinctive part of his education, presents common features the world over. All children delight in play and instinctively choose such games as will develop their powers. Doubtless, however, different games produce mental differences which subtly mould the characters of individuals and races. To the second, the formal part of his education, the child's instincts are frequently opposed. Hitherto he has *played;* now he must *work*. This formal education differs greatly in different regions of the world and in different sections of the community, and always it is most opposed to the child's instincts amongst civilized communities. For man has not evolved into a civilized being; he has merely developed into one. The change in him consists solely or principally in a change of mental acquirements, not in a germinal change. He transmits his civilized habits by tradition, not by inheritance.

495. While the ancestral brute was evolving into the human being, he became carnivorous and gained his subsist-

ence in part by hunting other animals. The instinct to hunt, therefore, was evolved in him. His work was a form of sport, and consequently was delightful, as it remains to the civilized man—as delightful as their instinctive activities to lower animals. But later when man discovered other and surer means of gaining subsistence, such as agriculture, he was prompted to exertion by no instinct, but only by intelligence. In labour, therefore, apart from the chase, man feels no instinctive delight. He works only because he must, or because he *acquires* a love for work through interest in its results.

496. As civilization advanced, the divorce of labour from instinct became ever more complete. It would be difficult to devise anything more entirely opposed to the child's instincts than much of the school-room education of highly civilized races. Probably no child can be otherwise than somewhat miserable when at his lessons; at any rate, he is not so happy as when pursuing his instinctive sports. But there are degrees of misery. The child's instincts of curiosity and imitativeness remain as aids to his teacher. If by means of them he can arouse his pupil's interest, his own task will be rendered easier and the child's lot less unhappy. Work will then become in some measure a form of play. In some measure it will be founded on instinctive activity.

497. The formal or scholastic education of children has undoubtedly improved, especially of late years, in many civilized communities. Formerly, particularly during the Dark Ages, it consisted mainly of a cramming of the letters of the alphabet in their assigned order, followed by a cramming of one, perhaps two, dead languages. Concurrently the child was crammed with the "mysteries" of religion. From first to last his memory was outrageously taxed, while his intelligence, his thinking power, was allowed to lie fallow, or positively injured. This system of education was fundamentally similar to that which now obtains in China, and even more closely resembled that followed by the Hindoos who have Sanscrit for a dead language. Where no other form of scholastic instruction is given concurrently it is invariably associated with a stagnant civilization, in which literary education is practically limited to the wealthy and priestly classes, and literary production is small in quantity and poor in quality as in contemporary Asia or mediæval Europe.

498. In England the improvement has affected especially the working classes. Until lately, indeed, they had no school-room education. To-day trained teachers instruct the

children, whose dawning intelligence is expanded by Kindergarten and object lessons. Their subsequent education pursues an equally rational course. So strong is the interest aroused by some elementary teachers that I have often heard working-class children greet holidays with regret. Moreover, the education is practical; the knowledge acquired in school links up with the interests of adult life, so that the individual rarely forgets much of that which he has learned in the class-room. We see the result in the growing intelligence, the lessened brutality of the hand-workers; in the fall of the crime-rate; in the intellectual and moral improvement manifested by soldiers and sailors, who we are told are enlisted from the lowest classes. As compared to his progenitors the modern workman has a greatly improved set of mental acquirements. Because more intelligent he is more civilized.

499. Improvement is less marked in the education of the higher classes. I suppose no healthy child exists among them but detests most of his lessons. Their instructors, from the nursery governess to the university tutor, are seldom trained to teach. Both the subjects taught and the methods by which they are taught seem purposely designed to inflict the maximum of labour, boredom, and suffering, while obtaining the minimum of desirable results. All formal education should have two main objects—to impart useful information, and to create a right tone of mind. Information that is obviously useful is imparted mainly at the beginning and at the end of the period of instruction. The very young child of the upper classes learns to read and write and acquires the rudiments of mathematics. The nearly grown boy or the young man devotes his time to acquiring the special information which will fit him for his chosen walk in life. Between the two periods is an interval of eight or ten years during which the main endeavour is to form the mind, to develop the thinking faculties. If the lessons by means of which we seek to expand the reflective powers impart at the same time useful information, it is of course so much the better.

500. Two principal methods of intellectual training are advocated at the present day, the classical and the scientific. The first has been in use for hundreds of years. The second was anciently practised and has now again come into vogue. They cannot both be employed for the same individual with advantage, for the classical method, if pursued with any thoroughness, makes too great a demand on the available time. Moreover, the habits of thought engendered are incompatible.

501. Now, whether the classical method be good or bad, one thing concerning it is certainly true; it does not in the remotest degree resemble the mental training received by the Greek and Roman youth. It is classical only in the sense that the languages, the systems of verbal signs in which instruction is given, are the same as those in which the ancients expressed their thoughts. The ancients acquired a perfect knowledge of their systems of signs colloquially through the natural exercise of the very young child's imitative instincts—a method quite different from and very much superior to that employed by the modern school-boy, who toils in misery at his desk for years and yet gains only a very rudimentary knowledge. In the one case, there was no exceptional strain on the memory and its contents linked up with the experiences of adult life; in the other, the strain on the memory is immense, but the knowledge gained is so little connected with the interests and occupations of adult life that, as a rule, it is speedily forgotten. The literature, the thoughts embalmed in the languages so acquired, makes no impression on the average boy. He thinks of classical authors only as immense bores. If then this form of teaching has any merit it consists solely in such expansions of the thinking powers as may arise through committing words to memory and studying their relationships.

502. Exceptionally the classical languages are acquired with greater thoroughness, and a real study is made of the literature. But it is evident that the mental effect produced is not the same as that which was produced when the literature was a fresh and living thing, a subject of lively interest and discussion, to the early Pagans or to the men of the Renaissance, inquirers standing on the threshold of scientific knowledge and eagerly curious concerning it. It would, indeed, be difficult to imagine a being more unlike the antique Greeks or Romans, the men who thought and fought and wrought so daringly, than the average classical scholar of distinction, the university magnate or the learned ecclesiastic, for example, men who turn respectful eyes on the past, rather than a scrutinizing gaze on the present and the future. We can hardly conceive the nimble-minded Greeks, with their intense curiosity and mental activity, or the equally keen and practical-minded Romans of the Republic, ignoring the whole science of the day—a science which has developed so magnificently of late, and on which the very existence of civilized nations depends. The true modern representatives of the great Pagans are not to be found in college halls or

country parsonages, but in thinkers and workers like Darwin, Huxley, Kelvin, Cecil Rhodes, the strenuous men who rule Egypt and India, or the argonauts who seek the way to the North or South poles; the men who have become a name, "For always roaming with a hungry heart," to whom

> "All experience is an arch wherethro'
> Gleams that untravell'd world whose margin fades
> Forever and forever."

503. The model followed in our upper-class schools is, in fact, the monkish not the classical one. The classical method was ideally scientific. Comparatively little strain was placed on the memory, for the knowledge of the time was limited, and, except in the case of the later Romans, no alien language was taught. The reflective powers were developed to the utmost. The individual was taught, not so much what to think, as how to think. The mind was left free from prejudice, open to every fresh experience. The appeal to verifiable evidence was constant. Whatever science was in existence was acquired by every educated individual. The monks, on the other hand, ignored science, but received a more or less thorough education in the words of at least one classical tongue, which, indeed, with religion, constituted almost the whole of their formal mental training. Now whatever the merits of a training by means of a study of words, at least it did not confer on the monks that mental receptivity, that readiness to utilize fresh experience, that intellectual enterprise and daring, which characterized the ancients, and which is the first requisite for individual and national success in modern times. It did not free their minds from prejudice. It has not made the Hindoos and Chinese receptive and progressive. There is little reason to believe it confers these characteristics on the modern school-boy.

504. We cannot reach sure conclusions as to the value of a system of education by observing individuals. The modern civilized individual, however rigorously he may have been trained in any system, has a number of other influences acting on him. Consequently it is always possible for the adherents or opponents of this or that system to maintain of any given person that his characteristics have arisen because of his formal education, or in spite of it (*e.g.* through innate capacity). As in similar problems connected with heredity we must seek confirmation of our opinions by comparing masses of individuals with other masses differently trained. Probably the instinctive or play-ground education of the

English public school-boy is as good as anything the world has seen. Habits of truth and honour, self-reliance, enterprise, resolution, and high courage the boy tends to acquire from his companions and retain in after life. He has good and frank manners also, and some degree of refinement, but for them his home surroundings and companions are responsible. Such things cannot be acquired from books. His race cannot be innately stupid, for it has been very successful and progressive and has produced more really great men than perhaps any other in the modern world. Moreover, many of the best of the lower classes have risen into and intermarried with the higher. The school-master, therefore, has magnificent material to work on.[1] He is not hampered by limitations of time and expense. If his system of education be good he ought to produce a type of supreme intellectual vigour and excellence. Notoriously he fails.[2] It is admitted on all hands that young Englishmen of the better classes are, as a rule, averse to, if not incapable of mental toil and enterprise. Arrived in a world where men, strong because possessed of applicable knowledge and effective because enamoured of thought and labour, are making history as it has not been made for two thousand years, the public school-boy or university student finds nothing in his past that links him with the stirring life around. His long labour with words has been too uncongenial and uninteresting to endow him with a love of classical or indeed any literature except of the lightest kind. His reflective powers have been so little developed that he turns with loathing from deeper books, no matter how valuable intellectually or materially. The writers of such books cannot even earn a living wage in England. Necessarily he declines on sport, the one interest to which he is linked by his past. The boys in the play-ground have taught him very well, the school-master has trained him very ill. If ever he acts a part worthy his nation as worker or thinker it is under conditions that bring the characteristics, especially the courage, resolution, and self-reliance, developed in the play-

[1] The same material that naval officers are made of—probably the most effective men as a class in the nation.

[2] I fear all this will appear very dogmatic and even profane to the advocate of "classical" education. We have any number of assertions that classics confer all sorts of benefits on the individual—gentleness, "true" refinement, intelligence, and so forth. But definite proof is lacking. During the course of history every nation and every class that has adopted a scientific education has been progressive and intelligent, and has produced many great men and a fine literature. Is there any evidence that a "classical" training is as invariably associated with these characteristics? There is no other criterion.

ing-fields into action—perhaps as a subordinate officer on active service, or as a civil servant in some remote corner of the empire. We speak of such men as educated Englishmen; but after the inevitable lapse of their school knowledge they are extraordinarily ignorant as a class of all except the simple things that men pick up from newspapers or in conversation with another.

505. The rise and expansion of the Anglo-Saxon race in modern time has been very remarkable. Constituting as it does one of the great outstanding events of human history, remote generations will probably regard it with much the same feelings that we now bestow on the achievements of Greece and Rome—more especially since this expansion, unlike that of the ancients, is, from the nature of the case, a permanent one. But it differs from all similar outbursts of national energy in one particular; it has been the work mainly of lower-class men. Greece and Rome and all the other great nations of antiquity owed their rise and progress to an enlightened patrician class. During the Dark Ages the patricians were still the leaders of the people though they produced very few great men. The Renaissance was largely the work of the patrician classes. Russia owed her uprising during the eighteenth century to one man; but the preparatory work of the French Revolution was done principally by patricians. Japan owes her sudden awakening to an intelligent study by the same class of Western civilization. But in Great Britain after the Reformation the masses developed independence of mind; the civilization consequently put on an industrial and scientific aspect. The nation became powerful because of its wealth and progressive and formidable because of the energy and enterprise of its common men, who as commercial and military adventurers penetrated to all parts of the world. Successful in war, it was yet more successful in peace. Many daughter states were founded in which their peculiar characteristics made the common men successful colonists. Even where patricians ruled their tools were of superlative excellence. Under the same inspiring influence a great literature and philosophy came into being.

506. The patrician class, at any rate subsequently to Tudor times, participated least in the change of mental training, and in proportion to their power and wealth contributed least to the national success. The nation became great more in spite of them than because of them. Their education fell into the hands of a section of the Protestant clergy that most nearly resembled the orthodox type—into the hands of men averse

as a rule to innovation, with little interest in or knowledge of science, and with a profound distrust of scientific methods of thought. A scientific training tends to mental independence, and therefore to nonconformity—though, as scientific men will maintain, only to nonconformity with untruth. In the absence of disturbing influences, a training in classical words has an opposite effect. From this cause or that, from a conscious or half-conscious recognition of the mental effect, the educational methods of the Dark Ages were retained to a large, but perforce diminishing extent. The result achieved is similar to that which obtains in many orthodox continental states. The patricians of England can hardly be termed devout. They are clerical rather than catholic, at any rate as regards the men. They uphold the Church as a matter of tradition and party politics, but indifference to religion, or even complete scepticism, is probably more prevalent amongst them than amongst the lower ranks of society.[1] Gradually

[1] "The age we live in is notoriously an age of material standards and low ideals. Everything is estimated with cynical frankness at its money value. The getting of wealth at all costs, and the spending of it on comfort and pleasure are recognized as the sufficient purpose and reward of life. Art and literature are not untainted. And the millionaire, instead of being regarded as a menace to civilized society, is exalted into a popular hero, and even oddly haloed as a kind of saint if he chooses to spend a fraction of his swollen treasure on pauperizing his fellow-creatures. . . . The true end of education is not to impart information useful or other, but to keep alive the spiritual side of nature, to fan the divinity which informs the clay." (Rev. James H. F. Peile, *The Monthly Review*, Jan. 1902, pp. 132–3.) Here we have an exposition of the aim of the clerical school-master, together with an admission of complete failure. In the mouth of an orthodox cleric the phrase "to keep alive the spiritual side of nature," usually means nothing more than the creation of a "simple" or "steadfast" faith in the precise doctrines of the sect to which he happens to belong. Patrician society is like the American people. It so influences immigrants that in a generation or two the characteristics of the alien disappear. Society modifies the millionaires much more than the millionaires modify society. Except during rare and temporary outbursts of asceticism the great majority of men have always striven strenuously for wealth. The only difference at the present day is that there is more wealth to be got, and that more people get it. "Society" had as many and even more faults during the Georgian as during the Victorian era. Its delinquencies are no new thing. Very wealthy men are numerous in America, where they entirely dominate society. The American millionaire is seldom held up to admiration, but at least he sometimes leaves his millions for educational purposes. No British peer who was not the first of his line has ever done the like. This method of discarding wealth, of pauperizing fellow-creatures, a very plebeian trait, is never displayed by those in whom the spark of divinity has been fanned in the orthodox way. Boys do not acquire their religious and ethical tones from their school-masters, with whom they are rarely intimate, but from their parents and com-

they have lost place as real leaders of thought and action, becoming leaders of "society" instead. They still retain great wealth and considerable political power, and thus have unique opportunities to achieve distinction; but a glance at history demonstrates how little the nation owes to its successive governments, and how much to the rough energy of the people. It is, indeed, remarkable how few members or scions of the actual peerage, the class that has been the most exclusively and continuously trained by "classical" methods, have achieved greatness during the last few centuries. It has been wittily said that "formerly none of the peers of England

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panions. The school-master's business is to impart useful information and develop the intellectual faculties. If he fails in this his work is the merest pretence.

Wealthy men existed in former times, for instance amongst the Pagans and in England during the Elizabethan era, but they did not always devote the whole of their wealth and leisure to trivial pursuits. It is true that the Elizabethan patricians had a school training as "classical" or even more classical than the patricians of the present day, but, such as it was, it left them in touch with intellectual problems of the time, for after fifteen hundred years, during which the spark of divinity had been industriously fanned, knowledge had advanced little beyond the Pagan standard. They shared in full the mental activity awakened by the revival of Greek literature, by great contemporary scientific discoveries, and by vehement and fruitful controversies. They could still be thinkers and leaders. But the world has progressed since then. The same learning does not in every age produce the same effects. That which placed a man in the forefront four hundred years ago, when Latin was the only avenue to any sort of learning, and Greek the only path to the higher planes of thought, can no longer do so. The school-master who so trains pupils, that should be the future leaders, and will be the actual legislators of the nation, as to make them intellectually capable of little besides mere routine or trivial enjoyments incurs a terrible responsibility. No doubt the system by which the upper classes are educated has improved in recent years; but it is equally certain that there must be much greater improvement before they can come again to the front in the fashion of their forefathers. With his opportunities the school-master should present us with a patrician class at least as able as that of Greece and Rome, at least as capable of intellectual enjoyments and of carrying through to successful conclusions enterprises involving thought and toil.

Nevertheless, however much we blame the school-master, we must recognize that the whole of the fault does not lie with him. He teaches by a wrong system, but he was taught by it, and the parents of his pupils elect to have their children taught by it. Patrician decay is due to defective training, but the causes of that decay lie in the nature of things. When constant foreign and internecine war vexed the world the patrician was forced on pain of extinction to be thinker and actor at least as capable, or more capable than lesser men. Peace gave him security. He is suffering from cessation of selection—a cessation which affects educational systems, not the race, as some writers seem to imply.

could write, but all could make their mark; but now, when all can write, none can make his mark." Lord Byron and the two Pitts were certainly men of great achievements. These with the Dukes of Marlborough and Wellington, who received the greater part of their education in the rough-and-tumble of a soldier's life, practically exhaust the list. Stronger evidence of the essential leanness, meanness and barrenness of patrician education is hardly necessary. Some great orators there have been among the peers, but oratory, appealing as it usually does to the passions and prejudices rather than to the reason of mankind, is often indicative of nothing more than *misdirected* natural powers. Savages are sometimes eloquent. Few of the greater thinkers and workers of history have been so.

507. The mental inefficiency of the aristocracy has been an incalculable evil. Progress, material, intellectual, and social, is always quicker when intelligently directed from above. The nation has suffered from the loss of those who should have been its best. Many dull and indolent men, who might have been keen and capable thinkers and workers, have occupied positions of national importance. In stirring modern times nations suffer eclipse, not as a rule because they regress, but because other peoples progress faster. The masses of other nations are becoming, or have become as well trained as our own. In some cases their ruling classes are becoming better trained. A needlessly bad tone has been given to society. Whenever a successful man has risen by virtue of innate capacity or acquired excellence, the imitative faculties of his descendants have lowered them to the prevailing standard. Periodically a cry is raised to end or mend the House of Lords; but so long as wealthy men exist they will exercise a dominant social and political influence, and will, as a rule, bequeath wealth and influence to their descendants. A practical, a speedy, indeed an ideal way to mend the peerage would be to raise the mental status of its members by giving them a better, a scientific training. Their wealth and leisure should enable them to command the best possible.

508. What is a scientific training? It is not necessarily opposed to religion. Certainly it can never be opposed to a true religion. It is opposed only to such doctrinal assertions as are known to be untrue, for example the assertion that the universe is but six thousand years old. It does not consist in a mere cramming of facts connected with this or that department of science. Such a cramming may be as

useless or absolutely detrimental as a similar cramming of words. It consists in so treating the facts, and especially the broad generalizations of science (*i. e.* things *known* to be true), that the pupil is supplied with a maximum of useful information (that is, information which will link up with his subsequent experiences), and of so manipulating this information that his receptive powers are not diminished beyond their natural and inevitable decay, while his reflective powers are increased to the utmost extent. Then from his subsequent experiences he will derive the greatest value possible. A "classical" education errs by not supplying useful information. A dogmatic education errs by destroying the power of utilizing experience. A scientific education must avoid both errors. It must not waste the pupil's time by imparting knowledge which will be valueless to him, and which therefore he will forget; it must not blunt his receptive and thinking faculties by inculcating generalizations in such a way that he shall become incapable of profiting by fresh experience. Not since Pagan times, when data of science were few and easily manipulated, has scientific education at all approaching the most perfect possible been given to any body of men. But, because, amid the competitions of an industrial civilization, the survival of the form of mental training which develops the greatest intelligence is alone possible, the time is rapidly approaching when the best possible will be given to all men. The nation that first applies that method will, for a time at least, be the leading nation.

509. Savage man differs from lower animals chiefly in that he has invented articulate speech and so acquired the power of learning from his progenitors and fellows and transmitting to his descendants an immense mass of traditional knowledge. Civilized man differs from the savage chiefly in that he has invented and more or less perfected certain artificial aids to speech, written symbols by means of which he is able to store in an available form knowledge vastly more abstruse and voluminous than the savage is able to gather and preserve. His books are artificial memories of unlimited capacity and unerring accuracy. Moreover, by means of these symbols he is able, as in the mathematics, to perform feats of thinking utterly beyond the powers of his unaided mind; just as, by means of machinery and other mechanical contrivances, he is able to perform physical feats utterly beyond the unaided powers of his body. To written symbols, representing words or thoughts, therefore, is due,

practically speaking, his whole advance beyond the savage in the past, and to them are due, also, his vast potentialities for future advance.

510. But the device by which he records his knowledge is much more perfect than that by which he aids his thinking. Any man to whom books are available commands all the knowledge that has been garnered during thousands of years. The mathematics, since they are applicable to only a limited field of thought, aid his thinking to an extent far less than books aid his memory. It follows that the principal aim of that part of formal education, which is not especially intended to supply the individual with useful knowledge, should be to develop his reflective powers. Much scientific teaching as practised at present does not fulfil this condition. For example, the medical profession includes the largest number of scientific men in the world. From first to last during his career the medical student is loaded with a monstrous and ever-increasing burden of facts, but no systematic effort is made to increase the acuteness and range of his thinking processes. A great deal of the burden on his memory is necessary; but not all of it. Thus, since he treats the ailments of an animal, man, largely by means of vegetable drugs, he is taught botany and zoology. In botany he learns such things as the peculiarities which distinguish various natural orders of plants from other natural orders. In zoology he acquires a more or less elaborate knowledge of the structure of certain types of animals—the vascular system of the sea-urchin, the organs of generation of the earthworm, the skeleton of the frog, the bones of the cod's head, the dentition of the different species of mammals, and so forth.[1] But no man is a better physician for knowing the difference between a raceme and a rhizome, nor a better surgeon because he has studied the anatomy of the cockchafer. His subsequent experiences do not link up with these fragments of knowledge, which though necessary to the equipment of the professional botanist and naturalist, are so remote from the labours and interests of the medical career that presently they are forgotten. In the end the average doctor

[1] Teachers and examiners are always under the temptation of insisting on such learning. If the student is made to commit a mass of data to memory both teacher and examiner have a comparatively easy task, and they need not be very competent nor strenuous men. But if the student is made to follow a sustained train of thought, the task of the teacher to make him understand and that of the examiner to ascertain if he has understood is of much greater labour and difficulty. Only very energetic and capable teachers and very patient examiners are fitted for this work.

has a knowledge of botany and zoology not much more profound nor useful intellectually than that possessed by the average farmer or stockbreeder. Either he should be otherwise employed during his earlier studies, or his later work should be so modified as to link up with them. Facts, scientific or other, have by themselves no intellectual or scientific value. It is the recognition of the relationship between facts in a natural group and between different groups that confers the value. No doubt medical students, in proportion to their intelligence, get a general notion of the essential likenesses, which, amid distinguishing differences, bind together all living nature. But this result, if it be the one sought, is attainable by direct teaching at a hundredth part of the cost in time and labour.[1]

511. I suppose every man is apt to attach undue importance to his special line of work. Just as Professor James' hen cannot help thinking a nestful of eggs "the most utterly fascinating and precious and never-to-be-too-much-sat-upon object" in the world, so the classic, the physicist, or the naturalist is prone to believe his particular study the most admirable and important, and never-to-be-too-much-insisted-on, belauded, and generally advocated in the world. Bearing this well in mind it seems to me nevertheless that no kind of study can be made to bear intellectual fruit of nearly such value as the study of heredity. It lies at the root of every science and every study connected with life from botany and zoology to medicine, sociology or pedagogy. Who knows it not knows not life except in its superficial aspects. He may be a student of philosophy or a worker in biological science, but in these days when heredity enters so much into philosophy and links together so many biological sciences, he cannot be a very effective thinker or worker. It furnishes a master-key to the more tremendous events of history, and

[1] "Thus there gradually accumulated a new mass of material; investigation became more and more specialized and the danger became imminent that workers in the various departments would be unable to understand one another in their special researches. There was lack of any unifying bond, for workers had lost sight of the general problem in which all branches of science meet, and through which alone they can be united into a general science of biology. The time had come for again combining and correlating the details, lest they should grow into an unconnected chaos, through which it would be impossible to find one's way, because no one could overlook it and grasp it as a whole. In a word, it was high time to return to general questions." (*The Evolution Theory*, Weismann, English Translation, p. 27.) All this, written of the naturalists of the pre-Darwinian era, is very true of the medical men of the present day, whose science, after all, is a biological one.

is our only hope against disasters that loom great and terrible in the near future. It goes deep down to the springs of human life, and thought, and conduct, and explains why some nations are inheriting the earth and the fruits thereof, while others are dying physically or mentally. The philanthropist must know something of this science or he will grope in the dark. The statesman must know something of it or he may labour in vain.[1] Transcending all else in importance is the educational value of heredity. No nation in which a knowledge of it was widespread could possibly be stupid or brutal. The habits of thought which must be brought to its study are exactly those which counteract best the tendencies which have plunged so many races into their Dark Ages. So few are the essential facts of heredity, but so prolonged, close, and accurate must be the reasoning founded on them, that no great strain is placed on the memory while the reflective faculties are exercised in the highest degree. So largely would the students learning link up with the subsequent experiences of his whole life that little would be forgotten, and a sure foundation would be laid for a clear and wide intellectual outlook.

512. It will be easy to declare that I propose to regenerate mankind by making it study heredity. I am almost disposed to accept the challenge. If it be thought that I exaggerate let the reader consider the case of China. China is still in her Dark Age. Suppose we changed her present system of classical education for that which forms the principal mental food of our own governing classes; would such an alteration in the mental *tone* of the Chinese result that a great intellectual, and therefore social and material revival would follow like that in Japan? Some change would result, doubtless, especially in those Chinamen who assimilated, as so few Englishmen do, the thoughts of the great Grecians; but the general mental tone of the Chinese, the murky atmosphere of prejudice, would suffer little alteration. But if heredity and all that a study of heredity implies, including the doctrine of evolution, the essential facts and generalizations of many biological sciences, and the utter and necessary reliance of the student on verifiable evidence first, verifiable evidence next, and verifiable evidence last, were taught, can it be doubted that that fog of superstition and prejudice, which now chokes the nation, would clear away like mist before a summer sun, and that we should then see such an outburst of energy and enterprise, such an intellectual and

[1] See the next Chapter.

material growth, as would throw the kindred but smaller and weaker people of Japan into the shade. The mental habits of the Chinese would be changed, and with that change would come an alteration in much besides. Just such a change—not so great perhaps because we are more enlightened, but great enough—would occur in England were elder boys and university students taught the main facts and conclusion of heredity, instead of the words and the relationship between the words of a dead language. Their labours, moreover, would be full of interest. No longer would they toil in misery at a task against which instinct and reason alike rebel.[1]

513. However with education controlled as at present, and in the face of widespread prejudice and ignorance, there can be no hope that any considerable change in mental training will occur for many years. Before then the nation will have lost and suffered much. The most we may expect with any degree of probability is that the authorities who control the education of the great majority of scientific men will perceive the necessity of including a tolerable knowledge of heredity in the mental equipment of medical students. At present the science is not taught at all to them, or taught so casually that no student gains an adequate knowledge of or realizes the importance of the subject with which he is dealing. There does not exist even a text-book to which the independent inquirer may turn.

514. The teaching of heredity involves the inculcation of such facts as that the world is more than six thousands of years old, and that the various species of plants and animals, including men, have arisen by evolution from pre-existing forms. Doctrinal objections, therefore, may be raised against it even by medical men. But that these things are true is definitely known, and as true they are accepted by every reasonably-educated man. That opposition on such grounds to them is possible demonstrates very forcibly the necessity

[1] A very thorough acquaintance with the essentials of heredity could be acquired in a tenth of the time devoted to classics. I do not mean to suggest, therefore, that the study of this science alone ought to supplant that of classics. An adequate study of many other subjects which are now not taught, or very scrappily taught—for example, physics—could be added to the school and university curriculum, the great object in every case being to bestow on the student such a knowledge of his environment, and such powers of utilizing his knowledge, that in after years he shall be capable of more than routine, and have pleasures other than those afforded by mere sport.

of an improvement in medical education, since it demonstrates that some medical men at least, though workers in a scientific subject, are out of touch with scientific truth.

515. The present position of the medical profession is deeply unsatisfactory. Its intellectual status is not what it should be. As the largest body of scientific workers it ought to exercise a preponderating intellectual influence. It exercises hardly any. Certainly the whole body of medical men have not wielded an influence at all comparable to that by means of which, during the last half-century, a few workers in heredity and its corollary evolution, have "shaken the thought of the civilized world," and forever altered our conception of nature. Owing to lack of breadth in medical education, to the enormous strain placed on the memory, and to the comparative neglect of the reflective faculties, the intellectual outlook of the average medical man is not noticeably wider than that of the average solicitor or merchant. He is just as much steeped in mere commonplace popular prejudices, just as non-receptive to fresh evidence. Indeed it is not unusual to hear members of other professions express the opinion that doctors tend, as a rule, to narrowness and conventionality.

516. It is not enough that the medical man is an ordinary citizen, a little less influential than the parson, a little more enlightened than the town councillor. By right of superior knowledge and intellectual training he should be much more. Owing to the nature of his studies a tolerable knowledge of heredity and all that it implies would be particularly easy of acquirement by him. He would have to learn almost no fresh facts, but would as a student undergo a course of close reasoning and thinking which would occupy comparatively little time, but which would remedy the principal defect in his education. It is not a valid excuse to declare that there is not available time for instruction in heredity in the already overloaded medical curriculum. Much in that curriculum is redundant or at any rate useless, since in the lack of a knowledge of heredity it fails to link up with subsequent experience. Again, it is no valid excuse to declare that not enough is certainly known concerning heredity to justify its inclusion in medical studies. That contention, though often urged, indicates nothing more than ignorance as to the true state of our knowledge. Even were it valid the materials for study in the hands of medical men are so magnificent that it could soon be made invalid. In any case, it is neither expedient nor right that medical

men should be excluded from the intellectual part of their own sciences.[1]

[1] "The ossification of the intellect, like that of the larynx, occurs earlier in some persons than in others. . . . But the mind is liable to a much more disastrous change; like the man of whom it was said that he had been dead for some years but people did not like to tell him so, it may while still seemingly alive undergo a process analogous to fossilization. Examples are seen in all departments of human activity, but in none are they so conspicuous as in science, which is nothing if not progressive. . . . At the recent meeting of the French medical congress . . . in Paris, Professor Cornil delivered an address on the part played by morbid anatomy in contemporary medicine, in which he told of the opposition which the newer science met with from the powers and principalities of medicine in his own early days. The story is so interesting that we venture to repeat it almost in the words of the distinguished narrator. Professor Cornil as a student first worked in the hospitals from 1857 to 1860. At that time Virchow's great work on cellular pathology had lately been published, and Trousseau's career as a clinical student had begun. The faculty of Paris, justly proud of the fame of Corvisart, Laënnec, Bouillaud, Grisolle, and so many others, was strongly inclined *stare super antiquas vias*. Official medicine had indeed, like Bottom, 'an exposition of sleep' come upon it, and it was content to dream of the glory of the great men who had shed lustre on it. Instead of going forward, many of the teachers of that day recommended to their pupils old writers like Baglivi, Borsieri, Lorry, Franck, and Boerhaave with the commentary of Van Swieten. At the Academy of Medicine, Velpeau vehemently denounced the histological examinations of tumours made by Lebert, Follin, Verneuil. When Professor Cornil presented his thesis for the doctor's degree in 1864, which dealt with the histology of nephritis, one of his examiners said to him, 'Your work is extremely meritorious, but what the devil is the good of it all? Have you found under your microscope a way to cure albuminuria?' Another said: 'You speak in your paper of the multiplication and proliferation of cells; have you ever seen such a thing? I have often tried, but have never succeeded.' The examiner was good enough to describe his method of search, which struck the young candidate as so futile that he thought it prudent to say nothing; his silence gave his judge an easy triumph. Such being the attitude of the Faculty, it can readily be understood that it was by no means disposed to sanction the establishment of a chair of histology. Duruy, one of the most enlightened Ministers of Public Instruction France has ever possessed, had for years striven to overcome the resistance of the Faculty, and a small *coup d'état* was required to make it yield. It is an interesting piece of medical history. We, however, have no reason to congratulate ourselves that we are not even as those foreigners. Fossilization is as common here as elsewhere. Have we not known one of the greatest teachers of physiology who to the last denied the migration of blood corpuscles? Have we not known a physician of the highest eminence who said, in reference to the same thing, that he would as soon believe that a brick could pass through the wall of a house as that a corpuscle could escape from a blood-vessel? Did not a leading surgeon, only twenty-five years ago, warn his pupils against speaking of the 'lumen' of an artery to the examiners at the College of Surgeons, because 'they would pluck you for it, you know?' Lister's teaching encountered no more bigoted

517. Hitherto the nature of their training has tended to render medical men excessively conservative. Nevertheless they have already assimilated and put to magnificent practical use one of the two great scientific achievements of the age—Pasteur's discovery of the microbic origin of disease. The other great achievement, Darwin's discovery of the adaptation of species to the environment through Natural Selection, has hardly been assimilated, and certainly put to no practical use as yet. Both these discoveries should have been made by medical men; and would in all probability have been made by them had their mental training been on more liberal lines.[1] They had long possessed the microscope and been acquainted with the facts that some diseases were infective and some races more resistant than others to certain forms of disease. But, even if the authorities who control medical education be slow to insist on the teaching of heredity, yet necessity must soon force medical men to its study. Practical problems have arisen which can be dealt with only by them, and which ever more and more press for solution. Applied heredity will one day be a branch of the Science of Public Health.[2]

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opposition anywhere than in his own country, and bacteriology was a laughing-stock to most men over middle age up to a comparatively recent time." (*British Medical Journal*, Dec. 3, 1904.) With the education medical men receive ossification of the intellect must necessarily be a frequent occurrence. The reflective faculties alone enabled us to utilize experience which appears to contradict opinion previously formed.

[1] As a fact one medical man, Dr. W. C. Wells, did outline the theory of Natural Selection as long ago as 1813. He supposed that the natives of Africa had become resistant to the diseases of the country through the weeding out of the less-resistant individuals. (See *Origin of Species*, pp. x., xi.) His speculations fell on stony ground. To this day most medical men attribute racial adaptation to prevalent disease to the transmission of acquired immunity.

[2] The late Interdepartmental Committee on Physical Deterioration was the recipient of some interesting but conflicting medical statements, which—because so conflicting—show as clearly as need be the necessity of a training, not merely in heredity, but also in precise scientific habits of thought. What should be a science was converted into a "tumbling ground for whimsies." It had been alleged that the nation is deteriorating physically. Both the College of Physicians and the College of Surgeons "laid stress upon the fact that the figures included in the memorandum of the Director-General did not appear to them to support the view that an increasing deterioration of physique is taking place in the classes of the population from which military recruits are chiefly drawn." Sir William Taylor, Director-General of the Army Medical Service, expressed the opinion that "the idea of progressive physical deterioration has occupied a much too prominent position in the minds of those who had to consider and report on the advisability of the inquiry." Apparently he did not believe in this progressive deteriora-

tion. Dr. Eicholz, one of H.M. Inspectors of Schools, with Dr. W. Leslie Mackenzie drew "a clear distinction between physical degeneracy on the one hand and inherited retrogressive deterioration on the other." Dr. Eicholz stated:—

"With regard to physical degeneracy the children frequenting the poorer schools of London and the large towns betray a most serious condition of affairs calling for ameliorative and arrestive measures. . . . Nevertheless even in the poorer districts there exist schools of a type above the lowest, which show a marked upward and improving tendency, physically and educationally—though the rate of improvement would be capable of considerable acceleration under suitable measures. In the better districts of the towns there exist public elementary schools frequented by children, not merely equal, but often superior in physique and attainments to rural children. And these schools seem at least as numerous as schools of the lowest type. While there are unfortunately very abundant signs of physical defect traceable to neglect, poverty, and ignorance, it is not possible to obtain satisfactory or conclusive evidence of hereditary physical deterioration—that is to say, deterioration of a gradual retrogressive permanent nature, affecting one generation more acutely than the previous. There is little, if anything, in fact to justify the conclusion that neglect, poverty, and parental ignorance, serious as their results are, possess any marked hereditary effect, or that heredity plays any significant part in establishing the physical degeneration of the poorer population. In every case of alleged progressive hereditary deterioration among the children frequenting an elementary school it is found that the neighbourhood has suffered by the migration of the better artisan class, or by the influx of worse population from elsewhere. Other than the well-known specifically hereditary diseases which affect poor and well-to-do alike, there appears to be very little real evidence on the pre-natal side to account for the widespread physical degeneracy among the poorer population. There is accordingly every reason to anticipate rapid amelioration of physique as soon as improvement occurs in external conditions, particularly as regards food, clothing, overcrowding, cleanliness, drunkenness, and the spread of common practical knowledge of home management. In fact, all evidence points to active rapid improvement, bodily and mental, in the worst districts so soon as they are exposed to better circumstances, even the weaker children recovering at a later age from the evil effects of infant life."

Professor Cunningham apparently took a middle position. He stated: "In spite of the marked variations which are seen in the physique of the different classes of the people of Great Britain, anthropologists believe, with good reason, that there is a mean physical standard, which is the inheritance of the people as a whole, and that no matter how far certain sections of the people may deviate from this by deterioration (produced by the causes referred to) the tendency of the race as a whole will always be to maintain the inherited mean. In other words, these inferior bodily characters, which are the result of poverty (and not vice such as syphilis and alcoholism) and which are therefore acquired during the life-time of the individual, are transmissible from one generation to another. To restore, therefore, the classes in which this inferiority exists to the mean standard of national physique, all that is required is to improve the conditions of living, and in one or two generations all the ground that has been lost will be recovered." Professor Cunningham did not explain why he supposed that alcohol and syphilis altered the hereditary tendencies of the germ-plasm, whereas insufficient food and the like did not. Nor did he explain how it was that races which had long suffered from alcohol and syphilis had not become degenerate notwithstanding the alleged inherited deterioration caused by these agencies. Alcohol has been extensively and continuously used by all civilized races for thousands of years, and I have heard a distinguished authority declare that "Civilization is Syphilization."

On the other hand, medical temperance advocates and alienists were strongly of the opinion that all sorts of agencies affecting parents, including alcoholism and disease, were causes of innate degenerative changes in offspring. They founded these opinions on two classes of "evidence." On the one hand, they argued that, since alcohol and disease are plainly injurious to the individual somatic cells, therefore they must injure the germ-cells, and therefore they must alter for the worse the hereditary tendencies of the germ-plasm. But they failed to demonstrate that the hereditary tendencies of any kind of cells are ever altered by external influences. Again they argued that the parents of lunatics and other degenerates are often drunken, as shown by the statistics of public asylums for the insane. But pauper lunatics are drawn chiefly from the poorer, that is, the more drunken classes, and it was not shown that the sane people of these classes have a smaller proportion of drunken parents than the insane. Dr. Eicholz, on investigating the condition of a poor school at Lambeth, "was informed that there were not more than twelve parents out of two hundred who did not fortify themselves by the irregular use of alcoholic stimulants." Numerous other essential considerations were neglected. (See § 264.) The facts of race adaptation under adverse conditions were entirely ignored except by one gentleman, who declared: "In past centuries there have been many instances of drunken nations, whose vitality does not seem to have been greatly interfered with. I attribute this to the fact that in those days the women, the mothers of the race, were sober. But if the mother as well as the father is given to drink, the progeny will deteriorate in every way, and the future of the race is imperilled." Implied in this statement are some novelties. It would seem, since the future of the race as distinguished from that of the individual is imperilled, that germ-plasm, when in a woman, is more susceptible to the influence of alcohol than germ-plasm when in a man. It would seem, also, since *no* race that has been afflicted by alcohol has undergone progressive deterioration, that female drunkenness is a phenomenon which has occurred for the first time during the last decade or two. It is interesting to remember that Englishwomen formerly drank ale for breakfast, and that Catherine of Russia published a law forbidding women to get drunk before nine o'clock at night. Apparently the committee were inclined to endorse this remarkable essay on heredity.

It must be noted by the reader that the question whether parental alcoholism and disease produce innate changes in offspring subsequently born has been prominently before the medical profession for several years. There has been more than one long and heated controversy on the subject (see, for example, *The Lancet*, February to September 1901, and July to October 1903); but from first to last absolutely no evidence demonstrating the alleged influence on the germ-plasm has been produced except of the curious kind referred to above. Thus a research committee was appointed in 1899 by *The Society for the Study and Cure of Inebriety*, "to investigate the conditions under which the tendency to inebriety is capable of transmission to offspring." The deliberations of the committee turned mainly on the question whether offspring were injured by parental drinking. Notices asking for evidence were inserted in some thirty scientific and other journals. Many letters were received, but no evidence was obtained.

It is quite indisputable that races adapt themselves to adverse conditions, and, short of miracle, no cause for this adaptation is conceivable except Natural Selection. The prevailing medical, or rather alienist belief, then, amounts to this :—that during any given epoch injurious influences cause racial deterioration ; but eventually, in some mystical way, this deterioration emerges as racial improvement of an exactly opposite kind.

CHAPTER XXV

PRACTICAL PROBLEMS

Physical deterioration—The influence of urban conditions on the race—Public health—Water-, Earth-, and Air-borne diseases—Intemperance—Child-birth—Insanity.

518. THE principal conclusion we have reached in our study of heredity is the one that variations are very rarely caused by the direct action of the environment on the germ-plasm—so rarely that racial change is never due to this cause. Were the fact otherwise, racial adaptation to the environment, and therefore, the persistence of life, would be impossible. Practically speaking, therefore, all variations, except those due to the regressive action of bi-parental reproduction, are spontaneous. It follows, as a necessary consequence, that all progressive racial change is due to selection, whereas apart from the effects of reversed selection, all regressive racial change is an accompaniment of cessation of selection. We saw how perfectly the adaptation of the various races of mankind to a multitude of diseases and to the hard conditions of civilized life, accords with this hypothesis.

519. Of late years the public mind has been exercised on the subject of physical deterioration. We are told that, since a large and increasing proportion of the population have become town-dwellers living under bad hygienic conditions, the race is undergoing degeneration. The terms "deterioration" and "degeneration," however, are used in a very vague way. If it be meant that bad and insufficient food, overcrowding, overwork, lack of light and air, prevalence of disease and intemperance, and the like, render the inhabitants of slums individually less robust than their country cousins, then the statement is obviously true. Of course an individual reared under conditions unfavourable to his development tends to be less robust than one reared under

better conditions. But if it be meant that the conditions of slum life weaken the race as such so that successive generations of individuals are born more and more innately defective, then the statement is just as certainly untrue. It is founded on a confusion between inborn and acquired traits. There is not an iota of evidence that country children removed shortly after birth to the slums are, on the average, more robust than the natives, nor that town-bred infants removed to the country tend to be inferior to their rustic playmates.

520. Owing to this confusion between inborn and acquired traits a belief is prevalent that urban families cannot persist beyond the fourth generation without an infusion of country blood. This statement is on a level with that with which children are sometimes amused when they have lost a tooth. They are told that a gold tooth will replace the missing one if they refrain from putting the tongue in the cavity. No child ever does refrain. Similarly, since intercourse between town and country is very free, and since emigration from country to town is very large, hardly a town family exists that has not intermarried with country families or their near descendants. Even if it were true that urban families tend to become extinct within four generations, it would prove, not that the race deteriorates in towns, but only that selection is so stringent that the birth-rate tends to fall below the death-rate. Country blood does not strengthen city blood. It weakens it, for it has been less thoroughly purged of weak elements. Slums are not a creation of yesterday. They have existed in many countries from prehistoric times. Races that have been much exposed to a slum life are not inferior physically nor mentally to those which have been less exposed. Thus, for example, the Chinese, who have been subjected for a longer time and to a greater extent to these influences than any other race, are certainly not inferior to the Dyaks of Borneo. The Jews, also, are a case in point. Europeans are not inferior on an average to the savages of the Western Hemisphere. Were the latter placed under the frightful conditions which prevail in our large towns, they would not only deteriorate individually, but perish *en masse*. The history of civilization is, in effect, the history of the gradual evolution of the power to resist the lethal influences which surround the town-dweller. As we have seen already, without this evolution civilization would have been impossible.

521. To sum up:—slum life weakens individuals exposed to it; but this acquired weakness is not transmitted to

offspring. On the contrary, owing to the increased elimination of the unfit, slum life strengthens the race. But it strengthens it only against the conditions which surround slum life; the race is no better in any other respect, in brain and muscle for example. Contrariwise, were slum life abolished, the race would, in time, be weakened in its power of resisting the banished conditions; but the individual would be strengthened in many ways immediately. Since, then, the power to exist in slums would be of no advantage in the absence of slums, it would be an unmixed benefit to abolish these physical and moral plague-spots, provided that were done permanently. Undoubtedly as science progresses and the community, especially the governing class, grows more enlightened, this is what will happen. Already some progress has been made, as is proved by the fall in the death-rate. The problem of physical deterioration in connection with slum life, then, is narrowed to the question of improving the lot of the individual. We need have no fears for the race.

522. But, though conditions adverse to the individual do not tend to cause racial deterioration, beneficial conditions do. The fall in the death-rate and the prolongation of the average length of life indicate that many individuals are now surviving who would have perished formerly. The improvement is manifested in all classes of the community, and is due to the advance made in medical science, both with respect to the treatment of individuals and in the department of Public Health.

523. The science of Public Health (sanitation, preventive medicine), unless it makes great advances in the future, is able to operate only within narrow limits. As practised at present it exercises supervision over the food, water and housing of the community, and endeavours to abolish or diminish zymotic disease. By improving the water supply it has greatly reduced the prevalence of, and ultimately may quite eliminate, water-borne maladies. By letting air and light into the dwelling-houses and by preventing overcrowding it has lessened earth-borne disease. But in all probability this reduction of mortality from consumption, though it may continue till slums have quite disappeared, is not permanent. As generations pass, as the numbers of the unfit increase through lessened elimination, as the race regresses, the task of the sanitary reformer will grow in magnitude and complexity. The disease is difficult to detect in its earlier stages, especially in very resistant sufferers, in

whom it may exist unsuspected for months or years. Bacilli in a latent condition may persist, also, in people who to all appearances have quite recovered. Every such person is a focus of infection, the bacilli being disseminated not only by actual expectoration, but in the minute droplets of fluid which are expelled in the acts of sneezing and coughing. We can hardly expect in our climate, and with our social habits and dense population, to render the conditions as unfavourable to the bacilli as they are in tropical Pacific islands, where the natives are becoming extinct. Segregation of consumptives to any degree of completeness is impracticable, not only because of their enormous numbers, and of the difficulty of detecting the disease in its incipient stages, but also because, owing to the long duration of the quarantine necessary, we could not exclude from our shores travellers from less sanitary areas. Apparently, therefore, our only hope of permanently lessening the prevalence of the disease lies in a reduction of the number of people susceptible to it. In other words the problem presented by consumption is one which ultimately will have to be solved—if ever it be solved—by the student of heredity. Some method will have to be devised to lower the output of children by people predisposed to the complaint, otherwise the mortality from consumption cannot be greatly or permanently reduced. A few States of the American Union have already laws forbidding the marriage of consumptives. It is, however, no part of my present purpose to suggest remedies for the mere discussion of which the community is not as yet prepared. My principal object is to demonstrate that there are certain practical problems of great importance which cannot be dealt with until the public, and especially the medical profession, are in a position to bring an adequate knowledge of heredity to bear on them. The mere existence of such knowledge would be of incalculable benefit, inasmuch as the race would become alive to the dangers which menace it, and improper marriages, meeting, as they should, with universal censure, would become less frequent.

524. Neither sanitation nor a study of heredity offer any remedy against such air-borne diseases of short duration as measles. At present sanitation has not even diminished them. They are endemic; if a system of sanitation, efficient beyond anything that seems as yet possible, succeeded in abolishing them from any area, it would render the community liable to epidemics—a much greater evil. Since inborn immunity against the more important of these diseases

is rarely manifested, it is clearly beyond the power of artificial selection to render the race insusceptible to them. The only hope of lessening the evils caused by them lies in the discovery of vaccine lymphs similar to that which has already banished small-pox.

525. We have seen that just as all races undergo protective evolution against other stringently selective agents of elimination, so various races of mankind have undergone evolution against certain narcotics. Human races that have not undergone this evolution, to some extent at least, are now as incapable of existing under the conditions of civilization as races that have undergone no evolution against tuberculosis. On the other hand, some races that have undergone considerable evolution are now hardly injured by the presence of almost unlimited supplies of alcohol (or other lethal narcotics). Nature, in effect, has carried on a great and successful scheme of temperance reform, but on lines opposite to those advocated by human reformers. She has eliminated drunkards; temperance reformers propose to eliminate drink.

526. We have seen also that every race which has undergone any phase of evolution tends to regress, with a rapidity that is proportionate to the rapidity of the previous evolution, towards the ancestral type when the eliminating agency which caused the evolution is withdrawn. It follows, were alcohol or opium withdrawn from a race which has undergone evolution against it, the race would gradually lose its innate resisting power, and revert steadily towards that ancestral type in which the susceptibility to the charm of alcohol was very great. It follows, further, that repressive legislation, unless it were made eternal, would result ultimately in disaster. If passed by a race that had undergone evolution, it would be in danger of repeal by descendants who had undergone reversion. In this instance at least it would not be possible to give immortal permanence to a mortal law. Any one with a basket of fruit is able to manufacture alcohol; it is used in our arts and sciences, and men will drink ether or methylated spirits when they cannot procure anything more palatable;[1] some races, as the South Europeans, have

[1] "An Inflammable Beverage.—A Bill has been introduced into the Manx Legislature for regulating the sale of methylated spirits. The measure is prompted by the necessity of preventing the use of this spirit as a beverage, especially among the lower classes during Sundays and hours when the public-houses are closed. It is provided that only licensed persons may sell methylated spirits at places mentioned in the licence. Publicans are prohibited from taking out such a licence, and the sale of methylated spirits by any one is forbidden between Saturday

undergone such considerable evolution that alcohol as an intoxicant has no longer much charm for them. They still enjoy it greatly as a beverage, however, and could hardly be persuaded to pass a self-denying and perhaps self-destructive ordinance abolishing its use. Travellers of less fortunate races would acquire the taste amongst them, and return with it to their own countries.

527. But apart from these purely theoretical considerations, effective prohibitive legislation, especially amongst civilized nations, has already been proved impracticable. It has been tried by scores of Governments on hundreds of occasions during thousands of years, and has invariably failed,[1] except in the case of some Mahomedans, amongst whom it has been partially successful, but at a terrible cost. The same influence, religious fanaticism, which has rendered them temperate, has, by limiting intercourse with more enlightened if more drunken peoples, rendered them barbarous also. It cannot endure for ever. Moreover, the Mahomedans, like the Buddhists, have substituted opium for alcohol. Amongst all modern peoples, dwelling under the ordinary conditions of civilized life, repressive measures, at any rate severely repressive measures, not only fail, but worse than fail.[2] Vast numbers of people combine to break the law by all sorts of devices. Modern civilized society is so complex, means of intercommunication are so perfect, the manufacture and secret sale of alcohol are so easy and profitable, the desire to obtain it so fierce, the freedom of the individual so great, that an illegal traffic is organized at once, which swiftly grows beyond the control of the authorities. Secret debauchery is substituted for open drinking. The actual amount of drunkenness is increased. The successful evasion of one law has for its concomitant a contempt for all law, which in turn is followed by a long train of attendant evils. If the society be at all highly organized, if the population be dense, the means of communication good, and the government democratic, the law is soon repealed.

528. These statements are very sweeping, but there is

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night and Monday morning. A penalty is provided for preparing methylated spirits for use as a beverage or with any beverage."—*The Daily Telegraph*, February 11, 1905.

[1] See, for example, Samuelson's *History of Drink*, also *Alcoholism*, pp. 97–112.

[2] See, for example, *The Temperance Problem and Social Reform*, pp. 115–508, by Messrs. Rowntree and Sherwell (Hodder and Stoughton); also *Alcoholism*, pp. 144–157.

ample evidence to justify them. I cannot do more than glance at it here, and must limit myself chiefly to English-speaking peoples. Total prohibition is now the law in five States of the American Union.[1] It has been tried and abandoned in ten.[2] When the prohibitory laws were passed, the number of persons per square mile averaged eighteen in those States which have *continued* prohibition, and forty-one in those which have *abandoned* it. In 1890 the numbers had increased to twenty-three and ninety-eight respectively.[3] In that year, in the five prohibition States, not a single town contained 50,000 inhabitants, and only five per cent. of the people lived in towns of more 30,000 inhabitants.[4] New York has a population of 3,500,000; Chicago, 1,850,000; Boston, 582,463; Portland, the classic prohibition city, 41,508. In 1888, the latest year for which statistics are available, there were forty-two convictions for drunkenness per 1,000 of the inhabitants in Portland; in New York thirteen per 1,000; in Chicago, twenty-three per 1,000; in Boston forty-five per 1,000.[5] The sale of drink is permitted in Boston, but not in the surrounding areas. Forty-four per cent. of those convicted in Boston were absentees—people who had come in from the surrounding prohibition areas to procure drink.[6] Cambridge, one of its suburbs, is the largest prohibition city in the States. Since it adopted "no licence," the proportion of arrests for drunkenness per head of population has been more than doubled.[7] The following is the condition of Portland, as depicted by General Neal Dow, the great apostle of prohibition: "A few weeks ago the police arrested eighty persons, sixty of them for drunkenness. That is a larger number by far than was ever before arrested in Portland for that offence. It would be interesting, perhaps startling even, to compare that harvest with those of Boston, New York, or Chicago, as to the proportion of drunkenness to the population."[8]

529. Throughout the prohibition States of America the condition of the towns is everywhere similar to Portland. "The position of things in Maine and other States is not that prohibition is imperfectly enforced, but that, after a long period of experiment, the authorities have deliberately suspended prohibition by a definite (albeit irregular) system

[1] *The Temperance Problem and Social Reform*, p. 119.
[2] *Op. cit.*, p. 120.
[3] *Op. cit.*, p. 120.
[4] *Op. cit.*, p. 124.
[5] *Op. cit.*, p. 158.
[6] *Op. cit.*, p. 321.
[7] *Op. cit.*, p. 321.
[8] *Op. cit.*, p. 158.

of licence."[1] Local option, a form of prohibition, is not enforced in a single large town of America, except where there is an adjacent "safety valve."[2] Canada presents much the same spectacle as the United States. Wherever the population is at all dense prohibition fails.[3] Most of the Australian colonies have a law of local option in one form or another. Practically speaking it is nowhere enforced[4] except in the "King Country," the inhabitants of which are almost exclusively Maoris, and in the Clutha district of New Zealand. Its success may be gauged by the following: "The Maori chiefs in the 'King Country,' New Zealand, have asked the Government to substitute a limited licensing system for the prohibition which is in force at present, and under which liquor of bad quality is being sold everywhere. Mr. Seddon, the Premier, approves of the proposal. He told a deputation that the chiefs and the police were unanimous in stating that prohibition had spread the evil it had been intended to exclude. Sly grog-selling is rampant, and could not be stopped. The same thing was going on in the Clutha district in Otago, where there were no Maoris, and where prohibition was enforced by popular vote."[5]

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530. The following is a typical example of the operation of prohibitive legislation in a modern democratic community:— "The Clutha Prohibition is not the only one we have had in New Zealand. A Local Option law existed in this colony many years ago. Under its provisions it was open to the people in any district to vote 'No Licence.' In the North Seventy Mile Bush in the Hawke's Bay Province, in a township called Ormondville, a man who had drunk himself mad went home one day and murdered his wife and four or five children. Naturally a thrill of horror passed through the district, and when the next Local Option poll was taken the people voted solidly and solemnly for 'No Licence.' The public-houses in Makotutu, Ormondville, and Norsewood were closed for three years. Did drinking and drunkenness cease? No. The drinking customs of the people underwent a change for the worse; sly grog-selling became rampant, and more liquor was ordered for consumption in that district than ever before or since. In private houses bottles were kept from which any one might help himself, so long as he deposited the requisite sixpence per nip on the mantelshelf. In more

[1] *The Temperance Problem and Social Reform*, p. 242.
[2] *Op. cit.*, pp. 315–322. [3] *Op. cit.*, pp. 326–346.
[4] *Op. cit.*, pp. 350, 352, 354, 355, 357.
[5] *The Morning Post*, October 29, 1900.

than one instance this led to the woman of the household cultivating a taste for liquor, with the inevitable result that secret dram-drinking led to the downfall of women who would never otherwise have known the taste of liquor. Secret rooms were fitted up as bars, where every kind of liquor was dispensed, and in some of these shocking scenes were witnessed. Meantime the business of the township suffered, as travellers were compelled to pass on to neighbouring towns to obtain accommodation. Visitors who had been in the habit of spending a few weeks in the bush for health's sake were prevented from the same reason from sojourning in the district. Drunkenness and debauchery increased, and, so soon as the prescribed period of Prohibition had passed, the people voted to re-open the hotels. The Clutha people are passing through a similar experience; the stipendiary magistrate of the district has deemed it his duty to report to the Government that sly grog-selling, drunkenness and debauchery, lying, sneaking, and spying had succeeded where the people had previously been law-abiding and decent. It will be long before regulation will once more hold sway, because not only have the promises made in the name of Prohibition not been kept—they have been proved to be utterly fallacious. Injury has been done where benefit was predicted, and immorality has succeeded to decency of behaviour. As Principal Grant of Canada recently declared, it would be better to return to the drinking customs of thirty years ago than that the degradation existent in Maine should come as a result of so-called Prohibition."[1]

531. Probably of all modern repressive measures the Gothenburg System has afforded the best results. Formerly the laws and social customs of Sweden and Norway seemed almost as if purposely designed to create in a population that had undergone only a limited amount of evolution the maximum of drunkenness possible—to make drunken even those who were not greatly inclined to drunkenness. "At the commencement of the nineteenth century it was enacted that in Sweden the right of distillation should go with the soil, *i. e.* that it should belong to those who possessed or cultivated the land; and ten years later the privilege was extended to tenants and other persons resident in the country, if the owner of the estate gave them leave. . . . When the home distillation was allowed, it was a miserable state of things. One peasant would set his still going one

[1] Mr. I. T. M. Hornsby, a journalist of New Zealand, *Westminster Gazette.*

week, and invite his neighbours to come in, and they would be sure to do so, and all would get drunk together, and the following week his neighbour would begin."[1] The great intemperance which existed (and still exists) in Scandinavia demonstrates the marked contrast between a race which has undergone much evolution and one which has undergone comparatively little. Facilities for drunkenness, as great or greater than those which formerly existed in Scandinavia, have long been present in the south of Europe, the inhabitants of which are comparatively temperate.

532. About the middle of the century domestic stills were abolished, a higher excise duty was imposed, and eventually the sale of spirits was taken over by a company which proposed not to, and doubtless did not, sell for the sake of profit. The consumption of spirits fell five-fold and drunkenness greatly diminished. The consumption of beer and other intoxicants, however, rose in about the same proportion, and of late years drunkenness has increased; for example, the number of arrests for drunkenness rose from 39 per 1,000 in 1875–1879 to 58 per 1,000 in 1898.[2] The low density of population in Scandinavia—less than one-twentieth of that in England and Wales—made the enforcement of repressive legislation particularly easy.

533. Total prohibition, therefore, from the nature of the case, is an ideal impossible of realization in all civilized communities when the population is at all dense. Partial repression may do temporary good under favourable circumstances—*i. e.* when there is much intemperance and public opinion is strongly roused, when the population is sparse, the police service effective, and the profits of illicit drink-selling not very great. But the evidence of all history indicates that the real solution of the problem must come from the elimination, not of drink, but of the drunkard. The problem is plainly one of heredity, and is very similar to that of consumption. It cannot be successfully approached by a community ignorant of the laws of heredity and the facts of racial adaptation. It is essentially a question for the man of science, not for mere enthusiasts, however well-meaning.[3]

[1] *The Temperance Problem and Social Reform*, pp. 435–6.

[2] *Op. cit.*, p. 461.

[3] Mr. H. G. Wells in his admirable and most suggestive work, *Mankind in the Making*, has discussed this question. "Those who have read Mr. Archdall Reid's *Alcoholism*, for example, will know that he deals constantly with what is called the drink craving as if it were a simple specific inheritance. He makes a very strong case for this belief; but strong as it is, I do not think it is going to stand the pressure of a

534. The human infant comes into the world gifted with a great capacity to make mental acquirements—with a great

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rigorously critical examination. . . . He has not convinced me that there is an inherited drink craving, any more than there is an inherited tea craving or an inherited morphia craving" (pp. 55–6). Mr. Wells is mistaken. The drink craving, as I stated very plainly, is an acquirement, and as such is never inherited. But the inborn tendency to acquire it is certainly inborn and inherited, for otherwise successive generations would not be drunken. This predisposition, this susceptibility to the charm of alcohol, is greater in some races, families, and individuals than in others. "I believe that many causes and temperaments go to the making of drunkards" (p. 58). This may be true, but it is not material. Whatever the causes and temperaments which make men delight in drink, the drunkard is always one so constituted that he does delight in it. Wherever alcohol is plentiful, that one type tends to be eliminated, no matter what the sub-types may be. A species is not the less a species because it contains a number of varieties. Mr. Wells might as well meet a statement that elimination by carnivora evolved wariness in antelopes with an objection that wariness is a complex thing depending on a number of special senses and other physical and mental factors. "There can be no denying that those nations which have had fermented drinks the longest are the soberest; but that, after all, may be only one aspect of much more extensive operations. The nations that have had fermented drinks the longest are those which have been civilized the longest" (p. 59). Mr. Wells forgets the West African savages. "The great prevalence of drunkenness among the upper classes two centuries ago can hardly have been bred out in the intervening six or seven generations, and it is also a difficult fact for Mr. Reid that drunkenness has increased in France" (p. 60). I had already dealt with this point elaborately (*Alcoholism*, pp. 108–9). The course of a river is not to be judged by eddies in a backwater. "Even if we admit Mr. Reid's conception, this by no means solves the problem. It is quite conceivable that the world could purchase certain sorts of immunity too dearly. If it was a common thing to adorn the parapets of houses in towns with piles of bricks, it is certain that a large number of persons not immune to fractures of the skull by falling bricks would be eliminated. A time would, no doubt, come when those with a specific liability to skull fracture would be eliminated, and the human cranium would develop a practical immunity to danger from all sorts of falling substances . . . But there would have been far more extensive suppressions than would have appeared in the letter of agreement" (pp. 60–1). This point also had been dealt with elaborately (*Alcoholism*, pp. 124–6). There *has* been alcoholic elimination; but in what particular do Terra del Fuegians or Australian blacks surpass mentally Europeans who have been weeded out by alcohol for thousands of years? What warrant is there for supposing that artificial selection conducted on the lines of Natural Selection would bring about results that were different?

Mr. Wells, Mr. Bernard Shaw, and some other writers insist that our knowledge of heredity is too vague and limited to permit of its practical application to human beings. If this be so, the future will not mend it. Since variations are spontaneous, since the same parents may produce very dissimilar offspring, we shall never be able to state precisely what the result of mating given individuals will be. We can only say in capacity to remember experiences and a corresponding capacity to learn how to utilize remembered experiences. Correlated to these mental powers is a large brain. Apart from pathological conditions, therefore, an infant who is born with a large head is, other things equal, better fitted for its start in life than one with a smaller head. The skeleton of the human mother has been so modified that, relatively to her size, she has a much more capacious pelvis than any other mammal. Apart from parturition, however, this peculiarity of shape is a disadvantage. Her feet being close to the median line while her thigh-bones are set wide apart, she is forced to preserve her balance, when walking, by swaying from side to side. Men, who as a rule are much more active and capable of enduring fatigue, have narrower pelves. Two opposed adaptive agencies, therefore, have been at work, one to widen the woman's pelvis, and the other to narrow it. Similarly as regards the child, one adaptive agency has tended to enlarge its head so that it may be intelligent, and the other to reduce its head so that it may be capable of being born. Between them these agencies have brought about a close correspondence in size between the head and the pelvis. Moreover, Nature has adopted the device of uniting the bones of the head by means of a loose membrane, so that in difficult parturition they override one another, whereby the shape of the head is altered and its size reduced by the amount of fluid squeezed from the brain into other parts of the body.

535. The parturitions of savage women resemble those of the lower animals in their comparative ease, the mother often resuming her duties immediately after birth. As a rule the

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general terms that offspring tend to reproduce, in greater or lesser degree, the characters in which their parents agree, and to regress towards the specific or ancestral type in characters in which they disagree. This amount of knowledge enables us, within wide limits, to produce any type of plant or animal we please, and is quite sufficient to enable us to undertake selective human breeding. Whether it is right or practicable to undertake it is another question. Personally I do not think it expedient that the drunkard or the lunatic should reproduce his type. The question of practicability depends altogether on a diffusion of a knowledge of heredity amongst medical men, and through them amongst the public. Consumption will grow no worse unless an era of good sanitation is followed by one of bad sanitation—an unlikely event. The drink problem will be solved by Nature, if not by us—and even in spite of us. But the problem of lunacy will grow in magnitude and terror till men are forced to deal with it in a scientific way. Selective human breeding, in so far as certain types must be forbidden to reproduce themselves, is a dire necessity, and therefore a certainty in the future.

difficulties of civilized women are very much greater, for few of them are able to pursue their occupations for a fortnight or more after parturition. Their difficulties increase with each successive generation. At the beginning of the nineteenth century, according to the statistics of the Rotunda Hospital, instrumental aid was given to women on the average once in 608 cases. Probably it is now given twenty times as often. No doubt much of this change is due to the greater skill and confidence acquired by medical men; but certainly not all of it. Every medical man in ordinary practice sees many cases in which the woman would perish but for his aid.

536. Several attempts have been made to explain this growing disproportion between the child's head and the maternal pelvis. Sir James Simpson supposed that parental education increased the size of the child's brain; but this hypothesis involves the fallacy of Lamarckianism. Again, it has been supposed that the occupations of civilized women are the cause of the disproportion; but, since women of all classes are almost equally affected, this explanation cannot be correct. It is difficult, for example, to understand why a fishwife or the wife of a country labourer should have a more contracted pelvis than a savage. Yet again it has been supposed that the disproportion has been caused by the prevalence of rickets. No doubt some civilized women, especially among the urban populations, are more or less deformed from this cause; but it cannot furnish the sole nor even the principal explanation, for difficult labours are common even in such remote rural districts as the Orkneys and the Hebrides, where the dietetic habits of the people have altered very little.

537. The explanation is probably found when we remember the constantly increasing skill and care with which women are treated after child-birth. Civilized women would perish in multitudes did they receive no better treatment than their savage sisters. Savage races, therefore, are kept very strictly purged of narrow-hipped women and large-headed children. But wherever the skilled nurse and doctor have penetrated such women and children have been preserved in large and constantly increasing numbers, to transmit their characteristics to offspring. A type is surviving which was eliminated formerly, and consequently the race is undergoing change. Here, then, is another practical problem of heredity. Unless some means be found to reduce the number of births from families in which difficult labours are common, the curse on women will grow in magnitude with each generation till at length no child is born without surgical aid.

538. Probably of all practical problems of heredity, that of insanity presents the most menacing aspect. "Insane persons have multiplied a hundredfold with civilization to such an extent that where a few years ago one madman was enough, now 500 are needed. In the United States, while the population doubled in a little more than thirty years, the insane increased sixfold, so that in the last decade the increase in population was 30 per cent.; and that of the insane was 155 per cent. In France there were 131·1 insane per 100,000 inhabitants in 1883, 133 in 1884, 136 in 1888. These figures indicate that the number of the insane is larger in most civilized countries, and is increasing every year."[1] "There is now one officially known lunatic to 301·32 individuals of the general population, as against one to 335 nine years ago, and one to 536 in 1859."[2] "From 1st January 1858 to 1st January 1902, the total number of lunatics officially known to the Board . . . has increased from 5,824 to 16,288, showing an increase of 10,464. . . . Since 1858 the number of lunatics under the protection of the Board has increased 180 per cent."[3]

540. The following are the figures for Ireland:[4]—

Years.	Lunacy and Idiocy.	Population.	Ratio of Lunacy and Idiocy to population.
1851	9·980	6,552,385	1 in 657
1861	14·098	5,798,967	1 „ 411
1871	16·505	5,412.377	1 „ 328
1881	18·413	5,174,836	1 „ 281
1891	21·188	4,704,750	1 „ 222
1901	25·050	4,458,775	1 „ 178

As in the case of difficult parturition, many explanations have been offered of the increase of insanity. Parental disease and alcoholism have been thought to explain it in part. But the phenomena of adaptation, the falling death-rate, and the lengthened average duration of life indicate clearly that this explanation is not valid. The growing stress of modern life has been thought to explain it. But, while it is possible that certain classes live under conditions of greater strain, it is very doubtful whether the people at

[1] Lombroso.

[2] *Fifty-fourth Report of the Commissioners in Lunacy*, 1901, England and Wales.

[3] *Op. cit.*, Scotland.

[4] Macpherson, *Edinburgh Medical Journal*, May 1903, p. 398.

large do so. Insanity has increased rapidly in remote districts, as in Ireland, where the conditions of life have not greatly altered. Moreover, this supposition is likewise negatived by the falling death-rate. The fact that lunatics are now better treated and live longer than formerly, and therefore accumulate, has been thought to explain it. But the increase of insanity is admittedly too enormous to be covered by this hypothesis. Besides, the sum total of lunatics is diminished by improved treatment, so that many are now cured who would have remained insane formerly.

541. Formerly lunatics were treated with neglect or great cruelty. "Love is merely a madness, and, I tell you, deserves as well a dark house and a whip as madmen do."[1] No lunatic asylum appears to have existed in antiquity. During the dark ages the insane were revered as saints if their delusions were in accord with the current theology; otherwise they were liable to be burnt as possessed of devils.[2] The Mahomedans, who were first in this field of charity, established an asylum during the twelfth century. Only four asylums are known to have existed in Christendom before the fifteenth century. Subsequently and gradually they became more common; but until lately their inmates were treated like wild beasts. "In most countries their condition was indeed truly deplorable. While many were burnt as witches, those who were recognized as insane were compelled to endure all the horrors of the harshest imprisonment. Blows, bleeding, and chains were their usual treatment, and horrible accounts are given of madmen who had spent decades bound in dark cells. Such treatment naturally aggravated their malady, and that malady in many cases rendered impossible the resignation and ultimate torpor which abbreviate the sufferings of ordinary prisoners. Not until the eighteenth century was the condition of this unhappy class seriously improved. The combined progress of theological scepticism and scientific knowledge relegated witchcraft to the world of phantoms, and the exertions of Morgagni in Italy, of Cullen in Scotland, and of Pinel in France renovated the whole treatment of acknowledged lunatics."[3]

542. Until very recently, then, in the vast majority of cases, the unfortunate lunatic was placed under conditions which insured death or permanent insanity. From the moment his mental unsoundness declared itself he ceased to

[1] *As You Like It*, III. ii.
[2] Lecky, *History of European Morals*, vol. ii., pp. 86–7.
[3] *Op. cit.*, vol. ii., p. 90.

have offspring. The natural selection of the sane, therefore, was very stringent. For some generations past, however, lunatics have been treated with great humanity and skill. Beyond all classes of the community they are now watched over by the State. Men of sound mind, but suffering from bodily illness, may perish in the slums for lack of proper nourishment and care; but the insane are removed to special sanatoria, where, without expense to themselves, they receive food and lodging and are placed under the care of trained nurses and medical specialists, over whom in turn the Commissioners in Lunacy exercise a jealous supervision. As a consequence the lunatic frequently recovers, and is restored to his family, and the right to have as many children as other people.

543. "If, as I have always strongly held and enunciated, hereditary predisposition is the chief factor in the causation of insanity, if the reproduction of their species by physically and mentally tainted, immature, and drunken parents is allowed to go on unchecked, the outlook of our descendants is indeed gloomy. Let me give a concrete instance, and—*ex uno disce omnes.* A man who has been an inmate here more than once—on the last occasion for some five or six years—unexpectedly began to improve, and at length was so much better that his relatives wished to give him a trial at home. I willingly assented, and he was in due course discharged. Within a few months we heard that he was engaged to be married, and he actually was married to—it will hardly be credited—the daughter of a woman who has been here for years, and is never likely to be anywhere else. . . . Similar cases, which are far from being isolated or rare, are constantly being forced under our observation."[1] "For years I have been struggling to prevent idiots and lunatics being sent from our county asylum to marry and breed idiots—just as if the thing were desirable. I gave it up in hopeless despair about four years ago, owing to the following case:—A woman who is more than half idiotic came to live with two sisters—one a total, the other a partial idiot. She married a very dull, partially idiotic man, and had almost immediately to be taken to the asylum. There she gave birth to a complete idiot, and was sent home a few weeks afterwards, with the result that the same thing had been repeated nine times."[2]

[1] Annual Report (1902), F. H. Craddock, Medical Superintendent of Gloucester County Lunatic Asylums.

[2] Extract from a Woman's Letter, quoted by Dr. R. R. Rentoul.

544. The severity of Natural Selection with regard to the insane has been greatly reduced, and, as in all similar cases, characters which selection formerly eliminated are tending to become more common. Here we have to deal not necessarily with regression. Except in the case of congenital idiots, regression probably plays but a small part in the causation of insanity—at any rate regression of the brain and mind *en masse*. Partial regression, however, may account for many cases of insanity, though we have no means of ascertaining it. The huge brain of man is a very complex and delicate machine. A defect (an unfavourable variation, progressive or regressive) in any of its parts is apt to throw the whole out of gear; and, like other variations, such a defect, such a predisposition to insanity, tends to be inherited. In this case, as in others, there may be blended, particulate, or exclusive inheritance; or parental insanity, latent in the child, may reappear in succeeding generations. If the insane parent departs very widely from the normal type, exclusive inheritance in offspring or descendants is, according to Mendelian principles, very probable. Here also it follows, unless we find means to check the output of children by the mentally unsound, lunatics will multiply until the State is able no longer to bear the expense of their maintenance.

545. Whether the theory of heredity formulated in this volume be or be not correct must be judged by the reader. I have endeavoured to found its conclusions wholly on evidence which may be verified, and as much as possible on evidence which falls within the experience of most educated men. I have tried also to demonstrate the importance of the subject. However greatly I may be shown in the future to have erred in this or that particular, it is evident that the time has arrived when the subject of heredity must engage the attention of thinking people, especially medical men. A knowledge of it should be a part of the ordinary professional equipment of the physician. Apart from its intellectual and educational value, the subject possesses a practical interest. We cannot expect botanists and zoologists, whose studies are singularly exclusive, to pay much attention to the recent past or immediate future of Man. Historians, too, are preoccupied with minor political changes. A great field of knowledge, in which biology and political history meet, remains untilled. It is the task and the duty of medical men to gather its harvests and apply them to the

future betterment of mankind. It must be remembered how greatly Darwin benefited thought and knowledge by calling the attention of men of science from the exclusive study of the individual to the scrutiny of the race. A similar work awaits medical men. Owing to improvements in medical science and the consequent survival of the hitherto unfit, tremendous problems have arisen, the solution of which cannot long be delayed without disaster to the species.

APPENDIX A

CHARACTERS, INBORN AND INHERITED

(See § 70.)

THE list of examples given in the text may be greatly extended. Thus De Varigny[1] says that when the small brown honey-bee from High Burgundy is transported into Bresse—although not very distant—it soon becomes larger and assumes a yellow colour; this happens even in the second generation. Vilmorin noted that the red, yellow, and violet colours of carrots appear only after cultivation. Moquin Tandon has noted that violets, blue in the valleys, tend to become white at a greater altitude. Animals transferred from cold to warm climates tend to lose their wool and acquire hairs, whereas animals taken from warm to cold climates acquire wool. Fowls in Columbia are said to lose their feathers, though the young are hatched with the usual down. Snails from different localities, which differed in appearance, have grown alike when reared in the same environment. The leaves of the common dandelion are more incised and dentate on dry than damp soil. *Artemia salina* develops characters resembling *Artemia milhausenii* when removed to salter water. Turkeys reared from the wild species tend to lose their metallic tints and to become spotted in the third domestic generation. Pictet[2] has recently altered the colour of butterflies by transferring the caterpillars from the normal food plant to another. He found that each kind of abnormal food impresses its characteristic effects on the offspring. These effects persist and increase for some generations, but eventually the race becomes accustomed to the new food, and thereupon returns to the primitive type. "Clayton allowed six bean plants to grow in a spot where they would catch all the sunshine of the day, whilst six other similar plants were protected by a boarding which effectually screened off the sun. When freshly gathered in October the weight of the beans and pods of the exposed plants was to that of the protected as ninety-nine to twenty-nine, whilst the weight of the dry beans was as sixteen to five. The next year the weight of the fresh beans and pods obtained from the sunshine-grown seed of the previous year was half as much again as in the case of the plants from shade-grown seeds, in spite of the fact that all

[1] *Experimental Evolution.*

[2] *Influence de l'Alimentation et de l'Humidité sur la Variation des Papillons.*

the plants were now grown in sunshine and under precisely similar conditions. In the fourth year plants with an exclusively shady ancestry produced flowers but failed to mature fruit."[1]

Many other examples of racial change under the direct action of the environment have been alleged.[2] Most of them admit of the simple explanation that the reputed variations are no more than mere acquirements. But such examples as those instanced by Pictet and Clayton cannot be set aside so easily. Pictet's observations raise the presumption that under novel conditions the germ-plasm may be affected temporarily by direct action, but that it tends always to swing back to the normal, the change in the offspring being something between a variation and a modification. Obviously Pictet's observations do not disprove the contention that racial change—permanent change that is—is not usually due to direct action. The lesson conveyed by Clayton's beans is even more instructive. We do not know that the alteration caused by shade was more permanent, more innate, than that caused by nutrition in Pictet's butterflies, but, in any case, its occurrence rendered the race extinct. Had there been among the beans a single individual, the germ-plasm of which was insusceptible to the direct action of the environment, the descendants of it would have survived, and an insusceptible type would have been established by Natural Selection. This insusceptibility, therefore, was essential to the persistence of the race, and a like insusceptibility to the influences by which they are surrounded is essential to the persistence of all races; for all races are exposed to influences injurious to the cells of the individual.

No doubt germ-cells are as liable to injury as any other kind of cell. But the somatic cells reproduce their types truly even when exposed to prolonged injury, as in the case of a gland affected by tuberculosis. We have no reason to suppose that germ-cells are less resistant. Apparently their hereditary tendencies have been so firmly implanted by Natural Selection that an injury which is sufficiently powerful to change them is usually sufficient to cause the death of the cell. It is probable, in fact, that the action of Natural Selection is more complex than biologists have supposed. As indicated by Darwin, the environment eliminates unfit individuals and so produces evolution; but, in addition, it is likely that it eliminates unfit germ-cells—that is, all germ-cells easily altered by its influence. Natural Selection therefore operates, not only on the individuals of a race, but antecedently on the germ-cells whence they spring; and this doubtless is a partial explanation of the fact that even the

[1] Vernon, *Variations in Animals and Plants*, p. 247.

[2] See for example *Evolution and Adaptation*, by Prof. H. D. Morgan. Chapter IX.

higher animals which produce few offspring nevertheless contain an altogether disproportionate multitude of germ-cells. Material is thus provided for a germinal selection more real than that which Weismann sought to demonstrate[1]—a germinal selection strictly comparable to the selection of individuals which follows later. Probably a similar form of selection prevails among the somatic cells. This hypothesis may appear far-fetched at first sight; but, when we remember (1) the apparently wasteful superabundance of germ-cells in the higher animals, (2) the fact that somatic cells usually perish under the action of the environment before they alter their hereditary tendencies, (3) that all species must perish unless their germ-cells possess a like insusceptibility, (4) that this insusceptibility must have resulted from Natural Selection; and (5) that in this case Natural Selection can operate with greater advantage when it selects germ-cells than when it selects individuals, the truth of the hypothesis is rendered at least possible.

It is obvious that an immense amount of confusion has been caused in biological discussion by an inaccurate use of the terms *inborn* and *acquired*, or their equivalents. An endeavour to gain the clearest possible perception of their meanings will therefore be well worth our while. Living beings develop from the germ mainly under the influence of three distinct stimuli, that operate from the external world—nutrition, injury, and use. Other stimuli, such as temperature, exist, but they are comparatively unimportant, and we need not pause to discuss them. To take the example of the human being; up to the time of birth the infant develops wholly or almost wholly under the stimulus of nutrition. Subsequently some of his structures continue to develop under this influence—for example his organs of generation, his hair, his teeth, and his external ears. But as regards other of his structures, though nutrition continues to supply the *materials* for growth, it ceases to supply the *stimulus*.[2] No matter how well he be fed, his limbs for example do not develop much beyond the infantile standard except they be used. If at any time the individual be injured, as by a cut, and survives, the wound supplies the stimulus for the growth that occurs during the process of healing.

Now, when we say that one individual is *innately* like or unlike another, we mean, in effect, that the likeness or unlikeness is due to a similarity or dissimilarity in the germ-plasms whence the individuals sprang. On the other hand, if we say the two individuals agree or differ in their acquirements, we mean that the stimuli under which they developed have been similar or dissimilar in kind or degree. Here the words inborn and acquired are used quite correctly.

[1] See § 158.
[2] See note p. 272.

But when we speak of the inborn or the acquired characters of an individual, then our use of the terms, however much sanctioned by custom, is clearly inaccurate, and has, in fact, been productive of endless confusion. Here, by inborn characters we usually imply those characters which have been developed under the stimulus of nutrition, and by acquired those characters which have been developed under the stimulus of use or injury. But it is difficult to understand how characters developed under one form of stimulus can be more inborn than those developed under another. The individual develops under each only because a prolonged course of ancestral evolution has evolved in his race the capacity to so develop. The capacity to react to the stimulus of use or injury, results just as much from the constitution of his germ-plasm, as the capacity to respond to the influence of nutrition. Moreover, the growth which results from use is, apart from the stimulus, of exactly the same nature as that which results from the stimulus of nutrition; thus when inspecting a man's limb we cannot separate the two. The confusion which results from this illegitimate use of terms is well demonstrated by such a case as the following. Imagine identical twins in utero; suppose that one receives more than his fair share of nutriment, and consequently develops better than the other. Then clearly the two will differ by acquirement, but it would puzzle us to indicate which twin has made the differentiating acquirement.

Logically, therefore, all characters are acquirements. Moreover, all characters are equally inherited, or rather not inherited, for given similar stimulus a man's child develops his "acquirements" just as certainly as his "inborn" characters. The term inherited, like the term inborn, is, in fact, used by biologists, consciously or unconsciously, in a metaphorical sense. When we say that a child has inherited his father's nose, we do not mean that the organ has been transferred to the child, leaving the parent derelict We mean merely that their germ-plasms were similar, and that their characters have developed under similar stimuli. But in this sense a child inherits a scar on its parent's nose; for, given the fit stimulus, a cut, the scar develops just as inevitably as the nose. When people speak of the inheritance of an acquirement, they imply no more than that a character, which use or injury developed in the parent, has appeared in the child under the quite different stimulus of nutrition. When we remember that the capacity to develop a given character under a given stimulus is an adaptation which has been slowly evolved in the race under stringent selection, we are able to realize the miraculous nature of the phenomenon that is supposed to occur. In a single generation a character is thought to be transferred from one category to another. Thus suppose a child is said to inherit a scar; then the parent makes the acquirement by virtue of a power with which evolution has endowed his race; but the child makes it in quite another fashion—by virtue of a mystic power with which evolution has not endowed the race, but which he develops suddenly.[1]

APPENDIX B

MENDEL'S LAWS, AND THE MUTATION THEORY OF EVOLUTION

(See p. 75.)

In the year 1865 Gregor Mendel, Abbot of Brünn, published the results of some interesting and important experiments. He crossed varieties of the pea. The flower of this plant is not adapted to receive the visits of insects, and therefore is normally self-fertilized, the pollen from the anthers falling on the stigma of the same flower. Mendel amputated the stamens and fertilized with pollen conveyed from a distinct variety. Thus he crossed dwarf peas with the ordinary tall type. The first hybrid generation consisted solely of tall plants, which were allowed to self-fertilize themselves, as were their descendants. The next generation broke up into tall and dwarf plants, in the average proportion of seventy-five per cent. of the former and twenty-five of the latter. No plants were intermediate in height. Subsequently, these dwarf plants produced only their like, and continued to do so as long as the experiment was carried on. It seemed evident that their race was purged of the influence of the tall variety. A similar number of tall plants behaved in a like manner. Their race also had become "pure." But the remaining plants (50 per cent.) behaved like their cross-bred parents, producing tall and dwarf offspring in the old proportion, the dwarfs being all pure, and the tall plants pure and impure. This process, also, continued indefinitely.

Mendel named the "tall" character *dominant* and the "dwarf" *recessive*, and supposed that when the "units" which represented them in the germ-cells met in the fertilized ovule, the dwarf unit became latent, leaving the other to direct the development of the plant. He supposed, also, that, during the formation of the germ-cells of this plant, a separation of units took place, so that each pollen-grain and each unfertilized ovule received a single dominant unit, or a single recessived unit, but never a blended unit nor both kinds of units. Whence it followed that when a pollen-grain containing a dominant unit fertilized an ovule containing another dominant unit, the plant that resulted was a pure dominant. Pure recessives arose in a similar manner. But

[1] See pp. 248–50.

when dominant unit met recessive unit, the result was an impure dominant plant that looked like a pure dominant, but produced all three kinds of offspring. His hypothesis may be illustrated by taking black and white marbles, a hundred of each, to represent respectively the dominant and recessive units, and mixing them in a bag. Then if pairs of marbles be withdrawn at haphazard, it is evident that on the average half of them will have partners of their own colour, while the other half will be united to partners of the opposite colour. The twenty-five black pairs will represent the pure dominants and the twenty-five white pairs the pure recessives, while the fifty mixed pairs will represent the impure dominants. If each marble be imagined as a germinal unit capable of multiplication in the embryo, then it is evident that each black pair will for ever give rise to only dominant plants, each white pair only to recessives, while the black-and-white pairs will produce only impure dominants, from which will spring in each generation pure dominants, pure recessives, and impure dominants in the old proportion. The points to be especially noted are (1) that each germ-cell (gamete) contains a single unit for each Mendelian character, (2) that each fertilized ovule (zygote) contains two, one from the ovule and one from the pollen-grain, (3) that these do not blend, but, while one becomes active, the other remains latent, and (4) that both kinds multiply during the formation of the embryo and then separate, so that one unit, and one only, is present in each of the germinal descendants of the fertilised ovule, one-half of the sperm and ovules therefore containing dominant and the other half recessive units.

In addition Mendel found that several other characters in peas were capable of similar segregation; for example, colour of seed-skins, colour of cotyledons, shape of seeds, and colour of flowers. In such cases one character was always dominant over its opposite number. Having ascertained the dominant character, he could foretell with fair accuracy the proportion of descendants that would display it. He found, moreover, that, if a given character were dominant, it did not necessarily follow that the other characters associated with it in the original parent were also dominant. In other words, a variety, dominant over another as regards one character, was perhaps recessive as regards another; whence it followed that characters of both varieties might be visible in the first cross-bred generation. Lastly, he found that characters were inherited independently of one another; thus, when varieties were crossed, descendants might resemble the pollen-parent in one or more particulars, and the pistil-parent in the others; that is, the original sets of characters tended to break up and form new combinations; so that, for example, a plant with yellow cotyledons might have a seed-coat or flowers of a colour different to that which had previously been associated with the yellow albumen.

Mendel's laws have been tested and found true as regards a number of characters of cross-bred plants and animals. In peas, yellow cotyledons, round seeds, and coloured seed-skins are dominant over green cotyledons, wrinkled seeds, and white seed-skins. In flowers colour is generally dominant over white. Similarly pigmented coats in mice and rabbits are dominant over albino coats. In rabbits the normal short hair is dominant over the long or Angora coat. In poultry the "rose" comb is dominant over the "single" comb. In mice the waltzing habit is recessive to the normal. In stocks the hairy leaf is dominant over the smooth leaf. In guinea pigs the rough coat is dominant over the smooth, and the short over the long. "Among guinea pigs there occurs a series of alternative pigment types which show Mendelian relations to one another. If we write them in this order, (1) agouti (*i. e.* black ticked with yellow, the ancestral or wild type of coat), (2) black, (3) yellow, (4) albino, we may say that each is dominant over all which follow it, and recessive in relation to all that precede it."[1] Many other examples might be given.

The essential features of the Mendelian phenomena are, (1) that certain of the characters of the crossed varieties do not blend, but segregate, in offspring, and (2) that these characters may be inherited independently of one another; they are what are technically termed allelomorphs, separate inheritable units, each of which in one set of allelomorphs is capable of displacing its opposite number in another set. But, while dominance is complete in some cases, it is incomplete in many others. Thus if short-haired guinea pigs be crossed with the long-haired or recessive type, some of the long-haired descendants have hair shorter than their long-haired ancestors; whereas some of the short-haired descendants have longer hair than their ancestral type. Rough-haired cross-breds are often less rough than their types. Cross-breds between white and pigmented individuals may have coats spotted with white. In Mr. C. C. Hurst's experiments on poultry[2] it was found with regard to a number of Mendelian characters that dominance was complete in 36·3 per cent. of the cross-breeds of the first generation and incomplete in 61·4 per cent. According to Mendelian law, all cross-breeds of the first generation should exhibit only dominant characters; but "the appearance of a few impure recessives in the first cross indicates that the normally recessive character (normal foot) may sometimes dominate."[3] In many instances the first cross-breed generation resembles the common ancestral type, not the dominant parent, and Mendelian segregation occurs only subse-

[1] Castle, *Popular Science Monthly*, July 1905, p. 197.

[2] Report, II, to the Evolution Committee of the Royal Society, 1905, p. 137.

[3] *Ibid.*, p. 154.

quently. The dominant character is usually the ancestral or normal type from which the recessive variety has been derived. Thus the normal agouti coat in guinea pigs is dominant over all the derived varieties. There are exceptions, however; for example, in guinea pigs the derived rough coat is dominant over the normal smooth coat. Professor De Vries maintains [1] that Mendel's law obtains only when a variety in which a character has become latent is crossed with a variety in which that character is visible—that is, when a regressive variety is crossed with its own ancestral type. If the character is absent, not latent, in one of the conjugating pairs, as when a progressive variety mates with its ancestral type, he believes that the union tends to be more or less sterile; or, if offspring arise, that they tend to blend in varying degrees the characters of both varieties and to reproduce the blended type in descendants; that is, they breed true, there being no Mendelian segregation.[2] Apparently he is of opinion that characters which have once appeared in a species, but which are seemingly absent in descendants, are never entirely lost, but become latent. Thus, according to him, a white flower, derived from a blue or red variety, has the colour dormant. It is probable that, in the example given, he is right. Large regressions occurring in a single generation usually indicate latency, not complete loss. But in the immense majority of instances—that is, when small and newly-acquired characters disappear in a single generation, or when, in the absence of selection, larger and more ancient characters slowly disappear in the course of many generations—there is every reason to believe that the loss is complete. We are driven to this conclusion by our knowledge of the extreme parsimony of nature. All progressive evolution consists of an increase in the complexity of the germ-plasm. It is reasonable to suppose that that which can be added can also be subtracted. De Vries' hypothesis unnecessarily endows the germ-plasm with an almost unimaginable complexity. It supposes, for example, that all the characters of man's remotest ancestors are latent in him—all the traits of the long and varied line of lower animals from which he is descended.

Perusing Mendelian literature, the reader is apt to gather the impression that segregation of parental characters in descendants is the normal, and blending quite the exception. As a fact, however, segregation is rarely seen except when varieties are crossed, a thing which of course seldom happens in nature. In normal pure or intra-varietal breeding blended inheritance is the rule. Thus, when two human beings mate, the inheritance is rarely Mendelian. Professor Castle states, "In man a condition of hypophylangia (two-jointed instead of three-jointed digits) is dominant over the normal condition. . . .

[1] *Species and Varieties*, p. 276, *et seq.*: Open Court Publishing Co.
[2] *Ibid.*, Lecture IX.

In man, a peculiar dark-coloured condition of the urine known as alkaptonuria, is inherited as a Mendelian recessive character."[1] To his examples may be added albinism, polydactylism, deaf-mutism, colour-blindness, hæmophilia, cataract, eye-colour, perhaps colour and texture of hair, and a few other characters. But the claim that these "suffice to show that Mendelian or alternative inheritance is neither a rare nor an exceptional phenomenon," is, to say the least, hardly justified. Even in cross-breeding blended inheritance is extremely common. But of this more anon.

The Mendelian theory of heredity is linked in the minds of many of its supporters with the "mutation" theory of evolution. In the present work we have maintained that, since the individual in his own development recapitulates (with variations) the development of his parent, therefore, of logical necessity, he must recapitulate (with omissions and additions) the life-history of his race. It follows that a progressive variation implies a complete recapitulation of the life-history as presented by the parent, *plus* a prolongation; whereas a regressive variation implies an abbreviation of the life-history, and therefore a reversion to the ancestral type. We noted that, though variations occur all round the specific mean, yet the more or less rapid disappearance of all structures that are not maintained by selection, demonstrates that the tendency to regression is stronger than the tendency to progression. Moreover, since progressive variations tend to disappear in the next generation, since newly-evolved structures can only be maintained by stringent selection, and since old-established structures such as the vestigial remains of organs long useless are, speaking comparatively, extremely stable, we concluded that time was the principal element in the establishment of stability, and that stability was never absolute, but always relative. But the mutation theory accounts for stability differently. It supposes that variations are of two distinct kinds—an unstable kind, which tends to disappear in offspring and which plays no part in evolution, and a stable kind, which has no tendency to disappear, which "selection alone can eliminate,"[2] and on which, therefore, evolution is founded. The unstable type of variation is termed continuous or "fluctuating." The stable type is termed a mutation, or a discontinuous variation.

One of the main difficulties in the way of discussing the mutation theory arises from the apparent divergence of opinion among its supporters as to what constitutes a mutation. The word "discontinuous" implies that it is a large variation, an "abnormality," and it seems to be so understood by most of the supporters of the theory. Thus Professor Castle writes: "We find within a species two varieties, one larger than the other. Have they

[1] *Popular Science Monthly*, July 1905, pp. 197–9.

[2] *Mendelism*, by R. C. Punnett, Macmillan & Bowes, Cambridge, p. 52.

diverged by gradual cumulation of minute differences in size, or by a single step? These alternative views are known respectively as the selection theory and the mutation theory."[1] Other writers, however, imply that mutations are not necessarily distinguished by magnitude. Thus Mr. Punnett writes: "The difficulty of distinguishing between the two is very great. The simultaneous existence of small mutations and large fluctuations leads to the disguising of the former by the latter . . . . it is by the selection of mutations, often very small, that the gardener improves his varieties."[2] De Vries limits the term "mutation" to discontinuous progressive variations, and strenuously denies that mutations are subject to Mendel's law.[3] Most mutationists, however, seem to apply the term to regressions as well as progressions,[4] and some of them insist that a mutation is distinguishable from a variation only by the fact that inheritance as regards the former is Mendelian, whereas it is blended as regards the latter. Thus Mr. Punnett writes: "The magnitude of the mutation may be great and striking, or it may be comparatively small. But whatever its size its inheritance would seem to be according to the law of gametic segregation."[5] Occasionally language is used which implies that the writers regard all variations as (Mendelian) mutations, the term "variation" being then applied by them to the characters which we have termed "acquirements."[6]

Here, then, we have the rival theories of evolution and heredity—the selection theory, which supposes that evolution depends on

[1] *The Mutation Theory of Organic Evolution from the standpoint of Animal Breeding*, by Prof. W. E. Castle, *Science*, April 7th, pp. 521–525.

[2] *Mendelism*, pp. 51–2–3.

[3] *Species and Varieties: Their Origin by Mutation.* Lectures IX and X.

[4] See, for example, *Mendelism*, p. 49. "It is probable that the dwarf pea arose as a mutation from the tall."

[5] *Mendelism*, p. 47. See also *The Mutation Theory of Organic Evolution from the standpoint of Animal Breeding*, by Prof. W. E. Castle, p. 6. According to Mr. Bateson and Miss Saunders, "such discontinuity will in fact depend not on the blending or non-blending of the characters, as hitherto generally assumed, but on the permanent discontinuity or purity of the unfertilized germ-cells." Report, I, to Evolution Committee of Royal Society, p. 130.

[6] "Mendel's discovery then has led us to materially alter our ideas of the evolutionary process. The small fluctuating variations are not the material on which selection works. Such fluctuations are often due to conditions of the environment, to nutrition, correlation of organs, and the like." (Punnett, *Mendelism*, p. 52.) "Variations which are distributed symmetrically about a modal condition, so as to produce, when graphically expressed, a frequency of error curve, represent the result of a number of causes acting independently of each other. These causes are principally external, consisting in varying conditions of food-supply, temperature, density, moisture, light, etc. These conditions alter from generation to generation, and so do effects dependent on them. Mutations, on the other hand, have an internal origin in the hereditary 'substance' itself. They are relatively independent of the environment, being affected only by such causes as affect the nature of the hereditary substance itself, one of which is apparently cross-breeding." (Castle, *Op. cit.*, p. 8.)

the accumulation of small fluctuations, and that stability results from the fixing of originally unstable variations by continued selection, and the mutation theory which supposes that evolution depends on mutations which are stable from the beginning. Which of these theories is true? Have the selectionists failed to note that the variations on which evolution is founded are absolutely stable from the moment of their first appearance, or have the mutationists, in their general neglect of the doctrine of recapitulation, failed to note that the variations on which evolution is founded are invariably fluctuating at first, but become more and more stable under the influence of selection?

We may dismiss at once, as obviously in conflict with notorious and indisputable facts, the hypothesis that mutations are stable, and therefore are the materials of evolution, because their transmission is Mendelian. The human race offers peculiarly favourable opportunities for the study of heredity—opportunities that have been woefully neglected. Of necessity, we know it better than we can possibly know any other species. We constantly note the occurrence of variations amongst our relations and friends, and we cannot possibly miss the occurrence of mutations, at any rate considerable mutations among them. Owing to the cessation of stringent selection as regards many particulars, Man is probably the most variable of all natural species.[1] The varieties of mankind, scattered as they are over the whole habitable world, have diverged so greatly from one another that they differ, not in one or a few characters, but practically in all observable characters. Great migrations to distant lands, and therefore to novel conditions of life, have occurred. All human races appear to be inter-fertile, and hardly a race exists which has not crossed occasionally with members of almost all other races. In some instances this inter-crossing has been so extensive that over large stretches of country, as in South America, the half-breeds outnumber the pure varieties. In other instances several varieties have united to form races of compound hybrids. Now, how often do we observe a mutation the transmission of which is Mendelian? In pure or intra-varietal breeding only in very rare cases of useless or injurious mutations—albinism, polydactylism, and the like. The most striking evidence against the Mendelian-mutation hypothesis is afforded, however, by crossed varieties. If human evolution has been on lines of Mendelian mutations, then, of course, crossed human varieties should display Mendelian inheritance. Not a solitary example has been recorded. The most diverse races—*e. g.* Anglo-Saxon and Negro—blend perfectly, and the blend is transmitted unfailingly to the latest descendants. The Negro, it is true, transmits his eye colour to the vast majority of his descendants, but this is prepotency in the Darwinian, not dominance in the Mendelian sense. Pre-

[1] See § 141.

sumably the phenomena of heredity and evolution are alike in man and in other species. The Mendelian-mutation theory, therefore, is obviously erroneous. There is no escape from the conclusion that it is founded on an amazingly restricted survey of the facts;—unless indeed we adopt the hypothesis that human racial differences are not innate, not founded on real evolution, but are merely due to "conditions of the environment, to nutrition, correlation of organs, and the like." In that case we must suppose that the mulatto, for example, appears to be a blend of his parents, not because he really blends their innate qualities, but because his environment is a blend of the African and the European. In other words, we must suppose that all human racial differences are mere acquirements.

If then a mutation is not a character, large or small, the inheritance of which is Mendelian, what is it? Presumably it is a considerable change in a single character—a change which separates it more or less widely from the ordinary type of that character (Bateson),—or it is a simultaneous change, large or small, in a considerable number of characters (De Vries). Whichever view we adopt, the difficulties in the way of a mutation theory of evolution seem insuperable. It must be remembered that every species under pain of extinction must be closely adapted to its environment, that all its ancestral types must always have been so adapted, and that evolution is nothing other than a process of continuous adaptation to a changing environment. The exceedingly delicate co-adaptation of all the parts of the organism to one another, especially in the case of the higher animals, must also be borne in mind. This co-adaptation is a principal "object," a principal result, of selection; for by means of it organisms are fitted to their environments. Lastly, it must be borne in mind that selection is, not only a cause of evolution, but also a cause of specific stability.[1] In the absence of selection species tend to change rapidly. Mutations are admittedly rare, and even so are seldom adaptive—so rare and so seldom adaptive that the student of his own species, which unfortunately not every biologist is, sees few mutations and never one that is adaptive. Imagine the effect of a large mutation (*e.g.* tumour) on the exquisitely co-ordinated animal economy, especially if it be internally situated! Imagine the effect of a considerable number of smaller mutations! In either case the chances against increased adaptation of the whole to the environment and of the parts to one another are as a million to one. But suppose the seemingly impossible happened, and a variation of one or other type did prove to be favourable, the question of its persistence would then arise. To persist the mutation, since Mendelism is excluded, would have to be, not only favourable, but so prepotent in a Darwinian sense as to be able to maintain itself against all

[1] See § 141.

the levelling effects of bi-parental reproduction. Except in the Mendelian sense such a strength of prepotency is unknown in nature.

De Vries, indeed, supposes that in "mutating species" many individuals tend to change simultaneously in the same direction, that they tend to be infertile with the parent type, and that thus new "elementary species" are established. But probably all the instances of epidemic mutation recorded by him are instances of reversion in species which have undergone rapid evolution—reversions of the kind that is common enough in prize breeds of animals and plants. It is noticeable, besides, that none of the examples quoted by him imply increased adaptation. Most of them are instances of unimportant changes in colour and shape of leaves or flowers—unimportant that is regards the adaptation of the whole individual to the environment and of its parts to one another.

If evolution has resulted from the selection of mutations which, unlike fluctuating variations, are stable and never disappear, except through the action of selection, how shall we account for the regression of the old-established parts in the *total* absence of selection—the vestigial parts of plants and animals for example?

For some thousands of years man, especially civilized man, has been stringently selected by disease, and in a number of instances has undergone great evolution against it. Obviously human variations, as regards resisting power to disease, are of a most fluctuating type. In the same community, even in the same family of people of the most resistant race, we may find individuals who are highly resistant to this or that disease, others whose resisting power is very low, and all intermediate types. The hypothesis of evolution by prepotent mutations is excluded by the fact that, when a race (*e. g.* Spanish) which has undergone evolution against a disease (*e. g.* tuberculosis) crosses with a race (*e. g.* American Indian) which has undergone no evolution, the offspring blend the characters of their parents, and are neither so resistant as the one race nor so susceptible as the other. Surely, if in this most familiar and easily investigated example, evolution has proceeded on lines of "fluctuating" variations, we have no right as scientific men to assume that in all other instances it has proceeded on different lines.

Plants are more variable than animals; or rather species of plants tend more to break up into a greater number of varieties than species of animals. Parthogenetic species of plants (*e. g.* hawksweed, dandelion) or self-fertilized species (*e. g.* wheat, pea) possess an exceptionally large number of varieties.[1] The obvious

[1] See De Vries, *Species and Varieties*, pp. 59–61. "Thousands of forms (of dandelion or hawksweed) may be cultivated side by side in the Botanical Gardens, and exhibit slight but undoubted differentiating features, and reproduce themselves truly by seed."

explanation lies in the fact that their variations are not swamped by bi-parental reproduction. The swamping, or rather averaging effect of sexual reproduction is naturally greatest in the case of those animals whose superior powers of locomotion enable them to commingle most. It is least in the case of plants that are self-fertilized, and especially in the case of those which reproduce parthenogenetically. Species of animals, of which the powers of locomotion are limited, possess almost as many varieties as plants.[1]

We are told that selection (*i. e.* the selection of small fluctuating variations) cannot create. But if it cannot create it can alter, and so in the course of ages produce what is in effect a new creation. The essence of the selection theory is that nothing that is useful, and therefore permanent, is ever "created," but that all such characters arise by the gradual alteration of pre-existing structures. In this way the human hand and brain, to take extreme example, have arisen from ancestral structures which were immensely different, but which in every stage were useful to their possessors. Thus also have arisen the scales of fishes and reptiles, the feathers of birds and the hairs of mammals.

The mutation theory of evolution is quite impossible. If, instead of groping in the comparative obscurity which surrounds wild nature, or amid the confusion which has resulted from the unrecorded crosses and the generally abnormal conditions under which domesticated species exist, men had turned their attention to the clear, voluminous, decisive evidence, much of it statistical, afforded by their own species, it would never have been propounded.

Bi-parental inheritance, as we have seen, may be blended, particulate, or exclusive. Since characters may be inherited independently of one another, particulate inheritance may be regarded as a variety of the exclusive type. Exclusive inheritance may be alternative, as in typical Mendelian cases, or non-alternative, as when one parent is prepotent over the other in the Darwinian sense.

Since many species reproduce parthenogenetically, the union of germ-cells derived from different individuals is clearly not a necessary condition of reproduction. Nevertheless this method of reproduction, notwithstanding its obvious disadvantages, is so nearly universal in nature, that it must possess some function of immense importance. Weismann has suggested that this function is the causation of variations, both progressive and regressive. But variations have been proved to occur in abundance in parthenogenesis, and, as we see, parthenogenetic and self-fertilized species are particularly rich in varieties. It has been proved,

[1] For example, snails. See Romanes, *Darwin and after Darwin*, vol. iii., p. 16.

moreover, that the actual effect of bi-parental reproduction (amphimixis) is to cause regression towards the specific (*i. e.* ancestral) mean; for which reason species that reproduce bi-sexually, and are endowed with large powers of locomotion, produce comparatively few varieties. Such species when they evolve, when they progress or regress, do so as a whole. Unlike parthenogenetic or self-fertilized types, they form varieties only when sections of the species are geographically separated. It would appear, therefore, that the actual effect, the real function, of bi-parental reproduction is the elimination of useless progressive variations.[1] This is necessarily of the greatest importance to large, complex, and mobile animals. For obvious reasons, variations tend to occur in the greatest number in them, and when unfavourable tend to throw their many closely co-ordinated parts out of gear. None of the higher animals, therefore, reproduce parthenogenetically, nor are self-fertilized. Neither the one nor the other method of reproduction provides the maximum quantity of regression. Only some plants and lower animals are thus produced.

Blended inheritance causes regression to the parental, and therefore towards the specific mean. While it is a potent cause of the elimination of useless progressive variations, it does not prevent that raising of the specific mean as regards useful characters which results from stringent selection.[2] Equally effectual as a cause of regression is that form of exclusive inheritance in which one parent is prepotent in the Darwinian sense; for, since this parent is usually the one which has not varied progressively, the ancestral type is reproduced. This form of inheritance is more common and of greater importance than most authors seem to realize. Very seldom, for example, does a child inherit a small variation—*e. g.* a mole—which is present in one parent but absent in the other.

Alternative inheritance cannot cause regression towards the specific mean. The most it can do is to produce new combinations of the parental characters—new combinations which would have a disastrous effect on the co-ordination of the parts were Mendelian characters less rare. Nevertheless this form of reproduction does occur; and it should be possible to find a valid explanation of it.

Alternative inheritance occurs especially in the case of characters in which parents differ greatly, we may even say radically. Thus if one parent be fair and the other dark, the inheritance is usually blended; or if one parent has a small variation (*e. g.* a mole), which the other lacks, the inheritance is exclusive in the Darwinian sense; but if one parent is totally devoid of pigment

[1] See Chapter VI.
[2] See § 140.

(*i.e.* an albino), or has an extra digit, or lacks a phalanx, then the inheritance tends to be alternative. We have constantly spoken as if alternative inheritance were a rare phenomenon. In the sense meant the statement was true, and has deceived no one. But in another sense it is not true. In all species, the members of which are divided into males and females, all the larger differences between the mating individuals are subject to alternative inheritance. The male sexual characters are latent in the females, the female characters are latent in the males. It has been surmised that the inheritance of the sexual characters is Mendelian. It is very much more probable the inheritance of Mendelian characters is sexual.

Nature, especially in the case of the more complex plants and animals, has devised all sorts of methods to secure cross-fertilization, the most effectual being complete sexual differentiation. All very complex types, therefore, present two methods of inheritance, the blended and the alternative. Smaller parental differences are subject to the former, larger differences to the latter. In blended inheritance there is of necessity no latency, even though one individual be more or less completely prepotent over the other. In alternative inheritance there is constant latency, but no true prepotency, though there may be something which is often confused with it but is radically different, namely, dominance[1]; for dominance involves latency of the alternative character, which prepotency does not. This dual method of inheritance provides the machinery whereby a maximum amount of regression is secured.

Evolution, no matter how stringent the selection from which it has resulted and by which it is maintained, is never perfect. Often as regards the sexual characters, primary and secondary, but more especially as regards the latter, we see, not complete dominance and latency as in perfect alternative inheritance, but some degree of blending. This occurs in its most pronounced form in hermaphrodites. More common is a slighter degree of blending, as when women display rudimentary moustaches, or men unusually large mammæ. Distinct from this blending, though perhaps generally combined or occurring with it, is the transference of a male or female character from the set in which it is normally found to the opposite set—as when women have long thick beards or men fully-developed female breasts. Nature has evolved alternative inheritance to create and perpetuate sexual differentiation, but she is not a consciously discriminating agency, and, just as the blending of sexual characters sometimes occurs, so, on the other hand, the inheritance of non-sexual characters is sometimes alternative. As we have seen, whenever the latter happens the non-sexual differences are, like the sexual differences, usually considerable. Nature

[1] See *Reports to Evolution Committee*, I, p. 137.

makes the mistake, so to speak, of treating them as sexual. Of course, however, the alternative inheritance of large non-sexual differences is not certain, not so "clean" as that of sexual differences, the alternative inheritance of which has been established by a long course of selection.

It nearly approaches perfection in the case of hæmophilia, which, when it occurs, is almost as much a male character as a beard. But in most instances anomalies occur which tend to link up the perfectly alternative type of inheritance with the perfectly blended type. Thus, as in the case of Mr. Hurst's poultry hybrids, partial blending was very common. Again, the alternation of Mendelian characters is not so perfect as that of the sexual characters; one of a pair is generally so dominant over the other that when the two are brought together, the latter is almost always reduced to latency—for example, when an albino is crossed with a normal individual, the offspring are generally all pigmented, the albino only reappearing, if at all, in subsequent generations.[1] Lastly, the various items of a set of Mendelian characters do not tend to hang together with the persistency which usually characterizes the sexual characters. Unlike the latter they behave as discrete allelomorphs, each of which is independently capable of displacing its opposite number. This is only what might be expected; it has been a main "object" of Natural Selection to evolve a definite combination of sexual characters, but not of Mendelian characters.

A circumstance which tends to confuse our thinking on this subject, and so to obscure our recognition of the essential similarity between the Mendelian and the sexual phenomena, is the following:—When we cross two types that possess alternative Mendelian characters, the first generation consists of impure dominants. If these are self-fertilized or bred together, as they usually are in Mendelian experiments, we get pure dominants, impure dominants, and pure recessives, in more or less definite proportions. The pure dominants can then be bred together,

[1] It should be noted that, in man at least, the dominance of the pigmented type over the albino is by no means complete. Suppose an individual varies so from his parents as to be a pure albino. The chances are he will mate with a pigmented individual. His children will be pigmented impure dominants. The allelomorphs will separate in the gametes. Albinos are so few that they practically always mate with pigmented persons. Therefore, if the dominance of the pigmented type were complete, all the offspring and descendants should be pigmented, except in the very rare cases when an albino allelomorph meets another of the same kind. But the descendants of albinos are so frequently albinos, that the latter hypothesis seems excluded. It appears clear, therefore, that the albino descendant of an albino is probably not always a pure recessive, but that he is often an impure dominant in whom the albino character has the upper hand. In this imperfect dominance of the pigmented type, albinism resembles the sexual characters which are alternatively dominant.

as can the pure recessives. Nothing of this kind ever occurs as regards the sexual characters, for we cannot mate males with males, or females with females. We must perpetually mate together impure dominants, or at least cross dominants with recessives.

It is evident that the significance of the Mendelian phenomena has been mistaken. They are anomalies—rare anomalies—of sexual reproduction. Interesting and important as they undoubtedly are, they furnish no master key to all the problems of heredity.

Varieties are usually fertile when crossed, and their offspring and descendants frequently exhibit Mendelian phenomena. Species tend to be infertile when crossed, and Mendelian phenomena are less common; the hybrids appear, rather, to blend the parental characters. Probably this apparent blending is nothing other than a more or less complete return to the ancestral type, which resembles either species more than they resemble one another. The difference of behaviour between crossed varieties and species may perhaps be explained by the hypothesis that characters tend to behave as Mendelian allelomorphs only when they differ within certain limits. If the difference is too small the characters blend; but if it is too great, neither character is inherited, or there may be a combination of blending and loss.

Apart from Mendelian or sexual latency (*i. e.* the latency of the recessive character in the impure dominant) is that more permanent kind of latency which occurs when ancestral characters lie dormant through an indefinite number of generations. According to Darwin, "Besides the visible changes that it (the germ) undergoes, we must believe that it is crowded with invisible characters proper to both sexes, to both the right and left sides of the body, and to a long line of male and female ancestors separated by hundreds and even thousands of generations from the present time; and these characters, like those written on paper with invisible ink, lie ready to be evolved whenever the organism is disturbed by certain known or unknown conditions."[1] If, however, Darwin's works be carefully studied, it will be found that all, or almost all, the instances of latency quoted by him are drawn from domesticated animals and plants.[2] A similar lack of evidence that latent traits are common in natural varieties may be noted in the works of other writers, for example the Mendelian experimenters. If we cross such varieties, we may render characters latent (usually in the

[1] *Animals and Plants*, vol. ii., pp. 35–6.

[2] Unfortunately my acquaintance with Botany is so small that I am not sure that all the plants mentioned by Darwin are cultivated varieties. (See *Animals and Plants*, vol. ii., pp. 32–5.

Mendelian sense) but we shall seldom discover characters which have previously been latent. Thus, if varieties of men be crossed, not a single latent character is revealed.[1] It would be too much to say that no latent characters occur in natural varieties, but unquestionably they seem far from common. I am not aware that any instances of latency have been recorded among parthenogenetic or self-fertilized species.

The evolution that results from artificial selection differs from that which results from Natural Selection mainly in that it is much more rapid. The breeder, paying scant attention to other characters, chooses the largest favourable variation in the particular character he wishes to develop. It seems probable, then, that characters tend most to become permanently latent when selection is most stringent and evolution most rapid. The Mendelian doctrine does not explain this permanent kind of latency. According to it the allelomorphs meet in the zygote (the fertilized ovum) only to separate in the descendant gametes (the sperms and ova). This separation, however, has only been surmised. It cannot, of course, be seen. Even if it occurs it is certainly incomplete, for, as we have seen, in many instances some degree of blending is observable. It is a question whether it ever really occurs, for on the hypothesis that allelomorphs are interchangeable but not combinable, the blending is difficult to explain. A link between permanent and Mendelian latency is furnished when species alternate parthenogenetic with bi-parental reproduction. Here the male allelomorphs do not separate from their opposite numbers; they merely become latent for a more or less prolonged period; they may, indeed, be rendered permanently latent by various circumstances—in aphides by supplying the animals with plenty of food and preserving a continuously warm temperature. Similarly it is conceivable that in pure "derived" dominants and recessives the opposite numbers are not really absent but only permanently latent. If this be so, since the breeder chooses as large variations as possible, since large favourable variations occurring simultaneously in two individuals, male and female, are not very common, he is often

[1] Darwin (*Animals and Plants*, vol. ii., p. 21) mentions a number of half-caste races as having very bad dispositions, and adds, "From these facts we may perhaps infer that the degraded state of so many half-castes is in part due to reversion to a primitive and savage condition, induced by the act of crossing, even if mainly due to the unfavourable moral conditions under which they have been reared." But there appears no valid reason for attributing any part of the moral delinquency of half-castes to reversion. Racial mental peculiarities of this sort are acquired, not innate. (See § 468.) Darwin himself says, "That many excellent and kind-hearted mulattos have existed no one will dispute. And a more mild and gentle set of men could hardly be found than the inhabitants of the island of Chiloe, who consist of Indians commingled with Spaniards in various proportions."

forced to mate his selected individual with one of the ordinary type. If the inheritance happens to be Mendelian a new race of "pure" dominants or "pure" recessives, as the case may be, is established, in which the "opposite number" ordinarily remains permanently latent so long as the breeding is inter-varietal, but is apt to spring into activity under the influence of crossing or other causes which disturb the stability.

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THE END

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