

of investigation, but it soon had many devoted followers who have done much to advance the science, among the more important being Zirkel, Rosenbusch, Fouqué and Michel Levy.

There yet remain two illustrious names to be mentioned among the founders of geology. They are Charles Lyell and Charles Darwin. Lyell (1792-1875), who exercised a profound influence on the geology of his time, adopted the principles of Hutton, and with marvelous industry collected a vast store of facts in support of the doctrine that 'the present is the key to the past.' He pushed the Huttonian doctrine to its logical conclusion and became the great leader of uniformitarianism, a creed which, according to the author, 'grew to be almost universal in England during his life, but which never made much way in the rest of Europe.' Lyell's 'Principles of Geology' must certainly be regarded as one of the classics of our science. To Lyell, in conjunction with Deshayes, we owe the classification of the Tertiary into Eocene, Miocene and Pliocene, upon the basis of the proportion of living species of shells. Lyell was not so much an investigator as 'a critic and exponent of the researches of his contemporaries.' Ramsey said of him, "We collect the data, and Lyell teaches us to comprehend the meaning of them."

Darwin (1809-1882) did much, not only by his contributions to the literature of geology, but in the introduction of the doctrine with which his name is associated, to revolutionize the geological thought of his time. His demonstration of the imperfection of the geological record and the great antiquity of the earth's crust came, according to the author, 'as a kind of surprise and awakening.'

In concluding the lectures the author calls attention to three prominent facts: first, that but three of the men considered, Werner, Sedgwick and Logan, could be called professional geologists, the others

being either men of leisure, as Hutton, Hall, de Saussure, von Buch, Lyell and Darwin, or professionally engaged in other pursuits, as was the case of the great majority; second, that geology affords 'some conspicuous example of the length of time that may elapse before a fecund idea comes to germinate and bear fruit,' as, for instance, the length of time taken for the true principles of stratigraphical geology to become recognized; and third, that 'one important lesson to be learnt from a review of the early history of geology is the absolute necessity of avoiding dogmatism' the examples of the Wernerian catastrophist and uniformitarian schools being cited.

In endeavoring to give a somewhat comprehensive review of this latest important work of Sir Archibald Geikie it has been impossible to bring out clearly the delightful biographical and personal touches which so charm the reader. In the summary of the work which I have given it has been my endeavor to use, so far as possible, the phrases and happy expressions with which the book so richly abounds. The volume is one of much significance to the student of geology, as it for the first time presents to English readers anything like a satisfactory statement of the development of geology. Many of the men to whom we owe so much regarding our modern views of the science, and whose work has been but little considered by recent writers, are brought before us in their true proportions. The book must take high rank among the many other masterpieces of the distinguished author.

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CHARACTERS, CONGENITAL AND ACQUIRED.

II.

ACQUIRED physical characters (properly so termed) may involve not only quantitative changes, which alone we have as yet considered, but qualitative changes also.

Here, again, a wide field for investigation presents itself. 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 in 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 which is wholly qualitative. Thus eyes which, when unaccustomed to the task, are rendered sore by the continued scrutiny of small objects (*e. g.*, print, as in the case of an adult learner) may by practice be trained, without apparent physical change, to endure this proceeding without damage. Most of these qualitative changes are best studied in connection with mind, but there is one series, of vast importance to the higher animals, and especially to man, which is entirely physical, and to which I may, in conclusion of this part of my subject, draw attention. I allude to the power which Natural Selection has developed in high animals of acquiring capabilities of resisting various poisons, particularly those of offensive and defensive poisons (toxins) which are secreted by various plants and animals. Thus men acquire greatly increased powers of 'tolerating' nicotine and opium, which are *toxins* secreted respectively by the tobacco and poppy plants to protect them from organisms to which they are liable to fall a prey. Thus also man may acquire the power of 'tolerating' the poisons of various species of parasitic micro-organisms which afflict him and the higher animals, and which are the cause of that great class of diseases known as zymotic. These toxins, also, are defensive products by means of which the pathogenic organisms ward off the attacks of the phagocytes

in the blood of the host by which they are liable to be destroyed.* When the phagocytes, through experience of the toxin, acquire the power of tolerating it they destroy the microbes whereby *acquired immunity* is achieved, as in chicken-pox, measles, scarlatina, small-pox, typhoid, etc. Without this power of acquiring immunity (temporary or permanent) there could be no recovery from such a disease as measles, for instance; and therefore, since, unlike malaria, for instance, most of these diseases pass from one infected person to another, and are for that reason diseases of comparatively dense populations. Without this power of acquiring immunity no dense populations could exist. In other words, if this power of acquiring immunity had not been evolved in man, civilization would have been impossible.

I have said that the power of acquiring physical traits does not exist among low animals, or, if it exists, does so in proportion as they are lowly placed in the scale of life, to an extent very small as compared to its development among high animals. If I am right as to this, low animals (*e. g.*, invertebrates) should be incapable or little capable of acquiring immunity against zymotic disease. I am not aware, however, that any observations on the subject have been made.

I dare say that many who read the foregoing will be inclined to dispute the facts and inferences put forward, and to urge, for instance, that I have not established any proof, nor even brought forward convincing evidence, of the truth of my assertion that low animals are incapable, or less capable than high animals, of acquiring physical characters. There is, in truth, no literature to which I can appeal, for the question is

* Vide *The Present Evolution of Man*, pp. 199-32 (London, Chapman & Hall, 1896); and an 'Address on Acquired Immunity,' by the author, *Lancet*, September 11, 1897.

entirely new; and therefore, also, so far as I am aware, no experiments directly bearing on it have been made. Moreover, in the highest animals all acquired physical characters are merely extensions of previously existing inborn characters. Thus the limb of an infant, which is compounded, as we may suppose, almost entirely of that which is inborn, grows under the influence of exercise and use into an adult limb. There is a sharp dividing line, but we cannot perceive it; and, therefore, as regards the infant's limb, we cannot as yet say where the inborn ends and the acquired begins. But in mind, which we have next to consider, the case is often very different. There the inborn is often sharply marked off from the acquired, and we shall find it emphatically true that low animals are infinitely less capable of acquiring mental traits than high animals. Whence, reasoning by analogy, we may, with some confidence, assert that if, as regards mind, the statement is true, in the absence of evidence to the contrary, it is probably true also as regards the physical parts.

Mind, doubtless, owes its origin to movement—to the necessity for coördinated movement in the various parts of the complex cell-community which we call a multicellular animal. Neither mind nor nervous tissue, the organ of mind, exists in plants, among which there is little or no movement. So, also, low in the animal scale, as among sponges, in which cells are not coördinated to perform movements *en masse*, there is no mind nor any need for it. Higher in the scale, as among Coelenterates, in which masses of the cells combine to perform macroscopic movements, we begin to find traces of nerve tissue, but as yet there is, so far as we are aware, no mind. All movement apparently is purely reflex. Yet higher in the scale, as among the Mollusca in which the increasing complexity of the environment necessitates increasingly complex

coördinated movements of masses of the cell-community, the nervous mechanism by means of which this coördination is carried out becomes still more developed and complex, and mind apparently dawns. So far as we know, consciousness then first appears, and with consciousness the rudiments of instinct.

I have elsewhere defined instinct as "the faculty which is concerned in the conscious adaptation of means to ends by virtue of inborn inherited knowledge and ways of thinking and acting."* In other words, instinct depends wholly on congenital characters, and not in the least on those which are acquired. This definition of instinct is far different from those which have hitherto found acceptance, but I think on consideration it will be found that it more correctly describes what we commonly mean by the term than any other hitherto put forth. By instinctive action do we not mean action which is independent of all previous experience and therefore of acquirement? When an insect secures its proper food in the proper way, spins a cocoon, mates with an individual of the opposite sex, or lays its eggs, with fit provision for the future, in an appropriate place, does it not act solely by virtue of inborn inherited knowledge and ways of thinking and acting, and, since it is unguided by experience, not in the least by virtue of knowledge and ways of thinking and acting which are acquired? To the mind of every naturalist will at once occur innumerable instances of actions, some of them extremely complex and elaborate, performed by insects and other comparatively low animals, in which experience can play no part; in other words, which are wholly independent of acquired knowledge and ways of thinking and acting. By means of instincts animals are enabled to place themselves in harmony with an environment infinitely more complex than

* *The Present Evolution of Man*, p. 137.

that to which reflex action alone can adapt them. The element of consciousness and its outcome, choice, are introduced. The conscious animal, unlike the unconscious, is enabled to choose between two or more courses, to which two or more instincts impel him. Thus the male spider approaches the gigantic female, guided by both the mating and life-preserving instincts, and all the complications of his subsequent conduct are due to his power of choice between two or more courses.

Higher in the scale, concurrently with the evolution of the power of acquiring physical traits (properly so called), is evolved the power of acquiring mental traits. It increases in successively higher animals, and at length, in the highest animals, becomes of such importance that it overshadows and replaces instinct, which, since it no longer holds a commanding place as a factor in survival, undergoes great retrogression.* If I can make my readers grasp all that is implied in the above I think they will admit the vast importance I have claimed for my subject—an importance which is not only from the standpoint of the man of science, but from many other standpoints, such as those of the moralist, the sociologist, the statesman, the philanthropist, the physician and others as well.

Let us contrast two animals which, for convenience, we may regard as at opposite ends of the scale, the dragon-fly and man. Tennyson's beautiful lines occur to me. I quote from memory :

To-day I saw the dragon-fly
Come from the wells where he did lie.

*Just as physical characters (*e. g.*, limbs of serpent, lost digits of horse, eye of proteus) undergo retrogression through atavism, wherebymore and more remote ancestral conditions are reverted to till that remote ancestral character is reverted to, when the character did not exist. Vide *The Present Evolution of Man*, pp. 18-30.

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.

Physically, like other low animals, the dragon-fly does not develop in response to exercises and use, or, if he does, it is to a very small extent compared to higher animals. Natural selection has nicely co-ordinated his structures, but has not evolved in them (at least to an appreciable extent) the power of developing further and in the right direction during the changing stress of circumstances. For example, his principal organs of locomotion, his wings and the structures which subserve them, are certainly wholly inborn. Mentally, at the beginning of each stage of his existence he is able to co-ordinate his muscles perfectly, and thus at the beginning of each stage his locomotion is apparently as good as at the end. Both in the water and in the air he knows what food to seek, and what enemies to avoid, and how to do so. At the fit time, impelled by an inborn impulse, he leaves the water, and, having undergone his last metamorphosis, is able, at once, to adapt himself to life in an entirely new environment, where the medium in which he exists, his mode of locomotion, his prey and his enemies are different, and where his procreating instinct comes into activity. But experience teaches him little or nothing; he cannot acquire mental traits; in other words, *he has little or no memory.*

Far different is the case with man. We have seen how much he acquires physically, so that the adult differs from the infant mainly in traits which he acquires, not in those which are inborn. Mentally, his powers of acquirement are even more remarkable; and, therefore, even more as regards his mental characters than as regards his physical characters, the adult differs

from the infant in that which is acquired, not in that which is inborn. At birth the infant's mind is a blank; he can coördinate only a very few groups of muscles (*e. g.*, the breathing, sucking and defæcating groups), and in these the coördination is never very delicate and elaborate. He knows nothing of his environment; he cannot, as can the dragon-fly, instinctively adapt himself to it. But gradually as his body develops under the influence of use and exercise, his mind develops also under the influence of experience, and the blank left by the retrogression of instinct is filled and more than filled by acquired knowledge and ways of thinking and acting. Slowly and painfully the infant *learns* to coördinate his different groups of muscles till at length he can perform such complex acts as speaking, writing and walking in which the coördination is exceedingly delicate and elaborate.* Much, very much, besides the power of coördinating his muscles is acquired by man. For instance, all the vast

* It has been denied (*e. g.*, *Lancet*, May 1, 22 and 29, 1897) that speech and bipedal progression are acquired. The denial arises from that habit of thinking in abstract terms which is the bane of many writers. One cannot speak without words, and every word is acquired and, therefore, speech itself is acquired. For instance, no one is born with the knowledge of the word 'brick.' Again, this sound (brick), like all others in a language, is produced by a particular and very delicate and complex coördination of the speech muscles, different from what is required to reproduce any other sound. The child *learns* to make this coördination, just as in after life he may learn to make that coördination from which results a foreign word, or that coördination of a different set of muscles from which results a written word. Again, a child *learns* to walk in just as true a sense as afterwards he may learn to bicycle. Speech and bipedal progression are common to the whole human race, and, therefore, they are invariably regarded as inborn characters. Writing and bicycling are not common to the human race, and, therefore, they are regarded as acquired; but very plainly the former are as much acquired as the latter. What alone is inborn is the *power of acquiring* speech and bipedal progression and vastly more besides.

contents of his memory and all that arises out of memory are, of course, acquired. Here, again, all that is inborn is the *power of acquiring the contents of the memory*. I have elsewhere defined *rêason* as 'the faculty which is concerned in the conscious adaptation of means to ends by virtue of acquired non-inherited knowledge and ways of thinking and acting.*' Compare, for instance, the construction of a cocoon by a caterpillar, or the first web spinning of a spider, to the construction of a house or the weaving of a net by a man. In the absolute absence of experience the caterpillar and the spider plainly act by virtue of inborn knowledge and ways of thinking and acting, in other words, by instinct; the man, on the other hand, as plainly acts by virtue of acquired knowledge and ways of thinking and acting, in other words, by reason.† In fact, so vast a part does the

* *The Present Evolution of Man*, p. 138.

† The terms 'instinct' and 'reason' are used very loosely even by scientific writers, the meaning of the former often being too much extended, while that of the latter is too much restricted. Thus, it is said, that we instinctively like or dislike this or that object, *e. g.*, man, implying thereby that we do so in the absence of experience. But the new-born infant (unlike the new-hatched fish) has no such instinctive like or dislike; his subsequent likings or dislikings arise as a result of experience, whether such experience remains as a recognizable part of consciousness or not. Again, actions which depend on acquirement, but which have become automatic from frequent repetition, are often termed instinctive, owing to the instinct-like absence of mental effort with which they are ultimately performed (*e. g.*, bipedal progression; vide *Present Evolution of Man*, pp. 144-5). On the other hand, the term rational is often restricted to such actions as conspicuously result from a correct chain of inferences, or to such as are not performed under the influence of violent emotion. For example, when an angry man embarks on foolish litigation we term his action irrational, thus expressly excluding it from the category of rational actions. But his action is certainly not reflex, nor, as certainly, is it instinctive, and, therefore, if we group all actions under the headings of reflex, instinctive and rational this action can belong to the last group only.

acquired factor play in all that is mental in man, that I have been unable to discover any action in him which is purely instinctive. Purely reflex actions he has in plenty, as, for instance, the movements of the various hollow viscera; but of the few instincts which survive in him (*e. g.*, parental and sexual love) none apparently are gratified without the aid of rational action. Consider, for instance, how greatly the instinctive appreciation of female beauty is modified by the acquired factor; there are savage tribes who mutilate, to render beautiful as they think, the faces of their women to a frightful degree.* Consider, again, how much there is rational (*e. g.*, the coordination of her muscles) in the mother's care of her offspring.

As in the case of physical characters, no systematic attempt has been hitherto made to differentiate between the mentally acquired and the inborn. As a result, much confusion and inaccurate thinking is manifest in writings, scientific and otherwise. I propose to deal with these to some extent presently; but first it would be interesting to trace, in however slight a manner, the evolution of the power of acquiring mental traits in animals. But, even before doing this, one other digression I may permit myself, since it has an important bearing on much that follows. It has been maintained that acquired characters, mental and physical, are transmissible. I will not here pause to consider whether such characters as I have ventured to denominate 'enforced,' nor whether such characters as result from the complete or partial reproduction of lost parts, are transmissible. The battle has been fought in countless publications, and I do not know that I have now anything very new or original to add; but I should like to say a little concerning the alleged transmissibility

* Our women have worn crinolines and chignons and still wear earrings and corsets.

of such characters as result from use or experience, for instance, the acquired enlargement of the blacksmith's muscle through use, or the mental change involved in the acquirement of a knowledge of mathematics through experience. Characters like these are held by a section of biologists to be transmissible, in part at least. But when a parent acquires such characters they reappear in the child only in response to stimulation similar to that which caused them to arise in the parent. For instance, without such stimulation the child gets neither the enlarged muscles nor the knowledge of mathematics; in fact, the child must in all cases, acquire such characters afresh; from which it is plain that that which is acquired by the parent does not become inborn in the child.

It may, however, be maintained by Neo-Lamarckians that stimulation causes not only the acquirement of a character, but increases also the power of acquiring it, and that it is this increase in the parent which is transmitted to the child, and which renders more easy the acquirement of the character by the latter. But there is no tittle of evidence showing that the stimulation which results in the acquirement of a character (mental or physical) causes also an increase in the power of acquiring it. The converse is in fact true; the infant's power of acquiring characters, mental and physical, is immense, and to it is mainly owing the development he undergoes in his passage from infancy to old age; but this power steadily declines in his long stimulated parts (mental and physical), till in the old man it is reduced to a minimum and tends to vanish. Clearly, then, as regards such characters as result from use and experience there can be no transmission to the child; therefore, as regards them, evolution must have proceeded

wholly on lines of Natural Selection. Moreover, instincts (and such physical characters as are analogous to instincts, *i. e.*, in-born physical parts) cannot have resulted from the transmitted effects of experience and use, since they do not increase under such stimulation. There is, for instance, no reason to suppose that any instinct is sharpened by use, or, in other words, by experience. In fact, it would be a contradiction in terms to suppose that it is, since, if my definitions are right, all that is acquired pertains to reason, not to instinct. Moreover, did instincts increase under stimulation and were this increase transmissible in however slight a degree, then instincts should be most developed in the highest animals and less in lower animals. The contrary, however, is the fact.*

All acquired mental characters depend, of course, in the last analysis, on memory; and, therefore, an animal which is incapable of acquiring mental characters, and which, therefore, depends wholly on instinct, can have no recollection of past events, nor, as a consequence, any ideas concerning the future; it must live entirely in the present. To this it may be objected, however, that various insects display an instinctive memory, and, for instance, return again and again with food to the nest where they have laid their eggs. If, however, my definitions are correct these returns are not due to memory, but to an impulse (similar to that which causes them in the absence of experience to know a fit spot wherein to lay their eggs), which causes them again and again to return to this particular place, quite independently of any recollection of having been there before.† It has even

* It follows, then, from the above, that, except as regards the effects of mutilations, which I do not here consider, evolution can have proceeded only on the lines of in-born variations.

† Compare the swiftly forgotten alarm of a house-fly with the more and more permanent fear of successively higher creatures.

been denied that animals so high in the scale as fish possess a memory (the power of acquiring mental characters).* The seat of the memory has been held to be the cortex of the brain, and fish alone of all vertebrata have no cortex.† I think, however, there can be no doubt that fish have some power of acquiring mental traits, since trout in a much-fished stream soon grow more wary. Indeed, memory may be detected in animals much lower than the fish. Even so low in the scale as the oyster is a rudimentary capacity for mental acquirement observable, for "even the headless oyster seems to profit from experience, for Diquemase asserts that oysters taken from a depth never uncovered by the sea open their shells, lose the water within and perish; but oysters taken from the same place and depth, if kept in 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."‡

As I have already said, speaking in general terms, the higher placed an animal is in the scale of life the greater is its power of acquiring mental characters, as will be apparent presently and as might have been expected; but it is also true that the higher species of a lower class or order often exhibit greater capacities for acquirement than

* Vide *Lancet*, January 23, 1897.

† And, therefore, in choosing the dragon-fly as an animal conspicuously lacking in acquired mental traits, to contrast with man, in whom they are conspicuously abundant, I have not intended to imply that the former is quite incapable of acquiring mental characters, only that it is so little capable of acquiring them that it forms an admirable foil to man, the animal above all the most capable of such acquirement. I do not *know* that the dragon-fly is quite lacking in this quality, but only that it is so little developed in him that I personally, with my imperfect knowledge, have not been able to detect any traces of it.

‡ 'Animal Intelligence,' by Romanes, pp. 24, 25.

the lower species of a higher class or order. It is even true that some invertebrates exhibit far greater mental receptivity than many vertebrates. Speaking again in general terms, the power of acquiring mental characters is only developed to a considerable extent in such animals as tend their young, and in them it is developed in proportion to the length of time parental care is continued. Furthermore, it is developed to a very great extent only among such animals as not only tend their young for prolonged periods, but also lead gregarious lives. When animals, after laying their eggs, abandon them to chance it is clear in cases where mind (*i. e.*, consciousness and all that results from consciousness) plays a part in securing survival that such mind must be considerably developed from the moment of hatching. Hence it is that in such animals instinct greatly predominates. Moreover, they cannot acquire traits by imitation from their parents, and, therefore, whatever is acquired by the one generation is completely lost to the next; in other words, they have no traditional knowledge, and all that is mental in the individual is either inborn or has been discovered by himself. But when the animal, after birth, is protected for a prolonged period by its parent it is clear that instinct (inborn knowledge and ways of thinking and acting) becomes less necessary for survival, since an opportunity is afforded for acquiring fit knowledge and ways of thinking and acting from the environment, particularly from the parent. It is then possible for knowledge to become traditional, and to be handed down from parent to offspring. When, in addition, such animals lead gregarious existences the individual has the opportunity of acquiring mental characters, not only from the parent, but from other members of the community as well, and then complex mental acquirements have the best chance of being transmitted, in-

stead of being lost. Under such circumstances the power of acquiring useful mental characters becomes a main factor in the struggle for existence, and those individuals that most possess it survive in the greatest numbers; and therefore, concurrently with the growth of knowledge, occurs an evolution of the power of acquiring knowledge and a corresponding retrogression of instinct, which, in the ancestry, was a main factor of survival, but is now no longer so.

I have given the dragon-fly as an example of an active animal which does not tend its young, and in which, therefore, instinct is developed to a high degree. The ant, on the other hand, is an animal which not only tends its young, but also lives in great communities; and we have striking evidence that some species of ants, at least, and probably all of them, are actuated largely by knowledge and motives which are acquired, *i. e.*, by reason, and not by inborn mental characters, *i. e.*, by instinct. Thus enslaved ants, captured as pupæ and educated wholly by their captors, differ markedly from the free members of the species; they have other knowledge and ways of thinking and acting; and the fact that the slaves, in their new homes, so readily adapt themselves to the changed environment, so readily exhibit knowledge and ways of thinking and acting which must be acquired and cannot possibly be instinctive, for the reason that their ancestry can never have been subjected to the influence of a like environment, proves how great a share reason has in all that is mental in them. And since the slaves clearly acquire mental traits which fit them for their duties as servants, it is not unreasonable to suppose that the slave-holders, in like manner, individually acquire the mental traits which fit them for functions as masters, *i. e.* that in them the slave-holding habit is not instinctive, but rational.

The lower vertebrata do not tend their young, which, therefore, are hatched highly endowed with instinct, but with little power of acquiring mental characters. Reptiles, having better developed brains, have greater capacities for acquirement than fish; they can be trained to a much great extent, can learn much more, and have been known to manifest affection for their masters, in which cases the acquired affection has been so strong as to overcome the instinctive dislike. Birds and mammals, like ants, tend their young, which, in proportion to the amount of protection accorded, are born helpless and devoid of instinct, but capable of mental acquirement. Ever, as we rise upwards in the scale, do we find this increasing protection associated with a growing helplessness at birth, and a steadily enlarging capacity for acquirement which finds physical expression in a more and more developed brain, especially of the cerebral portion of it. A partridge at hatching and a fawn at birth are able to coördinate their muscles to a considerable extent, and have many other instincts. The parrot and the pup are very much more helpless, but their capacity for acquirement is greater in proportion. Highest of all, the human infant is born absolutely helpless; it is unable to coördinate all but a very few groups of muscles; its instincts are reduced to a minimum; it cannot even seek the breast; but it is protected with prolonged and tender care, under which its vast powers of acquirement come into play.

Instincts, therefore, have undergone great retrogression in the higher types, but amid this general retrogression three instincts at least have undergone evolution: (1) the parental instinct to protect the offspring; (2) the parental instinct to impart to the offspring the acquired knowledge which subserved the parents' survival; and (3) the instinct which impels the offspring to imitate the parent, and so acquire the phys-

ical and the mental traits, the traditional knowledge and ways of thinking and acting, which the latter acquired. This subject is a very interesting one, but my space is limited, and therefore I will not dilate on it, but content myself by instancing such familiar examples as the hen, the cat and the human being in proof of my statements. Each of these animals teaches its young in a different way, and the instinct of the young causes it to imitate the parent and sport in such a manner as to develop (*i. e.*, favor the acquirement of) the physical and mental characters which conduce to the survival of the individual and the race. If it be doubted that animals lower than man have traditional knowledge, which is handed from generation to generation, I have only to instance parrots of New Zealand, which have recently acquired the habit of sheep eating, and the change which soon occurs in the demeanor of the higher animals towards man when he first enters a land where he was previously unknown, *e. g.*, the Galapagos Islands. In such lands lower animals (insects, for instance), if they exhibit alarm on his first appearance, show no increase of it in subsequent generations.

Some of this traditional knowledge, especially when it is of a kind greatly to favor survival, is doubtless of vast antiquity. Of such a nature, if I am right in regarding it as an acquirement, must be the slave-making habit of certain ants, since their very physical structure has been immensely modified by it—not by the *congenital* transmission of acquired characters, but wholly by the transmission and accumulation of such inborn variations as best served the utilization of the acquired character; hence, for instance, the great jaws of *F. rufescens*. In man occur many examples of physical structures modified by the persistent acquirement, in generation after generation during long ages, of particular acquired characters. For example, his whole di-

gestive apparatus has been modified by his acquired habit of cooking or otherwise modifying his food, to which cause may even be attributed the unsoundness of the teeth of civilized man; these, since they are no longer absolutely essential to survival, having undergone retrogression as regards their power of resisting bacteria, etc. His lingual muscles have been modified by his acquired habit of speech. His slowly-acquired habit of bipedal progression has resulted in immense and obvious physical alteration. Even the acquirement of surgical knowledge, at first rudimentary, but now highly advanced, has caused at least one important modification. Animals, as a rule, bear their young easily. When any disproportion exists between the foetal head and the maternal pelvis both mother and offspring perish and the peculiarity is not transmitted. Savage women are under much the same conditions, and give birth almost as easily as lower animals. But for ages civilized women in labor have received artificial aid; they are, therefore, nearly all incapacitated for a time after the birth of each child; indeed, the recent advance of obstetric science has enabled so many of the otherwise unfit to survive among us for some generations past that now numerous women are quite unable of parturition without instrumental aid.*

The evolution of the power of acquiring characters, mental and physical, appears to me the most important, indeed the very central fact in the evolution of all the higher

animals. Beyond all other characters this has been steadily evolved by Natural Selection, and therefore the higher placed an animal is in the scale of life the more is it developed in him. Possibly some other mammals are as capable of acquiring physical characters as man; it may be that as much of the physical development they undergo after birth is due to the effects of use and exercise; but, beyond question, no other animal is mentally so receptive as man. His power of acquiring mental characters (*i. e.*, his memory) is enormous, and so greatly does he depend on it for survival that, as we have seen, his inborn mental characters (*i. e.*, his instincts), except in a few instances, have undergone complete retrogression. His mind, as I have said, is a blank at birth, and it follows, since so much is acquired, that the disposition or character of every man must be almost entirely acquired, and not inborn, as is usually assumed. Part of the contents of his memory are recognizable (*i. e.*, may be distinctly remembered), but very much, especially all that is acquired during infancy, is not so. We speak of it as 'forgotten,' but forgotten things, though they can no longer be represented in consciousness, yet leave their impress on the mind. To take an illustration: imagine twin infants in the same 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 its 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

*The use of forceps was formerly very rare in midwifery practice, but is now very common. Doubtless this is mainly due to a change in fashion, the modern obstetrician, on the average, being more skilful and, therefore, more ready to use his instruments than his forebear; but, doubtless, also, it is due in part to a growing disproportion between the maternal pelvis and the foetal head in highly civilized races. It is not possible that the saving of so many narrow-hipped women and big-headed children can have left the race unaffected.

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 excess of timidity would be acquired.

In practice, owing to the necessity of the case, we act as if we realized that man's mind, his character, his disposition, is almost entirely acquired; and, therefore, every parent carefully trains his child for a prolonged period, striving by precept and example to inculcate fit mental traits, that is, fit knowledge and ways of thinking and acting. Even the savage mother does this, and civilized nations have vast state establishments for educating their youth. Moreover, we realize that a child reared by the brave or the cowardly, the active or slothful, the moral or the immoral, the patriotic or the non-patriotic, the devout or the sceptical, and so forth, will exhibit the traits of his educators, even if they be not his progenitors. In fact, we realize, as regards man (though this is not true as regards such animals as the dragon-fly, in which, as we have seen, the mentally acquired is practically non-existent), that the mind of one generation imprints itself on the mind of the next, not racially, but educationally; but, in thinking of this or that adult man, or this or that race of men, we are apt to consider their mental peculiarities as innate and acquired. Especially is this done by men of learning, historians, anthropologists, psychologists, philosophers and the like. It is not realized by them that *man's real mental evolution has lain in the evolution of his power of acquiring mental traits*, and that not in a single other inborn peculiarity does he mentally transcend lower animals, and, therefore, that one adult individual or race must differ from another individual or race wholly in the traits that are acquired, *and in the power of acquiring them*. For example, no man or race is born with greater mu-

sical, artistic or mathematical powers than any other man or race, but merely with greater powers of acquiring them; for, in the absence of appropriate stimulation (*i. e.*, experience, education), they do not develop even in the most 'gifted.' It seems probable, moreover, that powers of acquiring these and other particular faculties have not been separately and especially evolved by Natural Selection, but, on the contrary, that they are but particular manifestations of the general power of acquiring mental traits, which is what has been evolved by Natural Selection.* Thus there appears to be no more reason for supposing that the mathematical faculty has been especially evolved than for supposing that the faculty for understanding the uses of machinery has been evolved; both the one and the other must have been equally useless to the primitive savage.

In lower animals the amount of mental receptivity is closely associated with the size of the brain, the larger brain being the concomitant of greater receptivity, and, as a consequence, of lessened instinct. Associated with this truth is the fact that modern representatives of ancient animals (*e. g.*, ungulates) have much larger brains than their ancestors, denoting the evolution in them of the supremely important faculty of acquiring mental characters. Now, since so little that is mental is inborn in man while so much is acquired, we must conclude that differences in the sizes and shapes of the brains of different races imply not inborn mental differences, but differences in the power of acquiring mental characters, and, therefore, for example, that the native Australian, with his small

* Of course, I do not mean by this that the man who is capable, for instance, of high musical attainments, is also necessarily capable of high mathematical attainments. We know that this is not so. Nevertheless, even as regards these faculties much must depend on the 'bent' given to the individual's mind by circumstances occurring early in life.

brain, differs from the Chinaman or Japanese, with his large brain, not mainly in that which is mentally inborn, but mainly in that he has lesser power of acquiring complex mental characters. If this is true, and there is a mass of evidence proving that it is true, for children of one race reared by another and very different race develop the mental features of their educators, not of their progenitors (*e. g.*, Europeans reared by savages or savages reared by Europeans),* then much of the reasoning of numerous thinkers has been founded on false premises, and is invalid. They have commonly estimated the mental calibre of a race by the intellectual feats performed by it, but plainly these are wrong criteria, since whether these feats be great or small depends almost entirely on the environment, that is, on education. A South Sea Islander, for instance, would, and could, do nothing in his ancestral environment compared to what he would be intellectually capable of were he during early life transferred and trained in the midst of a learned and scientific society.

In discussing this subject one is embarrassed by the wealth of the material that presents itself for criticism. In the lightest, as in the weightiest literature, it is constantly assumed that various racial peculiarities and differences which are manifestly acquired are inborn—that this or that race is inherently brave or resolute, or enterprising, or industrious, or gifted with a genius for colonization or empire, while this or that other race is timid, or irresolute, or indolent, or servile, and so forth. To illustrate my remarks and conclude my essay I may cull a few examples from an enormous field. Dr. Francis Galton says: "The importance to be attached to race is a question that deserves a far

larger measure of exact investigation than it receives. We are exceedingly ignorant of the respective ranges of the natural and acquired faculties in different races; and there is too great a tendency among writers to dogmatize wildly about them, some grossly magnifying, others as greatly minimizing their several provinces. It seems, however, possible to answer this question unambiguously, difficult as it is."* But, if I am right, as I think I am, in the foregoing, surely *every* writer has too greatly exalted the importance of the inborn and too much minimized the importance of the acquired factor in man. Does not Dr. Galton himself exalt vastly too much the importance of the inborn factor, as witness the following passage, which, in this respect, is similar to many others in his work:

"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 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 condition of the time was such that they had no refuge elsewhere than 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 had aimed at selecting the rudest portion of the community to be, alone, the parents of future generations. She practiced the arts which breeders would use, who aimed at creating ferocious, curish and stupid natures. No wonder that club law prevailed for centuries over Europe; the wonder rather is that enough

* Consider, for instance, how different in either case would be the contents of memory and all that arises out of memory.

* 'Hereditary Genius,' preface to edition of 1892, p. xxv.

good remained in the veins of Europeans to enable their race to rise to its present, very moderate, level of natural morality." * Dr. Galton implies that a tendency to charity, meditation or to the cultivation of literature is an inborn and transmissible character, whereas they are, in fact, acquired. A Quaker's child, for example, reared by North American or West African savages shows none of the gentle altruistic nature of his progenitors, and obviously shows no literary tendencies. The child of a blood-thirsty and immoral savage may be made sanctimonious to an even unpleasant degree, as has happened under the influence of missionaries in certain Polynesian islands, where by act of the native legislature flirtation is now a legal offence. The children of aborigines have done exceedingly well, as compared to Europeans, in the Australian government schools. The Church, therefore, may have brutalized society in the Dark Ages, by its influence on the characters acquired by the individuals comprising it; for instance, by inculcating celibacy it may have prevented people who had acquired the best characters from having families, and so passing on their acquired excellencies, like language or even property, to descendants. But since mere chance, not innate tendencies, must have determined in each case the inclination or disinclination towards charity, etc., the Church cannot have selected any *particular type*, and therefore cannot have caused real evolution or retrogression.

It is, of course, impossible for obvious reasons to prove of a particular person with (for instance) charitable inclinations that in a different environment he would have acquired different inclinations. But what cannot be proved of the individual can be proved of the race, which is but an aggregate of individuals. If my definitions are correct, innate inclinations or tendencies

are of the nature of instincts, and these can arise only very slowly under the prolonged action of Natural Selection, and, if they disappear, can do so only equally slowly after cessation of selection. But consider how rapidly a race (*e.g.*, the Japanese) may change its characteristics. Consider, in particular, the enormous change, as expressed in the resultant civilization, which occurs in the character of a race when it changes its religion. Compare the mental characters of the races of Asia Minor and North Africa as they changed successively from Pagan to Christian and from Christian to Mohammedan. Consider how much Pagan, Mohammedan and Christian negroes differ in their mental characters. Consider how closely Mohammedans of all races resemble one another mentally. Consider how indistinguishable mentally are Catholic Teutons from Catholic Celts in Ireland, and how markedly they differ both from the Protestant Teutons and the Protestant Celts of Great Britain. I have, however, dealt somewhat fully with this matter of religion elsewhere,* and my space here is limited. Still I am in hopes that the little I have said proves that any tendency towards charity, etc., is wholly acquired and not inborn.

Again Galton says: "The ablest race of which history bears record is unquestionably the ancient Greek, partly because their masterpieces in the principal departments of intellectual activity are still unsurpassed, and in many respects unequalled, and partly because the population that gave birth to the creators of those masterpieces was very small. Of the various Greek sub-races, that of Attica was the ablest."† He further says: "The average ability of the Athenian race is, on the lowest possible estimate, nearly two grades higher than our own—that is, about as

* 'The Present Evolution of Man,' p. 188-196.

† 'Hereditary Genius,' p. 329.

* Ibid, p. 343, 344.

much as our race is above that of the African Negro. This estimate, which may seem prodigious to some, is confirmed by the quick intelligence and high culture of the Athenian commonalty, before whom literary works were recited and works of art exhibited, of a far more severe character than could possibly be appreciated by the average of our race, the calibre of whose intellect is easily gauged by a glance at the contents of a railway book-stall."* De Quatrefage says: "There can be no real relation between the dimensions of the cranial capacity and social development." * * * "By such an extension the Troglodytes of the Cavern of L'Homme-Mort would be superior to all the races enumerated in the table, including contemporary Parisians."† But Mill wrote: "Of all vulgar modes of escaping from the consideration of the effect 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;"‡ and Buckle, the historian, who, notwithstanding the deficient knowledge of his time, had a true appreciation of the problem, said: "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 may say so, of opportunity, that is, an improvement in 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."*

Mill and Buckle, though unacquainted with the doctrine of evolution, were surely right. The ancient Greeks and Romans were certainly of extraordinary mental prowess, but it is more than probable that they surpassed our more remote ancestors only because the environment in which they lived was more favorable than the mediæval to the acquirement of fit mental traits; because, in their free, intellectual atmosphere, they were trained to the performance of intellectual feats, which were impossible to the fettered minds of our forefathers, who could hardly achieve greatness, except as priests or warriors, or as painters, sculptors, architects, musicians, or as other laborers in such arts as served the grandeur of the Church or the Throne. The splendor of the Greek and Roman achievements, therefore, does not constitute a proof that the Greeks and Romans were splendidly endowed, but only that the traits which they acquired from their progenitors enabled them to use their endowments splendidly. In judging of the mental capabilities of a people as a whole, as in judging of physical powers, it is safer to take as a test their corporal structures, their bodies and brains, rather than their physical and mental feats, for whether these latter be great or little depends on circumstances which may be favorable or the reverse. Had the Troglodytes received the same mental training as the Greeks it is possible or probable, since their brains were large, that they would have performed feats intellectually as great, but had Aristotle or Plato received the training of the cave-men great feats would have been impossible to them. They would have died

* Buckle's *History of Civilization*, Vol. I., p. 178.

* *Ibid.*, p. 330-331.

† 'The Human Species.'

‡ Mill's *Principles of Political Economy*, Vol. I., p. 390.

unknown to fame. Moreover, such feats as were performed by the Greeks would not have been recognized as great among prehistoric peoples, and such intellectual giants, but physical weaklings, of the modern world as Darwin and Spencer would have earned, and in that state of society deserved, the contempt of their fellows.

Mr. Herbert Spencer attributes much of the contents of man's mind to the transmission and accumulation of acquired mental characters. Thus he attributes the altruistic feelings to this cause and anticipates a happy future for many by their continued increase. Mr. B. Kidd, whom I confess I have a little difficulty in taking seriously, on the other hand, attributes these feelings to Natural Selection. He is very severe on Mr. Herbert Spencer and writes: "The confusion of ideas to which the tendencies of the times give rise finds remarkable expression in Mr. Herbert Spencer's writings." * The tendencies of the time seem to have confused Mr. Kidd's own ideas to an even greater extent, and it would have been well had he harkened to Mr. Spencer's warning against thinking in abstract terms. †

As already indicated in this JOURNAL, ‡ Natural Selection implies elimination of the unfittest, and Mr. Kidd has failed to record a single death as due to the absence of this feeling in him who perished, and the presence of it in him who survived. Having regard to the foregoing, is it not abundantly evident that the altruistic feelings have not undergone evolution at all in man, neither by the transmission of inborn characters nor that of acquired characters? As I say the child of a philanthropist if reared by West African savages might well be a fiend in cruelty, he certainly would have no philanthropic tendencies as we understand them ;

the child of a cannibal, properly trained, might well develop into a philanthropist ; and surely that which may be entirely lapsed or developed in a single generation cannot properly be regarded as a direct product of evolution. Like patriotism, or devotion to a particular religious system, or a knowledge of language, or of letters, or of the uses of steam, or of the bicycle, the altruistic feelings are purely acquired (and not transmissible), and are not immediate products of evolution, but result indirectly from the evolution of man's mental receptivity, that is, from the evolution of his vast power of acquiring mental characters. Men in various times and places have been *taught* to worship sticks and stones, and to hold in reverence all kinds of absurd beliefs and notions, so also a child—any child—by fit training may be rendered highly altruistic—may be taught to receive and practice altruism, as he may be taught to reverence and practice fetishism ; whence it follows, as a logical conclusion, that in every individual the altruistic feelings are purely acquired. It matters not that, in a greater or less degree, they are universal. So is knowledge of language and religion, which, though universal, is as much acquired as is a knowledge of history or of astronomy. If, then, in the ancestry of man, these feelings were ever instinctive, as we may suppose them to be among bees, this instinct, like almost all others, was lapsed long ago, and was replaced by an acquired character.* We need not await, then, the slow evolution of the social millenium by the accumulation of inborn altruistic variations, as Mr. Kidd expects, nor by the accumulation (and transmission) of acquired variations, as Mr. Spencer expects. Were we all agreed

*I cannot here pause to discuss the cause of the retrogression of instinct. But I have dealt at length with the cause of the retrogression of physical parts in my book, and that of the retrogression of instinct follows the same law. An outline of the theory was given in SCIENCE of September 3, 1896.

* 'Social Evolution,' p. 158.

† 'The Inadequacy of Natural Selection,' p. 67.

‡ September 11, 1897, p. 371.

as to the training of our children it would be achievable in the very next generation, for surely, if a generation can be reared to reverence a stick or a stone, an inanimate idol, and this or that grotesque religious system, it can be reared also to love and reverence man.

One paragraph more and I have done. We hear of the evolution of morals or of language or of religion, of the printing press, of the locomotive, of the bicycle, and so forth. In the popular mind, and, I fear, even in the minds of some scientific men, this evolution ranks as a process of the same order as the evolution of a plant or animal. Evolution means unfolding, and, therefore, the word is perhaps correctly applied to the bicycle, etc. But there is this essential difference between a living being and the bicycle: The former is the progeny of a parent; the latter is not. So also the language of to-day is in a figurative sense only the progeny of the language of the former times; the morals of to-day have, in a figurative sense only, descended from those of yesterday. All these things are human inventions, and belong not to human evolution, but to what has been called evolution in the environment. The so-called 'Social Evolution,' of which we have lately heard so much, is therefore a myth from the biological standpoint. As I have said, and as I wish to iterate and reiterate, neither the altruistic feelings in particular, nor morals in general, nor anything of the kind, has undergone evolution in man. What has undergone evolution is his enormous power of acquiring characters, these among others. G. ARCHDALL REID.

SOUTHSEA, ENGLAND.

SOME RECENT OBSERVATIONS ON THE INFLUENCE OF THE THYROID GLAND ON METABOLISM.

IN an article by Professor Chittenden, published in *SCIENCE*, June 25th, a summary

is given of what was then known regarding the influence of the thyroid gland on metabolism. Since that time a valuable contribution to our knowledge has come from Bernhard Schöndorff, published in *Pflüger's Archiv für Physiologie* (Band 67, p. 395). He finds that, contrary to previously received notions, the feeding of thyroid glands or iodothylin to an animal does not invariably stimulate proteid metabolism. Further he finds that the loss of weight so often observed under such treatment is due mainly to an increased combustion of the body-fats, and that the increased excretion of nitrogen through the urine observed by Voit and others is not necessarily due to an increased proteid metabolism, but to an increase in the excretion of urea and allied bodies which are known to exist pre-formed in the tissues in considerable quantities.

The investigation was carried out on a dog of 55 pounds weight. It was kept in a suitable cage, and its food so regulated that under ordinary conditions the animal remained at a constant weight and in nitrogenous equilibrium. The thyroids were administered for the most part in the form of dry tablets prepared by *Borroughs, Wellcome & Co.*, of London, but sometimes fresh or dried sheep's thyroids were given either alone or with the tablets. At first the dosage was ten of these tablets administered with the daily food. Within a few hours the animal's weight began to fall, and at the end of twenty-three days it had lost nearly two and a half pounds. During the first eight days the nitrogen also showed a minus balance; that given off in the urine and feces amounted to 32 grams, while the food contained only 31 grams. During the next fifteen days, however, there was a plus balance. Evidently these results point to a largely increased consumption and elimination of non-nitrogenous material, and in the light of previous researches Schöndorff attributes them to an increased combustion