DARWIN MADE EASY.

BY

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THE DARWINIAN THEORY.

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Chapter I.—ITS MEANING.

We must not confuse the Darwinian theory with Evolution. It is a part of that larger whole. Evolution is the name for the idea of the unity and continuity of phænomena. The evolutionist regards all the phænomena of the universe as natural, and does not believe in the intervention of the supernatural. To him there never is, never has been, and never will be, any break in the series of events. The evolutionist pure and simple does not recognise any hiatus between man and other animals, between the animal and the plant, between the living and the non-living.

In this wide sense I cannot, strange as this may seem, call Charles Darwin an evolutionist. For in the "Origin of Species" he uses one phrase, not so far as I know contradicted or modified in more recently published utterances, that may fairly be quoted as evidence of his belief in the supernatural origin of life. It is the well-known sentence: "There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one."

Darwin's great work was done in relation to living things. His two remarkable theories of Natural Selection and Sexual Selection have bearing only on plants and animals. Darwin's hypotheses had to do with the evolution of these two highest forms of matter known to us. They have nothing to do with the question of the origin of life, or the first formation of organic bodies. In dealing with his ideas, we must start, as he started, with life as existing on the earth.

Organic matter is given. The question is how, organic or living matter once in being, the many diverse forms of plants and animals have arisen.

The understanding of Darwin's theories turns on the understanding of the word "species." What is a species of plant or animal? What is meant when we label a certain number of animals, *Canis familiaris* (dog) *e.g.*, and another set, *c. lupus* (wolf)? The old idea, still prevalent among the uneducated, was that the word "species" should be applied to all the animals, or to all the plants, that had taken origin from one original pair of parents, or from one parent in which the two sexes were united in the same individual. The question as to the origin of this original pair of progenitors, or original bi-sexual progenitor, was answered by the statement that these had been specially created out of nothing by god.

Clearly this conception of species was wholly based on the teachings of the Mosaic cosmogony. As long as men were foolish enough to take as their guide, not only in matters of daily conduct but on scientific questions, the Hebrew bible, such a conception of a species was the only possible conception.

To the naturalist of to-day the word "species" is a convenient label to be placed on a certain set of living beings that have certain points of resemblance, one with another. It is entirely arbitrary; as arbitrary as the name you give your child. Indeed, all our classification terms are thus arbitrary, artificial. They are very convenient, but they do not express the fact that any corresponding divisions exist in nature. We look abroad on the world and see that, roughly speaking, all things in it are either living or non-living, but we find it impossible to give a satisfactory definition of the living as distinct from the non-living, when we study the lowest forms of organic bodies. Yet for convenience' sake we make an artificial and useful division between the two great realms of objects.

In the same way we speak of the two animal and vegetable *kingdoms*. It is impossible to distinguish the lower animals from the lower plants, but we speak of the two kingdoms, and find it a great convenience thus to speak. In like manner we divide the kingdom *e. g.* of animals into artificial groups that we call *sub-kingdoms*. Of these one

is the Vertebrata or backboned animals. The sub-kingdom is broken up into *classes*. The Vertebrata are said to consist of the fishes, amphibia, reptilia, birds, mammals. A class such as the Mammalia is made up of *orders*. Thus among the thirteen orders of the class Mammalia are the Carnivora (flesh-eaters). In the same arbitrary way our orders are divided into *genera*—Canis (dog) is a genus of the order Carnivora—and each genus into *species*—familiaris (common) is a species of the genus Canis.

We carry our artificial classification further, and often divide a species into varieties. The species Canis familiaris contains many varieties, as the mastiff, the greyhound, the bull-dog. These varieties, whether of a plant or animal species, are admitted by everyone to be due to quite natural causes. They have originated without any intervention of the supernatural. The evolutionist holds that all the other divisions have had an equally natural origin, and that species have evolved under natural laws in the past, as varieties are known to evolve under natural laws in the present; that all the complex forms of living things that have lived on the earth have been produced by perfectly natural processes one from another, and all from the simplest original forms of living matter. But the special creationist holds that species have been called into existence at the will of an almighty being.

Let us now see what light Charles Darwin has thrown on this question. Long before his time other thinkers had grown dissatisfied with the no-explanation "god did it." In England, in Germany, and in France men had begun to think that the idea of an almighty god calling into being species separately was not tenable, and that it was more probable that a slow process of development had gone on by which the forms of living things had grown more and more numerous and different one from another.

In England the grandfather of Charles, Erasmus Darwin, had written as early as 1794 the following passage in his "Zoonomia":—"When we revolve in our minds, first, the great changes which we see naturally produced in animals after their nativity . . . when we think over the great changes introduced into various animals by artificial or accidental cultivation . . . when we enumerate the great changes produced in the species of

animals before their nativity . . . when we revolve in our minds the great similarity of structure which obtains in all the warm-blooded animals . . . one is led to conclude that they have alike been produced from a similar living filament. . . . From their first rudiment or primordium to the termination of their lives, all animals undergo perpetual transformations . . . and many of these organised forms or propensities are transmitted to their posterity. . . . The three great objects of desire are those of lust, hunger, and security. A great want of one part of the animal world has consisted in the desire of the exclusive possession of the females; and these have acquired weapons to combat each other for this purpose. . . . The final cause of this contest among the males seems to be that the strongest and most active animals should propagate the species, which should thence become improved. . . . From thus meditating on the great similarity of the warm-blooded animals and at the same time of the great changes they undergo both before and after their nativity; and by considering in how minute a portion of time many of these changes of animals above described have been produced; would it be too bold to imagine that in the great length of time since the earth began to exist, perhaps millions of ages before the commencement of the history of mankind, would it be too bold to imagine that all warm-blooded animals have arisen from one living filament, which THE GREAT FIRST CAUSE endued with animality, with the power of acquiring new parts, attended with new propensities, directed by irritations, sensations, volitions, and associations; and thus possessing the faculty of continuing to improve by its own inherent activity, and of delivering down those improvements by generation to its posterity, world without end?" To which one is inclined to add, *Amen!* Here are undoubtedly the germs of the ideas of Evolution, of natural selection, though they are confused by the introduction of "The Great First Cause," and are only applied to birds and mammals, not to living things generally.

In Germany Goethe had a shadowing forth of the great truth:—"The inward perfection and purpose of the animal body are built up stage by stage, and the changes depend on its connexion with the external world. No

part of an animal considered carefully is useless or, as men have phrased it, produced arbitrarily. One will not in the future as to organs ask for what do they serve, but whence do they spring? One will not assert that a bull has horns in order to push, but one will inquire how he could have horns at all in order to push. This plan of nature works eternally; there is no rest or stay. But not all that she brings forth can she preserve and maintain; she cannot retain all which she produces. We have still a most unfinished variety of organic forms remaining, which cannot yet be connected in one great genealogical tree."

In France, Etienne Geoffroy St. Hilaire (the elder of the two St. Hilaires) and Lamarck had ideas as to the production of species from pre-existing species even more clear than those of either the Englishman or German. Thus, in the Life of Etienne, written by his son, we have the following:—

"And in this Memoir written in 1795, published at the beginning of 1796, is found the germ of the philosophic anatomy, not merely foreshadowed, not merely indicated, but formulated with marvellous clearness. Nature, these are the author's own words, has formed all living things on a uniform plan, essentially the same in principle, but varying in a thousand ways in all details. And in the same class of animals the diverse forms in which nature has been pleased to make each species exist, are all divided one from another. It suffices her to change certain proportions in the organs to fit them for new functions, to extend or restrict their use."

In "Lamarck's Philosophie Zoologique" he gives at the end of the first vol. on p. 424 (1809), under the heading chapter iii., the following remarkable summary of his views:—"That it is not true that species are as old as nature, and that they have all existed for the same length of time the one as the other, but that it is true that they are formed successively, that they have only a relative persistence and remain constant for no great length of time."

Again, in his "Histoire Naturelle des Animaux," Introduction, p. 161 (1815), Lamarck writes:—"That the conditions in which the different races of animals found themselves placed as they spread by degrees over different points of the globe and in the waters have given to each

special habits, and that these habits, which they were obliged to contract according to their habitats and manner of living, may have, for each one of these races, modified the organisation of the individuals, the form and condition of their organs, and placed these in relation with the habitual actions of these individuals, it is now no longer possible to doubt." And again: "However small the modifications may be that have taken place under our eyes, and of which we have convinced ourselves by the observation of those animals whose habits we have arbitrarily changed, these same modifications suffice to show us the extent of those which, with time, animals may have experienced in their form, their organs, even their organisation, from the conditions under which they have lived, and which have modified all the races to an almost infinite extent."

The idea that these great men had put thus vaguely, Charles Darwin reduced to distinct form. They all held that species must have evolved under the influence of external circumstances. He showed that they had evolved, and demonstrated at least one of the principles on which evolution took place.

His great work on the "Origin of Species" was published in 1859. To those who are wont to speak of the premature nature of his conclusions the following facts are commended. From 1832 to 1837 he had been travelling round the world in the "Beagle" collecting facts. On his return he continued collecting facts for five years more Then, from 1842 to 1844, he made notes. In the latter year he drew out a sketch of his work, and fifteen years later published his conclusions.

We must remember that the "Origin of Species" is, to a large extent, an abstract and a statement of results. Some of the enormous number of facts on which the conclusions given in the "Origin of Species" are based will be found in the two volumes of the "Animals and Plants under Domestication," published after the "Origin of Species."

The first part of the "Origin of Species" is occupied with the discussion of these four points, each of which must be discussed briefly here. Variation under domestication. Artificial selection. Variation under nature. Natural selection.

(1) *Variation under Domestication.*—The animals and plants that have been brought under the dominion of man vary, *i.e.*, no two individuals of the same species are completely alike. The rose-trees produced from a given rose-tree are dissimilar. The puppies of the same litter are not all alike. Every breeder, every horticulturist knows that the living things he has under his care vary.

(2) *Artificial Selection.*—Man, by noticing the "accidental" variations that occur, has been able, by careful selection and careful breeding, to aid in the production of many variations. The word "accidental" is used, as at present we cannot tell why one seedling of a pansy should have an arrangement of color different from its companions—why one member of a family should be swifter than its fellows. Granted the initial variation, artificial selection may come into play. Man selecting and breeding from the individuals selected, a form of plant or animal very different in details from the parent whence it sprang, and from the unvarying descendants of that parent, may be obtained.

In the Animals and Plants under Domestication Darwin gives innumerable cases of the results of this selection by man. In the little space at my disposal I can only mention one or two. From the plant-kingdom take the following. In the year 1596 the hyacinth was first introduced into this country. In 1597, from the one variety brought in four varieties were, according to Gerarde, known. In 1629 Parkinson speaks of eight. In 1864 Paul mentions 700.

In Scotland a white rose-tree in the year 1793 produced a red seedling. From this the gardener bred carefully and closely. In 20 years 26 varieties were known, and in 50 years 300, all derived from one "accidental" variation.

Amongst the animals, the example most frequently quoted, and perhaps the most remarkable, is the case of the pigeon. Every one knows the many different kinds of pigeon, the runts, barbs, pouters, tumblers, jacobins, carriers, fantails. All these are known to have originated from one original form, the blue rock pigeon (Columba livia), during the time that man has taken an interest in the breeding of these birds.

The thoughtless folk cry out, "Yes, but these are all of the same species. They are all hyacinths, or roses, or

pigeons. They never become any other 'species.'" The very obvious answer is, that they are all of the same species still to us, because *we know the history of the case.* We name them still as all of the same species, because we know they are all derived by natural variation and artificial selection from one parent form. But if *e. g.* the varieties of pigeon were placed before an unprejudiced observer, who did not know their history, and he were asked whether they all belonged to the same species, he would, I doubt not, reply "No, nor even to the same genus."

(3) *Variation under Nature.*—Little proof of this is required. Everyone has set out on the hopeless search for the two blades of grass exactly alike. In the wild woods or in the trim garden, in the waters of the ocean as in the aquaria, endless variation is evident. There is perhaps less need to insist on this variation than on that occurring under domestication. But the great question arises, "What results from this variation of living things in a state of nature?" We have seen how the variations of domestic animals or plants may be seized on and utilised towards the production of new varieties. Is anything of the same nature taking place among the living beings not directly under the sway of man?

(4) *Natural Selection.*—Here is the great suggestion of Charles Darwin; the key to so many problems in biology. He shows (*a*) that there is a struggle for life among living things; (*b*) that any variation of structure or function giving to its possessor an advantage in the struggle is likely to be preserved; (*c*) that the possessor of such a variation is more likely to survive than its fellow not thus gifted; (*d*) that the possessor of such an advantageous variation is more likely than another destitute of it to have offspring; (*e*) that in the offspring the variation will be repeated and intensified; (*f*) that, transmitted from generation to generation and becoming more and more marked, the modification becomes at last permanent, and a new variety, or a new species results.

The struggle for life. The world is one great battlefield. Beneath its surface, within the depths of its waters, in the very air is eternal strife. All living beings are ceaselessly fighting. The life of our great cities, with its contest of class with class, of individual with individual, is the

type of all life. In the darkness of the soil of the earth the roots of the plants are struggling with each other for food. In the microscopic drop of water the Infusoria sweep ceaselessly round and round, searching for the food that is not sufficient for them all. Every living thing is an Ishmael. Its hand is against all others. The hands of all others are against it. And as among men, so also among the more lowly organised creatures, the bitterest struggle is ever between those who are akin one to another. *Væ victis*, woe to the conquered, is the cry of the world. If plant or animal does not succeed, it perishes. How does nature, in her silent, imperturbable fashion, take advantage of these eternal variations in the flowers and in the animals? By Natural Selection, or the survival of the fittest. Who are to be the survivors in this battle? Who are doomed to be numbered among the slain? Those best fitted for the struggle will survive. Those not adapted to the circumstances of the unending fight are doomed. The fittest will hold out the longest. That which possesses in strength or in any other way an advantage over its fellows will conquer them in the struggle for existence. If any variation in an individual plant or animal is of such a nature that its possessor will be better fitted for life-work, that possessor will have an advantage over its fellows—will stand a better chance than they of surviving, will transmit its variation to its offspring, possibly in intensified form. The offspring, even better fitted than their parents for life, triumph yet more completely over their fellows. Thus is the original slight variation strengthened until, after a long time, forms result so differing from the first individual that presented the variation, that the biologist is constrained to regard them as belonging to a species other than that comprising the original plant or animal. This is the great principle of Natural Selection, or the survival of the fittest. The variations that are of benefit to the beings possessing them are naturally selected. The enunciation of this principle and the elucidation of it have been in especial the work of Charles Darwin.

At the base of everything there is this variation of the individual. That the variations are infinite in number and in kind no one can doubt. But as to the causes of variation and as to the laws which govern it, we are much

in the dark. On both these points Charles Darwin speaks with his usual caution; and although since the publication of the "Origin of Species" many suggestions have been made and some light thrown on the subject, we are not yet in a position to do more than still suggest.

Variation, *i.e.* the possession of some quality of structure or of function by one or more individuals of a group whose other members do not possess the quality, is of two kinds: that which appears in the individual during the course of its life, and is due to the conditions of life; and that which appears in the offspring in consequence of the coming together of two parent forms. Thus a plant may as it grows up to the adult condition—as it passes through the stages of budding, flowering, fruiting, show certain modifications of form, of color, of function that are probably due to the circumstances in which it is placed. Or it may show modifications that are due to the fact that the seed whence it sprang was ripened by pollen from a plant other than that which produced the seed.

The conditions of life have much to do with variation. No two individuals of the same species are exposed to identical conditions. Two amœbæ in the stagnant water receive different quantities of heat and of light and of food. To all the forces from without that impinge on the living body, that body, as long as it is alive, responds. And such response is often in the nature of a change slight enough at first, but with great potentiality, if it is repeated and intensified. We may regard many of the variations in structure and function that distinguish individuals one from another, as due to the effect of the conditions of life on different individuals. This response on the part of the living organism to the forces that environ and play on it, is called Adaptation.

But without doubt, a second great cause of the initial variation without which the principle of natural selection would have nothing on which to work, is cross fertilisation. The seeds of plants, the ova or eggs of animals, are almost always the result of the crossing of two individuals. That this is the case in all the higher animals in which the two sexes are in distinct individuals is evident. But even in the lower animals, in which the two sexes are present in the same individual, such as the leech or the snail, there

are in almost every case arrangements that compel or at least permit of cross fertilisation. Thus if A and B are two bisexual individuals of the same species, the ova of A are fertilised by B, and those of B by A.

With plants the rule is that both pollen (the fertilising agent) and ovules (the seeds that are to be) are found in the same individual. For a long time botanists thought that the ovule of a given violet *e.g.* was fertilised by the pollen from the same violet. But the researches of Darwin in England, of Gaertner and Kölreuter in Germany have shown that this is very rarely the case. Generally the ovule of a given flower is fertilised by the pollen of another flower of the same kind.

In this cross fertilisation we have the possibility of endless variation, for the offspring is the product of two differently circumstanced parents. Like as the two parents may be, they have lived in slightly different places, have received different supplies of food, have come into contact with different external agencies. Hence every new being is the result of the collision of two cells, male and female, from two parents that have been subject to different conditions of life. Nor must we expect in such a case that the offspring will present those qualities only that are to be found in the parents. There is what I have called a collision of two cells. The properties of the one parent will act on those of the other, and new modifications may result. When we place together our copper with its properties as a metal, and our nitric acid with its properties as an acid, we find new bodies formed, with properties other than those of the two substances used. In like manner, when two living beings conjoin to form offspring, that offspring is likely to present not only the characters of its parents, but new and often unexpected characters, due to the blending and modification within it of the ancestral characters. The name given to the principle by which the descendants of certain parent forms present characters that are due to those of the parents is called Heredity, whether those characters are like or unlike those of the parents.

The Darwinian theory, therefore, is that all the species of animals and plants in existence to-day have been evolved from pre-existing living forms; that this evolution

is explained by natural selection; that variations occurring in living beings under certain conditions, may be of advantage to the possessor; that the possessor of these has a better chance than others in the battle for life; that he survives when others may perish; that he has a better chance of producing offspring; that to the offspring the special useful characteristic is transmitted; that in them it becomes intensified and ultimately fixed as a permanent mark of the group. Two of the causes of variation in individuals appear to be the varying nature of the conditions of life, and cross fertilisation.

Chapter II.—ITS DIFFICULTIES.

The antagonists of Darwinism are constantly, with much emphasis and repetition, reminding us of the difficulties of the theory. They are not, as a rule, sufficiently generous to confess that their instructor as to those difficulties was Darwin himself. Every weapon against his idea has been placed in the hands of its opponents by Darwin. Since the publication of the "Origin of Species" in 1859, not a single scientific objection of any moment has been brought forward that was not anticipated in that work.

The chief difficulties are the following. The absence of intermediate forms; the perfection of certain organs; the persistence of certain forms of living things; instinct, man, and mind.

(1) *The Absence of Intermediate Forms.*—This difficulty is embodied in the frequent question addressed to the evolutionist by unbelievers in science. "Where are the connecting links?" It was urged in the years immediately following the publication of the "Origin of Species," and urged then with some justice, that the intermediate forms between the different species, genera, orders, classes of plants and animals were wanting. But now, after twenty-four years of further work in biological science, this objection no longer holds. For the researches of the botanist, the zoologist, and the palæontologist, guided to a large extent by the great principle associated with Darwin's

name, have shown us that these "connecting links" exist, or have existed. To-day we can state positively that hardly a species of plant or animal exists that does not glide, as it were, into the species most closely allied to it. Scarcely any species of living thing can now be marked off by a hard-and-fast line from all other species. The gradations between the groups that we make in our artificial way are insensible. And that which is true of species is also true of larger divisions in our system of classification. Generally, orders, classes, sub-kingdoms, are found to pass imperceptibly into their neighbors, and certain forms of living things are found hovering on the border line of two groups, and placed by some observers in one, by some in another division.

The general reader will understand this better if I take one or two examples from the animal kingdom. The examples shall be taken from the cases of forms intermediate to classes, as they will be comprehended better than illustrations of connecting links between species. These last need for their understanding a special knowledge of botany or zoology. The sub-kingdom of Vertebrata, or back-boned animals, is still divided generally into five special classes—the Mammalia, or animals that suckle their young; Aves, or birds; Reptilia, or reptiles; Amphibia, or the frog-class; Pisces, or fishes. When science, as well as the general ideas of men, was vitiated in its thinking by the inaccurate dogma of special creation, it was thought that these five classes were clearly marked off one from another. But now-a-days intermediate forms are known between the different classes. Mammalia and Aves *e.g.* are connected by the Ornithorhyncus, ορνις (ornis) = bird, ρυνχος (rhunchos), = snout; that is the duck-billed platypus of Australia, an animal with a fur covering, with the bill of a bird, with webbed feet, and with points of internal structure that are partly mammalian, partly avian. The Aves and Reptilia are connected by the extinct Pterodactyl, πτερον (pteron) = wing, δακτυλος (daktulos), = finger. This animal has a wing developed on one finger of the anterior limb, and yet is to a large extent reptilian in its structure. The Reptilia and Amphibia pass so readily into each other that until within the last few years the members of the two groups were

placed together under the head of Reptilia. The frog *e.g.* is in its early life a fish, in its adult condition a reptile. In it and its allies we have links not only between Reptilia and Amphibia, but between both these and the lower vertebrate class, the Pisces. Another connecting link between the Reptilia and the Pisces is the Lepidosiren, or mudfish of the Gambia, an animal as to which there was for a long time dispute. Some naturalists placed it in the higher, others in the lower class.

Nor are these linking-on forms only to be found connecting classes. The larger divisions or sub-kingdoms which are divided into classes also pass by insensible gradations into one another. Thus the Vertebrata are connected with the Mollusca or soft-bodied animals by the Amphioxus, or lancelet of the Mediterranean. This little animal, usually classed with the fishes, is about one inch in length, has no bones or cartilages whatever, no teeth, no true heart, no gills, no brain, no sense organs. The sole representative of its backbone is a rod of tissue lying along the middle line of the back. The backbone of every vertebrate, even of man himself, begins as just such a rod in the middle line of back, marking out the position of the vertebral column that will appear later, first as cartilage, then as bone. Hence we are entitled to regard Amphioxus as the lowest vertebrate, though if the history of the development of the vertebral column in the higher members of the sub-kingdom were not known, we should have no suspicion of its true relations.

But Amphioxus, in many details of its structure, is closely related to a group of the Mollusca called the Ascidioida. ασκος (ascos), = bag, ειδος (eidos), = likeness. Certain members of this group have a line of tissue identical with the structure met with in Amphioxus, and are a transitory condition in the rest of the Vertebrata. Further, in the structure of their breathing apparatus, and in many other points of their anatomy, they are closely allied to the lowest of the Vertebrata.

In the same way it could be shown that other groups in the animal, and groups in the vegetable kingdom, are connected by intermediate forms, and generally it may be said that the distinctions between the divisions of living things are fading away in the light of advancing knowledge,

or in common phrase, the majority of connecting links are known. That all are not known is to be ascribed to two causes. (*a*) In the battle for life intermediate forms are often crushed out. This might be expected from the general principles of natural selection. Suppose some one member of a group A varies in some particular direction, and by the transmission, intensification, and fixing of the variation, a new form B arises. The members of the group A that have not varied are still fitted for their life conditions. The members of the group B are fitted for certain slightly or largely different conditions. But the intermediate forms are likely to be crushed out of existence between the living things of group A and group B.

That this is the case is shown by the fact that the connecting links are dying off. Ornithorhyncus is becoming extinct in Australia, as Amphioxus is vanishing from the Mediterranean Sea. A century hence these witnesses to the truth of the Darwinian hypothesis will probably be extinct. But a century hence this will not matter greatly, as everyone will then be an evolutionist.

(*b*) The objection may be raised, that even if this suppression of intermediate forms occurs, the remains of these forms ought to be found in the records of the rocks. But the reply to this is "the imperfection of the geological record." For a fossil to be of value to the student in connexion with this study of intermediate forms four things are necessary. The plant or animal must be preservable. Thus a fossil jelly-fish is inconceivable. The conditions in which it is at the time of its death must be favorable to its preservation. Millions of living things have died under such circumstances that their remains could not be preserved. The sedimentary rocks in which the remains are preserved, supposing the first two requisites are attained, must **not** be subjected to any agency such as fire that will destroy the organic remains. These rocks, with their remains, must be observed by man. When we consider how many living forms are incapable of preservation, and especially those that are of most interest in this connexion; how often the conditions necessary for their preservation have been wanting; how frequently other changes have destroyed or altered the rocks containing fossils that have

been preserved; how limited is the area of the earth's surface yet investigated; and how, in especial, the tropical regions of the earth where evolution has probably been most active, have received but little study, there should not be much wonder that the record of the fossils is very imperfect. But it should be remembered that every new discovery among the rocks has been in harmony with Evolution, and opposed to the idea of special creation.

(2) *The perfection of certain organs.*—The unbelievers often point to such organs as the human eye, and ask: "How is it possible to conceive that this wonderful structure has been slowly evolved in the course of a long period of time from simpler conditions, that lead us back ultimately to mere specks of color?" The answers are three. First, that this is much more possible than the creation of such an organ. Second, that we have every possible gradation in the animal between the eye of man and the lowest and simplest eye known. Third, we see in the development of every individual human being every complex organ pass through stages of development from the most simple form to the most complex, and these stages are identical with the permanent conditions in certain of the lower animals. The eye of man, *e.g.*, is but a modification of part of the integument, and in its stages of development passes rapidly through condition after condition that are identical with the eye-structures to be seen in more simply organised members of the animal kingdom.

(3) *The persistence of certain forms of living things.*—This difficulty takes two forms. The follower of Darwin is asked how he explains the fact that whilst variation and natural selection are at work everywhere, yet certain low, simple forms persist, so that even to-day the single-celled organisms that represent some of the very earliest stages in the evolution of the animal or plant kingdom are yet in existence. In answer to this the reply is given that variation is not universal. To take an example. Suppose 100 members of the group A; 1 only varies; 99 remain as their ancestors were. The descendants of the one, if the variation is transmitted, intensified, and fixed, give rise in turn to a new form, B, so distinct from A as to be called a new species. But the descendants of the 99 unvarying ones are still as their ancestors, and are still

members of the species A. Of a hundred men, *e.g.*, one may vary in the direction of some new higher order of thought, whilst the ninety and nine continue in the same old errors and superstitions.

Again it is known that in certain parts of the world, as *e.g.* Egypt, the living forms are to-day not different from those that by pictorial and other representations we know to have existed there hundreds of years ago. But in the first place the few hundred, or even thousand years of history are only a heart-beat in the vast ages that this earth has been in existence. A thousand years in thy sight, oh Evolution, are but as a watch in the night! And further in the cases usually quoted, as Egypt, *e.g.* the conditions of life during the historical period have been uniform, and therefore variation to any great extent would not be expected.

In this connexion it may be well to deal with one special case that the average Christian Evidence man is always bringing forward—that of the Trilobite. Of course he knows nothing, as a rule, of the structure of the Trilobite and its relations to other animals. But he has read that it occurs very low down in the sedimentary rocks, that it is of fairly complex organisation, and that other animals lower than it in the scale of structure are not preserved as fossils in the rocks below. The answers are that the rocks below the Silurian, in which the Trilobite first appears, are rocks that have been changed by the action of heat to such an extent that all organic remains have disappeared from them; that we are wholly unable to tell what ages have thus had their records destroyed—ages during which living things probably existed before the time of which the Silurian strata are the memorial; and that the predecessors of the Trilobite in the gradual evolution of the animal kingdom were for the most part of such a nature that their remains did not allow of preservation.

(4) *Instinct.*—The difficulty as to the evolution of instinct is not nearly so great now as in 1859. The old idea that reason was the prerogative of man, instinct the gift of god to the animals below man is exploded. The lower animals reason, and much that has been ascribed to instinct is the result of education. That certain animals learn very rapidly to perform certain acts that have hence been called

instinctive may be explained, partly at least, by the fact of heredity. For the details on this interesting question the reader is referred to Dr. L. Büchner's "Mind in Animals" (Mrs. Besant's translation). Here I can only say that the difficulty of instinct is by no means insurmountable, and that as instincts are generally useful to the animal possessing them, they come within the range of the operation of natural selection. And the difficulty that is supposed to meet the follower of Darwin in the case of societies such as those of the bees and the ants, vanishes, I think, if we bear in mind that the principle of natural selection tells in regard to societies as well as individuals, and that a variation such as that of differentiation of labor, as in the bee-state, that is useful to the community, would give that community an advantage over other communities and would be likely to be transmitted, intensified, and become fixed.

(5) *Hybridism.*—When members of two closely allied species cross one with another the offspring is either sterile, or produces offspring that is sterile. Sooner or later the descendants of such a union are infertile. This fact is often considered as strong evidence against the Darwinian theory. The stress laid on it is due to the emphasis with which Darwin himself dwelt on it. I cannot but think that he over-estimated the force of this fact. For no evolutionist believes that a new species arises by so cataclysmic a process as the crossing of two previously existing species. The process of evolution is far more gradual than this. If it were contended that only by the crossing of two widely different forms a new form originates, the result of the sterility of hybrids (the cross between two species) would be of great moment. But as nothing of the kind is the contention, I fail to see how this sterility is to be regarded as an argument of any great strength. Moreover, the believers in special creation seem to me to reason in a circle. They first tell us that the distinguishing mark of a species is that its members cannot interbreed with the members of another species. Then when we ask how are we to distinguish one species from another, we are told "by the fact that the members of each species can only interbreed one with another." It is, on the theory of Darwin, quite con-

ceivable that two forms, B and C, might evolve along different lines from a common parent A, until at length they were so differentiated one from another, and even from the common parent, and were living in such different conditions of life, that the reproductive cells of A or B and C, cannot act on one or the other so as to produce fertile offspring.

One or two of the chief points urged by Darwin as evidence that the facts connected with hybridism do not tell irresistibly against his theory are the following. Sterility is visible in individuals of the same species. Crosses between different pairs of animals that all belong to the same species have varying degrees of fertility. If it were a law, fixed as that of the Medes and Persians, that between members of the same species crossing, with as result a fertile progeny, were impossible, we should expect to find that the crossing of two individuals of the same species would always produce fertile offspring. But finding, as we do, that there are varying stages of sterility between individuals said to be of the same species, we are led to think that the excessive condition of complete sterility is only an extreme case, and is dependent on causes as purely natural as are the different degrees of fertility or of sterility between individuals of the same species. There is every gradation, again, between the most perfect fertility and the most complete sterility, and it is difficult to conceive of the special creation of groups of animals or plants between which crossing is impossible, without conceiving of the special creation of groups between which the results of crossing would be representative of every one of these intermediate stages.

Again, so-called true species exposed to conditions of life that are different from those to which they have been subject, often become infertile. Animals that breed perfectly well in certain places and climates are found, on removal to other places and climates, to be quite incapable of producing offspring. Here it seems clear that infertility is due to changed conditions. Nobody invokes the aid of the creator in these cases, and it appears to be a rational explanation of the infertility of hybrids, or the crosses between different species, that the conditions of life are so altered as to bring about sterility.

The great cause of the sterility between animals and plants sufficiently different one from another to be placed in different species, is probably difference in their sexual elements, a difference not the result of interposition from without, but of the modification these elements have undergone as the living beings in which they are produced have been exposed to different external conditions.

In this discussion Darwin makes a fair use of analogy. He points out that certain trees can be grafted one upon another, whilst others are incapable of being thus grafted. Thus, the pear can be grafted upon the quince, and, with greater difficulty, upon the apple, a plant, by the way, more nearly allied to the pear than is the quince. But the pear cannot be grafted upon an elm. This difficulty of grafting is not referred to any special creative act. Indeed, the distinctions between plants that would be founded on the ease or difficulty of grafting would not coincide at all with the classification-divisions, and distinctions at present recognised—*i.e.*, if we based our species on the possibility or impossibility of grafting, the species thus mapped out would not be identical with those recognised to-day. Yet generally it may be said that plants closely allied can thus be blended, and that if they are not closely allied, grafting is impossible. As Darwin puts it: "There is no more reason to think that species have been specially endowed with various degrees of sterility to prevent their crossing and blending in nature, than to think that trees have been specially endowed with various and somewhat analogous degrees of difficulty in being grafted together in order to prevent their inarching in our forests."

Again, to take an illustration from the highest living thing, certain races of man cannot interbreed. Thus the Egyptian women and the whites are almost universally infertile. If the believer in special creation holds that species, as originally created, were doomed to infertility one with another, he must at least believe that more than one species of man were created, and that the Adam and Eve story is open to suspicion.

When we consider that the amount of sterility between individuals of the same species varies, that with changed conditions the sterility of individuals is affected, that the study of the anatomy and physiology of plants and animals

shows that the chief cause of sterility is difference in the elements of the beings crossed, and when we take into account the phænomena of grafting, the difficulties of hybridism are certainly not overwhelming.

(6) *Man.*—Many who are with Darwin in all that he says as to the lower animals and as to plants, part company with him when he applies his theory to the human race. This is but another example of man's false pride. He was wont, some years back, to classifly himself in an order, and even at one time in a sub-class by himself. But all this is over now, and the order Primates or Quadrumana, now includes man, ape, and monkey. In the same way the old fancy that the principal of natural selection was not to be applied to man, is passing away. Even the clergy are admitting that man's bodily structure may have been derived from one of the lowers animals. For further details on this point the reader is referred to my pamphlet on the "Origin of Man," and to my translation of Haeckel's "Populäre Vorträge" ("Pedigree of Man").

Not a single point in the anatomy or physiology of man separates him from his allies, the lower animals. It must be understood that when I speak of man I mean the human race as a whole. In this inquiry into the origin of species, and especially of the highest form of living things, man himself, we must not fix our attention on any one race, and least of all on the highest race. The ordinary person, when he discusses the origin of man, has in his mind the civilised and cultured European. It is this product of the evolution of man himself that he compares, most unscientifically, with the anthropoid or man-like apes. But the true comparison is between the lowest types of men and the man-like apes. If this comparison is made, if we study the various races of men from the highest to the lowest, aud at the same time study the nearest allies of man, we find that there are greater differences in every point of anatomy and physiology between man and man than between man and ape—that is to say, if we study the skeleton, the digestive apparatus, the absorbent system, the circulatory system, the respiratory organs, the secreting organs, the nervous system, the sense organs, the muscles, the voice apparatus, the method of reproduction, and the history of the development of mer generally and of the

apes—if we study the working of all these various organs, we find that in every case the gap is not between man and ape, but between man and man. To take but one crucial case. It is usual to state that in his brain-weight man is immeasurably the superior of the ape. But the heaviest human brain yet investigated weighed 67 oz., the lightest 8 oz., whilst the anthropoid apes have been found to have a brain-weight of 16 oz.

(7) *Mind.*—Even those who admit the probability of the truth of the Darwinian hypothesis in relation to man's body, deny in many cases the possibility of its truth in relation to man's mind. But mind is only a function of the nervous system; and just as the nervous system of man is separated by no line of demarcation from that of the lower animals, so his mental powers are separated by no line of demarcation from those of the lower animals. In my "Origin of Man" it is shown that if we consider the mental powers of the highest and lowest men, there are greater differences between them than between those of the lowest man and the highest ape. Nay, more than that, the mental powers of the lowest men are inferior to those of the highest apes, just as their brain weights are lower than the average brain weight of the anthropoid apes.

Chapter III.—ITS EVIDENCE.

Great questions such as this of the origin of species can only be decided by an appeal to evidence. Evidence is of two kinds; direct and indirect or circumstantial. In our courts of justice both are admitted. A man sees a murder committed and gives direct evidence as to its committal. Or the accused is found guilty on purely circumstantial evidence. He has blood on him the clothes and money of the murdered man are in his possession, he has a reason for the killing of the victim, has been seen near the place of death at the time of death.

In dealing with the origin of species we have to be content for the most part with indirect evidence. Of the direct kind not much can be brought forward in favor of

the origin of species by natural selection. In favor of their origin as special creations there is no evidence whatever. In fact, this view of the special creation of certain distinct kinds of plants or animals by an almighty power is entirely unsupported. There is not a single witness of repute on its side. The solitary argument that is sometimes urged by the ignorant on its behalf is the account in the first chapter of Genesis. But this is worthless as evidence in a scientific question. The Bible cannot for a momemt be admitted as witness in this great controversy. It has, on questions such as this, no more authority than the Koran or Vedas. And the class of persons called clergy, who claim the right to speak as to the origin of species, have no voice in the matter. As clergymen, their opinion is as valueless as that of the butcher, the baker, and the candlestick maker. If they have studied science, then as scientific students they are entitled to a hearing; but the fatal profession, as a profession, is not in a position to give a verdict on a question that can only be decided by skilled biologists and geologists.

Of direct evidence in favor of special creation there is none. Of direct evidence in favor of the origin of species by natural selection there is something. The whole of the two large volumes on animals and plants under domestication is, it seems to me, evidence of this order, evidence that tells for Darwin. But when we turn to the indirect, whilst again there is none on the side of the old belief, that on the side of the new is consistent, illimitable, overwhelming. It is consistent, for every fact of science, every discovery of the past twenty-four years, is in harmony with the views of Darwin. It is illimitable because the number of these facts and discoveries is beyond all computation. It is overwhelming because only minds blind or bitter are now unconvinced.

I, following in the main our master, range the evidence under six heads. General principles, classification, distribution, morphology, embryology, prophecy.

(1) *General Principles.*—The hypothesis is in harmony with the general principles of the eternity of matter, the eternity of motion, and the conservation of energy. These three great principles, summed up, perhaps, in the last of the three, are the enunciation of the majestic law that matter

has never been created or destroyed, that motion has never been created or destroyed, that the forms of matter, and the forms of motion are convertible one into the other, without any loss. The doctrine of special creation is in direct contradiction to this great truth. The Darwinian hypothesis is in harmony with it.

We use the word "matter" as a convenient name for all that which can effect the senses. This is no definition. But it is a useful convention. No one has ever seen matter created or destroyed. All experiments show that matter is readily transformable from one of its conditions to another, but that with the transformation there is never any loss or gain. The candle burns in the closed glass flask until it goes out or is burnt away. At the end of the experiment the weight of the closed glass flask and its contents is exactly what it was at the beginning. A change has taken place, that is all. A piece of gun-cotton is set on fire. Poof! It has vanished in smoke. The ignorant man thinks it is destroyed. But the chemist, weighing the gun-cotton first, and the air in which it is placed, and then after the burning weighing the gases that are formed, finds that the weights before and after the experiment are the same. Ceaseless transformations of matter, but never any creation, never any destruction. And this we are led to believe has been always the case.

Motion is change of place. Sometimes it is what we call molar motion, or that of evident masses. Moles = a mass. All that which is commonly called motion is of this kind. The movement of our own bodies, that of a falling stone, or of cricket ball thrown across the field, are molar motions. But there are forms of motion that affect the minute particles of bodies, forms out of the reach of our ordinary perception as cases of motion. Only of late years has it been shown that chemical action, heat, and light and electricity, and magnetism, and life, are modes of motion. In these cases the motion appears to be of minute particles, the little masses of bodies. Moles = a mass, "icula" is a diminutive ending. Hence molecule is a little mass, and the motion of these small ultimate particles of substances is molecular motion. It has been shown as to these various forms of molecular motion that all are transformable one into the other without any loss, or an

creation. The copper and zinc placed in the battery set up chemical action. The wires carried from the copper and zinc are found to be electric. The wire becomes hot. Broken across, a spark with light and sound leaps across the interval. Wind the wire round a piece of soft iron, and this attracts a magnet. Bring the two ends of the connecting wire into contact with a muscle that has been recently removed from the body of an animal, and the muscle contracts. Finally dip the wire ends into acidulated water, and the water is decomposed into hydrogen and oxygen. Chemical action is set up. Not only our experiments, but our observations, show that there is ever going on this transformation of a definite quantity of one form of motion into a definite quantity of another. Ceaseless transformation of motion, but never any creation, never any destruction. And this we are led to believe has been always the case.

Work is done when matter is set in motion. A man lifting a cannon-ball from the ground to the table does work. A stone falling from a cliff to the shore does work. Energy is the capacity to do work. The man who lifts the cannon-ball puts forth energy. This energy in motion is balled kinetic energy. κινησις (kinesis) = motion. The stone on the cliff is in a position to do work. Remove the cliff and it falls. But it is, as long as it remains on the cliff, only in a position to do work, and is not doing work. It possesses energy, or has the capacity to do work, but is not exercising that capacity. Its energy is that of position or potential energy. Potentia = power. There are therefore two kinds of energy; kinetic, that is energy in action; potential, that is energy in reserve.

The principle of the conservation of energy states concisely all the facts that I have now enumerated. It says that the various forms of energy, whether they be kinetic or potential, are transformable without any loss or any gain, without any destruction or any creation, one into the other; that the matter which is set in motion by energy and the amount of motion (molar and molecular) in the universe is, always has been, and ever will be, a constant quantity. This law is of general, of widest, application. It has to do with the living as well as the non-living. But the creation of a species means the creation of so

much matter and of so much motion. As long, therefore, as the principle of the conservation of energy is received as true, the special creation of a species of animal or plant is not thinkable.

(2) *Classification.*—In the first chapter attention was called to the impossibility of clearly defining the limits of the various groups in our artificial systems of classification. Every species, genus, order, class, runs into the neighboring species, genus, order, class. On the hypothesis of special creation this fact is meaningless. If every species is the result of a direct act of the almighty, it might be expected to be with ease distinguishable from every other species. But if all species have arisen by the gradual modification of pre-existing forms, we should expect to find them overlapping and dovetailing. I do not say that this difficulty of definition of groups of living things is irreconcilable with the theory of special creation. Once admit a creator, and there is no knowing what form his vagaries may take. But the theory gives no explanation of the fact, a rational explanation of which is afforded by Darwinism.

In truth, our systems of classification on the hypothesis of special creation are only so many records of meaningless caprice on the part of a creator. But on the hypothesis of the origin of species by natural selection or descent with variation, our systems of classification are a historical record. They are veritable genealogical trees. The placing of a number of animals or plants together in one group is equivalent to stating that they have had a common ancestor from whom they have all descended within a comparatively recent period, that is, within a few thousands or millions of years. The very difficulty of defining a genus or species becomes no longer a source of trouble. It is a delight to us, as it affords us a continual reminder that all the different genera and species have arisen by modification of pre-existing forms, and graduate imperceptibly one into the other. Our classification of animals and plants is at once a proof and a record of the evolution of living things.

(3) *Distribution of Living Things.*—The facts of the distribution of plants and animals both in space and in time are explained by the one theory, and not explained by the

other. On the subject of their distribution in space to-day, or geographical distribution, Mr. A. R. Wallace is our great authority. He is an evolutionist, and has shown in his beautiful works upon the Malay Archipelago and upon islands how the manner in which plants and animals are distributed is fully explained by the hypothesis of the origin of species by natural selection. As to the facts of palæontology, or the arrangement of the remains of past living things in the rocks, these are also on the side of Darwinism. The slow, gradual rise in complexity of structure in the organisms as we study the older rocks first, and the more recent after; the appearance of the simpler forms in the early strata, and the more highly organised in the later, are explicable and full of meaning in the light of the evolution theory.

I can only take one example from the distribution of living things in space, and one of their distribution in time. In the case of the great sub-kingdom Vertebrata, the forms that are first encountered in the rocks are not the Mammalia or members of the highest class, but the Pisces or fishes, members of the lowest; and if of these fishes the earliest instances are not the lowest, such as the lancelet, the lamprey, the hag of our seas to-day, the reason is that these lowest forms are not of such a nature as to admit of preservation. As we ascend the series of sedimentary strata, Amphibia appear next, then Reptilia and Aves, and lastly Mammalia. Of the Mammalia the forms first appearing are of the lowest type. Remains of the higher Mammalia, of the Primates or the order to which man belongs, are not forthcoming until comparatively recent strata are reached.

With the plants as with the animals, the simpler forms that are capable of preservation appear first, the more complex later. The Cryptogamia or flowerless plants, such as sea-weeds and ferns, appear lower down in the rocks than the Phænogamia or flowering plants. When these last make their appearance, the first forms that we meet with are the Monocotyledons, the class of plants with parallel veined leaves, such as the grasses and lilies. These are succeeded by the Dicotyledons, plants with net-veined leaves, and among these the first forms that appear are the Gymnosperms or naked seeded plants, such as

the cone-bearing trees, in which, despite the size to which the trees often attain, the complexity of structure is much less than in the plants that have their seeds enclosed in seed-cases.

The only case I can take out of the many instances furnished by the geographical distribution of living things is the case of island insects. These are, as a rule, of the same nature as the insects of the adjacent mainland, but their wings are rudimentary. On the theory of special creation this is without meaning. Why should a creator have given these beings rudimentary wings, and their fellows on the continent well-developed wings? If the reply is, in order that they might not be blown out to sea, the question arises, "Why, then, does he give them rudimentary wings?" The wings ought to have been removed altogether if the creator had been at work. But if these island insects and the insects of the mainland had a common parent at a time when the island and mainland were connected, and if after the severance of the former from the latter, the insects less developed stood a better chance of not being blown out to sea, and therefore of surviving, than their fellows with fully developed wings then natural selection comes into play, and in time, by its agency, insects with rudimentary wings are alone to be found. The rudiments of the wings tell us of the origin of these insect forms, and of the stages through which their ancestors have passed.

(4) *Morphology.*—Using that word in its widest sense as the science of structure, the facts of morphology are all so much indirect evidence for the modern view. All the old and new discoveries as to the comparative anatomy of plants and animals are in harmony with it. Studied with the aid of this luminous suggestion, a new and beautiful significance is given to every fact in connexion with the anatomy of living things. Here I can only mention two cases out of many; those of homology and rudimentary organs.

(*a*) *Homology.*—Likeness in structure. Thus the arm and leg of man are homologous. Diverse as are their functions, the arm and leg are built on the same general plan. Why should this be on the theory of special creation? Or, to take a yet more remarkable case. The

twenty appendages of the twenty rings that make up the body of the lobster are all built on one fundamental common plan. The eyes, the small and large antennæ, the gnawing jaws, the two pairs of delicate jaws, the three pairs of feet jaws, the forceps limbs, the four pairs of walking legs that follow these, the six pairs of swimmerets, are all homologous. And again, the three feet jaws of the lobster are the homologues of the three active legs of the insect.

Taking an example from the plant kingdom, we find that all parts of the ordinary flower are metamorphosed leaves. A flower is, in fact, a condensed branch. The green outer leaves or sepas; the generally colored inner leaves or petals; the thread-like stamens or male organs with their fertilising dust or pollen; and most internal of all, the carpels, with their contained unripe seeds, dependent for their fertilisation on the contact with the pollen—all these four parts are only modified leaves. In like manner the white underground scales of the bulb of the lily or hyacinth, the leafy structures met with at the bases of the flower-stalks of most plants, are modifications of the leaf. These facts are shown by the structure of the organs concerned, by the history of their development, by the way in which at times they revert to the simple leaf condition, so that a flower-bud will be replaced by a tuft of ordinary green leaves.

Again, still studying the plants, we find that the most aberrant forms of the vegetable kingdom are yet connected by a number of intermediate forms with the normal plants. And further, we find that even the most remarkable and out-of-the-way structures are but modifications of the customary organs of other plants. Thus the strange-looking flower of the orchid, with its long spur, its oddly-shaped and colored labellum or lower lip, its one stamen, its remarkable rostellum, are found to be built up on the model of the normal form of flowers met with in its class. Fundamentally, the orchid and the lily, with its regularity and simplicity of parts, are modelled on the same type. Every one of the six stamens of the lily, those six stamens so characteristic of the class Monocotyledons, to which the orchid and lily both belong, are reproduced in the orchid. Only one stamen acting as a stamen, carrying the

fertilising pollen, is present in the orchid. But all the other five are represented by certain structures, and the two side lobes of the labellum, the two parts of the clinandrum, or "bed" in which the one true anther lies, together with a thread of simple vessels running up one part of the flower, are homologues of the five missing stamens. On the theory of special creation this modification of the same fundamental parts in different regions of the same plant, or in different plants, is unintelligible. On the theory of descent with modification, it is understandable.

Here once more nobody will say that such arrangements are impossible on the theory of special creation. But everyone must admit that they are far more understandable on the theory of descent with modification.

(*b*) *Rudimentary Organs.*—In most plants and animals occur structures that are apparently of no use to the possessor. These rudimentary organs are explained very satisfactorily by the Darwinian theory. The hairs on our body generally are full of meaning when we reflect that probably they are the remnant of the hair covering of an ancestral form. When once the little red fold in the inner angle of the eye of man is shown to be connected by innumerable gradations with the third eyelid of birds, it acquires a deep interest. To the special creationist these organs and their thousand fellows are a difficulty that is, I think, insurmountable. They are a mute appeal to the common sense of mankind.

Scarcely a plant or animal exists of any complexity of structure that does not present rudimentary organs, that is organs so aborted and reduced that they can be of no functional value. The presence of such organs is wholly inexplicable on any other theory that has yet been enunciated, save that of Darwin. For a special creator to specially create organs that are of no use whatever in a living being is a waste of time and of material. But when animals or plants have evolved by gradual modification from other forms, we should expect to find them presenting traces of organs that were better developed and useful in their ancestors, but that have died out more or less completely in the course of modification.

The illustration given above, in the case of the orchid,

is a case in point. Here also the little thread of spiral vessels that runs up the front of the column in the orchid flower that is formed by the union of the stamen and carpel parts of the flower, is the rudiment of one of the six stamens of the ordinary Monocotyledon. Or, again, consider the case of the fox-glove and its allies. These plants have four stamens. But the members of the orders most nearly allied to the fox-glove order have five stamens. Now, the rudiment of the fifth stamen is always to be found in the fox-glove and its fellows.

In the alimentary canal of man is a part called the cæcum. After the stomach follows, in the human being, the intestine. This is at first narrow, and is called the small intestine; it is afterwards of greater diameter, when it is called the large. When the small joins the large intestine it does not join it end on. The former runs into the side of the latter, so as to leave on one side a small blind part, a *cul de sac*, whilst on the other the main tube of the alimentary canal continues. This blind part is the cæcum (*cæcus* = blind). A small organ in man, it presents a small extension of itself called the appendix vermiformis, or worm-shaped appendage. The cæcum has length $2\frac{1}{2}$ inches, and its breadth is about the same as its length. The appendix vermiformis varies in length from 3 to 6 inches, whilst its diameter is about that of a quill. This rudimentary cæcum in the higher animals represents a very large organ in the lower. Thus, in many of the lower Mammalia, as *e.g.* the rabbit, the cæcum is of great length, and probably has a function of great extent and importance. Its presence in the higher animals is evidence of their origin from ancestral forms in which the cæcum was well developed and of significance.

(5) *Embryology.*—The development of the living thing from the first and simplest condition until the complete adult condition is reached. Every animal and every plant that is not of the very simplest organisation in its complete state, begins life as the simplest of organisms, and passes through stage after stage of ever increasing complexity until the final form is reached. Why should this be, on the theory of special creation? But on the theory of the origin of species by variation, natural selection, descent with modification, this is exactly what we should

expect to find. The human being is at first but a piece of protoplasm, later a cell, a pair of cells, 4, 8, 16, 32, a mass of cells, a bag containing a liquid, and so on through a long series of gradations, every one of which has its parallel in one of the lower forms of animals. For some time there is no indication that a vertebrate animal is evolving. Even when that is clear the kind of vertebrate is uncertain; and when at last we know that a mammal is developing, unless we knew within what parent the development is going on, we could not affirm whether it was man or ape until much later. At one time in the life of the human being there are structures in no wise differing from the gill arches of the fish. Nay, we carry in our necks as grown men and women a bone, the hyoid, supporter of the tongue, that is the homologue of the fishes' branchial apparatus. What a beautiful meaning has this progressive development of the individual to the evolutionist! It is an epitome of the history of the race. The higher animal, the highest animal, passes rapidly in a few years through stages that represent those traversed by ancestral forms in the unthinkable ages of the past.

With the plant the same set of phænomena is to be seen. Every one of the more highly organised plants begins life as a piece of protoplasm. This becomes a cell, and this cell passes through stages of development that are representative of the complete condition of the lower members of the vegetable kingdom. The oak or the rose is at first but a unicellular plant, differing in no essential of structure from the simplest alga.

In this place it will be well to explain the two terms ontogeny and phylogeny. ων, οντος (on, ontos) = a being; γενναω (gennao) = I produce. Ontogeny is the development of the individual. It is the synonym for embryology, and is the name for the series of changes traversed by the living being in passing from the simple condition of its first appearance up to the complete adult condition. φμλον (phulon) = a stem. Phylogeny is the development of the race, that is, the series of changes through which the ancestors of the plant or animal of today have passed in the course of the ages. If the theory of special creation held sway among scientific men, there could be no science of phylogeny. Ontogeny would be a

conceivable study. But it is the facts of ontogeny very largely that have forced men of science to the conclusion that evolution is the truth. The study of the development of the individual living thing adds daily evidence in favor of the theory of descent. Every fact that the embryologist adds to our sum of knowledge is in harmony with that theory.

So clearly is this recognised by biologists, that they have eunciated at the present time a generalisation at which I hinted above. That is, that the ontogeny of any living thing is an epitome of its phylogeny. Every stage in the history of the development of a plant or animal to-day represents a stage in the development of its ancestral forms in the past.

(6) *Prophecy.*—An hypothesis has passed into the region of fact when a prophecy based on it is found to be accurate. This is, with the multitude, a final proof that they accept even when any number of such proofs as those mentioned above are rejected. The theory of gravitation received its crowning piece of evidence when, reasoning on that theory, astronomers directed their telescopes to a part of the heavens were as yet no planet had been observed, in the expectation that there a planet should be, and found Neptune. And when Professor Huxley, reasoning on Evolution, as he studied the teeth of the horse and its allies, stated that a particular kind of tooth had probably existed in some dead animal, and that very kind of tooth was afterwards found among the rocks, the theory of descent with modification rested on a more secure basis than ever.

Reasoning on the theory of gravitation, Adams and Leverrier calculated that certain erratic movements of Uranus must be due to a planet in a particular place in the heavens. The very night (September 23, 1846) that Galle, of Berlin, heard the result of the calculation from Leverrier, he turned the telescope of the Berlin observatory to the part of the heavens indicated by the calculation based on the theory, and found the planet Neptune, farthest away from the sun of all known planets; its distance, 2,750 millions of miles; its diameter, 37,000 miles.

The theory of the evolution of species by variation and natural selection has also been applied deductively. Let

us take once again the instance already more than once mentioned, the case of the orchid flower. Darwin, believing that the orchid was no special creation, but that it had arisen from a parent common to it and other Monocotyledons, was encountered by the fact that only one stamen was present in this flower, although most Monocotyledons had six. Reasoning deductively on his own great induction, he began to look for the other stamens. By a series of delicate dissections and observations of the development of the plant, he succeeded in finding the representatives of the five vanished stamens. And this is but one case of the many in which a biologist or zoologist, basing his calculations on the hypothesis of Darwin, has looked for certain structures that had not yet been observed, and has found them. The theory of the origin of species by natural selection is in truth a lamp to the feet of the naturalist, a guide to him in all his ways.

Reasoning on the theory of Evolution, a typical tooth was pictured that probably belonged to some extinct animal, ancestor of the horse and its allies of to-day. The facsimile of this theoretically-constructed tooth was afterwards found as a fossil in the Pliocene and older Miocene rocks, and the animal to which it belonged was named Hipparion.

Every contest between two rival hypotheses can only be decided by an appeal to fact. Sentiment does not enter into the question. Here, then, are two hypotheses; the one of special creation, the other of the origin of species by variation, natural selection, descent with modification. They are not only antagonistic. They are mutually exclusive. Difficulties attend both, but the difficulties attendant on the old theory are overwhelming, whilst those that environ the new are in no case insurmountable.

When we turn to the question of fact, we find that of evidence for special creation there is not a particle. Not a single piece of evidence, direct or indirect, is forthcoming on behalf of the doctrine of intervention from without. On the other hand, direct evidence of the origin of species by natural selection is not wholly wanting, whilst the indirect is incredible in its amount and in its importance.

As to direct evidence, I think we may fairly argue that the observed variations in plants and animals under man's

jurisdiction, and the production of varieties so many in number and so different in nature one from the other, are of this order. And the facts of embryology also appear to me to be of the direct order. For when we desire to see a case of special creation none is forthcoming. But when we desire to see a case of the evolution of a complex organic form, we have only to turn to the development of a highly-organised plant or animal. In some twenty or more years we actually see a human being evolve from the condition of a single cell to that of a thoughtful, active man or woman.

Of indirect facts in favor of the hypotheses of Darwin there is no end. Some attempt has been made by him and by those that follow him to group the facts. Whilst, therefore, we begin by saying that every fact that has been observed has been on the side of the modern view, we may remind ourselves that the great principle of the conservation of energy, now so firmly established, is violated by an act of special creation, is in harmony with the idea of the evolution of species; that our systems of classification, with their over-lapping and dovetailing of individual groups, are upon the one theory only the expression of an arbitrary and aimless act of will, are on the other a genealogical tree of all living; that the special-creation theory affords no satisfactory explanation of the appearance of the simpler forms of living things in the earlier and in the older rocks, followed by the appearance of more complex ones as the more recent rocks are studied, whilst this progressive advance in organisation is to be expected by the evolutionist; that the distribution of living things on the surface of the earth at the present day is explicable only on the scientific view; that the facts of the anatomy of plants and animals are in harmony with, and are full of significance on, the theory of Darwin; that such facts as the presence of rudimentary organs, and the cases of homology or likeness of structure without necessarily analogy or likeness of function are meaningless on any other theory than this; that the development of a living being from the simplest conditions through more and more complex ones until the final condition for the particular plant or animal is attained appears to be an epitome of the ancestral history of the living being and is in direct contradiction to the special-

creation hypothesis; that this great induction as to the origin of species, an induction from innumerable facts, is found not to fail whenever it is applied deductively; that, in short, reasoning on it, certain phænomena are expected, and these phænomena are actually found. When we reflect on all this, it is impossible for anyone who deals with these questions in the true scientific spirit, to hesitate for a moment as to which of the two theories is more likely to be true.

Chapter IV.—ITS HISTORY.

The Darwinian theory, received at first with a storm of disapprobation and railing, is now accepted by the scientific world at large. In this, the closing chapter of a pamphlet I can only indicate very briefly the way in which the ideas of Darwin were and are met.

Originally the most frequent weapon employed was ridicule. In ordinary society his claims as a thinker were dismissed with such phrases as "Oh, yes, says we come from apes;" and several publications, such as "Our Blood Relations" and "The Loves of the Gorillas," indicate by their title the methods adopted by their writers in dealing with the new generalisation.

Even at the present time there are some speakers and writers who think that they can slay a great idea by jests that only recoil on themselves. A few men, grossly ignorant of science generally and of Darwin's conceptions especially, still derive satisfaction and pecuniary profit from sneers and mockings addressed to Sunday-school children, or to the tea-meetings of the credulous. Men on the very verge of the grave are yet not unwilling to spend the last hours of their lives in sorry and unseemly jesting about those great matters; and ministers of religion are still to be found who will permit their churches to be used for the purpose of treating with buffoonery a question to which all men of culture are giving thoughtful attention, and on which the men of science have decided in favor of the man whose teaching is ridiculed.

So embittered and unfair are many of the opponents of Darwin in the early time, that his own care is actually used as an argument against him. The *Quarterly Review* of July, 1860, complains quite pathetically of his want of dogmatism, and appears to think that because Darwin only says, "I think" that species are the result of natural causes, he is less credible than a clergyman who says, "I know" that the writer of Genesis knew accurately the mind of the infallible god; and a Rev. F. O. Morris, perhaps the most amusing, and certainly the most ignorant assailant of Darwinism, devotes two or three pages of his "All the Articles of the Darwinian Faith" to a list of phrases such as—"I believe," "I think," "It is possible," taken from the "Origin of Species."

Some of the attacks are anonymous, and the writers of these must now congratulate themselves on their superior acuteness as compared with the want of wisdom on the part of others who were foolish enough to put their names to their lucubrations. I must rescue one of these anonymous beings from oblivion. He is too funny to be left alone, and his words are an apt motto for Christian Evidence persons, who without any scientific qualification attempt to deal with this subject. They should be written on the forehead of every one of these, and of every priest who as a priest, and not as a scientific man, presumes to give an opinion on Darwinism.

"It certainly has seemed to me the height of presumption for one, without scientific or literary acquirements, to attempt to refute the theory of so distinguished and universally admired an author as Mr. Darwin—a theory which has met with so much support from clever and enlightened men, and which men, far cleverer and more experienced than myself, though disapproving and disagreeing with it, have not attempted to refute." Nevertheless our tyro, as he calls himself, moans over Darwin's misfortune in espousing an "untenable theory," and placidly reminds the great philosopher that "God has hidden many things from the wise and prudent, and has revealed them unto babes."

A few scientific men of repute opposed the teaching of Darwin at first. A yet smaller number still oppose. As instances of permanent opposition on the part of men of

distinction in biological science, I mention the names of Agassiz, Beale, St. George Mivart. There are other names that could be given, of men such as Lyell and Owen, who opposed at first but gave in their allegiance afterwards, and of scientific men such as Houghton, who, unskilled in biological science gave adverse verdicts on a matter on which they were not qualified to speak. As to Agassiz, a sentence from the Rev. Dr. Peabody's funeral sermon on this great zoologist settles the whole question in his case. "His repugnance to Darwinism grew in great part from his apprehension of its atheistical tendency." Dr. Beale is known as a religious man and a reader of papers at the Victoria Institute, whose object is the reconciliation of science with the holy scripture. St. George Mivart is a Roman Catholic.

It is impossible to avoid the conclusion that, in each of the three cases mentioned, opposition to the views of Darwin has been due to the warping of the mind of the individual person by the influence of religion. Agassiz could not have brought to bear on the great questions at issue a clear and unprejudiced reason if he dreaded that his adhesion to one side in the argument would tell against the religious belief that he held so dear. Dr. Beale, again, is one of the school rapidly passing away, that is godly first and natural afterwards. He makes his science subordinate to his theology. St George Mivart is a devout member of the faith that to-day, as in the days of Bruno, Galileo, Copernicus, Kepler, sets its face against all new truth, the faith that would, were it possible, to-day imprison and burn a Darwin as readily as it imprisoned a Galileo and burnt a Bruno.

On the other hand, not a single biologist whose views on religion have not been of a pronounced nature has opposed the ideas of Darwin.

The name of Asa Gray, botanist of America, must be noted as that of a Darwinian who believes the truth of Natural Selection to be reconcilable with the theories of theology. He believes in Evolution. But he believes in it as part of the plan of god. His ideas are in the main those of Mr. G. St. Clair as given in his "Darwinism and Design." But with few exceptions, the scientific thought of every country to-day is with Darwinism. In scientific

papers, magazines, reviews and at the meetings of scientific societies—the matter is no longer one of discussion. The Darwinian hypothesis is regarded as a fact equally assured with that of gravitation, and the reasonings and inductions of all biologists are based on and guided by this great truth, still rejected by the really religious people. I use the phrase "really religious people" because, as I shall show presently, the churches are now changing front on this question. But the real believers, the Booths, Moodys, Sankeys, Spurgeons, are as virulent against the truth as ever.

The way in which the papers regarded the suggestions of Darwin may be gathered from one or two extracts. I will only refer to the *Times*, the *Saturday Review*, and the *Quarterly*, of secular papers. The *Times*, in reviewing the "Origin of Species" at the end of 1859 was cautious and critical in the true scientific spirit. But the appearance of the "Descent of Man" in 1871 quite threw the "leading journal" off its balance. I should imagine that the two reviews were written by two different men. I quote three or four delicious sentences: "We wish we could think that these speculations were as innocuous as they are unpractical and unscientific, but it is too probable that if unchecked they might exert a very mischievous influence. . . . A man incurs a great responsibility who, with the authority of a well-earned reputation, advances at such a time the disintegrating speculations of such a book. He ought to be capable of supporting them by the most conclusive evidence of facts. To put them forward on such incomplete evidence, such cursory investigation, such hypothetical arguments as we have exposed, is more than unscientific, it is reckless."

The *Saturday Review* is interesting as putting very clearly the recognition twenty-five years ago of the assault made by Darwinism on religion. "It tends to trench upon the territory of established religious belief." And the closing words of this article may be quoted as showing how completely the writer, a representative of a large school, was a partisan rather than a judge. "No conceivable amount of evidence derived from the growth and structure of animals and plants would have the slightest bearing upon our convictions in regard to the origin of conscience or

man's belief in the supreme being and the immortality of his own soul."

The words are strong, even for a Saturday Reviewer. "No *conceivable* amount of evidence," "the *slightest* bearing," "our *convictions*." This is the spirit in which the reviewer deals with a scientific question. It is true that the writer would urge probably that the rejection of the evidence is rejection on his part because it is evidence derived from animals and plants, and not from man. But surely man is an animal, and if he is only "a little lower than the angels," he is also only a little higher than the beasts. Any evidence derived from his nearest allies must have a very direct bearing on every function of his body, even if the function be that of the nervous system, and even if it have to do with such intricate questions as the origin of conscience and man's belief in god. But the Saturday Reviewer has convictions, and therefore is not open to conviction, and on his convictions, as on those of so many people, "no conceivable amount of evidence" will have the "slightest bearing."

The *Quarterly Review* is very interesting. First it falls foul of Darwin for his "loose statements and unbounded speculation." "On what, then, is the new theory based? We say it with unfeigned regret in dealing with such a man as Mr. Darwin, on the merest hypothesis, supported by the most unbounded assumptions." Then, in a passage of great moment to us, it puts the antagonism between Darwinism and religion very clearly. "Now we must say at once, and openly, that such a notion is absolutely incompatible, not only with single expressions in the word of god on that subject of natural science with which it is not immediately concerned, but . . . . with the whole representation of that moral and spiritual condition of man which is its proper subject matter. Man's derived supremacy over the earth; man's power of articulate speech; man's gift of reason; man's free will and responsibility; man's fall and man's redemption; the incarnation of the eternal son; the indwelling of the eternal spirit—all are equally and utterly irreconcilable with the degrading notion of the brute origin of him who was created in the image of god and redeemed by the eternal son." Finally the *Quarterly* indulges in a most unfortunate hope as to

the fate of the theory. "We trust that Sir Charles Lyell abides still by these truly philosophical principles; and that with his help, and with that of his brethren, this flimsy speculation may be as completely put down as was . . . the "Vestiges of Creation.'" The words I quote were written in 1860. The 9th edition of Lyell's "Principles of Geology" was issued in 1853. In this the great geologist gave his opinion against the theory of Darwin. But in his 10th edition, 1868, Lyell subscribes to the Darwinian hypothesis. Nothing is more beautiful or more pathetic in the whole range of science to my thinking than this confession of an old man, after fifteen years deliberation, that he was wrong in the past, and that he had altered his views on a point of such magnitude as the question of the "Origin of Species." I quote from the 9th edition two sentences: "Let us now proceed to consider what is defective in evidence and what fallacious in reasoning in the grounds of these strange conclusions. . . . From the above considerations it appears that species have a real existence in nature; and that each was endowed at the time of its creation with the attributes and organisations by which it is now distinguished." Both these sentences are omitted in the 10th edition, and in this edition, amidst a large quantity of details and of reasoning that is added to what had appeared in its predecessors, the following sentences occur: "We feel disposed at once to declare a theory which is in harmony with so many facts must be true. . . . Such a relationship accords well with the theory of Variation and Natural Selection, but with no other hypothesis yet suggested for explaining the origin of species."

I cannot do better for myself, for my readers, and for the fame of the great geologist, than quote in full the beautiful passage in the 10th edition of his Principles, in which he speaks of the reception of this new truth and of all new truth by the unbelievers who call themselves religious. The words are very solemn. "We are sometimes tempted to ask whether the time will ever arrive when science shall have obtained such an ascendency in the education of the millions that it will be possible to welcome new truths instead of always looking upon them with fear and disgust, and to hail every important victory

gained over error instead of resisting the new discovery long after the evidence in its favor is conclusive. The motion of our planet round the sun, the shape of the earth, the existence of the antipodes, the vast antiquity of our globe, the distinct assemblages of species of animals and plants by which it was successively inhabited, and, lastly, the antiquity and barbarism of primeval man—all these generalisations, when first announced, have been a source of anxiety and unhappiness. The future now opening before us begins already to reveal new doctrines, if possible more than ever out of harmony with cherished associations of thought. It is therefore desirable, when we contrast ourselves with the rude and superstitious savages who preceded us, to remember, as cultivators of science, that the high comparative place which we have reached in the scale of being has been gained step by step by a conscientious study of natural phænomena, and by fearlessly teaching the doctrines to which they point. It is by faithfully weighing evidence with regard to preconceived notions, by earnestly and patiently searching for what is true—not what we wish to be true—that we have attained that dignity, which we may in vain hope to claim through the ranks of an ideal parentage."

Turning now to the religious papers I can only make reference to one or two. The *Evangelical Magazine* in reviewing a book against Darwinism by an obscure clergyman named Lyon, writes: "The writer of this little volume brings logic, scientific knowledge, and wit to bear in the exposition of Mr. Darwin's fallacies, and supplies an admirable refutation of his theories."

The *Christian World*, dealing with the same work, tells us that "From some previous acquaintance with the subject, I hesitate not to pronounce 'Homo *versus* Darwin' a complete refutation of the assumptions and mischievous speculations of Darwin."

Good Words published an article that I grieve to say bore the honored name of Sir David Brewster. It is a sad instance of how the physicist is not competent to deal with these biological questions, and least of all when his mind is warped by religion. Brewster calls the speculations of Darwin "speculations which trench on sacred ground, which run counter to the universal convictions of mankind

poisoning the fountains of science, and disturbing the serenity of the Christian world." He names them "dangerous and degraded." He states that Darwin's "reasonings are almost always loose and inconclusive. His generalisations seem to have been reached before he had obtained the materials upon which he rests them." And in a passage for which all Freethinkers will be for ever grateful, he writes: "We cannot suppose that he intended to undermine the foundations of natural and revealed religion; but, we cannot conceal our conviction that the hypothesis, which he makes it the object of his life to support, has a tendency to expel the Almighty from the universe, to degrade the god-like race to which he has committed the development and appreciation of his power, and to render the revelation of his will an incredible superstition."

But the most comic of all these comic papers is, as we might expect—the *War Cry* not being at the time in existence—the *Catholic World*. This paper does not hesitate to call Darwiu the Devil. This it does by implication in the following passage: "Like Satan, who was cast from heaven in a moment, when desirous of elevating his throne to a level with that of god, so man falls and degrades himself when he becomes too proud to listen to god's word, making reason the supreme and sole criterion of truth and certitude;" and actually in this: "Like the Devil, he sometimes assumes the garment of light, and puts on an appearance of virtue." Anon, the *Catholic World* declares for the antagonism of the Bible to Darwin: "He sets aside all revealed truth. He knows nothing about the simple and sublime narrative in the first chapter of Genesis;" and comforts itself and its readers by a prophecy: "We think there is little to fear that its frivolous arguments will excite anything but laughter and ridicule among men of solid erudition."

I now pass to the consideration of the position of the clergy on the question. At first that position was wholly and virulently antagonistic. Later, as those robbers of men's birth-rights, those poisoners of life at its very source, saw that the truth was once again too strong for their falsehoods, they repeated the shifting of ground that they have had to execute so many times. To-day the astute among them agree with Darwinism, in everything save

its complete application to man. This they resist and will resist, for they know that when once all people understand that every structure and function of the human race, even the structure of the nervous system, and that function of the nervous system called mind, are of entirely natural origin, the days for the picking of the people's pockets by the priests will be at an end.

I can only quote one or two choice extracts from clerical utterances given forth early in the history of the controversy. First, let me pay tribute to the courage of the three clergymen, who at the British Association meeting of 1869 actually dared to oppose the Darwinian hypothesis. They were the Venerable Archdeacon Freeman, the Rev. Dr. McCann, and the irrepressible F. O. Morris. The nature and effect of their efforts may be gathered from the comments of the President of the Biological section, Professor Busk, a man never identified in any way with attacks on religion. Said he: "It was easy to set up a kind of idol and knock it down, calling it Darwinism. But really it had nothing to do with a theory of Darwinism." At the end of the discussion he remarked: "Not any one of the three authors had shown any knowledge of what the Darwinian theory really was." It was at the same meeting of the British Association that the late Bishop of Oxford maintained the traditions of his order by sneering at the new truth. He met with a rebuke from Professor Huxley that even a clergyman and a bishop must have felt: "If I had to choose my father from an ape or a man capable of employing his great knowledge and easy eloquence in railing at those who consecrate their lives to the proving of the truth, I should prefer to be the son of the humble ape."

These are published utterances. But every reader who had arrived at years of reason and understanding by 1859 remembers how the clergy, as a body, railed and raved. I call to mind a sermon against Darwin that I heard as a boy, and the closing sentence rings in my ears now. It was typical of so much of the blatant, priestly outcry against the man and his works. "Believe in Darwin," cried the excited orator. "Not I. I never read a word of him." I take an extract from "Homo *versus* Darwin," by the Mr Lyon mentioned above, as it puts unmistakably the

ideas of the religious world as late even as 1871: "Practically Darwinism, as it has been called in the latest exposition of it, is Atheism."

The Rev. J. H. Laing in the same year publishes "Darwinism Refuted." The Rev. W. Mitchell, Vice-President of the Victoria Institute, writes: "Any theory which comes in with an attempt to ignore design as manifested in god's creation, is a theory, I say, which attempts to dethrone god. This the theory of Darwin does endeavor to do. . . . So far as I can understand the arguments of Mr. Darwin, they have simply been an endeavor to eject out of the idea of evolution the personal work of the deity." The Rev. F. O. Morris says: "Does the good man think we are simpletons to be befooled by such trifling as this? And it is with it and such as it, a scientific book forsooth! that our professors and men of science would, if they could, beguile believers and overturn religion. This is the book that has been the Will-o'-the-wisp that has led away the weak-minded into the Slough of Despond of a shallow and contemptible Infidelity." And in a volume of Essays, published under the direction of Cardinal Manning, the Roman Catholic Church spits its venom at the great thinker and his followers. The theory is "degrading" of Darwin and those that think with him." Mr. Laing writes in this essay: "Whether this fallacious process of the pleading proceeds from knavish design, or, as I think it does in this case, from mere imbecility of mind, it renders equally untrustworthy the pretended guides who make use of it." More coarsely, Mr. Laing sums us all up as a "shallow multitude, strangers to mental discipline," and in an indignant outburst as "buzzards." He has, however, one true idea of Darwinism: "This is the doctrine for the sake of which, and its like, we are asked by its admirers to banish religion as an incubus from the hearts of children, and treat the name of the creator as an intruder." And he also prophecies: "(This) sketch may perhaps enable any one with his wits about him, to see his way clearly enough through the pretensions of this ridiculous book."

Let us never forget that this is the same Church a prelate of which, the Bishop of Salford, told his hearers

in the year 1882, that Charles Darwin, then dead but a few days, was burning in hell.

I have referred to the disingenuous change of position on the part of the Church, and the dishonesty involved in this change, unaccompanied as it is by any renunciation of the claims that the Church yet makes on men. Nothing I can write could speak more plainly than the words of Canon Liddon. I quote from the introduction of his sermon entitled "The recovery of St. Thomas." In this introduction he speaks of Darwin and his theory thus: "The present writer cannot, of course, express any opinion whatever as to the scientific value of Mr. Darwin's application of his general theory to the 'Descent' of man. . . . If the Church should hereafter teach that this 'formation' was not a momentary act, but a process of development continued through a long series of ages, she would not vary the traditional interpretation so seriously as was done in the case of passages which appeared to condemn in terms the teaching of Galileo. Nor would the earlier description of the creation of man in the sacred record present any greater difficulty. It is very far from clear that the Darwinian hypothesis has so established itself as to make such a modified interpretation necessary; only let it be considered that here, as elsewhere, the language of the Bible is wider than to be necessarily tied down to the terms of a particular account of man's natural history."

I repeat that no words of mine could bring before the mind of the reader more clearly than do those of Canon Liddon the depths of infamy into which the Church has sunk. The gross, the unblushing dishonesty of a body that pretending either to infallibility in itself, or in its head, or in its book, or in its god, can after it, or its head, or its book, or its god, have taught for centuries certain falsehoods, calmly turn round and say that the refutation of these falsehoods does not affect its position; such iniquity it is difficult to qualify in words. Nor is any member of that body free ftom the charge of dishonesty who does not repudiate with disdain the conduct of its representatives. Least of all is the priest, be he Canon Liddon or some lesser man (I mean lesser in position, not in honesty), free from this charge who deliberately writes and issues a passage such as that I have just quoted.

The honest men are those like the irrepressible Mr. Morris, whom I find even in this year of grace, 1884, writing in country newspapers against the Darwinian craze. These are at least honest. They see that Darwinism and the supernatural are incompatible, just as the principle of the conservation of energy and the supernatural are incompatible.

To all religious persons who think that the theory of Darwin is in harmony with revealed religion, I commend, in addition to the passages already given, these concluding extracts, from a sermon by the Rev. B. G. Johns. I remind them that his words are those that the religious of twenty years ago would have endorsed almost to a man. "They are far more curiously anxious to prove man's nearness to the beasts that die than to accept his birth from the breath of a living god, as meant, and made to be immortal. So monstrous, so incredible does this seem, that it sounds like a jest; yet this, brethren, is neither time nor place for jesting, least of all with such things as eternal life and eternal death, the birth, the destiny of the whole race of man. It is no jest, brethren, but the grave and shameful teaching of a book, now put forth by one of the men of science of this very age; calmly put forth as the inevitable and incomparable result of long, careful, and exhaustive study. . . . . And if it be so, if the incredible boast of science be true, our text is a lie. And if the text be false, the whole book in which the words are shrined is unworthy of belief; the whole framework of the Book of Life falls to pieces, and the revelation of god to man, as we Christians know it, is a delusion and a snare. It is interesting to note that Mr. Johns is chaplain to the school for the blind.

I have, I think, shown that the early reception of the theory of Darwin by the majority of people was a very hostile one; that the religious world was antagonistic to it; that the clergy were especially bitter against it; that everyone saw at first that there was no reconciliation between the theory and the bible, while most heldthere was no reconciliation between it and religion generally. I have shown also something of the dishonest change of front of the clergy, and as I end, have but to remind my readers that in every country but England the Darwinian hypothesis has

passed into the region of accepted truths; that by the scientific men of England it is regarded as in that fortunate position; that nations sorrowed at his death as at that of their own citizens; that Du Bois Raymond could call him when dead "the Copernicus of the organic world"; that Huxley wrote of him, "He found a great truth trodden under foot, reviled by bigots, and ridiculed by all the world; he lived long enough to see it, chiefly by his own efforts, irrefragably established in science, inseparably incorporated with the common thoughts of men, and only hated and feared by those who would revile, but dare not." What a gap is made in the world by the death of this man! Every nation has lost a citizen—a citizen that has done true work and has deserved well of the Republic.

He leaves behind him a vast and ever-increasing army of scientific children. All the young thought of the day is with him. The duty, the joy of these, and of us who are of them, will be to work out yet further the noble ideas received by us from him, and in some measure to endeavor by our numbers, our devotion to truth, our enthusiasm, to atone for the irreparable loss the world has sustained in his death.

THE ORIGIN OF MAN.

By EDWARD AVELING, D.Sc.

Chapter I.—GENERAL INTRODUCTION.

The three chapters that follow this one are a sequel to the four already published under the title "The Darwinian Theory." In discussing the meaning of that theory, the difficulties that encounter its students, the evidence on which it rests and the history of the hypothesis of Darwin, the attempt was made to give in language at once popular and accurate some idea of the scientific belief of to-day as to the origin of the many species of plants and animals that lived in the past or are living now.

As the greater includes the less, the Darwinian hypothesis of the origin of species covers the particular case of the origin of man. But man has only quite of late learned to regard himself as amenable to the same general laws, no more and no less, as the rest of Nature. Hence, even when the first outburst of ignorance against the principles taught by Darwin had in part died away, there were many who, whilst accepting with a tardy grace and with something of reserve those principles as affecting plants and the lower animals, regarded them as having no bearing on the question of the origin of the human race. Darwinism was all very well in respect to the lower forms of living things, but as regarded Man (with a very large M)—Oh, no!

The great naturalist, no more afraid of the conclusions to which his generalisations led than in love with them, applied the principle of Natural Selection and that of Sexual Selection to man. Sexual Selection, briefly, works thus. In the animal kingdom males predominate in number over the females

of particular species. The females have the opportunity of selecting certain favored males, to the exclusion of others. Hence there is a struggle among the males for the possession of the females. The arbiter is often brute force. Very often the decision of the female is determined by other considerations. More beautiful coloring or sweeter song or more artistic skill, *e.g.*, may render certain males more acceptable than others less gifted and less happy. The sexual selection of the males that vary in some special direction as to hue, shape, voice-ability or even bodily strength results in these males having offspring, by whom the variation that has led to the selection of their fathers will be inherited, in whom it may be intensified and, in their after generations, fixed.

I have no intention in the following chapters of applying in detail the principles of Natural and Sexual Selection to man. Their application by our master led to the conclusion upon his part that man had evolved from the lower animals. My purpose is rather to give some of the evidence, direct and indirect, that points in this direction.

Of the magnitude of the question as to whence man has come there is no need to speak. That solved, the questions what man is to-day and whither he moves become possible of solution. Until we are quite clear as to the origin of man, we cannot hope to deal satisfactorily with his present conditions, or to anticipate at all definitely his destiny.

To the question, "Whence comes man?" only two answers are forthcoming. We have to choose between the reply of religion and of the Bible, and the reply of science and of Darwin. Either man is a special creation, and that in the image of God (Gen. i., 27), or he is the result of evolution or development from some lower form. Between these two alternatives there is no mean, and there is no peace. One is true, the other false.

A question of this kind can only be solved by an appeal to evidence, and the best judges of that evidence are scientific men. One word as to the judges ere we turn to the evidence that is to be laid before them. Every man and woman of common sense has the right to an opinion, and to the expression of it. But the expression is only worthy of respect at the hands of others inasmuch as it is that of an individual, unless it comes from one who, by his scientific knowledge, gives that which he says a generic value. The only class

that can speak in any sense *ex cathedrâ* on this question is the class of men and women to whom biological questions are familiar. Nevertheless we have the clergy, with their usual presumption, not only giving, but declaiming their opinions on the scientific question of man's origin. Once more let it be repeated that the clergyman as a clergyman has no voice in this matter whatever. You might as well ask a smuggler his opinion on the Excise Acts.

For the evidence bearing on the question in discussion. It must be either direct or indirect. On this point the reader is referred to pp. 22, 23 of the "Darwinian Theory." All that is there said in respect to the want of all evidence, direct or indirect, for the creation of species holds in respect to the special creation of man in the image of god. Of this there is literally no evidence whatever. On the other hand, just as there is an immense, an increasing, a conclusive body of evidence, mainly indirect, in favor of the evolution of species, a like body of evidence exists in favor of the evolution of man.

Some of this evidence is now to be given. In weighing it let us keep in mind two things: (1) that on the opposite side no evidence at all is forthcoming; (2) that we are studying man as a whole, not merely the highest kinds of men.

In all this inquiry we have to take into account not the highest and most civilised races only, but the lowest and most degraded. It is by constantly considering only the European peoples and the contrast between them and the anthropoid or manlike apes that thoughtless people arrive at the astounding conclusion that man is infinitely superior to the lower animals. To this false conclusion the false statements of religion and of the priests have also conduced. The fact is that if we study all races of man, in no single point of his anatomy, his physiology, or his psychology is man clearly marked off from the brute. Including as human all from the loftiest men and women down to the savages, to the idiots, and to those ape men and women who, the children of normal human beings are themselves no more, and in many cases much less than apes, it may be asserted, without fear of contradiction that in every point of structure and function there is a greater difference between man and man than between man and ape—*i.e.*, the interval between the highest man and

the lowest man in regard to any anatomical or physiological point is greater than it is between the lowest man and the highest ape.

The evidence to be given will be arranged under three heads. Anatomical facts, or those having to do with the structure of organs; physiological facts, or those having to do with the function of organs; then psychological facts, or (using the word psychology in its widest sense) those having to do with mental phænomena. These divisions are like all the rest, artificial but useful. Especially is this artificiality noticeable in the marking off the brain functions from the rest of the body functions, and the making a distinction between psychology and the rest of physiology. The facts now to be noted are taken largely from Darwin's "Descent of Man." But other authors have been laid under contribution. I ought especially to mention Dr. W. Lauder Lindsay, whose work on "Mind in the Lower Animals," and essays on diseases in the animal kingdom, terribly wordy as they are, contain many most useful facts.

Chapter II.—ANATOMICAL FACTS.

Anatomy is derived from ανα (ana) = up, τομη (tome) = a cutting. It is the account of the structure of the body. Out of all the innumerable facts that might be given in this connexion, all pointing to man's relationship, not only to the animals nearest to him in the scale of being, but to his relationship to others far below, some will be taken that bear on the following subjects. The hair covering of the body, the skeleton, the teeth, the blood, the brain, the ear, the eye, the muscles, the voice, the reproductive organs. In all cases let us bear in mind that the question is whether man has been created in the image of god, or whether he has risen by variation, and natural and sexual selection from some lower form of animal.

1. *The hair covering.*—A common objection is that the mammals below man have a covering of fur or hair that invests their bodies generally, whilst man has only the hair covering on certain parts of his body. To this objection there are many answers.

(*a*) We have hairs nearly all over our body. It is true that they are rudimentary. But they are present. Hold the hand up so that the light shines across the back of it, and the minute hairs are visible. Everywhere with the exception of the back of the extreme joints of the digits these rudimentary structures are to be seen. This is meaningless if we are made in god's own image, as we have no evidence as to the distribution of hair on the body of deity. But if we have risen from a lower form of animal these hairs are rudiments of the coating that in our progenitors invested the body completely. [See p. 30 "Darwinian Theory."]

(*b*) In many cases the amount of hair on the body is in proportion to the animal nature of the individual. Of course this ratio cannot be said to be invariable, as certain low savage races are without hair on the body. But in most of the civilised peoples the more hairy the skin is, the lower is the type of man. The huge powerful "navvy," whose muscular system is strongly developed, and in whom the intellectual faculties are not highly developed, has shaggy arms, legs, and chest.

(*c*) Physiologists tell us that the human embryo or fœtus before birth is covered with a soft down called the lanugo (woolliness) that disappears after a time. This temporary covering of hair-like material is intelligible on the hypothesis of the evolution of man from a hair-covered animal.

(*d*) The cases of ape-men, or microcephali. These are, as I have already said, children of normal human parents, that revert to the simian type. These monsters, with their receding foreheads, their difficulty in walking, or inability to walk, upright, their habit of swinging from piece to piece of furniture, their ape-like grimaces, are covered as to their bodies either completely, or to a great extent, with hair.

2. *The skeleton.*—Just as the exoskeleton (outer protective organs) or hair covering of man does not differ essentially from that of his allies, so the endoskeleton (inner protective and supporting organs of man) differs in no essential from that of his allies. Every bone, every prominence on every bone, every marking for the attachment of muscles is the same in man as in the anthropoid apes. Of course there is not much difficulty, even to the non-anatomical mind, in distinguishing the skeleton of a European from that of a gorilla. But the

difference in little details between the two would certainly not be so great as the difference between the skeletons of a European and an Andaman Islander. A somewhat apocryphal, but suggestive, story was wont to be told at Cambridge, which, so far as I know, has never seen the fierce light that beats on a published book. Two undergraduates visiting the anatomical museum came to the skeleton of a man and of a gorilla placed side by side for the purposes of student comparison. One of the students was an anti-Darwinian, and rather short sighted. He glided off into a sweet flow of running words upon the absurdity, not to say impropriety of dreaming for a moment that "this, the man, could have come from that, the gorilla." He dilated upon the enormous superiority of this to that. From these simple premisses he arrived at the conclusion that Darwin was either a fool or a rogue. Thus, for some few minutes. Then his companion called his attention to the fact that the labels had been changed, and he was praising the gorilla.

To understand the thoroughness of the similarity between man's skeleton and that of his allies is only possible to a skilled anatomist. To the ordinary reader the details would be as uninteresting as unintelligible. Yet a few special facts may be given that will be understood by everyone. Let us take the cases of the tail, the hyoid bone and the visceral arches.

(a) The tail.—The objection as to the tail is nearly at an end. But there are still some ignorant people who think that they have disproved Evolution by asking how is it that man has no tail. In the first place man's nearest neighbors, the anthropoid apes, the gorilla, the chimpanzee, the ourang-outang, the gibbon, have no tail; or, more accurately, they have such an appendage exactly as man has. For, in the second place, man has a tail. Truly it is rudimentary. At the lower end of the vertebral column is the coccyx or *os coccygis* = κοκκυξ (kokkux) = a cuckoo's bill. *Os* = a bone. This coccyx, or os coccygis, is the remnant of the caudal appendage (canda = a tail), of the tailed animals. It is a small bone made up of three or four reduced vertebræ of no anatomical value at all. No muscles are inserted into the coccyx. Its value is genealogical. It tells us that the common ancestry of man and the man-like apes, was a tailed mammal.

(b) The hyoid bone.—This is a bone found in the neck of

the human being. It is not connected with any other bone directly. Muscles pass from it to the bones of the head and of the chest, and the tongue is attached to it. The hyoid takes its name from a letter of the Greek alphabet (the hupsilon or *u*) and from ἐιδος (eidos) = likeness. The bone has a central solid body, with two pairs of projecting horns. The horns are the greater and lesser cornua. Cornu = a horn. You can feel the larger pair of horns projecting right and left within the throat if you grasp your throat rather far back with the finger and thumb, so that the two digits are beneath and below the two angles of the lower jaw. That your finger and thumb are pressing the hyoid bone may be known by moving the tongue. The bony points will be found to slip away from your grasp. This little bone is the remnant of the gill-supporting apparatus of the fish. Here we have one of the cases in which bone structure in man carries us back millions on millions of years and reminds us of descent from animals that now seem too remote and too lowly to be recognised as part of the family to which he belongs in the ages. The gills of the fish are supported on a series of bony arches called branchial arches. These are in pairs. No comparative anatomist has the least doubt that the hyoid bone, with its two pairs of cornua, is the homologue (*i.e.*, representative in structure), of two of those pairs of branchial arches. This leads me to my third point in this connexion.

(*c*) *The visceral arches.*—Let us try to carry our minds back to the early hours of the life of the human embryo—to that strange time before its birth. Early in that life-history which begins within the organism of the mother-parent the embryo body has the front region of the side of the body quite closed, as indeed it is in the adult, whose neck of course presents no openings or clefts. But at a certain period in the embryonic life this anterior region of the lateral wall of the body shows on each side of the body certain vertical thickenings or ridges. These become more and more marked, and the integument between then thins gradually away. At last the ridges are arches, and the thin regions between them are clefts. If I may use the rough comparison, the front parts of the side of the body have the appearance of a grid-iron, the bars of which are the thick arches. These arches are the visceral or branchial arches. Viscera are internal organs

χια (branchia) = gills. The clefts between them leading

into the interior of the human being's body are the visceral or branchial clefts.

In this stage of development the embryo of man is therefore, as far as this region of his body is concerned, identical in structure with that of a fish. The visceral arches are the same as those that support in the fish the gills of the fish. These arches become in one or two cases part of the adult skeleton; in others they never enter into that skeleton. Thus the first visceral arch becomes on each side half of the lower jaw, and at the end of it, nearer to the skull, forms one of the bones of the inner ear. The second and third visceral arches make up the cornua and body of the hyoid bone. The rest become obliterated as arch-structures. As to the clefts, through which in the fish passes water that has been taken into the mouth for breathing purposes, they are in man all closed up completely at a comparatively early time. It is impossible to avoid the conclusion that this remarkable series of arches and the intervening clefts represent in their transitory appearance in the human animal the more permanent condition in a piscine ancestor of man.

3. *The teeth.*—The whole of the history of the teeth of the Primates (the mammalian order to which man, the anthropoid apes, the baboons, the spider monkey, the lemurs, etc., belong) is so much evidence in favor of the origin of man from some lower form. We can only take the case of the wisdom teeth. These are the four last teeth in position and in date of appearance. They are at the back of the upper and lower jaws on each side. As to their time of appearance, they may appear between the age of seventeen and that of twenty-five, or they may not appear at all. Coming comparatively late in life they generally, like Charles Lamb, make up for this by leaving early. They are really useless, placed so far back in the mouth, and very soon become lost in certain cases. In many people they are either not all four cut, or even not one of them appears. Thus the present writer has only cut 1·5 of his wisdom teeth, and he is assured by dentist friends that it is not an unusual thing for none of the four wisdom teeth to emerge. What is the significance of these wisdom teeth? If man is made in the image of god, are we to believe that—does not the whole wickedness and absurdity of the doctrine come out at the supposition? But if we look at the shape of the jaws of man and of the Simian Primates

we can understand what has happened. The lower jaw of man has an angle that is nearly right—*i.e.*, the ascending posterior portion is nearly vertical, and the lower part that runs forward runs nearly horizontally. In the lower jaw of the ape that angle is an obtuse angle—*i.e.*, the ascending part slants somewhat backwards. With such an obtuse angled lower jaw there would be room for the last or wisdom teeth to act and work on the food. But as with advancing development the shape of the jaw altered, and the obtuse became a right angle, the wisdom teeth would be pressed upon, and would have less and less possibility of grinding the food. From disuse they are dying out. On the special creation hypothesis the wisdom teeth are a gross blunder on the part of the almighty. On the hypothesis of Evolution they are disappearing organs that were once of use to our ancestors, and their very disappearance is an argument in favor of the scientific creed.

4. *The blood.*—Anatomically the blood of man is not distinct from that of the higher Mammalia. Everyone is familiar with the customary reply of the medical witness in courts of justice when murder cases are the centre of interest. "Are these marks those of blood?"—"Yes." "Of the blood of a mammal?"—"Yes." "Of the blood of a human being?"—"I cannot tell." Few facts are more important witnesses as to the community of our origin with that of the "lower" animals than this impossibility of distinguishing between our blood and theirs. By anatomical, microscopical, chemical, or physiological investigation it is not within our power to say more than that the blood under study is that of some animal other than of the mammal tribe, other than the musk deer, other than one or two special animals, the shape or size of whose blood corpuscles betray them at once. The murderer who says that the stains found on his or her garments are those of a bird or of a reptile lays himself open to conviction. But whoever says it is due to a rabbit, or a dog, or any ordinary mammal, can, as far as forensic medicine is concerned, be safe. This is one of the dangers that lead to the opposition of our highly-cultivated upper classes to the further advance of education among their inferiors. Whether this educational alarm will be well or ill-founded, the fact remains that no amount of microscopic or spectroscopic investigation reveals any real

difference between our blood and that of the majority of Mammalia.

5. *The brain.*—This is the organ around which the battle of ignorance and prejudice against knowledge has raged most furiously. Other organs in man may be similar to those met with in the rest of the animal kingdom. But this organ of reason and of imagination, of the poetry of a Shakespere, and the power of generalisation of a Newton must be in the human race widely separated from the organs in the non-human animals that are dignified with the same name. Precisely the same blunder that is made in comparing man generally with other animals is met with in an intensified form when the comparison is between the human brain and that of other animals. Thus the popular idea is that the brain of man in structure, volume and weight is separated from that of his fellows as by an impassable gulf. The idea is false. But it must be admitted with the deepest regret that this false idea has been originated and fostered not only by the clergy, who are not expected to know or to do better, but even by the scientific men. Again and again it is stated in works supposed to be scientific that this great gulf is fixed between our brains and those of other Mammalia. It is therefore necessary to give my authorities for the direct contradiction that I am obliged to give to this statement.

(*a*) As to brain *structure.*—There is not a single convolution or depression in the brain of man that is peculiar to him. Even the convolution to which Gratiolet clung as distinctive, the supra-marginal has been found in the orang-outang, has been found to be absent in man. On this point see Bastian, "Brain as an Organ of Mind."

(*b*) As to brain *volume.*—The volume of the human brain has been found to be as much as 1,900 cubic centimetres (a. c. c. is about $\frac{1}{17}$ of a cubic inch). It has been found to be as low as 1,200 c. c. in ordinary adult Europeans. Now the cubical capacity of the highest anthropoid apes may be taken as 600 c. c. Here then is a difference, 1,900 — 12,00 = 700 between man and man, and a difference 1,200 — 600 = 600 only between man and ape. More than this. If we note the volume of the brains of some of the ape-men we find that they have a cranial capacity far less than that of the ordinary anthropoid ape. Thus we know of at least ten cases of beings born of human parents in

whom the brain volume was less than the 600 c. c. of the apes.

Name.	Age.	Brain Capacity.
1. Gottfried Mæhre	44	 555
2. Michel Sohn	20	 370
3. Frédéric Sohn	18	 460
4. Conrad Shuttelndreyer ...	31	 370
5. Microcephalus of Jena ...	26	 350
6. Ludwig Racke	20	 622
7. Marguerite Mæhler ...	33	 296
8. Jean Mœgle	15	 395
9. Jacques Mœgle	10	 272
10. Jean Georges Mœgle ...	5	 480

(*c*) As to brain *weight*.—This is, in one way, a better test than volume, just as the amount of matter in a book or a lecture or a life is of more importance than the length of either book, lecture, or life. We may take the average weight of the brain in a European man as 49 ounces. That of an anthropoid ape is 15 ounces. A great interval truly between 49 and 15. But every one of the numbers between these is to be found in the list of human brain weights. Human beings have been encountered the weights of whose brain have been 48, 47, 46 ounces, and so on down to 17, 16, 15, and beyond. It is here only necessary to give two or three cases of weights less than the average in anthropoid apes. Professor Owen records a case of a microcephalous idiot, aged 22, in whom the brain weight was only 13·12. Professor Theile one aged 26, brain weight 10·6. Professor Marshall one aged 12, brain weight 8·5. With respect to this last case we must bear in mind that the brain weight of the child of 12 is $\frac{6}{7}$ that of the adult. Thus the average European child's brain weight would be $\frac{6}{7}$ of $49 = 42$ ounces. Once more then we find that the difference between the brain weights of man and man, 49 and 8·5, is greater than that between the brain weight of man and anthropoid apes, 49 and 15. For the verification of these numbers the student may be referred to Bastian's "Brain as an Organ of Man," pp. 365.

6. The *ear*.—The ear is one of the most variable of the organs of the human body. This is pointed out by Professor Hæckel in his lecture on the development of the sense-organs ("Pedigree of Man," Lecture X.), and will be corroborated by

anyone who observes the ears of any considerable collection of people, say at a theatre or a church. In some places, at all events, more instruction may be gained from the study of the ears of our companions than of the matter for the discussion of which the assembly is convened. It is not merely that they vary in length. Every detail of shape is variable. And this is, in the main, due to the fact that the sense of hearing is in man undergoing evolution. Perhaps no other function of our body is at the present time advancing so unmistakably as that of hearing. The various schools of music are only one proof of this growing extension of the auditory faculty.

One particular point literally is of interest to us. On the outmost edge of our ear is a little prominence, of very variable size in different human beings. It is from a quarter to halfway down on the irregularly curved line that runs from the topmost part of the ear to the lobe at the bottom of the ear. This minute point is without a doubt the remnant of the point of the ear of the lower animals. There is in the order Primates amongst its various species and individuals every gradation between the acutely-pointed ears of some of the lower monkeys and the ear of man.

7. The *eye*.—Of all the many structures in this complex organ we can, as with the ear, only call attention to one. In the inner corner of our eye, is a small red fold dignified with the disproportionate name of the *caruncula lachrymalis*. A caruncle or wattle is one of the red folds that occur on the head of the cock. The adjective *lachrymalis* is given because through two minute apertures in this caruncle the tears (lachrymæ) pass down into the nose cavity. The caruncle is not of so much interest to us physiologically as genealogically. It is the rudiment of the third eye-lid that at present is well developed in birds and other Vertebrata. If the eyes of a bird are carefully watched the observer sees a kind of transverse or side-way winking. This is due to the drawing across the eye of the *membrana nictitans*, or winking membrane, and this *membrana nictitans* is the third eyelid. Here again a complete series of gradations from the perfect eyelid of the owl, *e.g.*, to the *caruncula lachrymalis* of man is yielded by the study of comparative anatomy.

8. *Muscles*.—Not one of the 200 and odd muscles existing in the human body is peculiar to that body. Every one of them

nas been met with in the anthropoid apes, and everyone has been found to be connected with the same bones, the same parts of these bones, running in the same direction, having just the same function as in man. It is true that until recently there was a belief that a few of the many muscles did occur in man, and not in his allies, or did occur in certain of the anthropoid apes and were wanting in man. In general there are grounds for this belief, but in certain cases in the human subject, and in certain others in the Simian, these grounds are wanting. Thus, four muscles occur in all the anthropcid apes that are not generally present in man. All these four, however, have been found as varieties in the human body. Two muscles are usually present in man that are wanting in the anthropoid apes. But of these two, one is sometimes, and the other frequently absent in man. The interesting point here is that the six variable muscles are variable in man and ape.

The consideration of one or two special muscles is of use. Take first those of the ear. There are three very rudimentary muscles to each ear. They are so rudimentary that a skilled dissector alone can demonstrate them. One lies over, one lies in front of, the third behind the ear. That which lies over, when it contracts, raises the organ, and is therefore called the *attolens aurem*. *Attollo* = I raise, *auris* = ear. That which lies in front, when it contracts draws the ear forward. This is therefore called the *attrahens*. *Ad* = to, *traho* = I draw. That which lies behind the ear, when it contracts draws the ear backwards, and is therefore called *retrahens*. *Re* = backwards. In us not only are these muscles very rudimentary—they are almost functionless. Most human beings have no command of these structures, and even in the rare cases when movement of the ear by these small muscles does take place, the movement is generally involuntary and not attended with consciousness. The present writer has devoted a considerable amount of time and trouble to the acquisition of the power of ear-movement without success.

In animals lower than man the ear-muscles are well developed and capable of considerable movement. In the non-human Primates these organs are very mobile. There can be little doubt that in the Simian ancestor of man, a tree-haunting animal dwelling in forests where wild beasts roamed, the ears

were also very readily movable. Safety would depend largely on the power of perceiving the slightest sound when danger threatened. But thousands of years of evolution have changed all that, and now the muscles of the ear are reduced to a very rudimentary condition, and only in a few cases is there any remnant of the power once so marked and so valuable to its possessor. The presence of these muscles, like all rudimentary organs, is wholly inexplicable on the special creation hypothesis On this hypothesis we are to credit the three persons of the Trinity each with two attollentes, two attrahentes, two retrehentes aures. On the theory of descent or ascent with modification the presence of these small muscles is to be expected.

To take one other case. In the lower mammals there exists in many instances just beneath the skin a very extensive muscle. It runs all the length of the skin, and by its contractions moves that organ. The technical name of this muscle is the *panniculus carnosus.* Pannus = a garment, iculus = a diminutive, carnosus = fleshy. This is the muscle that horses and other members of the hoofed order (Ungulata) of the class Mammalia use in twitching off flies and other insects that are out of the reach of the tail. Remnants of this skin muscle are to be found in man. Indeed, the three muscles of the ear already discussed are portions of the panniculus carnosus, left stranded, as it were, after the general vanishing of the muscle. Other fragments of the same structure are, however, present. Thus the muscle by which the movement of the scalp over the skull is performed by certain gifted beings—a muscle known as the *occipito-frontalis,* as it runs from the occipital bone at the back of the skull to the frontal or forehead bone—this also is a portion of the *panniculus carnosus.* And in the neck, just below the skin, is a wide but very thin sheet of muscular tissue called the *platysma myoides.* πλατυς (platus) = broad. μυων (muon) = a muscle. ειδος (eidos) = resemblance. The platysma is attached to the clavicles or collar bones below, spreads over the whole of the neck up as far as the lower jaw. It is of no use to man. The three ear muscles and the *occipito-frontalis* we have seen to be practically useless to us, and the *platysma myoides* is, if possible, of still less utility than these. But it, like the attolens aurem, attrahens aurem, and retrahens aurem, and, like the occipito-frontalis, is of the deepest interest to everyone

but a special creationist, inasmuch as it is a reminder of our brute origin.

9. *Voice organ.*—As so much stress is laid on the wholly inaccurate statement that man, and man only, has the power of articulate speech, it may be noted that the structure of the larynx or voice-apparatus in man and in the anthropoid apes is identical. The same cartilages, great and small; the same folds and ligaments; the same complex set of muscles that, by moving the cartilages one on another, make the vocal ligaments tight or lax, approximate them or take them away one from another, and thus help to produce the different notes of the voice—all are present in man and apes.

In the next chapter the discussion of the physiology of voice in man and other animals will be briefly undertaken. In this chapter on anatomical facts it is only necessary to repeat that in all details of structure the larynx of man and the larynx of the anthropoid apes are the same.

10. *The organs of reproduction.*—Under this head, also, I can only make a statement of the same nature as that just uttered. Not only in general plan, but in the minutest particulars, the organs whose function is the maintenance of the species are the same in man as in the anthropoid apes.

I cannot end this chapter without again reminding the reader that only the merest fraction of the immense mass of available facts has been given. Literally their name is legion. But if their number is practically beyond reckoning, their nature is one. Not one of these facts of anatomy tells against the hypothesis of the evolution of man from some lower form. With that hypothesis every one of them is in harmony.

Chapter III.—PHYSIOLOGY.

We turn now to the consideration of the functions of man and of other animals. In the study of these we shall again find reason to believe that there is nothing in common between man and god (as to whose physiology we are lamentably ignorant), and that there is everything in common between man and the lower animals.

I may begin with a very broad assertion; but it is as incontrovertible as it is sweeping. Not one of the functions of the

human body is performed by man in any other way than it is performed by other members of the animal kingdom. From the first moment of the life of the human being, through all the stages of development up to the adult condition, in every detail of that adult life, the higher Primates, from the gibbon up to man, are one as to their general and special physiology.

With one part of the subject—viz., the physiology of the nervous system—the next chapter deals in detail. In this chapter my task is akin to that attempted in its predecessor. Out of the many thousands of facts that go to establish the identity of man's physiological nature with that of the anthropoid apes, I shall choose a few of those most striking and most easily comprehended by the student who is not necessarily a physiologist. The facts to be given will be grouped under the following heads. The sexes, parasites, wounds, diseases, drugs, periodicity, development. It will at once be seen that I am not taking up the various functions in the order in which they are considered in the ordinary books on physiology. The uniformity of the processes of digestion, of absorption, of circulation, of respiration, of secretion, and so forth in all the Primates, noticeable as it is, may not detain us. That monkeys, apes, men, feed, take up the digested food into their blood, circulate that blood, purify it by breathing, and by the secretions of different organs all in exactly the same fashion is a familiar fact. Let us turn to other facts not quite so familiar and equally significant.

1. *The sexes.*—Two points call for notice here. In the preceding chapter it was laid down that the structure of the organs concerned in the reproduction of the individual and in the perpetuation of the species were the same in man and his allies. It is now needful to mention that whilst this is the case those differences of structure that obtain between the male and the female of the human race are paralleled by, or better, are identical with the difference between the male and female in the anthropoid apes.

At regularly recurring lunar periods the female of the anthropoid apes is subject to the same physiological phænomena as the human. All the symptoms and concomitants are, with slight differences in detail, of the same essential nature.

Again, the whole of the process of reproduction in all its many details is in no essential different in man and his neighbors. Every act, from the commencement of courtship

to the end of the nurturing of the young that we see in the lower races of mankind, and every detail of it have been observed in the study of the sex relations of man's allies.

(2) *Parasites.*—Most animals are infested by other animals. The bodies of most members of the animal kingdom within and without are the happy hunting ground for one or more lower kinds of animal. It is found that man has no monopoly of parasitism. Not one of the creatures that is apt to infest him is peculiar to him. Everyone of them is found in or upon other animals. It is not only that these parasitic animals are of the same class or order. They are of the same genus, and in many cases of the same species. Thus the skin disease known as scabies, or less euphemistically "itch," is due to a little animal, a member of the same class, the Arachnida, to which the spider and scorpion belong. The generic name of this creature is *acarus.* Its specific name is *scabiei,* and exactly the same name must be and is given to the animal that causes scabies in the anthropoid apes, for it is identical with that which infests man.

Nor is this similarity of parasitism confined to those parasites that belong to the animal kingdom. Many of the organisms that affect man are of a vegetable nature—*i.e.,* if we admit the vegetable character of the group Fungi. This group comprises among others yeast, the mould that occurs on old leather and in wine-cellars, the puff-balls, and the mushrooms. The food of its members generally is organic matter that is passing into the condition of inorganic. Hence their name of saprophytes. σαπρος (sapros) = putrid, φυτον (phuton) = plant. Some of them find their food of this transition kind in other living organisms, and their habitat is within or upon those organisms. Thus some of the skin diseases of animals are due to the growth within the tissues of the skin of Fungi. Ringworm, that affects the skin of the scalp, is due to the growth of the mycelium of a fungus in the skin. The mycelium is the mass of threads that develop within the decaying matter on which the fungus feeds. μυκος (mukos) = fungus. Now this disease is, as people know only too well, readily transferable from one human being to another. But this disease is also found to be with equal readiness transferable from man to the anthropoid apes. The fungus whose ring of mycelium growing in the skin gives rise to the appearance whence the disorder takes

its name, finds an equally favorable nidus or nest for growth and development in the scalp of man and in the scalp of his allies.

As an instance of the general community of the animal nature, of how far down in the animal kingdom our kinship reaches, the following well authenticated case may serve. Certain mice in a house were observed to be affected with favus, a skin disease whose effects appear as yellow patches. Favus = honeycomb. A cat, by whom some of these favus-suffering mice were eaten, became affected with the same complaint. Here, we may take it, the transmission from the one to the other was from within, as it were. But a little later on the children of the family with whom the cat was in the habit of playing had favus patches appearing on their skin, and in this case the transmission must have been from the exterior of one animal's body to the exterior of that of the others.

These facts, and innumerable others of the same kind, bear witness to a remarkable oneness of nature between the integument and the interior of man and of animals less complex than man. Identically the same parasites could not infest different animals, and be so easily communicable from one animal to the others, were there not much that is common, if not actually identical in the nature of these animals.

(3) *Wounds.*—The whole of the question of the regeneration of destroyed, or recuperation of impaired tissues is of deep interest in this comparison of man with lower forms. The lower the animal, and the lower the tissue, the greater is the amount of restoration possible. Thus injury to an animal that belongs to one of the less highly-developed classes of the animal kingdom is, even if it be very extensive, likely to be completely atoned for by the reparative power of the animal. But the removal of any considerable portion of a more highly-developed animal is not likely to be followed by restoration of the part removed. In like manner, if even in man some lowly form of tissue, such as the fibrous or cartilaginous, is in part destroyed, it can be again made good. But if the tissue is a complex and excessively active one, as the muscular or nervous, there is little likelihood of its reparation.

There is then a close connexion between the lowness and simplicity of the organism or the part injured and the

power of restoration. One or two special cases taken from the inferior members of the animal kingdom (I always use the rather unfortunate word "inferior" in the sense of simpler) may serve to make this general proposition more clear.

In the great sub-kingdom of the ringed animals all the members have this power of restoration to a greater or less degree. Even the highest member, the lobster, of the highest class, the Crustacea, is able to reform its very large forceps-bearing limb with greater or less completeness if it is removed. In the Insecta. a class that is perhaps, on the whole, less complex than the Crustacea, the power of reparation is something more marked. But within the limits of this class itself, the general principle comes out. For there are three stages in the life of the insect, the larva or caterpillar, pupa or chrysalis, the imago or perfect insect, and it is in the larval or simplest stage that the power of restoration is at its best.

Parallel to this is the case of the Myriapoda, μυριος (murios) = many, πους (pous) = a foot, a class including the centipede and the millipede. In the members of this class the restorative power, always greater than in the more complex insects, is much more noticeable up to the last moult of the skin than after that moult has taken place, and the final fixed condition of the animal has been attained.

Similar phænomena are met with in the study of the highest sub-kingdom, that of the Vertebrata. In the lowest class, the Pisces, the power of reparation is most marked. The whole of the fin or limb of certain fishes has been restored after accidental removal. In the class above the Pisces, that of the Amphibia, to which the frog, the newt, the salamander belong, this capacity for reforming parts that have been taken away, is still well marked. Thus a salamander had its tail removed eight times in succession, and restored as many times. The same experiment with the leg of this amphibian was attended with similar results. The frog is clearly higher in the scale of being than the salamander. In the frog the reparative power is not nearly so evident. But in the tadpole, or lower condition of the frog, the power is possessed as completely as by the salamander, or even as by the fish. And this is in keeping with the fact that the tadpole is really a fish, whilst the adult frog is really a reptile. The power of

restoration of parts that the tadpole has, is almost wanting in the adult frog.

Finally we turn to man. It is well known that after operations the stumps occasionally give indications of partial regeneration. Rudimentary outgrowths are formed on them that take at times the appearance of very abortive digits. The case of supernumary fingers or toes is of the same kind. When an extra digit appears on the hand or on the foot of a human being, when a child is born with six fingers or six toes, removal of the extra digit is often followed by its reformation. This tendency to have extra fingers or toes is hereditary. It runs in families, as the phrase goes. To illustrate at once this fact, and the restorative power resident in the supernumerary digits, I take the cases quoted by Charles Darwin in his "Descent of Man." Four members of one family are recorded as having an extra finger on each hand and an extra toe on each foot. In another case one man had an extra toe. This was removed while its owner was a child. It had again to be removed at the age of 33. This man had a family of fourteen children. Three of them presented the paternal peculiarity. In one case the extra digit was removed three times.

The most interesting point about these cases is in that which I may call the double reversion. The increase in the number of digits is a case of reversion, for it is a generalisation in biology that repetition of similar parts implies lowness of organisation. In the plants and in the animals alike, if a series of similar parts occurs, as the uniform succession of cells in an Alga, or the uniform succession of rings in the body of a centipede or of an earthworm, the plant or animal is sure to be of a simpler nature than a living thing, such as a rose-tree or a vertebrate, in which a number of differentiated parts are combined into the one organism. Or, to look at the generalisation in another way yet more germane to the cases we are studying; in the lower Vertebrata the number of digits in the limbs is greater, as a rule, than in the higher. The digits that enter into the fin of a fish are very many. Those that enter into the arm or leg of a mammal are much fewer in number. When, therefore, an increase in number of the fingers or of the toes takes place in man, we have a case of reversion. For a repetition of similar parts implies lowness of organisation.

But the abnormal part, as we have seen, has the restorative power much better developed than the normal parts. In this also is a reversion. For the lower the animal and the lower the tissue, the greater its capacity for reparation. Why I said that in these instances of the appearance and reappearance of extra digits we have cases of double reversion will now be understood. There is reversion in the increase of number of parts. There is reversion in the fact that the abnormal part has the power of reparation much more marked than it is in the normal.

The cases known to every obstetric physician of intra-uterine amputation and restoration of the limbs thus amputated have a very direct bearing on this discussion. Certain membranous growths are sometimes formed within the uterus that may literally cut off a limb of the fœtus. The human embryo has at this early stage the power of restoring with greater or less completeness the organ thus removed, and at birth a leg or arm is found to have grown again in place of the one that had been amputated.

3. *Diseases.*—Just as man has no parasites that are special to himself, so he has no diseases that are not to be met with in other members of the animal kingdom. From the time of Boccaccio men have known that diseases are not only common to man and his fellows in the animal kingdom, but are communicable from him to them, or from them to him. The Italian novelist narrates the throwing of the clothes of a person just dead from the plague into the street, and how two hogs that laid down to rest on them rose plague-stricken.

Pericarditis, inflammation of the pericardium or serous membrane that surrounds the heart, occurs in birds. Goître or Derbyshire neck, the enlargement of one of the vascular or ductless glands (the thyroid of the throat) affects mules, horses, goats, pigs, sheep, oxen.

Many of the diseases of domestic animals are identical with diseases in the human species that are known by other names. Thus the cattle plague or rinderpest, that causes so much trouble to all European nations, is the typhus of man, and what is known as malignant pustule in the latter is joint-murrain in oxen and sheep.

All the so-called zymotic diseases are common to the Mammalia generally. They are named zymotic because they are

supposed to be due to a ferment, ζυμη (zume) = ferment, that is their concomitant, whether cause or effect is in most cases not yet known. These various diseases are, therefore, attended by the appearance of certain bodies within the blood of the animal affected. Identity of disease in different animals, and the possibility of the transmission of one of these zymotic diseases from one animal to another, argue a great physical similarity, if not a physiological identity, in the blood of these animals. Glanders in the horse may, under certain circumstances, be communicated to man. Small-pox attacks other Mammalia as well as the human race. The epidemic of this disease in England, in 1862, attacked sheep-flocks throughout the country. The history of its origin and transmission from farm to farm was as definite as the history of it in regard to men and women. The disease broke out first at the farm of Joseph Parry, at Allington, in Wiltshire. Cholera, again, is not only a human disease. Cats and dogs suffer from it, and, as it would appear, they may catch it as the result of cutaneous exhalations. Lower animals than the Mammalia are also affected. In 1846, when cholera attacked the British soldiers at Kurrachee, in India, the birds of prey fled from the infected district, and the fish were cast up in shoals on the sea-shore, dead. Yellow fever and typhoid are no exceptions to this general rule. The epidemic air has its effect on man and the lower animals alike. Diseases are transmitted from lower animals to man, and then from man to man. An ape may give typhoid fever to his keeper, and his keeper may give it to other men. And it is to be observed that this transference of any form of disease from man to some other animal, or *vice versâ*, is attended with exactly those slight modifications in symptoms and in the course of the malady that we should expect when it affected species allied, but not identical.

Naturalists who have had opportunity of studying the habits of anthropoid apes in their native countries, and under the normal conditions of their life, are among the best witnesses in this controversy as to the origin of man. Their testimony is unanimous. Whether it be Brehm, who observes the Primates of Paraguay, or Rengger, who observes the Primates of Africa, or anyone of the men, less able or less fortunate than these two indefatigable Germans, who follow in their footsteps, the evidence is in all cases the same. Thus

the statements of Brehm as to the Cebus Azaræ of Paraguay are corroborated in regard to other monkeys and apes both of the Old and of the New World. The young suffer from fever when they are cutting their milk teeth. At that time they are a source of both trouble and anxiety to their parents. All the diseases of the digestive organs to which human flesh is heir attack the Simian alimentary canal—from the slight pang of indigestion up to a severe inflammation of the bowels or a gastric fever. The eye, identical in its structure and in its functions in man and in his allies, is in him and them subject to the same infirmities. Apes and monkeys are known to suffer from cataract or opacity of the crystalline lens of the eye. The respiratory organs tell the same tale. Slight colds, coughs, a genuine catarrh, inflammation of the lungs, and even phthisis or consumption, with all its attendant train of symptoms—hectic flush, high temperature, and the rest—all these have been noticed again and again in the zoological kinsmen of man.

The diseases that have to do with the nervous system or even with that most complex organ of that system, the brain, are no exception to the general rule. Apoplexy is a not infrequent cause of death among the Primates generally. Every phase of mental weakness, from mere inferior capacity up to the wildest forms of madness, are known not only in monkeys and apes, but far down through the animal kingdom. Indeed the uniformity of mental disorders throughout this great kingdom is strong evidence in favor of the oneness of the nervous system of animals in all essentials, and of the truth that the highest mind is but the result of evolution from the lower and the lowest. Vice in horses is nothing other than incipient madness, a more or less marked form of lunacy. An extreme case of the same kind of mental disorder, only differing, therefore, from vice in the horse in degree is the "must" of the elephant. And to lead us on to the last set of illustrations as to disease that my space permits me to give, I may mention the fact that puerperal fever mania is not confined to the human female. This terrible form of brain disorder that occasionally seizes on women after childbirth with the most disastrous effects, as a rule, is met with in the lower animals, at least as far down as certain of the Ungulata or hoofed Mammalia. The sow has been known to suffer from puerperal mania.

In fact every disease of the reproductive system is common to all the higher Primates. To name but one other, perhaps the most striking example; the fearful scourge syphilis works its disastrous will on the anthropoid apes as well as on the human species.

4. *Drugs.*—The uniformity in relation to the attacks of diseases between man and the lower animals would lead us to expect a like uniformity in relation to the effects of different drugs on the organism of man and of other members of the same kingdom. The expectation is fulfilled. Generally it may be stated that every drug has practically the same effect on the human being and on other Mammalia. Indeed this is at once the result and the cause of most of the experiments as to the effect of drugs on animals other than man. As early investigation showed the identity of results whether he or his fellows were the subject of the experiments, later experiments have been tried on the inferior animals with a view to determining if newly-discovered remedies are of real value or not to the world of sentient things as a whole. For no one but an anti-vivisectionist holds for a single moment that these experiments are made for the benefit of the human race alone. The desire is to ascertain by carefully-conducted empirical attempts whether this or that substance is likely to be of use in the treatment of the diseases of animals generally, and likely to take its place among that list of pain-lesseners in which are written the names of opium and chloroform.

Passing over the multitudinous pharmaceutical remedies, from simple water up to ergot of rye, that have been shown by demonstration to have the same effect on the higher animals generally, I will only consider one or two substances that are of special interest, inasmuch as their action is admittedly on the nervous system. It will be evident that I select these because the last straw to which the opponents of Evolution cling, drowning in the sea of knowledge, is the strange fiction that man differs as to his nervous system from his allies.

Tea and coffee and tobacco have the same effect on the anthropoid apes as on man himself. Tea contains a certain vegetable alkaloid called theine, coffee a certain vegetable alkaloid called caffeine. An alkaloid is a complex organic substance, made up generally of four chemical elements, carbon, hydrogen, oxygen, nitrogen, usually combined to-

gether in large numbers of atoms. It is called an alkaloid because of its similarity to the alkalis, potash, soda, ammonia. The active principles of the plants, those bodies which give to the plants their value to man as medicines, *e.g.*, are the alkaloids. One of the most interesting points for us at present is that theine, the alkaloid of tea, and caffeine the alkaloid of coffee have been shown by chemical analysis to be identical in chemical composition and in properties. It is a very significant fact that the principle of the tea of China, the coffee of Arabia, the matè or Paraguay tea of America are one and the same. Its chemical formula, by whatsoever name you may choose to call it, is $C^8\ H^{10}\ N^4\ O^2$—*i.e.*, the alkaloid of these three plants consists of eight atoms of carbon, ten of hydrogen, four of nitrogen, two of oxygen.

It would seem from the generality of the habit of tea or of coffee-drinking that some want is supplied to the race of man by this principle. But this want is not the prerogative of man, for his neighbors are found to enjoy the non-alcoholic stimulants even as he enjoys them, and the effect produced on him by the drinking of tea or of coffee is repeated in the anthropoid apes when they take these beverages.

Tobacco has an alkaloid called nicotine. Its formula is $C^{10}\ H^{14}\ N^2$. It contains no oxygen. The properties of this alkaloid are familiar to every schoolboy. Its effect on the higher Primates is uniform. Apes at first suffer from the use of tobacco. They are nauseated by it. But, like man, they will in many cases persevere in its employment, and very rapidly appear to derive the same sedative comfort from smoking that is one of the happiest possessions of the human race.

The drug alcohol will furnish us with a concluding illustration. This is of greater importance than any other, because its action is so clearly on the nervous system, and on the higher centres of that system. The effect of alcohol on apes and monkeys, and, in fact, on the Mammalia generally, is the same as on man. And, if I may use the phrase, it is the same in its very diversity. By this I mean that, whilst the total effect of this drug is intoxication, whether it be man or another form of animal that is affected, the manner of the intoxication differs considerably in the different individuals. It is a familiar fact that this holds also with respect to man.

Thus, whilst the negroes of the north-east of Africa catch

baboons by setting out vessels containing beer and thus making the baboons drunk and incapable, yet experiments of Rengger in the same part of the world establish the fact that there is a "diversity of gifts" (I use the word in the English, not the German, sense) in the apes under the influence of alcohol. Some are rendered excessively morose, and want to fight everyone they come across. Others are reduced to a maudlin state, and weep on or without the least provocation. A few are "real good fellows," and with them the result of a stimulant is a diffusive *bonhomie*. These are the sort of apes that would ask everybody to dinner. Variable as are the individual effects, the next morning (that terrible next morning!) exhibits its human sameness. They sit melancholy, with their heads on their hands, and refuse everything but soda-water. This is the account of Rengger. But the present writer is distantly acquainted with an anthropoid ape, the property of a music-hall exhibitor, who has "evolved" further than his African compeers. He is said to get intoxicated (with his proprietor) every night, after the performance, and in the morning to enjoy a brandy and soda as well as a club man.

All this is very laughable and very tearful. But, half amusing, half painful as it is, the facts just given show very conclusively that the drug alcohol has similar effects, in their very dissimilarity, on the brains of man and of anthropoid apes, and show that the kinship in brain-nature goes low down into the animal kingdom. I may mention that a member of the lowest mammalian order but one, the Marsupialia, has been known to take rum and tobacco like a Christian. This order is confined naturally to Australia, and comprises such pouched animals (*marsupium* = a pouch) as the kangaroo, the oppossum, wombat. The creature of which I am speaking is an inhabitant of Queensland. Its technical name is *Phascolarctus cinereus*.

5. *Periodicity*.—Few phænomena are more mysterious than those connected with periodicity. It is a familiar fact to all men that certain functions, normal or abnormal, of the human body are, either in their recurrence or their duration, or their times of intensity, related to the periods of the moon. The relation of the reproductive function to lunar periods is well known. One form of that relation is the exceedingly definite gestation time in the human animal. To as in our pre-

sent investigation as to whether man is a special creation in the image of god, or is the result of development from lower animal forms, the most important fact is that this lunar periodicity is not confined to man. It is a general phænomenon throughout the animal kingdom. For such of the proofs of this momentous question as I am now able to give, I am indebted to a remarkable paper by Mr. Laycock, contributed to the British Association as long ago as the year 1842.

The paper contains a *resumé* of a very large number of observations made by Mr. Laycock on a very large number of animals. His conclusion is that a law of seven days periodicity is very general in the animal kingdom. It affects many members of that kingdom in regard to gestation metamorphosis (as in insects), acute diseases, such as fevers, and chronic disorders. I give one or two of his results. The time that elapses in the case of the glow-worm, from the impregnation to the hatching of the eggs, is exactly six weeks. Of the class Pisces (fishes) the gestation time is twenty weeks. As to the class Aves, or birds, the period of gestation in the fly-catcher species is two weeks; in the members of the order Grallidæ three weeks; in the duck four weeks; in the swan six weeks precisely. These are but a few chosen from Mr. Laycock's illustrations.

The result of observation on this point in 129 different species of Aves and Mammalia was that in sixty-seven cases the number of days between impregnation and birth was an exact multiple of seven, *i.e,* of one thirty-sixth of the human period. In twenty-four cases this was the fact within one day, and in every one of the other thirty-eight cases there was some uncertainty in the conduct of the observation and experiment that made the results of no value one way or the other.

This should be taken in conjunction with the fact that intermittent diseases attack the lower animals according to the same law of periodicity that holds in man. The dog suffers from tertian ague. Further, every physician knows that there are critical days, and what I may call sub-critical days, in acute diseases. On the critical days there is an intensity of the attack more marked than at any other time, and on the sub-critical there is also an attack, not so excessive as on the critical days. Now, these critical days are

the 7th, 14th and 21st, and the sub-critical are the 4th and 11th, midway between the critical.

The fact that this remarkable, and hitherto inexplicable law connecting certain functions, normal or abnormal, in man with lunar periods holds also in so many of the lower animals, seems to the evolutionist strong indirect evidence of the community of man's origin with that of the lower animals.

6. *Development.*—The last set of facts that I give under the head of general physiology, *i.e.,* the study of the functions of the body other than those of the nervous system, are facts of embryology. To my mind, these are the most convincing evidence in favor of the teaching of Evolution. Speaking broadly, man in his development goes through a series of transition stages that are identical with the persistent conditions of the lower animals. In his development from the egg or ovum, up to the state in which he is unmistakably a human being, he presents anatomical and physiological phænomena that are precisely those to be seen in lower animals than man in their adult state.

On the theory of special creation, the whole of this wonderful series of changes is without meaning. It is worse than meaningless. It is misleading. If it be true that man is the image of god, we are compelled to believe that god has gone through these stages of development. On the antagonistic theory the whole of the embryonic changes in the human being are quite intelligible. They correspond with the stages of man's evolution in the practically infinite past. They lead us up to the beautiful generalisation that man's ontogeny is an epitome of his phylogeny; that the history of the individual is a picture in little of the history of the race ων, οντος (on, ontos) = a being, γενναω (gennao) = I grow Phylum = a stem. According to the teaching of Evolution, every human being in a few years traverses the same ground as that traversed by his ancestors in the course of millions of millions of ages, and this is so in keeping with general truths that the idea seems *a priori* likely. For in our knowledge of things to-day the same principle obtains. The child who learns a language, or the man who acquires a knowledge of some advanced science, gains in a few days possession of the heritage of ages. The result of the laborious efforts, the trials, the successes, the failures of generations of men and women is ours to-day within the space of one or two heart-beats.

It is impossible to give all, or many, of the details in support of this general proposition, that the man in his development passes through stages representative of the complete conditions of lower animals, that are probably identical with certain of his ancestral forms. The full, or even the partial comprehension of these details is only within the power of the practical student of embryology. But once again a few facts comprehensible by the non-scientific reader may be given.

The human being is, at the commencement, an ovum or egg. That ovum is 1-125th of an inch in diameter. It is a single cell, with wall, with protoplasmic contents, with a nucleus *or endoplast* (the germinal vesicle) with a nucleolus, or little nucleus (the germinal spot). This first appearance on the stage of being is, in all respects, identical with the single cell that constitutes the whole of the lowest animals, and makes the whole of the lowest plants. It is to-day a scientific truism to say that no one could distinguish this cell that is to become a human being or not to become a human being, according as impregnation takes places or does not take place, from one of the microscopic organisms that hover on the border line, not only between the plant and animal kingdom, but between the kingdoms of the living and the non-living.

This single cell after impregnation divides into two, four, eight, sixteen, thirty-two and so forth, until a mass of similar cells is formed. This stage of the human animal is called the morula stage. Morus = a mulberry, and the appearance of the collection of many cells is not unlike that of a mulberry fruit. Just such an appearance is presented by certain low forms both of animals and of plants. A little later the inner cells have liquefied, and the outer condensed into two membranes, and now our embryo is a double bag, holding the liquid contents, as are some of the Cœlenterata, members of the sub-kingdom that contains the hydra (the fresh-water polyp) and the sea anemone.

Passing, of necessity, over a very large number of successive stages of development, let me only mention some half a dozen other casual points that bear on the contention of the evolutionist. How does the backbone of man make its first appearance? As a little rod of indifferent tissue running along the middle line of what is to be the back, and

marking where the bodies of the vertebræ will in good time be fashioned and placed. Now, in the Mediterranean sea, we find to-day Amphioxus, or the lowest of the Vertebrata, and in the middle line of the dorsal region of this rudimentary fish dissection reveals a line of indifferent tissue the notochord. νωτος (notos) = back. The Amphioxus is dying out rapidly. A century hence, possibly no such animal will exist. But a century hence the conclusive evidence yielded by this lowest vertebrate or highest invertebrate will not be needed. Every one will have accepted Evolution by that time.

The tail turns up again here. Early in the development of the skeleton of man the os coccygis (or tail) is relatively much larger than in the adult state. It extends at first considerably beyond the legs. And as to the legs and arms, the limbs generally, it should be noted that they in their incipient development, and in their first stages of development are exactly as they are in other Vertebrata—that in fact, the arms and legs of man begin to develop, and continue for some time to develop on the same plan as the fins of fish. One special fact may be noted in connexion with the development of the limbs. The great toe is a stumbling block to many who are studying Evolution. This and the thumb are in man supposed to be so essentially different in their arrangement with regard to the other digits as to make out man as a distinct creation. To what extremities are the opponents of this great theory driven! Now, in the very young embryo, long before birth, the great toe is much shorter than the rest of the digits, and instead of being parallel with the axis of the foot, is, as in so many of the Primates, at an angle with that axis.

The alimentary canal of man is in the zoology books usually distinguished from that of Aves, Reptilia, Amphibia, and Pisces on this ground. In man, and in the Mammalia generally, the alimentary canal is quite shut off (in the normal adult stage) from the renal and from the reproductive system. In the lower Vertebrata, on the other hand, the ducts from the kidneys, and in most cases the ducts that carry off the eggs in the female, or the impregnating secretion in the male, open into the lower or posterior end of the alimentary canal. Then that terminal portion of the intestine is known as a cloaca. Cloaca = a sewer. But there is a stage in the development of the human embryo when such

a cloaca exists, and the digestive system is not shut off from the renal or from the reproductive.

The kidney, or renal organ itself, is another illustration of the general thesis. Without going into anatomical detail, I may state that in the group Amphibia, and in other Vertebrata lower than the highest class, Mammalia, the structure of the kidneys is essentially different from that which is presented in the Mammalia. These more lowly-organised kidneys are called corpora Wolffiana. In the development of the Mammalia the first kidneys that appear are corpora Wolffiana, and these are replaced later on by structures of a more complex order. The transitory appearance of these bodies, and their replacement by their successors, are, I think, only understandable on the theory of Evolution.

With every other set of organs the same idea obtains. Thus the heart of the human being is at first only a pulsating undivided vessel. So is that of Amphioxus. From the heart of adult man passes off the great aorta, the vessel that carries the good blood for distribution to the body generally. In man this large artery makes a curve to the left-hand side of the body ere it reaches the inner aspect of the vertebral column, and runs down the front face of that column as the descending aorta. In the Mammalia generally this arrangement holds. In the Aves the curve is to the right, not to the left. In the Reptilia there are two aortic arches, one over-running to the right, the other to the left, that join together on the anterior aspect of the backbone. In the Amphibia the same plan as under the Reptilia obtains in the adult condition. But in the larval state (the tadpole, *e.g.*, of the frog) there are six aortic arches, three pairs, three to the right, three to the left, and this which is the state of affairs in the larva of the Amphibia is the persistent condition in the adult members of the lowest vertebrate class, the Pisces. Now in the development of man there are at first six aortic arches arranged just as in fishes. By a series of changes we have at last only the one on the left-hand side. But as surely as we reason that the arrangement of the aortic arches in the adult Amphibian is the result of evolution from the fish-like tadpole form, so we may reason that the present arrangement of the one aortic arch in man is the result of development from pre-existing conditions identical with those now persistent in fish. If this be not the truth, are we not entitled to

cry out to the holders of the antique belief, "To what purpose is this waste?" Why are there to begin with six pairs of arches when only one is ultimately to remain?

The helpless condition of the human embryo at birth, and its remarkable difference from the adult, are exactly paralleled by the condition of the anthropoid apes. The orang-outang, *e.g.*, does not attain its adult state until between the age of ten and fifteen, an age strictly comparable with that at which the human being in tropical latitudes ceases to be a child.

Chapter IV.—MIND AND MORALS.

We have considered some of the points in the anatomy and general physiology of man on which, with their innumerable fellows, are based the conclusion of the evolutionist. For this last chapter on the Origin of Man is reserved the consideration of one special branch of animal physiology—that which is usually known as mental philosophy.

At the beginning let me once more enter my protest against our artificial divisions. Physiology is the study of the functions of the body, and, therefore, to my mind, includes the study of that function of the nervous system that many call "mind." Morals again are but a division of the study of mind. The moral nature of an animal is that part of its mental functions that is not self-regarding, but has to do with other sentient beings. Since then, mind is but one of the functions of the body, and the moral nature is but a branch of mind, to separate the study of these from physiology generally is to make a distinction without a difference. The truth is that we are not yet free from the superstition that man is threefold, like a kind of miniature Trinity. Man's physical, mental and moral nature, man's body, mind and soul, have been so long regarded as really distinct states of phænomena that in a popular work it is convenient to follow the old divisions.

As, therefore, so much stress is laid on this branch of inquiry, having entered the necessary protest, I may now pass to the consideration of the evidence as to the origin of man that would be placed under the heading that is the title of this chapter.

Mind is a function of the nervous system. It is usual to

divide mind into three parts; a division as unreal, but as convenient as most of our methods of classification. Feeling, intellect, volition are the three customary branches.

Feeling includes the various forms of sensation associated with the ordinary sense-organs of touch, taste, smell, hearing, sight; includes also a number of what are called organic sensations that are not necessarily associated with aye of the sense-organs, such as those of hunger, thirst, nausea; includes all the emotions, such as pride, anger, love, hope.

Intellect is the outcome of feeling. None of the intellectual functions is possible without as predecessor certain sensations. An old-fashioned classification of the intellectual functions may even to-day be used without much detriment. Judgment, abstraction, memory, reason, imagination, according to this system, are the branches of intellect. More philosophical, but less easy of comprehension, is the three-fold division of intellect into (1) perception of similarity, when a given phænomenon is recognised as of the same nature as some previously observed phænomenon; (2) perception of difference, when a given phænomenon is recognised as of a nature other than that of some previously observed phænomenon; (3) memory.

Volition or will is again the outcome of sensation, and at least that branch of intellect which we name as memory.

Nor can we with profit enter upon the discussion before us without noticing three kinds of movement that take place in the human body, inasmuch as they have a distinct relation to the mental functions. Movements are either reflex, automatic or voluntary. A reflex movement is one not attended by consciousness or volition. An instance of this kind of action is the peristaltic movement of the intestine that is going on within every living person, and is altogether without the range of that person's consciousness or will. An automatic movement—or better, a sensori-motor movement—is not attended by will, but is attended by sensation. The contraction of the circular fibres of the iris, or colored part of the eye, when a light that falls on the eyes is too strong, is an example. A voluntary act is one attended both by consciousness and will. The majority of the acts best known to the ordinary person, such as the writing or the reading of these words, are of this order.

Of course these three branches of action graduate into each

other, as indeed the three divisions of mind mentioned above graduate into each other. Anyone who will observe with care the stages of the swallowing of a morsel of food will see a case of this gradation. The first stage, in which the food is passed to the back of the mouth, is a voluntary stage. The third, in which the food is carried from the top of the gullet into the stomach, is a reflex-action stage. But between these two is a brief, but clearly-marked, stage, of which we are conscious but over which we have no control. It is a stage of automatic, conscious, but involuntary action.

So much for preliminaries. As we turn to the consideration of details, the first thing that meets us is what I am obliged to call the unnecessary despair of Charles Darwin. Take this phrase from his "Descent of Man," p. 66: "In what manner the mental powers were first developed in the lowest organisms is as hopeless an inquiry as how life itself first originated. These are problems for the distant future if they are ever to be solved by man."

The inquiry is far from hopeless, I venture to think. The problems of the origin of life and of the origin of mind seem to-day as likely to be solved as the problem of the origin of man seemed to be, say at the beginning of this century.

Leslie Stephen speaks for the younger school, whose more hopeful utterances are the result of the teaching of Darwin, himself so hopeless on this point. He, speaking of the distinction that our ignorance has drawn between the mental powers of man and of the lower animals, writes thus: "The distinctions, indeed, which have been drawn seem to us to rest upon no better foundation than a great many other metaphysical distinctions—that is, the assumption that because you can give two things different names—they must therefore have different natures. It is difficult to understand how anybody who has ever kept a dog or seen an elephant can have any doubts as to the animal's power of performing the essential processes of reasoning."

Haeckel, as usual, is more outspoken than anyone else. He puts it distinctly, that the human mind differs only in degree, and not in kind, from the mind of other animals, and that in many individuals of the highest races of man the mental capacity is inferior to that of certain individuals of lower races.

In comparing the minds and morals of man with the

minds and morals of the lower animals two methods present themselves, by the use of one or the other, or by the use of both of which we can establish the great generalisation that there is no function of the human mind that *is not met with in the lower animals*. Either the particular function is not met with in certain beings that are, by common consent, men, or it is met with in other beings that are, by common consent, not men. No boldness is necessary to challenge any one to name a single mental function that is special to the human race. All that is necessary is a slight knowledge of the subject.

In this part of our study, more than in any other, is it necessary to guard against the common blunder of thinking only of the highest men. The comparison must be made between the lowest men and the most intelligent of the lower animals; we must bear in mind the numberless gradations between the mental and moral nature of a Darwin and of a criminal; we must bear in mind the similar series of gradations met with in the minds and morals of animals other than man; we must not forget either our savage individuals or our savage races, or the ape-men (microcephali) or the stages through which the fœtus and the child pass as man's mental nature evolves. And here also the law of the relation between ontogeny and phylogeny comes out. If the development of the individual (ontogeny) is an epitome of the development of the race (phylogeny), the study of the relatively rapid development of the child-mind reveals to us the line along which the far more slow development of the race-mind has taken place.

Every function of the human mind is met with in the minds of the lower animals. The basis of all mental functions is feeling. The fundamental perceptions here are of pleasure and pain. We may safely assume that no one will deny to animals very far down in the scale the power of perceiving pleasure and pain. Terror, an extreme form of emotional pain, has the same effects on the lower animals as on man. The contraction of some muscles, the relaxation of others, the erection of the hair, the bursting out of perspiration, the change in the character of the secretions, all are identical in man and in other Mammalia.

In the Royal Academy, a few years back, there was a remarkable picture, greatly noticed by the critics. The

subject a mounted knight about to enter a glen that is clearly enchanted. His horse and his hounds have caught the infection of the supernatural. Their faces, their bodies, their limbs, are all stricken with terror. Nothing in the picture was finer, nothing in it so fine, as the suggestion that the poses and the muscular contortions of the lower animals were but the development of the arrested tendency of the rider and master to show his terror. Yet in the picture of every living being in the painting there was further the suggestion that one word from the man, and horse and hounds alike would be themselves again, and for terror, courage would be to the fore. "Bad temper" is as characteristic of certain individuals among the lower animals as of certain human individuals, and this ill condition of mind, with its attendant train of ill deeds, is, as in us, generally due to ill-treatment. The baboon that showed its temper by throwing mud on the clothes of an officer had been insulted by its victim first, and showed a thoughtful appreciation of all the circumstances when it chose as the day of its mud attack, a Sunday, and the hour, the time when fashionable crowds were by.

Deceitfulness is a mental phænomenon, not by any means confined to man. We may place on one side the cases in which the beetles, crabs, snakes, turkeys, opposums, elephants, foxes, polecats, jackals, rats, figure death. Whether this figuring is voluntary, or the result of a cataplectic state is still a moot point. But in class after class, even of animals not near to man in organisation or in mind-powers, deliberate and purposeful deception is practised, involving a high condition of mental evolution. The trap-door spider of New Zealand plans out and makes nests of the most deceptive nature. One trap-door spider, *e.g.*, made its nest in a piece of ground in which holes had been made by rain drops, and in such a fashion that the nest was not distinguishable from one of the rain-drop holes. In this member of the class Arachnida of the sub-kingdom Annulosa that highest form of art, *ars celare artem*, is to be seen, for very often the arrangement that it makes of earth or vegetable matter is "apparently careless."

The sticklebat among fishes diverts the attention of dangerous foes by pretending to pursue an imaginary prey, and thus lures its foe from the neighborhood of the nest

of the sticklebat. Many small birds in England, as the chaffinch, and larger ones in England, or other countries, as our own partridge, the great rock partridge of Tibet, the ruffled grouse of North America will figure lameness in order to draw attention away from their young, or from their nests. The fox is proverbial for its powers of deception. In pursuit of ducks a fox will immerse himself in water all but his head, which he conceals in a bough of a tree. Thus he swims towards his prey.

Less dubious attributes of mind are equally evident in our study of the animal kingdom. Excitement, boredom, wonder and curiosity are illustrations. Nor do such qualities as emulation, magnanimity, require much comment. No one who has ever seen the cruel and brutal sport of coursing, no one who has watched horses racing, can for a moment doubt. Eager as the jockeys are, in the rare event of all being fair and above board, to get the better of the start and of the finish, the horses they ride are no less eager. Anyone who has ever held a bone just out of the reach of a dog will vouch for it that the emotion of hope is present in the minds of the lower animals, whilst the same quadruped furnishes, in the behavior of large dogs to annoying little curs, the stock example of magnanimity in the animals below man.

The faculty of imitation, on which depends so much of the growth mentally of the individual, is the possession of animals lower than man, and indeed we may say that most of the actions usually spoken of as instinctive are to a large extent learned of their parents by the young animals. Hawks, *e.g.*, are known to teach their offspring how to attack other birds, first by using dead, and then by using living specimens for the purposes of instruction. Occasionally this imitative faculty leads to the performance of acts not habitual to the animal. Thus dogs that have been brought up by cats will wash their faces with their paws—a most undoglike habit. A good example not only of the possession of this power at its best amongst non-human animals, but of that variation in its nature of such importance to the theory of Natural Selection is shown by the monkeys that men train to act. Charles Darwin, in his "Descent of Man," tells the tale of the monkey trainer who was in the habit of purchasing monkeys from the authorities of the Zoological Gardens in London. The usual price he gave was five pounds for each specimen.

But if this man were allowed to take a monkey away with him for a few days "on approval" he was willing to give twice as much. Questioned as to the reason, he replied that in a very short time he could tell if a monkey was likely or not likely to be of use to him. A monkey that was not attentive and persevering was of little value. If it was easily disturbed and its attention distracted by any slight motion or sound, as of a fly on the wall, or a noise without, the pupil was not likely to be a profitable one.

To give proofs of the possession of the faculty of memory in the lower animals would be absurd. But how far superior this faculty is in some of these inferiors of man to the memory possessed by man himself in certain cases, may be recalled to mind. The old Greek poets in their unconscious way knew this. On the return of Ulysses, the much-wandering, to Ithaca, the men that were once his friends do not recognise him. As he stands in his rags at the door, the suitors of Penelope within make jest and butt of him, not knowing that the only man that could draw the great bow hanging up so long disused is with them again. But after the old nurse has come out and known him for Ulysses and has been hushed into silence by his warning figure on his shut lips, the dog Argus, old and blind, recognises his master, and falls dead of joy.

Charles Darwin tells a sufficiently characteristic tale of his dog. It is a type of any number of the like stories that could be told by anyone who has kept dogs. The dog was a morose, uncompanionable animal, who would only take for companion his master. The master was away from home five years and two months. On his return a familiar word spoken in familiar voice to the dog was answered by no demonstration of affection or even of recognition. The animal simply rose and went out for a walk, as if it had gone through the same routine every day for five years past.

Much further down in the animal kingdom we find very distinct evidences of memory. The experiments of Sir John Lubbock prove conclusively that memory exists at least as low down in the animal scale as the class Insecta. The ants that the zoologist, botanist, politician, banker has made his special study certainly have memories that extend over a period of four months.

Turning to the man side of memory, in lower types of the human race, we find that among the individuals who are of

a mental organisation inferior to that of the average of their race, and among the races who are of a mental organisation inferior to the average of the genus *Homo*, memory is very deficient. Of this fact, in regard to individuals, everyone can furnish examples from his own experience, either taken from those diseased congenitally, *i.e.*, as the result of heredity, or from those suffering from acute or chronic nervous disorders. As to the weakness of memory in races, the testimony of travellers is again our help. In many of the savage peoples this mental function is not so well developed as in the horse or the dog.

The cases of the microcephali belong to the former, rather than to the latter category. In none of them was memory well developed. In the cases that had the greatest notoriety in this country, those of the Aztecs, the boy Maximo and the girl Bartola, the proofs of deficiency of memory are familiar. These ape-human beings would remember anyone who came to them two days running, or even with the lapse of only one day between the two successive visits. But if two or more days were allowed to intervene, all remembrance of the face and form that had been seen was lost.

Nowadays there is much talk about altruism. This philosophy teaches the difficult lesson that the standard of a man's acts, words and thoughts should be the welfare of others rather than of himself, the good of the world not that of any particular individual. The sacrifice of self, and the working for others that are implied in altruism are supposed to be men's prerogative alone. The lower animals are not regarded as possessing the social virtues by the ordinary people. How unjust all this is, the observer of the lower animals knows well. Instances of the possession of the mental, or if you will, the moral faculties implied in the word "altruism" are frequent, not only in individuals but in species and in orders of the lower animals, and not alone in those highest in the scale.

The virtue of mutual love is not only human. In many of the non-human animals it is shown far more powerfully than in man himself. Turning to the converse side of the picture, among the Bosjesmans and Australian blacks, the father is as likely as not to murder his child as soon as it is born. Even the mother treats her child no better than a cow treats her calf, leaving it to shift for itself at a very early age. On

the other hand, the love and respect of children to their parents is almost, or quite, unknown in savage races.

The naturalist, Wood, writing of the Bosjesmans of South Africa, and of the aborigines of Australia, says, "I very much doubt whether they have ever possesed the least idea that any duty is owing to a parent, from a child. It is said to be the glory of a North American Indian boy at as early an age as possible to be able to despise his mother and defy his father."

The love and kindness of parents towards their young is shown among the anthropoid apes in very human fashion. Thus the Cebus Azaræ of Paraguay was observed by Brehm not only to watch over its infant when asleep, but to drive away flies from the face of the sleeping child. The Hylobates, or gibbon, washes the face of its offspring. So close is the attachment between parents and young that in many cases the death of the latter was followed by that of the former. The elders could not survive the loss of their little ones.

Often, as with the children of the human race, orphans are adopted by those animals that are without offspring of their own. Generally the adopted young is of the same species as the benevolent adopter. But this is not always the case. Kittens have ere now been the foster children of anthropoid, or even of cynomorphic apes. κυων, κυνος (kuōn, kunos) = a dog. μορφη (morphē) = form. A baboon, one of the dog-like apes, adopted a kitten. The little orphan one day happened to scratch the foster mother, whereupon the baboon promptly bit off the claws of the kitten. In connexion with this anecdote, an interesting instance of the nature of anti-Darwinian criticism, and of the care of Darwin himself may be given. The *Quarterly Review* of July, 1871, cast doubt on the truth of the story of the kitten and baboon, inasmuch as it considered the biting off a kitten's claws by a Primate would be impossible. Patent, indefatigable, experimenting Darwin proceeds to try the experiment himself. In his simple way he narrates how he made the attempt to bite off the claws of a young kitten with perfect success.

Before turning to some cases that are supposed to be of special difficulty to the evolutionist, I take two other mental functions that are by common consent among the highest intellectual processes—viz., reason and imagination. Reason and instinct—what nonsense has been written and talked in thy names! Reason was human, instinct was not. All the

mental processes of man were due to reason; all those of other animals to instinct. Even at the present time there are many who still cling to this entirely untenable position, and many who consider that reason is very rare in the animals other than man, that it is not met with except in the higher classes. The whole question of instinct is very complex and interesting. The reader who is anxious to understand the exact position of modern thought on it is referred to the eighth chapter of Darwin's "Origin of Species," to G. J. Romanes' "Animal Intelligence," and especially his "Mental Evolution in Animals," and to Dr. W. L. Lindsay's "Mind in the Lower Animals." As I am here concerned with showing that reason exists in the lower animals rather than with considering the nature of instinct, I quote only one or two striking facts that, with others, establish that conclusion. These should be taken side by side with the deficiency or want of reasoning power in certain races and in certain individuals.

We may go very low down into the classes of the invertebrate sub-kingdoms without losing sight of reason. The Arachnida, Insecta, Crustacea, and generally the ringed classes are well to do in respect to their mental faculty. The spider that I saw not so long ago at Portsmouth who had built his web on the under side of a plank that reached from shore to a ship, and finding that the wind swayed the web to and fro, had steadied the web by means of a small pebble slung from the end of a little rope of threads, had certainly reasoned on unusual circumstances, and arrived at a very sensible conclusion.

Darwin's anecdote showing the reasoning powers of a crab is worth remembering. A naturalist observes a crab pass into his hole. Having nothing to do, the proverbial work is found for the man, and small stones are thrown at the mouth of the hole of the crustacean. Two or three miss the actual mark, and lodge on the edge of the hole. At last one falls in and disturbs the crab. This is with much labor removed and carried away to a distance from his dwelling-place. But returning from this excursion the crab sees the other stones lying near the mouth of his hole, and threatening to fall in. He pauses, he reflects, he reasons, and carries off all the other pebbles as he had carried off the first.

If we study the Vertebrata, the evidence of reasoning on

the part of animals becomes very much more strong. A few cases less familiar than the ones generally given may be quoted. My friend Captain Charles Bingham, who does not by any means hold the elephant in the same high estimation as the ordinary natural history books, tells in his paper on "Elephants," in the November number of the magazine *Progress* for the year 1883, of an elephant working under the direction of a Karen driver in a tributary to the Thoungyeen river. The task was the clearing of a block of logs that were all jammed together in a swollen stream. "For a full half-hour did the man, who was a Karen, work the elephant backwards and forwards, across and across the stream, now pushing at one log and now at another, but all in vain. The block would not clear away. During the whole time I observed that the elephant worked most unwillingly, evidently himself wanting to push at logs other than those pointed out to him by his driver. After watching for awhile his fruitless endeavors to disentangle the mass of logs, I asked the owner of the elephant, also a Karen, who stood by me on the bank, whether the elephant was accustomed to this sort of work. 'Oh, yes,' he said, 'he has worked timber for many years.' 'Tell the driver,' I said, 'to let the elephant push at whatever logs he likes.' The man smiled, as if doubting whether any good would come of that, but gave the required directions in Karen to the elephant driver, who immediately left off guiding or directing the beast. For a few minutes the elephant stood cogitating, filling his trunk with water, and squirting it over his back and sides. But on being spoken to gently by his driver, he left off this recreation, and went off himself to a particular log sticking up at an angle from the mass of logs, half below, and half above the water. He pressed his tusks to it, and pushed with all his might. The log moved, slid, was loosened, and the whole block of entangled logs floated down the stream."

In this case the elephant had reasoned out, or exercised a knowledge gained from long experience, and applied it with better effect than the human animal, his Karen driver.

Another interesting proof of the reasoning of an elephant going to the length of solving a simple problem in physics, is furnished by the fact that an elephant, wishing to bring an object within reach, blew through its trunk a blast of air that was reflected from the wall, and impinging on the desired

object, accomplished the animal's purpose. The result was obtained as a consequence of the law of reflexion so well known to man, that the angles of incidence and reflexion are equal. But it was hardly to be expected that an elephant should be acquainted with this generalisation.

A bear has been known to put into effect reasoning something similar to the Proboscidian in the story just given. In order to obtain a piece of wood floating on water, and out of reach, this animal set up a small current with its paw that slowly swept the desired object within range.

The cases of dogs exercising reasoning powers are endless. One that is of interest, as the reasoning brings about concerted action, is the instance of the Eskimo dogs, who in the polar regions divide the pack in which they are running when the ice becomes thin, and instead of continuing in a compact mass, by diluting, as it were, the band passes safely over the thin ice.

The most striking proofs of the possession of reasoning powers are furnished, as might be expected, by the animals that are in other respects the closest to man, *i.e*, by the anthropoid apes. For these proofs *in extenso* the reader must turn to Brehm's "Die Saugethiere von Paraguay" and to Rengger's books on South Africa. These writers give an immense number of facts, all of such an order as the three that follow.

Monkeys or apes to whom eggs had been given, by smashing the egg when first presented to them, and deluging their hands with the yolk, learnt at once a lesson. On the next occasion they with great care chipped off one end of the shell and sucked the egg, and this was done without any human instruction.

Tools that were given to them, handled somewhat clumsily at first, and causing injury, were ever after taken up, and handled with the utmost care, and with perfect safety.

Finally, I quote from Dr. Lauder Lindsay's "Mind in the Lower Animals," a passage bearing upon the general mental powers of the chimpanzee, whilst the concluding part has special reference to this animal's reasoning powers: "The chimpanzee shows in various ways a human like or civilised behavior. For instance, he sometimes takes his food like a man, making use of both men's foods and beverages, as man uses them. He helps himself to wine, drinks hot tea,

sugaring it, pouring it into a saucer, and waiting till it cools. He has been trained also to the domestic service of man. as he has been to man's companionship. He has been taught to attend a baker's oven fire on board ship, to act as galley fireman, regulating the temperature."

Imagination is a mind-faculty arrogantly claimed by man as his alone, and unjustly denied to his fellows. One might ask fairly how much imaginative power is in the possession of a microcephalous idiot or even of one of our slum inhabitants, or of an average middle-class business-man. But we may certainly assume that animals have imagination. The unnecessary fear that certain animals show in certain circumstances, as when a nervous horse shies at quite harmless objects, and even at shadows, is evidence of imagination on the part of these animals. The baying of dogs, not at the moon, as we generally think, but at a point near the horizon, is another instance of an act that appears to be due to imagination. The moonlight and the shadows have evidently an effect on the animals that can only be understood by supposing that their fancy is set in play. Moreover, dogs dream. We know that they will dream of the events of the day, and how can an animal dream without imagination?

There are however some points that have to do with mind functions and with morals also, on which doubt is felt, and even by those who are in the main evolutionists.

1. The *power of progressive improvements* used to be supposed to be an exclusively human power.

The Australian aborigines are incapable of mental cultivation, and the missionaries, even with the promise of rum in this world and heaven in the next, find that all attempts to civilise them are failures. The negro of East Africa, in contact with civilised peoples for centuries, has made no progress. Sir Samuel Baker speaks of the hopelessness of improving the mental state of such "abject animals" as the Bari of tropical Africa. The evidence of Livingstone is to the effect that the Johanna men are an unimprovable race. Monteiro, after quoting and agreeing with a number of authorities on the impossibility of bettering the mental condition of the negro, says: "I can see no hope of the negro ever attaining to any considerable degree of civilisation, owing to his incapacity for spontaneously developing to a higher or more perfect condition."

The trappers of America find that the animals they seek grow more and more wary, and that the traps by which they are caught, and the persons by whom they are slain at first, are after a time of no avail. Birds in wild regions of the earth into which the telegraph is introduced, at first fly against the wires, and "dash themselves dead." But ere long they learn, and the race as well as the individual learns, the lesson to avoid these sources of danger. The whole history of the dog species contradicts the insolent dictum of man. The establishment of regular training schools for the tuition of the home-flying pigeons in Belgium and in Germany, at Metz, Strasburg, Coblentz, Mayence, Berlin, is further evidence of the fact of the improvability of the lower animals.

2. *The use of tools.*—The ancient Caribs have no tools, nor even weapons. The Mincopies of the Andaman Islands in the Bay of Bengal, and the Dokos of Abyssinia are without tools or weapons. The aborigines of Tasmania and of Australia had no tools, and their only weapon was the boomerang. The lower animals use the tools made by man, and in not a few cases make and use implements as deserving of the name of tool as are some of the first efforts of man in this direction.

Non-human animals will draw carriages or guns, pile timber, fit drain-pipes, turn kitchen spits, work bellows. Thus a chimpanzee, already noticed in these pages, would lock and unlock a door or drawer, thread a needle, use knife, fork, spoon and cup, and even a napkin as decorously as a human being. It is important to notice that in this particular case, the usage of civilised implements was not compulsory. The animal actually preferred employing them to eating and drinking in the usual ape fashion. Animals lower than man, even in the wild state, will break off branches of trees from which they may or may not remove the leaves and use them as walking-sticks, fans, clothes. An Onapoor monkey learnt to brush its own clothes and shoes.

The history of the human race itself is a history of gradual evolution in tool-making and using. If man is the special creation for which so many contend, we should expect to find that from the outset his tools were of some degree of complexity. But, as a matter of fact, we find the most beautiful gradation from the wonderful and intricate machinery used by

men to-day down to stocks and stones. The iron age succeeded that of bronze, as the bronze succeeded that of stone. And the age of the stone implements shows evolution within itself, so that the geologist and anthropologist mark off the neolithic from the palæolithic. νεος (neos) = ; παλαιος (palaios) = ancient; λιθος (lithos) = stone. The neolithic stone implements are of a better fashion than the palæolithic. The simplest forms of the palæolithic tools are the merest modification of natural objects, requiring not a whit more intelligence and skill than that shown by numbers of animals that are regarded as man's inferiors.

3. *The use of fire.*—Of human beings that are without the use of fire we mention the dwellers in the Marianne, Ladrone, or Thieves Islands of the South Seas, the Dokos of Abyssinia, the Mincopies, and the dwellers in Teneriffe. The Australian aborigines never used warm water, and if the fire-stick they used went out they had to go to another tribe for a light. The Tasmanians also are unable to relight their fire-sticks if they once go out.

We have seen already that the anthropoid ape, at least, has the capacity for using fire and for understanding the niceties of furnaces and ovens. Thus De Grandpré, quoted by Büchner, tells us of a chimpanzee that heated the oven, let no coals fall, and summoned the baker when the temperature was as high as it ought to be.

4. *Dress.*—Some of the brute-men peoples never use clothes. The Tasmanian and Australian aborigines, the cave-dwellers, whom Dr. Mitchell, of Edinburgh, studied in Wick Bay, Caithness, and described in the *Daily Review*, Edinburgh, February 10, 1877; the Mincopies of the Andaman Islands wear no clothing, and the Egyptian fellahs, working for the iniquitous bond-holders, might, if they knew Shakspere and the Bible, quote Lancelot Gobbo and Genesis, "with a difference." "The old text is very well parted between our masters and us; we are naked and they are not ashamed." A baboon has been known to use a straw mat as covering for the head. Another animal of the same kind was wont to wrap himself in a sheepskin like a Kaffir. According to the *Graphic* of March 6, 1873, a female orang who lived at the Jardin des Plantes, in Paris, used to wear a surtout, which she would prudishly draw down over her feet when strangers came near. To the student, whose delight is to see our

human habits making their first appearance low down in the animal kingdom, the fact will be of interest that the larva of a species of fly will dress itself with the cast-off skins of plant lice and, if these fail, with pieces of silk or of paper.

5. *Houses.*—Of human beings who have no buildings in which they dwell, the following may be taken. The Caribs use only natural shelter afforded by rocks, caves and trees. The bushmen of South Africa have neither huts nor sheds. They live in holes dug by hand in the ground. The Dokos have no dwellings; the Veddas of Ceylon and the jungle dwarfs of the Western Ghâts, in certain districts of India, are in the same condition. The Australians make a daily dwelling of boughs, and abandon it the next day. The Tasmanians have not even this temporary dwelling-place. The orang in the Eastern world and the chimpanzee in Africa build platforms on which they sleep. The gorilla builds huts. The probability that the immediate ancestor of man was a tree-haunting animal has already been mentioned. The fact that many of the lower human races live in or on trees is in keeping with this. The ape-men of India and the Veddas of Ceylon live in hollow trees. The Bukones roost in trees on platforms made of sticks, exactly after the manner of the orang and the chimpanzee.

6. *Property.*—Even in comparatively lowly organised animals the notion of property and the recognition of another's property is to be seen. The monkey mentioned by Darwin, who having used a stone for breaking open his nuts secreted it in a corner of his cage, and allowed no other monkey to use it, and the dog with his bone, or a cat with her own basket, are cases in animals recognised as highly intelligent. But among the Insecta we find an idea of property in common. The best known instance is that of the ants who keep aphides or plant-lice as cows. Beetles are kept as domestic animals by ants for the sake of the sugar they yield, and in some ant-nests are found small blind beetles and wood-lice that live with the wiser or stronger ants as cats and dogs with men.

7. *Language.*—The advocates of the sad idea of man's special creation, speak of the language of man as articulate and that of other animals as inarticulate. I cannot find any satisfactory meaning for this word "articulate," except "intelligible to man," and this is a purely artificial dis-

tinction. But besides making this distinction without a difference, the special creationists fail to notice the following facts. First, man is born without the power of speech. Second, in many cases he never acquires that power. Third, several animals are known to use even that which is crudely labelled articulate language and to use it with intention, and with a clear sense of the meaning of the words used and of their bearing on events of people. Fourth, in many other animals who would not be granted in human phraseology the power of articulate speech, there are none the less the germs of that power. There have been dumb people in all ages and nations. In the cases of the microcephali, or ape-men, articulate language is wanting almost completely. Of the forty-two examples of this reversion to the ancestral type that are recorded in Vogt's "Mémoires des Microcophales," not one was ever known to string together words in such a way as to make a definite sentence. Not more than four out of the forty-two were ever known to speak even single words.

The dog has at least five distinct notes in his voice. The Cebus Azaræ, on whom so many of the observations of Brehm were made, has six notes. The fowl is said to have twelve. The Hylobates, or Gibbon, to whom reference has already been made in other connexions, has a whole octave of notes within the compass of his voice.

8. *The God-idea.*—The best disproof of this, the last of the human prerogatives, is given in Sir John Lubbocks "Prehistoric Times" (ed. 1872). Not only have we in these examples evidence that whole tribes have no belief in, no idea of a god, but in many cases there is no such thing as anything that could by any stretch of courteous imagination be called a religion. The conclusion to which Lubbock comes is that of all who have really studied the subject: "There does not appear to be any sufficient reason for supposing that these miserable beings are at all inferior to the ancestors from whom they are descended."

MONKEYS, APES, MEN.

By EDWARD AVELING, D.Sc.

Chapter I.—INTRODUCTION and CLASSIFICATION.

This chapter, and its three successors, form the continuation of two other series: "The Darwinian Theory," and "The Origin of Man," and they form at the same time the conclusion of a work I had planned. The design was to give an account, at once popular and accurate (1) of the principal generalisations bearing upon the theories of Darwin in general and upon their application to the human race in particular; (2) of the chief facts upon which the generalisations are based.

In "The Darwinian Theory" the general conclusions upon the origin of organic species were considered. In "The Origin of Man" some of the evidence upon which is based the certainty that the human race has evolved from some lower form was given. The work which now lies before us is of a more general nature. The design is to give a series of facts as to the anatomical structure of man and his allies that bear upon the question of their origin and point to the conclusion that their origin is common.

All the facts as yet observed and recorded lead, upon reflection, to the conclusion that the man-like apes and man have sprung from a form that was the parent of both ape

and man. In a word, the details now to be given will corroborate that which was stated in "The Origin of Man" (p. 3): "That in every point of structure . . . . there is a greater difference between man and man than between man and ape, *i.e.*, the interval between the highest man and the lowest man in regard to any anatomical . . . . point is greater than it is between the lowest man and the highest ape." Nor, in studying these details, must we lose sight of the fact also recorded on p. 3, that we have to do not with the highest only, but with the lowliest also of men.

Upon one point let me again utter a word of warning. It is against the dangerous phrase "connecting links." There is danger in using this phrase in relation to man and his allies. Low types of the human race, high types of the Simian, monsters like the ape-men, are not connecting links between the genus *Homo* (Man) and the genera, *Gorilla*, *Troglodytes* (Chimpanzee), *Pithecus* (Orang), *Hylobates* (Gibbon). *Homo* is probably not a result of evolution from any of the existing forms. *Homo* and these have probably had a common ancestry and ancestor.

The plan of these chapters is as follows. In the rest of this first chapter so much of zoological classification as is necessary to the understanding of the facts to be noted will be given. The facts themselves will then be ranged under certain heads corresponding with those that enter into the plan of work in my General Biology. The order pursued here will not be exactly the same as that followed in the more technical work, and generally in my biological teaching. In the second chapter the erect posture, the hair covering, the height, teeth, blood vessels, muscles and reproductive organs will be considered. The third chapter will be wholly devoted to the skeleton, and the fourth to the brain.

A.—Classification.

The *Kingdom* Animalia is divided artificially into certain groups known as *Sub-kingdoms*. Of these the only one with which we are concerned at present is the highest, or the Vertebrata. This group, commonly known as that of the backboned animals, is marked off from other sub-kingdoms by characteristics that, as a rule, distinguish its members from

those of other and lower groups. It will be understood that in giving these characteristics the zoologist is quite conscious of the arbitrary way in which he proceeds, and is aware that in the lower Vertebrata, as in the higher members of the sub-kingdoms grouped heterogeneously under the name Invertebrata, characters are found that demonstrate the impossibility of drawing impassable lines of demarcation and therefore of rigid, hard and fast definition.

The characteristics of the sub-kingdom Vertebrata are as follows:—(1) The possession of a skeleton that runs along the length of the body in the middle line. (2) The separation of the body by this longitudinal, axial skeleton into a smaller dorsal and a larger ventral region. *Dorsum* = back, *venter* = belly. (3) The occupation of the smaller, dorsal region by the central part of the nervous system, and the occupation of the larger, ventral region by the digestive canal, the respiratory and circulatory apparatus and other organs. The upper region of the vertebrate body is the neural (*νευρον*, neuron = a nerve); the lower is the enteric (*εντερον*, enteron = intestine). (4) Certain thickenings or arches, at the anterior and lateral region of the embryonic body, with clefts between them. These are the gill-arches and gill-clefts of fishes, and are represented in man by the lower jaw and hyoid bone ["Origin of Man," pp. 7, 8]. (5) The possession of not more than four limbs. (6) Jaws that are part of the walls of the head, and teeth that are hardenings of the mucous membrane of the digestive canal. (7) A complete blood-system, with a heart that is provided with valves and a hepatic portal system, *i.e.*, a set of vessels carrying the venous or used-up blood from the digestive canal, not at once to the heart, after the fashion of venous blood generally, but round by way of the liver. *Hepar* = liver, *porta* = gate. The origin of the name "hepatic" is evident. The word "portal" comes from a mistaken notion, natural enough before the discovery of the lacteals or absorbents of the digestive canal by Asellius in 1622 and of their function by Pequet in 1649. Until these vessels were recognised as the way and means by which the fluid chyle—result of food digestion—was carried from the digestive canal into the blood system, the belief was held that the chyle went by way of the hepatic-portal vein, which thus acted as a gate for the entrance of digested food

into the blood. A passage from Bacon's "Essay of Empires" (Essay xix.), written in 1625, runs thus: "For their merchants, they are *vena porta;* and if they flourish not, a kingdom may have good limbs, but will have empty veins, and nourish little."

The sub-kingdom Vertebrata is divided into groups that lead us at length to *Classes.* Of these last, the highest is the class Mammalia, commonly known as those that suckle their young (*mamma* = breast), or yet more roughly as quadrupeds. The chief marks of the Mammalia are as follows:—(1) Hair-covering. (2) Heart with four cavities. (3) Some of the blood-corpuscles red and without a nucleus or more solid internal part. (4) The aorta or large vessel that carries the good, arterial blood from the heart to be distributed to the body generally, makes a single arch towards the left side of the body. In Reptiles two aortic arches, one on each side, in Birds one aortic arch, towards the *right* side of the body, occur. (5) Breathing by lungs. (6) Mammary glands.

The class Mammalia is again artificially broken up into *Orders,* fourteen in number. The highest of these is the order Primates or Quadrumana. *Primus* = first or highest. *Quatuor* = four; *manus* = hand. This order is marked off from its fellows among the Mammalia by characteristics, some of which have to do with the skeleton, others with the reproductive organs and processes. For our present purpose, it will be enough to say that the Primates present the following marks:—(1) One pair of clavicles or collar-bones; not two, as in Birds and the lowest Mammalia. (2) A placenta or vascular organ connecting the mother and the child before birth. (3) Incisor, canine and molar teeth present. (4) The placenta deciduate (*deciduus* = falling off), *i.e.,* coming away entirely after birth. (5) The placenta discoidal, or applied only at one definite region of the embryo, so as to be disk-like in shape. (6) Mammæ pectoral (*pectus* = breast) in position. (7) Hallux (big toe) with a flat nail and capable of some movement.

So far, then, our monkeys, apes and men are all members of the Kingdom Animalia, the sub-kingdom Vertebrata, the class Mammalia, the order Primates. The further working out of their classification will be better understood if the table now given is first studied and then referred to as the text is read.

CLASSIFICATION OF PRIMATES.

PRIMATES.	Simiadæ Lemuridæ	Cheiromyini		Cheiromys *	... Eastern Asia.
		Lemurini		Maki *	... S. Africa, Madagascar.
		Arctopithecini		Arctopithecus * (Marmoset)	... South America.
		Platyrrhini		Ateles* (Spider Monkey), Mycetes* (Howler)	South America.
		Catarrhini	Cynomorpha	Macacus * (Baboon)	... Old World.
			Anthropomorpha	Hylobates (Gibbon)	... E. Asia, Malay archipel.
				Troglodytes (Chimpanzee)	... West Africa.
				Pithecus (Orang)	... Borneo, Sumatra only.
				Gorilla (Gorilla)	... West Africa.
	Anthropidæ			Homo	
				Ulotrichi: H. papuus (Papuan)	... New Guinea.
				Ulotrichi: H. hottentotus (Hottentot)	... South Africa.
				Ulotrichi: H. cafer (Caffre)	... ... „
				Ulotrichi: H. niger (Negro)	... ... „
				Leiotrichi: H. australis (Australian)	... Australia.
				Leiotrichi: H. polynesius (Malay)	... Malay, South Sea islands.
				Leiotrichi: H. mongolus (Mongol)	... North and middle Asia.
				Leiotrichi: H. arcticus (Eskimo)	... Polar region.
				Leiotrichi: H. americanus (Red Indian)	... America (aborig.)
				Leiotrichi: H. mediterraneus (Caucasian), Xanthochroic	Teutonic lands.
				Leiotrichi: H. mediterraneus (Caucasian), Melanochroic	Mediterranean lands.

The order Primates is divided into three sub-orders. (1) Lemuridæ, thus named as it includes the Lemur of Madagascar. This sub-order is identical with the Mammalian order of Haeckel and Gegenbauer, known as Prosimiæ (pro = before, simia = ape) or half-apes. In my translation of Haeckel ("Pedigree of Man," pp. 77, 86, etc.) the Prosimiæ are often mentioned as an *order* representing in its members the persistent forms of the ancestors of all monkeys, apes and men. That this last truth still holds to the full, although here for convenience' sake the Lemur group is regarded as a *sub-order*, shows at once the artificiality of all classification, the reality of Evolution. (2) Simiadæ (monkeys and apes). (3) Anthropidæ; ανθρωπος (anthrōpŏs) = man.

The sub-order Lemuridæ or Prosimiæ has two divisions. *(a)* Cheiromyini, represented by the Cheiromys of Madagascar woods. *(b)* Lemurini, represented by the Maki or true Lemur.

The sub-order Simiadæ has three divisions. *(a)* Arctopithecini: αρκτος (arktos) = a bear; πιθηκος (pithēcos) = an ape. This family is represented by the marmoset, more squirrel-like than bear-like. *(b)* Platyrrhini: πλατυς (platus) = broad; ῥις, ῥινος (rhis, rhinos) = nose. The technical name comes from the breadth of the partition between the two nostrils. Unlike the Catarrhines and man, the members of this group have their nostrils widely separated, and the nose in consequence wide and flat. To ease the mind of the anxious reader, I may here state that the asterisks in the table have no deeper significance than this: they are affixed to such generic names as are only illustrative, not exhaustive. For example, the families Arctopithecini and Platyrrhini contain many more genera respectively than the exemplar ones, Arctopithecus, Ateles and Mycetes. Where the asterisk is not used the genera given are illustrative and exhaustive. For example, the four names given in lines 6-9 of the table exhaust the list of the man-like apes. *(c)* Catarrhini; κατα (kata) = (in composition) downwards. The technical name comes from the fact that, whilst the partition between the two nostrils is narrow in all the members of this group, the nose-openings look downwards towards the ground, like those of man. In the Platyrrhini the nose-openings look either outwards or upwards.

This third family, Catarrhini, of the second sub-order, Simiadæ, of the order Primates, has two tribes. (1) Cynomorpha: κυων, κυνος (kuōn, kunos) = a dog; μορφη (morphē) = form. Quadrupedal, dog-like apes, of the baboon type. (2) Anthropomorpha, *i.e.*, man-like or anthropoid apes; ειδος (eidos) = resemblance. Here, for the first time, all the genera are given; and here it is necessary. For now we are hard-by man and we must have a clear conception of the names of his nearest allies. They are the Gibbon, the Chimpanzee, the Orang, the Gorilla. They are placed as near by as is possible in ascending order. There is no doubt as to the position at the bottom of the list of Hylobates, and little as to the position of Gorilla at the top. The other two are, however, uncertain. In some respects the Orang, in others the Chimpanzee is the higher. It will be noted that the Gorilla is here separated as a distinct genus from the Chimpanzee. Some zoologists place these two man-like apes in the same genus.

The importance of a clear understanding of these anthropomorphic apes will be understood when the following quotation from Darwin's "Descent of Man" is read: "There can consequently hardly be a doubt that man is an offshoot from the Old World Simian stem; and that, under a genealogical point of view, he must be classed with the Catarrhine division" (edition 2, p. 153).

Finally, the sub-order Anthropidæ contains, according to the views at present held, only one genus, *Homo*. In classifying the members of this genus, I follow the plan of Haeckel ("Pedigree of Man," p. 86), to whose interesting essay the reader is referred for details. Thus, the species of this very heterogeneous genus are arranged in two groups. The Ulotrichi take their name from υλος (ulos) = wool and θριξ, τριχος (thrix, trichos) = hair. The hair is crisp and woolly, the skin dark in color, the skulls dolichocephalic (long-headed). The Leiotrichi or Lissotrichi take their name from λειος (leios) = flat, or λισσος (lissos) = smooth. The hair is smooth, the skin paler of hue and the skulls generally brachycephalic (short-headed).

Under the former head, Ulotrichi, range four species, whose nature and habitat will be easily gathered from the table. Under the latter head, Leotrichi, range six species. All the comment necessary in regard to them affects the last

three. In H. arcticus we see the extreme modification of man under the extreme conditions of arctic environment. H. americanus is held by Haeckel to be a variation from H. mongolus, whilst H. mediterraneus, or the Caucasian, is believed to hold a like relation to H. polynesius. The last of the ten species is divided again into xanthochroic and melanochroic groups: ξανθος (xanthos) = yellow; χροα (chroa) = color of the skin; μελας, μελανος (melas, melanos) = black. The former are more "inland bred"; the latter haunt the shores of the Mediterranean.

When we reflect in what an exceedingly striking way these various divisions of the group Homo differ, and what distinct varieties are arranged even under each of these so-called species, we are led to consider whether this regarding Man as a single genus is accurate, even when the genus is only looked upon as an artificial group. We cannot but think that here the ancient myth has not been without its effect on those who are most unconscious of the influence. Possibly as work goes on and as the idea that the human race sprang from one original pair of progenitors vanishes wholly, the idea that the initial variation whence Man arose from anthropoid occurred only at one time or place may also vanish, and Homo be looked upon as not a single genus.

In giving the facts now to be given as to monkeys, apes and men, for the most part the last-named will be considered as a whole, and the fact given will be true of man generally. But in some special cases measurements of different human peoples help, and will be given. At present the area of anthropometric observations is limited. But such results as have been obtained lead us to believe that if that area were co-extensive with that of human beings, and if, within it, all details were thoroughly worked out, the conclusion to which we are led would be yet more assured.

The acknowledgments I ought to make for the facts now to be noted would really cover the whole series of writers on comparative anatomy during the last few years. Three names, however, demand especial mention—Gegenbauer, Huxley, Flower.

CHAPTER II.

B.—General Facts.

Before directing attention to the special evidence afforded by the skeleton and by the brain, a number of general pieces of evidence will be considered here. They are placed under the following heads. Posture, hair-covering, height, teeth, blood-vessels, muscles, reproductive organs. The student is asked, in reading the succeeding pages, to make constant reference to the table of the Primates on page 5.

1. *Posture.*—The erect posture of the human being was, and still is by the ignorant, instanced in evidence of man's special creation. In the first place, a more thoughtful study of man himself helps to dispel this idea. For the child, whose life is always an epitome of the evolution of the race, does not at first walk erect. It crawls, lower-animal fashion, on all-fours. And again, in the microcephali, or ape-men, we find reversion here as in all other points. The ape-children do not learn to walk erect until some years after the usual human time. The ape-men and women often make use of, and in some cases seem to prefer, a partially quadrupedal mode of progression.

Following out, however, the plan that is to be special to these chapters, let us look at the habitual and at the occasional postures of the body in the order Primates. All the Lemuridæ are quadrupedal all through their lives. They never walk erect. In the Simiadæ, considered as a sub-order, the longitudinal axis of the body is in the lower forms horizontal. In those a little higher in the scale it assumes an inclined direction, the angle it makes with the ground increasing gradually, until in the highest forms the angle approaches habitually to 90°, and is often quite 90°, *i.e.*, the axis approaches and, on occasion, actually attains a vertical position.

This general statement as to the Simiadæ may be supplemented by a note or two on individual monkeys and apes that belong to this group. The marmoset is habitually quadrupedal. The platyrrhine monkeys also are habitually on all-fours, but one of them at least, the Spider Monkey, occasionally rises to an erect posture. The Cynomorpha, or baboon division, are, as all readers of travels know, very

frequently on their hind-legs, and the Anthropomorpha are semi-erect when they pass from place to place. Nor must we forget that the favorite resting-pose of some of the apes, notably the Chimpanzee, leaning forward and resting on the knuckles of the hand, is the position assumed by the ape-men when in repose. It is the position represented in the photograph of Marguerite Mæhler, ape-woman, of Rieneck in Germany. And if the reader will try the experiment, as I have just tried it, of crouching to the ground and throwing the weight of the body to some extent on to the hand placed on the ground in front, I expect he will find as I did, that the fingers are unconsciously flexed, and he rests on the knuckles rather than on the tips of the fingers. Of course the experiment is best tried with some one ignorant of its purpose.

In this first inquiry, notice the succession of adjectives and adverbs. Always quadruped (Lemur), habitually (spider monkey), generally (baboon), frequently (chimpanzee), abnormally (man).

2. *Hair Covering.*—Upon this topic generally something was said on pages 4 and 5 of the "Origin of Man." In this connection we need only say a word or two on the transition changes. The Lemurs have a covering that cannot be called hair. It is fur rather than hair. This is true also of the marmoset and the platyrrhine, or New World monkeys. In the Cynomorpha and Anthropomorpha fur is replaced by hair, which in its turn begins to disappear, even in these groups, and in man is, in anything like noticeable quantity, restricted to particular regions of the body. Thus in the Cynomorpha we meet for the first time with those bare portions of the body known as callosities (callosus = with a hard skin). It is true that by their prominent position and by the brightness of their color these callosities present a remarkable appearance, and actually play, by their attractiveness to the opposite sex, a part in sexual selection. But for our present purpose their chief interest lies in the fact that they are parts of the body from which the hair covering is vanishing. The general principle of hair-vanishing has set in. The Gibbon, lowest of anthropoid apes, has this general principle carried out in the same special way as in the Cynomorpha. The Gibbon has callosities. But in the rest of the manlike Simiadæ the principle affects other regions of

the body. Thus in the Chimpanzee, Orang and Gorilla, the hands, feet and face are bare. And in man the process of hair-vanishing has extended more or less completely from the hands to the arms, from the feet to the legs, from the face to the neck, and from all these to the trunk of the animal.

3. *Height.*—Pace by pace with the assumption of the erect posture, advances the increase in the length or height of the Primates. The Lemuridæ, the marmoset, the spider-monkey, are not longer than 3 feet. The Cynomorpha have a length, that is very generally a height, of about 4 feet. In the lowest of the anthropoids a reversion seems to occur. The Gibbon is usually some 3 feet in height. But after this genus the transition in height is interesting. The average stature of the Orang is some 4 feet 6 inches; of the Chimpanzee 5 feet; of the Gorilla from 5 feet to 5 feet 6 inches; of the higher races of man from $5\frac{1}{2}$ feet to 6 feet.

4. *The Teeth.*—Once again, for generals, the reference is pp. 8 and 9 of "The Origin of Man." The particular facts as to the teeth will now be given and will have to do, for the most part, with their number. To understand them, it is necessary to remind the student of the nature and the number of teeth in the human skull.

Consider one jaw only—say the upper. Its fellow—say the lower—is almost its identical counterpart. Starting from the middle line just under the partition between the two nostrils and working to one side—say the right—we find (1) two chisel-like teeth, useful for cutting into the food, and hence called incisors (incido = I cut into); (2) one sharp-pointed tooth, very useless to civilised man, but of a type much more frequent in purely flesh-eating animals called canine (canis = a dog); (3) two more massive teeth (I am always speaking of the adult jaw), whose free parts or crowns have two eminences or cusps, and thus give the teeth the name of bicuspids; (4) three yet more massive teeth, each with four or five cusps, the molars (molea = a mill) that crush the food as millstones crush grain. The two teeth on each side mentioned under (3) are known by another name than that of bicuspids. As they are in front of the molars, and as they, like these, crush or "mill" the food, the comparative anatomist calls them pre-molar.

Hence there are in each half of each jaw 8 teeth—in all

32. Time will be saved if the reader masters the very simple dental formula of man. Then he will be able, on reading those of other Primates, to compare easily the facts represented by the formulæ. Here is that of adult man :—

$$i.\ \frac{2—2}{2—2} \qquad c.\ \frac{1—1}{1—1} \qquad p.m.\ \frac{2—2}{2—2} \qquad m.\ \frac{3—3}{3—3}$$

In this the initials indicate the kind of teeth, the numbers above the horizontal line tell of the teeth in the upper jaw, the numbers below of the teeth in the under jaw, whilst the dashes mark as it were the median vertical line of the face, and guide us to the knowledge of the distribution of the teeth in the right and left half of the jaw respectively.

In the Lemuridæ the dental formula differs in the two divisions. In the Cheiromyini, the lower of the two, it runs thus :—

$$i.\ \frac{1—1}{1—1} \qquad c.\ \frac{0}{0} \qquad p.m.\text{ and }m.\ \frac{4—4}{4—4}$$

There is only one incisor on each side of each jaw ; there are no canines at all ; and there are four grinding teeth on each side above and below. Now this arrangement of the teeth is unlike that in all other members of the order Primates, and is very much like that seen in the Rodentia or gnawing mammals. Moreover, the incisors continue to grow after they are once formed, and are only kept at a normal length by the wearing of the upper ones against the lower. And this is exactly what occurs in the Rodentia.

In the higher division Lemurini of the sub-order Lemuridæ, the normal formula is—

$$i.\ \frac{2—2}{2—2} \qquad c.\ \frac{1—1}{1—1} \qquad p.m.\ \frac{3—3}{3—3} \qquad m.\ \frac{2—2}{2—2}\text{ or }\frac{3—3}{3—3}$$

But the evolutionist will not be surprised to hear that in two genera of this group the incisors are $\frac{2—2}{1—1}$, and in one of these the outer incisors, right and left, in the upper jaw very soon fall out, leaving the formula $\frac{1—1}{1—1}$. Here is a beautiful example of gradation : Cheiromys has $\frac{1—1}{1—1}$, Tarsius (of the

Lemurini), later on $\frac{1—1}{1—1}$; at first $\frac{2—2}{1—1}$; Lichanotus (of the Lemuridæ) always $\frac{2—2}{1—1}$; the rest of the division $\frac{2—2}{2—2}$.

Turning to the Simiadæ, the marmoset has—

$$i.\ \frac{2—2}{2—2} \qquad c.\ \frac{1—1}{1—1} \qquad p.m.\ \frac{3—3}{3—3} \qquad m.\ \frac{2—2}{2—2}$$

Here, whilst the number of teeth is the same as in man, a slight difference of arrangement obtains. The Arctopithecini have a pre-molar more and a molar less than the Anthropidæ.

The New World platyrrhine members of the order have 36 teeth in all, or 4 more than we have. The difference is in the pre-molars, always the most variable teeth. The formula shows this.

$$i.\ \frac{2—2}{2—2} \qquad c.\ \frac{1—1}{1—1} \qquad p.m.\ \frac{3—3}{3—3} \qquad m.\ \frac{3—3}{3—3}$$

But the Catarrhini, dog-like and man-like, have a teeth-arrangement identical, as far as numbers go, with ours. Their formula runs:—

$$i.\ \frac{2—2}{2—2} \qquad c.\ \frac{1—1}{1—1} \qquad p.m.\ \frac{2—2}{2—2} \qquad m.\ \frac{3—3}{3—3}$$

This is but one of the very many reasons that compelled Darwin to write the passage quoted on page 7.

Two other points have to be considered in respect to the teeth. One is the presence or absence of diastemata; διαστημα (diastēma) = an interval. In the Lemurini a diastema occurs between the two incisors on the right and the two on the left in the upper jaw, *i.e.*, occurs in the middle line. The Cynomorpha present a diastema in each jaw; in the upper jaw between the outer molar and the canine, in the lower between the canine and the first pre-molar. Such a gap also occurs in the Anthropomorpha, but in the female Chimpanzee it is nearly closed up—quite as nearly as in many human beings, although it is usual to say that in man there is no diastema.

The last note under this head is as to the relative sizes of the incisor teeth. In us the two incisors of the upper jaw that are nearer the median line are larger than the two outer ones that lie to their right and left. In the lower jaw the

converse obtains, and the inner incisors are smaller than the outer. Exactly the same peculiarity of arrangement is to be seen in the incisor teeth of the upper and lower jaws of the anthropoid apes.

5. *Blood-vessels.*—A whole history might be written upon the distribution of the chief vessels of the blood-system in Man and his allies, and its details would exhibit innumerable interesting gradations from the lowest of the Primates to the highest. Only one point, more as an example than as a type, will be given.

The great blood-vessel that carries the good blood from the left side of the heart for distribution to the body generally is known as the aorta. It makes in all mammals normally a curve to the left hand before reaching the middle line and posterior part of the body cavity. From this curved portion, the aortic arch, the arteries arise that convey the blood to the upper limbs and to the head and neck. In all, these arteries are four in number. (1) Two sub-clavians carrying the blood to the right and left limbs. (2) Two carotids going to the neck and head. In man these four vessels take origin from the arch of the aorta as three, one of which almost at once divides into two. As the aorta curves towards the left it gives off first, that is, most to the right of the man to whom it belongs, the right sub-clavian (sub = under, clavicle = the collar-bone), second, the right carotid, third, the innominate (nameless) artery, which almost at once divides into the left carotid and the left sub-clavian.

In the Cynomorpha and in Hylobates or Gibbon, the lowest anthropomorph, a different arrangement is seen. In these Simiadæ the aortic arch only gives rise to two vessels, one of which almost directly divides into three. The single vessel is most to the left and is the left sub-clavian artery. The innominate divides in these animals into (from left to right) the left carotid, the right carotid, the right sub-clavian.

Ascending through the anthropoid apes we find that whilst, as already mentioned, the Gibbon has the arrangement of one sub-clavian and one innominate, the genus Pithecus (Orang) has in some species the same grouping, but in others an aortic arch with its vessels placed as in man, *i.e.*, with three arising from the arch. The Chimpanzee and Gorilla groups have throughout all their members the human arrangement. Once

more the difference is between ape and ape and not between ape and man.

6. *Muscles.* — Some general facts under this head were given under anatomical facts ("Origin of Man," pp. 12-14). As the present work is altogether more special, one or two more details may be added.

First, as to the tail muscles. All the Primates up to the Cynomorpha have tails and are well-provided with tail-muscles. In the Cynomorpha there is one genus, Inuus, which is without a tail. But the muscles are present. In the man-like apes not only is the tail wanting. In many cases the tail-muscles are as absent as they are in man. But, as if no chance of error should be allowed, in some of the tailless apes the tail-muscles are present in a very rudimentary condition.

Next, a word or two upon the half-dozen doubtful or variable muscles. I said that three or four muscles are met with in Hylobates, Pithecus, Troglodytes and Gorilla that are not usually seen in man. These are (1) the *levator claviculæ* (raiser of the little clavicle), a muscle belonging to the shoulder region; (2) *dorso-epi-trochlearis,* or *accessorius tricipitis,* a narrow muscle running down from the *latissimus dorsi* (broadest of the back) to the triceps (three-headed) muscle at the back of the upper arm; (3) the *scansorius* (climbing muscle); (4) the *abductor ossis metacarpi quinti digiti* (drawer outwards of the metacarpal or palm-bone of the little finger). Of these the third has not been described in the Gorilla and is also absent in some Chimpanzees, whilst all four of the muscles are occasionally found in human subjects.

Further, man has two muscles not as yet seen in the Anthropomorpha: (1) *Extensor primi internodii pollicis* (straightener of the first division of the thumb); (2) *peronæus tertius* (third muscle of the fibula or outer bone of the leg). But (1) is by many anatomists said to exist in the Chimpanzee, and is sometimes wanting in man, whilst (2) is frequently absent in Homo.

As throwing some light upon the variable character of the muscular arrangements, even in very closely allied animals, I may mention that Hylobates has a muscle all to itself. The *abductor tertii internodii secundi digiti* (drawer outwards of the third division of the second digit or forefinger) has been encountered as yet in no other mammal. The Orang also is

the sole possessor of an *opponens hallucis* or muscle for opposing the big toe to the other toes, as the thumb is opposed to the finger-tips.

As a last contribution to this brief study of Primate muscles, it may be noted that in the spider-monkey, whose thumb is rudimentary and does not perform any movements, four are present out of the five muscles that in other members of the order serve to move the thumb.

7. *Reproductive Organs.*—It will be readily understood that in a short popular work no complete details are likely to be given under this head. If the work is popular the anatomical details necessary to the understanding of the facts would have to be given. For myself I think they ought to be given, and I should not hesitate to give them any more than I hesitate to describe the skeleton or the bones. But the details necessary would take up far more space than can be afforded, and the comparative results obtained would hardly repay us. For it may at once be stated that in all anatomical points the structure of the reproductive organs of man and that of his allies are practically identical.

Two notes only, therefore, to end this chapter. The position of the milk-yielding glands. In man, and in almost all the rest of the Primates, the mammary glands are two in number, and are situated on the breast. They are pectoral in position, as comparative anatomists say. But in the lowest members of the order, *i.e.*, in the Lemuridæ, there are in some cases, in addition to the two pectoral, two or more pairs of mammary glands on the abdomen, as they are in the dog.

Lastly, from the Cynomorpha upwards, the female Primates experience at regular intervals that in the anthropoids certainly approximate very closely to, if they are not identical with, the lunar periods, a condition of the sexual organs in no essential removed from the periodical visitations of the human female adult when unimpregnated.

CHAPTER III.

C.—The Skeleton.

By the skeleton, comparative anatomists mean the hard protective or supporting part of the animal organism. Thus, the hard, outer part of the body of a lobster, or the two parts of the shell of an oyster, or the single shell of a snail, are all, strictly speaking, skeletons. All the ordinary Vertebrate classes have hard parts without and within. Thus, in the Mammalia there is an outer or exoskeleton [ἐξω (exō) = on the outside] of fur or hair, and an endoskeleton [ἐνδον (endon) = within] of bones. Upon the former of these I dwelt in the preceding chapter. In the present chapter facts will be given as to the bony skeletons of the various members of the order Primates that will serve once again to show interesting transitions in anatomical structure from monkey to ape and from ape to man. All that is to be said will necessarily be more easily intelligible to one who knows something of human anatomy. But I proceed on the assumption that the reader is wholly unacquainted with that branch of knowledge. A picture of the human skeleton or, still better, an actual skeleton for reference, will make the text more comprehendable.

Following the plan of my Physiological Tables, pp. 4 and 5, we shall study the skeleton under the three divisions of the trunk, the extremities, the skull. Considering the trunk, we shall deal first with the vertebral column or backbone, second with the ribs. The extremities, upper and lower, will present us with the arch that supports and the limb that is supported. The skull consists of head and face.

1. *The Trunk.*—(*a*) Vertebral column. The backbone, characteristic of all Vertebrata, consists of a number of separate bones called vertebræ. In Mammalia, and therefore in the Primates, these vertebræ are divided by anatomists into groups. From above downwards the groups are: (1) Cervical vertebræ (*cervix* = the neck); (2) Dorsal (*dorsum* = back), carrying the ribs; (3) Lumbar (*lumbi* = loins); (4) Sacral; (5) Caudal, or coccygeal. In this preliminary explanation only the last two sets call for comment. The sacral vertebræ are thus named because the bone they form was offered as a specially sacred part of the body to the gods.

This bone, the sacrum, made up of consolidated vertebræ, is wedged in between the two hip-bones, and makes with them the strong basin or pelvis that rests upon the legs. *Cauda* = a tail, and the caudal vertebræ are those of the tail. In human anatomy these reduced rudimentary tail-vertebræ make a little bone at the lower end of the vertebral column. This bone is the *os coccygis*, so-named from a fancied resemblance to a cuckoo's bill ("Origin of Man," page 6).

Let us look first at the backbone as a whole, and then at the individual groups of vertebræ. Our backbone shows three very remarkable curves, upon which depends, in a measure, the power of resistance to shock. One is in the dorsal region, and the convex side of the curve is backwards; another in the lumbar, and the convex side forwards; the third in the sacral and coccygeal, with convex side backwards. Not any of the Primates exhibit these curves except the anthropoid apes and man. Up to the Cynomorpha, they are wanting. Even in the Anthropomorpha their appearance is graduated in an interesting way. The vertebral column of the Gibbon is nearly straight; only the sacral curve, the lowest of the three, appearing. In the Orang, the curves of the adult anthropoid are like those present in the human being at birth. In the Chimpanzee, the curves as they are in the backbone of the adult man begin to appear, and in the Gorilla they are much better marked.

1. Cervical vertebræ. In all the Primates, and indeed in all Mammalia, the number of these is seven. This is the more remarkable when we reflect that the fact is true equally of the neck of the giraffe, and of the elephant. In our present study only one point is of moment. Every budding anatomist, and therefore every first-year "medical," knows that in man the cervical vertebræ are distinguished from the other kinds by certain marks, of which one is the bifurcation of the spinous process, *i.e.*, of the process, which running backwards from the body of the vertebra, forms, with its thirty odd fellows, the ridge on the middle line of the back. None of the lower Primates exhibits this bifurcation, and only one of the anthropoids, the Chimpanzee. Even in the Chimpanzee, only one of the cervical vertebræ, the second of the seven, has this characteristic. It is significant that the bifurcation

does appear, even in this not very noticeable form, below man.

2 and 3. The dorsal and lumbar vertebræ may be taken together. Their interest lies in their number. Repetition of similar forms always implies comparative lowness of organisation. A comparison of the many similar segments of an earthworm with the fewer, more differentiated segments of a lobster, will furnish an illustration of this truth. Hence we should expect to find, as we ascend in our investigation of the Primates, a decrease in the number of dorso-lumbar vertebræ. In some of the Lemuridæ the number is over 20, the 12 or 13 dorsal being followed by as many as 9 lumbar. In the marmoset the dorso-lumbar are 19. In the Platyrrhini the number varies from as many as 22 (15 or 14 dorsal, 7 or 8 lumbar), to as few as 17 (12 dorsal, 5 lumbar, as in man). In the Cynomorpha the number is 19 (12 or 13, and 7 or 6). In the Gibbon of the Anthropomorpha the number is 18 (13 and 5). In the other three forms, the Orang, Chimpanzee, Gorilla, 17. In Man also there are 17. Whilst, however, the actual number of dorso-lumbar vertebræ is the same in the three highest anthropoids and in man, the distribution of the 17 between dorsal and lumbar vertebræ is very instructive. Thus the 17 of the Chimpanzee and the Gorilla are made up of 13 dorsal and 4 lumbar. The 17 of the Orang, however, are made up of 12 dorsal and 5 lumbar. And this is also the human arrangement. There are normally in man 12 dorsal and 5 lumbar vertebræ, and occasionally cases occur of 13 or 14 dorsal (the Gorilla type).

One or two other facts in relation to the lumbar vertebræ, or rather to one of them, may be given. The one is the fifth or last lumbar, as existent in us and in our nearest allies. Two of the four man-like apes present peculiarities in the fifth lumbar. Both the Chimpanzee and the Gorilla have the transverse processes of this bone, that jut out right and left, joined to the crests of the two hip-bones, right and left. And further, in the Gorilla the body of the last lumbar vertebra is fixed on to that of the first sacral, just as that is to the second and the second to the third. In fact the fifth lumbar becomes, so to say, a part of the sacrum. Now, both these peculiarities are occasionally seen in Man.

4. Sacrum. In the Cynomorpha there are only three sacral vertebræ. But in the Anthropoids, the number is the same as in us, five. This increase in number at first sight appears in contradiction to the principle given on p. 19. But it is related, in the highest Primates, to the erect posture, the greater strain on the legs, and the heavier work to be done by the sacrum.

5. Caudal vertebræ. From the Lemuridæ up to the Cynomorpha the caudal vertebræ are many in number, as the animals in these groups are "tailed." Thus, even in the highest group, the Cynomorpha, there are genera whose individuals have as many as 31 vertebræ. Yet even within the limits of this sub-division of the Catarrhini occurs the genus Inuus, already mentioned as a tailless dog-ape. Inuus has only 3 caudal vertebræ. None of the Anthropomorpha has more than 5, and often as few as 4 or 3, the human numbers, occur. Nor is it only numerically that the tail-region of the vertebral column is identical in Anthropomorpha and Anthropidæ. In the exceedingly reduced condition of the vertebræ the lower end of the column is identical in us and in the man-like apes.

(*b*) *Ribs.*—As the pairs of ribs correspond in number with the dorsal vertebræ, there is little to say in this connection, and what is said is rather supplementary than actually new. Of course, here again the principle that repetition of similar parts means comparative lowness of organisation, comes into notice. In the snake, *e.g.*, of the class Reptilia, we have an immense number of almost precisely similar pairs of ribs. Turning to our Primates, the Lemuridæ and Arctopithecini (Aye-aye, Maki, marmoset) have always more than 14 pairs, and in some cases very many more. The Cynomorpha have 13 or 12, as a reference to p. 19, where the number of dorsal vertebræ (always the same as that of the pairs of ribs) is given, shows. The Gibbon has rarely 14, generally 13. The Chimpanzee and Gorilla have 13 pairs. The Orang 12. Man has 12 pairs. As usual, the break is between ape and ape, not between ape and man.

II. *The Extremities.*—We shall take the upper limb first, and then the lower.

1. The arch of the upper limb. In man, and indeed, in all the Primates, this arch consists of the scapula, or blade-

bone, and the clavicle, or collar-bone. Of these two the scapula alone need detain us. This is an oddly-shaped bone. whose main part is large and flat, overlying several of the ribs. At the upper outer corner is the glenoid cavity, into which fits the head of the arm-bone, or humerus. A strong process (the spine) rises from the back of the scapula much nearer the top than the bottom of the bone, and joins at its free end with the clavicle. This last therefore runs from the top of the breast-bone to the end of the spine of the scapula. The scapula has three edges; an outer, running from the glenoid cavity down to the lower point of the bone, and called the glenoid border; an upper, running in Man nearly horizontally, and a long curved inner edge or border. In the lower Primates right up to the Cynomorpha, the shape of this complex bone is very different from that seen in man. The glenoid and upper borders are nearly of the same length, and the inner border is short and straight. Even in the Chimpanzee the shape is not yet human. The bone in this anthropoid is very long, owing to the elongation of the inner and reduction of the upper border. In the Orang and the Gorilla, however, the bone has acquired all the human characteristics in the main.

2. The arm. In studying the arm of the Primates a number of points present themselves. They will be arranged under the heads; length, humerus, the fore-arm, carpus (or wrist), manus (or hand).

(*a*) The length of the arm. Every schoolboy knows the school way of measuring height. You stand with your back to a wall, and stretch out your arms to their full length and horizontally against it. Then some interested companion marks the place to which the tips of the middle fingers of the hands reach. The length from the tip of the one middle finger to that of the other is as nearly as possible equal to the height of the body.

Let us see the results of the like measurement made on members of the highest mammalian order, other than man. If the experiment is made on any of the Lemuridæ, Arctopithecini, Platyrrhini or Cynomorpha, the arm-length, as defined above, is always more than twice the body height. This is also true of the lowest anthropoid ape. The Gibbon's arm-length is more than twice the body-height. In the

Orang the arms are shortening relatively, and the arm-length is nearly twice the body-height. The Chimpanzee and Gorilla have an arm-length one and a half times the height, and in man, as we have seen, the two are approximately equal.

Here for the first time we can take a measurement within the limits of the human race itself. And the measurement shall be one of precision, the result of a series of careful observations and recordals made in America. All of us know generally that certain low types of individuals have greater length of arm than higher types. But the numbers now to be given have to do with classes rather than individuals, and are of an especial interest as showing the effect of changed conditions ("Darwinian Theory," p. 10) in the production of variation.

If we stand erect and place the arms close against the sides, with the palms pressing against the thighs, the tip of the middle finger of each hand is found to be at some distance from the upper edge of the knee-cap, or patella. Clearly, the longer the arm of a Primate, the less will be this distance, and, as is well known, in all of the order except Man, the distance is nothing, or less than nothing, *i.e.*, the fingers reach beyond the upper edge of the knee-cap. That the arms are shortening relatively as the human race evolves seems to be shown by the numbers now to be given. The men upon whom the measurement was made were of three types: Americans; free negroes, whose parents had been free for some generations; pure negroes. The average of a great many measurements made upon a large number of individuals of each of these three classes was as follows:—

Distance from middle-finger tip to patella—

Pure Negroes	2·88	inches.
Free Negroes	3·293	,,
Americans	5·036	,,

The numbers, as the descriptive reporters say, speak for themselves.

(β) The humerus is the long bone that runs from the shoulder to the elbow. Like all long bones, it presents three regions: a head above that articulates with the cavity in the scapula, a long shaft in the middle, and at the lower end, where the humerus is jointed on with one of the arm bones, the condyles;

κονδυλος (kondulos) = a knuckle. The head of the humerus in man has a direction upwards and inwards, but does not run backwards at all. On the other haud, the head of the humerus has a backward direction in the Lemuridæ, Arctopithecini, Platyrrhini and Cynomorpha. But in the Anthropomorpha the direction of the humerus-head is as it is in Man, not as it is in the lower Primates.

Again, the longitudinal axis of the humerus is in Man much twisted upon itself. It does not run straight, as in the lower Primates. But the three highest apes have the humerus-axis also twisted, and to an extent closely approximating to that seen in the human arm.

(γ) Two notes may be made on the fore-arm. In this there are two bones, the ulna on the little finger side, the radius on the thumb side. Only the former of these enters into the elbow-*joint*. The upper end of the ulna presents a cavity, the sigmoid, into which the inner condyle of the humerus fits ; σιγμα (sigma) is the Greek S and ειδος (eidos) = likeness. Behind, and overhanging this cavity is the olecranon : ωληνης-κρανον (ōlēnēs-kranon) = elbow's point.

This process, when the elbow is straightened, fits into a depression in the back and lower part of the humerus. In all the lower animals, even up to the Cynomorpha, this olecranon process extends further up than, and beyond, the sigmoid cavity. In the Anthropomorpha and in Man the olecranon process is not extended upwards beyond the cavity.

We are able to turn the hand over so that the back lies upwards. This movement is that of pronation, as the hand then lies prone. The converse movement is that of supination, when the hand is made to lie palm upwards—supine. All the Primates have this power of turning the radius round the ulna. In the lower members of the order the power is greatly reduced, whilst in the higher forms it "almost equals that enjoyed by Man" (Flowers' "Osteology of the Mammalia," p. 245.)

(δ) The carpus, or wrist. This part of the limb in us consists of eight bones, in two rows of four each. The lower members of our order Primates have nine bones in the carpus ; an additional one, the *os centrale* (central bone) is present. The Lemur has nine ; so have the marmoset, the Platyrrhini, the Cynomorpha, the Gibbon and the Orang. But in the Chim-

pansee and Gorilla the os centrale is wanting, the number of wrist bones is eight, and the human arrangement obtains.

In the majority of the Primates both the bones of the fore-arm, the radius and ulna, are in direct articulation with the wrist-bones. Now, in Man, this is not the case. Our carpus articulates with the radius only; the ulna does not joint on to any of the wrist-bones. This human arrangement is met with in two of the anthropoid apes. The Gorilla and Orang have their carpus connected directly with the radius alone.

(ϵ) The last thing to be considered in connection with the upper extremity is the hand, or manus. In this the two main points are the nails, or claws, on the digits and the nature of the pollex or thumb. In most Mammalia the digits are provided with claws rather than nails. This is also the case in the lower Primates. Thus the Cheiromyini have claws on every digit of the hand, although that on the pollex is modified in the direction of a nail. The Lemuridæ and the marmoset present the same arrangement. The pollex-claw becomes in the Cynomorpha yet more flattened and nail-like, but it is not until the anthropoids are reached that a clear and distinct nail is encountered. In the Gibbon this nail is confined to the pollex; all the other four digits have claws. But in the three higher Anthropomorpha nails are seen on each of the hand digits, as in Man.

As to the pollex itself. This digit is not capable of opposition to the other digits in many of the Lemuridæ nor in the marmoset. In this last also the power of moving the thumb is not well marked. Nor is the pollex truly opposable in the Platyrrhini, though its power of movement is very notable. In this group the thumb is not nearly so distinctly different from the rest of the digits as it is in the rest of the Catarrhini. Indeed the pollex of Ateles is quite rudimentary and functionless, although all the muscles necessary for its movement are present.

I pass to the consideration of the lower extremity. Here, as with the upper, the arch and the limb will be studied.

1. The arch. In this case there is only one large and complex bone on each side, the hip-bone. It is so oddly shaped that even the ingenuity of anatomists failed to find a likeness for it. Hence its name *os innominatum* (nameless

bone). The two *ossa innominata* make with the sacrum the pelvis or basin. The length and breadth of the pelvis in different Primates give some interesting transitions. If we look at the skeleton of any quadruped, such as the dog, or even at the living animal, we see that the pelvis is long and narrow. But that of a human being is relatively much shorter and broader. A convenient phrase is used in the study of pelves. Pelvic index. Suppose that the length of the pelvis of any particular animal is multiplied by the number 100 and divided by the breadth of the same pelvis, the result will be a number greater than 100, or 100, or a number less than 100 according as the pelvis is longer than broad, as long as it is broad or shorter than it is broad. The number resulting from dividing the length $\times$ 100 by the breadth is called the pelvic index for the particular animal. This number will be less the higher the position of the animal in the scale of Mammalia.

The following list is that of the pelvic indices of some of the higher Primates. In every case the female pelvis is taken :—

Chimpanzee	141
Gorilla	128
Australian	116
Bushwoman	103
Eskimo	100
Hindu	93
Peruvian	91
European	78

From this list we see that the pelvis of the Chimpanzee is a little less than half as long again as it is broad; that the pelvis of the Gorilla is rather more than one-fourth as long again as it is broad; that two of the low human races have pelves longer than they are broad; that the pelvis of the Eskimo woman is as broad as it is long; that in the higher human races the pelvis is broader than long. In our present study the most important thing to be noted is that there is a much greater difference of pelvic index between man and man than between ape and man. 116 (Australian) – 78 (European) = 38. But 128 (Gorilla) – 116 (Australian) = only 12. The difference is even greater between two cul-

tured human races than between the Gorilla and the Australian and than between two anthropoid apes. 93 (Hindu)—78 (European) = 15. 128—116 = only 12. 141 (Chimpanzee)—128 (Gorilla) = 13.

2. The hallux, or great toe, is the only other part of the lower limb we need notice. Its length, in relation to the length of the foot, shortens as we ascend in the order Primates. The hallux is more than $\frac{5}{12}$ the length of the foot in Hylobates and Troglodytes (the Gibbon and the Orang)—is in fact nearly half as long as the whole foot. In the Gorilla, the fraction is less than $\frac{5}{12}$; in the Orang about $\frac{3}{12}$ or $\frac{1}{4}$; in Man it is about $\frac{1}{5}$ or $\frac{1}{6}$ ($\frac{2}{12}$).

The hallux follows much the same line as the pollex as to its power of movement and the nature of its claw or nail. In the Cheiromys, *e.g.*, the hallux is the only one of the foot-digits that has a nail; all the rest are furnished with claws. In this genus, as in the Lemurini, the great toe is large and opposable to the others. But in all the Simiadæ this part is smaller than the second digit, though it is capable of considerable movement. In the Gibbon the nail is only to be seen on the hallux; all the other four digits have claws. But in the three higher Anthropomorpha, nails are seen on each of the foot-digits, as in Man.

III. *The Skull.*—I have said that in considering this part of the skeleton it is customary to take the head and the face as two regions of the skull (p. 17).

(1) The head.—First let us look at the relative lengths of the bony base of the cranium, and of the cavity in which the brain is lodged. If the skull of any Primate is examined from below, we see that its base presents a large hole, the *foramen magnum*, through which the spinal cord runs up into the brain. In front of this hole lies a bony mass, entering into the floor of the brain cavity. This is called the basi-cranial axis. If, as in man, the foramen magnum is large, and situate in the base of the skull, and not quite at the most posterior part of that, it is evident that the length of the brain cavity will be more than that of this basi-cranial axis. But if the foramen is not large, and if it is situated at the very back of the base of the skull, or even, as in some cases, in the back rather than the base of that organ, it is evident that the length of the basi-cranial axis will be more nearly equal or even quite

equal to that of the brain cavity. Roughly speaking, the relations between these two lengths in different animals give some indication of the cerebral capacities of the different animals. I shall represent the length of the bony basi-cranial axis in each case by 100. In that case we have the following table :—

Basi-cranial axis	= 100
Brain cavity in some Lemuridæ, Arctopithecini, Platyrrhini (Squirrel Monkey) ...	= less than 100
Other Platyrrhini	= 100
Cynomorpha (howling monkey)	= 150 (not more than)
Anthropomorpha	= 170
Man	= 230—270

Up to the Platyrrhini, therefore, the basi-cranial axis is longer than, or as long as, the brain cavity. In all of the Simiadæ it is more than half as long. In Man it is less than half as long. Here we must bear in mind that these measurements have not been made, as far as I am able to ascertain, on any of the microcephalous skulls. Even without taking these into account, however, there is more difference between the 100 of the platyrrhine monkeys and the 170 of the anthropoid apes than between the 170 of the latter and the 230 of the low human races.

Into the base of the skull, forming part of that bony basi-cranial axis just considered, enters part of a very complex bone known as the sphenoid; σφην (sphēn) = a wedge. The sphenoid is wedged in between the frontal in front, the occipital behind, the parietals and temporals at the sides. This apparently single bone in the adult human skull is really made up of several bones conjoined (8 in all). We, however, are only concerned with so much of the sphenoid as enters into the floor of the skull. Even this portion consists of two parts. These, from behind forwards, are the basi-sphenoid and the pre-sphenoid. In the human skull these two parts are from a very early age so completely united that no trace of the suture or seam or line of jointure is visible. When we turn to the skulls of the lower Primates we find that in all of them up to the Cynomorpha this suture between the basi-sphenoid behind and the pre-sphenoid in front is quite

distinct until the animal is nearly full grown. On the other hand, the skulls of the Anthropomorpha show no trace of the line of junction, and the basi-sphenoid and pre-sphenoid are in these animals quite united, so as to form one bone, ere the milk-teeth are shed. That is, once again, the characteristic of the human skull appears in the apes first.

The relation of the frontal bone to the ethmoid may be taken next. In all the Primates the frontal or forehead bone is originally two bones, a right and a left. Each of these bones forms not only one half of that which is generally known as the forehead but also the roof of the orbit or eye-cavity. Between the two orbital roofs is a considerable cleft. In this cleft lies the ethmoid or sieve-bone; $\eta\theta\mu os$ (ethmos) = a sieve. This bone might be also called the nose-bone. For it is, as we might gather from its position, in intimate relation to the nose. The upper part of it on each side forms the roof of the nasal cavity, and is pierced with holes, through which run the branches of the olfactory nerve. Hence its name of sieve-like. In us the orbital plates of the right and left frontal bones join on to the ethmoid that lies between them at the side of the ethmoid. They do not extend at all behind that bone. But in all the rest of the Primates, save one, these two roofs of the two orbits not only join the ethmoid at its sides; they extend behind it and join one another. There is a post-ethmoidal union of the two frontals. This anatomical distinction holds between the skull of Man and the majority of the Primates. But even this is not an absolute distinction. For in one of the anthropoid apes, viz., the Orang, the two orbit roofs do not run posteriorly to the ethmoidal and conjoin. There is in the Orang, as in Man, no post-ethmoidal union of the two frontals.

Still dealing with the interior of the skull, we have to do with an interesting marking on one of the bones of the Primate skull that corresponds with a certain part of the brain. That part is the flocculus (a little lock of wool) of the cerebellum. The cerebellum, or little or hind-brain, has in the Primates a central lobe, the *vermis* (or worm) *cerebelli*, and two side lobes. From each of these side lobes projects in some Mammalia and in most of the Primates an irregularly-shaped extension of brain substance called the flocculus. This rests on the bone in which the ear is lodged, part of the

temporal of human, the periotic of comparative anatomy; περι (peri) = around; ους, οτος (ous, otos) = the ear. As a consequence, the surface of the periotic that enters into the internal wall of the skull has a depression or fossa (a ditch), corresponding with the flocculus. This fossa is well marked in the Lemuridæ, Arctopithecini and Platyrrhini, in all of whom the flocculus is large. The fossa is but faintly marked in the skull of the Cynomorpha, and in that of the Anthropomorpha it is nearly obliterated. Certainly in these the depression on the periotic bone is no more noticeable than it is in the skull of Man. And this goes hand in hand with the fact that neither the human nor the higher Simian brain has any flocculi attached to the cerebellum, whilst the presence in the human and higher Simian skull of traces of the depression is evidence that the anthropoids and Man are alike the offspring through evolution of common progenitors in whose brain the flocculi were present.

The complex temporal bone of the human skull furnishes us with one more instance of transition. This bone, like the sphenoid, in reality consists of many bones. Of these we need only discuss one—the tympanic. Tympanum = the drum (of the ear). The temporal bone has in Man a passage some $1\frac{1}{4}$ inch long, leading in from the external ear and closed at its inner end by the drum of the ear. This passage, the external auditory meatus, is formed by the elongation of the bone known as the tympanic. This is, at first, a simple ring of osseous matter, that is to be filled up, as it were, by the *membrana tympani*, or drum. In this primal arrangement there is no meatus, and the drum of the ear is, as in the Frog, practically flush with the surface of the skull. Now, this primal arrangement in the human being remains permanent in all the Primates up to the Platyrrhini. In these the tympanic bone is ring-like, and the meatus is very short or non-existent. But in all the Catarrhini, the change to the human condition has occurred. The ring-like tympanic bone elongates outwards, and becomes a lengthy, bony tube, whose canal is the external auditory meatus. And this is what takes place in Man.

(2) *The Face.*—The chief interest in connexion with the bones of the face and their relative arrangement centres in the facial angle. This is a measurement that we owe to the

Dutch ethnologist, Peter Camper (born at Leyden, 1722, died at the Hague, 1799). His idea was, by means of this angle, to indicate the degree of projection of the face in different races of men, and the relative development of the face as compared with that of the head. In the lower Mammalia, as the Dog, *e.g.*, the face projects greatly from the head—there is, in short, a muzzle. In the lower Primates also the face is developed in relation to the head to a greater extent than in the higher.

For the purpose of comparison, Camper suggested the drawing of two lines on the skull. One was to descend from the most prominent part of the frontal or forehead bone until it reached the margin of the upper jaw, where the incisors are inserted. The other was to run approximately in a horizontal direction through the middle of the opening of the external auditory canal to the point of junction of the nasal bone of the side observed with the frontal. These two lines will include an angle, and the angle will evidently be the greater, the smaller the face is relatively to the head and the higher the type of Primate intellectually. The following is a table of certain facial angles as measured on the skulls of certain Primates :—

Facial Angles.

Gibbon	20°
Chimpanzee	30°
Orang	30°–35°
Gorilla	35°–47°
Young Anthropomorpha	56°–60°
Namakas	64°
Callithrix sciurea	65°
Negroes	67°
Low Europeans " Australians	70°
Kalmuks	75°
European (average)	80°
Antique statues	90°

This list is worth studying. Notice first that the young Anthropomorpha have a facial angle larger than that possessed by the adult apes. The moral of this is obvious. The old law of phylogeny and ontogeny comes in again. The

life-history of the individual is an epitome of that of the race. The ontogeny is a brief phylogeny. The anthropoids in their development reach a certain phase of evolution. The same phase is reached by the developing man. But having reached this phase, represented, as far as concerns the facial angle, by 56°—60° in the above table, the anthropoids recede. Man, having reached the same phase, advances. These are two ontogenetical facts. Their phylogenetic equivalent is, probably, that the Simian ancestor of the Anthropomorpha and of the Anthropidæ varied in two directions. Having reached the phase represented, as far as concerns the facial angle, by 56°—60° the ancestor varied in two directions, that of the anthropoids with their adult facial angle from 20° to 47°, and that of Man with the adult facial angle from 70° to 90°.

Another point. Take the difference-numbers. 47° (Gorilla) − 20° (Gibbon) = 27°. 64° (Namakas) − 47° (Gorilla) = 17°. A greater difference between ape and ape than between ape and man. This result we obtain without taking into consideration the young Anthropomorpha, and without taking into consideration the curious case of Callithrix sciurea. This last is one of the squirrel-monkey species of Brazil. Its facial angle is actually at least as great as that of the Namakas or Hottentot inhabitants of Great Namakaland in South Africa. The country of the Namakas as the Europeans call these people, is limited by the Walvisch Bay northwards (23° S. lat.), the mouth of the Orange River southwards (28° 30′ S. lat.), the Atlantic Ocean to the west, the Kalahari desert to the east. In view of the similarity of facial angle in the platyrrhine Callithrix and this *Homo hottentotus*, it is interesting to note that the former is inoffensive, intelligent and easily and thoroughly tamed, whilst the latter "possess every vice of savages and none of their nobler qualities" (Anderson). The Kalmuks are a Mongol race (*Homo mongolus*), partly Chinese, partly Russian subjects, ranging from the steppes of the Don and Volga to the deserts and mountain ranges of Upper Asia. They are a nomadic, warlike, Buddhist race.

Observe also, in the table, the steady gradation from 64° in the low men up to 90° in the statues. These last are of moment. They—representations of the gods or of demi-

gods, or, at lowest, of very lofty men and women—have a facial angle 10° greater than that of the European of to-day. And this is at least in part due to the fact that the ideal is always higher than the real.

This part of our subject will be concluded by a study of two tables in which are incorporated the results of certain measurements on the skulls of certain microcephali or ape-men. As this chapter closes, and the next will be in part occupied, with notes on these, let us begin by understanding what the microcephali are. In different countries, probably in different centuries, human parents, in many cases quite normal, have produced as offspring beings of an abnormal type. Often covered as to a large part of their bodies with hair; unable to walk erect until long after the usual time when the human child has ceased to crawl on all-fours; incapable of speech; unteachable; with receding foreheads that cover brains whose capacity and weight are inferior to the capacity and weight of the brains of the anthropoid apes —these animals, born of human parents, are of the ape structure. Their technical name is microcephali: μικρος (mikros) = small, κεθαλη (kephalē) = head. I shall follow Carl Vogt, and call them ape-men.

Of the many cases on record, and even of the smaller number of these that have received careful scientific investigation, I shall only deal with ten observed and described in Germany. Here is a list of them:

	Country.	Name.	Age.
1.	Germany ...	Gottfried Mœhre	44
2.	„ ...	Michel Sohn...	20
3.	„ ...	Frédéric Sohn	18
4.	„ ...	Conrad Schuttelndreyer ...	31
5.	„ ...	Of Jena	26
6.	„ ...	Ludwig Racke	20
7.	„ ...	Margaret Mæhler	33
8.	„ ...	Jean Mœgle	15
9.	„ ...	Jacques Mœgle	10
10.	„ ...	Jean Georges Mœgle ...	5

The results of two sets of measurements made upon the kulls of the ape-man and a comparison with the results of

similar measurements made on the Chimpanzee and the Negro and the average European skull follow :

Skull Measurements.

	Front of mouth to foramen magnum.		Base of skull.
Schuttelndreyer	18·5	.....	20
Mæhler	20	.....	21.4
Of Jena	21·5	.....	23
Mœhre	25·2	.....	29
Frédéric Sohn	25·8	.....	27·7
Racke	29·5	.....	30·1
Michel Sohn	30·9	.....	32·6
Chimpanzee	32·5	.....	37·1
Negro	45·4	.....	49

The foramen magnum is the large hole in the base of the skull through which the spinal cord passes to enter the brain that lies within the cranium. This foramen lies far back in the skull. The first series of numbers gives the proportional distances in the various skulls from the very front of the mouth, from the most prominent part of the upper jaw, to the front edge of the foramen magnum. The second series gives the proportional numbers that represent the whole length of the base of the skull from the most prominent part of the upper jaw to the hinder border of the foramen. The difference between each pair of numbers on the same line will give the proportional length of the foramen in the skull considered. As the foramen is generally about the same length in the different microcephalous skulls, the first seven pairs of numbers run approximately parallel. But in the chimpanzee and negro the length of the foramen from front to back is considerably greater than in the ape-men.

Notice that the length of the skull in the anthropoid ape is intermediate between its length in the negro and in the microcephali. Also that in the latter the foramen is placed farther back in the skull than in the chimpanzee. The ape-men, in a word, are farther from the human type in this respect than is the chimpanzee.

Auditory opening to naso-frontal suture = 100.	*Occipital Curve to Auditory Opening.*
Of Jena	63·1
Chimpanzee	63·3
Mæhler	65·9
Frédéric Sohn	72·3
Schuttelndreyer	74·7
Pongo	80·0
Mæhre	81·4
Racke	82·6
Case of Sandifort	85·5
Michel Sohn	88·9
Average Skull	93–103

The auditory opening is the aperture of the ear. The naso-frontal suture is the line of junction between the nasal bone of one side and the frontal. This suture, or seam, is just above the place on which a pince-nez rests, and is between the upper parts of the two orbits. In the table just given the length from this suture to the middle of the auditory opening is taken as 100. The occipital curve is the strongly-marked ridge on the back part of the posterior bone of the head, the middle point of which is the prominence at the back of the head, which, like the darkness in Egypt, may be felt, if it is not covered by artificial hair or by head-gear. The numbers given express the relations of the distances from the middle of the auditory opening to this prominence of the occipital ridge.

Clearly, the higher the number in this list the greater the length of the posterior region of the skull. The interesting point, however, is in the succession of the skulls. The microcephalus of Jena comes lowest in the list. His number, 63·1, is nearly identical with that of the chimpanzee. Then follow three more ape-men, and then a pongo or gorilla from the Berlin museum. Four more ape-men's names intervene between the case of the anthropoid ape and the men of average brain-power. Thus we have, as far as this measurement is concerned, two anthropoid apes interpolated amongst the ape-men.

CHAPTER IV.

D.—The Brain.

This last chapter will be devoted to the consideration of the organ that presents most difficulty to the anti-evolutionist. In spite of the fact that brain-evolution has been the line along which especially, Man has evolved from the brute-ancestor common to him and the anthropoids, nevertheless our general thesis can be maintained in respect to this organ as to all others. The evidence now to be given will once more show that there is more difference betwen ape and ape and between man and man than between ape and man.

First, certain terms will be explained. Then the brain-characteristics of the Primates generally will be given, and the brains of those members of the order lower than the man-like apes will be briefly considered. After that the brains of the Anthropomorpha and Man will be studied.

I. *Terms.*—With the brain as with the skeleton, he that has already mastered the requisite anatomical details, or even he that can follow that which is to come, on the actual brain or even on a picture, will be better off than the average reader of these lines. None the less, I believe a person of ordinary intelligence will be able to understand all the facts to be presently given, if he reads carefully the next few paragraphs.

The spinal cord of the Primates, passing through the *foramen magnum* in the base of the skull, expands into the brain or *encephalon.* This organ presents three chief regions with which alone we are concerned. They are the brain proper or cerebrum, covering over in Man all the rest of the encephalon; the ganglia or swellings at the base of the cerebrum; the cerebellum, little or after-brain, lying under the posterior part of the cerebrum.

(*a*) *Cerebrum.*—This, by far the largest part of the encephalon, has two hemispheres, lying right and left. Each of these presents fissures, lobes, convolutions, all on the exterior, and within cavities.

1. The Fissures.—In addition to the one longitudinal, median, deep fissure separating the right half of the brain from the left, the following fissures are to be seen in each hemisphere. (*a*) The fissure of Sylvius.—This runs from a point in the base of the brain about $\frac{1}{3}$ of the length from the anterior end

upwards and backwards. Thus it marks off a part of the brain that lies behind and below it (the temporal lobe) from a larger part lying in front of and above it. (β) The fissure of Rolando. This divides the larger part lying in front of and above the fissure of Sylvius into two parts. Running nearly vertically from above downwards, this fissure marks off the frontal lobe before the fissure from the parietal lobe behind it. (γ) Internal perpendicular fissure.—This can only be seen on the inner face of each hemisphere. If the hemispheres are forcibly separated, and the inner face of one of them is observed, a fissure is seen towards the posterior part of that face that runs vertically and marks off a small posterior lobe, the occipital, from the parietal in front. There is another fissure, but the three just described are all that enter into our present calculations.

2. Lobes.—These have just been described in the main. Named after the bones of the head for the most part, they are on each side: α. the frontal, bounded posteriorly by the fissure of Rolando; β. the parietal, bounded anteriorly by the fissure of Rolando, inferiorly and posteriorly to some extent by that of Sylvius, whilst at its upper posterior portion it glides on the outer aspect of the brain into the occipital lobe, without any very clear line of demarcation; γ. the temporal, bounded in front and above by the fissure of Sylvius, and also gliding posteriorly into the occipital as far as the outer aspect of the brain is concerned; δ. the occipital, at the back of the cerebral hemisphere, marked off on the internal face from the parietal by the internal perpendicular fissure; ϵ. the central lobe or island of Reil, which lies deeply placed at the bottom of the fissure of Sylvius.

3. Convolutions.—The external surface of each cerebral hemisphere exhibits certain convolutions or folds, separated by sulci or furrows. Most of the convolutions with which we shall have to do need only be designated by the name of the particular lobe to which they belong. But one or two that are of importance in evolution must be mentioned. The two convolutions that bound the fissure of Rolando are called the ascending frontal (in front of the fissure) and the ascending parietal (behind the fissure). The supra-marginal convolution is also of much moment. It is the convolution whose presence so eminent a man as Gratiolet held as peculiar to

the human brain. This convolution or lobule lies above the upper and posterior end of the Sylvian fissure, and belongs therefore to the parietal lobe. In man and in some of his allies the main convolutions are connected by small pieces of nervous tissue at certain parts of the brain. These connecting pieces are called the bridging-over or annectent convolutions ; *annecto* = I tie on.

4. Cavities.—Within the cerebral hemispheres are two cavities, one on each side, called the lateral ventricles. *Latus, lateris* = side. *Ventricle* is a name used in anatomy for a cavity. These two ventricles, with other cavities within the brain, are the remains of the primitive groove that first appears in the embryo mammal at what will be the dorsal region. Each lateral ventricle extends forwards, downwards and backwards. The forward extension (anterior *cornu* or horn) runs into the frontal lobe. The downward extension (middle cornu) runs into the temporal lobe. The backward extension (posterior cornu) runs into the occipital. The central part or "body" of the cavity corresponds with the parietal lobe.

(*b*) Brain-ganglia.—These are certain masses of nerve tissue distinct from, and covered over by, the cerebral hemispheres. The only ones with which the reader need be troubled are the hippocampi, the corpora striata, optic thalami, corpora albicantia, olfactory lobes.

In the middle or descending cornu is a swelling of the nerve tissue, known, from its peculiar shape, as the hippocampus major ; in the posterior cornu is a similar swelling, the hippocampus minor. Finally, within the "body" of the ventricle are two swellings of nerve-matter known as the corpus striatum (striped body), the anterior, and the optic thalamus (bed), the posterior.

The corpora albicantia (whitish bodies) are two round, white nervous masses, visible, without any dissection, about the middle of the base of the brain ; whilst the olfactory lobes are two ganglia connected with the sense of smell, lying below the frontal lobes and above the nose cavities.

(*c*) The cerebellum is the little hind brain already mentioned (p. 35).

II. The brain of Primates generally.—The distinctive characters of the Primate brain by which it is marked off

anatomically from that of other mammalian orders are as follows :—*a.* Transverse pattern of convolutions. The arrangement of the convolutions of the cerebrum is not of the oblique, slanting order, as in the horse. Nor are they arranged lengthwise, as in the dog. Their main direction is transverse to the longitudinal axis of the brain. *b.* No corpora trapezoidea, or trapezium-shaped nerve-masses, in connection with the medulla oblongata or swollen top of the spinal cord as that part joins the encephalon. *c.* Two corpora albicantia (p. 37) in place of the single central body that represents these in the lower mammals. *d.* An occipital lobe (p. 36). *e.* Without additional external nervous-tissue growths from the under surface of the temporal lobe. *f.* Olfactory lobes never reaching sufficiently far back to run across the fissure of Sylvius. *g.* A central lobe or island of Reil. *h.* The lateral ventricle not extending into the olfactory lobe, but extending into the occipital and presenting in the posterior cornu that passes into the occipital lobe a swelling, the hippocampus minor.

III. Lemuridæ to Cynomorpha.—The eight characters just given are those that serve to distinguish the Primate brain from that of other Mammalia. A note or two on the brains of the members of the order below the Gibbon follow.

Lemuridæ.—Whilst these lowest Primates exhibit all the marks just given, the low nature of their brain is shown by (*a*) the projection of the olfactory lobes in front of, and the cerebellum behind, the cerebral hemispheres; these last are not sufficiently developed to cover completely, as they do in man, the olfactory lobes and the cerebellum ; (*b*) the occipital lobe with its contained posterior cornu and hippocampus minor is rudimentary ; (*c*) the cerebral hemispheres are quite smooth, or with the merest trace of incipient convolutions ; (*d*) the fissure of Sylvius, between the parietal and temporal lobes, is the only one ever present, and if this appears, it is only a mere trace.

Marmoset.—Here the cerebellum is covered by the cerebral hemispheres, although the olfactory lobes are still exposed; the occipital lobe has, in fact grown larger ; the cerebellum is nearly smooth, but not quite without convolutions; the Sylvian fissure is larger than in the Lemuridæ, and a trace of the fissure of Rolando, between the frontal and parietal lobes,

is now visible. The central lobe, or island of Reil, is wanting.

In the Platyrrhini there is a further advance. The cerebellum and olfactory lobes are generally both covered, and although in the Howler monkey the cerebral hemispheres are nearly smooth and the occipital lobe is small, yet many of the convolutions that are seen in the human cerebrum are now present as well as the third of the chief fissures, the perpendicular, marking off the occipital lobe. The Cynomorpha have all the chief sulci and folds of the frontal and parietal lobes and the commencement of the occipital convolutions. The frontal lobes are also rounder and less pointed than in the Platyrrhini.

IV. We pass to the last and the most important part of this discussion. That is the comparison of the brains of the anthropoid apes and Man. This subject will be dealt with under the following heads: the size and weight of the brain, its shape, the number and arrangement of its fissures and the nature of the convolutions.

(*a*) Size and weight.—These have been already discussed at some length in "The Origin of Man," pp. 10, 11. But a few more facts supplementary to those given there may be noted. Upon the weight question little need be added to that which has already been said. But as to volume much must be said. And first, concerning the weight of the brain. Its ratio to the weight of the body should be mentioned. Amongst the anthropoid apes this ratio is least in the lowest of them, the Gibbon. But I cannot find any numbers expressing that ratio exactly in either the Gibbon or the Gorilla. We have, however, the numbers for the Orang, the Chimpanzee and Man. In the Orang examined by the late Professor Rolleston the body was about 22·3 times as heavy as the brain. In the Chimpanzee examined by Professor Marshall the body was about 19 times as heavy as the brain. In Man the average ratio of body weight to brain weight is 36 to 1. All the three numbers are more favorable to the Primates as regards brain development than those of most other animals. Thus the average ratios of body to brain weight are in the class Mammalia 186 to 1, in birds 212 to 1, in reptiles 1321 to 1, in fishes 5,628 to 1. We must not, however, lay undue stress upon these numbers, as in some

small Vertebrata the kindred ratios are higher than even in the Primates. Thus in the field-mouse 31 to 1 is the proportion; in the goldfinch 24 to 1; in the blue-headed tit 12 to 1. Nevertheless the fact is interesting that in at least two of the Anthropomorpha the brain is relatively to the body of a greater weight than it is in Man.

In the measurements that are now to be given, I again follow the plan adopted once or twice before, and compare some of the lowest forms of men with the man-like apes. The two comparisons that are now to be instituted are in respect to brain-surface and to brain-volume.

Total Brain-surface.

Jacques Mœgle	7,813 sq. m. m.	
Mæhler	8,014	„
Child	9,040	„
Chimpanzee	9,300	„
Schuttelndreyer	9,399	„
Racke	14,482	„
Negro	24,705	„
White	25,155	„

Chimpanzee ...	33
Microcephali (average)	44·6
White	100

This table shows the actual extent of surface of the cerebral hemispheres. It will be observed that the normal European brain has a surface of about 25,000 square millimetres (1 sq. m. m. = about $\frac{1}{625}$ of a square inch). The surface of the negro brain is not very much less in extent. There is a difference of more than 10,000 sq. m. m. between the negro and Ludwig Racek, the ape-man, in this particular measurement, and Racke is 5,000 sq. m. m. in advance of any other observed ape-man. This may be partly accounted for by the fact that Racke was an epileptic, and in cases of epilepsy, the brain is often of unusually large size, though its greater mass is probably due, not to increase in the quantity of true brain tissue, but to growth of an inferior kind of material. Another noticeable thing is that the surface of the child's brain is very much less in extent than that of the adult, although, as we know, the volume and mass of the two brains

do not greatly differ. The advance is in complexity rather than in size.

From our present point of view, however, the most interesting number is the 9,300 sq. m. m. of the Chimpanzee. This number is intercalated amongst those that refer to the brains of the ape-men. The relative positions of the adult human being, the anthropoid ape, and the abnormal man, are well shown by the three numbers given at the end of this table. Taking 100 as representing the total brain-surface of the white race, 44·6 represents the average of the total brain-surface in such microcephali as have been examined, and 33 the brain-surface of an average anthropoid ape. The difference number (100 – 44·6 = 55·4) between the two kinds of men is nearly five times as great as the difference number (44·6 – 33 = 11·6) between the lower man and the ape.

Brain Capacity.

Brain Capacity.	Australians	Negroes	Ancient Egyptians	Parisians, 12th century	Parisians, 19th century
1,200 to 1,300 cubic centim.	45·0	7·4	0·0	0·0	0·0
1,300 to 1,500 „	45·0	68·6	54·6	44·8	24·7
1,500 to 1,700 „	10·0	24·0	45·4	50·7	63·6
1,700 to 1,900 „	0·0	0·0	0·0	4·5	11·7
	100	100	100	100	100

MICROCEPHALI.

	Country.	Name.	Age.	Brain Capacity.
1	Germany	...Gottfried Mæhre ...	44	... 555
2	„	...Michel Sohn ...	20	... 370
3	„	...Frédéric Sohn ...	18	... 460
4	„	...Conrad Shuttelndreyer	31	... 370
5	„	...Of Jena	26	... 350
6	„	...Ludwig Racke ...	20	... 622
7	„	...Marguerite Mæhler	33	... 296
8	„	...Jean Mœgle ...	15	... 395
9	„	...Jacques Mœgle ...	10	... 272
10	„	...Jean Georges Mœgle	5	... 480

Of all measurements, those given in the last table are of the most importance. But I have in this table placed before the numbers that represent the brain capacity of ten of the microcephali the results of the observations of Paul Broca upon a number of skulls of different races. This is for the purpose of comparison.

Broca's numbers call for comment in some little detail. The great French anthropologist had the opportunity of examining a large number of skulls that were unearthed from cemeteries in Paris, and from beneath a house whose building certainly dated back to the time of Philip Augustus. These are classed in the above table as Parisians of the twelfth century. As the type of race advances the cranial capacity advances. Between 1,200 and 1,300 c. c. are only found skulls of the two lowest races—the Australians and Negroes. Between 1,300 and 1,500 c. c. are nearly one half the Australians and twelfth-century Parisians, more than one half the Negroes and Egyptians, and less than one-fourth of the most recent type. Between 1,500 and 1,700 c. c. come one-tenth of the Australians (and all of these really are below 1,600 c. c.), about one-fourth of the Negroes, nearly one half of the Egyptians, about one half of the earlier Parisians, and considerably more than one half of the Parisians of to-day, Only the Parisian skulls exceed in capacity 1,700 c. c., and more than twice as many per cent. of the modern men pass this limit as compared with their ancestors of six centuries ago.

Even in these cases of normal human beings our former generalisation holds. The Gorilla's cranial capacity is often as much as 600 c. c. The difference between this number and 1,200 c. c. = 600 c. c. But the difference between 1,200. c. c. (Australian) and 1,900 c. c. (European) = 700 c. c.

That the gap is between the different members of the human race rather than between these and the anthropoid apes, is shown yet more clearly in the second part of the table, where the cranial capacities of some of the microcephali are recorded. With the exception of Ludwig Racke, everyone of these beings, born of human parents, had a capacity less than that of the ape-age Gorilla; and in one case, that of the adult woman, Marguerite Mæhler, less than one half that of the anthropoid era.

The case of Racke has already been noted as exceptional. But placing him on one side, we have the startling fact that normal human parents have given birth to offspring whose brain capacities are far below those of man's nearest allies. The difference between the 296 of Marguerite Mæhler and the 1,900 of some modern Parisians is over 1,600 c. c. And yet both these are members of the human race.

(*b*) Shape.—The human brain is, to use a common-place phrase, almost as broad as it is long, becoming in some cases nearly of a circular outline. On the other hand, the brains of the lower Primates are relatively longer than broad. Those of the Anthropomorpha, as usual, present characters more nearly allied to the human than to those of the catarrhine brain, for example, and, indeed, in some cases actually overlap, as it were, the human brain. The Chimpanzee has a brain ovoid (or egg-like) in shape but rather short and broad. The Gorilla's brain is less ovoid than that of the Chimpanzee, and is relatively broader than that of any other anthropoid. The Orang, whilst differing in certain particulars from Man more than its and his allies, approaches him in others. The beak-like frontal lobes make the outline of the Orang brain much less human in aspect than are the outlines of those of the other two apes. The overlapping mentioned above is illustrated by the account given by Marshall ["Philosophical Transactions," 1884] of the brain of a Bushwoman dissected by him. Its shape was "long, narrow, ovoid."

But in one very important point the Orang ranks highest. That is in the want of symmetry of the two halves of its brain. The convolutions of the right and left hemispheres respectively do not correspond exactly. This is also the case in a yet more marked degree in the brain of Man. Here the symmetry is more noticeable than in any of the Anthropomorpha, in all of whom it is to be seen; even more noticeable than in the Orang, whose brain exhibits this characteristic most clearly as far as the anthropoids are concerned.

Is there any reason for this want of correspondence in the arrangement of the brain-folds in the higher Primates? The suggestion of Bastian ["Brain as an Organ of Mind," p. 410] is that it is connected with a functional inequality between the two hemispheres. The suggestion is a luminous one

Perhaps it may be supplemented by another, upon which a passage from Haeckel may throw light. "That the human pinna (external ear) is a rudimentary organ is demonstrated by the extraordinary variations in its size and shape." The better way, possibly, to put it is that the sense of hearing is at the present time undergoing much modification. Variations in its functional activity are very frequent and diverse. There are contending schools of music, and the general ear is slowly being educated to the appreciation of finer tones, more complex successions, and more subtle harmonies. As the function of hearing is undergoing variation and evolution, the organ of hearing (not alone on the exterior, but internally) is varying, and diversities of form appear in individuals, and even on the opposite sides of the same head.

The application of this to the asymmetry of the brains of the highest Primates is obvious. As was said a little further back, these have evolved along the line of brain development, and one at least of them, Man, is yet marching on. As the function is varying the organ ought to be found to be variable. And this is the case not only on opposite sides of the same brain, but in different individuals, just as it was with the ear. I quote Rolleston's words as to a particular part of the brain in support of this proposition. The words are true generally. "In the higher species of the . . . Apes, as in the higher varities of the species Man, we find variability the rule, uniformity the exception; in the lower species, as in the lower varieties of Man, the reverse conditions obtain." Nor can I leave this interesting subject without reminding the reader that not only is there in all the anthropoids this asymmetry, but that in the lower human races it is little, if at all, better marked than in the Anthropomorpha, and that it is most marked in the most civilised races and in the most cultured individuals.

(*c*) Fissures.—Let me again remind the reader of the names and positions of these. Neglecting the longitudinal that separates the two hemispheres, the brain of all the highest Primates presents on each side, the fissure of Sylvius running backwards and upwards between the parietal and temporal lobes, that of Rolando running nearly vertically between the frontal and parietal lobe; that known as the internal per-

pendicular, running vertically on the inner aspect of each hemisphere, where the hemisphere is in contact with its fellow, and separating the parietal and occipital lobes. It may be stated here that, corresponding with this last, an external fissure is in some cases seen, but its presence would appear to be indicative of comparative lowness of cerebral organisation. Thus the Mangabey, one of the Catarrhini, has an external perpendicular fissure. It is well marked again in the Gibbon, in the Chimpanzee and in the Gorilla. In the Orang, however, it is shorter and less obvious, and in Man it is but very poorly represented. Even on a single and not very important point like this, the reader will notice how the gradations go.

But besides these fissures that we have seen to be present in Primates lower than the man-like apes, two new fissures appear. These are the calloso-marginal and the hippocampal. Both of them are only to be seen on the inner face of the hemisphere. The calloso-marginal is a fissure or furrow that lies just above the thick transverse band of nerve-tissue that joins the two hemispheres near their bases, and is known as the *corpus callosum* (hard body). Its position just above this body, and just on the margin of the hemisphere, accounts for its name. The fissure of the hippocampus is hard by that nervous mass, the *hippocampus minor*, that lies in the posterior extension of the brain ventricle into the occipital lobe. It lies behind the middle of the inner face of the hemisphere, and is just by the junction of that inner face with the under surface. Both of these new fissures, then, are present in Man. But both of them appear first in his allies. The Orang, Chimpanzee and Gorilla have all of them a calloso-marginal and a hippocampal fissure on each side.

The fissure of Sylvius and that of Rolando remain for consideration. As to the former, the most noticeable thing in the ascending series is the gradual movement of it towards the horizontal plane. As the Sylvian fissure lies between the parietal and temporal lobes, it follows that the more vertical is its direction the smaller relatively is the anterior part of the brain. But as the line of the fissure passes from the nearly vertical position, parallel to that of Rolando, that we see in the lower Primates, towards the almost horizontal position it has taken in the human brain, the frontal and parietal

lobes, in which are probably resident the higher mental functions, increase in relative size.

When we examine this fissure in the anthropoid brains, we find it least horizontal in the Gibbon, then in the Orang, then in the Chimpanzee and Gorilla. In these last its direction is but very slightly different from the direction of the fissure in Man.

As to the fissure of Rolando, the most important point there is its position rather than its direction. The higher the animal the farther back is this brain-cleft; the larger is the proportion of brain-substance before it as compared with that posterior to it; the larger, in a word, is the frontal lobe as compared with the rest of the brain. Now, in the Chimpanzee and in the Gorilla, this fissure lies well in front of the middle of the brain. Not more than $\frac{1}{3}$ of the brain-substance lies in front of it. In Man, on the other hand, the fissure of Rolando lies either at about the middle of the encephalon or behind the middle. Not less than $\frac{1}{2}$ of the brain-substance lies in front of it. But in the brain of the Orang the position of the fissure of Rolando is, by measurement, almost exactly midway between that held by it in the brain of the Gorilla and in Man.

(*d*) Convolutions.—A word or two as to the folds in the brain of the Gibbon alone first. In this lowest of the Anthropomorpha the occipital lobe is nearly destitute of convolutions, and the ascending frontal and parietal folds are quite rudimentary. It will be remembered that these lie respectively before and behind the fissure of Rolando. And here it should be stated that these two convolutions are quite well marked in some monkeys below the Gibbon. Thus the Mangabey, already mentioned, has them both very distinctly shown. In the Gibbon appear the first traces of the annectent or bridging-over convolutions (p. 37).

It is upon these and the supra-marginal lobule that our last words may be said. And first, as to the annectent. In Man there are generally two of these on each side. They run across the perpendicular fissure, and therefore connect the occipital and parietal lobes of each side. One of them lies lower in a vertical line than the other.

In the Chimpanzee, the first, or upper of the two annectent convolutions of Man is wanting, and the second, or lower

though present, is deeply placed in the fissure, not superficial and visible on the exterior.

In the Gorilla the first or upper is present, but is deeply placed, not superficial, and apparently the second is absent.

The Orang has the first, and, unlike all the other anthropoid apes, has this upper annectent convolution superficial and visible at once to the eye. The second is, however, absent.

Man has generally both the upper and the lower on each side, and both are superficial. But neither is quite a constant in the human brain, and in the Orang the first or upper, resembling, as it does that of man in its superficial position, resembles it also in its variability. Indeed, it is of these convolutions Rolleston wrote the words quoted on p. 44.

Now lastly, as to the supra-marginal lobule. This, as I have said above (p. 36), was regarded as the crucial anatomical point of distinction between Man and his fellows. Man had the supra-marginal lobule and no other Primate had. Thus Gratiolet. Let us once more recall the exact position of this cerebral structure. It lies at the top of the Sylvian fissure folding over this from before backwards. All the three highest anthropoids have in their brains this convolution. It does not really appear until the Chimpanzee. In the brain of this ape the supra-marginal lobule is, at the best, only rudimentary. In the Orang it is more fully developed, and in the Gorilla brains that have been thus far examined, this convolution, supposed by Gratiolet to be the special prerogative of Man, is found to be existent in a yet more notable degree. With these discoveries vanishes the last imaginary distinction between the human and Simian brain. In its train vanishes the whole dream-series of anatomical prerogatives of Man and the very idea that he is a special creation.

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