CERTAIN PHASES IN THE EVOLUTION OF MAN.

ABSTRACT OF THE HUNTERIAN LECTURES DELIVERED BEFORE THE ROYAL COLLEGE OF SURGEONS IN FEBRUARY AND MARCH, 1912.

BY
ARTHUR KEITH, M.D., LL.D., F.R.C.S.,
CONSERVATOR OF THE MUSEUM AND HUNTERIAN PROFESSOR.
(Concluded from page 737.)

THE RELATIONSHIP OF THE GIBBON TO THE PRIMITIVE HUMAN STOCK.

To those who make a special study of the evolution of man the small anthropoid or gibbon is the most important of all surviving apes. Those who are familiar with the gibbons as seen in the Zoological Gardens or who have kept them as pets value them for their mental and bodily characters, but the student is drawn to them because, structurally, they belong to a very ancient animal world and throw light on a very early stage in man's origin.

The gibbon, which lived in Europe in Miocene times, is now confined to the jungles of further India, to Borneo, Java, and Sumatra. There are two very distinct kinds, the large gibbon, few in number and restricted in distribution, and the small or ordinary gibbon, of which there are numerous varieties spread over a vast jungle or forest country. The structural differences between the siamang or large gibbon and the ordinary or small gibbon are similar in degree and in nature to those which separate the gorilla from the chimpanzee. Mankind during the greater part of the Pleistocene epoch

was also separated into two distinct types—the Neanderthal and the modern. When it is remembered that the gibbons, African anthropoids, and Pleistocene man represent three successive stages in the evolution of the highest primates, it is a remarkable fact that there should be in each stage a process at work which led to a separation into two kinds, one a massive and brutal form, restricted in numbers and in distribution, and the other less brutal, widely distributed, and divided into numerous varieties or races. The siamang, the gorilla, and Neanderthal man are the representatives of the brutal type; the gibbons, the chimpanzees, and modern human types the representatives of the other.

Although size or bulk of body is, as a rule, a character of very little value in classifying animals according to their degree of relationship, this is not the case as regards the higher primates. All the very ancient monkeys are of small size. The gibbon, compared to these very early forms, is large, but when compared to man, the African anthropoids, and the orang, it is small, being only a fifth to an eighth of their size. Great size and stature of body

came with the evolution of the stock of "giant" primates, which gave rise to the great anthropoids and man, probably some time before the beginning of the Miocene epoch. The small anthropoid or gibbon represents the stock from which the large-bodied primates arose. When compared to the gibbon, and especially to primitive apes, the large-bodied primates are veritable giants.

The main interest of the gibbon, from an anatomist's point of view, lies in the fact that in this ancient form those remarkable changes which adapted the body to the upright posture are already evolved. We are apt to think of the upright posture as a human characteristic, but this is not the case. It is true that in man only are the lower extremities adapted for ground progression, but these changes, remarkable as they are, are minor when compared with the transformation which we see in the body of the gibbon. The gibbon is essentially an ordinary monkey adapted to the upright posture. There can be no doubt

that in all the very ancient primates the axis of the body was carried horizontally; the gibbon is the earliest known form in which the axis of the body is carried upright; in its system we see the introduction of a structural principle which served as the stepping-stone to the human posture. Few biologists have realized the extent of the structural transformation necessitated by the upright posture. The position, shape and fixation of all the inner organs had to be altered, all the contents of the thorax and abdomen rearranged. The method and mechanism of respiration was changed; the musculature of the spine and trunk had to be adapted to new posture. It was at this stage the tail became useless, its muscles modified to form the pelvic floor.* The carriage of the head, the new use of the limbs, brought about a modification of all the joints and

Fig. 5.—Chart of the Tertiary period of the earth's history. The relative depth of the strata of each formation is shown according to the estimates of Professor Sollas. A genealogical tree of man and of the anthropoid apes is represented on the chart. The time represented by the chart covers many millions of years.

bones of the body. Yet, although the brain and nervous system did also participate in this structural revolution, the change which took place was to such a slight degree that, by studying the brain of the gibbon, one can make a very accurate guess as to its ancestry. It came out of the stock which gave origin to the higher monkeys of South America on the one hand and to the ordinary monkeys of the Old World on the other. The period of the evolution of the gibbon dates back to soon after the separation of the fauna of Africa from that of South America, the latter continent being apparently the centre of evolution of the earliest forms of monkeys. It is believed that the separation just mentioned took place soon after the commencement of the Tertiary period. In Professor Keith's opinion, the upright posture was an extremely ancient character, having been evolved probably early in the Eocene epoch. The giant forms of primates, which we have not discovered as yet earlier than the middle of the Miocene epoch, were probably evolved in an earlier epoch—the Oligocene.

* These changes will be dealt with more fully on a future occasion by Professor Keith.

EXTINCT ANTHROPOIDS.

The evidence obtained from an examination of extinct forms of animals closely allied to mankind supports the opinion that the antiquity of man was very much greater than has hitherto been supposed. So far only two extinct forms of great or giant anthropoids have been discovered. One of these (of which only a fragmentary palate has as yet been found) belongs to the Pliocene formations which occur along the southern foot of the Himalayas and was named *Paleopithecus* by Mr. Lydekker. This anthropoid is a missing link between the orang of Borneo and Sumatra and of the chimpanzee of Central Africa. It is related more nearly to the orang than to the chimpanzee. The discovery of *Paleopithecus* shows us that in the Pliocene period the great anthropoids had already assumed their modern size and form.

More importance must be attached to *Dryopithecus*, a great anthropoid which lived in the jungles of Europe during the Miocene epoch and became extinct early in the Pliocene. It was about the size of the chimpanzee, and like that animal in several features, but it differed in certain points from all the existing great anthropoids and showed features which linked it with the small and much more primitive anthropoid—the gibbon. *Dryopithecus* was widely spread in Europe; the most complete remains have been found in the middle Miocene formations of the south-west of France. Its teeth occurred in rather later formations in the upper valley of the Rhine and in the valley of the Danube. At least three forms of this great anthropoid lived in Europe. The molar teeth of this ape have rather a close resemblance to the corresponding human teeth. It is possible that some of the molars attributed to this animal are really human teeth, or of the Miocene stock which gave rise to man. The molar teeth are the only points in which *Dryopithecus* resembled man, and there was no reason to regard this extinct anthropoid more than another as a possible human ancestor.

Not only were the great anthropoids represented in Europe during the Miocene epoch, but so were the small anthropoids or gibbons. The teeth and jaws of the European gibbons of that long-past time differ from those of their modern representatives in about the same degree as the corresponding parts of a modern Englishman differ from those of an aboriginal Australian. The European gibbons, as is the case with modern Asiatic gibbons, were separated into two very distinct forms—one large in size, strong in limb and tooth; the other smaller and more primitive. The earliest trace of the European gibbon occurs in the inferior or older Miocene; but the characters of even the modern genus are so primitive in nature that we may expect to find remains of these small anthropoids in strata of a much earlier or older formation. To students of human evolution the discovery of the gibbon at the beginning of the Miocene epoch is a matter of great importance, as we know thereby that the upright or vertical posture was evolved then; how much earlier we can only guess.

Discovery of fossil remains has also thrown light on the origin of the ordinary or dog-like monkeys of the Old World. In the matter of their dentition they have become specialized, while the gibbon and man have retained a primitive form of dentition. The Old World dog-like monkeys have acquired a form of molar dentition which was new among primates. In the middle Miocene formations of Tuscany is found the remains of a fossil ape (*Oreopithecus*) possessing teeth which are intermediate in form to those of the gibbon and dog-like monkey.

An account of the most important and surprising discovery yet made regarding the early history of the primates was recently published (1910) by Dr. Max Schlosser. In the oldest of the Oligocene formation of the Fayoum of Upper Egypt remains of three forms of monkeys were found. Two of these Dr. Schlosser regards as close allies of South American monkeys; the other he regards as an ancestor of the Miocene gibbon of Europe. The discovery has a double importance: it shows, in the first place, that the Old World monkeys and anthropoids have, as many formerly believed, a common origin with those of South America; in the second place, it shows that the basal anthropoid stock was in process of evolution by the beginning of the Oligocene period. It is therefore possible that we may discover, as Professor Sergi asserts has already been discovered, remains of man in strata of the Pliocene epoch.

PRESENT POSITION OF THE THEORY OF HUMAN EVOLUTION.

In his concluding lecture Professor Keith reviewed the state of knowledge concerning the evolution of man. All the evidence indicated a very great antiquity for later phases in the evolution of the human body. More than forty years ago Sir Charles Lyell expressed his belief that the remains of man would be found in the Cromer beds of East Anglia. Although the actual bones of man have not been found in those beds, flints worked by man's hands have been discovered not only in the Cromer beds, but also beneath a deeper and much older formation—the red crag. Mr. Reid Moir, the discoverer of the pre-crag flints, regards them as being of at least early Pliocene age. The eoliths of the uplands of Kent, although of a somewhat later date than the pre-crag flints, serve better to convey an idea of the time which has elapsed since men first lived on the Kentish plateau. It is a most fortunate circumstance that these implements were first observed, and their antiquity inferred by the late Sir Joseph Prestwich—a geologist of sound judgement, and conservative in his estimates as regards the past period of man. We owe much to Mr. Benjamin Harrison for the manner in which he has developed our knowledge of these early flints. The deposit or "drift" in which the crudely worked flints or eoliths are found is mixed with fragments of greenstone and chert. The strata from which these greenstone fragments have been washed lie now in the weald 500 ft. below the level of the southern edge of the plateau. Prestwich realized that, at the time these ancient flint implements were imbedded, hills containing the greenstone strata must have occupied the position of the weald, and towered high above the level of the Kent plateau, and that after the greenstone fragments and flint implements were imbedded on the plateau these hills had been gradually washed away to a depth of at least 1,000 ft. The lowlands of the weald have thus been formed since Pliocene man cut the implements now found in the plateau drift. When these facts, and the existence of a primitive form of anthropoid in the earlier part of the Oligocene period, are kept in mind, it becomes possible to believe in the existence of Pliocene man of a modern type—such as Professor Ragazzoni had discovered in the north of Italy.

Another consideration made anthropologists claim a great antiquity for modern man—in contradistinction to Neanderthal man. Mankind as seen in the world to-day—European, Mongolian, Red Indian and Australian—were most diverse in type. Their evolution from a common form demanded the elapse of an enormous length of time. In England we find the types of skulls of her most ancient inhabitants repeated in her modern population. With the exception of the Neanderthal type, all the ancient Continental forms are still to be found in Europe. From predynastic to modern times Professor Elliot Smith found that the skull of the Egyptian has changed only in detail. The oldest human crania found in America are of the Red Indian type. We are forced to believe that human evolution works slowly; yet it has effected the extraordinary contrast seen between two such representatives of the modern type as the negro of Africa and the fair-haired native of North Europe. To accomplish such a degree of divergence one must carry the history of modern man at least well within the Pliocene period. Of the survivals of ancient human forms, it is very likely that the aboriginal Australian is the best living representative of Pliocene man. From such a type one can understand the origin of the negro on the one hand, and of the European on the other. Neanderthal man was a yet earlier and, in his later development, a yet more aberrant type.

Two discoveries made in recent years appear to render it impossible to suppose that the modern type of man existed so early as the Pliocene period. The first was the discovery of the Heidelberg jaw in a stratum belonging to the oldest or first stage of the Pleistocene epoch. It was of a most primitive, brutal, and yet human character. It indicates an individual of the Neanderthal type, but of a more massive form than is found at a later date in France. If we accept the Heidelberg individual as typical of the human race of that period (early Pleistocene), then we must suppose that human evolution proceeded at a more rapid rate than we have at present any conception of. We have to remember that in the world to-day, and it has always been the case, there are types or forms representing

very different degrees of antiquity and stages of evolution. It is therefore not only possible, but probable, that the Heidelberg and Neanderthal man are survivals of a very ancient type, and in no way indicative of the stage reached by *Homo sapiens* in the Pleistocene period. Using the same manner of reasoning, it is unlikely that the man of Java (*Pithecanthropus*), who is very little older in date than the Heidelberg man, and has a brain capacity of only about half that of modern man, represented the highest type of man of his time. He, too, was evidently a survival of an early stage. At least, it is difficult to believe that in a single and short geological period, even allowing that the extent of that period may be a million years, man could, even in that space of time, double his brain capacity. No parallel instance of so rapid a degree of evolution can be found in the history of Pleistocene mammals.

As regards the degree of relationship between man and the great anthropoids the opinion of scientific men has changed very little since Darwin's time. Huxley regarded the structural difference between man and the gorilla as about equal in degree to that which separated the gorilla from ordinary monkeys. The divergence between the gorilla and monkey is undoubtedly the greater. It can be safely said that the brain of the gorilla represents an intermediate stage between the brains of man and of the small anthropoid (the gibbon); the brain of the dog-like monkeys represents a still lower or more primitive stage. In 1904 Professor Nuttall confirmed the inferences which anatomists had drawn concerning the relationship of man to anthropoids and monkeys. He established the fact that the blood of the great anthropoids reacts to certain tests in almost exactly the same manner as human blood; the reaction becomes less in amount when the test is applied to the blood of monkeys. The response in the case of those of the Old World is greater than with those of the New, thus bearing out the anatomists' opinion that the Old World monkeys are more recently related to the human stock than those of South America. There is also the evidence of disease. The great anthropoids are susceptible to syphilis—a human disease; monkeys can be inoculated with difficulty. Anthropoids in captivity are liable to typhoid fever, and when kept in captivity frequently die from that very human disease—appendicitis. There was no evidence that appendicitis occurred when the anthropoids lived in their native habitats and on their natural diet. Anthropoids are manifestly human as regards the nature of their diseases.

Although none of the existing anthropoids could be regarded as a human ancestor, there could be no doubt, seeing the extraordinary degree of structural similarity, that man and the great anthropoids were the products of a common stem. The gorilla shows the nearest structural approach to man. As to the time at which divergence occurred between the great anthropoid and human lines of descent no definite statement can as yet be made, but to obtain a working hypothesis it is necessary to place the point of divergence in a comparatively remote geological epoch—the Oligocene. The evolution of the great anthropoids from the small may have occurred early in the same period. The genealogical trees which have been constructed to explain the past history of the human stock are as yet little better than crude guesses to explain masses of ascertained facts of anatomy. Further discoveries will certainly cause these genealogical trees to be modified in detail, yet the sequence of events in the evolution of man's body is becoming clear. The great mass of his brain and his nude skin were evidently the latest of human acquisitions; the adaptation of the lower limbs for walking and the modification of his teeth to their present form were earlier modifications of his structure. The size of his body and his stature were still older human features, while the chief structural modifications to adapt the body to an upright or vertical posture, were of very ancient origin.

A CORRECTION.—Professor Keith asks us to apologize for an accidental slip of the pen, which prefixed the words "the late" to the mention of Mr. Barwell's name in a footnote to the first part of the report of the Hunterian Lectures on certain phases in the evolution of man (p. 737). Mr. Barwell's name stands second on the list of Fellows of the Royal College of Surgeons of England. He became a Fellow in 1853 in the same year as Mr. Thomas Bryant, and two years after Professor P. Redfern, who is senior Fellow, his diploma dating from 1851. We are glad to know that Mr. Barwell, though retired from actual practice, is hale and well.

Nova et Vetera.

THE GREGORIES.

THERE is a French saying, *Ce n'est pas lui qui a inventé la poudre*, equivalent to our description of a man who will not set the Thames on fire. But there is powder and powder, and there is one which has made the name of its inventor in a sense immortal. This is Dr. James Gregory, whose name used to be a word of fear in nurseries owing to its association with the detested powder which he devised. A correspondent, who may possibly have suffered from a too liberal administration of the Pulv. Rhei Co., has asked for some particulars as to its inventor. James Gregory was a member of the famous family of Gregories which gave many men of high eminence in various spheres of activity to Great Britain. Their real name was MacGregor, but this was for a long time proscribed. It is curious to think that the professors of mathematics and medicine who played so large a part in the intellectual life of Aberdeen, Edinburgh, and other places during the eighteenth century and the beginning of the nineteenth should have been cousins closely related to Rob Roy, the famous freebooter. A short account of them is given by Miss Agnes Grainger Stewart in a little book entitled *The Academic Gregories*.¹

James Gregorie, who was mediciner at Aberdeen University in the beginning of the eighteenth century, was the founder of the Aberdeen School of Medicine. It was his son that the freebooter offered to take with him and make a man of, an incident reproduced by Scott in the offer made by Baillie Nicol Jarvie to take his sons, which is related in *Rob Roy*. James Gregorie died in 1733.

He was succeeded by his son, James, who was professor at Aberdeen from 1732 to 1755. He had a hot temper, and when he gave it free scope his friends would say, "Ah! this comes of not being educated by Rob Roy." Whether this tended to soothe his irritability we are not told. He left no children, but the name survived in John Gregory, who, after receiving his preliminary education at Aberdeen, went to Edinburgh in 1742 to study medicine. After three years he proceeded to Leyden, where among his companions was John Wilkes. King's College, Aberdeen, in his absence had obligingly sent him the degree of M.D., and on his return offered him the chair of philosophy, which he held from 1747 to 1749. At the same time he engaged in general practice as a physician. In 1754 he resolved to seek his fortune in London; in 1756, however, the death of his brother James having left the chair of medicine in Aberdeen vacant, he was appointed to it. But there were no students to teach, and the Aberdeen degree was a laughing stock, a state of things which chafed his proud spirit. His wife died in 1763, and in the following year he was invited to go to Edinburgh. There he was very successful in practice, and in 1766 he was appointed to the chair of the practice of physic, and was made first physician to the King for Scotland. He was the author of a *Comparative View of the State and Faculties of Man with those of the Animal World*, *Lectures on the Duties and Qualifications of a Physician*, *Elements of the Practice of Physic*, a textbook which he did not live to finish, and other works. He died suddenly in the middle of the session 1772-73, and the university authorities were at a loss how to arrange for the continuance of the lectures. His son James, the inventor of the powder, though only a student, offered to lecture till the end of the term, and extraordinary as it may seem, this proposal was gratefully accepted.

James Gregory was born at Aberdeen in 1753, and received his early education there. Afterwards he went to Oxford, but he cannot have remained long there, for he returned to Scotland and began his medical studies in 1767. After enlarging his experience at St. George's Hospital, London, he took his doctor's degree at Edinburgh in 1774, the subject of this thesis being *De morbis coeli mutatione medendis*. In it he advocated the advantages of change of air in prolonging life, and dealt in detail with phthisis, hypochondriasis, and gout. He afterwards pursued his studies on the Continent, and in 1776 he was elected to the chair of the Institutes of

¹ In the Famous Scots Series, published by Oliphant, Anderson, and Ferrier, Edinburgh and London, 1901.