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EARLY MAN AND THE ASSOCIATED FAUNAS IN THE OLD WORLD[1]

By Sir ARTHUR SMITH WOODWARD

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THE correlation of Pleistocene and later geological formations is always difficult, but the relative ages of the sporadic and isolated deposits which contain the remains and handiwork of fossil man are especially hard to determine. Cave deposits can only be dated by their contained fossils, unless they are clearly associated with some wide-spread incursion of the sea, a pluvial period, or a glacial episode. River terraces, lake terraces, and raised sea beaches can also often be correlated by their relative height above the present level of the water in which they were formed. In neither case, however, is it easy to correlate the past sequence of events revealed by the deposits in one region with those of a distant region. There can be little success unless similar fossiliferous deposits have been traced at intervals through the intervening land.

An interesting illustration of the means of determining the geological age of human remains is afforded by the discovery of the skull of *Eoanthropus dawsoni* in an iron-stained gravel at Piltdown in the Weald of Sussex, England. This gravel occurs in a district where earth movements caused extensive denudation in late Tertiary and Pleistocene times. It consists chiefly of hard waterworn fragments of sandstone and ironstone from the Wealden formation on which it rests; but mixed with the local material there are numerous waterworn flints, which must have been derived from the denudation of the chalk formation which originally overlaid the Wealden district, and still fringes it both to the north and to the south. These flints are well patinated, and many of them exhibit small slightly hollowed flaked surfaces, which suggest that they lay long exposed to the weather—especially to frosts—before they were eventually washed into the gravel by a river.

The Piltdown gravel was certainly deposited by a

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river, and it seems to be the accumulation of a rapid flood or torrent. It varies from two or three to about seven feet in thickness, and when Charles Dawson studied the first section, he published a diagram of it, which showed three distinct layers, possibly of different ages. Subsequent examination of a larger area, however, has shown that the lenticular patches of coarse gravel and finer material are very irregularly arranged; and the larger elongated stones found in the lowest layer often have their longer axis sharply inclined downwards or even vertical, showing that they have been dropped by the sudden check of a very rapid current. The whole deposit therefore may represent only the brief episode of a storm, and the objects found in the different layers may all have been buried at approximately the same time. In any case, the varied staining of the fossils and flints has no special significance, owing to the irregular distribution of the different ferruginous materials in which they were buried. It should also be noted that Dawson altered the color of the first pieces of the human skull which he found by dipping them in bichromate of potash to harden them. The other pieces were hardened merely by a solution of gelatine, which preserved their original color.

None of the existing rivers of the Wealden country have their source in the Chalk, whence, as already mentioned, the flints in the Piltdown gravel were originally derived. At first sight, therefore, it seems as if this gravel dated back to the remote time when the covering of Chalk was much more extensive than it is now, and when the river which flowed over Piltdown actually arose in the Chalk and was obtaining pieces of flint from it. We have already observed, however, that the flints themselves do not appear to have been derived directly from the Chalk by the old Piltdown river, but to have been long exposed to weathering, and even perhaps to have formed part of more ancient gravels, before they were transported to the gravel in which we now find them. We know that such flints are actually derived by one gravel from another, because the comparatively modern deposits of the existing river Ouse, which flows in a valley near Piltdown eighty feet below the terrace or plateau on which the true Piltdown gravel rests, have lately been proved to contain numerous similarly patinated and weathered flints, which must have been obtained by the denudation of the Piltdown plateau itself. In short, as most of the flints are resistant enough to be redeposited in two or three gravels of successive ages, they really afford no clue to the peculiar geographical conditions under which any deposit containing them was formed, and they can not determine its antiquity.

Although, as Dawson showed, the Piltdown gravel extends over an area of several square miles, it is all situated within the basin of one existing river, the Sussex Ouse. The gravel was therefore probably deposited by the direct predecessor of this river, which then flowed on a well-defined plain 80 feet above its present bed and about 120 feet above the present sea-level. Subsequent denudation has left the Piltdown plain as a terrace, and if this can be correlated with any terrace in the valley of the Thames, not far away, where the succession of Pleistocene terraces is clear, its geological age is determinable.

For such correlation, the fossils and implements found at Piltdown need to be considered. They must be carefully scrutinized to decide which of them are contemporaneous with the actual deposition of the gravel, and which may have been derived from some earlier formation in the same way as the pieces of flint already mentioned. The skull of *Eoanthropus* must be of the same age as the gravel in which it was buried, for it is not waterworn, and the brain-case, the delicate fragment of the face, the half of the lower jaw, and the canine tooth were lying separately in four different places, all close together. If these specimens had been transported far, and especially if they had been washed out of an earlier deposit, they would not have been thus associated. Two lower teeth and a piece of the lower jaw of a beaver, found isolated, also seem to be contemporaneous; and they are important, because the peculiar pattern of the teeth differs from the characteristic Pliocene type and agrees with the Pleistocene and later type. Two teeth of the ordinary Pleistocene *Hippopotamus* appear to be in the same state of mineralization, and are likewise not waterworn. Similarly mineralized also are the tooth of a horse (*Equus*), the base of an antler of a red deer (*Cervus elaphus*), and a piece of the metapodial of a small deer which has evidently been broken and scratched by man. Most significant of all the fossils which are obviously contemporaneous with the gravel and the human skull is a piece of bone, 16 inches long, which has been worked by man into the shape of the blade of a cricket bat. Direct comparison shows that this piece was flaked from the middle portion of an elephant's femur which was about 5 feet in length. It therefore represents an elephant larger than the Mammoth of Middle Pleistocene and later date, and doubtless belongs to one of the gigantic Lower Pleistocene elephants, such as *E. meridionalis* or *E. antiquus*. Some broken pieces of the molar of a very primitive elephant, which I have regarded as *Stegodon* and others think may be an early *Elephas,* seem to be more mineralized than the other fossils just enumerated and are perhaps derived from an older formation. Highly mineralized fragments of teeth of *Mastodon* and *Rhinoceros* (probably *R. etruscus*) are exactly like the fossils from the Pliocene Crags of eastern England, and must have been washed out of a local Pliocene deposit which has been

completely destroyed. The fossils clearly contemporaneous with the skull of *Eoanthropus,* therefore, represent a Lower Pleistocene mammalian fauna; while the more highly mineralized fragments have been derived from an earlier formation of Pliocene age.

The flint implements in the Piltdown gravel are also in two states of preservation. Some "eoliths" are so much waterworn and deeply patinated that they must have been washed out of an older gravel. Other "eoliths" have perfectly sharp edges and are less patinated; and there are also a few more elaborately made implements in the same fresh condition. The latter may certainly be regarded as of the same age as *Eoanthropus,* and they are described by Dawson as pre-Chellean. They are all unusual in having been made from large flakes by coarse chipping on the convex face.

If, then, the derived fossils be eliminated, and the other mammalian remains and flint implements be compared with those in the terraces on the sides of the valley of the Thames, the assemblage is found to agree best with that in the "High Terrace" which remains from 80 to 90 feet above the present level of the river. This terrace, which is obviously older than the Middle Terrace where the mammoth, woolly rhinoceros, musk ox, and Arctic lemming occur, is generally admitted to date back to a warm episode at the beginning of the Pleistocene period. The Piltdown gravel, with *Eoanthropus,* 80 feet above the present level of the river Ouse, may thus be ascribed to the same remote date in the history of man.

A review of all the evidence, therefore, shows that the age of the Piltdown gravel with *Eoanthropus* is determined by the associated mammals, the flint implements, and the present height of the terrace on which it is laid.

Until recently, the only other fragments of primitive human skeletons known to rival *Eoanthropus* in antiquity were the lower jaw of *Homo heidelbergensis* from a river deposit at Mauer, near Heidelberg in Germany, and the top of the skull with other remains of *Pithecanthropus erectus,* from a river deposit in Java. The Mauer jaw was dated by its association with mammals which are typically Lower Pleistocene in Western Europe, though they also include at least two species which are survivals from the Upper Pliocene. The age of *Pithecanthropus* was determined both by its association with mammals like those found in the Lower Pleistocene of India, and by its synchronism with certain marine deposits which are known to be post-Pliocene. These two fossils are so different from the jaw and skull of *Eoanthropus* that they prove the human races at the beginning of the Pleistocene period to have been much more varied than they are at the present day. They are rightly referred to three distinct genera, and it is doubtful whether the Mauer jaw really belongs to *Homo.*

Now is added the skull with the lower jaw of *Sinanthropus,* which Dr. Davidson Black has lately described in great detail from a cave deposit near Peking in China. While distinct from each of the other fossils, it is remarkable as combining some of the special features of all three. It agrees with *Eoanthropus* in the fine spongy texture of the skull, which has not yet been observed in any other man or ape; it is also suggestive of our Piltdown fossil in its broad base and peculiarly shaped occiput. In the contour of the top of the head, with the great depressed bony brow-ridges, it is so like the skull of *Pithecanthropus* that some anatomists would refer it to the latter genus. Its lower jaw and teeth are strikingly similar to those of *Homo heidelbergensis. Sinanthropus,* indeed, is a wonderful compendium of the other known early approaches to the modern genus *Homo.*

The geological age of *Sinanthropus* is determined both by stratigraphical observations and by the associated fauna. The deposits in which it occurs are proved by the Chinese geologists to be older than the wide-spread loess of China, which in places contains remains of the woolly rhinoceros (*Rhinoceros tichorhinus*), and in other places the mammoth (*Elephas primigenius*). These, it will be remembered, are two of the characteristic fossils of the Middle Terrace of the Thames, which dates back to the later part of the Pleistocene period. With *Sinanthropus* are found remains of a gigantic beaver, *Trogontherium,* and a rhinoceros very like *Rhinoceros hemitoechus,* which are specially characteristic of the High Terrace of the Thames already mentioned as the probable equivalent of the Piltdown gravel. If, therefore, the widely distributed mammals just enumerated were living at the extreme eastern and western limits of their range in the Old World at one and the same time, as seems almost certain, *Sinanthropus* dates back to the early part of the Pleistocene period and must have been a widely-separated contemporary of *Eoanthropus.*

Having now determined from four sporadic discoveries that primitive types of true men were living with some extinct species and genera of mammals throughout the Old World in the northern hemisphere from east to west at the beginning of the Pleistocene period, the question arises as to where the human race originated. For some time it has seemed probable that the source must have been south-central Asia. Teeth of apes more varied than any found elsewhere have been collected in the Upper Tertiary rocks of India; and it is reasonable to suppose (with the late Dr. Barrell) that when the Himalayan Range arose, the forests in which these apes lived were divided into northern and southern portions. Those apes which were stranded to the north may have been compelled

by inclement conditions to change their habits, become dwellers on the ground, and develop into potential ancestors of man. American and other expeditions have sought hopefully, but hitherto in vain, for some trace of these missing links. I think recent discoveries in Africa suggest that such a search is not likely to meet with success.

During the last few years Dr. L. S. B. Leakey has been exploring Tanganyika Territory in S. E. Africa, and has proved that the jaws and teeth of apes are not uncommon in the Miocene deposits of that region. He has also shown that human remains occur with stone implements in Pleistocene deposits in several localities in the same territory. The succession of types of stone implements is essentially similar to that already observed in Europe; and the fossil mammals of the older Pleistocene deposits, like those in Europe, include a few survivals from the Upper Pliocene fauna. The mammals of the late Pleistocene deposits are little different from those which lived until the dawn of history in East Africa. Most unexpectedly, however, the human remains hitherto found in association with the earlier Pleistocene implements and faunas do not belong to primitive types like those of Europe and Asia, but resemble most closely the corresponding parts of modern man, *Homo sapiens*. One front of a human lower jaw found at Kanam in association with molar teeth of Upper Pliocene species of *Dinotherium* and *Mastodon* and remains of later African types of mammals, exhibits both the characteristic prominent bony chin and the crowded teeth of *Homo sapiens*. The associated stone implements are merely chipped pebbles, which recall the primitive eoliths and other trimmed flints which are older than the simplest Paleolithic implements (Chellean) in western Europe.

So far as can be determined from the fragments available, therefore, typical modern man appeared much earlier in S. E. Africa than in Europe or Asia, though he had not advanced further than his backward northern contemporaries in the art of tool making. It is indeed remarkable to find *Homo sapiens* with stone implements like those which were made by extinct genera of Hominidae in Europe and Asia.

This conclusion suggests to a paleontologist that some part of Africa—perhaps the region of the Rift Valley, which has been subjected to geological convulsions since the Pliocene period—was the original center of humanity. Many years ago, the late Dr. W. D. Matthew pointed out that if each race of animals evolved at a single center, a succession of waves of increasingly differentiated genera must have radiated outwards from that center. The latest and highest types would be found at the actual place of evolution, and they would be surrounded by rings of less advanced types of lower and lower degree until the lowest would occur at the outer limit. Dr. Leakey's discovery may therefore be interpreted as meaning that *Homo sapiens* began at the African center, and that *Eoanthropus, Pithecanthropus* and *Sinanthropus,* which were living at the same time at the extreme edge of Europe and Asia respectively, were the displaced remote offshoots of early stages in evolution at that center.

On the same supposition, the second offshoot was that of Neanderthal (or Mousterian) man (*Homo Neanderthalensis*) who was very widely distributed throughout Europe and part of Asia, and lived in Europe with the woolly rhinoceros and the mammoth. These animals, as already mentioned, are definitely proved to have flourished later than the earliest known races of man at both ends of their range; for they occur in part of the Middle Terrace of the Thames (not in the High Terrace), and in the loess of China which is more recent than the cave deposits containing *Sinanthropus*. As Neanderthal man buried his dead, he is known fortunately by several nearly complete skeletons as well as many fragments. By these comparatively satisfactory specimens he is proved to have varied much in structure, especially in the skull and jaws. Some have therefore supposed that he was evolving into modern man (*Homo sapiens*) and eventually gave rise to this higher and surviving type somewhere in Europe or Asia. As a paleontologist knows, however, variability is a special characteristic of the struggling end of a disappearing race quite as frequently as it is a mark of the beginning of a new race. The variability of Neanderthal man is indeed probably to be regarded as denoting his approaching end.

In this case, the common belief that modern man appeared in Europe as an invader replacing Neanderthal man in the later part of the Pleistocene period seems likely to prove correct. Until after this episode, the three great continents of the Old World were more closely united than they are now. Africa and Europe seem to have been connected by land at least across the present straits of Gibraltar; while Africa and Asia were more accessible to each other when Palestine was the well-watered forested country which recent discoveries of fossil mammals in caves show it to have been.

In conclusion, it must be admitted that no remains of Neanderthal man have hitherto been found in Africa. The remarkable skull from Rhodesia, with enormous bony brow-ridges, can not be referred to this category. Nevertheless, the discoveries of Dr. Leakey in Tanganyika Territory seem to indicate that intensive studies of the Miocene, Pliocene and Pleistocene deposits of the African continent are most likely to enlighten us on human origins.