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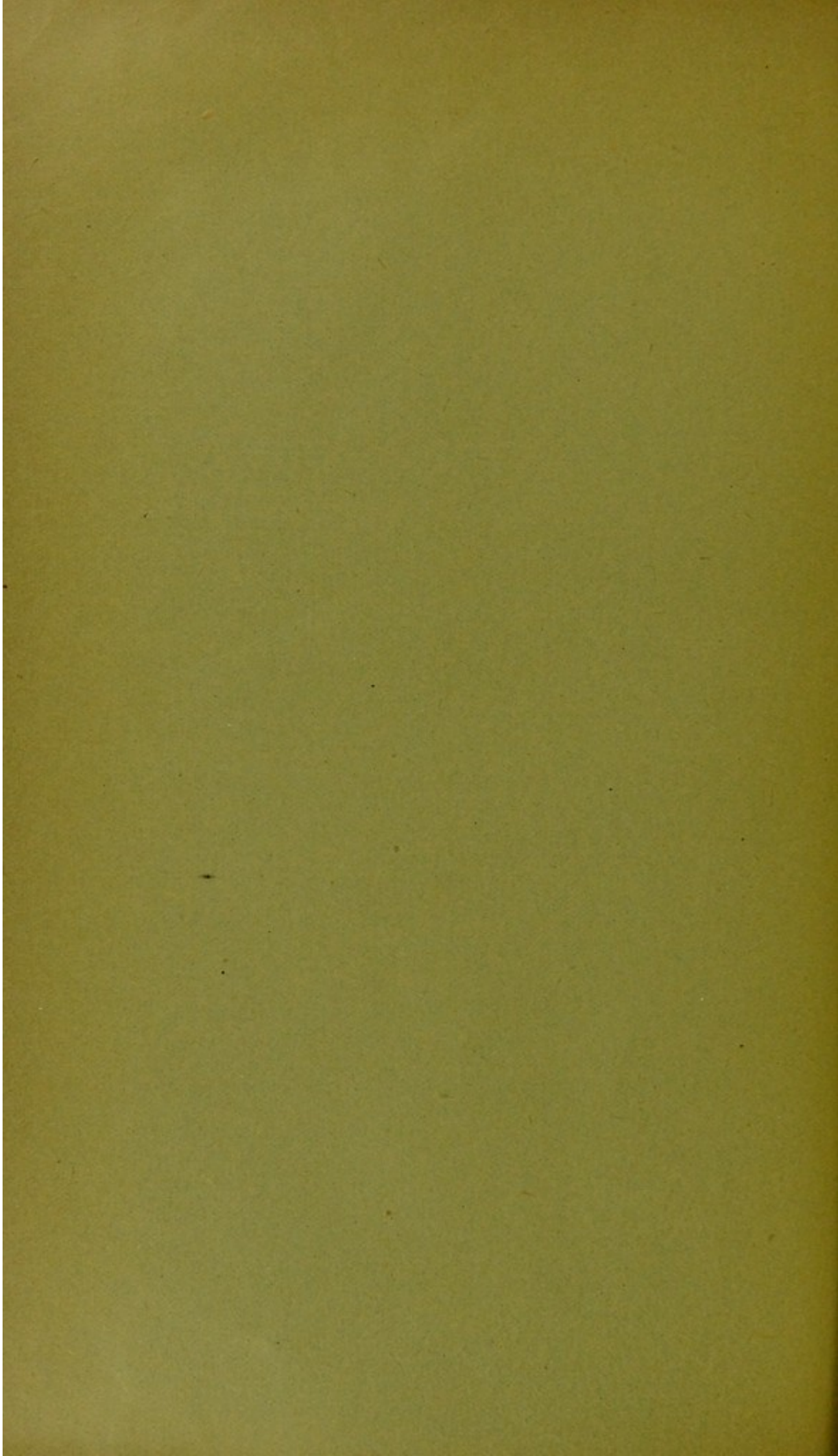
[FROM THE AMERICAN JOURNAL OF SCIENCE, VOL. I, JUNE, 1896.]

ON THE PITHECANTHROPUS ERECTUS, FROM
THE TERTIARY OF JAVA.

By O. C. MARSH.

WITH ONE PLATE.







On the PITHECANTHROPUS ERECTUS, from the Tertiary of Java; by O. C. MARSH. (With Plate XIII.)*

NEAR the beginning of last year, a discovery was announced that excited great interest throughout the scientific world, especially among those interested in the origin and antiquity of man. The announcement first made was that remains of a veritable missing link between man and the higher apes had been found in Java, in strata of Pleistocene age. The discovery was made by Dr. Eugène Dubois, a surgeon in the Dutch army, who had been stationed in Java for several years, and had devoted much time to the vertebrate fossils of that island.

The first definite information received in this country was in December, 1894, when Dubois's memoir on *Pithecanthropus* arrived.† One of the first copies reached the late Professor Dana just as he was printing the last pages of his great work on geology. He at once wrote to me in Washington, asking me to look up the memoir, and telegraph my opinion of the discovery, so that he could refer to it in his book. On inquiry, I ascertained that this memoir had not then been received at any of the scientific centers in Washington, and that the discovery itself was not known. On returning to New Haven, I found a copy of the memoir awaiting me (received December 29, 1894), and at Professor Dana's request, I wrote a review of it, which appeared, with illustrations, in this Journal for February, 1895.‡

The memoir of Dr. Dubois was an admirable one, and, although written in Java, with only limited facilities for consulting the literature on the subject and for comparing the remains described with living and extinct forms to which they were related, the author showed himself to be an anatomist of more than usual attainments, and fully qualified to record the important discovery he had made. In my review, therefore, of this important memoir, I endeavored to state fairly the essential facts of the discovery, as well as the main results reached by Dr. Dubois after a careful study of the remains.

* Abstract of communication made to the National Academy of Sciences at Washington, April 24, 1896.

† *Pithecanthropus erectus*. Eine menschenähnliche Uebergangsform aus Java. Von Eug. Dubois, Militairarzt der niederlaendisch-indischen Armee. Mit zwei Tafeln und drei in den Text gedruckten Figuren. 4to, Batavia, 1894.

‡ The figures then given in Plate II are repeated in the plate accompanying the present article.

My own conclusions in regard to this discovery, briefly stated in my review, were as follows:—

“It is only justice to Dr. Dubois and his admirable memoir to say here, that he has proved to science the existence of a new prehistoric anthropoid form, not human indeed, but in size, brain power, and erect posture, much nearer man than any animal hitherto discovered, living or extinct. . . .

Whatever light future researches may throw upon the affinities of this new form that left its remains in the volcanic deposits of Java during later Tertiary time, there can be no doubt that the discovery itself is an event equal in interest to that of the Neanderthal skull.

“The man of the Neander valley remained without honor, even in his own country, for more than a quarter of a century, and was still doubted and reviled when his kinsmen, the men of Spy, came to his defense, and a new chapter was added to the early history of the human race. The ape-man of Java comes to light at a more fortunate time, when zeal for exploration is so great that the discovery of additional remains may be expected at no distant day. That still other intermediate forms will eventually be brought to light no one familiar with the subject can doubt.”

In most scientific quarters, however, both in this country and in Europe, Dr. Dubois's discovery was not received with great favor, and the facts and conclusions stated in his memoir were much criticised. Among a score or more of notices of this elaborate memoir which appeared subsequent to my review, I do not recall a single one that, in attempting to weigh the evidence presented, admitted the full importance of the discovery made by Dr. Dubois. The early conclusions seemed to be that the various remains discovered were human, and of no great age; that they did not belong to the same individual; that the skull apparently pertained to an idiot; and that both the skull and femur showed pathological features. In fact, the old story of the distrust aroused by the discovery of the Neanderthal skull, nearly forty years before, was repeated, although in a milder form. Dr. Dubois has stated in a late memoir that, with the exception of Professor Manouvrier of Paris and myself, no one else, until very recently, regarded the remains as evidence of a transitional form between man and the apes.

It was a fortunate thing for science that the Dutch government appreciated the importance of the discovery made in its Javanese province by Dr. Dubois, and last summer allowed him to return to Holland and bring with him the precious remains he had found, and so well described. Not only this,

but he was also permitted to bring the extensive collections of other vertebrate fossils which he had secured from the same horizon and in the same locality where the *Pithecanthropus* was discovered. All these were shown at the International Congress of Zoologists, held at Leyden, in September last, and on the 21st of that month, Dr. Dubois read an elaborate paper on his original discovery and on his later explorations in the same region. This communication was in many respects the most important one of the session, and its presentation with the specimens themselves was a rare treat to the large audience present, especially to those fitted to appreciate the evidence laid before them.*

Professor Virchow of Berlin was president of the meeting on that day, and had brought many specimens to illustrate the remarks he was to make in the discussion. The famous Leyden museum was also drawn upon for an extensive series of specimens of man and the higher apes, so that, if possible, the true position of *Pithecanthropus* might then be determined once for all. Dr. Dubois, moreover, kindly invited Professor Virchow, Sir William Flower, and myself, to come an hour before the meeting, and personally examine the remains he was to discuss, and this invitation was most gladly accepted.

The first sight of the fossils was a surprise, as they were evidently much older than appeared from the descriptions. All were dark in color, thoroughly petrified, and the matrix was solid rock, difficult to remove. The skull-cap of *Pithecanthropus* was filled with the hard matrix, firmly cemented to it. The roughness of the superior surface, especially in the frontal region, was apparently due to corrosion after entombment, and not to disease, as had been suggested by some anatomists. The femur was free from matrix, but very heavy in consequence of the infiltration of mineral matter. The exostosis on its upper portion is a conspicuous feature, but of course is pathological. This feature is of little consequence, as very similar outgrowths occur on fossil bones of even Eocene age. The two teeth showed no characters that indicated their interment under circumstances different from that of the skull or femur. All the physical characters impressed me strongly with the idea that these various remains were of Pliocene age, and not Post-Tertiary, as had been supposed. The description of the locality and the account of the series of strata there exposed, as given by Dr. Dubois in his communication, confirmed this opinion, and a later examination of accompanying vertebrate fossils placed the Pliocene age of all beyond reasonable doubt.

* *Compte-Rendu des Séances du Troisième Congrès International de Zoologie*, Leyden, September, 1895, pp. 251-271, 1896. See also *Transactions Royal Dublin Society*, vol. vi, pp. 1-18, February, 1896; and *Anatomischer Anzeiger*, Bd. xii, pp. 1-22, 1896.

The facts relating to the discovery itself, and the position in which the remains were found, as stated by Dr. Dubois in his paper, together with some additional details given to me personally, convinced me that, in all probability, the various remains attributed to *Pithecanthropus* pertained to one individual. Under the circumstances, no paleontologist who has had experience in collecting vertebrate fossils would hesitate to place them together.

In figure 1, below, a geological section is given, showing the series of strata exposed in the bank of the river Bengawan, near Trinil, in central Java, where all the remains of *Pithecanthropus* were found. The exact positions of these various specimens when discovered are also indicated.

1.

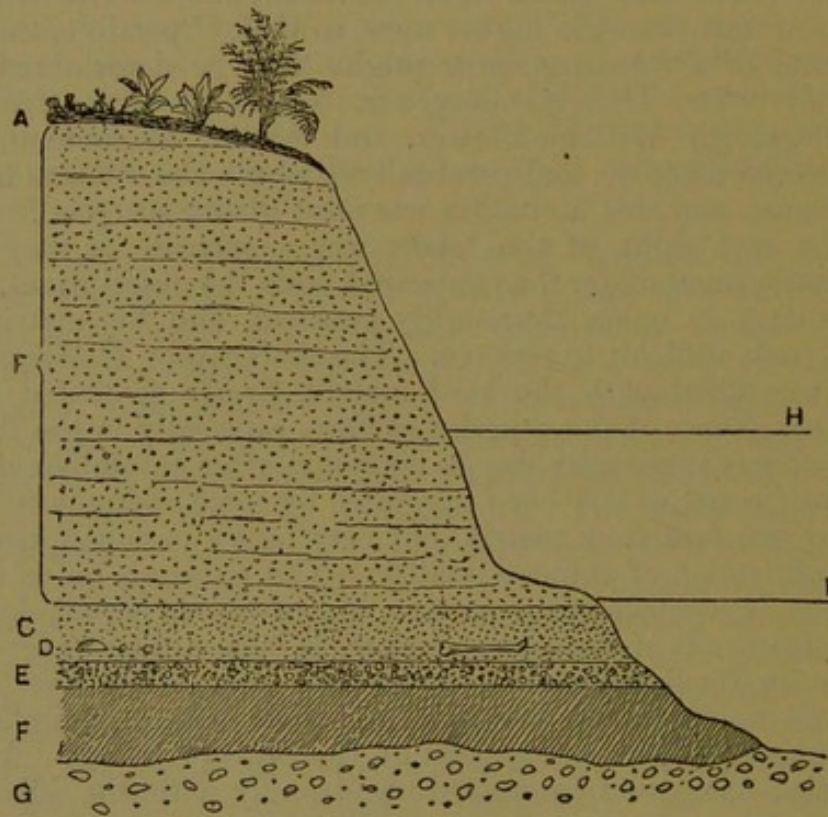


FIGURE 1.—Section of the bone strata at Trinil. (After Dubois.)

A, vegetable soil; B, sand-rock; C, bed of lapilli-rock; D, level in which the four remains were found; E, conglomerate; F, clay-rock; G, marine breccia; H, rainy season level of river; I, dry season level of river.

The above section, taken from Dr. Dubois's Dublin paper, makes clear many points as to the locality where the discoveries were made, which were left doubtful in the original memoir.

The three specimens originally described, the tooth, the skull, and the femur, were found at different times in the same horizon, all imbedded in the same volcanic tufa, as indicated in figure 1, D. The tooth was found first, in September, 1891, in the left bank of the river, about a meter below the water level during the dry season, and twelve or fifteen meters below the plain in which the river had cut its bed. A month later, the skull was discovered, only a meter distant from the place where the tooth lay. In August, 1892, the femur also was found, about fifteen meters distant from the locality where the other specimens were imbedded. Later, in October of the same year, a second molar was obtained at a distance of not more than three meters from where the skull-cap was found, and in the direction of the place where the femur was dug out.

The fossils thus secured were all carefully investigated by Dr. Dubois, who regards them as representing a distinct species and genus, and also a new family, which he has named the *Pithecanthropidæ*, and distinguished mainly by the following characters:

Brain cavity absolutely larger, and, in proportion to the size of the body, much more capacious than in the *Simiidæ*, yet less so than in the *Hominidæ*. Capacity of the skull about two-thirds the average of that of man. Inclination of the nuchal surface of the occiput considerably greater than in the *Simiidæ*. Dentition, although retrogressive, still of the simian type. Femur equal in its dimensions to that of man, and like that adapted for walking in an upright position.

Of this skull, the upper portion alone is preserved, the line of fracture extending from the glabella backward irregularly to the occiput, which it divides somewhat below the upper nuchal line. The cranium seen from above is an elongated oval in outline, dolichocephalic; and is distinguished from that of other anthropoid apes by its large size and its higher arching in the coronal region, as shown below in figure 3. The greatest length from the glabella to the posterior projection of the occiput is 185^{mm}. The greatest breadth is 130^{mm}, and the smallest, behind the orbit, is 90^{mm}. The cranium in its original condition must have been of somewhat larger dimensions. The upper surface of the skull is without ridges, and the sutures all appear to be obliterated.

This dolicocephalic skull, with an index of 70°, is readily distinguished from that of the Orang-utan, which is decidedly brachycephalic. The absence of the characteristic cranial crests will separate it from the skull of the adult Gorilla. In its smooth upper surface and general form, it shows a resemblance to the skull of the Chimpanzee, and still closer to that of the Gibbons (*Hylobates*).

A figure of the present specimen and the skull of a Gibbon for comparison are shown in figure 2, Plate XIII. These figures and those that follow are reproduced from illustrations in Dr. Dubois's memoirs.

In comparing the cranium of *Pithecanthropus* with skulls most nearly allied, both human and simian, the outlines given in figure 3, below, will prove especially instructive. The basis of this cut is the figure given by Dr. Dubois in his Leyden paper. This I have modified by omitting the outline of the microcephalic idiot, and substituting that of the well-known Neanderthal skull.*

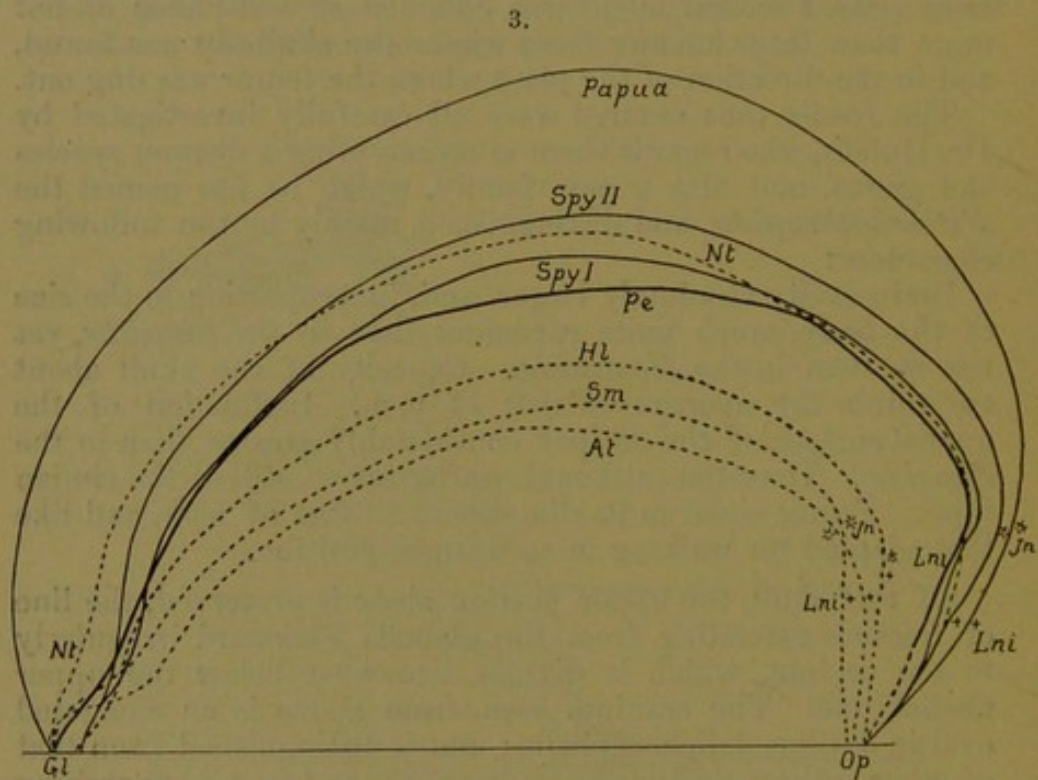


FIGURE 3.—Profile outline of the skull of *Pithecanthropus* (*Pe*), compared with those of a Papuan man, the man of Spy No. 1, Neanderthal man (*Nt*), man of Spy No. 2, and *Hylobates leuciscus* (*Hl*), *Semnopithecus maurus* (*Sm*), and *Anthropopithecus troglodytes* (*At*). (Modified from a figure by Dubois.)

Gl, glabella; *Op*, opisthion; *Jn*, linea nuchæ superior; *Lni*, linea nuchæ inferior.

Dr. Dubois's conception of the skull of *Pithecanthropus*, when entire, is indicated by his attempted restoration shown in figure 6, on page 481. Future discoveries must determine the accuracy of this restoration.

* In presenting the present paper before the National Academy of Sciences at Washington, I was fortunately able to exhibit a cast of the *Pithecanthropus* skull, recently sent to me by Dr. Dubois, and also to compare this with a cast of the Neanderthal skull. The latter was not available during the discussion at Leyden.

The tooth, the first specimen found, is represented in figure 4, below. It is the last upper molar of the right side, and is in good preservation. It indicates a fully adult, but not very old, animal. The crown is subtriangular in form, with the corners rounded, and the narrowest portion behind. The antero-posterior diameter of the crown is 11.3^{mm} , and the transverse diameter 15.3^{mm} . The grinding surface of the crown is concave, and less rugose than in existing anthropoid apes. The diverging roots are a simian feature.

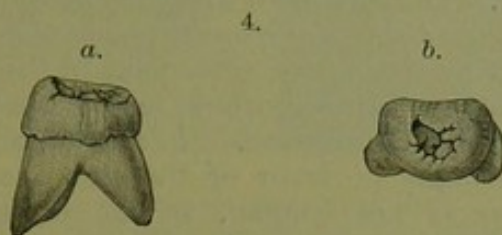


FIGURE 4.—Third right upper molar of *Pithecanthropus erectus*. Two-thirds natural size. (After Dubois.)
a, back view; b, top view.

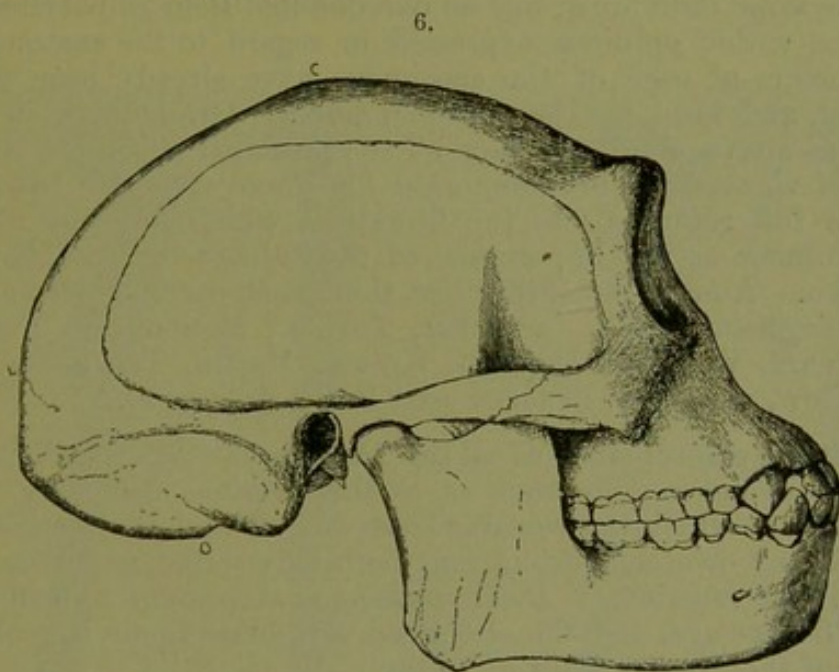


FIGURE 6.—Restoration of the skull of *Pithecanthropus erectus*. Two-fifths natural size. (Reduced from a figure by Dubois.)
c, sutura coronalis; L, sutura lamboidea; o, foramen occipitale.

The femur, which is from the left side, is in fair preservation, although it was somewhat injured in removing it from the surrounding rock. It belonged to a fully adult individual. In form and dimensions, it resembles so strongly a human femur that only a careful comparison would distinguish one

from the other. The bone is very long, its greatest length being 455^{mm}. The shaft is slender and nearly straight. The general form and proportions of this femur are shown in figure 5, Plate XIII, with a human femur for comparison.

These various remains of *Pithecanthropus* were again described in detail and compared with allied forms by Dr. Dubois in his paper at Leyden, and in the discussion that followed, the whole subject was once more gone over by anthropologists, zoologists, and geologists, in a most thorough and judicial manner. To attempt to weigh impartially the evidence as to the nature of *Pithecanthropus*, presented by Dr. Dubois in his paper and by those who took part in the critical discussion that followed its reading, would lead far beyond the limits of the present communication. I can only say that this evidence was strongly in favor of the view that the skull of *Pithecanthropus* is not human, as the orbital and nuchal regions show, while at the same time it indicates an animal much above any anthropoid ape now known, living or extinct. Opinions differed as to whether the various remains pertained to the same individual, but no one doubted their importance.

The varied opinions expressed in regard to the anatomical characters of each of the specimens have already been published, and need not be repeated here. Dr. Dubois, in his papers above cited, has met all the principal objections made to his views since he announced his discovery. He has also given full references to the literature, which promises to be voluminous as the importance of the subject becomes better known. Among the authorities thus cited may be mentioned Cunningham, Keith, Lydekker, Turner; Manouvrier, Pettit, Topinard, Verneau; Haeckel, Krause, Martin, Ten Kate, and Virchow, who have all taken part in the discussion.

After a careful study of all the *Pithecanthropus* remains and of the evidence presented as to the original discovery, the position in which the remains were found, and the associated fossils, my own conclusions may be briefly stated, as follows:

(1) The remains of *Pithecanthropus* at present known are of Pliocene age, and the associated vertebrate fauna resembles that of the Siwalik Hills of India.

(2) The various specimens of *Pithecanthropus* apparently belonged to one individual.

(3) This individual was not human, but represented a form intermediate between man and the higher apes.

If it be true, as some have contended, that the different remains had no connection with each other, this simply proves that Dr. Dubois has made several important discoveries instead of one. All the remains are certainly anthropoid, and if any of them are human, the antiquity of man extends back into the Tertiary, and his affinities with the higher apes become much nearer than has hitherto been supposed. One thing is certain: the discovery of *Pithecanthropus* is an event of the first importance to the scientific world.

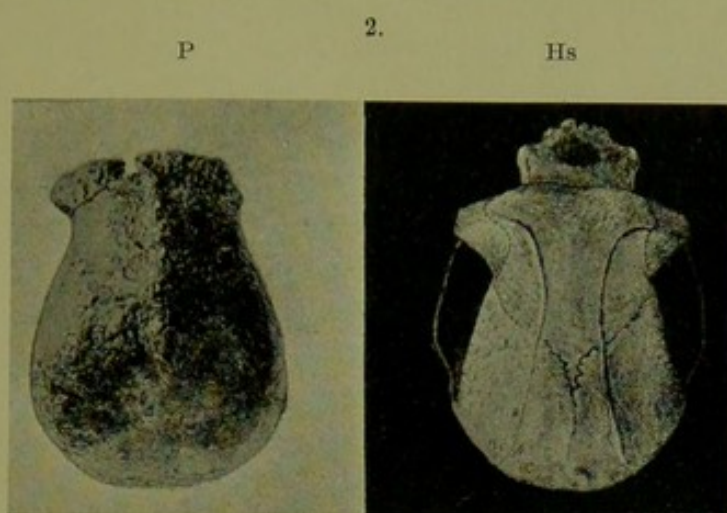


FIGURE 2.—P. Cranium of *Pithecanthropus erectus*, $\frac{1}{2}$.
Hs. Skull of *Hylobates syndactylus*, $\frac{1}{2}$. (After Dubois.)

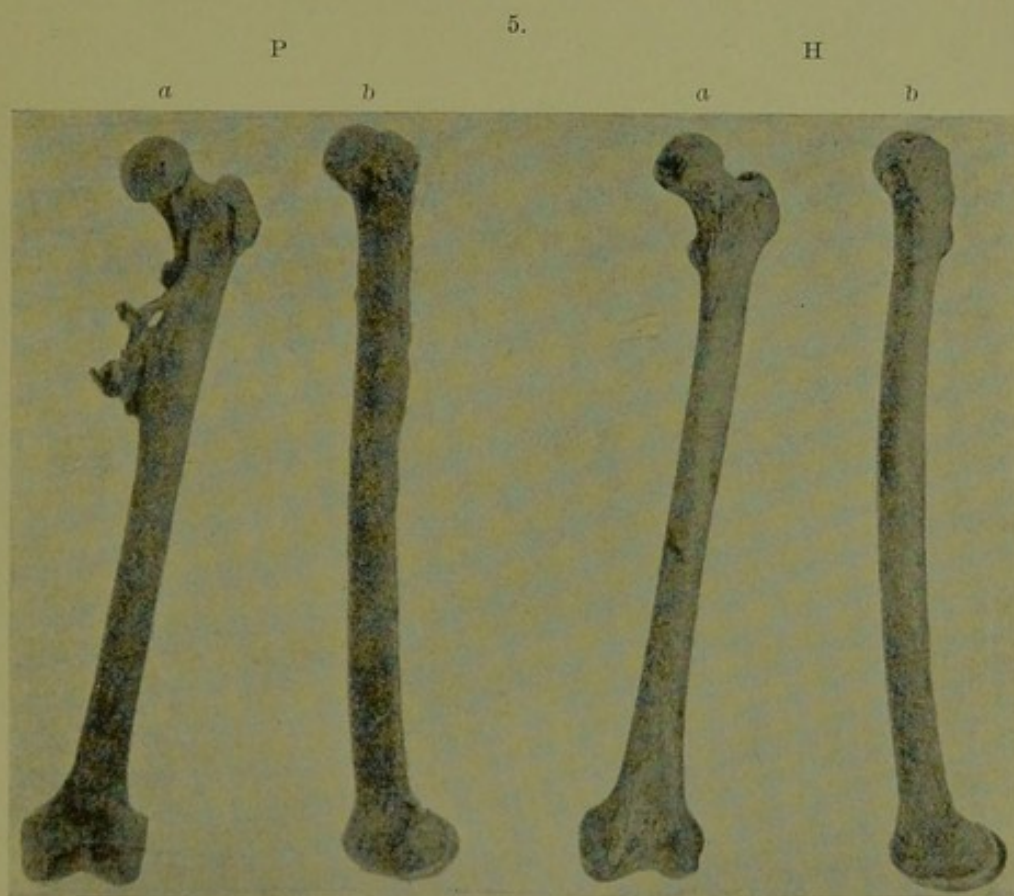


FIGURE 5.—P. Left femur of *Pithecanthropus erectus*, $\frac{1}{2}$.
H. Left femur of man, $\frac{1}{2}$. (After Dubois.)
a, front view; *b*, exterior view.

