

**Pithecanthropus erectus : a form from the ancestral stock of mankind / by Eugène Dubois.**

**Contributors**

Dubois, E.

**Publication/Creation**

Washington : Government Printing Office, 1900.

**Persistent URL**

<https://wellcomecollection.org/works/czbkt8pc>

**License and attribution**

Conditions of use: it is possible this item is protected by copyright and/or related rights. You are free to use this item in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s).



Wellcome Collection  
183 Euston Road  
London NW1 2BE UK  
T +44 (0)20 7611 8722  
E [library@wellcomecollection.org](mailto:library@wellcomecollection.org)  
<https://wellcomecollection.org>

PITHECANTHROPUS ERECTUS: A FORM FROM THE  
ANCESTRAL STOCK OF MANKIND.

BY

EUGÈNE DUBOIS.

---

FROM THE SMITHSONIAN REPORT FOR 1898, PAGES 445-459  
(WITH THREE PLATES).

---

WASHINGTON:  
GOVERNMENT PRINTING OFFICE.  
1900.

THE HISTORY OF THE  
CITY OF NEW YORK

FROM 1624 TO 1861

BY JOHN E. BOWEN

NEW YORK

1861



## PITHECANTHROPUS ERECTUS—A FORM FROM THE ANCESTRAL STOCK OF MANKIND.<sup>1</sup>

By EUGÈNE DUBOIS.

The fossil remains upon which I have founded this new species consist of a calvarium, or skullcap, two upper molars, and a femur. With the exception of one tooth, the second upper molar on the left side, they have already been described by me in a paper published in Batavia in 1894.<sup>2</sup> It now seems desirable to give some special details.

It is well known that a not inconsiderable number of anatomists and zoologists hold diametrically opposite views regarding the significance of these remains. For instance, as to the skull, a few have believed that it is human, although of much more ape-like appearance than hitherto known, while others have considered it the skull of an ape far more human in character than any previously discovered. It is remarkable that only a few have believed in a third possibility, intermediate between these two views, viz, that we have before us here a transition form between apes and men that is neither man nor ape. Recently this intermediate view has made quite significant progress, and a considerable number have accepted it. As to the anthropists and pithe-cists, as the upholders of the extreme views may be called, the former find their fossil Java man more ape like than they at first did, while the latter have placed their most anthropoid of apes still a few steps higher on the ladder of ascent toward man. These views now tend to coincide still more, because in the meantime it has been possible to test them by an exhibition of the objects themselves, and I have been able to give further particulars, especially as to the circumstances under which the remains were found.

For the proper interpretation of these osseous remains the circumstances under which they were found is quite as important a factor as the anatomical considerations. I will therefore first give some particulars regarding their situation when discovered.

Near the remains that are the subject of this paper I have collected in

<sup>1</sup> Part of a paper read before the Berlin Anthropological Society on the 14th of December, 1896. Translated from the *Anatomischer Anzeiger*, Vol. XII, pp. 1-22.

<sup>2</sup> *Pithecanthropus erectus, eine menschenähnliche Übergangsform aus Java*. Batavia Landesdruckerei, 1894.



Java, at Trinil, in the Ngawa district of the Madiun Residency, a great number of fossil skeletal parts of other vertebrate animals belonging to the same species as those found by me during five years of researches at many other places in the same strata, which lie exposed over some hundreds of square kilometers. To judge from the uplifting which these strata have undergone, in the course of which they have all been tilted (at Trinil about 5 degrees south), and also from other geological evidence, they are older than the Pleistocene, apparently older than the early Pliocene. They are of a fluviatile character, and lie, more than

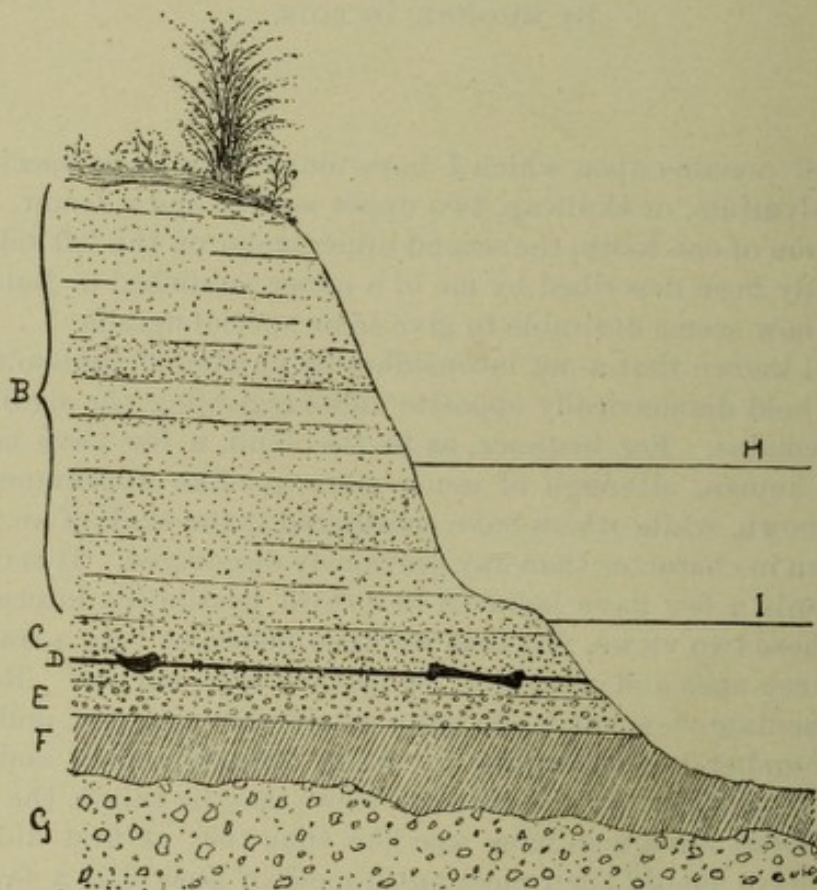


FIG. I.—Section of the ossiferous strata at Trinil

A, area of growing plants; B, soft sandstone; C, lapilli stratum; D, level at which the skeletal remains were found; E, conglomerate; F, argillaceous layer; G, marine breccia; H, wet-season level of the river; I, dry-season level of the river.

350 meters thick, unconformably, upon marine strata, which K. Martin, in Leyden, has determined as Pliocene.

According to the fauna, also, as far as I have been able to study it up to this time, it is highly probable that the strata are early Pliocene. This fauna is very similar to the fossil vertebrate fauna of western India, but appears to be younger than the Siwalik fauna of the early Miocene or later Pliocene and somewhat older than the fauna of Narbada, which has been placed in the earliest Pleistocene.

At the place where the remains were discovered at Trinil the strata, everywhere composed of volcanic tufa, lie exposed in the cliff-like decliv-



ity of the bank of a river of considerable size, the Bengawan, or Solo. They usually consist here of a sandstone of slight consistency which, in its deeper layers, at about the level of the river during the dry season, becomes coarser and coarser as more and more lapilli or volcanic stones form part of its composition. The bones are found throughout the entire thickness of the sandstone strata, being very numerous in the lower half, and most so in the stratum, about 1 meter thick, in which the lapilli are found. In the conglomerate which lies under this I found but few, and none at all in the subjacent argillaceous layer.

The four fragments of the skeleton of *Pithecanthropus* were found in different years, because, on account of the rise in the river during every rainy season, the excavations were necessarily suspended and could not be resumed until the next dry season. Besides, in the same working season one fragment was found later than the other, because the stone had to be removed cautiously in layers and by marked-off areas.

The four fragments were, however, found at exactly the same level in the entirely untouched lapilli stratum (fig. 1). They were therefore deposited at the same time; that is to say, they are of the same age. The teeth were distant from the skull from 1 to, at most, 3 meters; the femur was 15 meters away. The quite sharp relief of their surface does not support the theory that they have been washed out from some older layer and then embedded for a second time. They were found at the place of their original deposit. Besides they all show exactly the same state of preservation and of petrefaction as do all other bones that have been taken from this particular stratum at Trinil.<sup>1</sup> Their specific gravity (sp. gr. of compact tissue=2.456) is much greater than that of unpetrified bones (sp. gr. of compact tissue=1.930). The femur weighs 1 kilogram, therefore considerably more than double the weight of a recent human femur of the same size; the medullary cavity is partly filled with a stony mass. The eroded upper surface which the skullcap and not the femur shows occurred in the bed where it was found, appearing on many bones excavated near the skullcap, and is caused by infiltration of water through the cliff at that place.

Associated with these bones I also found very numerous remains of a small axis-like species of *Cervus*, frequently, also, the remains of *Stegodon*. Farther away were found *Bubalus*, apparently identical with the Siwalik species, *Leptobos*, *Boselaphus*, *Rhinoceros*, *Felis*, *Sus*, *Hyana*, that all appear to be of new species. Of species found in other situations of the same stratum I will mention a gigantic *Manis*, more than three times the length of the existing Javanese species; a *Hippopotamus*, belonging to the same subspecies, *Hexaprotodon*, as the forms from the Siwalik and Narbada strata of western India.

Upon the evidence of these remains I determined that the four skeletal

<sup>1</sup>The color of the femur is also of the same chocolate brown as that of the calvarium. The latter appears to be somewhat different because it has been prepared with varnish for taking a cast.

Parent Elephant Africa

India

Buffalo



fragments were of exactly the same age, and very probably early Pliocene. Further, these remains, in connection with the anatomical investigation of the skeletal fragments, have firmly convinced me that these fragments are all parts of one and the same skeleton. The total result of the discussion of these fragments that has been carried on by many eminent anatomists in no way contradicts this conclusion; on the contrary, it raises the presumption that it is highly improbable that they do not belong together.

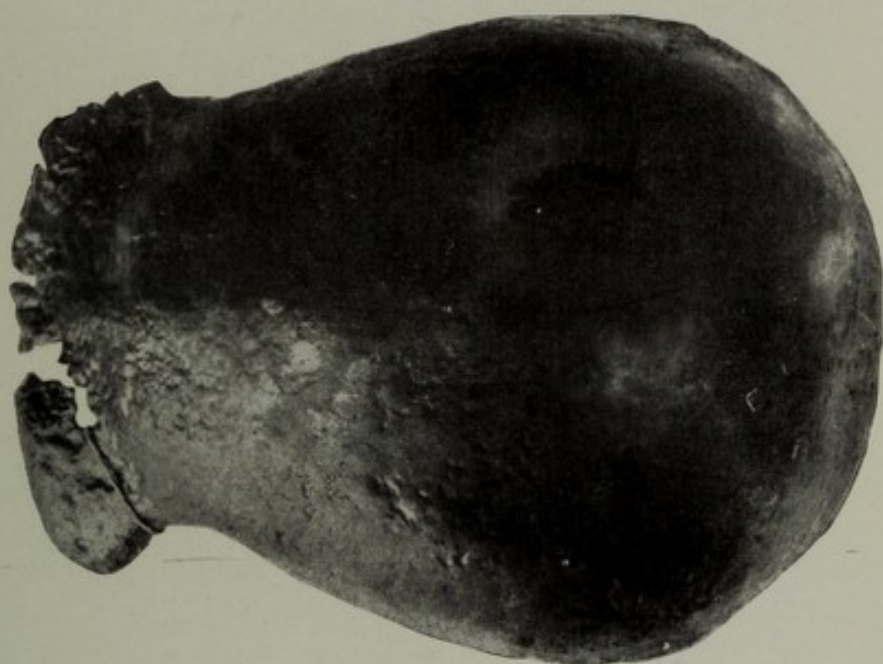
A few anatomists hold that the fragments are parts of a human skeleton; according to others there is no doubt but that they belonged to individuals of the same race. Others, again, consider the femur to be quite human, while they think that the skullcap and the teeth must have belonged to the most anthropoid of all anthropoid apes. A few anatomists, however, agree with me in the opinion that a femur entirely human in character might nevertheless belong to the same individual as this ape-like skull, because a similar function would entail a similar form. Besides, this femur has certain peculiarities that I have not been able to find in a single one of some hundreds of thigh bones, so that it is not human in the usual sense of the word.

If we adopt the view that the skullcap is that of an ape, and, indeed, as must be acknowledged, that of the most man-like of all, but that the femur is that of a man, then both of these fragments must have been deposited at the same time in what was very probably an early Tertiary bed. We would then have in this case two specially important, but wholly unknown, closely related forms found together. Now, on the one hand, human bones have never been recognized below the Middle Pleistocene, much less as low as the Tertiary, and, on the other, but few remains of apes have been found, and these are much smaller, more significant, and by no means as human in character as the skullcap in question. There is therefore little probability that this view is correct. The view that these fragments were derived from different individuals of one and the same race has also very little to support it. After explorations which have been extended for five years over hundreds of square kilometers of exposed strata more than 350 meters thick and containing everywhere a numerous and homogeneous fauna, I have found, with but one possible exception, nothing which could be referred to this or any similar race.

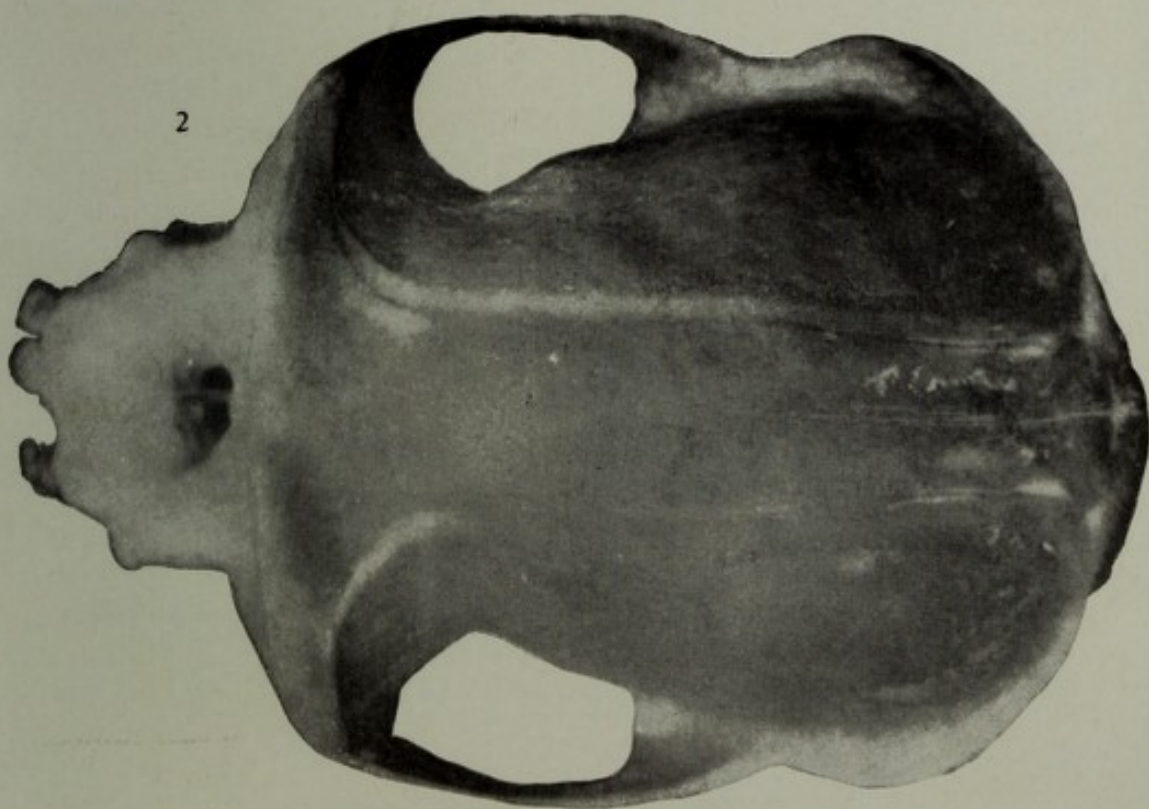
According to all paleontological experience, the parts must have belonged to a single skeleton in case their anatomical configuration does not contradict such unity of origin. This is, however, not the case. The considerations advanced by many anatomists on this subject lead, when taken together, really to no other conclusion than that the fragments were derived from one individual. The more I myself have studied these fragments the more firmly I have been convinced of this unity of origin; and at the same time it has become ever clearer to me that they are really parts of a form intermediate between men and apes,



1

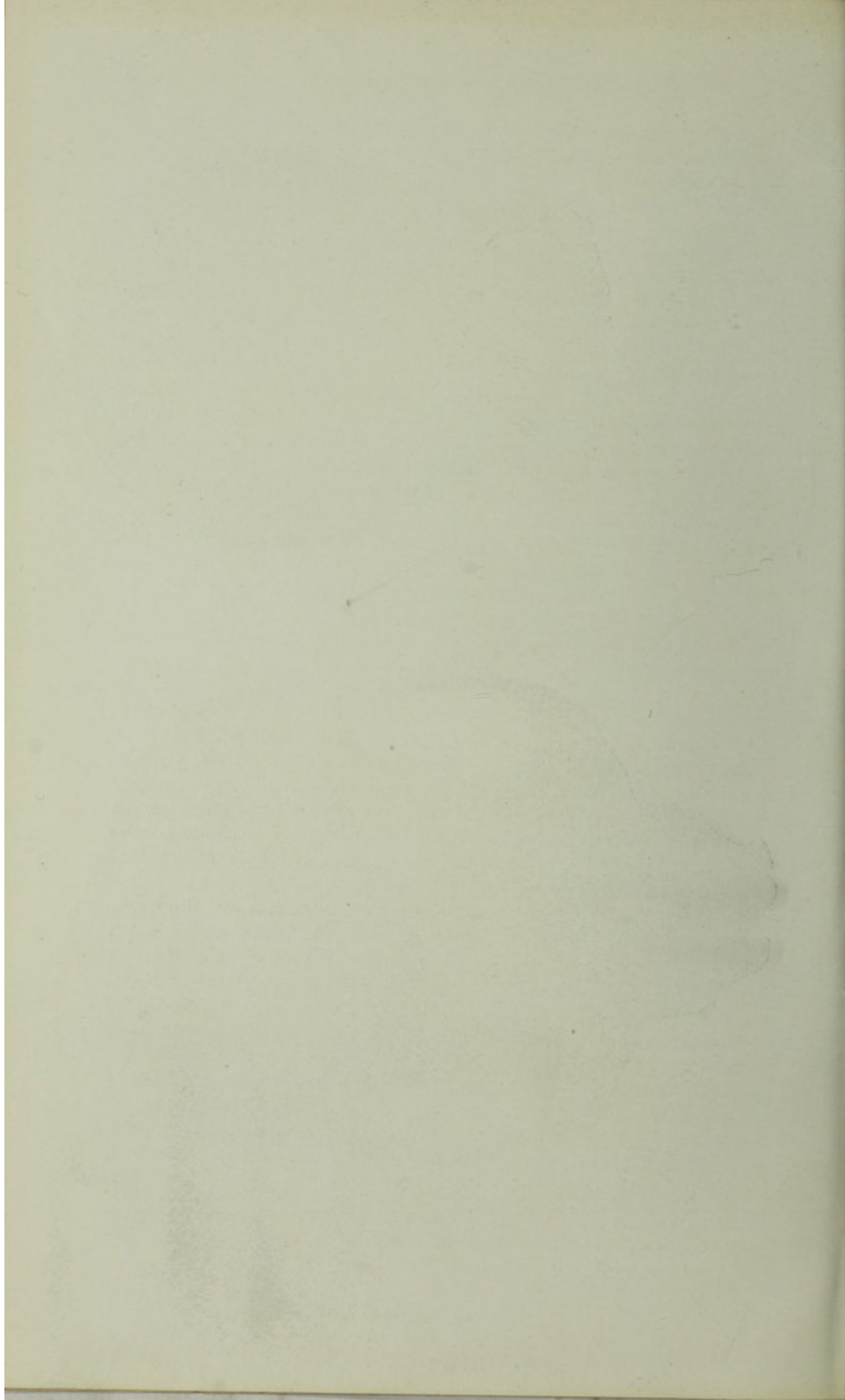


2



1. *Pithecanthropus erectus*, Dubois, skull cap, from above, after photograph. One-half natural size.
2. *Anthropopithecus troglodytes*, Gmelin, adult female, skull from above, after photograph. Two-thirds natural size.





which was the ancestral stock from which man was derived. They all show, though in somewhat different degree, intermingled human and ape-like characters.

#### I.—THE SKULLCAP.

In the form of the skullcap similitude to that of the ape is undoubtedly predominant. Never yet has there been seen so flat and low a human skull, never yet, outside of the true apes, has so strong a projection of the orbital region been found. The skulls of Neanderthal and Spy and all microcephalic skulls are more highly vaulted, especially in the parietal region; the ratio between the central portion of the skull and the orbital part lying in front of the temporal fossa is quite the same as in the apes, differing widely from that of the lowest human skulls, even that of Neanderthal and those of microcephali. Virchow has referred especially to this. It can be seen only on the left side, the right having suffered a notable loss of substance. The part of the wall of the orbit that lies in front of the deepest portion of the temporal fossa and belongs to the zygomatic process (external angular process) of the frontal bone is, in its antero-posterior dimension, about twice as large as that of the most ape-like human skulls. Further, it would be difficult to find in a human skull so strongly developed a *torus occipitalis transversus* as that of the Javanese skull, and the lower part of the *squama temporalis* of that specimen retreats outwardly, as it does in the apes.

Those who have followed the history of the Neanderthal skull are aware that there has never existed regarding it such divergence of opinion as to its man- or ape-like qualities as has arisen concerning the Pithecanthropus. The two opposed views in that case were: Ape-like man or diseased man; the native of the Neanderthal has from the very first always been considered as an undoubted, real man. The human character of the Pithecanthropus is, however, very questionable. The skull of the gibbon almost doubled in size would not be very different from it in external appearance.

Its considerably greater size constitutes a significant difference between it and all other skulls of apes. In the length and breadth measurements of the skull the chimpanzee is exactly a mean between it and the largest gibbon. Its cranial capacity I estimated in my above-mentioned description, according to a comparison of the external lineal dimensions, as about 1,000 c. cm. Estimating now upon a more recent comparison of the internal linear dimensions with those of gibbons' skulls makes it but little more than 900 c. cm.<sup>1</sup> A capacity of 900 c. cm. is, however, far above anything we know in the skull of apes. The largest skulls of anthropoid apes have, on the average, no greater capacity than about 500 c. cm., and it is very seldom that they have been found to attain the capacity of 600 c. cm.

<sup>1</sup> Besides the method of estimating the capacity which I detailed in my last description, and which I again applied after removing the siliceous matter from the



Disregarding this, some believe that the skull may have belonged to a true ape. If we should imagine the skull of *Hylobates agilis* to have somewhat more than doubled its mass, we should have a skull of a similar great ape. But if in actual fact a *Hylobates* had reached such a size, it is quite certain that his cranial capacity would not have increased in the same degree, for we continually find in the most diverse families that large animals have relatively smaller brains than smaller allied species. For example, the dwarf antelope (*Nanotragus pygmaeus*) has in proportion to its bodily weight more than four times as much brain as the Beisa antelope.<sup>1</sup> The smaller lower apes very much surpass in this respect the large anthropoid apes, and the gibbons possess, in proportion to their bodily weight, at least twice as much brain as the great anthropoids.<sup>2</sup>

Such an imaginary gigantic *Hylobates* would be about as tall as a man and about as heavy as the great anthropoids. Its cranial capacity would therefore not exceed some 500 c. cm. But this is only a little more than that of *Pithecanthropus*. A true ape with a capacity of 900 c. cm., must, on the contrary, be a giant besides which the largest gorillas would be dwarfs. Even if the bodily size increased only in

---

cavity of the skullcap so that I could compare the dimensions of the cranial cavities, two other methods were also used by me, as follows:

A. (1) The external volume of a skullcap above a plane passed symmetrically through the glabella and the external occipital protuberance was determined. (2) Its surface was found by weighing a tin-foil covering that had been spread over it. (3) Its internal capacity was approximately determined by deducting from the value found under (1) the product of the surface found under (2) with the medium thickness of the skull plus the volume of the frontal sinuses. From the result thus obtained (540 c. cm.) the capacity of the entire *Pithecanthropus* skull was established by (4) comparing with it skulls of *Hylobates* of as similar build as possible, whose skullcap capacity and total cranial capacity has been determined by direct measurement.

B. After the siliceous matter had been for the most part removed from the skullcap, this was also directly measured by filling it up to the above-mentioned plane with mustard seed and adding to this volume the estimated volume of the siliceous matter yet remaining. I found that the above-mentioned portion of the cavity of the skullcap measured about 550 c. cm. The cast of the cavity of the Neanderthal skull taken to the same plane measures 750 c. cm.

It is well known that Huxley estimated the entire capacity of the Neanderthal skull at 1,236 c. cm. The ratio of the capacity of the skullcap to that of the entire skull is, therefore, 3:5. In a skull of the *Hylobates agilis*, which, though only half the size, strikingly resembles that of *Pithecanthropus*, I find the same ratio.

According to all these methods, the total cranial capacity of the *Pithecanthropus* skull is found to be 900 c. cm., or somewhat more. The difference between this and my earlier estimates (compare also the *Verhandl. der Berliner Gesellschaft für Anthropologie*, 1895, p. 728) depends upon this, that in the first I did not allow sufficiently for the thickness of the skull (it is about 6 mm.), and secondly I could not directly compare the cavity of the skullcap.

<sup>1</sup> According to Max Weber, *Waarnemingen over het hersengewicht van zoogdieren*. *Bijdragen tot de Dierkunde*, Amsterdam, 1888, p. 14.

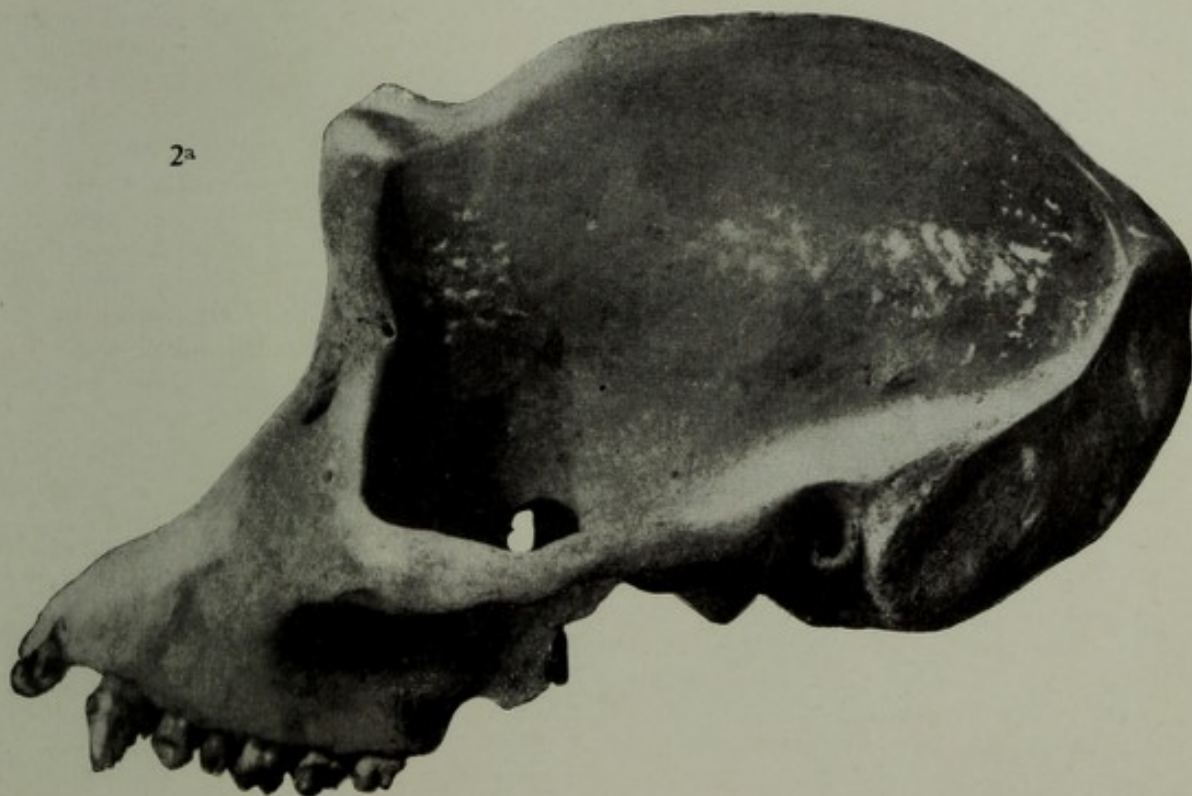
<sup>2</sup> Compare the statements of Owen, *Comparative Anatomy*, Vol. III, p. 143, and M. Weber, *Zool. Ergebnisse einer Reise in Niederländisch Ost-Indien*, pp. 99, 100.



1a

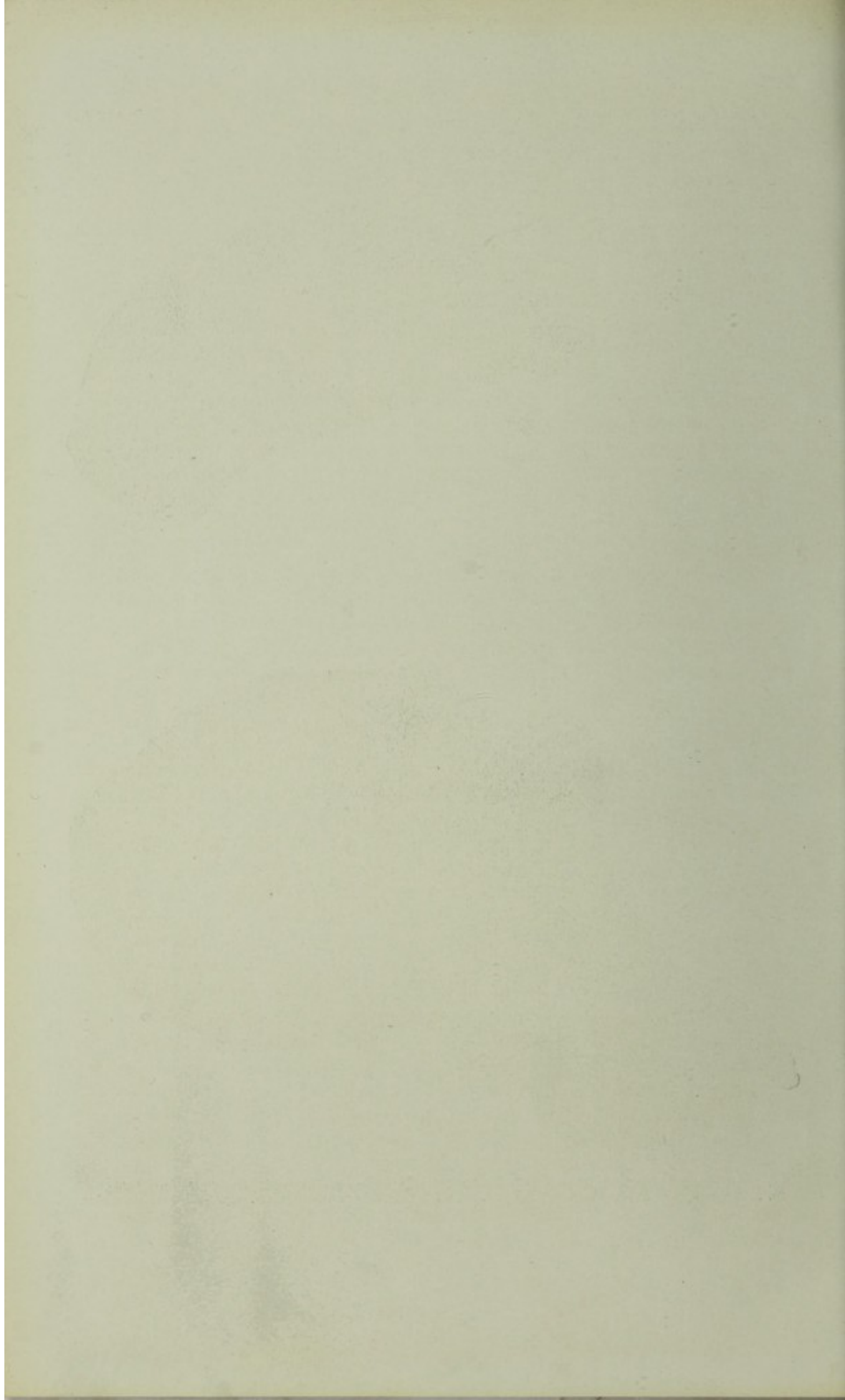


2a



1a. *Pithecanthropus erectus*, Dubois, skull cap, from left side, after a photograph. One-half natural size.  
2b. *Anthropopithecus troglodytes*, Gmelin, skull, from left side, after a photograph. Two-thirds natural size.





the same ratio as the cranial capacity, the animal would have a body almost twice as large as that of a large gorilla. But the bodily size increases in a greater ratio than that of the brain and the cranial capacity, so that it may be assumed that the size of an anthropoid ape having a cranial capacity of 900 c. cm. would be at least three times as large as that of a large gorilla; that is to say, about as large as a pretty large horse. It is not easy to imagine an ape like that leading the tree life of the nimble *Hylobates*.

The cerebral portion of the skull of such a gigantic ape would, in relation to the rest of the body, be much smaller than that of the gorilla. This relatively small cranial capsule would have all the provisions for the attachment of a powerful masticatory apparatus for furnishing nourishment to the gigantic body, such as is shown by the skull of a gorilla, but in a much greater degree than in this living gigantic ape. For a jaw of such mighty proportions, which would be much larger in mass than the whole of the rest of the skull, there would have to be a zygomatic arch much more extensive and more strongly vaulted than that which the gorilla possesses. Upon the skullcap there would have been formed strong bony ridges for the attachment of the temporal muscles, and these ridges would certainly have formed crests in the middle and behind. The orbital rims would have been raised in a much more striking manner than is seen in the gorillas' skull, and the impression of the bestiality of such a gigantic ape would have been much greater.

We see, however, nothing of this in this fossil skull. It is as smooth, even, and destitute of crest as the skull of an ordinary gibbon.

The skullcap, therefore, in spite of its ape-like appearance, can not have belonged to an ape, because in its excessive capacity it is dissimilar to both a gibbon's skull and that of a great gorilla.

There are, however, some features that separate this skull from that of the apes of the Old World and ally it to that of men. These concern the occiput. As already remarked above, there is a peculiar formation occasioned by the abrupt separation of the *planum nuchale* from the upper part of the *squama occipitalis*, determined by the *torus occipitalis transversus*, which is certainly a pithecoïd feature; compare the inclination of the *planum nuchale* to a plane formed symmetrically through the most prominent part of the glabella and of the external occipital protuberance, and it will be seen that in this respect there is a great difference between this skull and those of all the apes of the Old World. The most diverse species of the latter show a slighter variation with each other regarding the angle between the nuchal plane and the glabello-protuberantial plane than is shown between them and the fossil skull. Among the anthropoids I find not more than three degrees of variation; in *Semnopithecus maurus* the inclination of the nuchal surface is  $4^{\circ}$  less, and in *Macacus cynomolgus* it is  $10^{\circ}$  less than the minimum among the anthropoids. In the Java skullcap,



however, it surpasses the maximum of anthropoids by  $18^{\circ}$ , being, nevertheless, but  $9^{\circ}$  below the Spy skull No. 2, and about  $12^{\circ}$  below the usual angle in recent human skulls.

The apes of the New World are in this respect much nearer to man than even the anthropoids. In an *Ateles beelzebuth*, for example, I find the angle of inclination of the nuchal surface  $11^{\circ}$ , in a *Cebus niger*  $7^{\circ}$  greater than the maximum of anthropoids. Indeed many other things in their cranial formation are more similar to that of man. The platyrrhines stand, however, so far from man in other respects that they are excluded from any closer comparison. In any case there is in this

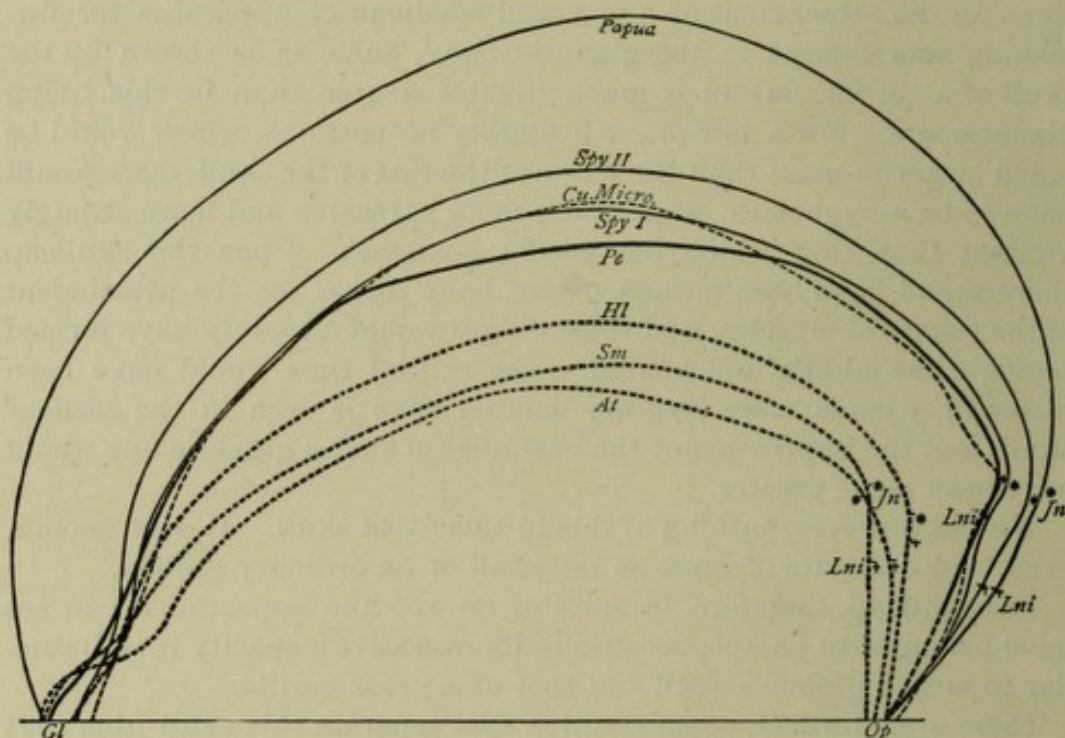


FIG. 2.—Profile curves of the skulls of *Pithecanthropus erectus* (Pe), a Papuan, the Spyman (I), Cunningham's microcephalous Joe, *Hylobates leuciscus* (Hl), *Anthropopithecus troglodytes* (At), and *Semnopithecus maurus* (Sm). Glabella (Gl), Opisthion (Op). Linea nuchae superior (Jn). Linea nuchae inferior (Lni). (Figure from Transactions of Royal Dublin Society, February, 1896.)

feature not an accidental but an essential difference between the anthropoid skull of Java and those of the anthropoid apes.

In man the strong forward inclination of the nuchal portion of the occipital bone is considered to have a relation to the upright position. I can not see why it should not be interpreted in the same way in the fossil skull under consideration.

By the removal of the siliceous matter from the interior of the skull-cap, which was at first partially and afterwards quite completely effected, it was shown that the *sulcus transversus* of the occipital bone, which, as place of attachment for the tentorium, marks the boundary between the cerebrum and the cerebellum, lies at about the same relative distance from the superior curved line of the bone as it does in the



gibbons.<sup>1</sup> By laying bare the *sulcus transversus* we have obtained a more fixed point of departure for measuring the height of the skullcap as an expression of the relative extent of the cerebrum. Accordingly, we find that the skull of Pithecanthropus was almost as highly vaulted as that of the Spy and Neanderthal men, remaining, however, far below the vaulting of the skulls of recent men. The exceptionally highly vaulted skull of Hylobates agilis, inclosed, however, a cerebrum that reached nearly to the upward curve of the Neanderthal man. The remaining apes fall in regular series. Cunningham's microcephalous boy Joe has a flatter brain than the gibbon and the chimpanzee.

The breadth indices of the skulls represented here are about the same; therefore the height of each profile curve is an approximate measure for the relative sizes of the cerebrums.

If, then, the former possessor of this cranium was not an ape, and if he possibly walked erect, must he then have been a man?

I think that the ape-like form of the skullcap and its capacity, too small for a man, can not be brought to harmonize with such a conception. Even Cunningham, who has examined the skull, and is convinced that it is human, finds that its ape-like characters greatly predominate, and that there is nothing human about it except its excessive size for an ape. Virchow has also, after a personal examination of the skullcap, very clearly adjudged it, in Leyden and Berlin, as the skull of an ape. So experienced a craniologist as Hamy, in Paris, said, after examining the same, that he never would have supposed it to be human. On the contrary, the most ape-like human skulls that are anywhere known, the Neanderthal, the Spy, and the Australian skulls, were not considered by any as apes. It was only questioned concerning these skulls whether or not their resemblance to the pithecoids should lead us to give to that race a higher phylogenetic significance.

According to the conception which we have of the human skull, the Java skullcap is certainly not a human relic.

But the size also is not adapted to that of the human skull. For it is quite inadmissible to suppose that we are here dealing with a microcephalous skull, not only on account of the great improbability of such a view, but also because its form is quite different. We are certainly acquainted with normal human skulls of an equally small capacity; but

<sup>1</sup> As I have been able to remove only a quite small portion of the siliceous matter from the cavity of the skullcap, I, as well as others, had erroneously (as now appears, misled by its different position on the right and left sides) taken the lower edge of the *sulcus transversus* for its upper one. I now find that it lies considerably higher than I had at first supposed. On the other hand it appears from an examination of a large series of gibbon skulls that the average distance from the superior curved line is somewhat greater than I had previously stated. My present data are therefore more correct than those given in the *Verhandlungen der Berliner Gesellschaft für Anthropologie* 1895, p. 731. The similarity to the gibbon is therefore much greater.



these appear less "bestial" the smaller they get, while, on the contrary, the very "bestial" Neanderthal and Spy skulls are very large. The smaller the absolute size of a cranium is, within the same species of mammals, the more significant is its relative size as compared with the rest of the body, and the more reduced are those features of the cranium that have directly to do with the size of the body and are especially related to the skeleton of the face. It is exactly these features that constitute the bestial marks of any skull.

A skull that in comparison with that of normal man is so small and so ape-like in its form that it is declared by not a few experienced anatomists to be the skull of an ape, can not be human!

The fossil skullcap has been, with more or less strong conviction, interpreted as follows:

As that of an ape by—	As that of a man by—	As an intermediate form by—
R. Virchow. <sup>1</sup>	W. Turner. <sup>6</sup>	E. Dubois. <sup>13</sup>
W. Krause. <sup>2</sup>	D. J. Cunningham. <sup>7</sup>	L. Manouvrier. <sup>14</sup>
W. Waldeyer. <sup>3</sup>	A. Keith. <sup>8</sup>	O. C. Marsh. <sup>15</sup>
O. Hamann. <sup>4</sup>	R. Lydekker. <sup>9</sup>	E. Haeckel. <sup>16</sup>
H. Ten Kate. <sup>5</sup>	Rud. Martin. <sup>10</sup>	A. Nehring. <sup>17</sup>
	P. Matschie. <sup>11</sup>	R. Verneau. <sup>18</sup>
	P. Topinard. <sup>12</sup>	A. Pettit. <sup>19</sup>

<sup>1</sup> Verhandl. Berl. Anthropol. Ges. 1895, pp. 81, 336, 435, and Die Nation, 1895, No. 4, p. 53.

<sup>2</sup> Ibid., p. 78.

<sup>3</sup> Ibid., p. 88, and Anthropol. Congress, Kassel, 1895.

<sup>4</sup> Gegenwart, Januar, 1895, p. 5.

<sup>5</sup> Nederlandsch Koloniaal Centraalblad, 1895, p. 128.

<sup>6</sup> Journal of Anatomy and Physiology, 1895, vol. 29, pp. 424-445.

<sup>7</sup> Nature, vol. 51, 1895, pp. 428-429.

<sup>8</sup> Science Progress, 1895, vol. 3, pp. 348-369, and Proceed. Anat. Soc. February, 1895.

<sup>9</sup> Nature, vol. 51, 1895, p. 291.

<sup>10</sup> Globus, Bd. 67, 1895, pp. 213-217.

<sup>11</sup> Naturwissenschaftl. Wochenschr., Bd. 10, pp. 81, 82.

<sup>12</sup> L'Anthropologie, 1895, tome 6, No. 5, pp. 605-607.

<sup>13</sup> Jaarboek v. h. Mynwezen in Nederlandsch Indie, 1892. Pithecanthropus erectus, etc., Batavia, 1894. Leidener Zool. Congress, September 21, 1895. Roy. Dublin Society, November 20, 1895. Anthropol. Institute of Great Britain and Ireland, November 25, 1895. Berliner Gesellschaft f. Anthropol., December 14, 1895, etc.

<sup>14</sup> Bulletin Soc. d'Anthropol. de Paris, 1895 (6), 6, p. 12; 47 Revue Scientifique, série 4, tome 5, Mars 7, 1896, pp. 289-299.

<sup>15</sup> American Journal of Science, 1895, vol. 69, pp. 144-147.

<sup>16</sup> E. Haeckel, Systematische Phylogenie der Wirbeltiere, Berlin, 1895, p. 633.

<sup>17</sup> Naturwissenschaftl. Wochenschr., 1895.

<sup>18</sup> L'Anthropologie, 1895, tome 6, pp. 725, 726.

<sup>19</sup> Ibid., p. 726. Earlier (ibid., pp. 65-69) he considered it as human.

In opposition to the view of the human character of the fossil skull, the two other views taken together constitute a majority, which certainly would be considerably greater, namely, by an increase of the pithecanthropists, if all the learned people who have expressed an opinion upon this fundamental specimen had openly published their views about it. It may also appear questionable whether this majority might not be increased through later expressions of the authors above cited.



For example, Cunningham is now of the opinion that the fossil skull belonged to an individual with strongly marked simian characters.<sup>1</sup> He might on this account be properly placed under the first category.

In a praiseworthy manner Manouvrier,<sup>2</sup> in a recently published figure, has undertaken to restore the skull of *Pithecanthropus* according to the cast. Before this I had tried the same thing, especially for my own satisfaction, in order that I might be clear as to the result of such an unprejudiced restoration. After the emptying of the skullcap I have now tried it again. The fact that I have arrived at different results

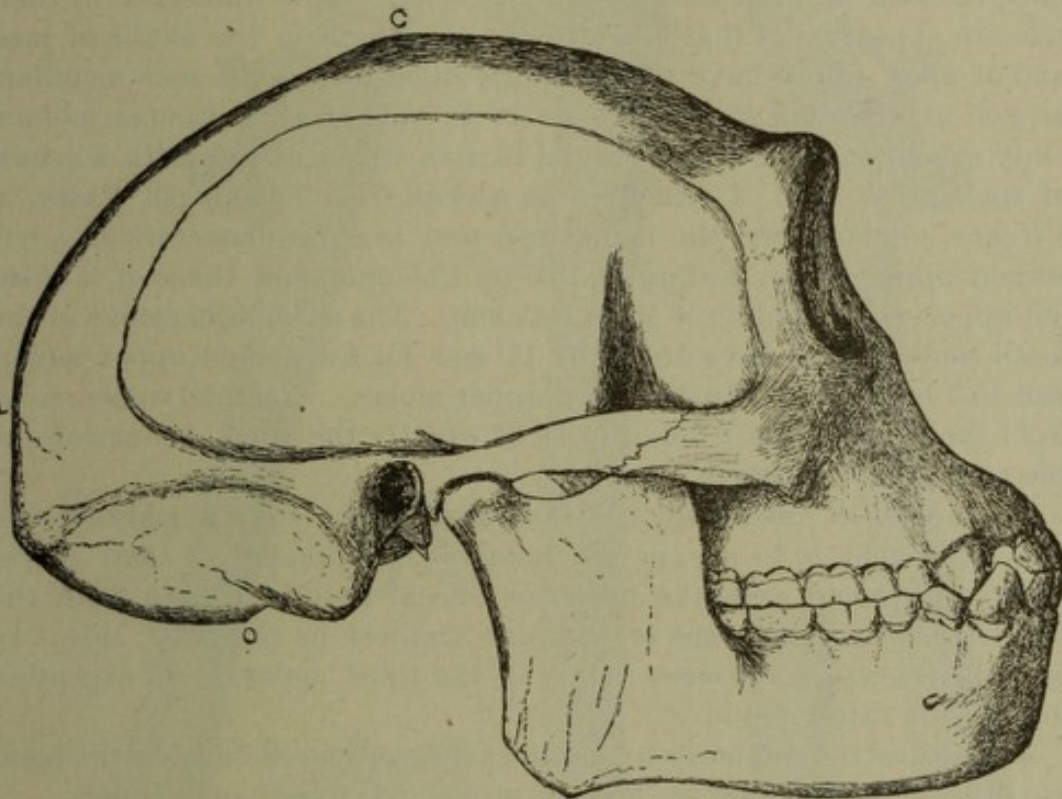


FIG. 3.—Attempt at a restoration of the skull of the *Pithecanthropus erectus* half the natural size C, coronal suture; O, foramen magnum.

The following corrections should be made in this figure: The point O (posterior border of the foramen magnum) is about 3 mm. (in the half-sized figure; in nature, therefore, 6 mm.) too high. Also the posterior part of the *Linea temporalis* is about 3 mm. (in natural size about 6 mm.) too low.

than those of the worthy Parisian anthropologist in some not unimportant points arises chiefly from this, that I had resort to the emptied fossil skullcap itself for the restoration, which caused me to consider the temporal and occipital regions somewhat differently from what Manouvrier did. It is this that induces me to now publish my restoration also.

Especially of the temporal region I will again say that it has the very greatest similarity to that of the adult gibbon, and indeed the entire skullcap, with the exception of the strongly inclined *planum nuchale* of

<sup>1</sup> *Nature*, vol. 53, 1895, pp. 116 and 296.

<sup>2</sup> *Revue Scientifique*, série 4, tome 5, Mars 7, 1896, p. 294.



the occiput, has the greatest likeness—only being double the size—to the highly vaulted skull of a gibbon. It is not strange, therefore, that I have made the facial portion of the skull not very different from that of the gibbon.

## II.—TEETH.

The teeth, a left second upper molar and a third right upper molar, belong, if we may judge from the circumstances of their discovery, to each other and to the skullcap. They are also modeled in a very similar manner and are in the same state of preservation and of petrification. The unequal wear of their crowns and the considerable difference in their size are appearances that can often be seen both in the skulls of men and of apes. Both have very strongly diverging roots, such as others as well as myself acknowledge never to have seen in human molars. Only exceptionally are there found in man upper molars with a crown of such great size. I measured on a skull from New South Wales, in Virchow's laboratory, the transverse and sagittal diameters of a left second upper molar, finding it 15.5 by 12.5 mm., and those of a third left upper molar, finding it 15 to 10.5 mm. The same dimensions of the fossil molars from Java are 14 by 12 mm. for the second upper molar, and 15.3 by 11.3 mm. for the third upper molar. A second upper molar from the cave of Spy I found to be of exactly the same dimensions as the molar from Java.

In the form of the crown the Javanese molars show a marked ape-like type; that is to say, in the relative development of their cusps. As in anthropoid apes, the posterior buccal cusp is in both teeth the smallest, so that the cusps of both are smallest on the outer side. In man the reverse is the case. Only in the third molar is an exception to this rule rarely found.

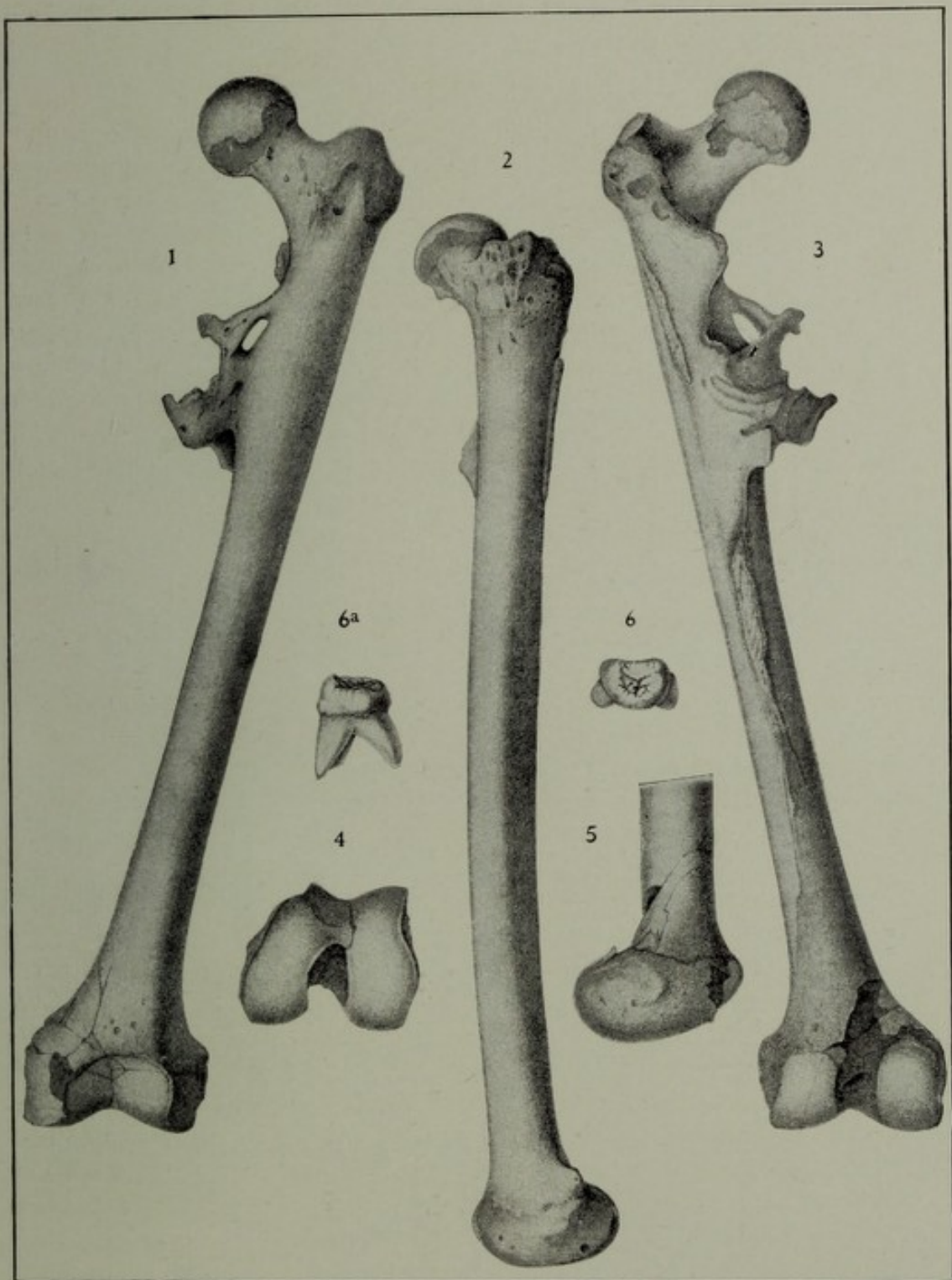
An exhaustive comparison has, however, convinced me that the teeth are in no closer relation to those of any of the living anthropoids.

In spite of all their simian characters, both, especially in the third molar, show a strong retrogression of the crown, such as is more frequently found in man than in the anthropoid apes. According to this the general arrangement of the dental arch must have been widely different from that which obtains with the great anthropoid apes. Comparing the size of the teeth with that of the skull, the proportion is found to be the same as that in the gibbon, but somewhat less than that which prevails with the anthropoid apes. They therefore agree very well with the smooth, crestless skullcap.

## III.—FEMUR.

The femur was quite generally declared to be human by authors who had closely examined either the actual specimen or drawings of it. It has, as before mentioned, a very deceptive resemblance to the human femur. It differs from the latter, however, and that difference is as

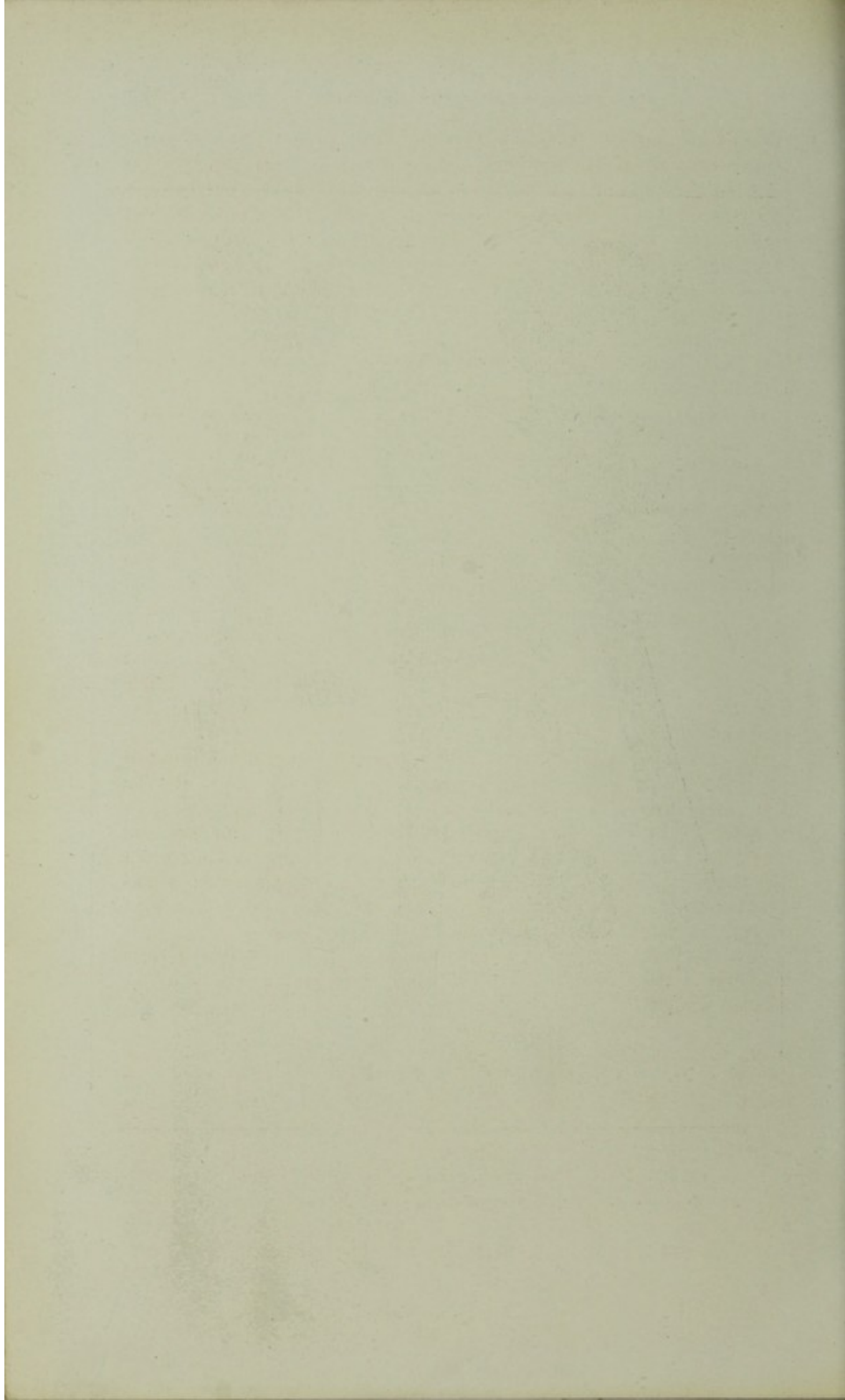




PITHECANTHROPUS ERECTUS.

Left femur: 1, From before; 2, from side; 3, from behind; 4, from below; 5, lower end from median side. 6, Right 3d upper molar, from below; 6a, from behind.





great as that between bones of the same name in different but somewhat related species of mammals having a similar locomotion, as, for instance, *Colobus* and *Semnopithecus*, *Cervus* and *Antilope*. The most important difference concerns the form of the diaphyses in the popliteal region. It is much rounder than in man. The *planum popliteum* is therefore less extensive and more convex, so that exactly in its middle a kind of swelling extends as far as the neighborhood of the condyles. In the human femur the most projecting portion of the popliteal region is in the neighborhood of the lateral lip of the *linea aspera*. In the fossil femur, on the contrary, that lip is situated more on the lateral surface of the shaft.

After examining hundreds of human femora, Manouvrier could find only two that had a somewhat similar shape. It is therefore a very rare form in man. With the gibbon a similar form normally occurs, the median convexity in this species being, however, somewhat higher. This may be explained by the peculiar insertion of the femoral head of the biceps femoris that occurs in this species, it being attached in the middle line below the adductor magnus in close connection with the vastus internus. An extension of these conditions might, as Dr. Hepburn has pointed out to me, produce the median convexity of the entire popliteal region which we find in the fossil femur. In man the popliteal space becomes flattened by reason of the wide separation of the medial and lateral muscles in this region. In those isolated cases of a similar formation, found in an examination of hundreds of femora, there may have been a simian form of muscular attachment.

The exostosis of the fossil bone—considered by me as the result of a traumatic periostitis, and by Virchow as caused by a psoas abscess that had descended from along the spinal column—appears as a so-called tendinous or aponeurotic deposit of osseous tissue, such as occurs not very infrequently in man and is also to be seen, though in a less degree, on the humerus of the skeleton of an orang-outang in the Dresden Museum. This pathological formation has no significance as regards the systematic determination of the bones.

It has been generally allowed by everyone that the femur must have belonged to an animal that walked erect. The circumstances under which it was found, in the neighborhood of the skullcap, make it very highly probable that both belonged to the same individual; and now, since we have shown that the anthropoid skullcap may not have belonged to an ape, but possibly to a being that walked upright, this probability increases quite to certainty, for this reduces the deficiency in human characters which the skullcap showed when compared with the femur. The femur is not human in the usual sense, for it, as we have seen, shows features that occur only very seldom in human femora. Besides, the similarity of form may, as before stated, be sufficiently explained by a similarity of function, so that an entirely human form of femur need not necessarily have belonged to a man,



but be found likewise in some other genus. Only an examination of the entire skeleton could give a complete solution to this question.

According to the relative proportions of these parts they can not both have belonged to an ape. For an ape with such a cranial capacity would, as we have seen, have been a giant, whose femur would certainly have been much larger than twice the size of that of a siamang. But a man with a cranial capacity of 900 c.cm. would have a shorter femur; for all men, except microcephali, that have so low a capacity as this have a much smaller stature than that of 165 to 170 cm., which is the height of the individual, as calculated from the length of this femur according to human proportions. This is again an evidence that the individual in question was, in the anatomical sense, neither an ape nor a man.

With the length and breadth measurements of the skull, however, the length of the femur agrees very well, both from a human and anthropoid point of view. A man with a skullcap of these dimensions could well have had a femur of that size, and if we conceive the proportions of a siamang to be doubled, the length and breadth of the skull and the length and breadth of the femur will exactly correspond with that of *Pithecanthropus*.

Nothing contradicts the view that the possessor of this cranium had a body to which this femur belonged. The skull requires exactly such a femur and no other.

As, therefore, from different points of view, probability speaks most strongly in favor of the common origin of these fragments, it is carrying skepticism too far to longer doubt that both of them, and the teeth as well, belonged to one skeleton.

I believe that it now hardly admits of a doubt that this upright-walking ape-man, as I have called him, and as he is really shown to be after the most searching examination, represents a so-called transition form between men and apes, such as paleontology has often taught us to recognize between other families of mammals; and I do not hesitate now, any more than I formerly did, to regard this *Pithecanthropus erectus* as the immediate progenitor of the human race. This is my conviction after the most careful testing of the matter, and has only become stronger after having submitted the specimens to many anatomists.

The exact position to be assigned to the ape-man in a system is more or less a matter of taste. According to the anatomical characters ordinarily used to separate the groups of mammals, we must at any rate exclude it from the genus *Homo*. Unless we considerably change and extend the characters that have hitherto been considered good for the family of the *Hominidæ*, it can not even be admitted there. Quite the same may be said of the *Simiidæ* and its species.

The relation of man and of *Pithecanthropus* to extinct and living apes are here shown in the form of a family tree (fig. 4).



This tree is partly an expansion of that of the primates as given by Haeckel.<sup>1</sup> To *Dryopithecus* I have, according to Gandry's recent view,<sup>2</sup> given a place between the *Cercopithecoidea* and the *Simiidae*. As I have already stated in my first description, I regard as the progenitor of all anthropoid apes *Protohylobates*, a highly generalized hypothetical form, which, as well as its nearest living relatives, *Hylobates*, retained, along with many human peculiarities, yet many characters from its monkey-like ancestors that came lower in the scale. As immediate

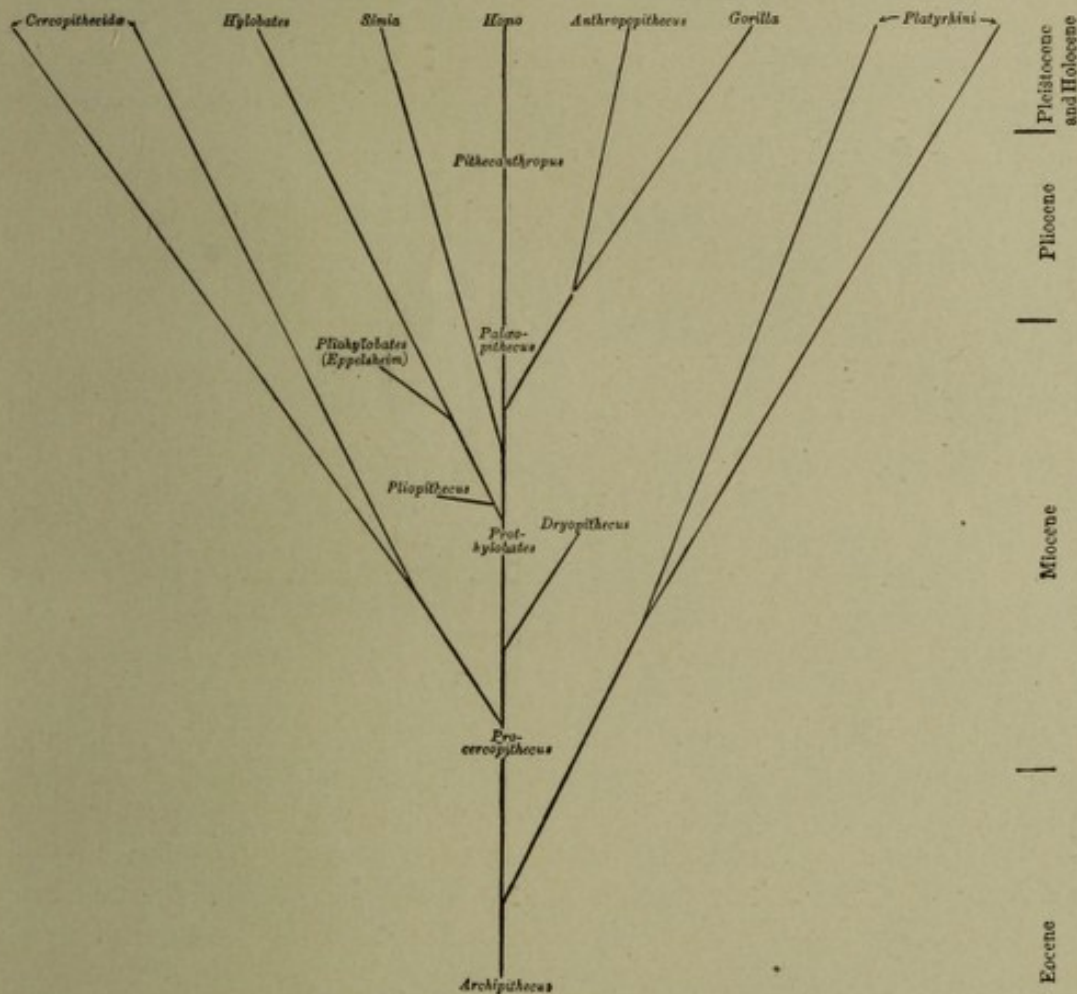


FIG. 4.—Family tree of man and apes.

ancestor of *Pithecanthropus* I have placed *Palaeopithecus* of the Siwalik strata. In this also, as I have convinced myself after a careful examination of the type specimen in the museum at Calcutta, are the characters of *Hylobates* mingled with those of man. We first find in *Pithecanthropus erectus* a form in which the human characters preponderate.

<sup>1</sup> E. Haeckel, *Systematische Phylogenie der Wirbelthiere*, Berlin, 1895, p. 601.

<sup>2</sup> A. Gandry, *Comptes rendus de l'Académie des Sciences*, T. 110, Paris, 1890, pp. 373-376.



