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On PITHECANTHROPUS ERECTUS: a TRANSITIONAL FORM between MAN and the APES. By DR. EUGENE DUBOIS. (Abstract.)¹

MANY years ago, Dr. Dubois said Junghuhn and others had discovered fossil remains in Java. With the object of continuing the work of exploration, he (Dr. Dubois) had been employed by the Dutch Indian Government to make further investigations. During the years 1890–95 he had been successful in obtaining a large quantity of remains of mammals and reptiles, belonging mainly to extinct species, closely allied as one might expect to the later Tertiary and Pleistocene faunæ of India.

The chief localities in which these discoveries were made are in the southern slope of a low range of hills, called the Keudengs, which extends for about 60 miles between the residences Kediri, Madiun, and Surakarta on the one side, and Rembang and Samarang on the other.

The area in which these vertebrate remains are abundantly found has, in many places, a breadth averaging from one to three miles. The specimens discovered were lying in beds of cemented volcanic tuff, consisting of clay, sand, and lapilli stone. The very general occurrence of the remains of fresh-water animals in these beds and their arrangement in what English geologists call current-bedding or false-bedding prove conclusively their fluviatile origin. The strata throughout the whole area have undergone considerable disturbance by folding, the result of which has been to give them a general southerly dip of 3° to 15°. The whole formation reaches a maximum thickness of more than 350 metres.

The strata rest unconformably upon beds of marine marl, sand, and limestone, which are according to Professor Martin, of Leiden, of Pliocene age.

The fossil vertebrate fauna met with in these strata is the same throughout the Keudeng and other localities in Java. Its age can only be decided after the description of Dr. Dubois' collection has been published, but there are already sufficient grounds for saying that the stratigraphical position of the fauna and its relation to the Post-Tertiary and Pleistocene vertebrate faunæ of India points to the conclusion that it is most probably younger Pliocene. In no case, however, can it be later than the oldest Pleistocene, for the species found belong

¹ This abstract appears by permission of the Royal Dublin Society, before which body the paper was read on the 20th of November, 1895; the paper is published in full in the Transactions of the Royal Dublin Society, vol. vi, part I, page 1. (February, 1896.) The illustrations, which are also kindly lent by the Royal Dublin Society, are unavoidably deferred till the next number.

SECTION OF THE BONE STRATA AT TRINIL.

- 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.

Profile outlines of the skulls of *Pithecanthropus erectus* (Pe), a Papua man, the Spy man No. 1, the microcephal Joe described by Professor Cunningham, and of *Hylobates leuciscus* (Hl), *Sennopithecus maurus* (Sm), and *Anthropopithecus troglodytes* (At). Gl—Glabella. Op—Opisthion. Jn—Linea nuchæ superior. Lni—Linea nuchæ inferior.

**FEMUR, TWO MOLAR TEETH, AND CALVARIA OF
Pithecanthropus erectus.**

exclusively to living genera, except the extinct *sub-genera* *Stegodon* and *Hexaprotodon*, and must therefore be younger than the principal part of the Upper Miocene or Lower Pliocene Siwalik fauna, which includes a good many extinct genera; further the number of the extinct species seems to be somewhat greater than that of the Nabadá fauna, which belongs to the early Pleistocene.

In the neighbourhood of Trinil (in the regency of Ngawi, of the Residency Madiun) Dr. Dubois discovered a spot at the foot of the Keudeng very rich in fossil remains. Here in August, 1891, and during the following year he unearthed a large quantity of fossil bones, amongst which he discovered the calvaria, thigh bone and teeth of a great man-like mammal, which he considered an intermediate form between man and the apes, and named accordingly *Pithecanthropus erectus*. So much impressed was Dr. Dubois with the importance of his find, that he determined at once to publish a provisional description of the remains.

This monograph, which was necessarily incomplete, owing to the author's isolation from various sources of comparison and reference, has given rise to much discussion amongst anatomists and zoologists in Europe and America, and it was with the view of providing further information that Dr. Dubois had returned to Europe, bringing with him the specimens in question.

The lecturer then proceeded to furnish a more detailed account of the locality from which the remains were obtained.

In the neighbourhood of Trinil the Bengawan or Solo river runs as far as Ngawi, a distance of $7\frac{1}{2}$ miles, between steep banks, composed almost exclusively of the above-mentioned volcanic sand and lapilli, cemented together and hardened into soft rock, similar to those in the Siwalik hills. In this area the strata have a general dip S. of about 5° , and are only concealed by a thin covering of vegetable mould; through these, in the immediate vicinity of Trinil, the river has cut its channel to a depth of 12 to 15 metres.

At points above and below Trinil, the Pliocene marl and limestone appear under these strata.

The first fossil bones here discovered were cut out of the rock by means of hammer and chisel, and consisted of the horn of a species of small deer, which is among the commonest of the fauna, a molar tooth of *Stegodon*, and a few other bones, all belonging to the same homogeneous fauna met with in other parts of the Keudeng Hills.

In making the excavations care was taken that the layers were removed one by one. They consisted from above down-

wards of alternately coloured sandrock which became coarser owing to a greater admixture of lapilli especially in the deepest layer, which measured about one metre in thickness, and which merged below with a conglomerate layer. Under this there is a sharply defined layer of hardened blackish clay. In the sandrock the bones were found in increasing numbers from above downwards, so that the lapilli layer contained the most; in the conglomerate layer but few were met with; whilst in the clay none were discovered.

It was in the lapilli layer on the left bank of the river, amidst hundreds of other skeletal remains, that the third molar tooth was found. This was in September, 1891; here also, a month later, on exactly the same level in that layer the cranium was discovered at a point one metre distant from the spot where the tooth was picked up. The mammalian remains found in the same layer are for the most part those of extinct species, for it is almost certain that some of them are now living in Java.

These comprised the bones of a species of *Cervus* which still survives in the Malayan Isles. Many remains of *Stegodon*, besides some of a species of *Bubalus* apparently identical with the Siwalik species. At the same time a *Bos elephas* differing from the known species, living or fossil, was discovered. In addition the genera rhinoceros, sus, felis, hyæna, and others were represented, whilst a gavial and crocodile were found which differ somewhat from the existing species in India, were unearthed.

The setting in of the rainy season prevented the continuance of the excavations until next May, when work was resumed, with the result that in August, 1892, the left femur was discovered in precisely the same layer at a distance of 15 metres from the spot where the skull-cap and molar tooth were found in the previous year.

In the October following a second molar tooth was discovered. This lay 3 metres from the place where the skull-cap was picked up, in a direction towards the spot where the femur was found. This tooth was not described in Dr. Dubois' first monograph, as it was only subsequently met with among a number of teeth taken from the same place.

Of the remains of animals found in the same strata in other places, the most interesting are a gigantic pangolin (*Manis*), three times as large as the existing Javanese species, a hippopotamus belonging to an extinct Siwalik sub-genus, a tapir, an *elephas*, and the extinct sub-genus *leptobos*.

These details as to the geological conditions under which the four bones were discovered were advanced to prove that they

not only came from the same bed, most probably late Pliocene, but that they were all found at precisely the same level in it, hence most probably they must be of equal age. The fact that their contours are sharp is opposed to the view that they have been washed out of an older (later ?) bed. Dr. Dubois therefore thought that there was little reason to doubt their origin from the rocky strata.

All the bones were in the same state of fossilization, harder than marble, very heavy, and of a chocolate-brown colour. The femur was twice the weight of a recent human femur of the same dimensions. The erosion on the surface of the skull-cap was not the result of disease as some critics had suggested, but was due to the corroding influence of the water, which had similarly affected all the bones found in this locality.

In discussing the question as to whether the bones belonged to the same individual or no, Dr. Dubois stated that in his opinion the distances apart at which they were found was no argument against their common origin. In his experience he had frequently found portions of the same skeleton as widely separated and, in some instances, fragments of the same bone were met with as far apart. Nor had he ever found anything like a complete skeleton which seemed to prove that the bones must have been widely scattered. Dr. Dubois advanced the theory that in all probability the remains were those of animals which had perished in volcanic catastrophies, their corpses being washed down in the course of a large Pliocene river. Most probably the bones, before they were deposited and buried in the old alluvia, were separated from one another by the rotting of the flesh or it may be together with the flesh were torn apart by crocodiles. In support of the latter view Dr. Dubois noted the fact that many remains of crocodiles were found as well as the marks of their teeth in the spongy parts of many fossil bones.

Considering the few examples there are of the fossil remains of anthropoid apes, and the absence of human remains from strata older than the middle Pleistocene, the lecturer urged that it was almost impossible to conceive that the thigh bone now discovered, which most certainly belonged to the Tertiary Period, could be human, whilst the skull found alongside of it should be regarded as that of a great anthropoid ape, a supposition which would necessarily involve their separate origin; much more reasonable to him appeared the view that they belonged to one and the same intermediate form.

Dr. DUBOIS, in referring to his critics, divided them into two groups, the first, which included Professors Sir W. Turner, Cunningham, A. Keith, Lydekker, Paul Matschie,

Rudolf Martin, and A. Pettit, held that the thigh bone and calvaria were human. The second group consisted of those who thought that the skull was simian and the femur human, and who further denied that there was any organic connection between them.

Only Professor Manouvrier of Paris, and Professor Marsh in America admitted the *possibility* of the remains belonging to a transition form between man and the apes.

In discussing the bones in detail, Dr. Dubois said most were agreed that the femur was human and not simian in character. Virchow alone was singular in maintaining the view that it belonged to the ape, most probably a *Hylobates*, and advanced in support of his opinion the fact that the bone had a straight candle-like shaft such as never occurs in man.

The lecturer however declined to agree with this conclusion, as he pointed out that the shaft of the bone was distinctly curved, though not to the same extent as is ordinarily met with in human femora. Further there could be little doubt that the fossil bone belonged to a form having an erect posture, and in this respect the condyles are quite human in their characters, contrasting markedly with those of *Hylobates*, which are distinctly simian.

Mr. Dubois, however drew attention to three minor points of difference between the fossil bone and the typical human femur, and stated that after having examined a very large number of human femora of different races, he had been led to consider these three characters as marks of differentiation from the human femur. The points of difference referred to by the lecturer, were—

1. The more rounded form of the shaft on its inner side.
2. A less extensive popliteal area which, moreover, is convex in its middle, thus imparting a rounded, instead of a flattened, form to the shaft in this situation.
3. A less raised and more simian-like trochanteric line.

Mr. Dubois laid particular stress on the small development of the popliteal space, the like of which he had never seen in a human femur, and pointed out that Dr. Hepburn had shown that in *Hylobates* the *vastus internus* muscle and the *femoral head* of the *biceps flexor cruris* came into close proximity to each other on the lower part of the posterior surface of the femur *below* the level of the insertion of the adductor magnus muscle. They are only separated from each other by a strong inter-muscular septum, which extends to within an inch of the inner joint. By this means the superior part of the popliteal surface of the femur is rendered *convex*, and presents a median longi-

tudinal elevation. An extension of these muscular attachments would exactly produce the appearances found in *Pithecanthropus erectus*.

Dr. Manouvrier too admitted that he had never seen a similar form of popliteal surface, though he had examined many thousands of specimens. Dr. Dubois, therefore, held that though the femur might be human, yet considering the circumstances under which it was found associated with an ape-like skull and simian teeth, he was justified in assuming that it was not human but belonged to an intermediate form. A form possibly like that of a gigantic gibbon, for it was only necessary to double the linear dimensions of the thigh bone and skull of an existing *Hylobates* to have dimensions exactly corresponding to the Java form.

In referring to the exostosis which is connected with the fossil bone behind the shaft just below the small trochanter, the lecturer stated that most were agreed that this pathological growth could have effected little if any change in the normal general form of the bone.

In regard to the skull-cap there was much greater divergence of opinion. Cunningham, Turner, A. Keith, R. Martin, and Topinard regarded it as human. Lydekker thinks it that of a microcephalic idiot, whilst Krause, Waldeyer, Virchow, Hamy, Manouvrier, Flower, and Marsh denied the possibility of it being human, and regarded it as more probably that of an ape. The calvaria measures 185 m.m. in length and 130 m.m. in breadth; its cranial capacity has been estimated at 1,000 c.c.

This is in marked contrast with the highest cranial capacities of the anthropoid apes, which never exceed 600 c.c., and more usually measure about 500 c.c. On the other hand many instances are met with among Australian Veddahs and Andamanese of a cranial capacity as low as 1,000 c.c.

As the cranial capacity is doubtless correlated with the size of the body, Dr. Dubois pointed out that assuming the femur to belong to the skull, the height of the individual estimated from it according to human proportions would be 165 to 170 c.m. Contrasting this with the height of Veddah women, which averages about 143 c.m., we are justified in declining to admit the possibility of a skull with such a small capacity being human. The other alternative is that the skull is that of a microcephalic idiot; all things considered this is most improbable. It is far more likely, therefore, assuming the skull and femur to belong to the same individual that we have *not* to deal with a human cranium.

The Trinil skull in form and size very closely resembles the type of the anthropoid apes. The smallness of the arch of the

vertex, the low receding forehead, the *torus occipitalis*, and the especially strong projection of the orbital parts of the frontal bone, are all simian characters. Further, the superior occipital ridge seems to unite with the posterior part of the temporal ridge, and forms a well marked swelling, common as a rule in the skulls of full grown apes, but never seen in human crania, not excepting those of microcephalic idiots.

Whilst admitting the close resemblance between the Trinil skull of the Neanderthal and Spy crania, Dr. Dubois drew attention to the difference in size and capacity between his specimen and those mentioned. The Neanderthal skull has an estimated capacity of 1230 c.c., whilst its length and breadth exceeds the Trinil skull by about 15 m.m., the same holds good with regard to the Spy crania. The most important points of difference between the Spy skulls and Dr. Dubois' specimen were the more marked flattening of the parietal region and the relatively greater dimensions of the orbital parts of the Java skull. The Trinil skull differed in similar respects from the microcephalic skull described by Professor Cunningham.

As Virchow has pointed out the orbital part of the Trinil skull is quite different from that of man, and on comparing the fossil calvaria with crania of the anthropoid apes, the proportion between the lengths of its orbital and cerebral parts is found to be exactly the same as in the skulls of gibbons. In *Hylobates* alone is the arch of the cranium as high as in *Pithecanthropus*. A further point of importance in the Trinil skull is the pronounced forward slope of the infra-inial part of the occiput; in this respect it differs little from the human form, and is much more marked than in the anthropoid apes, as the following figures show.

In the anthropoids the angle formed by the median line of the nuchal plane and the median line from the glabella to the hinder border of the foramen magnum varied from 83° to 86° , in *Semnopithecus maurus* it was 90° , in *Macacus cynomolgus* 106° . In man the angle is about 50° , in the No. 2 Spy skull 56° , in the microcephalic skull described by Cunningham it is 68° , whilst in *Pithecanthropus* it equals 65° .

In discussing the question of the teeth, one of which had been discovered since the publication of his memoir, Dr. Dubois stated there was much difference of opinion regarding their origin,—Krause, Ten Kate, and Turner considered them simian, whilst R. Martin, Lydeker, Cunningham and Manouvrier inclined to the view that they were human. Both the teeth are modelled after exactly the same type, so that there is little ground for disputing the connection between them, the crenation of the crowns is the same, and the dimensions are not dissimilar.

The more recently discovered tooth was much more worn on the crown than the third molar previously found, but Dr. Dubois pointed out that it was not uncommon to find the second molars more worn than the third molars, so that this circumstance did not disprove the assumption that the two teeth belonged to the same individual.

Dr. Dubois considered that the teeth were not human, first on account of their great size and the divergent nature and length of their fangs, and secondly, because the *buccal* posterior cusp is in a state of retrogression, exactly as is seen in the case of the molars of anthropoid apes.

Summing up his arguments the lecturer said that on geological and anatomical grounds we were justified in assuming that we had in these four specimens evidence of a form intermediate between man and the anthropoid apes, and further, that it is exceedingly probable that the several bones all belonged to one and the same individual.

The concluding words of the lecture may be given *in extenso* :—

“I attempted to give here a diagrammatic representation of my views with reference to the phylogenetic evolution of man and the apes.

“In the Eocene, when the Old World and American mammal fauna were more nearly related, we have a hypothetical genus, *Archipithecus*, from which diversified a branch giving rise to the platyrrhine apes, the families *Cebidæ* and *Hapalidæ*. In the early Miocene or, perhaps, in the Upper Eocene, from a common hypothetical *Palæocercopithecus*, the ancestor of the Old World apes, there branched off all the lower Old World apes, the *Cercopithecidæ*. Afterwards in the Miocene, when the main stem had become more anthropoid, there branched off the Upper Miocene or Lower Pliocene form *Dryopithecus*, which in its characters is intermediate between the lower catarrhine apes and the man-like apes. Still later in the Miocene originated the hypothetical form *Prothylobates*, a very generalised form, which I regard as the ancestor of all the anthropoid apes and man. During the Middle and Upper Miocene, there originated from this stem-form, first a branch giving rise to *Pliopithecus*, and the form from which we have the femur of Eppelsheim (‘*Dryopithecus*’ sec. Pohlig), which I call *Pliothylobates*; further, the existing genus *Hylobates*; secondly, branches giving rise to *Simia*, and to *Troglodytes* and *gorilla*.

“Lastly, we have in the main stem, originating from *Prothylobates*, during the Lower Pliocene (or Upper Miocene) the *Tiwalik Palæopithecus*, which after a careful examination of the specimen in the Indian museum at Calcutta, on which the

genus is founded, I regard as a decidedly Hylobatoid form, but approaching towards man. Between this form and man comes in the Upper Pliocene, *Pithecanthropus*, which, while still retaining many Hylobatoid characters, approaches, as I have tried to show, nearest of all to man, but cannot be placed in the genus *Homo*."

The following discussion took place on exhibition of the remains of *Pithecanthropus erectus* to a meeting of the Institute.

Sir WILLIAM FLOWER congratulated Dr. Dubois upon the results of his successful explorations in Java, resulting in the discovery of a large and interesting Mammalian fauna, and said that all present must feel particularly indebted to him for giving them an opportunity of inspecting the specimens he had exhibited that evening, and for the full and lucid explanation he had given of them. It was unfortunate that the fragmentary condition of the remains of *Pithecanthropus* was such as to leave much of its real nature open to conjecture. A comparison of the cranium with that of the Neanderthal man, showed a decidedly lower form, especially in the narrower frontal region. On the whole it presented, except in size, a remarkable resemblance to that of *Hylobates*.

Sir JOHN LUBBOCK also congratulated Dr. Dubois on his interesting discovery. He asked for some further details as to the position of the bones with reference to the remains of the Pliocene Mammalia, for in Dr. Dubois's original memoir this was not explained in detail. He also inquired whether the great amount of abnormal growth on the femur would not have considerably interfered with the movement of the animal. If so that would point to its being human. A man might well have been engaged in some sedentary occupation, or perhaps supported by his family. A monkey, however, was more dependent on retaining its activity unimpaired.

Mr. BLAND SUTTON was of opinion that the three specimens—calvaria, teeth, and femur—should be separately discussed. It was pure assumption to believe that they belonged to the same individuals. In regard to the teeth and calvaria he would not offer an opinion. The femur was undoubtedly human, and exhibited the muscular markings characteristic of a typical thigh bone of a thoroughly adult man. The irregular bony mass connected with the shaft was such as is met with in that very rare disease known as *myositis ossificans*, which is characterised by extensive ossification of the tendons and tissues of muscles at their attachments. Thus it was curious that two sets of human remains, the Neanderthal and the Javan, which had

given rise to much discussion, belonged to diseased skeletons; the Neanderthal fragments exhibited clear and undoubted evidence of rickets.

Mr. Sutton was of opinion that the attempt to form a new genus for these remains was at least premature, and the generalisation as to the probable phylogeny of anthropoids and man based upon it, was one calculated to bring ridicule upon Anthropological Science.

Mr. E. T. NEWTON called attention to the fact that the bones of *Pithecanthropus* being, apparently, in a similarly mineralized condition to those of the extinct animals found in the same stratum, was strong evidence of their being of the same age. It was a noteworthy fact that so many observers were agreed as to the great similarity to *Hylobates* presented by the calvaria and femur of *Pithecanthropus*, and from the occurrence of the latter in beds where several of the forms were gigantic representations of living genera, nothing was more likely than that *Pithecanthropus* was a gigantic *Hylobates*. And still further, it was in *Hylobates*, rather than in the larger anthropoid apes, that many anatomists traced the greatest resemblance to Man.

Sir WILLIAM TURNER said: The opportunity which Dr. Dubois has given us of seeing his very interesting specimens and the fuller description of the conditions under which they were found, have enabled us to realise their characters and antiquity much more clearly than was possible from a perusal of his memoir published last year. The association of these specimens with bones and teeth of mammals, many of which are now extinct, and their correspondence with them in mineralization, shows them to be of undoubted antiquity, and if their human character is accepted, makes them rank as the most ancient human remains which have yet been discovered. As regards the thigh bone, the opportunity of carefully examining it, both last week in Edinburgh, and now at this meeting, does not lead me to alter the opinion which I expressed in my published criticism of the original memoir, that there is nothing in its form and appearance which would lead one to say that it possessed characters specifically or generically distinct from those of a human thigh bone, and in this respect my conclusion is in harmony with the opinions of many anatomists who have seen it. The bone is in various parts undoubtedly modified from disease; for in addition to the remarkable branched and pointed exostosis, there is evidence of a pathological growth of bone for some distance down the linea aspera, and of new bone growth around the posterior border of the articular area of the condyles.

Clearly therefore increased periosteal bone formation had been taking place for some time before death, and it is not unlikely that the convexity of the popliteal surface of the bone, to which Dr. Dubois attaches so much importance as differentiating it from the human femur, may have been produced by increased periosteal activity in that region. Further it may be stated that there seems to be no prolongation of articular area on the back of the femur immediately above the inner condyle, such as Havelock Charles has associated with the squatting posture.

As regards the skull cap, now that one has seen it, there is more difficulty in coming to a conclusion. If, however, the thigh bone and calvaria belong to the same skeleton, and Dr. Dubois, from his personal examination of the locality, has no doubt on this point, the establishment of the human character of the femur would require us to regard the calvaria as also human. Without question they were found in the same geological horizon and belong to the same epoch. The calvaria is less distinctively human than the Neanderthal skull cap which everyone now admits to be human. In the latter there is a forehead with rounded frontal eminences, but in the Java specimen the frontal bone is flattened and slopes abruptly backwards in a manner such as approximates it much more to the shape in the ape than to a human skull, even as low as the Neanderthal; though I should state that in the Edinburgh University Museum is the cast of a microcephalic woman with a frontal flattening very like that of the Java calvaria. In the parietal region the Neanderthal and Java specimens have a great resemblance to each other, and both differ from the corresponding region in the ape by their considerable breadth and less rounded sides. In the occipital region, as Dr. Dubois testifies, the form is more human than ape-like. The internal capacity of 1,000 cub. cent. is more like that of man than of the ape. No existing species of ape has a greater internal capacity than from 500 to 600 c.c., whilst I and other anatomists have measured many human crania with a capacity of less than 1,100 c.c. and some even with less than 1,000. As the capacity indicates the mass of the brain and its possibilities to exercise function both as a sensori-motor centre and as the seat of intelligence, it will rest with those who regard this calvaria as belonging to a *Hylobates*, much larger than any existing species, to give a satisfactory explanation of the presence of so large a brain in an animal, which, if the thigh bone belonged to the skull, had not the bulk of body of a large gorilla; in which animal the brain cavity does not reach 600 c.c. The thigh bone certainly cannot be regarded as that of *Hylobates*. In

conclusion, may I express the thanks of anthropologists in this country to Dr. Dubois for his courtesy in bringing the specimens for our inspection, and the further hope that the government of the Netherlands may continue the search for additional remains in the same locality.

Dr. GARSON said that he had studied Dr. Dubois' memoir on *Pithecanthropus erectus* very carefully and also the various criticisms of it which had been published. He was therefore extremely glad to see the specimens themselves, as they showed many morphological details of which the plates and diagrams gave but an imperfect idea; the paper also which Dr. Dubois had read that evening threw further light on the specimens. In the first instance he had been very uncertain as to the geological epoch to which they should be referred, but from the additional information Dr. Dubois had just given regarding the mammalian fauna found in the same formation with them, he was satisfied as to their being Pliocene. As regards the specimens themselves, although there was no absolute proof that they all belonged to the same skeleton, he did not think there was any positive proof to the contrary. Some authorities had urged, from a study of the plates, that the femur was less worn than the calvaria, but examination of the specimens themselves does not support this view. Again it had been said that the last molar tooth was little worn and therefore probably came from a younger cranium than that found. He had seen several instances, however, where the last molar was almost unworn while the other teeth of the series were considerable worn and the skull was thoroughly adult with the sutures obliterated, precisely as was shown by the calvaria and the other molar tooth recently added to the specimens now under consideration. The local conditions under which the specimens were found must have considerable weight in determining the question as to whether or not the several fragments belonged to the same individual; of these Dr. Dubois was in the most favourable position to judge.

The femur is extremely human-like, and if taken alone would undoubtedly be said to be that of *Homo*. The last molar tooth, also, might perhaps be ascribed to the same genus, as in a skull of an Australian native in the Royal College of Surgeons Museum he had found a last upper molar tooth measuring 16 mm. transversely and 11.4 mm. in the antero-posterior direction, which is even slightly larger than in the Javan specimen. The calvaria, on the other hand, is very different, and much more gibbon-like than one would imagine from the drawings of it. The large bony formation on the femur is very

similar in size and character to what occurs in the femur of a skeleton of a man in the Pathological Collection of the College of Surgeons, except that in the latter specimen it is situated lower down on the shaft of the bone, and the ossification extends from the femur to the ischium; there are also several other ossifications of the muscular attachments and aponeuroses. The modification of the surfaces for the attachments of the muscles of the back of the thigh near the popliteal region of the femur from Java are interesting, but even if the bone be taken by itself, he was not certain as to their significance. The fact that a pathological condition of great rarity to the extent to which it obtains, is present in the femur, is apt to make one think it possible that an aberrant condition may also be present in the calvaria, and that it might have belonged to a microcephalic *Homo sapiens*. The probability of chances is, however, very much against such a combination of abnormalities occurring in the same individual. The characters of the calvaria also did not, to his mind, support such a conclusion. By these the specimen, if taken alone, might be ascribed to a large extinct *Hylobates*, although it should be remembered that in these large extinct forms the brain is proportionately smaller than in the recent, whereas in this specimen the capacity of the calvaria indicates as far as he could judge a proportionally larger brain. This then brings us to the hypothesis of Dr. Dubois, that the position which should be assigned to it is somewhere on a phylogenetic line between *Hylobates* and *Homo*. The characters of the femur and also of the molar tooth, particularly as regards its fangs, being in some respects different from those of *Homo sapiens*, and considering the strong opinion Dr. Dubois has formed from examination of the strata and the other mammalian remains therein contained, it is most reasonable to conclude that the specimens are probably parts of the skeleton of one animal, and that it belonged to one of those extinct species of primates more or less related to *Homo sapiens*, which there are strong *à priori* grounds to believe existed in Pliocene times. He was of opinion that the specimens could not be ascribed to either the genus *Homo* or species *sapiens*, and must be classed as another and distinct genus and species, but he did not think it necessary to create a new family of Primates for the specimens as their characters were sufficiently close to those of *Homo* to be included in the family *Hominidæ*.

Mr. KEITH saw no reason for dissenting from Dr. Dubois' conclusion that these fossil remains belonged to a late Tertiary period. He thought Dr. Dubois was also right in regarding the remains as of one species, but it was open to question if of one

individual. The third molar was slightly worn, the second considerably so; such a condition indicated an animal in an early stage of maturity. But the sutures of the calvaria were ossified; such a condition occurred only in the later stages of human life, very seldom in the earlier. It was true that ossification of the sutures began in the early stages of maturity of the apes' skull, but ossification was directly due to the great development of the temporal and occipital long ridges—a development absent in this calvaria. The sutures would therefore follow the course of ossification usually taken in the human skull, so that the teeth and calvaria evidently belonged to different individuals.

The chief question that had to be settled was, whether the skull was human or not. What was the criterion of a human skull? What was the criterion of an ape's skull? How were they to be distinguished? To his mind there were only two differences between the skulls of men and apes, and they were differences, not in kind, but in degree. The first difference was in the large excess of cranial capacity of the human skull; in the extent of its cranial capacity the skull before them merited to be called human. The second difference between the skulls of apes and men lay in the large development of muscular ridges and processes for the fixation of the masticatory apparatus; the development was extensive in apes; it was slight in men. In the extent of this development, also, the calvaria in question was distinctly human.

Dr. Dubois had placed *Pithecanthropus* directly in the stem of the human race, and regarded it as representing the human race during the late Tertiary period. *Pithecanthropus* was, in short, Pliocene man. He thoroughly agreed with Dr. Dubois as to the genealogical position of *Pithecanthropus*, but entirely differed from him as to his method of nomenclature. In fact, the question arose, where in the ancestry of the human race was one to draw a line to mark where pithecoïd forms cease and man commence. Dr. Dubois had drawn that line between the Tertiary and Quaternary periods; but it seemed to him, that in the nomenclature of a race, the same principle should be followed as in the nomenclature of a human individual. The same name serves in infancy as in old age. Hence he thought it better to call Dr. Dubois' *Pithecanthropus erectus*—Pliocene Man.

Professor THOMSON said what struck him most was the very different complexion put upon the case, now that they had an opportunity of examining the actual specimens. This only went to prove how difficult it was to form any correct opinion

on such a matter by the mere perusal of a monograph, however good. For his part all he felt justified in saying was that the calvaria was undoubtedly ape-like in all its characters, except in regard to its capacity: on the other hand the femur displayed all the features of a well-developed human thigh bone.

He could not agree with Dr. Dubois in the arguments he advanced regarding the causation of this peculiar modelling of the popliteal surface, for it seemed to the speaker that the same arguments would apply equally well against Dr. Dubois' conclusions; for, according to his own showing, there was little difference between the popliteal surface in man and the chimpanzee, though in the latter the adductor magnus muscle was extensively attached to that surface.

Regarding the teeth Professor Thomson was not inclined to admit the impossibility of their being human, for an examination of Australian Crania had led him to conclude that the size of the teeth was not sufficient to preclude the possibility that they were human molars.

As to whether or no the calvaria and thigh bone belonged to the same individual was a matter of vital importance. Unfortunately the evidence advanced was not conclusive, and the only course left open at present was to reserve one's judgment. This, however, did not detract from the remarkable value of the discovery of this skull, which he regarded as by far the most important contribution to our knowledge of an intermediate form between man and the known apes.

Prof. G. D. THANE said the difficulty of forming an opinion upon the remains before the meeting is rendered very great by the circumstance that the indications afforded by the femur and by the calvaria are directly opposed to one another. The femur in its conformation is human, and of a high type. It is a question whether the peculiar features of the lower part of this bone referred to by Dr. Dubois may not be related to the pathological processes by which it has been affected. The individual to whom this femur belonged undoubtedly stood on the lower limbs only with the knee-joint fully extended, as indicated by the designation "*erectus*" given by Dr. Dubois, possessed a great toe, and not an opposable hallux, and was therefore zoologically "man." The teeth are human in their characters, but peculiar in their large size and their spreading fangs. The calvaria, however, apart from its size, appears to resemble more nearly that of one of the higher apes than the corresponding part of a European skull, and approaches more closely to the former than the Neanderthal specimen. Probably its most pronounced simian feature is the form of the occiput.

Assuming provisionally that the remains are from the same individual, judgment must be reserved in view of the isolated character of the find, since there is always the possibility of the calvaria belonging to an exceptional, or microcephalic individual of a well developed human variety. But, just as the racial character of the Neanderthal skull was established by the discoveries at Spy, so it may be hoped that in the future other specimens will be forthcoming which will establish the value of these as bringing before us a distant stage in the phylogeny of Man.

STONE COOKING-HOLES *and* GROOVES *for* STONE-GRINDING *used*
by the AUSTRALIAN ABORIGINES. By R. H. MATHEWS,
Licensed Surveyor.

[WITH PLATE XVII.]

WHILST I was engaged in searching for and describing aboriginal rock paintings and carvings in the county of Cumberland, New South Wales, I came upon some holes in a large rock, which had apparently been used by the aborigines as ovens for cooking their food. As I have never seen ovens of a similar character described in any scientific work, I have thought that a few remarks upon them would be of interest to the members of your Institute, and would also perhaps have the effect of inducing others to give us the benefit of their observations in different parts of Australia. There must be a number of gentlemen living in the interior of the colonies, where the natives are still numerous, who could furnish valuable information in regard to their modes of cooking, and the implements used. This is a subject on which anthropologists always endeavour to obtain information, and we find it set down among the "Hints to Travellers" issued by various learned Societies.

The supposed ovens referred to consist of holes in the surface of a large tabular rock of Hawkesbury sandstone, about 200 feet in length and 50 feet wide, with a slight slope towards the north-east. These holes have the appearance of having been formed by the weathering away of soft patches of the rock, and the largest of them are about 15 inches deep. It is likely that they have been artificially deepened by the natives to render them suitable for use as ovens. In Nos. 1 and 4, Plate I, I found a number of loose pieces of sandstone, of irregular shapes, averaging 3 or 4 inches each way, which had evidently been burnt in the fire. Indications of fire were also discernible on the walls of the holes, which induced me to think that they