Palæontology. — *The fossil human remains discovered in Java by* Dr. G. H. R. VON KOENIGSWALD *and attributed by him to* Pithecanthropus erectus, *in reality remains of* Homo sapiens soloensis. *Conclusion.* By Prof. EUG. DUBOIS.

(Communicated at the meeting of November 30, 1940.)

As a matter of fact the morphologic similarity of the skull cap which I described in 1894, together with other fossil remains, as *Pithecanthropus erectus*, to the homologous part of a small *Hylobates* species is so striking that I never lost sight of this resemblance, nor feel at liberty to regard the "Java man" as a real, be it ever so primitive m a n. Evidence of that is to be found in a number of my publications, attesting, on the other hand, to d i s t i n c t n e s s of the *Pithecanthropus* from the *Hylobates* organism, and at the same time to the much greater distinctness from the chimpanzee.

Nevertheless VON KOENIGSWALD, recently, wrongly proclaimed that I changed my mind, a few years ago, from an originally and permanently hominide view to a, surprisingly, new Hylobate-one. HANS WEINERT, on his part, since 1928, wrongly imputed to me, originally, a preference of the chimpanzee for resemblance to *Pithecanthropus*.

To prove that these ways of putting things are wrong, I may reproduce, in the first place, some literal quotations from that monograph, the first scientific description of the fossil species under consideration [1]):

p. 1. „Classe. **Mammalia.**
„Ordnung. P r i m a t e s.
„Neue Familie. *Pithecanthropidae.*

„Hirnschädel, absolut und im Verhältnis zur Körpergrösse viel geräumiger als bei den *Simiidae*, jedoch weniger geräumig als bei den *Hominidae*; Inhalt der Schädelhöhle ungefähr zwei Drittel vom durchschnittlichen Inhalte derjenigen des Menschen. Neigung der Nackenfläche des Hinterhauptbeines bedeutend stärker als bei den *Simiidae* [2]). Gebiss, obwohl in Rückbildung, noch vom Typus der *Simiidae* [3]). Femur in seinen Dimensionen dem menschlichen gleich und wie dieses für den Gang bei aufrechter Körperhaltung gebaut.

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[1]) EUG. DUBOIS, Pithecanthropus erectus. Eine menschenähnliche Uebergangsform aus Java. II und 40 Seiten in folio. Mit 2 Tafeln und drei Textfiguren. Batavia. Landesdruckèrei. 1894. (Vorwort datiert: Tulung Agung (Java), Januar 1894.)

[2]) After complete preparation of the fossil skull cap, the nuchal occipital region appeared strikingly similar to that of the gibbons; in *Pithecanthropus* the inclination of the planum nuchale, particularly, was certainly not much stronger than in *Hylobates*.

[3]) The first lower premolar and the mandible then were not known.

„*Pithecanthropus erectus*, genus novum, species nova.

p. 3. „Die Oberfläche des Schädeldaches ist glatt, ... zeigt durch seine glatte Oberfläche und seine allgemeine Form grosse Aehnlichkeit mit dem Schädel von Anthropopithecus (vergl. Taf. I), jedoch noch mehr mit dem von *Hylobates* (Fig. 1)".

„Tafel I. Fig. 1. *Pithecanthropus erectus* n.g., n.sp. Schädeldach, von oben, nach Photographie.
„ 1a. „ „ n.g., n.sp. Schädeldach, von der linken Seite, nach Photographie.
„ 2. *Anthropopithecus troglodytes* Gmelin ♀ adult. Schädel von oben, nach Photographie.
„ 2a. „ „ Gmelin ♀ adult. Schädel von der linken Seite, nach Photographie.
Fig. 1 und 1a $^1/_2$ natürl. Grösse.
„ 2 und 2a $^2/_3$ „ „ (Reducirt zu ungefähr gleicher Grösse mit 1 und 1a.)

„Die Tafel zeigt die Verschiedenheit in der Bildung der occipitalregion und der Superciliarregion des Schädels, sowie die bedeutendere Wölbung bei *Pithecanthropus*. Wie aus den Textfiguren 1 und 2 [1]) zu ersehen ist, stimmt in diesen Beziehungen *Pithecanthropus* viel mehr mit *Hylobates* überein."

p. 12. „Aus der Beschreibung und aus den Vergleichen geht hervor, dass das fossile Schädeldach eine Art andeutet, die in ein anderes Genus als *Gorilla, Simia* und *Homo* eingereiht werden muss; diesem letzteren nähert es sich durch seine absolute Grösse und Wölbung, zeigt jedoch grosse Uebereinstimmung mit *Anthropopithecus* und, der Form nach noch mehr mit *Hylobates*."

p. 25. „Aus dem Vergleiche geht also mit Sicherheit hervor, dass zwischen dem Femur der fossilen Form und dem des Schimpanse bedeutende Unterschiede bestehen, hauptsächlich in der viel ansehnlicheren Schlankheit des fossilen Knochens und seiner relativ und absolut grösseren Länge, ferner in der Form des Schaftes und besonders des unteren Gelenkendes; ...

„Das Femur der Hylobatiden underscheidet sich von dem fossilen ausser durch seine absolute Grösse, hauptsächlich durch die Form der Condylen" ...

p. 26. „Dagegen stimmt dieses Genus in der relativen Dicke des Schaftes des Femur mit dem Menschen überein."

p. 27. „bei den Gibbons, die im Verhältnis zu ihrer Grösse keinen schwereren Oberkörper haben als der Mensch, finden wir auch ebenso schlanke Oberschenkelbeine wie beim Menschen" ...

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[1]) In Figure 2 the seeming inclination of the lower portion of the occipital much exceeds the real inclination, on account of damage of the fossil.

p. 28. „Man könnte nun annehmen, dass die grosse Länge der unteren Extremitäten wie bei den Gibbons in Correlation stand zu den als vervollkommnete Kletterorgane länger gewordene Arme. Diese Annahme erscheint aber unbegründet, wenn man bedenkt, um wie viel die fossile Form grösser ist, als die *Hylobates*-Arten. Schon beim Körpergewichte der Hylobatiden ist, wie es scheint, die erworbene Specialisirung an der Grenze des Erreichbaren angelangt. Der Siamang bewegt sich weniger schnell als die übrigen Arten derselben Gattung, und aus den Spuren von geheilten Knochenbrüchen, die so oft an den Skeletten von Hylobatiden zu sehen sind, geht hervor, dass die pfeilschnellen Bewegungen zwischen den federnden Aesten der breitkronigen indischen Waldbäume, wozu diese Tiere der bewunderenswürdig specialisirte Bau ihrer Extremitäten befähigt, nicht ohne Gefahr sind. Für den so grossen Körper der fossilen Form wäre eine solche, eher fliegen als klettern zu nennende, Bewegung ganz unmöglich. Andererseits ist es sehr merkwürdig, dass gerade die Gibbons, die bezüglich des Grossenverhältnisses zwischen Beinen und Oberkörper mit dem Menschen übereinstimmen, die einzigen Affen sind, die — wenn auch auf mangelhafte Weise — aufrecht gehen können, ohne dabei, wie Schimpanse, Gorilla und Orang-Utan thun, die Hände als Stütze zu gebrauchen. Der directe Beweis dafür, dass die javanische Form sich auf ganz andere Weise bewegt haben muss als die Hylobatiden dies für gewöhnlich thun, wird übrigens durch den gänzlich verschiedenen Bau des unteren Gelenkendes des Femur, insbesondere der Condylen, geliefert."

In my report „Pithecanthropus erectus, eine menschenähnliche Uebergangsform", read September 21, 1895 [1]), „habe ich die Profilcurven der zwei Spy-Schädel, ebenso wie die eines jüngst von CUNNINGHAM beschriebenen Schädels eines Microcephalen [2]) neben einander gezeichnet (Vergl. Figur 2). Dabei zeigt sich eine grosse Uebereinstimmung; es muss aber auffallen, dass der Scheitelteil des Trinilcraniums viel flacher ist als bei jenen. Wirklich ist dies eine Eigenschaft des fossilen Schädels, worauf ich jetzt hinweisen will, die, glaube ich, schwer an Menschenschädeln zu finden sein würde." [1]) The same figure, however, establishes conformity, in this respect, of *Pithecanthropus* with *Hylobates leuciscus, Semnopithecus maurus* and *Anthropopithecus troglodytes*, wanting what later I have called the v e r t e x p a r i e t a l i s, a true h u m a n distinctive.

I may now quote, translated, from a paper of 1907 [3]):

p. 456. "I now regard *Pithecanthropus erectus* as nearly allied to the living Gibbons. The thigh-bone and the skull have, however, double the

[1]) Compte-rendu des séances du Troisième Congrès international de Zoologie. Leyde, 1895, p. 265.

[2]) D. J. CUNNINGHAM, The brain of the microcephalic idiot. Scientific transactions of the Royal Dublin Society. May 1895. Plate 38, Fig. 5.

[3]) EUG. DUBOIS, Eenige van Nederlandschen kant verkregen uitkomsten met betrekking tot de Kendeng-fauna (fauna van Trinil). Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap. 2e Ser., dl. 24, pp. 449—458. Mededeelingen 1907. See pp. 456—457.

dimensions of the smaller species of these Long-armed Apes, for instance of the Wou Wou (*Hylobates javanicus*) from Java. The skull is ape-like rather than man-like in form, principally on account of the backward situation of the temporal constriction (not its depth, as RUDOLPH VIRCHOW supposed). The dentition was presumably still somewhat more human than that of the small Gibbons. The thigh-bone, adapted to the erect gait with stretched knee-joint, exhibits, however, yet vestiges of adaptation to climb. With the Gibbons, which distinguish themselves from all the other Apes and Monkeys by being in the habit of walking on their legs only, without the support of their hands — the relative length and the form of the thigh-bone vary in a high degree, and in this respect some individuals somewhat approach *Pithecanthropus*, though the knee-joint never is quite formed for the erect gait with stretched leg, as is certainly the case with *Pithecanthropus*.

"The feature, however, that distinguishes *Pithecanthropus* sharply from the Gibbons is, in the first place, exactly the resemblance of its cranial form to that of the small Gibbons. I cannot enough be pointed out, that the larger species of Gibbon, the Siamang (*Hylobates syndactylus*, possesses a much more truly monkey-like lowvaulted skull and a (somewhat) more bestial dentition than the smaller Gibbon species. Yet the difference in size of the animals is relatively small. And now, *Pithecanthropus*, with double the dimensions has retained the capacious skull of the smaller Gibbon species. The dentition is even less bestial.

"A definite part of the brain volume of *Pithecanthropus* can be measured accurately and compared with the homologous part of large and small Gibbons. What appears then? That the fossil form from Java, in the same progression as observed in the Gibbons, had twice as much brain as an (imaginary) Gibbon of double the size of the Wou Wou would have. Consequently, *Pithecanthropus* cannot be a Gibbon. Opposed to this is also the fact of its erect gait with stretched knee-joint.

"When now inspecting the endocranial cast, which gives us an idea of the form of the convolutions of the cerebrum, this appears to be of the human fundamental type, to represent, as it were, only the principal lines of the human forms. The inferior frontal convolution, in Man the seat of the centre of (articular) speech, is of the most simple, although typically human form. But we can also conceive the cerebral convolutions of *Pithecanthropus* developed from the still more simple ones of the Gibbons. Now it is a fact of general observation that with related animals the cerebral convolutions become more complicated according to the cerebrum increasing in size.

"In short, I consider *Pithecanthropus* to be a descendant of less spezialized (less long-armed) ancestors of the Gibbons (*Prohylobatides*), a descendant which had assumed the erect posture. Through this the arms and the hands, were, at least to a great extent liberated from locomotor functions, enabled to such tactile and prehensile faculties as we find

reflected in the very much increased brain volume and the exceedingly human morphology of the cerebral surface."

The best information about the real morphologic, and taxonomic, character of the *Pithecanthropus* fossils, however, would be given by the publication of very good photographic and plaster cast representations. I regret, that I have not been enabled to effectuate such publications, until in the years 1924 to 1926, the Koninklijke Akademie van Wetenschappen te Amsterdam much obliged those who took a particular interest in this important matter of science, and much indebted me, by rendering assistance in effectuating both modes of publication; the exact figures, accompanied by a very concise text [1]), appeared at the same time that accurate casts became available.

From the figures and the text the hylobatoid similarity, or at least resemblance in a number of points, is again evidenced, together with not a few points of difference.

I may quote some of the principal items from the first paper:

p. 267. "The fronto-biorbital index (Schwalbe) *i.e.* its ratio to the external orbital facial breadth, which latter I estimate at 115 mm as a minimum, is at most 79. In a cranium of a Hylobates agilis, in many respects resembling that of Pithecanthropus, this index is 78.4. The post-orbital length index (Schwalbe) is 25.5, the distance between the orbital constriction and the bregma-transversal being 47 mm. This index is 25 at the same cranium of Hylobates agilis. The whole pre-cerebral part of the frontal bone is hylobatoid, like the rest.

"It is seen that to the sagittal arc-length of the cranial vault the frontal bone contributes 100 mm, the parietal bone 90 mm. and the upper part of the tabular portion of the occipital bone 45 mm. This is an entirely different ratio between the two first divisions of the vault from that in Homo sapiens and Homo neandertalensis, where the parietal arc is longer than, or equally long as, the frontal arc. In the Hylobatidae, on the other hand, the parietal bone is much shorter, in comparison with the frontal arc, than in Pithecanthropus. The latter's fronto-parietal index is 90, that of the large (p. 268) gibbon genus, Symphalangus, 53 on an average, and that of the small gibbon species has an average value of 42. The relative length of the frontal squama diminishes with increasing size of the body, in consequence of the diminution that this entails of the ratio between the volumes of the

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[1]) EUG. DUBOIS, On the principal characters of the cranium and the brain, the mandible and the teeth of Pithecanthropus erectus. Proceedings Kon. Akademie van Wetenschappen te Amsterdam. Vol. 27. Nos. 3 and 4, pp. 265—278. — Figures of the calvarium and endocranial cast, a fragment of the mandible and three teeth of Pithecanthropus erectus. Ibid. Nos. 5 and 6, pp. 459—464. Eleven Plates of telephotographic reproductions, natural size. — On the principal characters of the femur of Pithecanthropus erectus. Proceedings Kon. Akademie van Wetenschappen te Amsterdam. Vol. 29, No. 5, pp. 730—743, 33 figures. — Figures of the femur of Pithecanthropus erectus. Ibid. pp. 1275—1277. Four Plates. At the same time plaster casts of all the fossil remains were available for distribution.

orbita (with the eye) and the cranial cavity (with the brain). Besides, in Pithecanthropus the cranial cavity has become more spacious in another way than through the greater size of the body.

"The lower part of the tabular portion of the occipital bone, the pars nuchalis, bends downwards and forwards at an apparently not very obtuse angle. But this obtuse angle was much larger in the intact skull, because at the fossil calvarium the loss of substance greatly increases towards the edge of the fragment, so that this edge only still consists in the knife-like lamina interna. In the intact state of the skull Pithecanthropus resembled the Hylobatidae in the steepness of the planum nuchale.

"The torus occipitalis presents the closest resemblance to that of Symphalangus syndactylus.

p. 269. ... There is also a powerful crista occipitalis interna, which feature distinguishes Pithecanthropus from the Hylobatidae, which have a wide groove, as impression of their round, barer vermis cerebelli, and agrees with the large Simiidae and Man... With respect to the sulcus transversus the parieto-mastoid suture lies exactly as in Hylobates. Also as regards the situation of the internal asterion Pithecanthropus agrees entirely with Hylobates. For the postasterial index (the ratio of the distance between the asterion and the occipital pole and the endocranial length) I find 15.5 in Pithecanthropus, 15.8 in Hylobates, and an average value of 24 in human skulls of different races.

"The form of the skull of Pithecanthropus is on the whole not human; nor is it a transition of any type of manlike apes to the human type. The agreement with the anthropoid canial type, particularly that of the small gibbon species, of the genus Hylobates, may on the other hand be called perfect, taking into consideration the inevitable deviation in the proportions in consequence of the ratio of the volume of the brain and the eye varying with the increasing bulk (weight of the body) and cephalization. For with increasing bulk the eye increases somewhat less in volume than the brain, and on account of the much higher cephalization of Pithecanthropus the brain was besides enlarged far beyond the homoneuric ratio. The fossil cranium is not more highly arched, has no less receding forehead, and the pre-cerebral part of the frontal bone projects equally far forward as in the Apes. The constriction ("Einschnürung") behind the orbitae is also perfectly pithecroid in its depth and its situation at a greater distance from the supraorbital border; so is the place where the external auditory meatus must have been, and the form of the crista supramastoidea. Perfectly pithecoid was further the shape of the torus occipitalis transversus and the value of the angle at which the nuchal plate of the occipital bone bands foreward and downward. In all these points Pithecanthropus is distinguished, no less strongly than the Anthropoid Apes, from Neandertal Man. From the latter character of the fossil skull it may be conluded that also the condyles of the occipital bone were placed in the same way at the skull, so that the head was not equipoised on the spinal column as in

modern Man, but was carried by strong nuchal muscles and ligaments as in Apes. It is not to be seen by the structure of the skull that Pithecanthropus deserves the name of (p. 270) *erectus,* assigned to him an account of the features of the femur.....

"It is certain that the erect posture of the body, which clearly appears from the shape of the femur, was not such a perfect one as in Man; the correlation, at least, did not extend to the skull.

"Nor can the skull, however, have belonged to an Anthropoid Ape, because the relatively very large skull as regards shape presents a close, nay striking resemblance to the skull of a small Hylobates species, the smallest of the Anthropoid Apes, whereas judging not only from the femur and the molar teeth, but also from the skull itself, Pithecanthropus must have surpassed the size of a large chimpanzee, and very much that of a medium-sized man. Those smallest Manlike Apes distinguish themselves especially by their large neurocranium in the proportion of their splanchnocranium, the facial part of the skull. This is a consequence of the law governing the relation between the quantity of the brain and the bulk of the body in closely allied species. Small species have in general larger brains in comparison with their body weight than large ones of the same genus, sometimes also of the same family, in general than large homoneuric species (species with the same organisation of the nervous system). Judging by the linear dimensions, and as will appear subsequently, by the cranial capacity, Pithecanthropus *as an Anthropoid Ape* would have been a giant of about 300 kg weight, much larger than the heaviest gorilla. But Pithecanthropus was *not* such a giant. This appears not only from the dimensions of the femur, but also in the skull from the great distance of the temporal line, the boundary of the surface origin of the musculus temporalis from the median line, an indication that this masticatory muscle was weak with respect to the size of the neurocranium, though in such a gigantic Anthropoid Ape as Pithecanthropus must have been, it would have had on the contrary a comparatively much larger area of origin, to find sufficient space at the then *relatively* small neurocranium. We may refer to the cranial crests of large male gorillas and orang-utans.

"That the fossil skull bears such striking resemblance to that of Hylobates, this dwarfish genus among the Anthropoid Apes, does not therefore compel us to class Pithecanthropus for this reason among this family, but it also gives support to the view that the Hylobatidae are actually to be considered as genuine and then the most primitive Manlike Apes, though such as are particularly specialized by their long arms and sabre-shaped canine teeth."

What induced VON KOENIGSWALD, who took little notice of the papers from which I have quoted, to his idea indicated in the beginning of this communication, was obviously the only taxonomic sentence, occurring at the end of my paper of 1924, which reads: "The approach of the mandible and the teeth, as also of the femur, to the human type, and the large

cranial capacity, added to considerations on the brain-quantities in nearly allied mammalian genera, all this leads me to the conclusion that Pithecanthropus should be considered as a member, but a distinct genus, of the family of the H o m i n i d a e."

This sentence was intended to reflect the current views of taxonomists at that time, from which mine, expressed in 1894, and to which I still adhere, is entirely different.

It is most regrettable, that for the interpretation of the important discoveries of h u m a n fossils in China and Java, WEIDENREICH, VON KOENIGSWALD and WEINERT were thus guided by preconceived opinions, and consequently did not contribute to, on the contrary they impeded, the advance of knowledge of m a n ' s p l a c e i n n a t u r e, what is commonly called human phylogenetic evolution. Real advance appears to depend on obtaining material data in an unbiassed way, such as the *Pithecanthropus* fossil remains and instructing material about the phylogenetic growth of the brain.