Anatomy. — *Comparison of the endocranial casts of the Pithecanthropus erectus skull found by* DUBOIS *and* VON KOENIGSWALD'*s Pithecanthropus skull.* By C. U. ARIËNS KAPPERS and K. H. BOUMAN.

(Communicated at the meeting of December 17, 1938.)

At the meeting of November 27th, 1937 VON KOENIGSWALD published his first communication [1]) on the fossil fragment of a right mandible, which he ascribed to a Pithecanthropus specimen. The object was found in the Trinil layer of Central Java.

The R. ascendens of the mandible failed, the fragment being broken caudally behind the third molar, frontally between the 1st and 2nd incisivus. Of the teeth, the molars and the 2nd premolar were preserved. The shape of the arcus dentium was human in character, being medially concave. Although the alveolus of the 1st premolar was covered by a crust, it was evident that there was only one alveolus and not two as there are in apes.

The second premolar was typically pithecoid and could be ascribed to an ape if it were not that it closely resembles the Sinanthropus premolar, although its relief is somewhat clumsier.

The relief of the molars is more complex than in man, but less so than in Sinanthropus (as also the posterior premolar).

The length occupied by the three molars in the jaw (40.0 mm) exceeds the human molar length, coming very near that of the Orang-Utan molars (42.4 mm, GREGORY). In backward direction the size of the molars showed a considerable increase, while in recent man the opposite is seen, the third molar being reduced in man. Even in Sinanthropus and in the Heidelberg jaw the third molar is reduced. The above mentioned relation is only found in Simia (also in Dryopithecus) so that this relation is pithecoid according to VON KOENIGSWALD.

On the other hand the breadth of the third molar exceeds its length. It has a high L/Br. index, as only occurs in man.

The mandible itself differs from the anthropomorphous mandible by its shortness and roundness. The chin is oblique (fliehend), a spina interdigastrica (typical of anthropoids) fails. Frontally the mandible decreases in height. There is a strong insertion surface of the m. digastricus (fossa digastrica). There are considerable resemblances with the Heidelberg jaw and instead of one mental foramen there are three, which would be an exceptional thing for an anthropoid.

Concluding VON KOENIGSWALD states that, apart from the pithecoid features of the large second premolar, the unreduced third molar and the length occupied by the three molars, the character of the mandible is hominid. In the size of the premolar it comes nearest Sinanthropus, from which, however, the mandible itself differs by its increase in height in frontal direction in the molar region and its decrease in the chin region and by the lack of a torus mandibularis. Its general shape resembles more that of the Heidelberg jaw without being so massive.

Considering the great resemblance of the fragment with the jaw fragment

[1]) G. H. R. VON KOENIGSWALD, Ein Unterkieferfragment des Pithecanthropus aus Trinilschichten Mittel-Javas. Proc. Kon. Akad. v. Wetensch., Amsterdam, **40**, 883 (1937).

of Kedoeng Broeboes described by DUBOIS, which fragment was stated by DUBOIS to be a Pithecanthropus fragment, VON KOENIGSWALD does not doubt that his mandible is of the same species, and — on account of the arguments mentioned above — he believes that its features are primitively hominid rather than anthropoid.

Since, however, already in the old Pleistocene of Java human relics occur (Homo modjokertensis VON KOENIGSWALD [1]), while in the young pleistocene layers of Ngandong OPPENOORTH [2]) discovered his Homo Soloensis (Javanthropus OPPENOORTH), VON KOENIGSWALD concludes that in the middle pleistocene, to which his Pithecanthropus belongs, Pithecanthropus already was a hominid relic.

At the meeting of January 29th, 1938 of the Academy of Sciences VON KOENIGSWALD gave a communication on a new Pithecanthropus skull found in the deepest layer of Trinil Java [3]).

After the reconstruction of the thirty pieces of which it consisted, the fragment appeared to have a striking resemblance with that of the Pithecanthropus skull found by DUBOIS. Both skulls show the same clumsy structure of the supra-orbital region, the same frontal flatness and small calotte height. Also the sudden bend in the occipital part of the skull is the same in both. Both skulls have a considerable postorbital narrowing and even the curious protuberance in the bregma region occurs in both. According to VON KOENIGSWALD no doubt both skulls are representatives of one species. This is confirmed by the measurements accompanying VON KOENIGSWALD's paper.

VON KOENIGSWALD considers his skull (and therefore also DUBOIS' Pithecanthropus) as being hominid, e.g. on account of the features of the temporal region, specially the deep mandibular fossa with a tuber mandibulare in front of it, as only found in Hominids (MARTIN and SCHWALBE). According to him this alone would justify calling it hominid [4]).

The meatus externus in VON KOENIGSWALD's skull lies under the elongation of the zygomatic bone, as also observed in man. VON KOENIGSWALD also believes that skull bones of such a thickness as found in this skull and in DUBOIS' Pithecanthropus do not occur in anthropoid apes, but should be considered as a fossil hominid feature.

On the other hand, by the absence of a mastoid process, present in man

[1]) G. H. R. VON KOENIGSWALD, Erste Mitteilung über einen fossilen Hominiden aus dem Alt-Pleistocän Ost-Java's. Proc. Kon. Akad. v. Wetensch., Amsterdam, **39**, 1000 (1936).

[2]) OPPENOORTH, De vondst van paleolithische menschenschedels op Java. Mijningenieur, **6**, 106 (1932) and Ein neuer dilavialer Mensch von Java. Natur und Museum, **62**, 269 (1932).

[3]) G. H. R. VON KOENIGSWALD, Ein neuer Pithecanthropus Schädel. Proc. Kon. Ned. Akad. v. Wetensch., Amsterdam, **41**, 185 (1938).

[4]) VON KOENIGSWALD is inclined to correlate the deepened fossa mandibularis of man with his faculty of speech.

and also in the Sinanthropus, Ngandong and Rhodesian skulls, his skull resembles that of anthropoids.

Considering the fact that both his and DUBOIS' Pithecanthropus skulls are adult but that the volume of his skull (750 cc) is smaller than that of DUBOIS' specimen (900—950 cc), VON KOENIGSWALD is inclined to accept that DUBOIS' skull is that of a male, his own of a female individual. He furthermore believes on account of the characteristics of the temporal region mentioned above and on account of the relation of frontal sinuses in DUBOIS' specimen (WEINERT) [1]) that Pithecanthropus was hominid. As another argument for this he refers to BLACK's and WEIDENREICH's opinion concerning the affinity of Pithecanthropus and Sinanthropus, the latter being doubtless hominid (capacity ♀ 1050 cc; ♂ 1100—1200 cc).

Nevertheless he emphasizes the primitiveness of this hominid as evidenced by the small skull capacity, the failing mastoid process, the occurrence of an unreduced third molar and the length of the molar insertion.

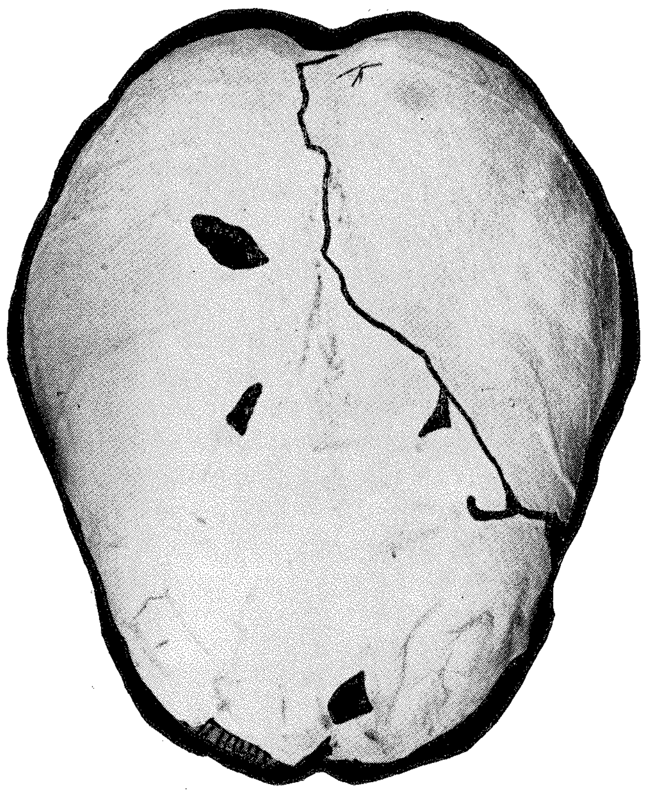

Fig. 1. Endocranial cast of the Pithecanthropus of VON KOENIGSWALD superposed upon the dorsal contour of the endocranial cast of Pithecanthropus erectus DUBOIS. Reduction ≠ ⅔.

[1]) WEINERT, Neue Untersuchungen über die Calotte des Pithecanthropus erectus DUBOIS. Zeitschr. f. Ethnologie, 199 (1922). As WEINERT, however, states, frontal sinuses also occur in the Chimpanzee and Gorilla (cf. his Rassen der Menschheit, p. 9).

The statements of VON KOENIGSWALD have been criticized by DUBOIS. Referring for this criticism to DUBOIS' articles in our Proceedings of January and March 1938 [1]), I only mention here that DUBOIS repeats that

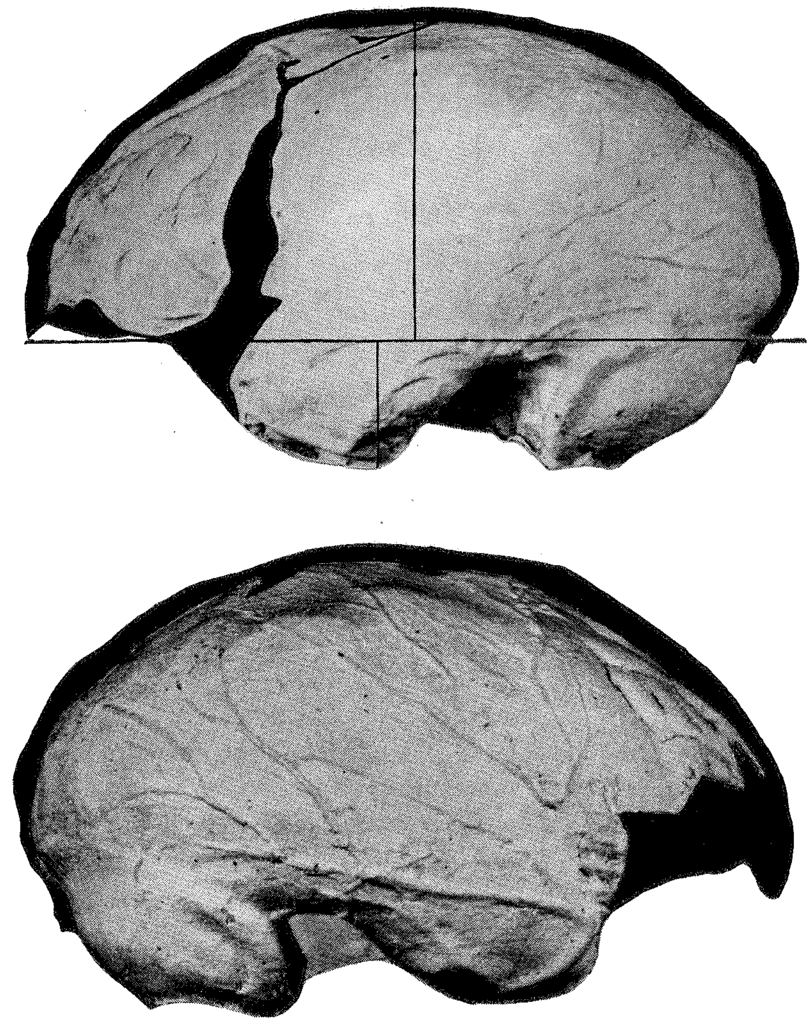

Fig. 2. The same as fig. 1. Lateral superposition. Reduction ≠ ⅔.

his Pithecanthropus skull was rather anthropomorphous (especially Hylobatid) in character and thus differs from Sinanthropus, which according to all authors is a primitive hominid, and furthermore that DUBOIS, granting the hominid features of VON KOENIGSWALD's mandible and skull, doubts their indentity with his Pithecanthropus fragments. He considers the skull

[1]) The mandible recently described and attributed to the Pithecanthropus by G. H. R. VON KOENIGSWALD, compared with the mandible of Pithecanthropus erectus described in 1924 by EUG. DUBOIS. Proc. Kon. Ned. Akad. v. Wetensch., Amsterdam, **41**, 139 (1938) and The same: On the fossil human skull recently described and attributed to Pithecanthropus by G. H. R. VON KOENIGSWALD. Ibidem, p. 380.

TABLE I.

Measurements and Indices	Pithecanthropus erectus DUBOIS	Pithecanthropus erectus v. KOENIGSWALD	Sinanthropus pek. (E) Black	Javanthropus Ngandong V OPPENOORTH	Rhodesian
Capacity	900—950 cc ♂	750 cc ♀	1050 cc ♀ (11—1200 ♂)	1300 cc	1260 cc
Greatest length measured on our endocranial cast	15.39 cm	14.7 cm	15.99 cm	17.8 cm	17.35 cm
Greatest breadth measured on our endocranial cast	12.61 cm	12.00 cm	12.30 cm	13.72 cm	13.68 cm
L/Br. index calculated from these measurements	81.9 [1])	81.6	76.95	77.1	78.8
Max. height perp. on lat. hor. [2]) / total length on lat. hor.	0.44 (R)	0.43 (L)	0.46 (L)	0.46 (L)	0.50 (L)
Dist. height perp. front. pole / Dist. height perp. occ. pole	1.11	1.01	1.19	1.23	1.32 (L)
Temp, occ. length [2]) on lat. hor. / total length on lat. hor.	0.742 (R) ?	0.740 (L)	0.72 (L)	0.734 ?	0.76 (L)
Temp. depth [2]) / total length on lat. hor.	?	0.167 (L)	0.149 (L) [3])	0.135	0.128 (L)
Temp. depth [2]) / temp. occ. length on lat. hor.	?	0.225	0.208	0.184 ?	0.168 (L

to be of an immature individual, the mandible to be of a mature individual related to Sinanthropus and especially to OPPENOORTH's Homo Soloensis (Javanthropus).

By the kindness of Dr. VON KOENIGSWALD, Prof. K. H. BOUMAN and I each of us received an endocranial cast of VON KOENIGSWALD's Pithecanthropus, which we examined independently. For BOUMAN's description I refer to the Acta Neerlandica morphologiae normalis et pathologicae (Vol. II, 1938, p. 1). Here I wish to emphasize, as also Prof. BOUMAN did, the close resemblance of VON KOENIGSWALD's and DUBOIS' endocranial casts. Figs. 1 and 2 give the general contours of both casts, fig. 3 shows their fissural pattern. In the accompanying table I give some measurements and

1) In his paper of Jan. 29th, 1938, p. 187 VON KOENIGSWALD gives 77.65. This, however, is a mistake, considering the length and breadth figures mentioned by him: $\frac{1545}{1260}$ being 81.5.

2) These calculations are made after the perpendiculars and distances on the lateral horizontal (passing underneath the tub. orbitale and occipitale pole) on the photos.

3) In my paper on Sinanthropus of Nov. 25th 1933 stands 0.173. This figure is wrong, not being calculated from the photo of the left hemisphere but from the drawing of the right.

indices of both endocranial casts from which it appears that the differences between the two Pithecanthropi are strikingly small.

Our table also shows that there is a gradual increase in the relative height from Pithecanthropus (average 0.43½) via Sinanthropus and Javanthropus (0.46) to the Rhodesian (0.50) and that the position of the height perpendicular, as indicated by the relation of its frontal and occipital distances (Pithecanthropus average: 1.06; Sinanthropus: 1.19; Javanthropus: 1.23; Rhodesian: 1.32) shifts more and more backward. There is a gradual decrease of the relative temporal depth in Pithecanthropus, Sinanthropus, Javanthropus and the Rhodesian compared with the total and temporo-occipital length, while both lengths gradually increase. The fact that the relation between total and temporo-occipital length in the Rhodesian (0.76) surpasses this relation in Pithecanthropus (0.74), while in Sinanthropus it is smaller (0.72), shows that in the Rhodesian the increase of the total length is more due to a relative increase of the temporo-occipital length, in Sinanthropus to a stretching of the frontal lobes. This may perhaps be correlated with the mesencephaly of Sinanthropus (77) and the brachencephaly (81.8) of Pithecanthropus, the latter affecting specially the frontal lobes.

In fig. 3 the fissures impressed on the frontal lobes of both Pithecanthropus casts are drawn. They show a resemblance beyond expectation, — confirming at the same time that the frontal fissural pattern as given by one of us in 1929 [1]) of DUBOIS' specimen is typical of this species.

As far as concerns the interpretation of the numbers added to the fissures, we refer to our former paper(s) on this subject.

We also call the attention to the peculiar fact that the arborisation of the dural arteria meningea media on the right hemispheres of DUBOIS' and VON KOENIGSWALD's specimens show a resemblance rarely found in this greatly varying [2]) vascular system [3]).

Turning to the question of the pithecoid or hominid character of these endocranial casts of Pithecanthropus, I would remark that just as in the dental system (length of the molar insertions, unreduced third molar, features of the second premolar) and in the calotte (small volume, failing mastoid) pithecoid features occur, next to hominid features (shape of the arcus dentium and of the mandible itself, presence of the tuber mandibulare, position of the meatus auditorius externus underneath the continuation of the zygomatic bone, massive skullbones), so also the endocranial relations show pithecoid and hominid features.

As far as concerns the fissures, I already pointed out that the frontal fissuration in Pithecanthropus shows far more affinities with that of Chimpanzees than ever observed in man, even in Neanderthal man.

1) The fissures on the frontal lobes of Pithecanthropus erectus DUBOIS etc. Proc. Kon. Akad. v. Wetensch., Amsterdam, **32**, 182 (1929). See also KAPPERS, The evolution of the nervous system in invertebrates, vertebrates and man. (Bohn, Haarlem, 1930).

2) Cf. GIUFFRIDA-RUGGERI, Ueber die endocranischen Furchen der Arteria meningea media beim Menschen. Zeitschr. f. Morph. und Anthrop., **15**, 401 (1913).

3) This arborisation has a hominid character as also emphasized by WEIDENREICH; see his paper. The Ramification of the middle meningeal artery in fossil hominids and its bearing upon phylogenetic problems. Paleontologia Sinica N.S.D. N°. 3, Peking (1938).

The frontal fissures on the left hemisphere of a Chimpanzee published in our 1929 paper differ chiefly from those on the left hemisphere of

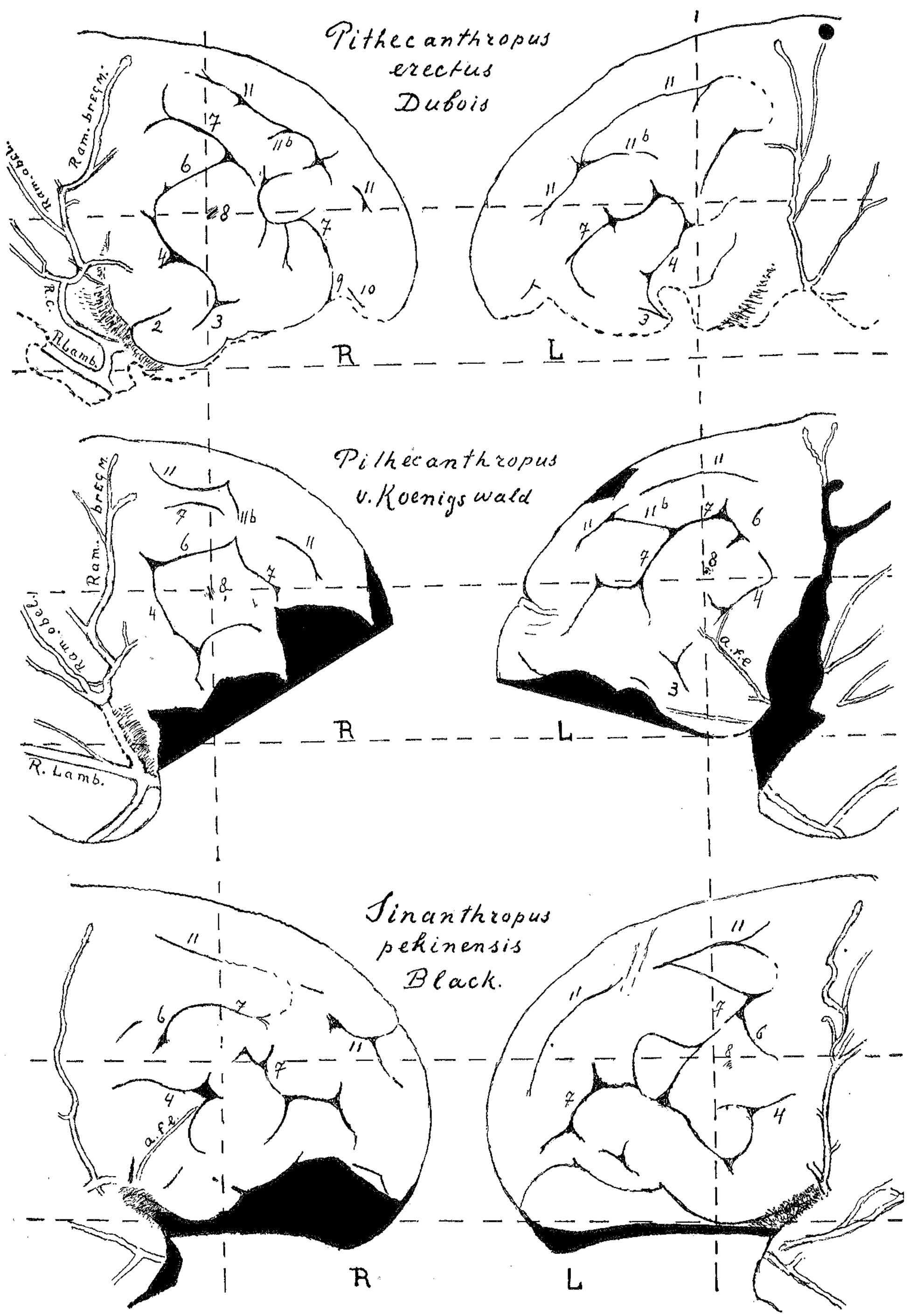

Fig. 3.

DUBOIS' Pithecanthropus by being steeper, more frontally curved (Cf. fig. 3 and fig. 4), which could be partly explained by the more brachencephalic shape of the brain (index Chimpanzee 84.2 Pithecanthropus 81.6).

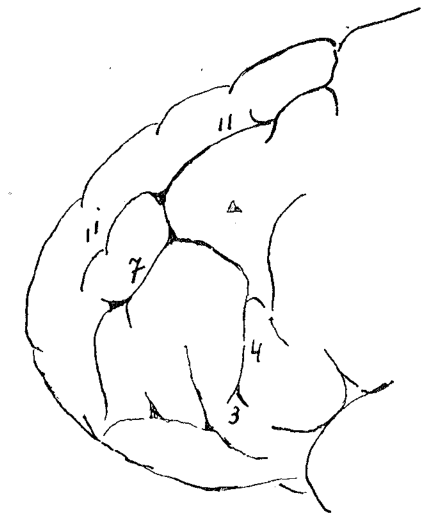

Fig. 4. Fissuration of the left frontal lobe of a Chimpanzee.

DUBOIS is inclined to consider his Pithecanthropus skull rather Hylobatid than Chimpanzoid. Since the presently living Hylobatids have an encephalic l/br. index of about 80, this index, as also their skull vault come nearer those of Pithecanthropus than the Chimpanzee's. The recent Gibbons and consequently also their brains are very small in comparison with the other anthropomorphs and their brains. Their frontal fissuration is too poor to be successfully compared with Pithecanthropus. But if ever a Gibbon of greater size and analogous index has lived, its fissures might perhaps resemble even more those of Pithecanthropus in being frontally less curved than in the Chimpanzee.

A pithecoid feature of the endocranial cast of DUBOIS' Pithecanthropus is seen in the possible indication of a lunate sulcus on the right occipital lobe on the level of the lambda suture, while in recent man (probably even on the Neanderthal cast of Dusseldorf) this sulcus lies a good distance behind the lambda suture. After all, DUBOIS' nomenclature "Pithecanthropus" seems to be the best expression for the intermediate character of this species.

Furthermore we believe that, although there are similarities also between the endocranial casts of Pithecanthropus and Sinanthropus, they should not be considered as belonging to one species, the latter having more hominid characteristics than the Pithecanthropus, as pointed out for the endocranial cast in 1933[1]).

Leaving the final decision concerning the degree of relationship between Pithecanthropus and Sinanthropus to those who are more competent to judge the skeletal details, we take this occasion to compare again the Pithecanthropus and Sinanthropus endocranial casts, referring to figs. 3 and 5 and table I. Although the fissural impressions, specially on the left hemisphere of Sinanthropus, are not as evident as they are in the Pithecanthropus specimens, we believe the drawings given here approach their relations as closely as possible. From this it appears that the frontal fissures in Sinanthropus may come closer to the Pithecanthropus fissures

[1]) The fissuration in the frontal lobe of Sinanthropus pekinensis BLACK, compared with the fissuration of Neanderthalmen. Proc. Kon. Akad. v. Wetensch., Amsterdam, 36, 802 (1933).

than was first expected. In this respect I would call attention to some resemblances between the right frontal fissuration of Sinanthropus and the

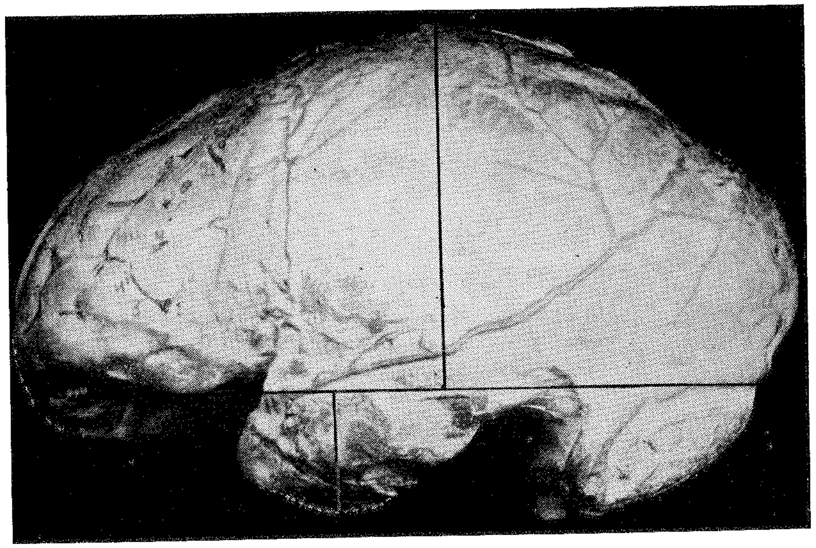

Fig. 5. Left hemisphere of the endocranial cast of Sinanthropus pekinensis (*E*) BLACK.

left frontal fissuration of Pithecanthropus DUBOIS. There also are resemblances between the left frontal lobes of Pithecanthropus VON KOENIGSWALD and Sinanthropus. Yet, in both Pithecanthropi the inferior frontal fissure[1] (4) runs far less horizontally than in Sinanthropus, which thus shows a more hominid character, closely resembling the shape of the relation in the Rhodesian cast, as stated in our '33 paper. Also the separation of fissure 6 from 4 and its remaining attached to 7 is more hominid. In our description of the Sinanthropus cast we already called the attention to the possibility that *if* on the left hemisphere of Sinanthropus an indication of ELLIOT SMITH's lunate sulcus (or of the mesial continuation of this sulcus, the s. polaris superior) occurs, it lies behind the lambda suture (as it does in man), while in Pithecanthropus (right hemisphere) the impression that perhaps *might* be identified with it lies on the level of the lambda suture (a pithecoid relation).

From our table I it also appears that the general height index in Sinanthropus (0.46) is greater than in both Pithecanthropi 0.44 and 0.43), and that its greatest height perpendicular lies nearer the occipital pole, the relations between the frontal and occipital distance of this perpendicular on the lateral horizontal being 1.19 in Sinanthropus and 1.11 and 1.01 in

[1] I may call attention to the fact that this diagnosis of fissure 4 in both cases is confirmed by the course of CUNNINGHAM's external frontal artery, orbito-frontal artery (a. f. e) (BOUMAN and LEY's external orbito-frontal artery; POIRIER and SHARPY's artère de la 3ème circonvolution cérébrale), a pial artery.

the Pithecanthropi. Furthermore the relation of the temporal depth to the total as well as to the temporal length of the cast is smaller in Sinanthropus.

Also the volume (♀ 1050, ♂ 11—1200 cc) and general contours of the Sinanthropus endocranial cast are more human. They closely approach those of Homo soloensis, Javanthropus OPPENOORTH[1]), as stated elsewhere[2]) (Figs. 6*a* en 6*b*).

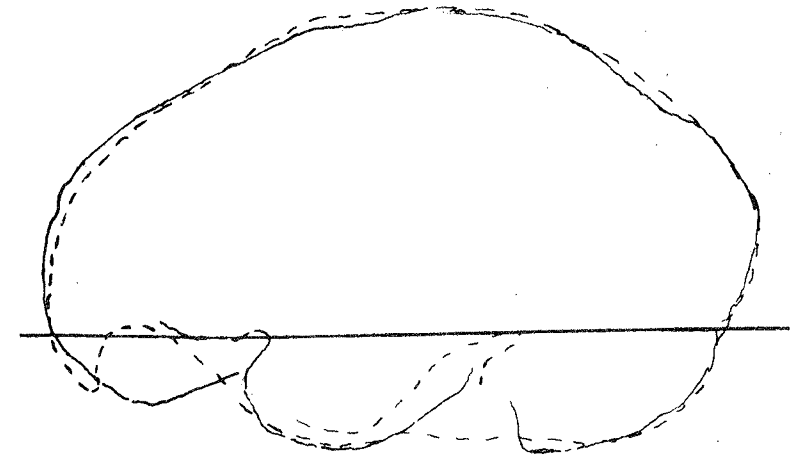

Fig. 6*a*. Continuous line left hemisphere Sinanthropus, dotted line left hemisphere Ngandong V endocranial cast, superposed with equal fronto-occipital length.

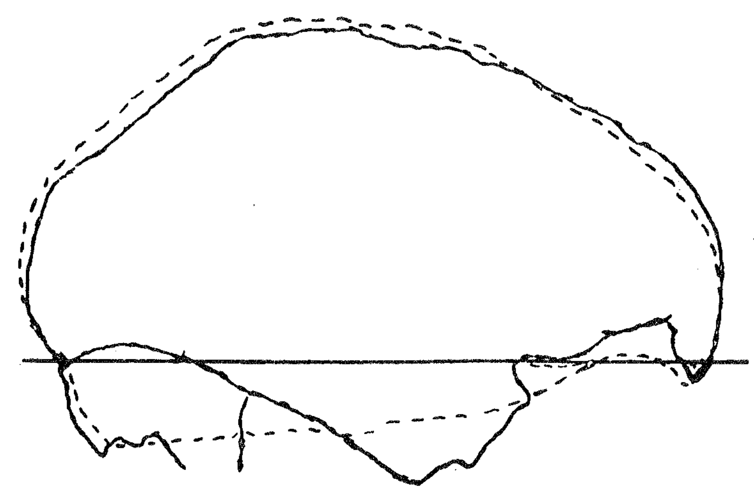

Fig. 6*b*. Continuous line right hemisphere Sinanthropus, dotted line right hemisphere Ngandong V endocranial cast, superposed with equal fronto-occipital length.

[1] OPPENOORTH, The place of Homo Soloensis among fossil men, in Early Man, ed. by Philadelphia, Lippencott (1937).

[2] ARIËNS KAPPERS, The endocranial casts of the Ehringsdorf and Homo soloensis skulls. Journal of Anatomy, **71**, 61 (1936).

Also WEIDENREICH frequently emphasized the human character of Sinanthropus [1]). For the study of endocranial casts of fossil skulls in general, including hominid casts, I also call the attention to Dr. T. EDINGER's [2]) valuable papers.

[1]) Cf. WEIDENREICH, Sinanthropus pekinensis. A distinct primitive Hominid. Proceed. of the Joint meeting of the anthropol. Society of Tokyo and the Japanese Society of Ethnology (1936). Ueber das phylogenetische Wachstum des Hominiden Gehirns. Kailbôgaku Zasshi, **9**, Aug. 1936; and Observations on the form and proportions of the endocranial casts of Sinanthropus pekinensis, other hominids and great apes. Paleontologia Sinica Ser. D, Vol. VII, Fasc. 4 (1936), and The relation of Sinanthropus pekinensis to Pithecanthropus, Javanthropus and Rhodesian Man. Journ. of the Roy. Anthr. Institute, Vol. **67**, 51 (1937).

[2]) T. EDINGER, Die Fossilen Gehirne. Springer, Berlin, 206 (1929). See also T. EDINGER, Paleoneurologie. Fortschritte der Paleontologie, **1**, 235 (1937).

Anatomy. — *Index curves of Asia and the Great Sunda islands.* By C. U. ARIËNS KAPPERS.

(Communicated at the meeting of December 17, 1938.)

Although the length breadth index of the head is by no means sufficient for a racial diagnosis, the typognostic value of this index, first emphasized by ANDERS RETZIUS, has been frequently confirmed, also in recent times.

So MORANT [1]) found that of 31 features of the skull six features have more value than the remaining 25 together, and that of these six the value of the length breadth index is about twice as influential for the coefficient of racial likeness as the other five.

More characteristic than the average index of a racial group are curves [2]) in which the individual indices are plotted and which show that the peak or peaks of the indices of a sufficiently large group usually coincide(s) with the peak or peaks of another group of the same race, even if their averages show some difference owing to the height of the peak(s) and the spread of the curve.

Such curves may also show that in addition to the peak(s) characteristic of a race a leap-like modification may occur in the form of an additional more brachycephalic peak, usually a fixation of an infantile stage. This fixation may have progressive value, as the development of the 78—80 peaks in a 73—75 index group when living under better circumstances, or a less favourable character, as the evolution of a hyperbrachycephalic peak in a brachycephalic people when living under poor circumstances.

This appears from BOAS' [3]), researches on Sicilian immigrants and his and GUTHE's [4]) on Jewish immigrants in America and from the curve of Armenian refugees measured by the KRISHNERS compared with the better situated Armenians measured by myself [5]). An analogous difference is observed between the head indices of the Palestinean and those of the poorer situated South-Arabian Arabs. It furthermore appeared from GUTHE's curves and from the curves I made of BOAS' material that the more brachycephalic peaks in the Jewish and Armenian curves again disappear in descendants living under better circumstances. That such additional peaks are fixations of an infantile stage is confirmed by KLEIN's researches [6]).

[1]) MORANT, A preliminary classification of European races, Biometrika, **20** B, 301 (1928).

[2]) In all my curves the index figure 70 stands for 70—70.99 etc. If no other indication is given, the indices are those of adult males.

[3]) BOAS, Abstract of report on changes in bodily form of descendants of immigrants. Gov. Printing Office, Washington, D. C. (1911).

[4]) GUTHE, Notes on the cephalic indices of Russian Jews in Boston. Amer. Journal of Phys. Anthrop., **1** (1918).

[5]) ARIËNS KAPPERS, The degree of the changes in the cephalic index correlated with age and environment. Proc. Kon. Akad. v. Wetensch., Amsterdam, **38** (1935).

[6]) W. KLEIN, The degree of the developmental changes in the length breadth index of the head of Dutch Askenasim Jews. Proc. Kon. Akad. v. Wetensch., Amsterdam, **38**, 1021 (1935).