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New Endocranial Values for the East African Early Hominids

THIS is a preliminary report on research carried out during 1971 and 1972 on the endocranial values of some East African hominids from Olduvai Gorge, Tanzania, and East Lake Rudolf, Kenya. The cranial remains suitable for the reconstruction of volumetrically accurate endocranial casts are as follows: from Olduvai Gorge, hominids OH 7, 9, 12, 13 and 24; from East Lake Rudolf, KNM-ER 732 and 406. Each set of hominid remains required its own reconstructive procedures; a full description of each is unnecessary here but will be published elsewhere. In this communication I report only the results and make some preliminary observations as to their significance. Table 1 shows the cranial capacities found for each hominid. Not all of these results should be equally regarded; some results are only approximations but others are stated with more confidence.

The cranial capacities for OH 12, 13 and 24, are based on partial plasticine reconstructions added to accurate plaster casts of the interior of the cranial fragments. OH 12 and 13 required considerable addition of plasticine, particularly in the frontal region.

OH 24 required correction of the distortion of the existing endocranial cast as produced by Mr Ron Clarke. Two coronal sections were made in a plaster cast of the original reconstruction as most of the distortion seemed to be in the vertical plane. The sections roughly divided the endocast into thirds which were then rotated so that the dorsal segments left a small gap on either side of the central portion. Some small degree of reduction of the biparietal width was necessary for the distortion has clearly enlarged this dimension. Finally, the endocast of the brain stem was carved out with a diamond rotary saw, and was correctly oriented in a more posterior position.

All of the reconstructions except KNM-ER 406 were coated with preservative and immersed in water to give the final displacement volume[1]. OH 7, based on the juvenile parietals, and estimated at 687 cm^3 by Tobias[2,3] was not reconstructed, but "fitted" over existing full endocasts. The endocast of OH 16 was not reconstructed as the skull reconstruction is not good enough, in my judgment, to give an accurate internal surface replica.

OH 9 and KNM-ER 732 were endocast directly from the originals using rubber latex; later small amounts of plasticine were added before determination of the total volume after first checking the dimensions of the endocast moulds against the originals. The differences in measurements were under 1%. In the case of OH 9, two reconstructions were made; the second followed Dr Alan Walker's skilful excavation of matrix from the middle and anterior cranial fossae. This permitted an unequivocal determination of the cranial volume. Only minimal modification was needed at the base and some plasticine was added to the parietal segments, particularly on the right side. Only the second reconstruction is given here. KNM-ER 732, comprising the right half of a presumably female robust australopithecine[4], was endocast directly with latex stabilized with plaster; plasticine was added to form the missing occipital and cerebellar lobes. The small fragment of the occipital bone that shows part of the right occipital condyle, the position of the hypoglossal canal and an accessory vein, was utilized to reconstruct the region of the foramen magnum.

The volume of the KNM-ER 406 skull was estimated by using the formula[5] $V=f\ \frac{1}{2}(LWH)+\frac{1}{2}(LWB)$, where f was obtained by using the average fs from OH 5 and from the new SK 1585 from Swartkrans[6,7]. The dimensions of length (L), width (W), breadth (B) and height (H), were taken externally; estimates of bone thickness based on both KNM-ER 406 and OH 5 were subtracted from the external measurements. These dimensions should closely approximate the true internal endocast dimensions of KNM-ER 406.

Of all the reconstructions made, only OH 12 could show considerable error, because it has the most plasticine addition. This involves all of the frontal lobe and the temporal lobe. The frontal and temporal reconstructions were made by placing the right temporal fragment, showing part of the foramen ovale and the middle meningeal artery, in correct relation with the remaining main parietal fragment. The bregmatic and frontal portions were similarly placed in the best position in relation to each other and the remaining endocranial reconstruction.

The results show (Table 1) that the volumes for the Olduvai hominids are either the same as or very near to, those given by Tobias[2,3] whose estimates were made by the method of partial endocasts. Table 2 gives some of the statistical results using Student's t test for small samples[8], using standard deviations based on the assumption of a coefficient of variation

Table 1 Volumetric Results

Specimen	Taxon	Cranial capacity (cm^3)	Method
OH 9	*Homo erectus*	1,067	Latex mould + plasticine
OH 12	*H. erectus* (?)	727	Plaster cast + plasticine
OH 13	*H. habilis*	650	Plaster cast + plasticine
OH 24	*H. habilis*	590	Plaster cast + plasticine + correction
KNM-ER 406	*Australopithecus robustus boisei* (male)	510	Volume formula + measurements
KNM-ER 732	*A. robustus boisei* (female)	506	Latex mould + plasticine

Average for *H. habilis*, including 650 cm^3 value for OH 16, and 687 cm^3 for OH 7, = 637 cm^3.

(s.d. = 64 cm^3, assuming coefficient of variation = 10%.)

Average for robust australopithecines, including OH 5 at 530 cm^3 and SK 1585 at 530 = 517 cm^3.

Average for gracile australopithecines[11] ($n = 6$) 442 cm^3.

of 10%. Naturally the small sample sizes involved make this very speculative. Nevertheless, even with a small sample size and large standard deviations, the values of "t" are still very high. Assuming that the mean values are reasonably close to the true means, the values of "t" would become considerably higher as the sample size increased, and it is doubtful whether the standard deviations would go beyond a figure giving more than a 10% coefficient of variation. OH 7 and 16 have been included as part of the habiline sample, using the values given by Tobias[2,3]. Although the value of 650 cm^3 for OH 16 may be doubtful in view of the fragmentary nature of the skull, it is unlikely that it is grossly inaccurate if the large size of the frontal portions and the associated dentition are considered. The high value given for OH 7 (687 cm^3) does not in any way seem extreme because no acceptable alternative ways of orienting the parietals could be found[9]. Furthermore, the parietals of OH 7 more than cover the completed OH 13 parietal regions on the reconstructed endocast (which gave a value of 650 cm^3) and came closest to fitting the 727 cm^3 reconstruction for OH 12 thus giving added support to the value found earlier by Tobias.

Table 2 Statistical Results

Student t test (two tailed)[8]	t	P	
(1) "Gracile" vs "robust" australopithecines*	2.46	<0.02	<0.05
(2) "Robust" australopithecines vs *H. habilis*	2.91	<0.02	<0.05
(3) "Gracile" australopithecines vs *H. habilis*	5.76	<0.001	
(4) "Gracile" and "robust" australopithecines vs *H. habilis*	5.38	<0.001	

* With $n=6$ for both groups, $t=3.56$ $P<0.01$ >0.0011

While the study of the morphological attributes of these endocasts is still in progress, the volumes and endocast shapes support the concept of a more advanced hominid population both distinct from *Australopithecus africanus*, *Australopithecus robustus* and *Homo erectus*, namely *Homo habilis*.

It would be unwise at this time to draw conclusions about the relationships between the fossils on the basis of endocast shapes until they have been more thoroughly studied. The KNM-ER 406 cranium is extremely similar to the cranial remains of OH 5; both gross observation and external measurements indicate that KNM-ER 406 is slightly smaller than OH 5. The appearance of the collateral vein in the occipital portion of KNM-ER 732, the overall shape and small size of the endocast, as well as the more gracile nature of the skull all suggest that KNM-ER 732 is most likely to be a female robust australopithecine skull[10]. The value of 506 cm^3 for ER 732 represents 95% of the 530 cm^3 values for OH 5 and for SK 1585, a value also consistent with sexual dimorphism as an explanation of the difference.

The low value of 732 cm^3 for endocranial volume of OH 12 (VEK IV), obtained from such a high geological level (Bed IV) in relation to the 1,067 cm^3 value for OH 9 (Upper Bed II), raises some interesting questions. Are these values simply the extremes of a range? Is OH 12 a remnant of the earlier *Homo habilis* taxon? Is it simply a small female *Homo erectus*? On the basis of the skull alone, OH 9 was certainly a large and very robust hominid. The occipital and other skull fragments of OH 12 are very thick, and one fragment, that of the left petrous temporal, does not seem to belong with the other fragments attributed to OH 12, but must have come from a somewhat larger, second individual. Even accepting the

OH 9 as a large male from the upper end of the range and OH 12 as a small female, there still remains a very considerable difference, and also a large hiatus between the Bed II habilines and OH 9. This, plus the announcement[10] of a new skull, with an estimated cranial capacity of 800 cm^3, dating from a 2.6 m.y. level from East Rudolf, would make any simple anagenetic explanation of hominids, existing as either single lines or types, as extremely speculative and unlikely.

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