Hadar

AL 288-1 MORPH

Gross Description

AL 162-28
A small posterior portion of an endocast from a point roughly at the level of bregma to midcerebellar lobe in length, and from a portion of temporal squamous suture on the left side to midparietal on the right. (See Kimbel et al., 1982 for description). The internal table of cranial bone is very well preserved, and important convolutional details appear, making this one of the most important brain endocast portions for early hominids in addition to the famous Taung child specimen and Stw 505. It is also one of the most controversial specimens.

AL 288-1
There are only two very small endocast fragments for this individual, and they unfortunately do not adjoin. There is a small fragment of occipital and parietal lobe, with a small portion of the mostly right superior part of the cerebellar lobe, which will be described here. The second portion, somewhat larger, is a part of the left parietal showing some of the terminal meningeal vessels. This fragment is devoid of details and will not be detailed here. We refer to the first fragment as Lucy A and the second as Lucy B.

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AL 333-45
This is a relatively undistorted posterior half of an endocast that required reconstruction of the frontal and temporal poles. Minor reconstruction was needed for the foramen magnum region. The left temporal region appears to be somewhat deflected, inferiorly (see Kimbel et al., 1982 for description of the cranial portions).

AL 333-105
This is an endocast of the basal portion of the brain of an infant, briefly described in Holloway (1978, 1983a, b). The entire dorsal region is missing, and the base is distorted.

AL 444-2
The endocranial portions of most of the frontal, parietal, and occipital lobes, including the cerebellar lobes, and inferior portions of the temporal lobes are somewhat distorted. The brain stem, superior temporal lobes, and rostral orbital surface of the frontal lobe required minimal plasticene reconstruction. The condition of the internal table of bone is poor, and there are no convolutional details.

Volume and Method

AL 162-28
The volume of this endocast approaches 400 ml, but too much of the remaining brain is missing to effect a

reliable reconstruction. The volume estimates have been made largely on the basis of comparison with South African specimens such as Taung and STS 60. A volume estimate of less than 385 ml was given by Falk (1983a, b). We believe the volume to be between 385 and 400 ml.

AL 288-1

There is not enough material present to hazard more than a guess, which we believe would be very similar to that for the Hadar AL 162-28 specimen, that is, between 375 and 400 ml maximum. We base this estimate on the similar size of the occipital portions of the two individuals.

AL 333-45

As reported in Holloway (1983a), the estimated endocranial volume is between 485 and 500 ml. The reliability is A2. The 485 ml figure was based on a regression formula applied to the biasterionic breadth. The 500 ml value is from the first endocast reconstruction, and a second one is now in progress.

AL 333-105

Plasticene was added to the basal portion to affect a total volume, which provided a volume estimate of 320 ml. Given its infant status, we expect an additional 20–25% growth to obtain an adult size, and 400 ml is our estimate for the adult size. We estimate the reliability as A3, signifying that a small portion of plasticene was added but that given both the distortion and the infant status, we must speculate heavily regarding its adult size.

AL 444-2

Our (RLH and MSY) estimates, based on repositioning the endocranial portions, is 550 ml. Using hemi-endocasts portions, RLH arrived at a volume of 545 to 560 ml. Water displacement was used in both cases. We regard the reliability as A1.

Endocast Details

AL 162-28

As rendered by John Gurche in Holloway (1983c), there are two significant groves that suggest cortical morphology. Groove A (HADAR Fig. 3) is identified as the interparietal sulcus (IP), and groove B a remnant of the lambdoid suture. This groove was not identified as a lunate sulcus (LS), except by Falk (1983b). Thus the posterior parietal and anterior occipital lobes show promising convolutional detail, albeit not without controversy. The remaining endocast surface is devoid of convolutional markings. The cerebellar lobes are broken at mid-level; thus there are no remnants of the sigmoid sinus or posterior cerebellar lobes. The transverse sinus is not visible, and there is no trace of a marginal/occipital sinus, whether enlarged or small. There is a small meningeal vein coursing across the left occipital pole, and a tiny vessel on the lower left parietal lobe.

AL 288-1

The most intriguing part of Lucy A's occipital is the clear presence of the lambdoid suture. The right inferior portion of the suture, just as it meets the right transverse sinus, clearly limits the lateral and inferior portion of the occipital lobe, and there is a distinct groove, moving superiorly along the lambdoid suture and anterior to it, that might be the dorsal limit of the lunate sulcus. The transverse sinus is small in diameter and it is most probable that it received flow from the sagittal sinus, but it is quite difficult to see this clearly because the medial portion of the left transverse sinus appears somewhat larger than the right side. The occipital lobes overhang only slightly the cerebellar lobes. There is not enough of the left occipital lobe to be certain about a petalial pattern.

AL 333-45

Unfortunately, cerebral convolutional details are lacking for this specimen, and landmarks such as the lunate sulcus (LS), interparietal sulcus (IP), or lateral calcarine sulcus (LC) cannot be unambiguously identified. There is a small left occipital petalial, but there is also a large fracture in the lambdoidal suture region of the left occipital pole that might be contributing to this petalia. Superior to the displaced lambdoid suture is a flattened region of the occipital lobe that carries a distinct depression and could be a remnant of the LC. If so, the anterior limit of the primary visual striate cortex (the LS) would be in a primitive, pongid condition. However, no clear IP sulcus abuts against what might be considered an anterior limit to PVC; thus the status of this important region is uncertain. The right sigmoid sinus is fuller than the left side, and both transverse sinuses are visible. It is unclear whether longitudinal sinus flow is to the right or left side. There is definite enlarged marginal/occipital sinus on the left side, commencing from the lateral sinus and coursing toward the sigmoid sinus and jugular foramen. There are discernable lateral parafloccular lobules on both sides of the cerebellar lobes, and the internal auditory meatus is seen on both sides within the temporal/cerebellar clefts. The poor quality of internal table of bone militates against any reliable meningeal vessels, except on the inferior aspects of both temporal lobes.

AL 333-105

There is considerable convolutional detail on the inferior frontal, temporal, and cerebellar lobes, but nothing for occipital, parietal, superior, and middle temporal nor dorsal frontal lobes. There is an indication of an enlarged marginal/occipital sinus, which traverses the foramen magnum, and this feature is thus far found only in robust forms.

The base of the infant's cranium was broken and thus the basal portion is severely distorted, with the left temporal lobe folded medially away from the small portion of dorsum containing inferior parietal lobe, which in itself is sprung laterally from the frontal portion. The frontal orbital bec is strongly pressed toward the right side, covering the orbital surface of the right frontal lobe. The right temporal lobe is present only in its anterior portion, and the Sylvian fissure is falsely accentuated by the sprung condition of the squamous suture. The inferior third frontal convolution is missing on the left side but shows interesting details on the right side. The superior portions of the cerebellar lobes are missing; thus the cerebellar form and details regarding sigmoid and transverse sinuses are not available for description. Additionally there is distortion through the foramen magnum region, such that the entire midsagittal orientation is seriously skewed, the left side being skewed posteriorly. The left temporal lobe shows a clear inferior temporal sulcus, a protruding foramen ovale, and a remnant of the foramen spinosum. The same appears on the inferior part of the right temporal lobe, and the middle meningeal vessels show a typical anterior and posterior bifurcation. The left temporal/cerebellar cleft shows the auditory nerve. The right frontal Broca's cap region is strongly protrusive both laterally and inferiorly, but there also appears to be a convincing inferior frontal orbital sulcus at its anterior margin, suggesting that at least in the infant state, there was a retention of a pongid pattern in this region of the brain.

AL 444-2

Aside from the fact that the cerebral occipital poles overhang the cerebellar lobes, little else can be said, except that the dorsal height of the parietal lobes at vertex appears very high and similar to that seen on SK 1585, a robust form.

Morphometric Data

AL 162-28

With so much of the frontal and temporal portions missing, metric data are sparse. We estimate A-P chord length to be between 95 and 100 ml, minimally. Arc lengths cannot be estimated. The maximum chord breadth is estimated to be between 85 and 90 mm, with arc breadth 130 mm minimally. The biasterionic breadth is estimated as ca. 62 to 65 mm. The bregma-asterionic chord (left side) is ca. 75 mm and the arc ca. 95 mm. Most important, the distance from the left occipital pole to the posterior part of the IP sulcus is ca. 15 mm, which is roughly 1/2 the distance found in *Pan troglodytes*.

AL 288-1

The parietal/occipital section is ca. 65 mm deep, and ca. 54 mm at its widest across the transverse sinuses. The distance, chord, from lambda to superior level of transverse sinus is 26 mm. We estimate the biasterionic chord breadth as between 65 and 70 mm. Johanson et al. (1982) provide a detailed description of the internal surface of the occipital and suggest that there may have been a marginal/occipital sinus.

AL 333-45

All measurements that follow are based on the second reconstruction. The chord length of the left side from frontal to occipital poles is ca. 120 to 125 mm; the right side is ca. 123 mm. The lateral arc length, left side, is 165 mm; the right, 162 mm. The dorsal arc length is 165 mm left and 160 mm right. The maximum chord breadth is ca. 100 mm, and the arc breadth over vertex is ca. 165 mm. The points for these measures are located on the superior temporal gyrus. The bregma-basion chord length is estimated to be ca. 85 to 90 mm, and the maximum height from lowest temporal lobe to vertex is ca. 80 mm. The bregma to deepest cerebellum is ca. 90 mm. The bregma-asterionic chord is ca. 90 mm, the bregma-asterionic arc is ca. 115 mm. The biasterionic breadth is ca. 75 mm. The bregma-lambda chord is ca. 70 mm and the arc ca. 75 mm. The maximum cerebellar width is ca. 78 mm, and the maximum width across the sigmoid sinuses is ca. 82 mm.

AL 333-105

Given the severe distortions one can only estimate the approximate measurements. The chord length is ca. 115 to 120 mm, but arc measurements are not possible given the distortions. The maximum chord breadth is estimated between 90 and 95 mm with arc breadth between 120 and 130 mm. The maximum cerebellar width, across the sigmoid sinuses, is 68 mm and is the only certain measurement on this endocast.

AL 444-2

The maximum chord length is 128 mm, the lateral arc is 165 mm, and the dorsal arc 178 mm. The maximum chord breadth ca. 99 mm, and arc breadth is 154 mm. The depth from the vertex to the lowest temporal poles ca. 82 mm. The maximum cerebellar width is ca. 86 mm. Additional measurements can be found by Holloway and Yuan in Kimbel, W., Rak, Y., and Johanson, DC. 2004. The Skull of Australopithecus afarensis. Oxford Univ. Press.

Significance

AL 162-28

The description by Holloway (1983c) suggested that there are relatively clear indications of an interparietal sulcus, whose posterior end was abutted against a small groove left by the inferior lip of the posterior portion of parietal bone, and that this remnant coincides with the lunate sulcus. It was suggested that if these identifications are accurate, the LS would have to be in a more human-like posterior position than found in any of the living apes, and would be an indication that the brain had undergone an important reorganizational event very early in hominid evolution. Falk (1983b) contested this view. While agreeing that the groove A depicted in the original *Nature* article was the IP, she claimed that the groove along the lambdoid suture was the LS, and most critically, that it was in a typical pongid-like anterior position. Holloway and Kimbel (1986) responded that Falk's (1983b) orientation of the endocast was incorrect, and that it had led her to regard the cerebellar lobes as projecting beyond the occipital lobes. Holloway and Kimbel also pointed out that based on several chimpanzee specimens, the length of the Hadar AL 128-62 chord from occipital pole to IP was less than half that found in chimpanzees. Holloway and Shapiro (1992) later demonstrated that by it being a remnant of the temporal squamous suture, one could be more certain that the original orientation by Kimbel et al. (1982), Holloway (1983c), and Holloway and Kimbel (1986) was correct. In addition the measurement of 70+ *Pan troglodytes* brain hemispheres indicates that the distance from the occipital pole to the proposed LS on the Hadar 162-28 specimen (15–16 mm) is almost 5 standard deviations anterior to the average 35 mm distance found in *Pan* brains, often with cranial capacities equal to or less than that of the Hadar 162-28 specimen (Holloway, 1988; Holloway et al., 2001a, b, 2003).

The issue of early brain reorganization at present rests on the correct identification and interpretation of these fragmented endocasts. For a review of the significance of the position of the lunate sulcus in hominids and pongids, see Holloway (1985). (See also our description of the position of the LS in Stw 505 later in this volume, as well as Dart's (1959) explanation).

AL 288-1

This find, comprised of an almost complete skeleton, was dated to about 3.2 MYA. It demonstrated a small brain, small body size, yet a series of features of the dentition, and in particular the pelvis and knee joint, that established this fossil as a biped with a non-ape jaw.

The possibility of a lunate sulcus just anterior to the lambdoid suture is tantalizing. If this should be true, the location would be in a relatively posterior position compared to the common chimpanzee, *P. troglodytes*. Too little of the posterior portion is available to be absolutely certain that this depression is indeed the lunate sulcus.

AL 333-45

As is often the case with early hominid brain endocasts, this specimen is a frustrating mix of characteristics that suggests a derived condition from the typical pongid pattern. The main significant finding is that the cranial capacity approaches 500 ml, suggesting, in comparison with other Hadar specimens such as AL 162-28 and "Lucy," considerable sexual dimorphism in brain size as well as in the dentition and postcranial skeleton. The slightly sprung left occipital lambdoidal region leaves the question of a left occipital petalia moot. Such an observation would indicate some early cerebral asymmetry, possibly reflecting cortical reorganization. We must await the discovery of new specimens to confirm these points.

AL 333-105

This is a rare find, given the paucity of basal portions of hominid endocasts as well as an infant status. It is highly frustrating that the distortions are so strong and displace rare and valuable mensuration.

AL 444-2

Despite the distortion this is one of the largest gracile forms of the morph currently designated as *A. afarensis* ever found. This specimen will be important to the analysis of sexual size dimorphism in these hominids. The similarity to robust forms (as represented by SK 1585 and OH 5) is very clear, and suggests that members of the clade to which AL 444 belongs were surely ancestral to them.

References

Dart, R. 1959. Adventures with the missing link. Philadelphia: The Institutes Press.

Falk, D. 1983a. Cerebral cortices of East African early hominids. Science 222: 1072–1074.

Falk D. 1983b. Hadar AL 162-28 endocast as evidence that brain enlargement preceded cortical reorganization in hominid evolution. Nature 313:45–47.

Holloway RL. 1978. The relevance of endocasts for studying primate brain evolution. In: Noback CR, ed, Sensory Systems in Primates. New York: Academic Press, pp 181–200.

Holloway RL. 1983a. Human paleontological evidence relevant to language behavior. Hum Neurobiol 2:105–114.

Holloway RL. 1983b. Human brain evolution: a search for units, models and synthesis. Can J Anthropol 3:215–232.

Holloway RL. 1983c. Cerebral brain endocast pattern of *Australopithecus afarensis* hominid. Nature 303:420–422.

Holloway RL. 1985. Les moulages endocrâniens des hominidés fossiles: L'aube de l'humanite. Science:36–45.

Holloway RL. 1988. Some additional morphological and metrical observations on *Pan* brain casts and their relevance to the Taung endocast. Am J Phys Anthropol 77:27–33.

Holloway RL, Kimbel WH. 1986. Endocast morphology of Hadar hominid AL 162-28. Nature 321:536–537.

Holloway RL, Shapiro JS. 1992. Relationship of squamosal suture to asterion in pongids (*Pan*): relevance to early hominid brain evolution. Am J Phys Anthropol 89:275–282.

Holloway RL, Broadfield DC, Yuan MS. 2001a. Revisiting australopithecine visual striate cortex: newer data from chimpanzee and human brains suggest it could have been reduced during australopithecine times. In: Falk D, Gibson KR, eds, Evolutionary Anatomy of the Primate Cerebral Cortex. Cambridge: Cambridge University Press, pp 177–186.

Holloway RL, Broadfield DC, Yuan MS. 2001b. The parietal lobe in early hominid evolution: Newer evidence from chimpanzee brains. In: Tobias PV, Raath MA, Moggi-Cecchi J, Doyle GA, eds, Humanity from African Naissance to Coming Millennia. Florence: Florence University Press, pp 365–371.

Holloway RL, Broadfield DC, Yuan MS (2003) Morphology and histology of the chimpanzee primary visual striate cortex indicate that brain reorganization predated brain expansion in early hominid evolution. Anat Rec 273A:594–602.

Holloway RL, Yuan MS. (In press). Endocranial morphology of AL 444-2. In Kimbel W, Rak Y, Johanson DC, eds, The Skull of *Australopithecus afarensis.* Oxford: Oxford University Press.

Johanson DC, Lovejoy CO, Kimbel WH, White TD, Ward SC, Bush ME, Latimer BM, Coppens Y. 1982. Morphology of the Pliocene partial hominid skeleton (A.L. 288-1) from the Hadar formation, Ethiopia. Am J Phys Anthrop 57:403–451.

Kimbel WH, Johanson DC, Coppens Y. 1982. Pliocene hominid cranial remains from the Hadar Formation, Ethiopia. Am J Phys Anthropol 57:453–500.

Figure 15. AL 162-28 (scale = 1 cm).

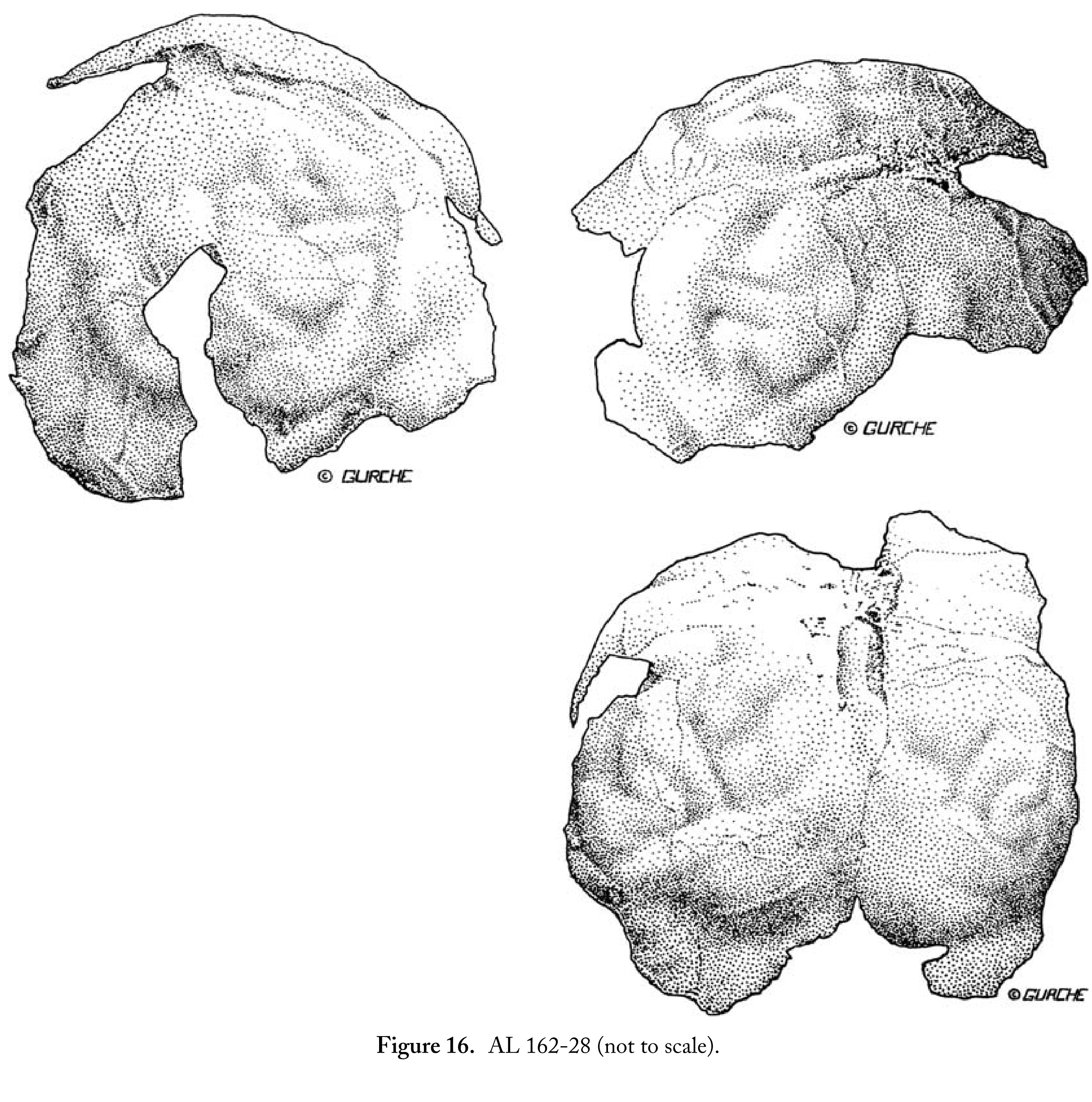

Figure 16. AL 162-28 (not to scale).

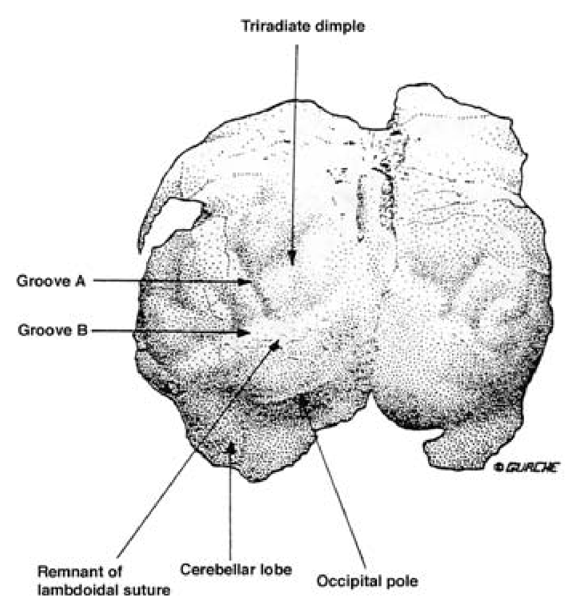

Figure 17. AL 162-28. Occipital view of Hadar AL 162-28 brain endocast of *A. afarensis* showing the proposed gyri and sulcal pattern suggesting a more posterior, human-like placement of the lunate sulcus. Groove A is the intraparietal sulcus, and Groove B is either the lunate sulcus or a depression created by the inferior lip of the posterior portion of the parietal bone. (See Holloway, 1983a for discussion.)

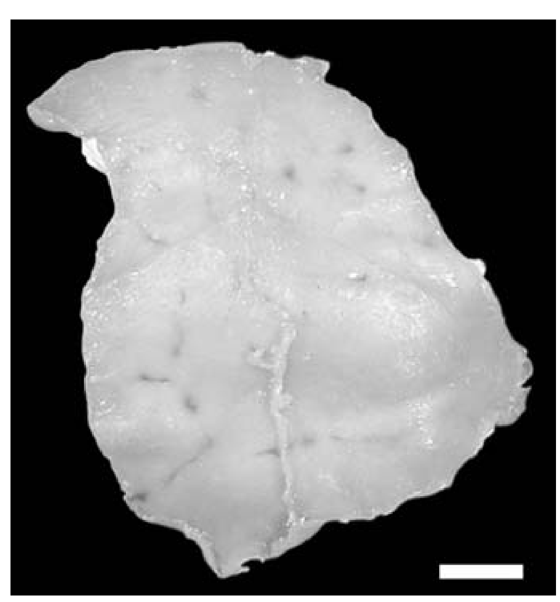

Figure 18. AL 288-1 (scale = 1 cm). Possible dasal and lateral aspect of the lunate sulcus.

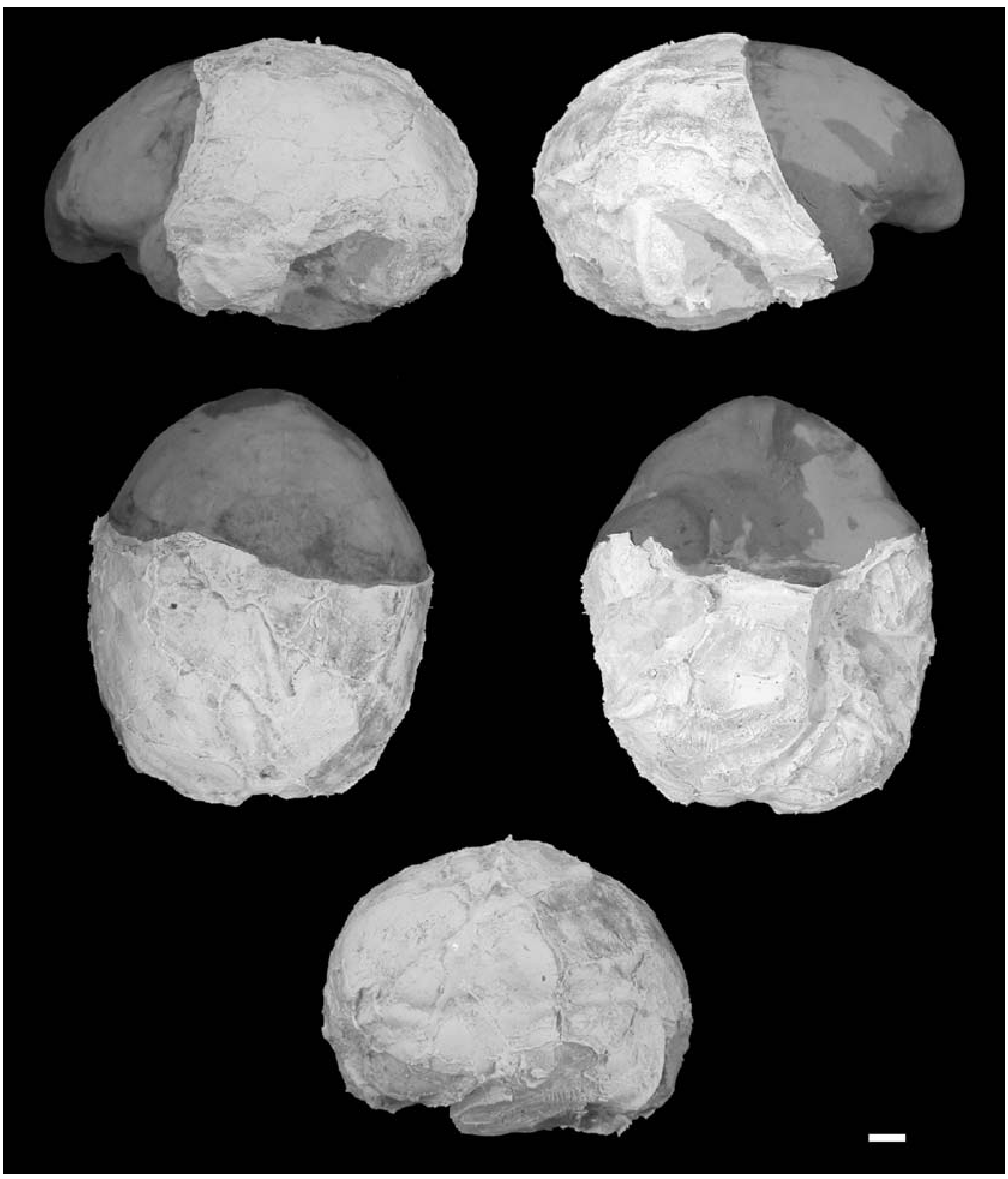

Figure 19. AL 333-45 (scale = 1 cm).

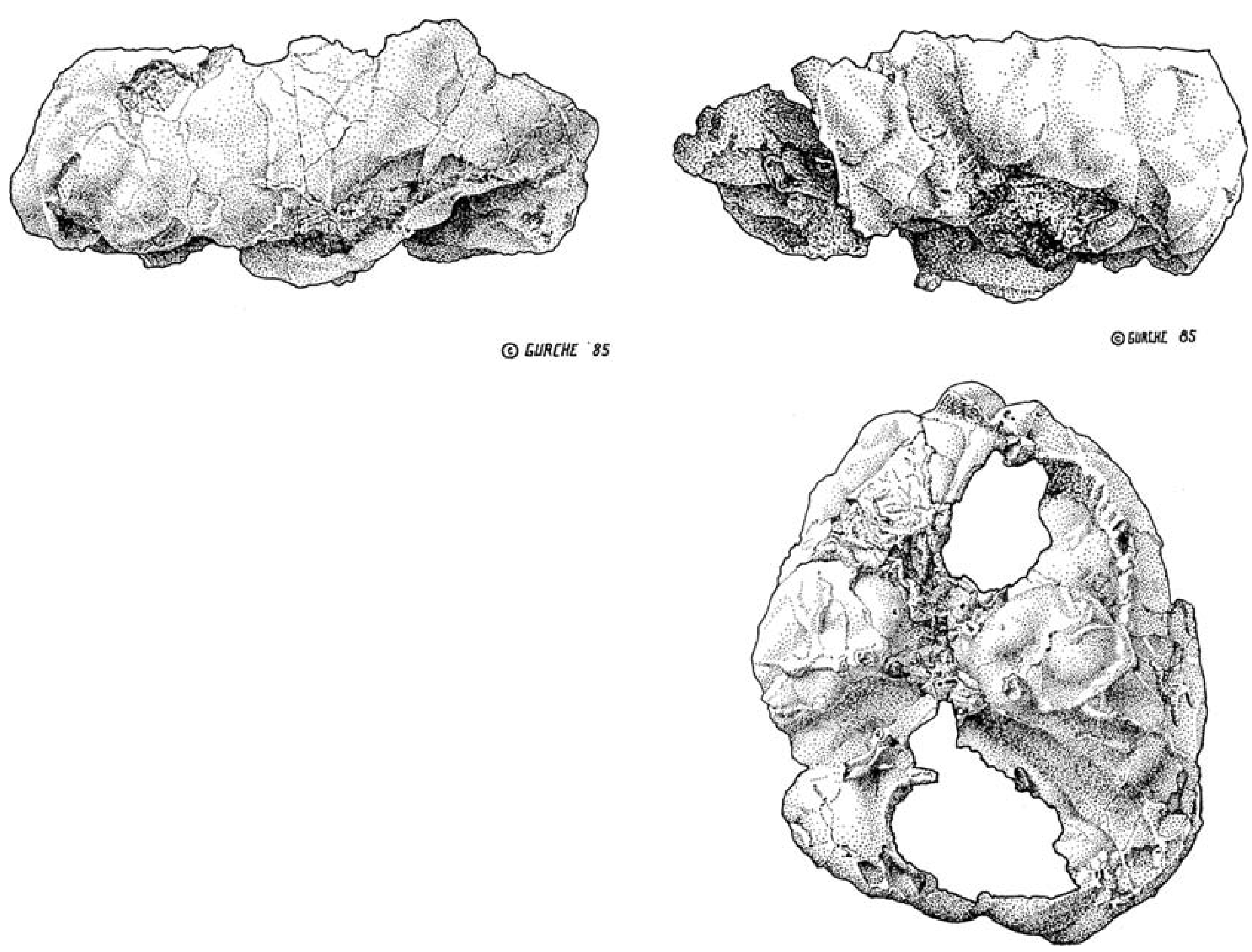

Figure 20. AL 333-105 partial cranium (not to scale).

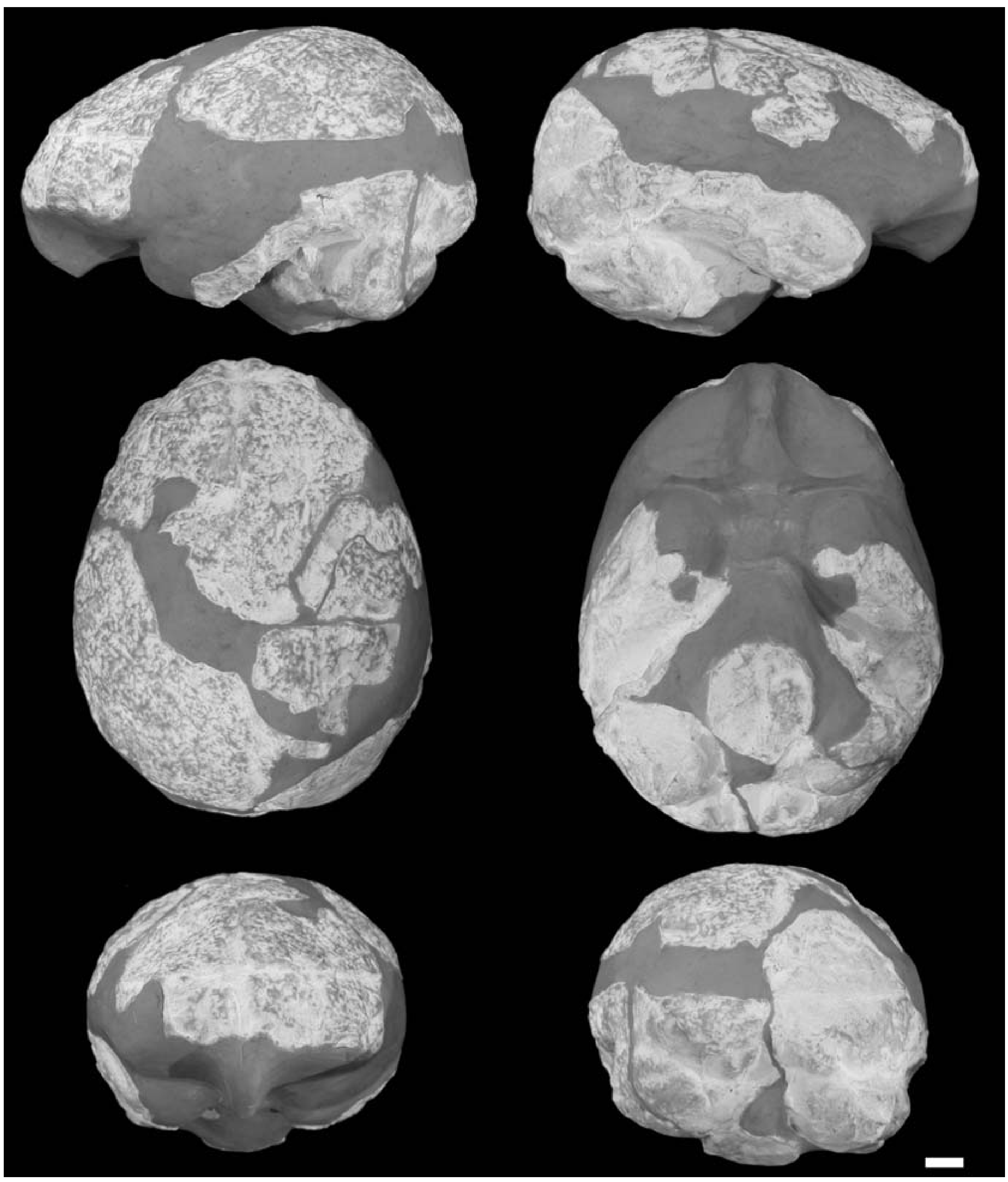

Figure 21. AL 444-2 (scale = 1 cm).

Swanscombe

Gross Description

Swanscombe is a nearly complete and undistorted brain endocast, missing the entire frontal lobe, and middle and inferior parts of the temporal lobes.

Volume and Method

The published value for the endocranial volume is 1325 ml (Mourant, 1938). This value was based on calculations from arc and chord measurements. We have not independently confirmed this value but are in the process of making a total brain endocast reconstruction. We regard the reliability as X2.

Endocast Details

This brain endocast shows a very great amount of convolutional detail. There is a small left occipital petalia in length, but the right width is larger. With the frontal lobes missing we cannot assess the frontal petalial pattern. The sagittal keeling is distinctive. The confluens drains primarily to the left transverse sinus, which is particularly large in this hominid. The lambdoid suture is well anterior to any delineation of the occipital lobes that might be interpreted as a lunate sulcus.

LeGros Clark (1938) did the original endocranial description. He exercised the greatest caution in interpreting the convolutional pattern, except to conclude that the Swanscombe brain endocast fell within the range of features known for modern *Homo sapiens*. He too (see infra) was struck by the complexity of detail in the occipital lobes, as well as the inferior parietal lobule of the parietal lobe. The occipital lobe morphology is very complex, and we regard LeGros Clark's (1938) identification of "b" rather than "a" as the lunate sulcus reasonable. The meningeal patterns show an extensive ramification of the middle and posterior branches of the middle meningeal vessel, and a large contribution from the posterior branch.

Morphometric Data

The maximum chord breadth is 140 mm, and the arc breadth over the vertex is 236 mm. The bregma-lambda chord is 101 mm, and the arc is 108 mm. The bregma-asterion chord, left side, is 123 mm, and the arc is 145 mm; on the right side these are 124 mm and 146 mm, respectively. The biasterionic breadth chord is ca. 112 mm, and the lateral arc across the transverse sinus is ca. 130 mm. The dorsal biasterionic arc is ca. 170 mm. We estimate the maximum cerebellar width as ca. 120 to 125 mm. The bregma-basion chord length is ca. 135 mm.

Significance

This is perhaps the finest brain endocast for all of Middle Pleistocene Western Europe in terms of lack of dis-

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tortion and convolutional detail, indicating that a large brain size had been achieved by this time, some 0.2 to 0.25 MYA.

Reference

Clark WE LeGros. 1938. The endocranial cast of the Swanscombe skull bones. J R Anthropol Inst 68:61–67.

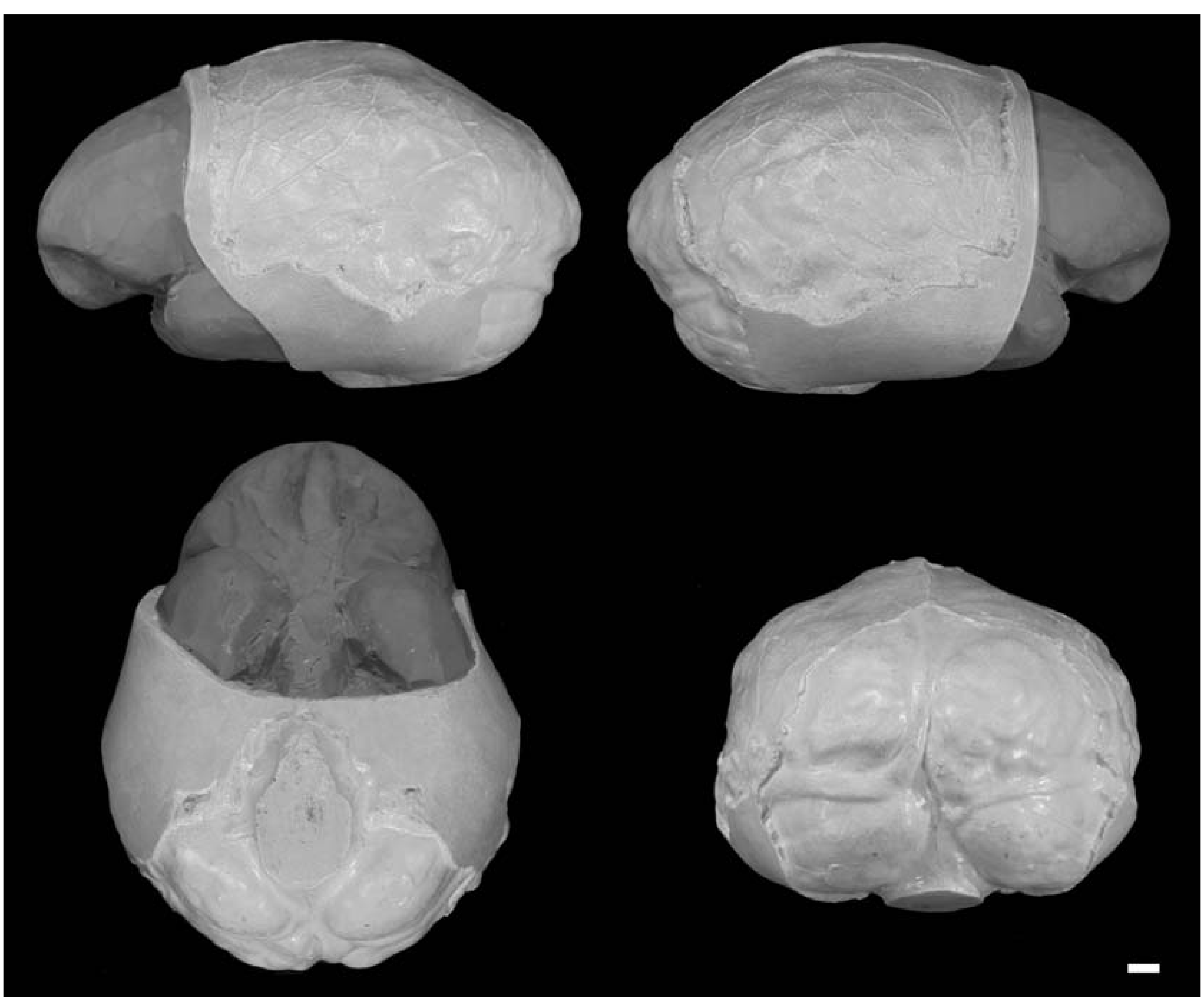

Figure 133. Endocranial views (scale = 1 cm).

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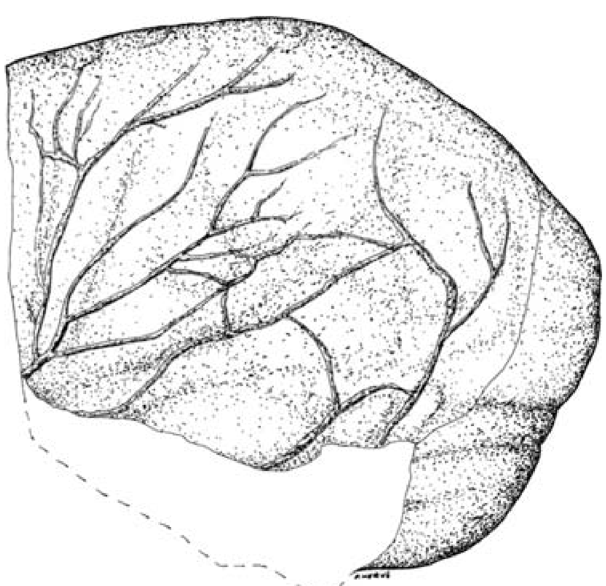

Figure 134. Stipple drawing accenting the meningeal pattern (not to scale).