Hominid Cranial Remains From Upper Pleistocene Deposits at Aduma, Middle Awash, Ethiopia

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ABSTRACT   The Upper Pleistocene localities of Aduma and Bouri have yielded hominid fossils and extensive Middle Stone Age (MSA) archaeological assemblages. The vertebrate fossils recovered include parts of four hominid crania from Aduma and a complete right parietal from Bouri. Archaeological associations and radiometric techniques suggest an Upper Pleistocene age for these hominids. The more complete cranium from Aduma (ADU-VP-1/3) comprises most of the parietals, the occipital, and part of the frontal. This cranium is compared to late Middle and Upper Pleistocene hominid crania from Africa and the Middle East. The Aduma cranium shows a mosaic of cranial features shared with "premodern" and anatomically modern *Homo sapiens*. However, the posterior and lateral cranial dimensions, and most of its anatomy, are centered among modern humans and resemble specimens from Omo, Skhul, and Qafzeh. As a result, the Aduma and Bouri Upper Pleistocene hominids are assigned to anatomically modern *Homo sapiens*. Am J Phys Anthropol 123:1–10, 2004.   © 2004 Wiley-Liss, Inc.

The Middle Awash project has investigated Plio-Pleistocene deposits straddling the modern Awash River since 1981. Abundant Middle Stone Age (MSA) archaeological remains are present in several parts of the study area. Two areas, Aduma and Bouri, have yielded hominid fossils from Upper Pleistocene sediments bearing these artifact assemblages. Four hominid fossils were recovered from Aduma, and one from Bouri. All specimens were found broken and scattered on the surface, but the most intact one (ADU-VP-1/3) was nearly in situ.

The MSA-bearing Pleistocene deposits at Aduma are the most extensively exposed and intensively studied, with numerous occurrences of in situ archaeological and paleontological remains. Several archaeological excavations conducted there since 1994 yielded MSA assemblages that are currently under study (Yellen et al., in preparation). Radioisotopic methods have been applied to horizons and materials associated with the stone tools and hominid remains at Aduma. The results place the Aduma archaeology and faunal assemblage as Upper Pleistocene, with most determinations falling between 70–105 Kyr (Yellen et al., in preparation). The purposes of this paper are to describe the newly discovered Upper Pleistocene hominid cranial specimens from the Middle Awash of Ethiopia and discuss their taxonomic placement.

GEOLOGY

The Aduma area (10°25′N; 40°31′E; Fig. 1) is located immediately west of the modern Awash River floodplain and east and south of the Pliocene Dulu Ali basaltic massif. Sands and silts of the Ardu Beds accumulated in three distinctive sets (A, B, and C), each bounded by an important and obvious erosional unconformity. These deposits overlie gravel lags with Acheulian artifacts. Today the Ardu Beds are preserved as small eroding hillocks surrounded by alluvial and eolian lag surfaces with many artifacts, carbonate clasts and pebbles, and vertebrate fossils. Sediments with similar lithology and artifact assemblage compositions are present on the northern end of the Bouri Peninsula (10° 21 N, 40° 27 E), ca. 15 km to the south.

The Bouri Formation, ca. 80 m thick, is divided into three members: Hata, Daka, and Herto (de Heinzelin et al., 1999, 2000). The Hata Member is Pliocene, the Daka Member is Lower Pleistocene, and the Herto Member is Late Middle Pleistocene. Sed-
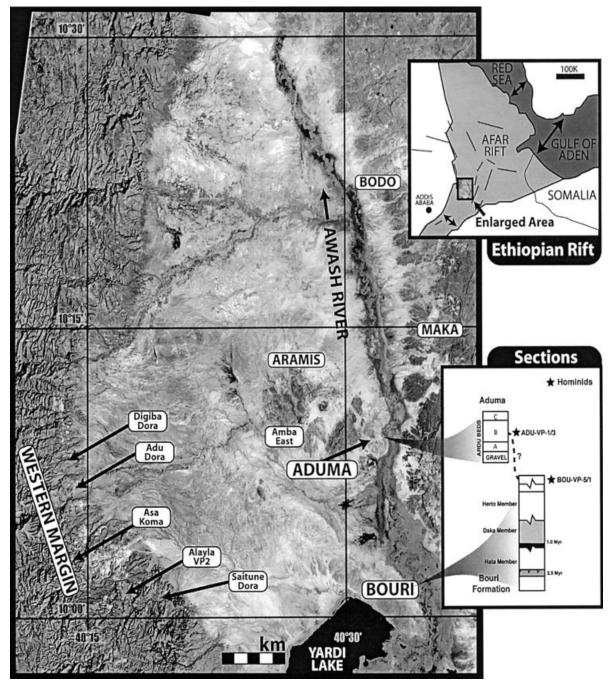
Fig. 1. Map showing location of Aduma and Bouri in Middle Awash of Ethiopia. At right, simplified stratigraphic columns show stratigraphic placement of Aduma and Bouri hominids.

iments that uncomformably overlie the Herto Member are exposed across the Bouri Peninsula. These deposits are mostly composed of channel deposits and eolian-bedded beach sands with gastropods. These deposits have abundant typical Middle Stone Age artifacts typologically similar to the artifacts from the Ardu Beds at Aduma.

Six archaeological sites have been systematically excavated in the Aduma region, but no hominid remains were recovered in these excavations. The

hominid remains described here were discovered on and eroding out of local lag surfaces and the sediments they cap. The recovered vault fragments, particularly for the more complete specimen, exhibit multiple weathering stages, with some pieces entirely unweathered. These preservational characters combine with the tight spatial clustering of the pieces and the lack of any other suitable deposits of origin to indicate strongly that all of the hominid remains and associated lithics and fauna initially
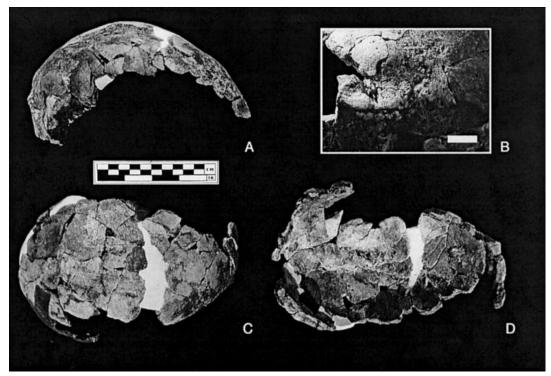
Fig. 2. Aduma cranium (ADU-VP-1/3). **A:** Lateral. **B:** Posterior (cm scale). **C:** Superior. **D:** Inferior.

rested in situ within the Ardu B horizons at Aduma immediately prior to their exposure, discovery, and collection (see Fig. 1). The Bouri hominid fossil was associated with typical MSA artifacts derived from a beach deposit with gastropod fossils similar to the deposits of Ardu B at Aduma.

CHRONOLOGY

Four different dating methods (Ar/Ar, uranium-series, luminescence, and radiocarbon) were used in attempts to determine the age of the Aduma deposits. There are inconsistencies in the ages acquired from the various dating methods applied, but most of them lie between 79–105 Kyr (Yellen et al., in preparation). The archaeological material indicates that the artifacts from Ardu B belong to the latter part of the MSA and probably predate the appearance of the Late Stone Age (LSA) in eastern Africa, which itself is poorly dated (McBrearty and Brooks, 2000, p. 501). Therefore, concordant age estimates among the archaeological assemblages and associated fauna are consistent with results from the clearly older upper Herto Member of the Bouri Formation (de Heinzelin et al., 2000; Clark et al., 2003).

DISCOVERY AND PRESERVATION

Cranial remains representing four adult hominids were recovered from Aduma. The first, ADU-VP-1/1, was a surface find of parietal fragments made by Y.H.-S. on December 4, 1994. The second is a small parietal piece (ADU-VP-1/2). Two additional hominids (ADU-VP-1/3 and 1/6; also from the surface)

were recovered on December 9 and 27, 1996, by T.D.W. and B.A., respectively. None of the Aduma specimens preserve the dentition or face, but the cranial vault of the most complete individual, ADU-VP-1/3, has been restored (Fig. 2).

The Aduma and Bouri hominids are all well-fossilized, although they shattered into many pieces as they reached the eroding surface of the deposits that encased them. ADU-VP-1/1 consists of multiple parietal and two occipital fragments. ADU-VP-1/2 is a fragment of a left parietal preserving only a small section of the sagittal and the coronal sutures. The more complete vault (ADU-VP-1/3) was found in more than 100 pieces scattered in an area of ca. 100 m². This area was crawled intensively, swept, excavated, and sieved to retrieve fragments. No parts of the browridges, face, or basicranium were recovered. The ADU-VP-1/6 specimen comprises six identifiable pieces and several other very small fragments.

The Bouri hominid fossil (BOU-VP-5/1; Fig. 3) is an almost complete right parietal found on the surface in 12 pieces by Alemayehu Asfaw on December 8, 1993.

DESCRIPTIONS
ADU-VP-1/3 (Fig. 2)

The frontal. The frontal bone is the least intact vault element, with only the right squama preserved. The browridges, the entire left squama, and the right squama anterior to bregma are missing. The coronal suture is entirely fused and obliterated except as it crosses the temporal line. A well-

Fig. 3. Bouri parietal (BOU-VP-5/1). **A:** Endocranial. **B:** Ectocranial. Scale bar is in cm.

marked, ca. 14-mm-long and 1-mm-wide, shallow vascular groove runs posteromedially near the antero-lateral ectocranial angle of the preserved squama. Ridges and concavities conforming to the cerebral gyri are seen endocranially. Small meningeal grooves branching from the middle meningeal artery are preserved around the sphenoidal angle. The squama is thicker toward the anteriorly prominent temporal line (ca. 10 mm) and thins medially (6.5 mm). The temporal line is very well-marked on the most anterior portion of the preserved part, and quickly loses definition posteriorly before it crosses the coronal suture.

The parietals. The parietals are undamaged along the totally fused and obliterated sagittal suture. The anterior portion is better preserved on the right, whereas the posterior portion is better preserved on the left. Both parietals are almost intact along the lambdoidal suture. This suture is also fully fused and obliterated except around the parietomastoid and asterionic regions on both sides. The anterior medial portion of the parietals shows modest keeling that extends for about 33 mm from bregma. The portion immediately lateral to the keeled midline on the right is flattened as far as the temporal line. The flattened area is bounded by the coronal suture anteriorly, and the temporal line laterally and posteriorly. Its limit corresponds with the end of the midsagittal keeling. On the anterolateral corner of the flattened surface, immediately posterior to the coronal suture, there is a shallow depression of ca. 11 mm in diameter. The remaining ectocranial surface of both parietals is slightly weathered and featureless. Parietal thicknesses vary from ca. 5 mm around the lateral wall (inferior to the temporal line) to 12 mm around the right asterionic region, the latter encompassing a modest angular swelling (angular torus).

Endocranially, the superior sagittal sulcus and the grooves for the middle meningeal arteries (mostly on the right side) are well-preserved. The superior sagittal sulcus is well-marked, particularly in the midparietal region. It runs along a ridge-like platform formed by parasagittal depressions on both the left and right sides. Its course is obliterated posteriorly by postdepositional damage. Meningeal grooves for the frontal branches of the middle meningeal arteries are preserved on the right parietal. A major groove originates at the sphenoid angle and passes superiorly and slightly posteriorly toward the superior sagittal sulcus. Two relatively large grooves branch out of the major groove and run posterosuperiorly, and disappear close to the midline. There are also small grooves branching out from the major groove. These run transversely and anterosuperiorly toward the coronal suture. Posteriorly, in the midparietal area, there is an additional, relatively large groove on each parietal. These grooves remain deep close to the superior sagittal sulcus, particularly on the left. Both grooves trend superoposteriorly, and are likely to be posterior branches of the middle meningeal artery.

The occipital. The occipital is the best-preserved element. The foramen magnum and associated structures are missing. Also missing are parts of the occipitomastoid region and parts of the nuchal planum on both the left and right sides. Enough is preserved on the left to confidently place the asterion. A round perforation with a diameter of 10 mm marks the right nuchal plane The antiquity of this perforation is indeterminate, but there are no signs of healing around it, and it is possibly carnivore-related. The superior sagittal sulcus on the endocranial surface of the occipital squama is not clearly discernible due to flaking and abrasion extending as far back as the internal occipital protuberance.

The occipital squama is intact and not as thick as the parietals. It is relatively thicker around the occipitomastoid region, and thins toward the missing foramen magnum. The occipital squama is smooth and rounded in profile. It is nearly entirely fused with the parietals along the barely visible lambdoidal suture, and is slightly more elevated than the parietals along the suture. The occipital lacks a torus. The superior nuchal line is well-developed and tightly arched, and displays a constant transverse thickness. The external occipital protuberance is well-marked, and its roughened and elevated surface is divided into superior and inferior halves by a wide, V-shaped, shallow transverse groove with steep sides and superiorly directed lateral arms.

There is a bilaterally elongate shallow depression that is 10 mm long and 36 mm wide (doubled from the preserved right half) along the midline immediately superior to the external occipital protuberance (Fig. 2B). Such a depression is sometimes identified as a suprainiac fossa on Neanderthal crania. The latter feature was defined by Santa Luca (1978) as an elliptical depression with an uneven floor, surrounded by a triangular uplifted area of bone with apices along the midline. This definition was followed by others who studied Neanderthals (Hublin, 1978; Arsuaga et al., 1997). When the Aduma cranium is oriented using the lateral profile of Omo I, the opisthocranion was most likely immediately above this depression. The external occipital crest (median nuchal line) is blunt but prominent. The inferior nuchal line is partially preserved on the right side as a ridge-like prominence running anteromedially toward the external occipital crest.

A substantial stretch of the superior sagittal sulcus demarcates the boundaries for the right and left cerebral fossae. The internal occipital protuberance is relatively prominent and marks the beginning of a well-marked internal median crest which runs inferiorly and anteriorly toward the foramen magnum. This crest divides the cerebellar fossae and is triangular in cross-section along the preserved part. The right and left transverse sulci are also well-marked, and a major part of the superior sagittal sulcus sweeps to the right to join the right transverse sulcus and continue across asterion onto the edge of the right parietal.

ADU-VP-1/1

The largest piece is a right midparietal fragment with a small section of the lambdoidal suture. The preserved anterior ramus of the meningeal artery suggests that the anterior break is very close to the coronal border. There is no temporal line or any other external structure. The sagittal length is 105 mm from the lambdoidal border to the anterior edge. When matched using the preserved lambdoidal suture and the anterior meningeal artery, ADU-VP-1/1 is very similar in size to the BOU-VP-5/1 parietal. The anteroposterior and superoinferior curvatures are also very similar. The maximum thickness on the midparietal is 10.2 mm, which is greater than the Bouri parietal or the ADU-VP-1/3 partial cranium. Three of the ADU-VP-1/1 fragments are occipital. The largest preserves the inferior nuchal line externally and the transverse sulcus internally.

ADU-VP-1/2

The bregmatic area of this specimen bears a weak, mound-like structure. The thickness at bregma is 6 mm. Posterior to bregma, it is 7.6 mm. The internal surface does not show any discrete anatomical features.

ADU-VP-1/6

The smallest piece of ADU-VP-1/6 is 4.5 × 9.5 mm, and the largest is 20 × 12 mm. The larger fragments are all parietal. One is a right parietal fragment close to asterion, with part of the lambdoidal suture. This piece of parietal has a thickened asterionic region insufficient to be considered an angular torus. The maximum thickness in the asterionic area is 11.4 mm. Two other fragments have preserved sutures. One of them bears part of the lambdoidal and the other the sagittal suture. One other large parietal piece is a midparietal fragment that cannot be sided with confidence.

BOU-VP-5/1

This is an almost complete right parietal, missing a small section along the anterior part of the sagittal border. The missing part of the coronal border extends posteriorly for 59 mm. The lambdoidal and squamosal borders are fairly complete, but damaged, with the asterionic region missing. The lambdoidal and bregmatic corners are preserved.

The lambdoidal border is almost complete, missing only the asterionic corner. The sutures are very well-formed and not fused. The parietal is very well-vaulted, showing marked curvature sagittally and coronally. Very strong bossing is noticeable in its lower two-thirds, almost midway in anteroposterior extent. The bone's outline is almost rectangular. The sagittal chord is 115.5 mm, and the arc is 128 mm.

The temporal line is inconspicuous. The asterionic region shows no thickening or angular torus. There is no thickening along the sagittal border. The thickness at bregma is 5 mm, and at lambda it is 6 mm. The maximum thickness of 8 mm is measured at the center of the squama.

COMPARISONS
Materials

Our comparative morphological and metric analysis focused on assessment of the more complete Aduma cranium (ADU-VP-1/3). The comparative material used included the originals of Omo I, Omo II, and Bodo, and casts of Ngaloba (LH-18), Eliye Springs (ES-11693), Kabwe, Saldanha, Florisbad,

Border Cave, Singa, Djebel Irhoud, Skhul 5, and Qafzeh 6 and 9, and published data on a variety of Levantine and European Neanderthals and their apparent precursors (Arsuaga et al., 1997). Cranial measurements of most comparative specimens were taken from the original specimens (Magori, 1980; Bräuer and Leakey, 1986; supplemented by indicated measurements from casts). Definitions of cranial variables follow Howells (1973).

Morphological comparisons

The supraorbital and glabellar regions of the Aduma cranium are missing. The Aduma cranium, Omo I, and other early anatomically modern human remains from Skhul and Qafzeh all have bilaterally broad frontal squamae. Moreover, the Aduma squama is high and rounded in the norma lateralis, with strong lateral bossing. Specimens such as Bodo and Kabwe generally have more receding frontals, while Kabwe and Saldanha have narrower frontal regions with moderate keeling along the midline (Singer, 1958). Neanderthals have relatively low squamae when viewed laterally, but more curved and expanded when in the Frankfurt horizontal and viewed anteriorly (Santa Luca, 1978). Based on the preserved portion, the Aduma frontal was more flattened and receding than Omo I, although not as receding as Ngaloba (LH-18).

The Aduma parietals are rectangular, anteroposteriorly elongated, and flexed more than most Middle Pleistocene hominids. Omo I has parietals that are similar to the Aduma and Bouri parietals in both curvature and posterior outline. However, the Aduma parietals show a degree of prelambdoidal and postbregmatic flattening, similar to LH-18 (Magori, 1980; Magori and Day, 1983). The anterior parasagittal parietal flattening observed on the Aduma cranium (posterior to the coronal suture and lateral to the midline) is absent in Omo I, Omo II, LH-18, and other Upper Pleistocene *Homo sapiens* remains from Africa and the Levant. Parietal thicknesses are within the range of variation of the comparative crania.

The endocranial morphology of the Aduma parietals is most similar to Omo II in the presence of a parasagittal depression along the superior sagittal sulcus. The grooves for the middle meningeal arteries, however, have different patterns in these two specimens. In Omo II, the major anterior branch runs superiorly, parallel to the coronal suture. This is the most common pattern in anatomically modern humans. On the right parietal of Aduma, the same groove runs posterosuperiorly, and many smaller grooves branch from it. Weidenreich (1936) described various types of meningeal groove patterns within the specimens he assigned to "*Sinanthropus pekinensis*" (= *Homo erectus*). There is often also a noticeable asymmetry of the groove patterns on the left and right sides of the same individual (Saban, 1984). Although the topography of the grooves for

the middle meningeal arteries is of little significance in taxonomy, it was noted that earlier hominids had relatively simple groove patterns, and that these patterns became progressively complicated (Saban, 1984).

More phylogenetically important endocranial parietal traits include the presence or absence of the Breschet sulcus (a sulcus that runs parallel to the coronal suture) and the lateral sulcus (sigmoid sulcus) in the asterionic region (Arsuaga et al., 1997). The Breschet sinus has been reported as rare in modern humans and Middle Pleistocene specimens, and it is frequently present in Neanderthals (Gracia, 1991). The Aduma cranium lacks the Breschet sulcus, at least on the preserved right side. The Bouri parietal lacks the lateral sulcus, but the Aduma cranium shows a slight contribution to this sulcus near the asterion. The presence of a lateral sulcus in the asterionic region is a derived condition present in modern humans and less frequent in Neanderthals (Arsuaga et al., 1989, 1991).

The Aduma occipital squama is smooth and rounded both transversely and parasagitally. The general morphology of the Aduma occipital is similar to Omo I, LH-18, Skhul 5, Qafzeh 9, and modern humans. Omo II and Kabwe are different from Aduma, Omo I, LH-18, and other early anatomically modern *Homo sapiens* such as Skhul and Qafzeh in having well-developed occipital tori. The absence of an occipital torus is characteristic of most anatomically modern humans (Olivier, 1975), whereas the torus is commonly present in earlier hominids. Omo II and Kabwe each have a well-developed occipital torus extending laterally to the mastoid processes. LH-18 has a centrally situated torus (Magori, 1980) comparable to Omo I. The occipital angulation is prominent in Omo II and Kabwe, whereas the lateral profile fullness of the occipital bone is similar in Aduma, LH-18, Omo I, Skhul 5, Qafzeh 9, and most anatomically modern humans. The Aduma cranium bears what some might interpret as a suprainiac fossa and a relatively well-developed external occipital protuberance. The suprainiac fossa is a feature usually associated with Neanderthals (Santa Luca, 1978).

The presence of a feature resembling the "suprainiac fossa" on the Aduma cranium bears special consideration. Neanderthal specimens manifesting all the characters used to define the suprainiac fossa were often young individuals such as Le Moustier, Engis 2, and La Quina H 18 (Hublin, 1980; Arsuaga et al., 1989). Indeed, several adult Neanderthal individuals lack a typical fossa bearing all the defining features. Furthermore, such a depression is also arguably present on the Swanscombe occipital (Santa Luca, 1978), on other non-Neanderthal fossil specimens such as Aduma, and occasionally on modern humans (on a populational basis). Therefore, the suprainiac fossa cannot be considered an exclusively shared derived Neanderthal trait, although its high

TABLE 1. Cranial measurements of ADD VP-1/3 and comparative specimens[1]

Specimen	BLA	PAC	ASB	BAC	BAA	LAC	LIC	PA
Omo I	130	124	(116)[3]	151	178	(80)[R]	(71)	(137)
Omo II	125	119	138	137	159	(94)	(74)	(148)
Eliye Springs[2]	128	117	120	139				
Kabwe	125	(136)		139	(152)	(95)		(145)
Singa	98	94	123	136	169	(90)[L]	(80)	(146)
Saldanha	120	109	(106)	132	162	(80)[R]		
Ngaloba	132	122	124	137	159			
Djebel Irhoud	111	107	122	139	169			
Skhul 5	138	124	124	139	166			
Qafzeh 9	144	131	110	137	165			
Sub-Saharan modern	129	116	106	133	159			
ADD-VP-1/3	(138)	124	(120)	(144)[R]	(183)[4]	(84)[R]	61	(135)
				(140)[L]		(83.5)[L]		
BOU-VP-5/1	128	116						

BLA, bregma-lambda arc (also known as parietal sagittal arc); PAC, parietal chord (also known as bregma-lambda chord); ASB, biasterionic breadth; BAC, bregma-asterion chord; BAA, bregma-asterion arc; LAC, lambda-asterion chord; LIC, lambda-inion chord; PA, parietal angle.
[1] Cranial measurements of comparative specimens are modified after Magori (1980).
[2] Eliye Springs' dimensions are from Brauer and Leakey (1986).
[3] Dimensions in parentheses (exclusive of ADD-VP-1/3) were taken from casts. All measurements are given in mm. R, right; L, left;
[4] This measurement was taken on right side, and arc crosses a ca. 50-mm stretch of reconstruction on inferoposterior part of parietal.
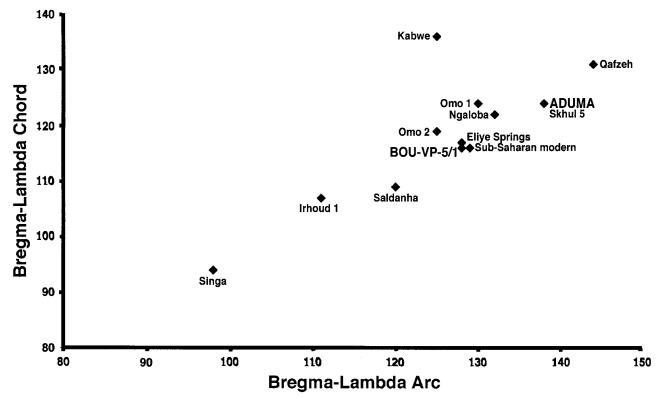
frequency in Neanderthal populations is clear and is probably related to the overall peculiar occipital morphology of these forms.

Metric comparisons

Seven variables were measured on the Aduma cranium (Table 1). The Aduma parietals are relatively long (124 mm). The measurements reported for Omo I and Skhul 5 are also 124 mm. However, the parietal length of Omo I is probably underestimated, because the exact position of bregma is undetermined, and the frontal part of the entire specimen on the original reconstruction (Day and Stringer, 1982) was incorrect. The left frontal portion of Omo I is displaced posteriorly, and the frontal length is artificially increased at the expense of parietal length. The parietals of Qafzeh 9 are very long (131 mm). The LH-18 parietal is 122 mm long, whereas the rest of the comparative specimens have shorter parietal lengths, ranging from 94–116.5 mm. Given the comparable length and breadth of Aduma and Omo I, it is probable that the overall cranial capacity of Aduma is similar to that of Omo I, estimated to be ca. 1,430 cc (Leakey et al., 1969; the cranial capacity of Omo I could be a little smaller if the cranium were reconstructed correctly).

Anatomically modern humans have more curved parietals than earlier hominids such as *Homo erectus* and archaic *Homo sapiens*. A bivariate plot of parietal arc and chord (Fig. 4) shows that Aduma and Skhul 5 have the same amount of parietal curvature. Aduma and Skhul 5, together with Eliye Springs, Saldanha, Qafzeh 9, and Sub-Saharan African moderns, have more curved parietals than Omo I, Omo II, Kabwe, and Djebel Irhoud. Figure 5 shows that specimens assigned to anatomically modern *Homo sapiens* have parietals that are anteroposteriorly long and narrower at the base (bias-

terion chord). Earlier hominids such as *Homo erectus* and specimens recognized as "archaic *sapiens*" have a wider base relative to their parietal length. This is shown by the index ratio of (bregma-lambda $\times$ 100/biasterionic breadth). Kabwe and Omo II have lower values, correlating with their wider biasterion breadths. The modern human mean is 124 ± 4, whereas Neanderthals have a mean value of 113 ± 3 (Stringer, 1989). The Neanderthal mean value is lower than in anatomically modern humans. The Aduma cranium has a value of 118.3, much lower than the modern human average. However, it can still be incorporated in the lower range of anatomically modern humans (within 2 SD). The very high value of Omo I might be an artifact of its faulty reconstruction.

DISCUSSION

The African fossil record directly relevant to the origin of anatomically modern humans is very limited (Stringer, 1992; Clark, 1992; Hublin, 1992; Smith, 1992; Deacon, 1992; Bräuer, 1984; Rightmire, 1984; Howell, 1994 and references therein). Based on the available fossil evidence, three groupings of Middle and Upper Pleistocene *Homo sapiens* have traditionally been discussed, with inclusion following morphological or chronological considerations (or both). Morphologically, the first group (sometimes dubbed "archaic *sapiens*") includes specimens such as Bodo, Kabwe, Ndutu, Saldanha, and KNM-ER 3884. These all appear to antedate 200 Kyr. The second group includes the premodern Upper Middle and Upper Pleistocene specimens such as Eyasi, Omo II, Ngaloba (LH-18), Eliye Springs, Florisbad, Singa, and Djebel Irhoud 1 (Howell, 1994). Most of these are not adequately dated. Florisbad and Singa were recently estimated at ca. 260 Kyr (Grün et al., 1996) and 133 Kyr (McDermott et

Fig. 4. Bivariate comparison of Upper and Middle Pleistocene hominid crania, based on bregma-lambda arc and chord.
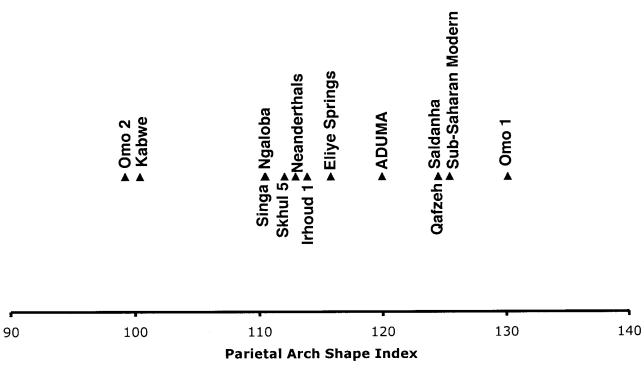

Fig. 5. Parietal arch shape index (bregma-lambda chord × 100/biasterionic breadth).

al., 1996), respectively. Despite such a placement, however, Florisbad morphologically appears to be associated with premodern Upper Middle and Upper Pleistocene specimens. The third morphological group includes the Klasies River Mouth specimens, Omo I, Dar-es-Soltane 5, and Border Cave. The group includes fossils that appear to postdate 130 Kyr and predate 50 Kyr. Most of the latter two

morphosets are associated with Middle Stone Age industries, but only the third group is usually addressed as early anatomically modern human (Stringer, 1989). Some authors believe that all three morphological sets can be subsumed within a single species, whereas others reject this idea (Tattersall, 1992; Howell, 1994). The recently described Herto fossils (White et al., 2003) assigned to *H. sapiens idaltu* are appropriate anatomical and chronological antecedents of the Aduma fossils.

The morphological heterogeneity observed in modern human populations is one of many hurdles faced in attempting to understand the tempo and mode of Upper Pleistocene hominid evolution and the emergence of anatomically modern humans. The Aduma crania are similar in preserved parts to specimens from the Middle East, and from northern and eastern Africa, between 100–300 Kyr. Specifically, the most complete Aduma cranium is most similar to crania thought to belong to the younger part of that range. This Middle Stone Age cranium, in most of its characters, is indistinguishable from other anatomically modern human crania.

CONCLUSIONS

The Aduma cranium is similar to many of the Upper Pleistocene anatomically modern human crania from Africa and the Middle East in its high vault profile, rounded occipital, well-curved parietals, and overall size. The Aduma cranium shows a mosaic of cranial characters, some of which resemble premodern humans such as LH-18. Other characters are shared with Omo I and Skhul 5 rather than with Neanderthals. Aduma is different from Neanderthals in its parietal and frontal morphology, and lacks the character complex described for Neanderthals (e.g., Santa Luca, 1978).

The discovery of the Aduma and Bouri cranial remains in Middle Stone Age contexts dating to the Upper Pleistocene of Ethiopia's Afar Rift is significant. These remains show further evidence of variation in anatomically modern human cranial morphology during the Middle/Upper Pleistocene of Africa, and open new possibilities for the recovery of additional, more complete remains in potentially datable contexts. For now, these youngest hominid fossils from the Middle Awash succession show that anatomically modern humans using Middle Stone Age technologies inhabited this region substantially before the European Neanderthals disappeared.

ACKNOWLEDGMENTS

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