letters to nature

Pleistocene *Homo sapiens* from Middle Awash, Ethiopia

Tim D. White*, **Berhane Asfaw**†, **David DeGusta***, **Henry Gilbert***, **Gary D. Richards**‡, **Gen Suwa**§ & **F. Clark Howell**‡

* *Department of Integrative Biology and Laboratory for Human Evolutionary Studies, Museum of Vertebrate Zoology, University of California, Berkeley, California 94720-3160, USA*
† *Rift Valley Research Service, P.O. Box 5717, Addis Ababa, Ethiopia*
‡ *Laboratory for Human Evolutionary Studies, Museum of Vertebrate Zoology, University of California, Berkeley, California 94720-3160, USA*
§ *The University Museum, The University of Tokyo, Hongo, Bunkyo-ku, Tokyo, 113-0033, Japan*

....

The origin of anatomically modern *Homo sapiens* and the fate of Neanderthals have been fundamental questions in human evolutionary studies for over a century[1–4]. A key barrier to the resolution of these questions has been the lack of substantial and accurately dated African hominid fossils from between 100,000 and 300,000 years ago[5]. Here we describe fossilized hominid crania from Herto, Middle Awash, Ethiopia, that fill this gap and provide crucial evidence on the location, timing and contextual circumstances of the emergence of *Homo sapiens*. Radioisotopically dated to between 160,000 and 154,000 years ago[6], these new fossils predate classic Neanderthals and lack their derived features. The Herto hominids are morphologically and chronologically intermediate between archaic African fossils and later anatomically modern Late Pleistocene humans. They therefore represent the probable immediate ancestors of anatomically modern humans. Their anatomy and antiquity constitute strong evidence of modern-human emergence in Africa.

The fossilized crania of one immature and two adult hominids were recovered with more fragmentary remains in 1997 from Herto Bouri, a set of localities in the Herto Member of the Bouri Formation in the Middle Awash study area of Ethiopia's Afar depression[6]. These new remains are associated with archaeological assemblages containing elements of both Acheulean and Middle Stone Age technocomplexes[6]. The three crania display evidence of post-mortem mortuary practice[6].

Here we describe the Herto fossils and compare them with Eurasian Neanderthals, and with earlier and later African fossils, to investigate the emergence of anatomically modern humans. The following descriptions focus on characters relevant to the study of Late Pleistocene hominid affinities. Craniodental dimensions are provided in Supplementary Information. The specimens are illustrated in Figs 1 and 2.

The most complete specimen so far recovered from the Upper Herto Member of the Bouri Formation is an adult cranium from Bouri Vertebrate Paleontology Locality 16 (BOU-VP-16/1). Exposure before discovery led to loss of the left side of the calvarium, but vault distortion is limited to a slight movement of rigid plates; the right temporal process of the zygomatic is displaced about 3 mm posteromedially at the frontozygomatic suture, and the internasal midline is shifted about 2 mm right-laterally. The palate is fairly intact, and the entire right facial skeleton is present. The specimen is fully adult, with patent vault sutures and a heavily worn dentition featuring progressively smaller M1, M2 and M3. Heavily worn premolars bear strong superolateral bevelling of the fully exposed dentine occlusal platforms (reminiscent of La Ferrassie 1). The cranium, interpreted here as a male, is generally large and robust, with a cranial capacity estimated by teff seed volume (right side doubled) at about 1,450 cm³, at the high end of the modern human range.

The BOU-VP-16/1 cranium is long and high in lateral view (Fig. 1). The distance between the cranial articular eminence and occlusal plane exceeds that observed in a sample of 2,000 modern human crania (American Indian and Predynastic Egyptian). The Baringo KNM-BK-62 mandible approximates the required ramal height for articulation with the Herto specimen, but this mandible is too small in other dimensions for an appropriate fit. The Herto occipital is strongly flexed, with an occipital angle (103°) that is more acute than that in almost all modern humans[7] and marked by a prominent, massive, rugose external occipital protuberance. There is no occipital bun or suprainiac fossa. The mastoid processes are large and projecting, with a mastoid height (37 mm) much greater than the Neanderthal condition and exceeding all but a few modern humans. The zygomatic root is high relative to the level of the external auditory meatus. The superior margin of the temporal squama is high and arched. The root of the maxillary zygomatic process is centred above the first molar. The zygomatic bone is robust in the infraorbital region. The infraorbital plate is oriented paracoronally and marked by a distinct canine fossa.

In anterior view (Fig. 1) the BOU-VP-16/1 cranium shows a broad upper and lower face, with moderate alveolar prognathism. The malar incisura is deep and bounded laterally by a robust malar tubercle. The broken nasal aperture is bounded inferiorly by a sharp nasal sill and prominent spine. The midface combines a broad interorbital area and tall, narrow nasal bones. The glabellar region is prominent, bilaterally arched, rugose, and projects anteriorly over the superomedial orbital corners. The frontal is moderately bossed and slightly receding, offset from the supraorbital torus by a supratoral sulcus. The supraorbital torus is differentiated into halves at the level of the (multiple) supraorbital foramina. The flat lateral portion is extremely broad anteroposteriorly (at zygo-frontal suture, 18 mm from orbital rim to temporal line), and forms a superoanteriorly facing trigone. There is an extensive frontal sinus that extends laterally to mid-orbit. The great length of the cranium is evident in superior aspect. Its glabella-to-occipital length (219.5 ± 2 mm) exceeds that found in most other fossil hominids (including Skhul and Qafzeh) and a global sample of over 3,000 modern humans[7]. Prominent temporal lines reach to within 35 mm of the sagittal suture, and parallel the latter over most of the parietal's length. Bi-stephanic breadth is only 96 ± 3 mm, well below the modern human mean despite the specimen's size. The angular torus is not prominent, and is fully within the modern human range.

Despite slight distortion of the cranium evident in posterior view, its profile is clearly 'en-maison', with the greatest interparietal breadth high on the vault. The lambdoidal suture is highly complex, bearing numerous ossicles. In inferior view the palate is deep and broad (75.5 ± 1.5 mm external breadth; near modern human maximum). The foramen magnum is large and anteroposteriorly elongate (45 mm, well above the modern human mean). The digastric grooves are deep and bounded medially by prominent juxtamastoid crests. Relative to most modern humans, the masticatory apparatus is well developed, the dentition large and heavily worn, glenoid fossa broad and deep, and pterygoid plates large and flared.

The second major adult specimen (BOU-VP-16/2) was an even larger adult, as judged by matching parts of its preserved temporal bone. It is represented by portions of temporal, frontal, parietal, zygomatic and occipital. Its occipital is not so angled in sagittal profile as that of BOU-VP-16/1, but bears a more prominent occipital crest. Both vaults are thick (see Supplementary Information). A third adult individual represented by a left parietal fragment (BOU-VP-16/43) shows an extensive squamosal overlap of 24 mm, but might have been slightly smaller overall than the other two adults.

The immature cranium BOU-VP-16/5 was found on the surface after its erosion from an indurated sandstone. It had been shattered into more than 180 small fragments from which the cranial vault

and facial portions were restored. A partial dentition comprises both left deciduous molars as well as unerupted fully formed canine and premolar crowns, and a first molar with wear facets. On the basis of modern human standards, we estimate the individual's age at death as 6–7 years. The cranium is morphologically compatible with the Herto adults. Its vault is pentagonal in posterior profile, and the face shows a clear canine fossa and strong malar incisura. The supraorbitals are poorly developed, with pronounced verticality and frontal bossing. As with the adults, the Herto child exhibits a character complex that is distinctly unlike that of Neanderthals[8].

The Herto crania are thus not Neanderthals. They exhibit none of the notably derived features that are common to those Eurasian specimens attributed to a Neanderthal lineage[9] represented by a multitude of fossils of successive ages, and culminating in the 'classic' Neanderthals. The Herto hominids are contemporaneous with obvious antecedents of the 'classic' Neanderthals, but do not resemble them. The Herto hominids also have derived characters not seen in *Homo erectus* and in other apparently older African specimens such as Bodo, Saldanha and Kabwe, and so cannot be assigned to those groups.

Figure 1 The Herto BOU-VP-16/1 adult cranium in lateral, frontal, three-quarter, posterior, superior and inferior views. Scale bar, 1 cm.

When BOU-VP-16/1 is compared metrically with a large global sample of modern human crania[7] (Figs 3 and 4), similarities and differences are apparent. The large overall size of BOU-VP-16/1 stands out, aspects of which are described above. Apart from its exceptionally great anterior–posterior length, the cranium exhibits large vault dimensions together with a deep, tall and broad face. However, the orbit and cheekbone dimensions are smaller, and facial projection anterior to the zygomatic is relatively weak. These metric aspects contribute to the comparatively modern gestalt of the face (contrary, for example, to Neanderthals or Kabwe). BOU-VP-16/1 is metrically indistinguishable from anatomically modern *Homo sapiens* (AMHS) in its high cranial vault and relatively large frontal and parietal sagittal dimensions as expressed in their size-standardized variables (by geometric means of 50 variables). Metric indices of neurocranial globularity and facial retraction have been proposed as diagnostic criteria for AMHS[10]. The former index is estimated at 0.54 in BOU-VP-16/1, within the range suggested to be characteristic of AMHS. Here again, though, the BOU-VP-16/1 parietal bone tends to be less curved, the occipital distinctly flexed, and supraorbitals projecting anteriorly, attesting to its retention of archaic morphology.

Among the global sample of modern humans, the Herto crania, both metrically and non-metrically, lack any derived affinity with modern African crania or with any other modern group, confirming earlier suggestions[11]. Instead, the closest approximations among modern individuals to the overall morphology, size and facial robusticity are found in some Australian and Oceanic individuals, although these are also clearly distinct from the Herto hominids.
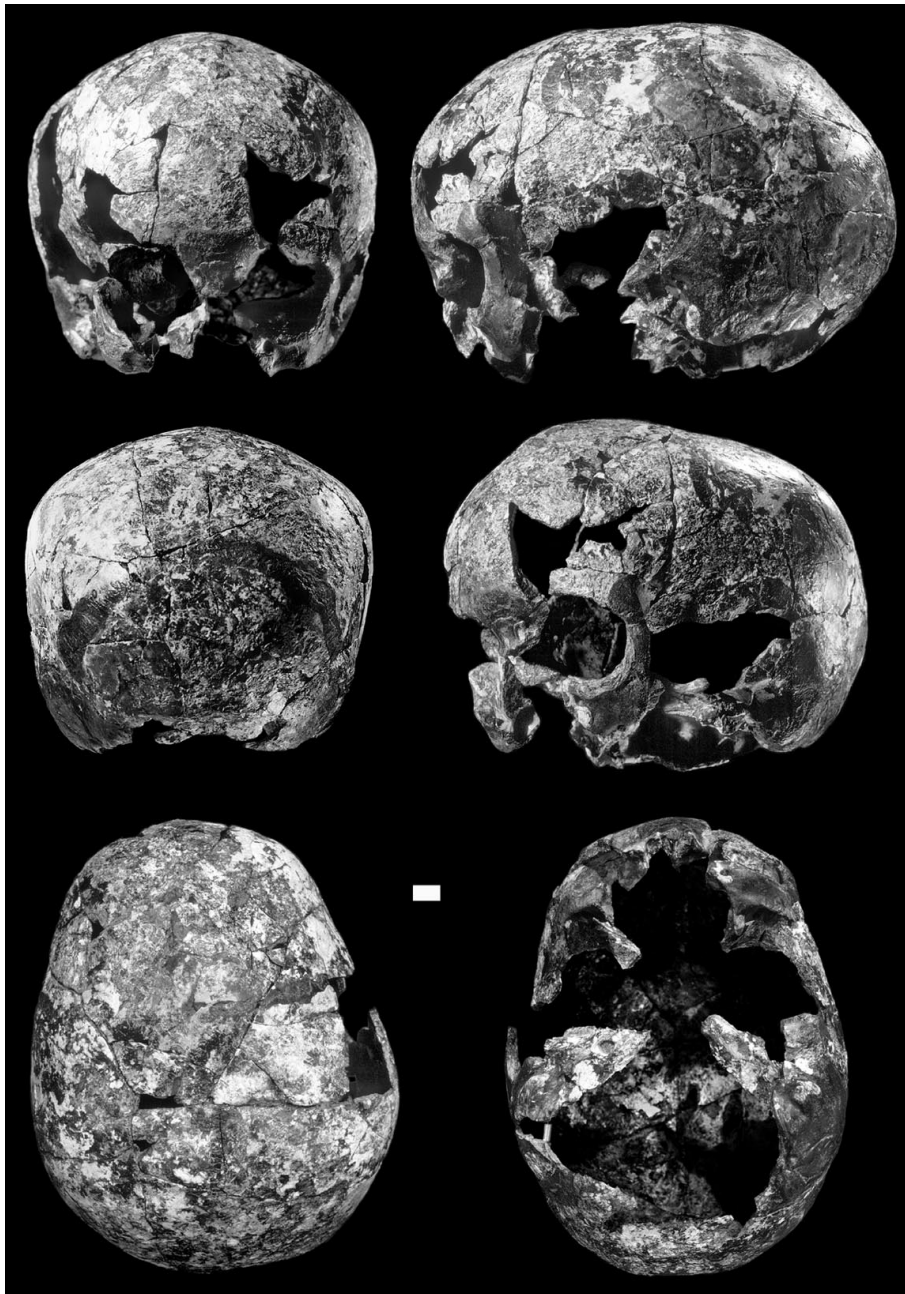

Figure 2 The Herto BOU-VP-16/5 child's cranium in frontal, lateral, posterior, three-quarter, superior and inferior views. Scale bar, 1 cm.

The Herto crania are likewise distinct from Pleistocene representatives of AMHS in some of the features outlined above. In supraorbital morphology and occipital construction and robusticity, BOU-VP-16/1 is distinguished from the later Klasies and Qafzeh specimens often identified as the earliest AMHS. Other African fossil crania that are possibly temporally intermediate between the early forms (such as Bodo and Kabwe—the 'early archaic *H. sapiens*' of Bräuer[12,13]) and AMHS exhibit considerable morphological diversity. The affinities of these specimens (such as Ngaloba, Omo 2, Eliye Springs and Jebel Irhoud—the 'late archaic *H. sapiens*' of Bräuer[12,13]) have proved difficult to assess. However, regardless of the particular relationships between these specimens, the general evolutionary position of the Herto sample is clear.

The morphology of the Herto crania falls between the more primitive morphology of the earlier African specimens (such as Bodo and Kabwe) and the more derived morphology of later AMHS (such as Klasies and Qafzeh). The Herto crania are intermediate, metrically and non-metrically, in an African series spanning about 600,000–100,000 years ago, although they are not the only such intermediates in the series. They sample a population that is on the verge of anatomical modernity but not yet fully modern (Fig. 4). This conclusion is supported by comparative anatomical, metric and cladistic considerations, and has profound evolutionary and taxonomic implications.

Some genetic studies[14] have concluded that populations whose contributions quantitatively dominate the modern human gene pool were located in Middle Pleistocene Africa. However, fossil confirmation of these predictions has been lacking. This has prompted some to assert that the sparse African record did not falsify the 'multiregional' evolution of AMHS in Europe and the Far East[15-17]. The Herto crania fail to confirm such 'multiregional'

speculation and conform more closely to most molecular predictions[14,18-20]. They add direct fossil evidence about the anatomy of the populations ancestral to modern humans. The many morphological features shared by the Herto crania and AMHS, to the exclusion of penecontemporanous Neanderthals, provide additional fossil data excluding Neanderthals from a significant contribution to the ancestry of modern humans.

The Herto hominids, although clarifying evolutionary questions, raise taxonomic issues. Widely scattered, often poorly dated, and morphologically diverse Middle and Upper Pleistocene hominid crania from the eastern hemisphere have been assigned to various taxa. In addition to the difficulties inherent in partitioning lineages, several of the available species names are based on inadequate type specimens (such as *H. heidelbergensis*, Schoetensack, 1908; *H. helmei*, Dreyer, 1935; and *H. njarasensis*, Reck and Kohl-Larsen, 1936). Because the Herto hominids are morphologically just beyond the range of variation seen in AMHS, and because they differ from all other known fossil hominids, we recognize them here as *Homo sapiens idaltu*, a new palaeosubspecies of *Homo sapiens* (see Methods). The available evidence from comparative anatomy, multivariate analysis and cladistic considerations suggests that '*H. rhodesiensis*' (Bodo and Kabwe) was ultimately ancestral to *H. sapiens idaltu*, which in turn was ancestral to *Homo sapiens sapiens* (AMHS).

The Middle Awash valley of Ethiopia has now yielded a succession of hominids spanning the past 6 million years[21-26]. Within this study area, and within the genus *Homo*, there exists a chronologically ordered succession of increasingly derived hominids: from Daka (1.0 million years ago) to Bodo (500,000 years ago) to Herto (155,000 years ago). When considered with the evidence from other sites, this
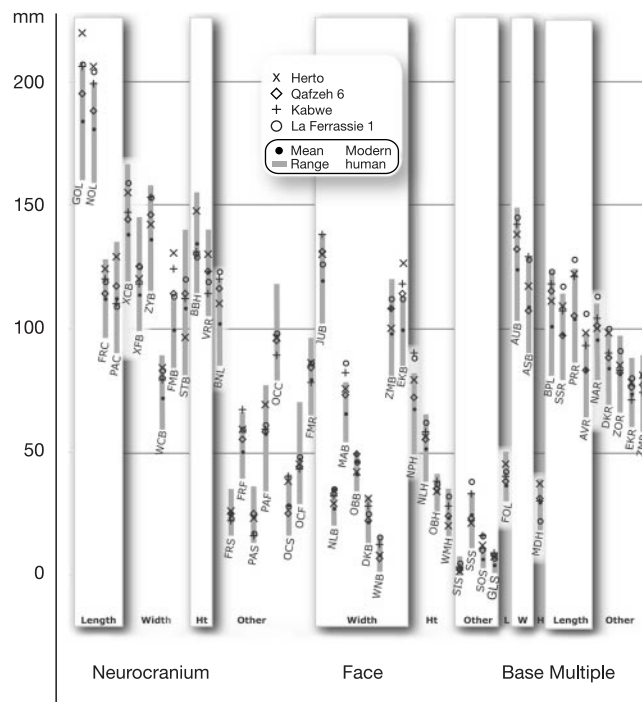

Figure 3 Univariate comparisons, by anatomical region and dimension, of BOU-VP-16/1 with Qafzeh 6, Kabwe, La Ferrassie, and modern (recent) human males. All comparative data are from Howells[7,27] on original specimens. The listed means are the grand means of the male sample means for the skeletal populations studied by Howells[7,27]. The measurement abbreviations are as per Howells[7,27], and are also defined in the Supplementary Information. Symbols: multiplication signs, Herto; diamonds, Qafzeh; plus signs, Kabwe; open circles, La Ferrassie 1; filled circles, means for modern humans; grey bars, range for modern humans. Ht, height.
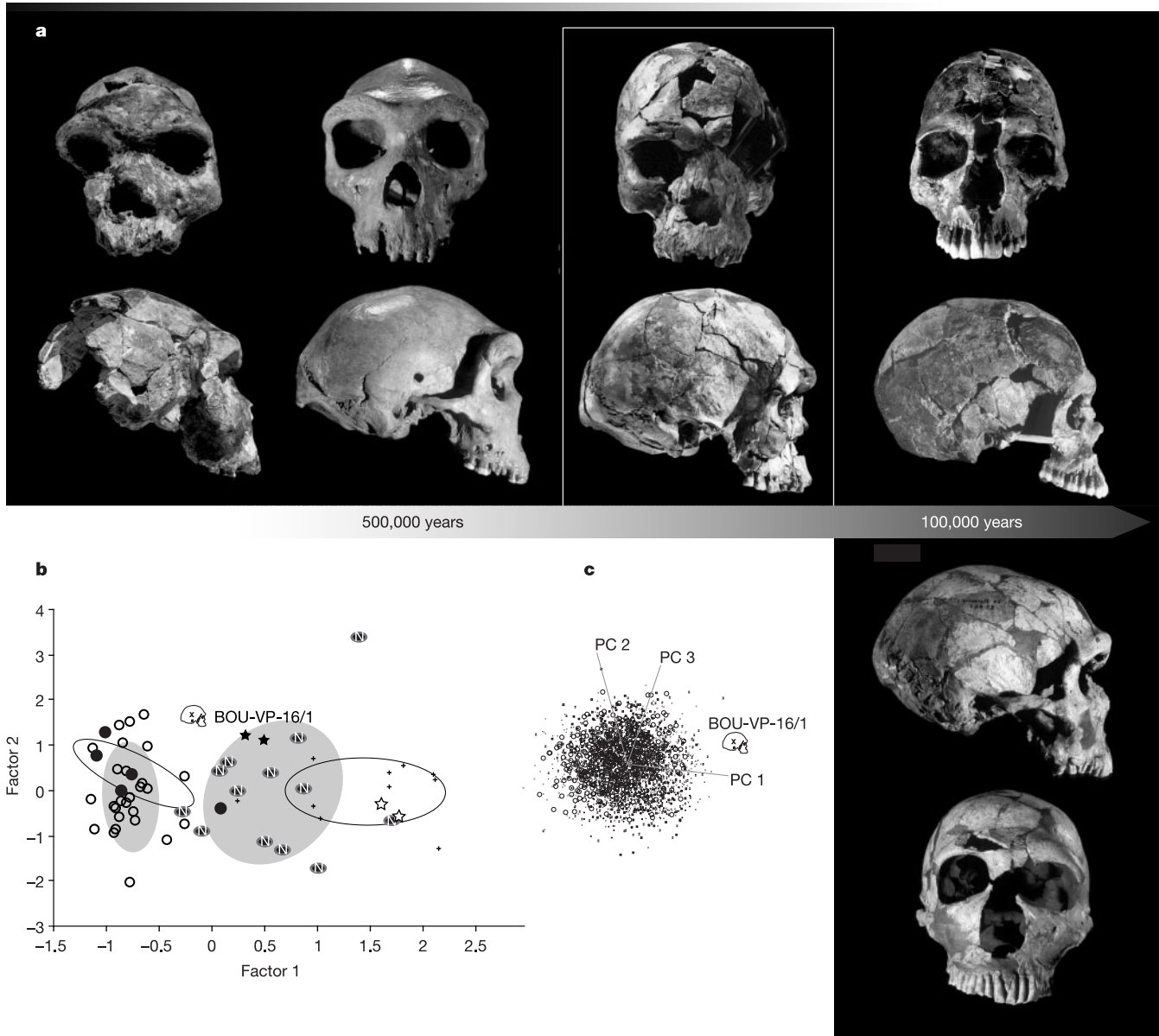
Figure 4 a, Comparative analysis of the Herto BOU-VP-16/1 adult cranium. **a**, From left to right, in anterior and lateral views, Bodo (The National Museum of Ethiopia, Addis Ababa), Kabwe (The Natural History Museum, London), Herto BOU-VP-16/1 (boxed), Qafzeh 9 (The Rockefeller Museum, Jerusalem), and, inset below, the La Ferrassie Neanderthal (Musée de L'Homme, Paris), all to the same scale, with approximate timeline. **b**, Plot of first two principal component scores, with the position of Herto BOU-VP-16/1 given by the fossil symbol marked 'x'. *Homo erectus*, includes KNM-ER 3733 and KNM-ER 3883 (open stars), and Sangiran, Ngandong and Zhoukoudian crania (plus signs). 'Neanderthals' (Amud, Atapuerca, Gibraltar, La Ferrassie, La Chapelle, La Quina, Monte Circeo, Petralona, Saccopastore, Shanidar, Steinheim and Tabun crania) are shown by circled letter N, Omo 2 and Kabwe by filled stars, and fossil AMHS (Qafzeh 6, 9, Skhul 5, Cro-Magnon and Predmostí 3 crania) by filled circles. Population means of 28 male modern human samples (shown by open circles) were taken from Howells[27] and included in the principal-components analysis (PCA). This was done to show the plot position of modern humans and the degree of inter-population variation. The ovals (line and shade) represent the 1 s.d. dispersion areas of the fossil AMHS sample, the Neanderthal sample, the Asian *H. erectus* sample, and the modern human population means. The measurements used for this analysis are those of the cranial vault (GOL, NOL, XCB, XFB, AUB, ASB, FRC and PAC; see Supplementary Information for meanings of abbreviations). The raw measurements were standardized for size by the geometric mean of all eight variables. PCA was performed on the size-standardized variables so as to describe shape. The limited number of measurements is a necessary limitation when including fossil specimens. This graph thus illustrates the phenetic affinities as reflected in a limited part of the anatomy. The comparative data are from Arsuaga *et al.*[9] and Howells[27]. **c**, Plot of the first three principal components of the complete Howells[27] data set of 3,024 modern (recent) human individuals, plus Herto BOU-VP-16/1 (the fossil symbol marked 'x'). The principal components were generated from the natural-log-transformed data. This and other results of multivariate analyses demonstrate the phenetic distinctiveness of the Herto hominids relative to modern human crania. However, finer details of the relative position of Herto hominids in multidimensional morphometric space are difficult to interpret because of the necessary inclusion of estimated measurements. The measurements used are given in the Supplementary Information.

shows that modern human morphology emerged in Africa long before the Neanderthals vanished from Eurasia. □

Methods

Order Primates L., 1758
Suborder Anthropoidea Mivart, 1864
Superfamily Hominoidea Gray, 1825
Family Hominidae Gray, 1825
Homo sapiens idaltu subsp. nov.

Etymology. The subspecies name 'idàltu' is taken from the Afar language. It means 'elder'.
Holotype. BOU-VP-16/1 (Fig. 1), an adult cranium with partial dentition. Holotype and referred material are housed at the National Museum of Ethiopia, Addis Ababa. Holotype from Bouri Vertebrate Paleontology Locality 16 (BOU-VP 16); differentially corrected GPS coordinates: 10° 15.5484′ N and 40° 33.3834′ E.
Referred material. BOU-VP-16/2 cranial fragments; BOU-VP-16/3 parietal fragment; BOU-VP-16/4 parietal fragment; BOU-VP-16/5 child's cranium; BOU-VP-16/6 R. upper molar, BOU-VP-16/7 parietal fragments; BOU-VP-16/18 parietal fragments; BOU-VP-16/42 upper premolar, BOU-VP-16/43 parietal fragment.
Stratigraphy and age. Bouri Formation, Upper Herto Member. Dated by ^{40}Ar/^{39}Ar to between 160,000 and 154,000 years ago (ref. 6).
Diagnosis. On the limited available evidence, a subspecies of *Homo sapiens* distinguished from Holocene anatomically modern humans (*Homo sapiens sapiens*) by greater craniofacial robusticity, greater anterior–posterior cranial length, and large glenoid-to-occlusal plane distance. *Homo sapiens idaltu* is distinguished from the holotype of *Homo rhodesiensis* (Woodward, 1921) by a larger cranial capacity, a more vertical frontal with smaller face, and more marked midfacial topography (for example, canine fossa). We consider the holotypes of *H. helmei* and *H. njarasensis* too fragmentary for appropriate comparisons.

1. Mbua, E. N. *Patterns of Middle Pleistocene Hominid Evolution in Africa* Dissertation, Univ. Hamburg, (2001).
2. Stringer, C. B. Modern human origins: progress and prospects. *Phil. Trans. R. Soc. Lond. B* **357**, 563–579 (2002).
3. Howell, F. C. Paleo-demes, species clades, and extinctions in the Pleistocene hominin record. *J. Anthropol. Res.* **55**, 191–243 (1999).
4. Stringer, C. B. in *The Age of the Earth: From 4004 BC to AD 2002* (eds Lewis, C. L. E. & Knell, S. J.) 265–274, Geological Society of London, Spec. Publ. 190 (2001).
5. Rightmire, G. P. in *Humanity from African Naissance to Coming Millennia* (eds Tobias, P. V., Raath, M. A., Moggi-Cecci, J. & Doyle, G. A.) 231–236 (Firenze Univ. Press, 2001).
6. Clark, J. D. *et al.* Stratigraphic, chronological and behavioural contexts of Pleistocene *Homo sapiens* from Middle Awash, Ethiopia. *Nature* **423**, 747–752 (2003).
7. Howells, W. W. Cranial variation in man. *Pap. Peabody Mus. Archaeol. Ethnol.* **67**, 1–259 (1973).
8. Tillier, A.-M. in *The Evolution and Dispersal of Modern Humans in Asia* (eds Akasawa, T., Aoki, K. & Kimura, T.) 15–28 (Hokusen-sha, Tokyo, 1992).
9. Arsuaga, J. L., Martínez, I., Gracia, A. & Lorenzo, C. The Sima de los Huesos crania (Sierra de Atapuerca Spain). A comparative study. *J. Hum. Evol.* **33**, 219–281 (1997).
10. Lieberman, D. E., McBratney, B. M. & Krovits, G. The evolution and development of cranial form in *Homo sapiens*. *Proc. Natl Acad. Sci. USA* **99**, 1134–1139 (2002).
11. Sarich, V. M. in *Conceptual Issues in Modern Human Origins Research* (eds Clark, G. A. & Willermet, C. M.) 392–412 (Aldine, New York, 1997).
12. Bräuer, G. in *Humanity from African Naissance to Coming Millennia* (eds Tobias, P. V., Raath, M. A., Moggi-Cecci, J. & Doyle, G. A.) 191–197 (Firenze Univ. Press, 2001).
13. Bräuer, G., (eds Mellars, P. & Stringer, C. B.) 123–154 (Edinburgh Univ. Press, 1989).
14. Cann, R. Genetic clues to dispersal in human populations: Retracing the past from the present. *Science* **291**, 1742–1748 (2001).
15. Wolpoff, M. & Caspari, R. in *Conceptual Issues in Modern Human Origins Research* (eds Clark, G. A. & Willermet, C. M.) 28–44 (Aldine, New York, 1997).
16. Hawks, J. D. & Wolpoff, M. H. The four faces of Eve: Hypothesis compatibility and human origins. *Quat. Int.* **75**, 41–50 (2001).
17. Wolpoff, M. H., Hawks, J., Frayer, D. & Hunley, K. Modern human ancestry at the peripheries: A test of the replacement theory. *Science* **291**, 293–297 (2001).
18. Templeton, A. R. Out of Africa again and again. *Nature* **416**, 45–51 (2002).
19. Underhill, P. A. *et al.* The phylogeography of Y chromosome binary haplotypes and the origins of modern human populations. *Ann. Hum. Genet.* **65**, 43–62 (2001).
20. Ingman, M., Kaessmann, H., Pääbo, S. & Gyllensten, U. Mitochondrial genome variation and the origin of modern humans. *Nature* **408**, 703–713 (2000).
21. Haile-Selassie, Y. Late Miocene hominids from the Middle Awash, Ethiopia. *Nature* **412**, 178–181 (2001).
22. White, T. D., Suwa, G. & Asfaw, B. *Australopithecus ramidus*, a new species of hominid from Aramis, Ethiopia. *Nature* **371**, 306–312 (1994).
23. Lovejoy, C. O., Meindl, R. S., Ohman, J. C., Heiple, K. G. & White, T. D. The Maka femur and its bearing on the antiquity of human walking: Applying contemporary concepts of morphogenesis to the human fossil record. *Am. J. Phys. Anthropol.* **119**, 97–133 (2002).
24. White, T. D. *et al.* New discoveries of *Australopithecus* at Maka, Ethiopia. *Nature* **366**, 261–265 (1993).
25. Asfaw, B. *et al. Australopithecus garhi*: A new species of early hominid from Ethiopia. *Science* **284**, 629–635 (1999).
26. Asfaw, B. *et al.* Remains of *Homo erectus* from Bouri, Middle Awash, Ethiopia. *Nature* **416**, 317–320 (2002).
27. Howells, W. W. Skull shapes and the map. Craniometric analyses in the dispersion of modern *Homo*. *Pap. Peabody Mus. Archaeol. Ethnol.* **79**, 1–189 (1989).

....

Stratigraphic, chronological and behavioural contexts of Pleistocene *Homo sapiens* from Middle Awash, Ethiopia

J. Desmond Clark*†, **Yonas Beyene**‡, **Giday WoldeGabriel**§, **William K. Hart**||, **Paul R. Renne**¶, **Henry Gilbert**#, **Alban Defleur**☆, **Gen Suwa****, **Shigehiro Katoh**††, **Kenneth R. Ludwig**‡‡, **Jean-Renaud Boisserie**§§, **Berhane Asfaw**|||| & **Tim D. White**#

* *Department of Anthropology, The University of California, Berkeley, California 94720, USA*
‡ *Department of Anthropology and Archaeology, Authority for Research and Conservation of Cultural Heritage, P.O. Box 6686, Addis Ababa, Ethiopia*
§ *EES-6/MS D462, Los Alamos National Laboratory, Los Alamos, Mew Mexico 87545, USA*
|| *Department of Geology, Miami University, Oxford, Ohio 45056, USA*
¶ *Berkeley Geochronology Center, 2455 Ridge Road, Berkeley, California 94709, USA, and Department of Earth and Planetary Science, University of California, Berkeley, California 94720, USA*
# *Department of Integrative Biology and Laboratory for Human Evolutionary Studies, Museum of Vertebrate Zoology, University of California, Berkeley, California 94720, USA*
☆ *CNRS UMR 6569 du CNRS, Laboratoire d'Anthropologie, Faculté de Médecine, Secteur Nord, Blvd. Pierre Dramart, 13916 Marseille Cedex 20, France*
** *The University Museum, The University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan*
†† *Hyogo Museum of Nature and Human Activities, Yayoigaoka, Sanda 669-1546, Japan*
‡‡ *Berkeley Geochronology Center, 2455 Ridge Road, Berkeley, California 94709, USA*
§§ *CNRS UMR 6046, Université de Poitiers, France*
|||| *Rift Valley Research Service, P.O. Box 5717, Addis Ababa, Ethiopia*
† *Deceased*

....

Clarifying the geographic, environmental and behavioural contexts in which the emergence of anatomically modern *Homo sapiens* occurred has proved difficult, particularly because Africa lacked adequate geochronological, palaeontological and archaeological evidence. The discovery of anatomically modern *Homo sapiens* fossils at Herto, Ethiopia[1], changes this. Here we report on stratigraphically associated Late Middle Pleistocene artefacts and fossils from fluvial and lake margin sandstones of the Upper Herto Member of the Bouri Formation, Middle Awash, Afar Rift, Ethiopia. The fossils and artefacts are dated between 160,000 and 154,000 years ago by precise age determinations using the ^{40}Ar/^{39}Ar method. The archaeological assemblages contain elements of both Acheulean and Middle Stone Age technocom-