Current events

Late Pliocene *Homo* and Oldowan Tools from the Hadar Formation (Kada Hadar Member), Ethiopia

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Journal of Human Evolution (1996) **31,** 549–561

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0047–2484/96/120549+13 $25.00/0

A broad consensus among paleoanthropologists holds that the *Homo* clade originated in Africa sometime between 2·0 and 3·0 Ma ago. However, a gap in the east African hominid fossil record spans the better part of this million year temporal interval. Although as many as three species of *Homo* greet the Pleistocene epoch in Africa [*Homo habilis*, *Homo rudolfensis*, and *Homo erectus* (=*ergaster*)], not one first appearance datum (FAD) for these taxa unequivocally predates 1·9 Ma (Kimbel, 1995; White, 1995), and their earlier Pliocene phylogenetic roots remain obscure (Wood, 1992). Therefore, any fossil specimen of *Homo* older than 2·0 Ma is potentially of great value.

In this preliminary report we describe the discovery of a maxilla of *Homo* closely associated with Oldowan stone tools and late Pliocene fauna in the upper part of the Kada Hadar Member, Hadar Formation, Ethiopia. Single-crystal $^{40}Ar/^{39}Ar$ laser probe analyses provide an age of $2{\cdot}33 \pm 0{\cdot}07$ Ma for this discovery which, therefore, represents the oldest association of hominid remains with stone tools, and possibly the earliest well-dated occurrence of the genus *Homo*.

Recovery

On 2 November 1994, during paleontological survey in a previously unexplored area containing deposits of the ''upper'' Kada Hadar Member, members of the Hadar project's hominid survey team (Ali Yesuf and Maumin Allahendu) recovered fragments of a hominid maxilla at a new locality, A.L. 666, a low, steep hill of undifferentiated silts capped by a small patch of a heavily weathered sandstone. The A.L. 666 outcrop occurs in a ca. 300 m × 600 m drainage basin of the Makaamitalu, a branch of the north (left) bank of the Awash River's Kada Hadar tributary.

The maxilla, A.L. 666-1, was found in two major portions comprising the left and right halves, broken cleanly along the intermaxillary suture. The left half, retaining P^3 and P^4 crown fragments and the roots of M^1, was spotted first, lying uncovered in a narrow gully draining the southeast facing slope of the hill. The right half, with P^3–M^1 crowns plus M^2–M^3 roots, was found topographically higher, on the surface of the southeast facing slope. Approximately 25 cm to the east of the right maxilla, alveolar bone, tooth crown and tooth root fragments from the left M^1–M^3 position were also found clustered on the surface. The latter occurrence marks the probable position on the slope from which the left maxilla tumbled into the gully. Intensive surface collecting followed by dry-sieving of the gully contents and adjacent slopes resulted in the recovery of nonhominid mammal elements and approximately 30 tooth crown, tooth root and bone fragments of the hominid maxilla. All of these pieces, except a partial right C crown, fit cleanly on to the main portions of the maxilla. The specimen is well preserved, undistorted, and most breaks are fresh.

Fresh-appearing Oldowan flakes and ''choppers'' were present on the surface at the base of the A.L. 666 hill and surrounding outcrops. To identify the *in situ* horizon, a trial excavation was undertaken during the 1994 field season. Although no additional parts of the hominid maxilla were recovered in the initial 2 m^2 excavation, additional lithic elements and several nonhominid bone fragments were encountered.

Stratigraphy

At least one disconformity, represented by an erosional surface with up to 8 m of relief, occurs high in the Kada Hadar Member above the 2.92 Ma BKT-2 marker tephra (Figure 1). Below the disconformity, from Sidi Hakoma up to middle Kada Hadar Member times, a meandering river system dominated the landscape, as recorded by several fining upward fluvial cycles, each comprising a sheet sandstone that gives way vertically to an overbank argillaceous siltstone or silty claystone often capped by a paleosol. Up to six lacustrine laminites interrupt the fluvial cycles. In contrast, above the disconformity sheet sandstones are replaced by coarse-grained conglomerates that are interbedded with sandy siltstones and paleosols, and lacustrine deposits are absent. The dramatic change in lithology above the disconformity reflects environmental change and/or faulting and downdropping of the Hadar basin.

The artefact-bearing horizon at A.L. 666, located 10–15 m above the disconformity and about 80 cm below the BKT-3 tephra (Figure 1), is a 3.5 m thick, massive to blocky pale brown siltstone containing minor amounts of pebble-size calcareous nodules and abundant white, calcified rhizoliths (root casts). Because the hill is eroded to an elevation lower than the tephra, BKT-3 does not occur at A.L. 666 itself. However, this same siltstone, with nodules, rhizoliths and artefacts, is observed 30 m to the northwest and 100 m to the southeast along the basin rim, where the sediment is directly overlain by BKT-3. Unique field characteristics among Hadar tephras (light brown color, occasionally cross-bedded, with root casts and brown clay-filled worm burrows) render BKT-3 a good stratigraphic marker in the upper Kada Hadar Member.

The position of freshly broken portions of the maxilla on a steep slope that was otherwise fairly devoid of accumulated overburden indicates that it had been exposed on the surface only a short time before discovery. We infer that it eroded from the silt horizon of the A.L. 666 hill based on the following circumstances: (1) silt matrix filled the maxillary sinus cavities and anterior tooth alveoli on both sides of A.L. 666-1; (2) a root cast was present in one maxillary sinus; and (3) the *in situ* bone fragments show patina and preservation details identical to those of the hominid maxilla.

Geochronology and biochronology

The radiometric age of the BKT-3 tephra is the primary constraint on the age of the hominid maxilla and artefacts from A.L. 666. However, BKT-3 is not a primary air-fall deposit and it contains no pumice fragments from which primary datable minerals can be extracted. Instead, ash-grade components of the BKT-3 eruption were transported by streams into Hadar's sedimentary record, presumably as a continuation of the deposition of the underlying flood plain silts. Conventional K/Ar and $^{40}Ar/^{39}Ar$ analyses, which employ bulk measurements that encompass thousands of grains, are not applicable to BKT-3 because such reworked tephras are prone to detrital contamination. Indeed, Miocene-age contaminants were detected in BKT-3 during fission-track analyses of zircons using the grain discrete external detector method, which produced an age of $2{\cdot}3 \pm 0{\cdot}5$ Ma (Walter, 1989). However, the large uncertainty did not instill confidence in the age.

Using the single-crystal $^{40}Ar/^{39}Ar$ laser microprobe method (York *et al.*, 1981; Lobello *et al.*, 1987), we have now dated three samples of BKT-3 from three separate localities: (1) H94-15, from an exposure 30 m northwest of A.L. 666; (2) H94-17, from an exposure ca. 500 m southwest of A.L. 666; (3) 76-B3 (Walter, 1981), from the tephra's type-locality, ca. 100 m west of A.L. 666.

Table 1 summarizes the results of 76 new single-grain analyses of the primary feldspar population, which consists of relatively fine-grained, low-K plagioclases ($Ca/K = 4{\cdot}0 \pm 1{\cdot}5$, based on $^{37}Ar/^{39}Ar$ measurements). Eight additional grains, distinguishable on the basis of

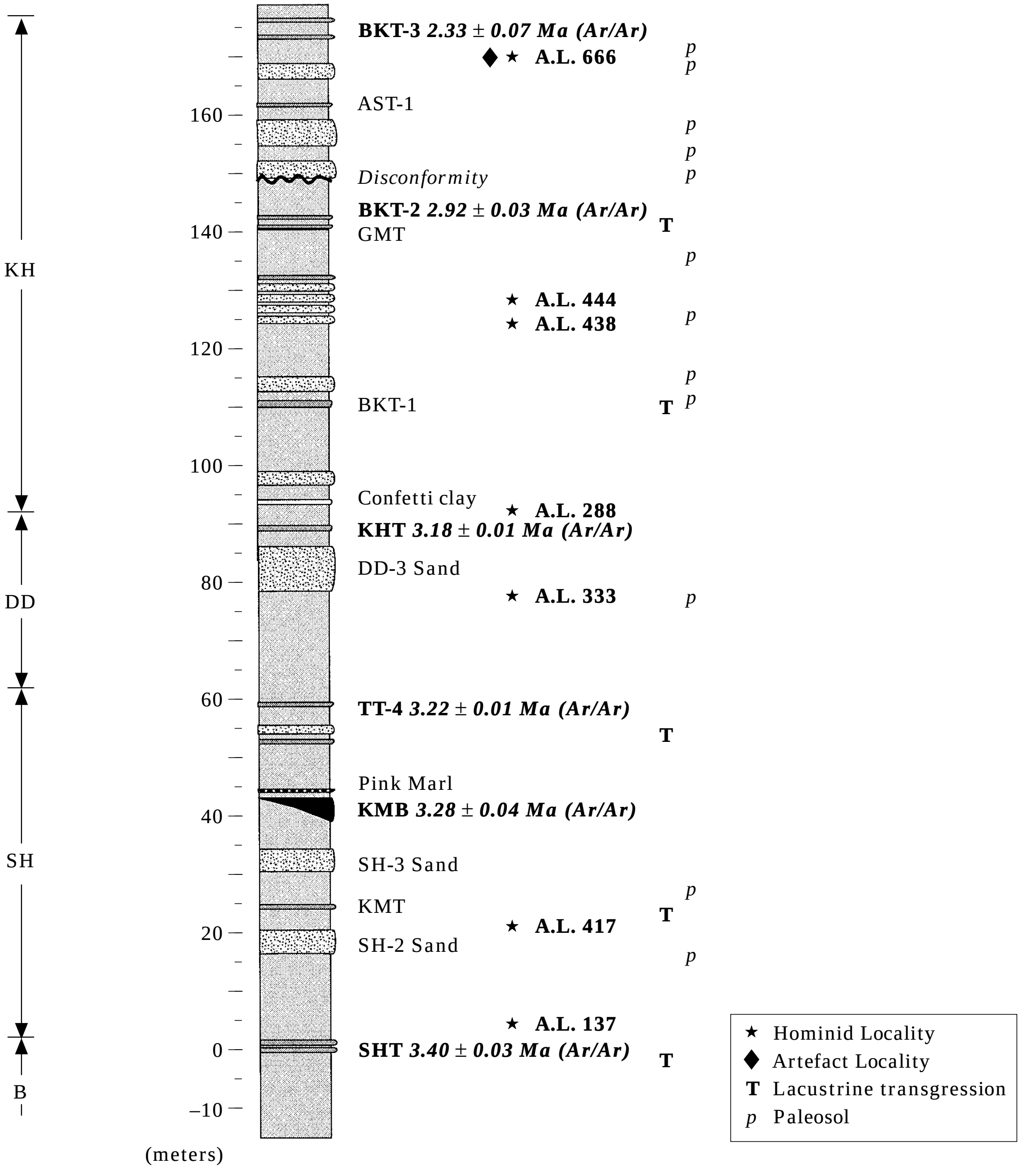


Figure 1. Composite stratigraphic section of the Hadar Formation based on exposures in the Kada Hadar and Ounda Hadar drainages, with selected hominid localities and radioisotopic ages indicated. Member boundaries shown at left (B = Basal; SH = Sidi Hakoma; DD = Denen Dora; KH = Kada Hadar).

Ca/K, yielded Miocene ages between 7·7 ± 0·8 and 27·0 ± 0·1 Ma. The primary feldspar population yields single grain ages ranging from ca. 1–4 Ma, with an average relative error of 30%. Radiogenic argon in these grains is measured by subtracting contaminant atmospheric ^{40}Ar from total measured ^{40}Ar; in the unradiogenic BKT-3 samples these two values are nearly

Table 1 Summary of single-crystal $^{40}Ar/^{39}Ar$ laser microprobe ages for BKT-3 feldspars

Sample	Number of grains	$(^{40}Ar/^{36}Ar)_i$*	MSWD*	Isochron age* (Ma)	Integrated age† (Ma)
H94-15	15	(299 ± 13	2·0	2·38 ± 0·47)	2·35 ± 0·16
H94-17	15	(288 ± 12	0·5	2·49 ± 0·22)	2·39 ± 0·21
76B3	46	(293 ± 3	0·8	2·32 ± 0·07)	2·32 ± 0·08
Total	**76**	**(295 ± 2**	**1·0**	**2·34 ± 0·06)**	**2·33 ± 0·07**

All grains are subhedral, clear, tabular crystals of plagioclase. Feldspars analyzed from H94-15 and H94-17 were about 0·5 mm wide and <1·0 mm long; those from 76B3 were, on average, 30% larger. Grains from each sample were placed in aluminium foil packets and inserted into a cadmium-shielded aluminium canister along with the neutron fluence monitor Fish Canyon sanidine (reference age of 27.84 Ma), and irradiated with fast neutrons for 2 h (4 MWh) in Position 5C at the McMaster Nuclear Reactor, Hamilton, Ontario. The samples and monitors were analyzed at the University of Toronto geochronology laboratory. Single grains of irradiated material were loaded into ca. 2 mm wide by 2 mm deep pits drilled into a disc of pure aluminium. The disc was loaded into the ultra-high vacuum extraction line, baked overnight at 190°C, and fused using a Spectra Physics 171 20W argon-ion laser. Extracted gases were purified using heated Zr alloy getters, and measured on a VG MS1200 mass spectrometer operated in the static mode, with an electron multiplier operating at 1·85 kV, and a gain of $1{\cdot}51 \times 10^5$. Each analysis was preceded by a blank run. Argon isotopes were corrected for mass discrimination by measuring replicate aliquots of atmospheric Ar. Production of neutron-induced interferences was measured on irradiated K-glass and CaF_2 salt. Constants used are: $\lambda = 5{\cdot}543 \times 10^{-10}$/a; $^{40}K/K = 1{\cdot}67 \times 10^{-4}$ mol/mol. J values for each of the samples are: H94-14 = $4{\cdot}618 \pm 0{\cdot}010 \times 10^{-4}$; H94-17 = $4{\cdot}628 \pm 0{\cdot}007 \times 10^{-4}$; and 76B3 = $4{\cdot}596 \pm 0{\cdot}016 \times 10^{-4}$. Uncertainties are 1 σ, and propagate errors in peak measurements, interference corrections, and the measurement of standards and blanks.

*In the isochron method, $(^{40}Ar/^{36}Ar)_i$ ratios and ages are derived by fitting a line through the individual grain data on a diagram of $^{36}Ar/^{40}Ar$ versus $^{39}Ar/^{40}Ar$. Straight lines of negative slope define grains of the same age (given by the $^{39}Ar/^{40}Ar$ intercept) that are variably mixed with contaminant argon of fixed composition (given by the $^{36}Ar/^{40}Ar$ intercept). Isochron calculations are based on the least-squares fitting algorithm of York (1969): no *a priori* assumptions are made about the initial $^{40}Ar/^{36}Ar$ ratio being atmospheric in value. However, all $(^{40}Ar/^{36}Ar)_i$ ratios derived by the fitting routine for BKT-3 are within errors of the atmospheric values of 295·5. MSWD is a reduced χ^2 statistic (ΣS/n-2), which measures how well the data are fitted to the line. This value should be about 1 if the observed and expected results are similar.

†Integrated ages are calculated by summing the Ar gas released from each single grain; such integrated ages are "model" ages because they assume that each grain formed with the same initial $(^{40}Ar/^{36}Ar)_i$ ratio of atmosphere (295·5).

equal. Because the contaminant ^{40}Ar is determined by multiplying the ^{36}Ar peak by 295·5 (the atmospheric ^{40}Ar:^{36}Ar ratio), absolute errors in measuring the tiny ^{36}Ar peak are magnified and dominate the age. Despite care in measuring the ^{36}Ar peak accurately, large errors and scatter in the ages of individual grains are inevitable, and it is necessary to analyze many grains to reduce the error to acceptable values. The grains' low K content and small size make their age measurement comparable in difficulty to the age measurement of 13,000 year K-rich sanidines, analytically at the current threshold of feasiblity of the $^{40}Ar/^{39}Ar$ method (Hu *et al.*, 1994). Because of the difficulty in determining the single-grain age for BKT-3, we prefer the *integrated age* as the best estimate of the formation age of the tephra. The integrated age sums the total gas from all grains in the subset (Table 1), excluding obvious contaminants. The combined ($n = 76$) integrated age of BKT-3 is 2·33 ± 0·07 Ma, statistically indistinguishable from the isochron age of 2·34 ± 0·06 Ma (Table 1). We conclude that the accurate and precise age of BKT-3 is 2·33 Ma, which is the minimum age for the A.L. 666 hominid and artefacts.

Biochronologic implications of the sparse fauna from the Makaamitalu basin (Table 2) are in broad agreement with the radioisotopic age of BKT-3. *Theropithecus oswaldi*, whose FAD in the Shungura Formation is in unit E-3, implies a *maximum* age of ca. 2·4 Ma, while a notably

Table 2 Makaamitalu Basin faunal list

MAMMALIA	Artiodactyla
Primates	Suidae
Hominidae	*Metridiochoerus* cf. *modestus*
Homo sp.*	*Kolpochoerus* cf. *limnetes*
Cercopithecidae	Hippopotamidae
*Theropithecus oswaldi**	Giraffidae
Rodentia	*Giraffa* sp.
Thryonomidae	Bovidae
Thryonomys cf. *swinderianus*	cf. *Syncerus*
Hystricidae	*Tragelaphus* sp.*
Hystrix cf. *cristatus*	Cephalophini sp.
Muridae	Hippotragini sp.
cf. *Golunda gurai**	Reduncini sp.
cf. *Millardia coppensi**	?*Parmularius* sp.
Carnivora	*Beatragus* sp.
Felidae	*Raphicerus* sp.*
Proboscicea	*Gazella* sp.*
Elephantidae	*Gazella praethomsoni*
Elephas recki atavus	
Perissodactyla	REPTILIA
Equidae	Crocodylia
	Crocodylidae
	Crocodylus sp.

*Taxa recovered from A.L. 666.

small third molar most likely attributable to the poorly known *Metridiochoerus modestus* suggests an age of ca. 2·0 Ma, although the present state of knowledge of this suid species does not preclude an older age. A well-preserved lower molar of *Elephas recki atavus* corresponds to Morphotype I of Beden (1983), the characteristic form in lower Member G (below unit G-13) of the Shungura Formation, but not in Member F, suggesting an age range of 2·0–2·33 Ma (Beden, 1985; Feibel *et al.*, 1989).

Hominid maxilla

The morphology of the new Hadar maxilla distinguishes it not only from that of the well known Hadar hominid species *Australopithecus afarensis* (known only from sediments below the BKT-2 tephra) but also from that of other *Australopithecus* species (White *et al.*, 1981; Rak, 1983; Ward & Kimbel, 1983; Kimbel *et al.*, 1984, 1994; Leakey *et al.*, 1995). Both maxillary and dental morphology tie the new Hadar specimen to the genus *Homo*.

The A.L. 666-1 maxilla features a relatively wide and deep palate with an evenly parabolic dental arcade. Subnasal prognathism is modest and the nasoalveolar clivus is sharply angled to the roof of the palate and to the floor of the nasal cavity. In anterior aspect, the maxilla appears deep and steep walled, and the frontal processes alongside the nasal aperture are mildly everted. The most inferior point on the zygomatic process root lies above M^1/M^2. The I^2 crown is strongly shovel-shaped; the canine is large but symmetric; M^1 shape is mesiodistally elongate; the M^2 occlusal outline is rhomboidal. Features that we attribute to male sex include inflated contours of the maxillary corpus and zygomatic process root due to expansive maxillary sinus cavities, absolutely long palate (est. orale–staphylion = 62.5 mm), and a fairly large canine (crown base area = 106 mm^2) that, though apically flattened by occlusal wear, projects below the level of the occlusal plane of the neighboring teeth (see Figure 2).

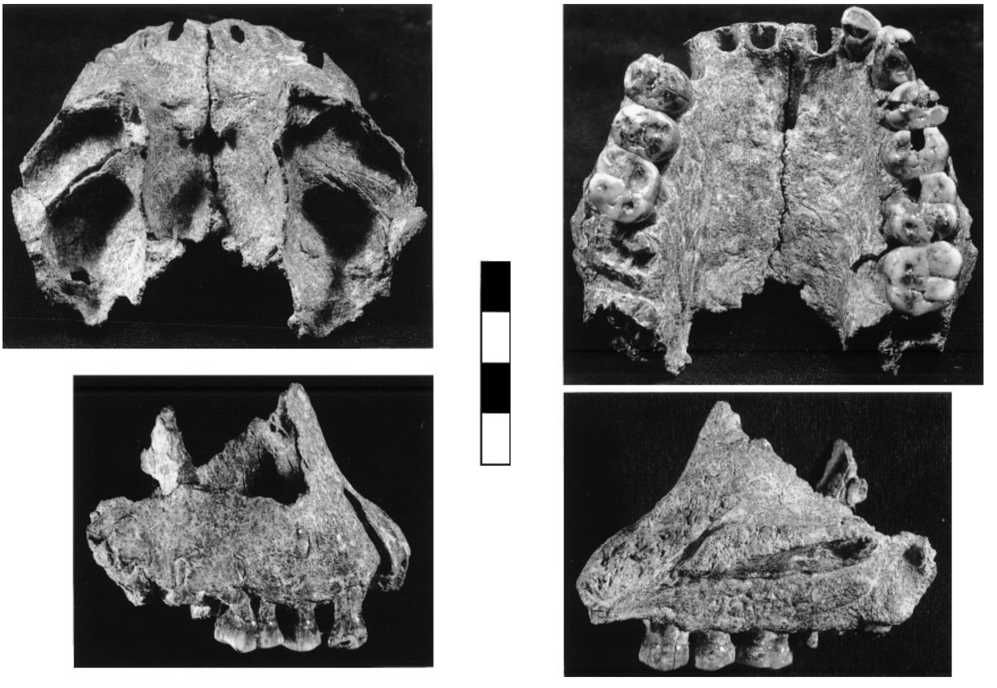


Figure 2. The maxilla A.L. 666-1. Clockwise from top left: superior, palatal, left medial, right lateral. Scale = 4 cm. Tooth measurements (BL × MD corrected, in mm): LI^2, 7·0 × 7·4; RC, 10·2 × 10·4; RP^3, 12·5 × 9·2; RP^4, 12·6 × 9·0; RM^1, 12·4 × 12·9; LM^2, 14·4 × 13·5.

Relatively broad palate. At 63% the palatal breadth:length index for A.L. 666-1 falls above the values for the pooled *Australopithecus* sample (pooled $n = 10$, $\bar{x} = 54\%$, range = 48–59%) but among those for *H. habilis* and "early" African *H. erectus* (pooled $n = 6$, $\bar{x} = 67\%$, range = 60–71%).

Mild subnasal prognathism. Expressed as the ratio of the horizontal projected length to the direct chord length between nasospinale and prosthion, subnasal prognathism in A.L. 666-1 is less (at 63%) than in any *Australopithecus* specimen (pooled species $n = 13$, $\bar{x} = 75\%$, range = 65–84%), but is well within the range for the pooled early *Homo* sample ($n = 6$, $\bar{x} = 57\%$, range = 47–69%).

Flat nasoalveolar clivus sharply angled to floor of nasal cavity at the distinct spinal crest; extensive intranasal platform horizontally separating anterior nasal spine from vomeral insertion/incisive fossa. The former character is a synapomorphy of *Homo*; the latter is the normative (arguably primitive) condition in *A. afarensis*, rare to absent in other species of *Australopithecus*, but retained in many early *Homo* maxillae. In combination they tie A.L. 666-1 to the early *Homo* sample (among which the resemblance to specimens such as O.H. 62, SK 847 and Sangiran 4 is particularly noteworthy).

Square anterior maxillary profile (absence of the superomedial tapering of the midface in anterior aspect). This configuration in A.L. 666-1 strongly diverges from the generalized triangular maxillary profile of *A. afarensis* and *Australopithecus africanus*, and in combination with flat, anterolaterally directed frontal processes, is similar to the morphology of specimens such as KNM-ER 1805, ER 1470, ER 3733 and Sangiran 4.

Narrow M^1 crown. A buccolingually broad M^1 crown is the standard condition in *Australopithecus* (White *et al.*, 1981; Leakey *et al.*, 1995). The crown shape index (MD:BL) of 1·04 for the A.L. 666-1 M^1 indicates a significantly narrower tooth than in any *Australopithecus* species for which decent samples are available (*A. afarensis*: 0·92, SD = 0·06, n = 11; *A. africanus*: 0·92, SD = 0·05, n = 17; *A. robustus*: 0·91, SD = 0·05, n = 20). On the other hand, the A.L. 666-1 tooth is a little narrower than the mean (1·00, SD = 0·02, n = 12) for *H. habilis* [as constituted in Wood (1993)].

"Rhomboidal" shape of M^2. The mesial cusps of the A.L. 666-1 M^2 dominate the distal cusps and the paracone bulges buccally relative to the metacone, creating an asymmetric rhomboidal occlusal outline. Brown & Walker (1993) suggest that this outline is typical of early African *H. erectus* M^2s (e.g., KNM-ER 3733, WT 15000, ER 807), but we would extend this description to the early African *Homo* sample writ large because it appears to characterize most if not all known *H. habilis* M^2s (see also Tobias, 1991: pp. 636–637), as well as the only known M^2 of *H. rudolfensis* (KNM-ER 1590). Although a rhomboidal M^2 crown is not unknown in *A. afarensis* and *A. africanus*, a square occlusal outline tends to be the rule in these taxa and in "robust" *Australopithecus* species.

To which early species of *Homo* A.L. 666-1 should be attributed is problematic. None of the characters mentioned in support of the generic assignment of A.L. 666-1 affords a clear-cut taxonomic division within the early *Homo* sample. Three factors are responsible for this: variation within the boundaries of conventionally delineated taxa; very small sample sizes for some taxa (*H. rudolfensis*, early *H. erectus*); and, most important, the fact that many of the maxillary characters that bear on the taxonomy of the Hadar specimen appear to be apomorphic for the *Homo* clade as a whole, and thus not useful for sorting taxa within it. Preliminary comparisons indicate close dental morphological similarities between A.L. 666-1 and *H. habilis* specimens from Olduvai Gorge (e.g., O.H. 16, O.H. 39), but we do not at this time rule out other taxonomic assignments for the Hadar maxilla.

Archeology

Thirty-four stone tools were recovered from the A.L. 666 locality during 1994 field work, among which 14 were excavated *in situ* (Figure 3). The degree of association between the excavated and surface tools is not yet firmly established. However, lack of abrasion on the edges of the surface artefacts and their fresh condition suggest that they were neither exposed on the surface for a long time nor transported over nontrivial distances.

The surface and *in situ* stone tools from A.L. 666 are made out of volcanic and sedimentary raw materials, with basalt and chert the most abundant. The most frequent lithic types are "typical" Oldowan flakes (Toth, 1985) that preserve cortical and semi-cortical features and plain striking platforms. They exhibit a range of lengths and have irregular lenticular cross-sections and simple parallel scar patterns. Three specimens are an exception to this, with a complex scar pattern possibly indicating rotation of the core during knapping. The convex longitudinal profile of the dorsal surfaces of the flakes suggests they were struck from round river cobbles. Although the surface collection has not yielded any typical core tools, we collected from the surface three bifacial "end-choppers" (Leakey, 1971) also made out of round river cobbles.

The trial excavation conducted on the southeastern face of A.L. 666 was limited to a $1{\cdot}25 \times 2{\cdot}0$ m grid and reached 80 cm below the surface. The density of lithics is low ($11/m^3$ of excavated sediment), a common feature among Plio-Pleistocene archeological sites (Leakey, 1971; Merrick, 1976; Isaac & Harris, 1978; Harris, 1983; Harris *et al.*, 1987; Kaufulu & Stern, 1987; Kibunjia, 1994). *In situ* flakes were horizontally concentrated within a 90 × 80 cm area of the excavation and vertically clustered within 9 cm, although one flake was found 25 cm lower than this cluster. However, neither the vertical nor the horizontal limits of the artefact concentration have yet been identified, and further excavations at A.L. 666 may reveal clusterings in lithic and faunal density that may have behavioral significance.

The excavated lithic sample, which lacks utilized and retouched flakes, is morphologically similar to the surface collection. On both faces of the single *in situ* core knapping scars show removal of flakes from different striking platforms. We refit an *in situ* angular fragment to this core, which was located in the excavation about 1·6 m from it. This suggests some degree of horizontal dispersion of the artefacts, although we cannot presently determine whether this was the result of discard or postdepositional dispersion.

The technological traits of the small A.L. 666 assemblage (such as a dominance of end-struck flakes, generalized flake scar patterns, and low flake scar counts on the dorsal faces of flakes) resemble those described for the type assemblage of the ''KBS Industry'' (Isaac, 1976) and are typical of other Oldowan assemblages (Harris, 1983; Leakey, 1971).

Fossil vertebrate remains, including isolated teeth of *Theropithecus oswaldi*, a bovid horn core (*Raphicerus* sp.), and mandible fragments of Muridae, were collected at A.L. 666. Sieving the surface of the slope produced 51 additional bone fragments (not including those definitely attributable to the hominid maxilla), approximately 90% of which are highly fragmented long bone shaft segments that cannot be attributed to taxa. Some specimens preserve traces of carnivore and possibly hominid-induced modification. The excavated faunal remains are limited to three specimens, including a fragment of a small bovid scapula that exhibits what may be a stone tool cut mark.

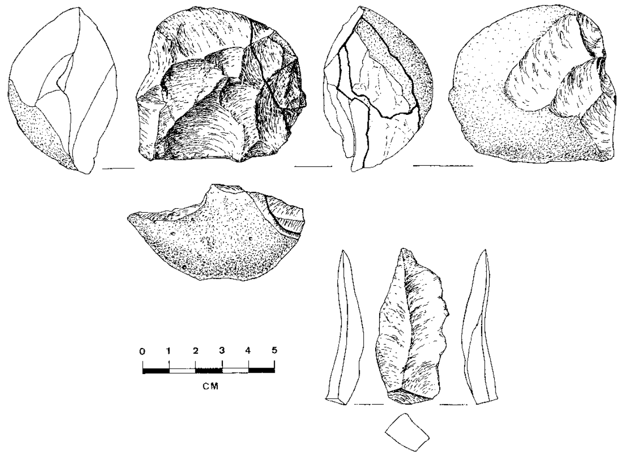
Paleoenvironment

The Makaamitalu basin has produced a small ($n=83$ specimens) but informative collection of fossil mammals identified at least to family level (Table 2). Bovids, mostly teeth, constitute 62% of the total mammalian sample. Of these, 33% represent Alcelaphini and Antelopini, which are grazers and usually arid-adapted mixed feeders, respectively. This is a substantial proportional increase over the representation of these tribes in the Sidi Hakoma (20%) and Denen Dora (18%) Members, although the lower Kada Hadar Member contains only slightly less (29%). High frequencies of these animals in fossil assemblages indicate open, dry habitats (Vrba, 1974). There are no Aepycerotini known in the Makaamitalu collection, whereas there are significant percentages in the Sidi Hakoma (32%), Denen Dora (18%), and lower Kada Hadar (10%) Members. Impalas are never found far from bush or woodlands (Estes, 1991), and their reduction or absence from a region in which they previously existed in great numbers suggests that the Hadar region became more ''open'' in later Pliocene times.

Tragelaphini and Reduncini are also represented in the Makaamitalu assemblage, indicating bush or tree cover and edaphic grasslands. Other mammals that indicate the presence of water include *Thryonomys* cf. *Thryonomys swinderianus*, the extant cane rat, which is known to

Figure 3. A sample of lithics from A.L. 666. (a) Upper row: *in situ* core and flake conjoined (refit indicated by dark outline). Lower right: flake from the *in situ* assemblage. (b) Flakes from the *in situ* assemblage. (c) Bifacially flaked ''end chopper'' from the surface collection. Drawings by Julia Moskowitz.

(a)



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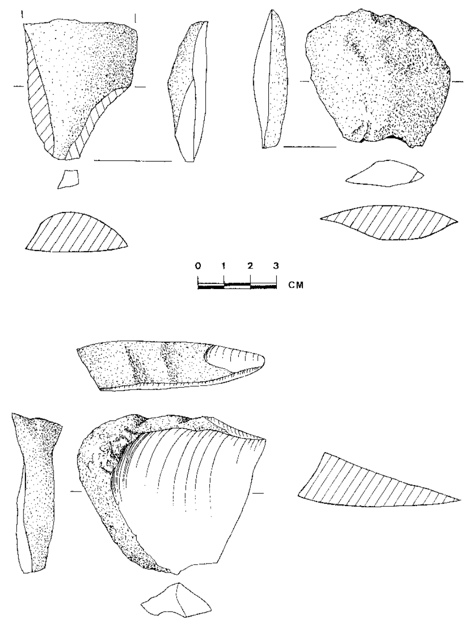

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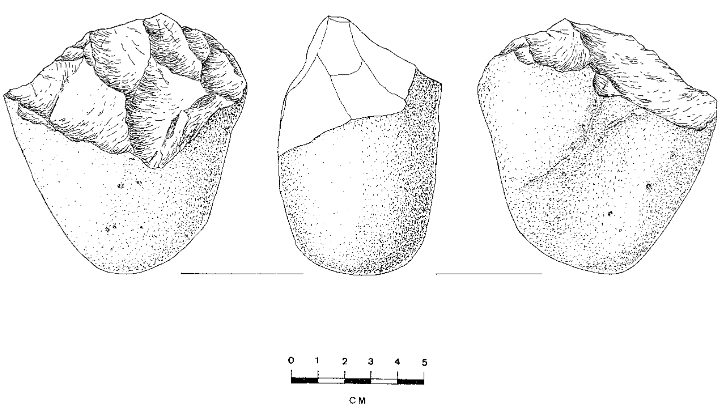

inhabit reed beds in standing water, and specimens of Hippopotamidae. Finally, the only nonhominid primate present in these deposits is *Theropithecus oswaldi*, which is thought to have lived in lake margin and flood plain areas of more open habitats (Eck, 1987).

Based on the limited fossil evidence presently available, the paleohabitat of the Makaamitalu faunal community appears to have been predominantly open, with wetlands and bushed or wooded grasslands, and with stands of trees close to the water source. This contrasts with the generally more closed habitats of the *A. afarensis*-bearing deposits of the Hadar Formation (older than 2·92 Ma), which featured dry bush/woodland and riparian woodlands in the Sidi Hakoma Member, riverine forests and wetlands in the Denen Dora Member, and dry bush/woodland in the ''lower'' Kada Hadar Member.

Conclusions

Our preliminary research at A.L. 666 documents a late Pliocene locality with hominid remains in close spatiotemporal association with excavated lithics and a large-mammal fauna, a rare phenomenon at any East African Plio-Pleistocene site. The earliest evidence for such association comes from two sites, FLK-NN and FLK-*Zinjanthropus* in Bed I, Olduvai Gorge, dated to 1·8 and 1·75 Ma, respectively (Leakey, 1971; Walter *et al.*, 1991), and FxJj38 NW in the lower KBS Member of the Koobi Fora Formation, about 1·85 Ma, though without fauna (Isaac and Harris, 1978; Feibel *et al.*, 1989). A.L. 666 represents a still earlier spatiotemporal co-occurrence of hominids, tools and fauna at a time when *Homo* as well as ''robust'' *Australopithecus* clades were flourishing—although there is no compelling evidence of direct association between the manufacture of Oldowan lithic technology and any particular hominid taxon.

There are few well-sampled fossiliferous African localities between 2·5 and 2·0 Ma. Recent claims for early *Homo* in this temporal interval (Hill *et al.*, 1992; Schrenk *et al.*, 1993; Kimbel and Rak, 1993) face one or more uncertainties of provenience, dating or phylogenetic affinity. The 2·33 Ma occurrence of *Homo* at A.L. 666 promises to add new insights on hominid paleobiology and behavior in this poorly understood time period. Further exploration and excavation during succeeding field seasons in the Makaamitalu basin and in other areas of Hadar that contain relatively young sediments should permit us to clarify archeological, paleontological and geological issues and to amplify the significance of these preliminary results.

Acknowledgements

We thank the Center for Research and Conservation of Cultural Heritage (CRCCH) and the National Museum of Ethiopia, Ethiopian Ministry of Information and Culture, for their cooperation, assistance and permission to conduct field work at Hadar and laboratory research in Addis Ababa. The 1994 Hadar field season was funded by grants from the National Science Foundations (DBS 9222604) and the National Geographic Society. $^{40}Ar/^{39}Ar$ dating at the University of Toronto was supported by the Natural Science and Engineering Council of Canada and the Connaught Foundation of the University of Toronto. Thanks to Julia Moskowitz for the art work in Figure 3, and to Charlie Lucke for printing the photos in Figure 2. We extend our appreciation to Alan Walker and Carol Ward for helpful discussion and the loan of comparative materials. For invaluable logistical help in the field we are grateful to the Ethiopian Institute of Geological Surveys (Ministry of Mines) and SOGEA. Without the wise counsel and hard work of CRCCH representatives Tamrat Wodajo, Tesfaye Hailu and

Ambachew Kebede, the 1994 Hadar field season would not have been successful. As always, we owe a huge debt of gratitude to the Afar people of Eloaha village for their friendship and assistance over many seasons of working and living together at Hadar.

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