Supporting Information

Ward et al. 10.1073/pnas.1316014110

SI Discussion: Geology and Dating

The third metacarpal (KNM-KP 51260) was collected from a sequence of fine sandstones and siltstones exposed in a small northern branch of Kaitio at the level of the Lokapetamoi Tuff in the Natoo Member of the Nachukui Formation (1) that is part of the Omo Group. Formations of the Omo Group are linked by tephrostratigraphic correlations at many levels, and through correlations to dated units, the chronology is well controlled (2). The fossil site lies at an elevation of ~405 m and was therefore covered by Lake Turkana during its high stand (~457 m) 7,000–10,000 y ago. Recession of Lake Turkana left a thin veneer of deposits over much of the area, so volcanic ash layers cannot be mapped continuously from one area of exposure to another. Therefore, compositional analysis of the glass in the volcanic ash layers was used to correlate among exposures. Some algal biolithites above the Lokapetamoi Tuff are sufficiently resistant that they can be mapped from one area of exposure to another.

At Kaitio, strata of the Nachukui Formation strike N 15°E to N 40°E and dip gently (4–8°) to the west in most exposures, except near faults, none of which affect interpretation of the age given below. A composite section used a prominent algal biolithite (stromatolite) to correlate from Kaitio to the northern branch of Nachukui (Fig. S1). The Ebei Tuff (1.475 ± 0.029 Ma) (2) lies 6 m below the Etirr Tuff in the northern branch of Kalochoro. The Etirr Tuff correlates with the Trail Bottom Tuff at Konso (3), where it is dated at 1.43 ± 0.02 Ma (3). The Lokapetamoi Tuff correlates with the Ivory Tuff at Konso, which lies between the Trail Bottom Tuff and the Karat Tuff dated at 1.41 ± 0.02 Ma (4). Therefore, as KNM-KP 51260 was recovered from strata at the level of the Lokapetamoi Tuff, it also must date between 1.43 ± 0.02 and 1.41 ± 0.02 Ma (~1.42 Ma).

During deposition of the Natoo Member, the delta of the Omo River was situated near Nariokotome, about 40 km south of its present location (5). Strata in which the metacarpal was found were deposited on a delta plain of the Omo River or along the delta fringe where the delta met ancient Lake Turkana.

1. Harris JM, Brown FH, Leakey MG, Walker AC, Leakey RE (1988) Pliocene and pleistocene hominid-bearing sites from west of Lake Turkana, Kenya. *Science* 239(4835):27–33.
2. McDougall I, Brown FH (2006) Precise 40Ar/39Ar geochronology for the upper Koobi Fora Formation, Turkana Basin, northern Kenya. *J Geol Soc London* 163:205–220.
3. Brown FH, Haileab B, McDougall I (2006) Sequence of tuffs between the KBS tuff and the Chair tuff in the Turkana Basin, Kenya and Ethiopia. *J Geol Soc London* 163:185–204.
4. Katoh S, et al. (2000) Chronostratigraphy and correlation of the Plio-Pleistocene tephra layers of the Konso Formation, southern Main Ethiopian Rift, Ethiopia. *Quat Sci Rev* 19(13):1305–1317.
5. Feibel CS, Brown FH (1993) Microstratigraphy and paleoenvironments. *The Nariokotome* Homo erectus *Skeleton*, eds Walker A, Leakey RE (Harvard Univ Press, Cambridge, MA), pp 21–39.

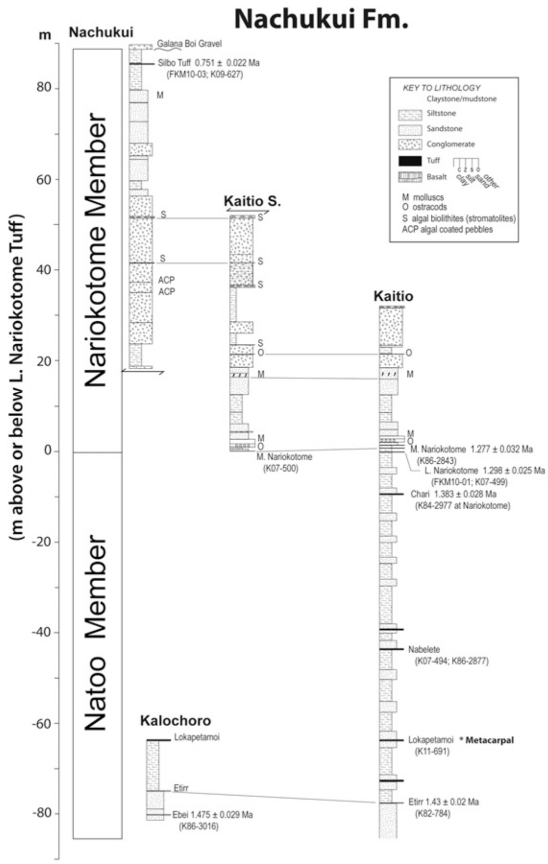

Fig. S1. Stratigraphic position of KNM-WT 51260. Stratigraphic columns of the Natoo, and Nariokotome members of the Nachukui Formation at Kalochoro (north), Nachukui, Kaitio (south), Kaitio, and Nadung’a.

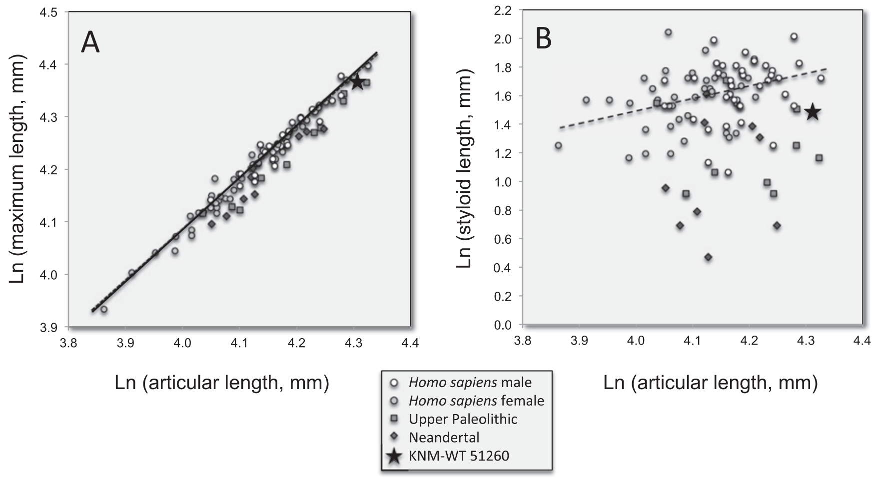

Fig. S2. Third metacarpal styloid proces length allometry. The observation of a slightly shorter third metacarpal styloid process of fossil hominins compared with modern humans is not allometric. (*A*) When the natural logarithm of maximum bone length is regressed on articular length (length between the center of the proximal and distal articular surfaces) following ref. 1 for modern humans, the slope of the RMA line (solid, $y = 0.994x + 0.098$, $n = 146$) and least-squares regression line (dashed, $y = 0.971x + 0.195$, $R^2 = 0.954$) are both isometric (95% CI of the least-squares slope = 0.94–1.01). ANOVA of least-squares residuals of modern human, Neanderthal, and Upper Paleolithic human groups from the relationship illustrated in *A* shows significant differences among groups ($n = 174$, $F = 26.149$, $P < 0.001$). Bonferroni-adjusted post hoc contrasts among groups show that modern humans have relatively larger maximum lengths than either fossil group, whereas the fossils do not differ from one another. KNM-WT 51260 falls at the low end of the modern human range of residuals and the high end of the range of residuals of the fossil groups. (*B*) The correlation between styloid length and bone length is low and nonsignificant ($r = 0.144$, $n = 146$, $P = 0.084$) in a combined-sex sample of humans and nonsignificant within subsamples of known males ($r = 0.259$, $n = 41$, $P > 0.1$) and known females ($r = 0.245$, $n = 38$, $P > 0.1$). Comparison of ln-transformed ratios of styloid length vs. articular length shows that, on average, Neandertal and Late Pleistocene *Homo sapiens* have smaller styloids than do modern humans. ANOVA of ln-transformed ratios of groups from the relationship illustrated in *B* shows significant differences among groups ($n = 174$, $F = 27.173$, $P < 0.001$). Bonferroni-adjusted post hoc contrasts among groups show that modern humans have larger styloids than either fossil group, whereas the fossils do not differ from one another, corroborating the result achieved when maximum bone length is regressed against articular bone length, in *A*. Even so, fossil and extant human distributions overlap substantially, as seen in *B*, so the possible functional significance of this on-average difference is unclear. KNM-WT 51260 falls within the ranges of both the modern and fossil *Homo* specimens, also seen in Fig. 2C. Data in Tables S3 and S4.

1. Trinkaus E, et al. (2010) Human remains from the Moravian Gravettian: Morphology and taphonomy of additional elements from Dolni Vestonice II and Pavlov I. *Int J Osteoarchaeol* 20 (6):645–669.

Table S1. Electron microprobe analyses of the glass fraction of tuffs in the sections shown in Fig. S1 along with comparative analyses where relevant

Tuff	M, N*	No.	SiO_2	TiO_2	ZrO_2	Al_2O_3	Fe_2O_3†	MnO	MgO	CaO	Na_2O	K_2O	F	Cl	Sum	H_2O‡	Total
Silbo Tuff																	
FKM10-03	1,1	10	71.8	0.18	0.14	10.4	3.37	0.15	0.03	0.15	3.89	3.82	0.05	0.16	94.1	6.3	100.4
K09-627	1,2	17	74.3	0.19	0.19	10.2	3.58	0.15	0.02	0.16	4.24	3.54	0.20	0.16	97.0	4.4	101.2
Middle Nariokotome Tuff																	
K07-500	1,1	8	73.3	0.25	0.17	10.2	3.70	0.13	0.03	0.19	3.57	2.48	0.29	0.12	94.4	6.1	100.4
K86-2843	1,2	16	74.1	0.23	0.15	10.1	3.71	0.16	0.03	0.19	3.40	3.18	0.00	0.12	95.5	5.0	100.4
Lower Nariokotome Tuff																	
FKM10-01	1,1	11	70.8	0.29	0.14	9.5	4.83	0.21	0.03	0.19	2.07	2.87	0.12	0.15	91.2	9.6	100.7
K07-499	1,1	10	73.2	0.28	0.17	9.5	4.86	0.23	0.03	0.17	3.91	2.91	0.23	0.13	95.6	4.1	99.6
Chari Tuff (K84-2977) and Tuff L, Shungura Fm. (TEC-76-L)																	
K84-2977	1,1	13	71.0	0.17		10.0	2.86	0.08	0.00	0.18	4.52	3.76			92.6		
TEC-76-L	1,1	17	73.1	0.17	0.14	10.7	2.79	0.07	0.01	0.18	4.20	4.55	0.07	0.13	96.2	4.1	100.2
Nabelete Tuff																	
K07-494	1,1	6	76.6	0.20	0.26	10.9	3.06	0.09	0.01	0.19	1.80	2.50	0.29	0.13	96.0	6.5	102.4
K86-2877	1,1	16	74.6	0.17	0.18	10.7	3.08	0.09	0.01	0.19	3.64	3.51	0.11	0.13	96.5	4.8	101.2
Lokapetamoi Tuff at metacarpal site (K11-691), at Nariokotome (K84-2972), and Ivory tuff at Konso [9711-65; analysis from Katoh et al. (1)]																	
K11-691	1,1	19	73.6	0.16	0.04	11.5	1.31	0.07	0.06	0.24	3.70	4.07	0.11	0.14	95.0	6.5	101.4
K84-2972	1,1	16	74.8	0.15	0.02	11.3	1.27	0.07	0.05	0.24	3.34	4.14	0.00	0.14	95.5	4.8	100.3
9711-65			74.4	0.15		11.5	1.29	0.06	0.04	0.24	3.29	4.56			95.5		
Etirr Tuff (K82-784), and Trail Bottom Tuff at Konso (9311-43)																	
K82-784	1,1	20	72.5	0.35	0.27	8.7	6.62	0.31	0.07	0.20	1.45	2.80	0.32	0.29	94.0	5.7	99.4
9311-43			68.3	0.37		8.3	6.40	0.27	0.05	0.16	3.34	3.78			91.0		
Ebei Tuff (K86-3016 at Kalochoro)																	
K86-3016	1,1	12	71.2	0.52	0.22	8.5	5.95	0.37	0.08	0.08	0.59	1.32	0.24	0.37	89.49	7.9	97.2

*M, N is mode number and number of modes.

†Total iron as Fe_2O_3.

‡H_2O computed by assigning H to oxygen remaining after allocation to other cations.

1. Katoh S, et al. (2000) Chronostratigraphy and correlation of the Plio-Pleistocene tephra layers of the Konso Formation, southern Main Ethiopian Rift, Ethiopia. *Quat Sci Rev* 19(13):1305–1317.

Table S2. Metric data from KNM-WT 51260

Measurement	Value (mm)
Bone length between centers of proximal and distal articular surfaces	74.5
Maximum bone length from head to styloid	78.9
Maximum mediolateral breadth of distal articular surface	15.6
Maximum dorsopalmar depth of distal articular surface	14.8
Mediolateral breadth at midshaft	8.7
Dorsopalmar depth at midshaft	9.9
Maximum mediolateral breadth of proximal articular surface	17.7
Maximum dorsoplantar depth of proximal articular surface	11.1

All data collected with standard dial calipers.

Table S3. Comparative data used in the analyses

Group	Specimen	Articular length (mm)*	Styloid length (mm)†
Homo sapiens female (n = 38)		59.5 ± 4.50 (47.6–67.4)	4.8 ± 1.05 (2.5–7.7)
Homo sapiens male (n = 41)		66.4 ± 4.06 (57.7–76.5)	5.3 ± 1.02 (2.9–7.5)
Homo sapiens sex unknown (n = 70)		64.2 ± 4.83 (55.5–75.8)	4.5 ± 1.26 (0.8–7.0)
KNM-WT 51260		74.5	4.4
Neandertal	Amud 1	(70.0)	2.0
	Kebara 2	67.9	3.7
	KiikKoba 1	56.5	0.7
	La Chapelle-aux-Saints 1	(67.0)	4.0
	La Ferrassie 1	68.5	1.9
	La Ferrassie 2	59.0	2.0
	Regourdou 1	61.6	4.1
	Shanidar 4	61.8	5.0
	Shanidar 6	57.5	2.6
	Tabun 1	(60.7)	(2.2)
Late Pleistocene	AbriPataud 230	59.8	2.0
Homo sapiens	AreneCandide 5	65.2	4.7
	AreneCandide 1	62.7	2.9
	Barma Grande 1	74.7	4.3
	Barma Grande 2	75.4	3.2
	Continenza	56.6	4.7
	DolníVestonice 13	68.8	2.7
	DolníVestonice 16	68.8	4.4
	DolníVestonice 58/59	75.1	4.4
	Grotte des Enfents 4	71.7	4.5
	Mladeč 31	77.8	4.1
	NazletKhater 2	59.7	2.9
	Ohalo 2	66.6	0.4
	Paglicci 25	69.6	2.5
	Qafzeh 8	65.6	1.7
	Qafzeh 9	60.4	1.3
	Sunghir 1	68.2	2.8
	Vado all'Arancio 1	64.0	5.5

Data given as mean ± SD (minimum–maximum). () denotes estimated dimensions. Late Pleistocene data provided by W. A. Niewoehner and E. Trinkaus (Washington University, St. Louis). Modern humans with known sex from the Terry Collection, and those with unknown sex by E. Trinkaus. Individual data shown in Table S4. Fossil data from refs. 1–6.

*Maximum length of bone measured from center of base to most distal point on distal articular surface.

†Maximum length of styloid from center of articular surface on base to most proximal point on styloid along axis of maximum bone length.

1. Crevecoeur I (2008) *Étude Anthropologique du Squelette du Paléolithique Supérieur de Nazlet Khater 2 (Égypte)* [*Anthropological study of the Upper Paleolithic skeleton Nazlet Khater 2 (Egypt)*] (Leuven Univ. Press, Leuven, Belgium).
2. Niewoehner WA (2000) The functional anatomy of Late Pleistocene and recent human carpometacarpal and metacarpophalangeal articulations. PhD thesis (Univ of New Mexico, NM, USA).
3. Niewoehner WA, Weaver AH, Trinkaus E (1997) Neandertal capitate-metacarpal articular morphology. *Am J Phys Anthropol* 103(2):219–233.
4. Sládek V, Trinkaus E, Hillson SW, Holliday TW (2000) *The People of the Pavlovian: Skeletal Catalogue and Osteometrics of the Gravettian Fossil Hominids from Dolní Věstonice and Pavlov, Dolní Věstonice Studies 5* (Archeologický ústav AV, Brno, Czech Republic).
5. Trinkaus E, Smith FH, Stockton TC, Shackelford LL (2006) The human postcranial remains from Mladeč. *Early Modern Humans at the Moravian Gate: The Mladeč Caves and their Remains*, ed Teschler-Nicola M (Springer Verlag, New York), pp 385–445.
6. Trinkaus E, Buzhilova AP, Mednikova MB, Kozlovskaya MV (2013) *The People of Sunghir: Burials, Bodies and Behavior in the Earlier Upper Paleolithic* (Oxford Univ Press, New York).

Table S4. Modern *Homo sapiens* data used in this analysis

Sex	Number	Max length	Articular length	Styloid length	Sex	Number	Max length	Articular length	Styloid length
F	87R	64.1	59.8	4.3	F	171	63.0	59.4	3.6
F	94R	67.3	61.8	5.5	F	66RR	63.3	58.4	4.9
F	106R	72.3	67.4	4.9	M	211	74.4	68.9	5.5
F	149R	58.7	54.0	4.7	M	213	72.9	66.2	6.7
F	172	71.0	65.7	5.3	M	234	70.0	65.2	4.8
F	47R	57.1	53.9	3.2	M	235	73.6	67.2	6.4
F	16R	67.4	62.2	5.2	M	261	64.6	60.4	4.2
F	39	68.5	61.7	6.8	M	335	65.1	62.0	3.1
F	240R	61.3	58.0	3.3	M	360	65.9	62.0	3.9
F	248R	62.8	58.2	4.6	M	362	76.7	72.1	4.6
F	289	63.4	57.5	5.9	M	367	71.6	65.8	5.8
F	300R	51.1	47.6	3.5	M	377	75.0	69.3	5.7
F	236R	59.4	55.5	3.9	M	468	70.0	64.5	5.5
F	662R	69.4	63.7	5.7	M	434	75.8	70.2	5.6
F	794R	66.1	60.3	5.8	M	522	73.2	67.9	5.3
F	880	69.9	64.5	5.4	M	645	74.7	68.6	6.1
F	920	58.8	55.5	3.3	M	770	81.2	75.6	5.6
F	929	67.4	62.4	5.0	M	789	79.0	72.8	6.2
F	970	67.5	62.4	5.1	M	806	71.6	65.9	5.7
F	992	61.0	55.4	5.6	M	908	76.0	71.0	5.0
F	1390	65.4	59.8	5.6	M	924	69.1	62.9	6.2
F	1370	65.5	57.8	7.7	M	942	71.2	65.1	6.1
F	1341	66.8	61.6	5.2	M	943	69.7	64.9	4.8
F	1203	63.1	58.9	4.2	M	954	69.7	63.6	6.1
F	1153	56.9	52.1	4.8	M	989	62.5	57.9	4.6
F	1124R	61.5	56.7	4.8	M	1279	73.5	67.2	6.3
F	1075RR	54.8	50.0	4.8	M	1295	66.1	60.5	5.6
F	1010	62.0	58.0	4.0	M	1206	69.4	64.4	5.0
F	1496R	72.1	66.5	5.6	M	1176	68.9	63.1	5.8
F	15.1	62.1	59.6	2.5	M	1158RR	62.0	57.4	4.6
F	1512	68.9	65.1	3.8	M	1101	62.9	57.4	5.5
F	1523	68.3	62.7	5.6	M	1067	69.9	62.6	7.3
F	1555	67.8	64.0	3.8	M	1520	69.9	64.6	5.3
F	1617	61.4	56.2	5.2	M	1569	71.7	65.8	5.9
F	79	65.5	60.6	4.9	M	1591	67.1	64.2	2.9
F	161	68.0	64.3	3.7	M	1602	70.2	65.6	4.6
M	1606	69.8	65.7	4.1	U	...	73.9	68.9	5.0
M	152	68.9	64.0	4.9	U	...	62.0	59.3	2.7
M	129	68.0	64.0	4.0	U	...	64.7	59.6	5.1
M	49R	75.3	69.4	5.9	U	...	73.7	68.4	5.3
M	82R	70.1	65.5	4.6	U	...	78.4	74.4	4.0
M	88RR	79.6	72.1	7.5	U	...	79.4	72.8	6.6
M	61	73.0	69.5	3.5	U	...	70.0	65.1	4.9
U	...	74.2	68.9	5.3	U	...	61.7	56.7	5.0
U	...	73.6	67.1	6.5	U	...	72.0	66.4	5.6
U	...	65.7	61.3	4.4	U	...	70.8	64.5	6.3
U	...	69.7	68.0	1.7	U	...	70.5	66.2	4.3
U	...	68.6	63.6	5.0	U	...	60.7	59.9	0.8
U	...	73.2	66.2	7.0	U	...	65.9	60.8	5.1
U	...	66.8	62.9	3.9	U	...	78.8	73.9	4.9
U	...	70.2	66.1	4.1	U	...	62.2	57.6	4.6
U	...	64.8	60.5	4.3	U	...	60.8	56.1	4.7
U	...	73.7	68.5	5.2	U	...	64.3	59.8	4.5
U	...	65.6	61.0	4.6	U	...	68.4	66.5	1.9
U	...	73.9	68.2	5.7	U	...	62.6	59.3	3.3
U	...	66.2	61.4	4.8	U	...	69.1	65.1	4.0
U	...	69.8	66.7	3.1	U	...	69.2	64.8	4.4
U	...	59.9	56.6	3.3	U	...	68.7	66.7	2.0
U	...	71.9	68.9	3.0	U	...	70.6	67.0	3.6
U	...	66.6	60.8	5.8	U	...	69.4	64.2	5.2
U	...	72.6	68.5	4.1	U	...	61.3	56.8	4.5
U	...	74.1	68.4	5.7	U	...	66.7	61.0	5.7
U	...	68.0	61.9	6.1	U	...	71.6	65.8	5.8

Table S4. Cont.

Sex	Number	Max length	Articular length	Styloid length	Sex	Number	Max length	Articular length	Styloid length
U	. . .	73.3	69.0	4.3	U	. . .	70.3	69.0	1.3
U	. . .	67.2	61.7	5.5	U	. . .	71.2	65.5	5.7
U	. . .	66.1	61.6	4.5	U	. . .	67.6	63.5	4.1
U	. . .	67.1	62.8	4.3	U	. . .	60.6	55.8	4.8
U	. . .	72.3	67.3	5.0	U	. . .	64.8	60.4	4.4
U	. . .	76.4	70.7	5.7	U	. . .	73.2	68.7	4.5
U	. . .	65.4	61.3	4.1	U	. . .	79.0	74.0	5.0
U	. . .	67.0	62.1	4.9	U	. . .	66.4	60.3	6.1
U	. . .	59.7	55.5	4.2	U	. . .	62.0	57.3	4.7
U	. . .	59.6	57.8	1.8	U	. . .	69.7	64.8	4.9
U	. . .	71.7	65.5	6.2	U	. . .	67.8	63.6	4.2
U	. . .	80.6	75.8	4.8					

Numbered specimens measured by C.V.W. from the Terry Collection at the Smithsonian Institution, specimens with unknown sex provided by E. Trinkaus. Articular length, distance from center of proximal to distal articular surface; Max length, maximum bone length; Styloid length, distance from center of proximal articular surface to tip of styloid along long axis of bone. All measurements in mm.