New Evidence for the Expansion of an Upper Pleistocene Population out of East Africa, from the Site of Station One, Northern Sudan

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Evidence for a hunter-gatherer range-expansion is indicated by the site of Station One in the northern Sudan, a surface scatter of chipped stone debris systematically collected almost 40 years ago, though not studied until present. Based on technological and typological correlates in East Africa, the predominant use of quartz pebbles for raw material, and the production of small bifacial tools, the site can be classified as Middle Stone Age. While often appearing in East African assemblages, quartz was rarely used in Nubia, where ferrocrete sandstone and Nile pebble were predominantly used by all other Middle Palaeolithic/Middle Stone Age populations. Additionally, façonnage *reduction is characteristic of lithic technology in East Africa in the late Middle Stone Age, while Middle Palaeolithic industries in the Nile Valley display only core reduction. It is proposed this assemblage represents a range-expansion of Middle Stone Age hunter-gatherers from East Africa during an Upper Pleistocene pluvial.*

Studies of mitochondrial DNA suggest that all modern humans are derived from a common ancestral group that was living in sub-Saharan Africa between 200,000 and 100,000 years ago (Cann *et al.* 1987; Vigilant *et al.* 1991; Horai *et al*. 1995; Quintana-Murci *et al.* 1999; Ingman *et al.* 2000). This 'Out of Africa' model posits multiple dispersals via the Arabian (Tchernov 1992; Ronen & Weinstein-Evron 2000; Rose 2000; Stringer 2000; Rose 2004) and/or Levantine corridors (Bar-Yosef 1987; 1994; 2000; Van Peer 1998) between 110,000 and 50,000 BP, which places these events in the latter half of the Middle Palaeolithic (henceforth MP)/Middle Stone Age (henceforth MSA).

It is reasonable to assume if any population expanded from East Africa to Northeast Africa, and subsequently into the Levant, they would have brought with them the lithic technology from whence they came. There are scattered assemblages from the Sudan that are characteristic of the Sangoan (e.g. Arkell 1949; Guichard & Guichard 1965), indicating some degree of technological continuity between Central and Northeast Africa during the late Early Stone Age (henceforth ESA).

To date, however, there has been no convincing archaeological evidence to suggest inter-regional affinities during the MSA between East Africa and Northeast Africa. On the contrary, MP industries of Sudan (e.g. Marks 1968a,b) are technologically and typologically distinct from those found in Kenya and Ethiopia (e.g. Breuil *et al.* 1951; Merrick 1975). Furthermore, comparative analyses of Egyptian and Levantine MP assemblages suggest that no compelling technological connections existed between these two regions at this time (Marks 1990; Van Peer 1998). So, while there is a plethora of genetic evidence supporting the 'Out of Africa' model, archaeological data along one of the primary corridors of human migration have been absent until now. Station One, an MSA site from northern Sudan, represents the only example of a techno-typological connection between the source area of anatomically modern humans and Northeast Africa.

Station One was discovered by A. Marks dur-

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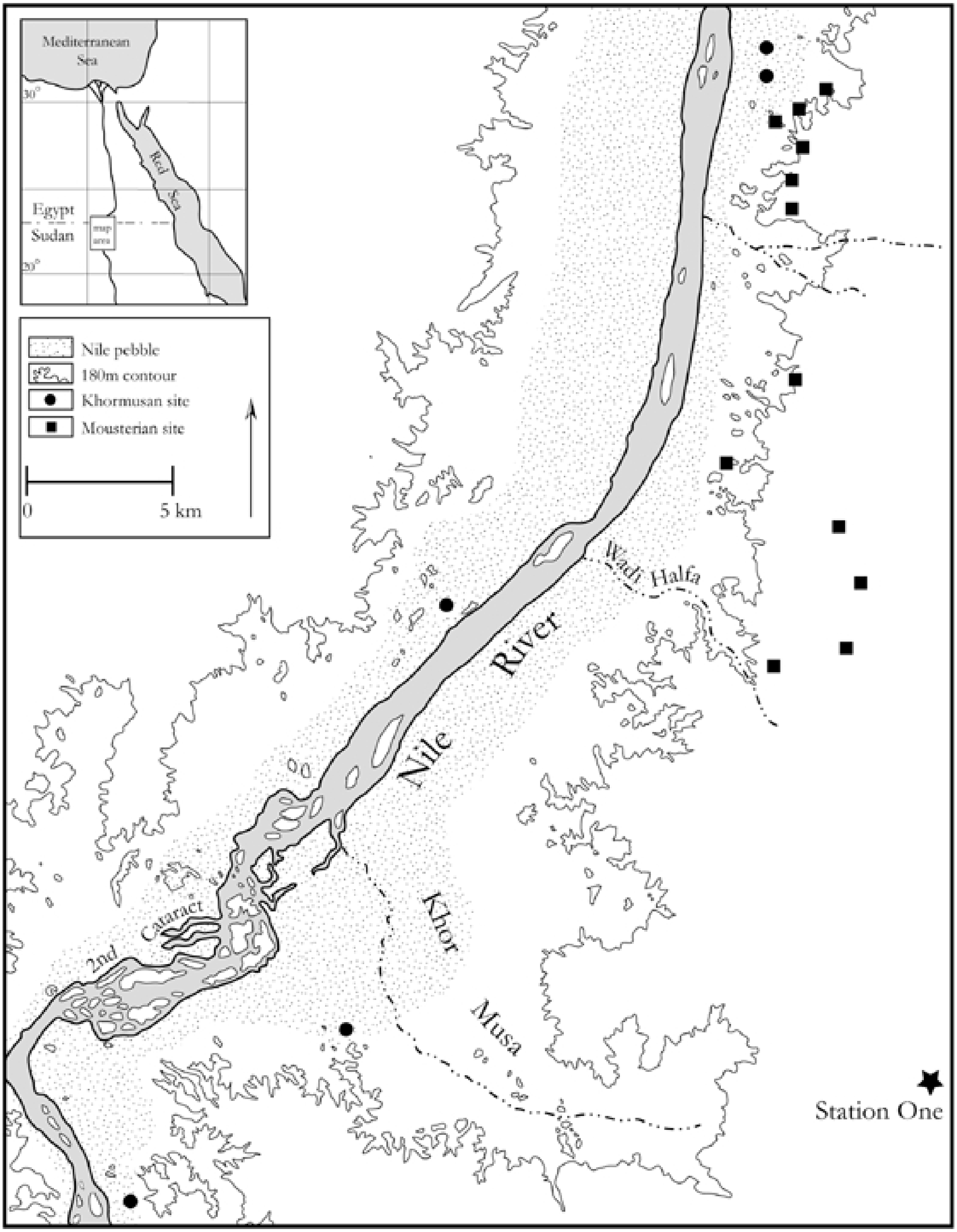

Figure 1. *Map of northern Sudan/southern Egypt showing location of Station One in relation to other MP/MSA sites.*

Table 1. *Variability of blank and core types within Station One assemblage by raw material.*

	Quartz		Silicified Wood		Ferrocrete Sandstone		Nile Pebble		Total	
	n	%	n	%	n	%	n	%	n	%
Debitage/Unifacial Tools										
flake	317	95.5	5	1.5	8	2.4	2	0.6	332	70.5
primary flake	49	94.2	1	1.9	1	1.9	1	1.9	52	11.0
biface thinning flake	31	86.1	3	8.3	-	-	2	5.6	36	7.6
Levallois	35	92.1	1	2.6	2	5.3	-	-	38	8.1
blade	9	75.0	2	16.7	1	8.3	-	-	12	2.5
primary blade	1	100.0	-	-	-	-	-	-	1	0.2
total	442	93.8	12	2.5	12	2.5	5	1.1	471	100.0
Cores										
single platform	23	85.2	-	-	1	3.7	3	11.1	27	29.7
multiple platform	5	100.0	-	-	-	-	-	-	5	5.5
90-degree	11	84.6	1	7.7	-	-	1	7.7	13	14.3
bidirectional	5	71.4	-	-	-	-	2	28.6	7	7.7
radial	18	100.0	-	-	-	-	-	-	18	19.8
Levallois	14	66.7	3	14.3	2	9.5	2	9.5	21	23.1
total	76	83.5	4	4.4	3	3.3	8	8.8	91	100.0
Total	594	91.0	20	3.1	18	2.8	21	3.2	653	100.0

ing the 1964 season of the Combined Prehistoric Expedition to Nubia. The site is an open-air occurrence of chipped stone material approximately 30 km east of the Second Cataract, in the Eastern Desert of northern Sudan (Fig. 1). The lithic artefacts, primarily manufactured from quartz pebbles, are scattered atop a lone inselberg capped by workable ferrocrete sandstone. The inselberg stands about 20 m above the pre-Nilotic peneplain; it is the only relief on the immediate landscape. As the assemblage was outside the reservoir floodplain and had no obvious relationship with materials found within the floodplain, it was not included in the final report. Originally called 1013, the site was renamed from its proximity to the first stop on the Sudanese railway travelling south from Wadi Halfa.

The site was initially recognized by the contrast of white quartz debris littering the deflated ferrocrete sandstone surface. The assemblage consists of 1939 pieces systemically collected from two distinct loci on the inselberg. A 10 m^2 unit was established in both loci; all material within these arbitrary units, including tools, cores, debitage, and debris, was collected. Lithic analysis has revealed there are no technological or typological differences between the two scatters.

The lithic assemblage

The material from Station One is in relatively good condition (considering the brittle nature of quartz), though edges and arêtes are rounded from wind abrasion. Among tools and debitage, only half the artefacts are complete, while the rest are either broken or are false burins (cf. de Heinzelin de Braucourt 1962; Brézillon 1971). The tendency of quartz to shatter upon impact makes identification of platform types exceedingly difficult.

The assemblage was initially sorted into four categories: debitage ($n = 1102$), debris ($n = 551$), cores ($n = 76$), and tools ($n = 210$). All tools and cores were examined, and a random sample of 25 per cent of the debitage was selected for attribute analysis ($n = 280$).

Raw material

Quartz comprises almost the entire assemblage, followed, in low percentages, by silicified wood, ferrocrete sandstone, Nile pebble, quartz crystal, and an unidentified metamorphic rock (Table 1).

The Station One inselberg is capped by a large slab of flakeable ferrocrete sandstone, ranging between 10 and 50 cm in thickness. Despite its quality and proximity, ferrocrete sandstone represents less than three per cent of the total assemblage. This patterning is anomalous when compared with almost all other MP/MSA sites in Nubia, which are dominated by tools manufactured almost exclusively on ferrocrete sandstone (Solecki *et al.* 1963; Guichard & Guichard 1965; Marks 1968a,b; Guichard & Guichard 1968; Irwin *et al.* 1968). Rather than exploiting the immediately available (and perfectly suitable) raw material, inhabitants of Station One chose to procure quartz pebbles found at the base of the inselberg. These nodules are small to large, ranging

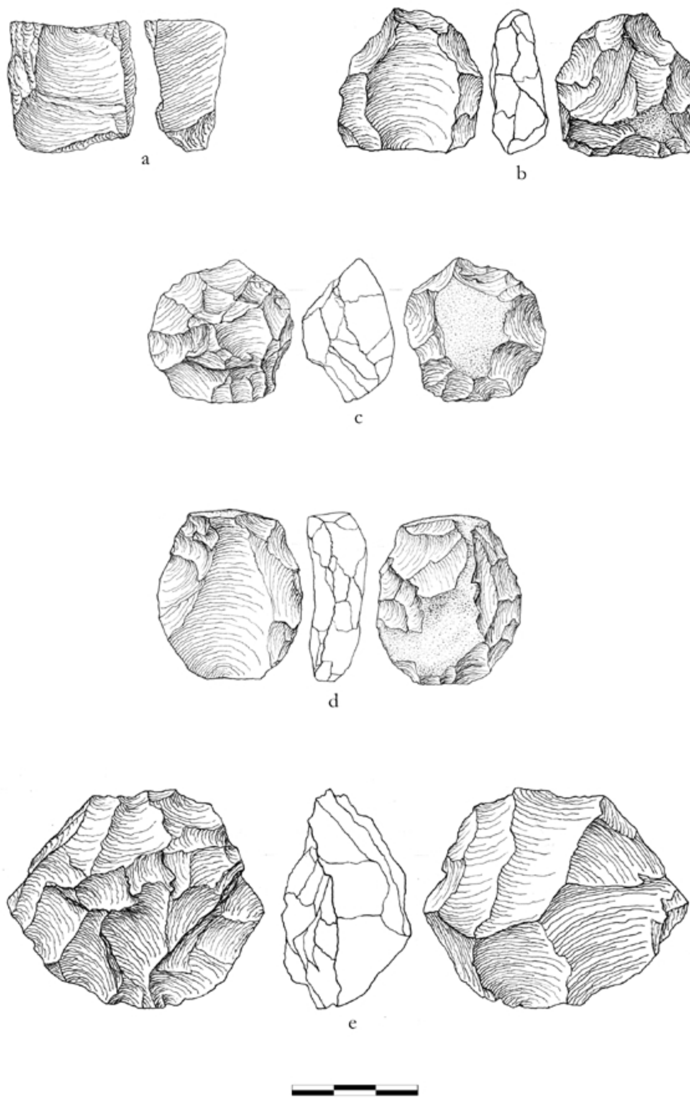

Figure 2. *Levallois (a, b, e) and radial cores (c, e) from Station One.*

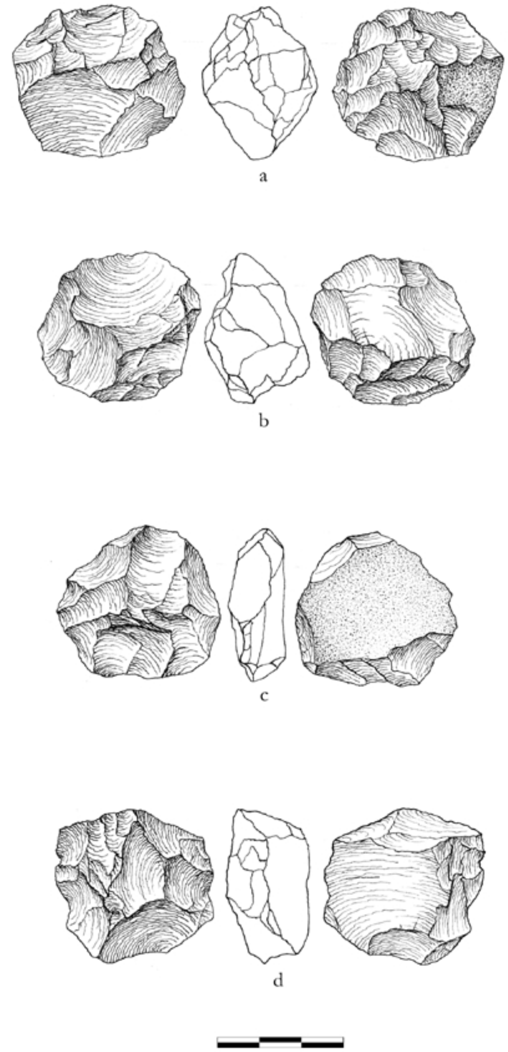

Figure 3. *Radial cores (a–e) from Station One.*

between 22.6 and 62.9 mm in maximum dimension, and are, as is typical of quartz, riddled with fracture planes.

The closest source of Nile pebble would have been 30 km to the west, within the Nile Valley (Fig. 1). This fine-grained chert is relatively free of inclusions and excellent for knapping. The nodules are heavily rolled and of similar sizes to the quartz pebbles, with the maximum dimension ranging between 29.4 and 60.3 mm.

Known sources of silicified wood include the Eastern Desert just behind Dibeira East, the Western Desert behind Buhen (Marks 1968a, 199), and in the Batn al-Hajar (Solecki *et al.* 1963). De Heinzelin & Paepe (1965) describe silicified wood as ubiquitous throughout the Cambrian sandstone formations outside the Nile Valley. This would imply a plethora of sources close to Station One. There are four cores of this variety from the site, ranging between 45.8 and 67.2 mm in length.

The few pieces of quartz crystal were probably obtained from the gravel pavement at the base of the inselberg. Its low frequency is most likely not indicative of conscious selection, but is rather a reflection of the scarcity of quartz crystal. There were no cores or distal cortical flakes of this material type from which to determine nodular proportions.

Technology

Attribute analysis was conducted on all unifacial tool blanks, cores, and a random sample of 25 per cent of the debitage (Table 1). Approximately half the cores are 'informal', including single-platform, multiple-platform, and 90-degree cores. Bidirectional cores are present, though low in frequency. The Levallois cores all have centripetal preparation on the working face (Figs. 2b,d–e & 3b–c), while an additional number of cores are radial, most likely all part of the same continuum of parametal exploitation of the raw material (Figs. 2c & 3a,d). In contrast, the local Type One and Type Two Nubian Mousterian cores are predominantly unidirectional and/or bidirectional with converging Levallois point preparation (Marks 1968a). Khormusan Levallois technologies, dating to the late MP, have a strategy similar to Station One, with radial exploitation to maintain convexity on the working face of the prepared core (1968b).

This cluster of core types — including discoids and partial-discoids approaching radial Levallois, some bidirectional elements, and a variety of 'unspecialized' core types — is similar to East and Central African occurrences, such as at Lukenya Hill (GvJm16, Industry A) (Merrick 1975), Prospect Farm (Anthony 1966; 1972; 1978; Merrick 1975), Nderit Drift (GsJi2/T) (Merrick 1975; Bower *et al.* 1977), Mumba Cave (Mehlman 1989), and Pomongwe Cave (Cooke 1963).

Unifacial blanks include flakes, primary flakes (>50 per cent cortex), blade/bladelets, primary blades, Levallois blanks, and bifacial thinning flakes. This last category is defined by a combination of attributes including: longitudinal curvature; bidirectional, three-directional, or radial scar patterns; a modified striking platform; and/or lipping.

Flakes make up about 75 per cent of all blanks, followed by primary flakes, Levallois flakes (Fig. 4a–e), biface thinning flakes, blades/bladelets, and primary blades respectively. In general, the blanks are trapezoidal to ovoid in shape; only 11 per cent are pointed and less than three per cent elongated. This trend is not surprising given the tendency toward centripetal core reduction; the pattern more likely results from the physical constraints of the small, rounded quartz pebbles rather than from a conscious choice of reduction strategies.

A few artefacts from Station One exhibit evidence for bipolar percussion. These pieces — all quartz — include two small bidirectional cores, a large single platform blade core, and several flakes. Considering the small, rounded nature of the quartz pebbles, it is not surprising that there was limited use of bipolar percussion, at least in initial phases of reduction. A similar strategy can be seen at other

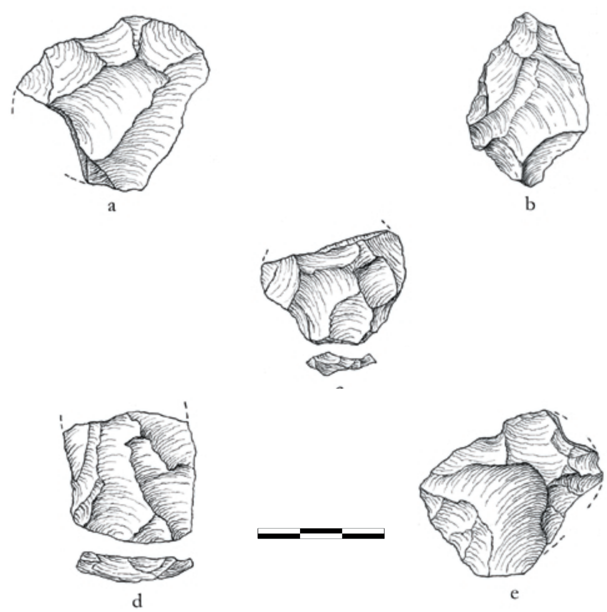

Figure 4. *Levallois blank (a–e) from Station One.*

late MSA/early LSA sites in sub-Saharan Africa with quartz industries, including Pomongwe (Cooke 1963), Mumba (Mehlman 1989), Matupi (Van Noten 1977), and Munyama (Valcke 1974).

Tool typology

The tool assemblage is comprised primarily of typical non-diagnostic MSA artefacts: retouched pieces, sidescrapers, notches, and denticulates (Table 2) (Fig. 5a–l). In addition to these ubiquitous types, diminutive bifacial and unifacial foliates and ovates with flat, invasive retouch are present (Fig. 6a–h), strongly suggesting affinities with MSA sites in Kenya (e.g. Merrick 1975; Anthony 1978; Ambrose 1998); and/or Ethiopia (e.g. Breuil *et al.* 1951; Wendorf & Schild 1974; Kurashina 1978), rather than with coeval Nubian MP/MSA industries (e.g. Marks 1968a,b; Irwin *et al.* 1968).

Retouched pieces make up the largest tool category within the assemblage, with continuous irregular or marginal secondary retouch. Almost all are on regular flakes.

Though low in frequency, the presence of 'naturally-backed pieces' is noteworthy because they have been observed in late MSA assemblages in East Africa (Anthony 1972, 81). They are described as:

> a crescentic tool, not a true crescent, that often bears on its curved back a small amount of marginal retouch. More often, the retouch is replaced by a false 'backing' resulting from the vertical trimming of the parent core. The flake, struck close to

Table 2. *Frequency of Station One tool types by raw material.*

	Quartz		Silicified Wood		Ferrocrete Sandstone		Nile Pebble		Total	
	n	%	n	%	n	%	n	%	n	%
retouched piece	43	93.5	1	2.2	1	2.2	1	2.2	46	21.9
sidescraper	34	97.1	-	-	1	2.9	-	-	35	16.7
endscraper	9	100.0	-	-	-	-	-	-	9	4.3
notch/double notch	33	94.3	-	-	2	5.7	-	-	35	16.7
denticulate	31	96.9	-	-	1	3.1	-	-	32	15.2
graver	8	100.0	-	-	-	-	-	-	8	3.8
naturally-backed piece	4	100.0	-	-	-	-	-	-	4	1.9
burin	3	100.0	-	-	-	-	-	-	3	1.4
scaled piece	1	100.0	-	-	-	-	-	-	1	0.5
truncated piece	1	100.0	-	-	-	-	-	-	1	0.5
unifacial point	3	100.0	-	-	-	-	-	-	3	1.4
bifacial foliate/ovate	5	100.0	-	-	-	-	-	-	5	2.4
misc. bifacial element	26	100.0	-	-	-	-	-	-	26	12.4
bifacial fragment	2	100.0	-	-	-	-	-	-	2	1.0
Total	203	96.7	1	0.5	5	2.4	1	0.5	210	100.0

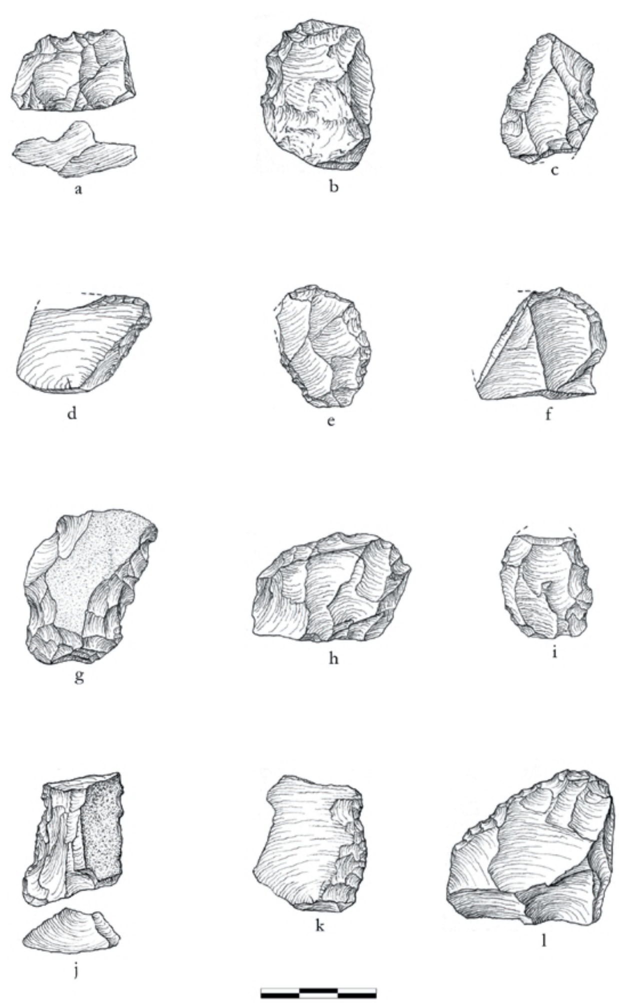

Figure 5. *Scrapers (d, e, f, h, j, k, l), denticulates (a, b, g, i), and retouched pieces (c, i) from Station One.*

> the trimmed edge of a small core hardly larger than the resultant flake, picks up, so to speak, the edge and its trimming scars (Anthony 1972, 81).

The four naturally-backed pieces at Station One are crescent to sub-crescent in shape, and possess invasive bifacial retouch on the working edge. The backing is not necessarily cortical; rather it is typically a fracture plane or remnant of previous removals from the core perpendicular to the dorsal surface. It is possible that these pieces are a by-product from the reduction of rounded quartz pebbles rather than a deliberate tool form.

Scrapers and denticulates are nearly as frequent as retouched pieces, making up over a quarter of the overall toolkit (Fig. 5a–h, j–l). There is a low percentage of endscrapers, including nosed, ogival, and convex forms. Four specimens are bilateral converging scrapers grading into retouched unifacial points.

The burins are simple and made from quartz flakes. In one case, the burin edge is created by a single blow coming from a truncated platform. Another burin is formed by a single blow on a natural fracture plane. The third, a dihedral burin, has two spalls removed from a cortical platform.

The assemblage contains three unifacial points. One is on a standard flake, while the other two are on Levallois flakes (Fig. 6d, e, h). It should be noted that these Levallois flakes were retouched into points, and are not derived from Levallois point production. Two points have obverse retouch, one is retouched inversely. Two points are triangular, and one is cordiform.

Bifacial pieces are distinguished by invasive retouch on both faces. These tools include foliates/ovates (Fig. 6a–c), miscellaneous bifacial elements (Fig. 6f–g), or fragmentary pieces that fall into a continuum of bifacial reduction. Some of these miscellaneous elements exhibit few retouching blows, suggesting they may be preforms, while others are extensively reduced, indicating they may be exhausted 'bifacial cores' (cf. Kelly 1988).

The bifacial foliates/ovates are typically small and thin, with a transverse cross-section ranging from biconvex to slightly plano-convex. All of the bifacial points are made on unifacial blanks, with flat and invasive retouch. One bifacial piece in particular, only 28 mm in length, is proportionate to the small points associated with the East African late MSA.

Discussion

Station One is anomalous among most other Upper Pleistocene occupations in and around the Nile Valley. Evidence for the production of small, thin, bifacial foliates is practically non-existent at all other sites in the region (Solecki *et al.* 1963; Marks 1968a,b; Irwin *et al.* 1968), making the relatively high frequency of biface thinning flakes (8 per cent of debitage), miscellaneous bifacial elements (16 per cent of tools), and bifacial foliates/ovates (<3 per cent of tools) noteworthy.

Sites with bifacial elements have been reported at Middle Pleistocene localities beyond the Nile Valley, from Khor Abu Anga near Khartoum to Abu Simbel in the north, though in every case these tools are large and elongated, resembling bifaces, picks, and large foliates associated with the late ESA/early MSA Sangoan industry (Arkell 1949; Cole 1954; Guichard & Guichard 1965; 1968; Chmielewski 1968). These typological similarities have led scholars to suggest that these Nilotic Sangoan occupations are indicative of late Middle Pleistocene hominid expansions from Central Africa. This model has recently been corroborated at site 8-B-11 on Sai Island, northern Sudan, which yielded a stratified sequence spanning the late Middle and early Upper Pleistocene. The primarily quartz assemblage, categorized as Sangoan, also demonstrates a conspicuous selection of quartz cobbles over tabular sandstone slabs. Van Peer *et al.* (2003) arrives at a similar interpretation — Sai Island is linked to a late ESA sub-Saharan lithic technocomplex.

The suite of tool types represented at Station One, including diminutive bifacial foliates/ovates with flat invasive retouch, small unifacial points, sidescrapers, and naturally-backed crescents resembles toolkits found in the East African late MSA (Fig. 7). There are few associated assemblages in Northeast Africa: Bir Tarfawi, Bir Sahara East, and Sai Island. The material at Bir Tarfawi and Bir Sahara is exclusively manufactured from quartzitic sandstone. The assemblages were found in sediments correlated with palaeolakes forming in OIS 5 (Wendorf *et al.* 1993). At Sai Island, Van Peer *et al.* (2003, 189) report a lithic assemblage manufactured from quartz whose 'most prominent typological feature is the presence of thin bifacial foliates . . . blanks were produced according to Levallois, Nubian, and discoidal reduction strategies'. The assemblage was found *in situ* within a black nilotic silt; excavators correlate these sediments with the OIS 5 palaeolakes at Bir Tarfawi and Bir Sahara.

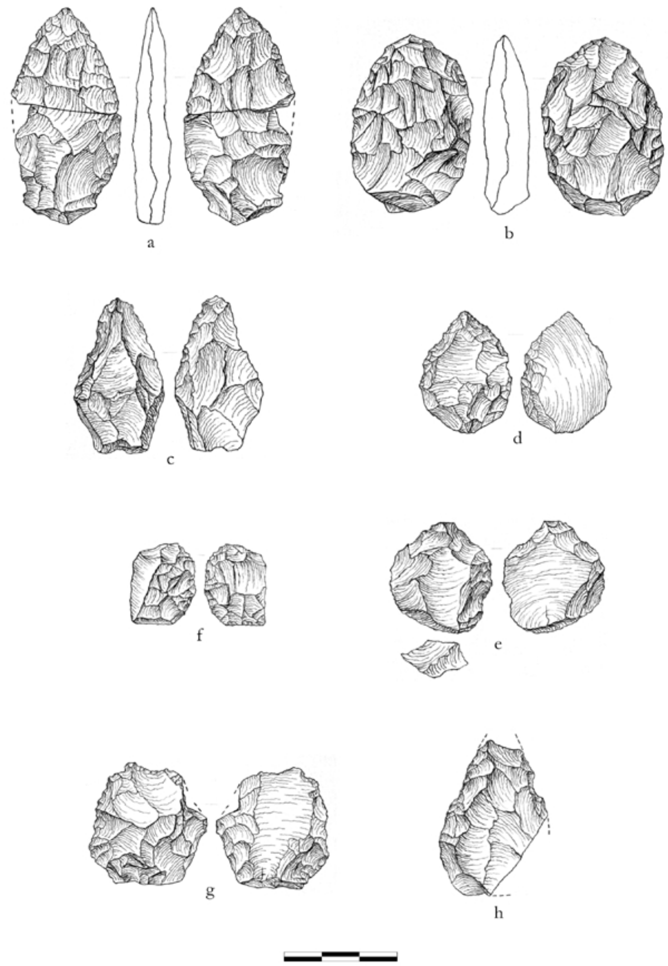

Figure 6. *Bifacial (a, b, c, f) and partly-bifacial tools (d, e, g, h) from Station One.*

With the exception of Station One and Sai Island, MSA, quartz industries are unprecedented in Nubia, though analogies can be drawn with sub-

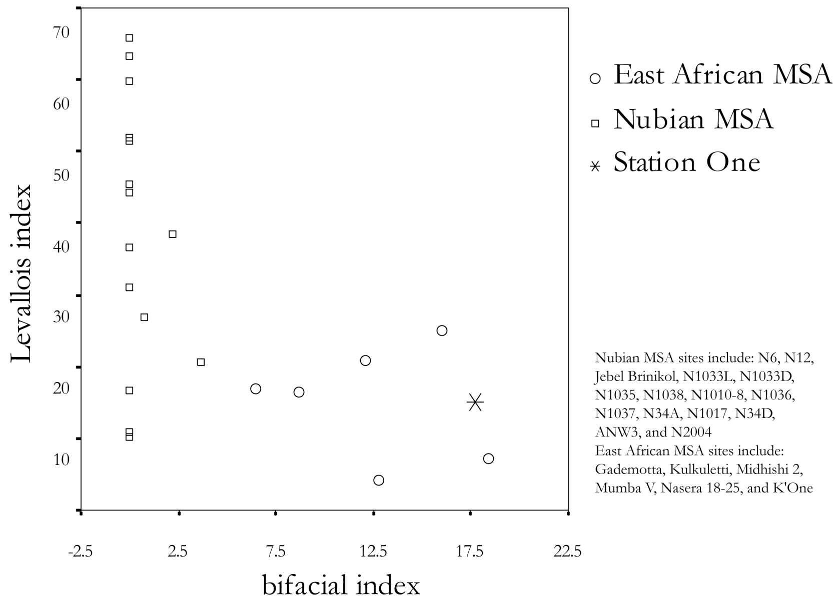

Figure 7. *Scatterplot demonstrating indices of Levallois versus bifacial reduction at MP/MSA sites in East Africa and Nubia.*

Saharan MSA sites in Central and East Africa. The use of quartz at Station One represents a deliberate choice not to exploit the most immediate raw material — flakeable ferrocrete sandstone found in large plaquettes — but rather to procure small, rounded quartz pebbles, which are less conducive to the manufacture of bifacial tools. Possible explanations for this trend are that the toolmakers were not familiar with the high-quality chert ubiquitous in the Nile Valley, did not have access to resources within the Nile Valley, and/or were simply more comfortable utilizing quartz.

The location of Station One on an inselberg overlooking the pre-Nilotic peneplain, combined with the presence of small, presumably hafted bifacial projectiles, suggests that the inhabitants of the site employed a subsistence strategy tied to large game moving through the savanna. Lézine (1989) describes a 500 km northward shift in Sahara vegetation zones during an early Holocene wet phase, which transformed the plains outside the Nile Valley into a grassland environment. It is conceivable that Upper Pleistocene humid episodes resulted in a similar phytogeographic reconfiguration. Large ungulates would have moved into this ameliorated niche, bringing with them hunter-gatherers exploiting these resources.

The proposed timing and techno-typological characteristics of Station One fits within the current model for the movement of modern human populations out of East Africa. Studies of mitochondrial and Y-chromosome DNA demonstrate that all modern humans are derived from a common ancestral group that was living in sub-Saharan Africa between 200,000 and 100,000 years ago (Cann *et al.* 1987; Vigilant *et al.* 1991; Horai *et al.* 1995; Quintana-Murci *et al.* 1999; Ingman *et al.* 2000). Populations began to branch off from the core gene pool around 130,000 years ago, a date corresponding with the end of the penultimate glaciation (190,000–130,000 BP). By this time, early *Homo sapiens sapiens* in sub-Saharan Africa had developed a suite of modern human technological innovations, including advances in specialized hunting.

Ambrose (2003) attributes these initial dispersals from Africa to one or a series of multiple bottleneck release(s) that occurred during the last interglacial (130,000–71,000 BP), as warmer climates and increased rainfall caused amelioration within marginal niches. Following Lahr & Foley (1998), it is conceivable these improved environments facilitated modern human expansion into previously uninhabitable territories. Exploitation of these zones may have also been aided by the development of low-mass/high-velocity armatures, exhibited by the widespread appearance of small, hafted unifacial and bifacial foliates in the late MSA (McBrearty & Brooks 2000).

This model of modern human emergence from East Africa is a testable proposition. It is assumed the toolkit(s) of these migrating populations will possess one or more of the same diagnostic culture traits recognized within the source area, in this case Kenya and Ethiopia. The presence of diminutive bifacial foliates/ovates with flat, invasive retouch is a *fossile directeur* of the East African late MSA. Thus, the identification of these tools within the Sudanese Eastern Desert, a marginal zone bordering East Africa immediately to the north, suggests an expansion of hunter-gatherer populations exploiting resources with which they were already familiar.

With the exception of Station One, eastern Sahara, and Sai Island assemblages, there is no compelling archaeological evidence demonstrating an early Upper Pleistocene movement of anatomically modern humans northward through the Nile Valley. The techno-typological lineages from these two areas are markedly different; industries from sub-Saharan Africa employed a combination of *façonnage* and core-reduction strategies, while Nubian industries maintained, solely, a core technology from the early Upper Pleistocene all the way to the Late Pleistocene. The concept of '*façonnage*', translated as 'shaping the face', represents a vastly different approach to producing lithic tools. In contrast to core tools, which are created by striking a core and retouching the subsequent blank, *façonnage* reduction is achieved by invasive surface flaking across one or both faces of a plaquette, blank or 'preform'.

While the population expansion represented by the Station One assemblage may be associated with the spread of modern humans out of sub-Saharan Africa, there is no evidence that this late MSA techno-typological package extended further northward into Egypt, much less the Sinai or the Levant (Marks 1990). At present, the northernmost example of Upper Pleistocene *façonnage* technology is in Sudanese Nubia (Fig. 8). There is no evidence to demonstrate any element of sub-Saharan lithic technology in Levantine Mousterian industries. The two regions demonstrate markedly different approaches to raw material reduction: in the Levant, industries are primarily based on the production of Levallois points (Bar-Yosef 1994), in contrast to the African MSA tradition incorporating a combination of *façonnage* and prepared-core reduction.

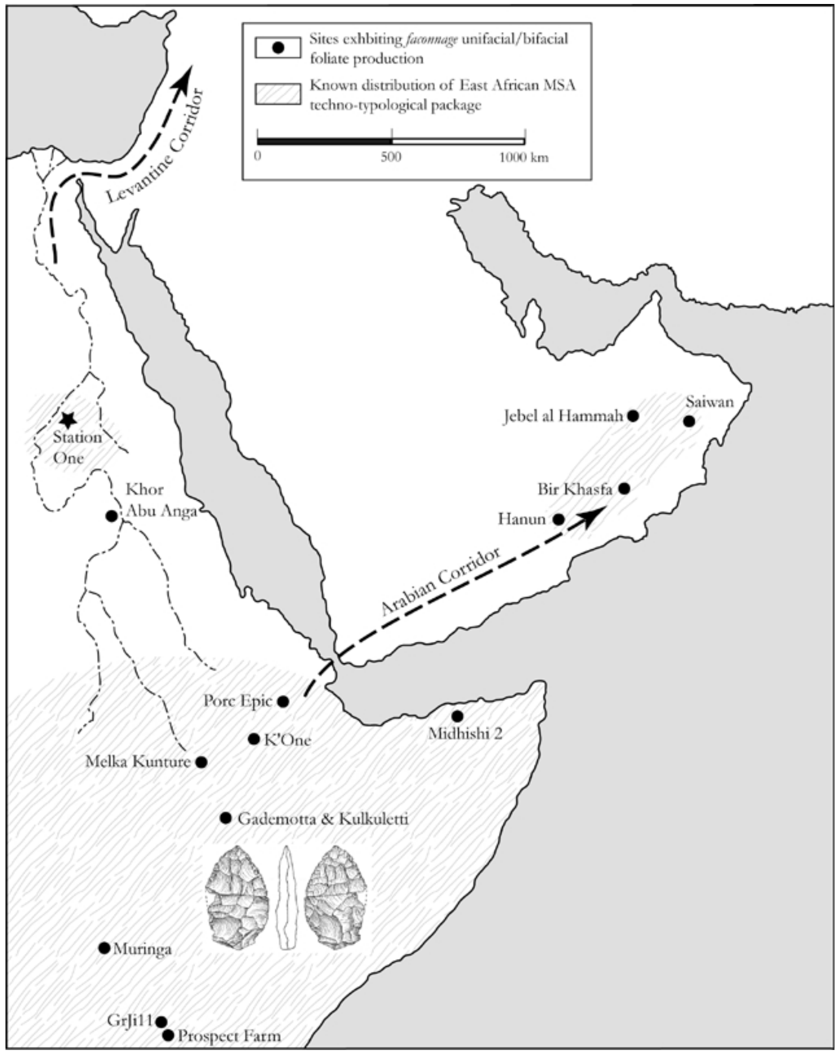

Figure 8. *Map showing the distribution of archaeological sites exhibiting East African MSA traits and potential corridors of human migration.*

Why, then, this restricted distribution of the late MSA techno-typological package? Conservative iterations of the 'Out of Africa' model describe a replacement of archaic groups by more biologically and/or technologically advanced peoples. Data from Northeast Africa and the Levant, however, suggest that the situation is far more complex than simple replacement, perhaps because of the presence of indigenous MP populations within the Levantine corridor. Monigal (2002) observes a continuous technological lineage in the Levant (though with temporal gaps in the sequence), stretching from the end of the Lower Palaeolithic to the Upper Palaeolithic. Thus, rather than an influx of African technology during the Upper Pleistocene, the archaeological findings demonstrate autochthonous technological development.

From this evidence, it is posited that the path of modern human expansion from East Africa was, in part, controlled by the availability of unoccupied, habitable territory, where there was little to no competition for resources. There were only two major territories available that fit this description: 1) northward into the deserts of Sudan, or 2) eastward across the Bab el Mandeb Strait into South Arabia (the term 'Arabian Corridor' is proposed for this route).

If, as examination of Upper Pleistocene industries in Northeast Africa and the Levant suggests, Station One marks the northernmost limit of hunter-gatherers spreading from sub-Saharan Africa, then this region is a *cul-de-sac* rather than a conduit for the spread of anatomically modern humans. The dispersal of early Upper Pleistocene ancestral populations off the African continent would have solely been via the Arabian Corridor (assuming the veracity of the 'Out of Africa' model). Ameliorated Arabia offered the only favourable, contiguous, unoccupied territory for expanding groups. A handful of tantalizing descriptions of small bifacial foliates, mirroring the *fossile directeur* of the East African MSA, have been discovered in Oman (Pullar 1973; 1977; Smith 1977; Villiers-Petocz 1989; Biagi 1994; Rose 2004), testify to a population expansion into this region. Much like the Sahara, southern Arabia provided ideal conditions for hunter-gatherer range-expansions during mesic environmental episodes. Though South Arabia presently houses the largest continuous aeolian desert in the world, during periodic phases of the last interglacial it was transformed into vast vacant grasslands marked by playa lakes and seasonal drainages (McClure 1978; Schulz & Whitney 1987; Sanlaville 1992; Lézine *et al.* 1998). If archaeological finds from this region do indeed display techno-typological continuity from East Africa, then this represents the only archaeological evidence for early Upper Pleistocene modern humans emigrating off the African continent.

While certainly intriguing, this interpretation of Upper Pleistocene findings in the Sudan and southern Arabia remains speculative owing to the paucity of archaeological data. These two areas are crucial for understanding the timing and nature of modern human emergence from sub-Saharan Africa. Further research in the marginal zones, along the initial path of expansion traversed by *Homo sapiens sapiens*, will provide direct archaeological evidence to test the 'Out of Africa' hypothesis.

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