Bone tools from Broken Hill (Kabwe) cave, Zambia, and their evolutionary significance

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Abstract

Shaped bone tools are now recognised as part of the technological repertoire of some Middle Stone Age hunter-gatherers in southern Africa. Currently accepted dates for the earliest bone working technology in the region range from ~70-90 ka. This study re-examines three bone objects from the site of Broken Hill (Kabwe), Zambia, that were described in the 1940s as formal bone tools. Broken Hill is well known for its fossils of Homo heidelbergensis, a species not previously associated with bone working, and less well known for its small sample of early Middle Stone Age lithic artefacts. The claim for bone tools at Broken Hill takes on added significance in light of new dates from south-central Africa which place the development of composite stone tool technology (Mode 3) in the later Middle Pleistocene (~300 ka). If these bone objects are indeed tools and associated with the hominid use of the cave, they may be the oldest evidence of bone tool working in the archaeological record. The results are reported of scanning electron microscopy of the surfaces of each putative tool and implications are drawn for the behavioural evolution of H heidelbergensis.

1 Introduction

The intentional shaping of bone to make tools and other artefacts has long been accepted by archaeologists as an indicator of behavioural modernity (Mellars 1991). In the European context, systematic bone, antler and ivory working remains a distinguishing feature of early Upper Palaeolithic technology made by anatomically modern humans after 45 ka (Davies 2001). Recent reports from sub-Saharan Africa also link bone working technology with anatomically modern humans, but in association with Middle Stone Age (MSA) assemblages dating to 65-90 ka (eg, Klasies River, South Africa (Singer & Wymer 1982:115), Katanda, DRC (Brooks et al 1995; Yellen 1998), Blombos Cave, South Africa (Henshilwood & Sealy 1997) and possibly as early as 120 ka at Mumbwa Caves, Zambia (Barham 2000). The antiquity of bone working in southern Africa adds support to models of a co-evolution of behavioural and anatomical modernity in the early Late Pleistocene (eg, Stringer 2001). No substantiated evidence exists for the making of formal bone tools before 120 ka, as opposed to the expedient use of bone as a tool which appears to have been part of early hominin tool kits.
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The relatively late development of shaped bone tool technology is at odds with the emergence of technically complex stone tool technology by 300 ka in central and eastern Africa (Barham 2001; McBrearty 2001). As McBrearty & Brooks (2000:503) remark “it is not clear why carving and polishing a bone point should be beyond the capabilities of the maker of a Levallois flake”.

This paper re-examines a small but potentially significant collection of putative bone tools (Clark et al 1947) from the well-known (and problematic) Middle Pleistocene hominid site of Broken Hill cave (Kabwe), central Zambia. Unfortunately, the taxa from which the raw materials were derived could not be identified even to the family level. The aim of this study is simply to assess whether these objects exhibit any evidence of intentional shaping. The replication of the stages of manufacture and possible uses of the objects was not conducted. The small size of the surviving sample of unmodified bone from Broken Hill also precluded a comparative analysis of tool size and shape in relation to the faunal collection as a whole (eg, Backwell & d’Errico 2001). To determine if deliberate shaping was involved, reference is made to observations from published experimental studies of changes in surface morphology as a result of purposeful cutting, scraping and polishing. An undoubted polished bone point from the Later Stone Age in Zambia serves as a comparative sample. The results confirm Clark et al’s (1947:25) initial interpretation of the objects as bone tools, and the association of the tools with the stone artefacts receives close scrutiny in the absence of direct dates on which to base a Middle Pleistocene attribution.

2 Broken Hill cave - context and age

The site was discovered in 1906 during zinc mining of a dolomitic outcrop (No1 Kopje) in an area of mineralised limestone near the town of Kabwe, central Zambia. In the course of tunnelling through the outcrop, miners intersected a 30 m long deposits that contained a variety of hominid remains and stone tools (Clark et al 1947). The cave was named Broken Hill after the dolomite outcrop intersected.

![Figure 1](image.png)

Figure 1. A reconstructed section through the deposits of the main cave in No 1 Kopje showing the slumped back passage and the likely location of the hominid remains (after Clark et al 1947). Two of the putative bone tools examined in this paper (E702, E700) were apparently found in the lower passage deposits.
downward sloping cave passage filled with clay, and brecciated sediments containing bone and stone artefacts. The cave entrance had been blocked and obscured by rock falls and the deposits were sealed further by the deposition of secondary zinc and lead ores. The highest concentration of artefacts and all the hominid remains apparently came from the back of the cave in an area that had slumped into a solution cavity below the water table (fig 1). Most of the hominid remains, including a nearly complete skull now attributed to *Homo heidelbergensis* (Rightmire 2001), were discovered in 1921 during quarrying when the remainder of the cave system was cleared. Nothing survived of No1 Kopje by 1930. Open cast mining of the hill and surrounding landscape had left a 100 m deep pit that has been filled with ground water since 1994 when the quarry pumps were switched off (A McInnes pers comm).

The accidental discovery of the cave and its unsystematic clearance have left archaeologists with a minimal record of the context of the artefacts and their association with the hominid remains. Reports from those present at the time of the discovery of hominid remains provide conflicting data on the location of the human bones in relation to each other (summarised in Pycraft et al 1928 and Hrdlička 1930). Subsequent analyses of the zinc, lead and other mineral content of the bones, selected fauna and some artefacts, including two of the putative bone tools described below (E700, E702), generally support the association of the finds with the lower passage of the cave where lead levels were highest (Clark et al 1947:7-11; Oakley et al 1977; Bartsikias & Day 1993).

The considerable quantity of bone and artefacts observed to have been removed from the cave (Mennell & Chubb 1907; White 1908) has largely been lost, with small collections now curated in Zambia (Livingstone Museum), South Africa (South African Museum, Albany Museum) and in the United Kingdom (Natural History Museum). As a consequence, the site is today known primarily for its nearly complete skull of *Homo heidelbergensis* with the archaeological content seen as too incomplete and lacking in context to contribute to current debates on human behavioural development (eg, McBrearty & Brooks 2000:504). The lack of an absolute chronology for the site limits further the utility of the archaeological assemblage. Bada et al (1974) published an aspartic acid racemisation date of 110 ka derived from a hominid fragment, but the technique is unreliable when applied to bone, and involves assumptions about temperature and calibration for the locality based on other dating methods (Schwarcz 2001:49). In the case of Broken Hill, there are no other direct dates available and the amino acid estimate should probably be disregarded. Estimates have been made based on faunal comparisons with Olduvai Bed IV (eg, Klein 1973). These have become increasingly older with the recalibration of the age of the Olduvai Gorge sequence (Kimbel 1995; Tamrat et al 1995). Rightmire (1998) now places the Broken Hill hominids in the early Middle Pleistocene between 400-700 ka, whereas McBrearty & Brooks (2000:481) argue that they could be as old as 0.78-1.3 Ma based on correlations with Olduvai Bed IV. Collaborative efforts are currently underway by one of us (CBS) to directly date the fauna and the hominid remains by uranium series dating, including non-destructive gamma ray spectrometry. Preliminary results suggest a late Middle Pleistocene age.

The limited archaeological record from Broken Hill can contribute to this discussion based on comparisons with securely dated assemblages elsewhere in Zambia. U-series dates on the early MSA (Lupemban industry) from the collapsed cave system at Twin Rivers hill, central Zambia (Barham 2000) range from >400 to 140 ka with a likely median age of ~265 ka. The Lupemban does not continue into the Late Pleistocene as demonstrated at Mumbwa Caves, central Zambia, where the Last Interglacial (OIS5e) assemblage reflects a shift in emphasis in the range of retouched tools made. Clark (1959a) established from the surviving Broken Hill collections that the artefacts throughout the cave could be attributed to the early MSA. No evidence was found of Acheulian or Sangoan (= late Acheulian) occupation. This he confirmed in his excavations of surface deposits located on the
south-western corner of the former No1 Kopje (ibid). The deposits contained a sequence from Acheulian, Sangoan to early MSA and provided a directly relevant comparative sample for making a typological assessment of the material from the cave. Clark also examined surviving dumps of cave fill from No1 Kopje (these too are now gone), and the two collections held in South Africa. He concluded that the “cultural material in the cave [original emphasis] belonged to the Middle Stone Age and was not older” (ibid:208). No Later Stone Age material was evident either, presumably because the entrance had been blocked long before. The artefacts, including the putative bone tools and presumably the hominid remains, may all have been deposited in one period that corresponds with the age of the early MSA.

The typological identity of the industry cannot be determined with greater precision from the existing collections and published data, but there are hints that it may be comparable to the Lupemban industry as described from Twin Rivers and Kalambo Falls (Clark 2001). A distinctive tool of the Lupemban is the long bifacially flaked lanceolates and these are best represented at Kalambo Falls and from sites in Angola and the Congo basin where fine-grained raw materials were used (Clark 1966, 2001). At Twin Rivers, the lanceolates were made on vein quartz and were consequently shorter and thicker than those made on more tractable materials (Clark & Brown 2001). Vein quartz was also the primary material available to the occupants of Broken Hill cave. White (1908) described the tools from No1 Kopje as being lance or leaf shaped, associated with “ridged flakes” which are possibly from radial or Levallois cores and a “chisel-edged artefact” which is possibly a burin. White also observed that bone tools were found with the stone artefacts. These collections were subsequently lost, but the stone tools are technologically MSA and typologically they could be Lupemban.

Clark’s (et al 1947:21) analysis of the small surviving collection of selected artefacts (n=87) held in the Natural History Museum (NHM) and in museums in Harare and Livingstone confirmed a generic MSA attribution with disc cores, prepared cores and flake-blade cores noted. The majority of flakes were also faceted. Among the flakes, a relatively high proportion (13%) were flake-blades or blades, and two flakes were backed by blunt retouching. One flake-blade in the NHM collection remains intact in a lump of breccia.

Blades are a small but distinctive component of the early MSA or Lupemban Industry at Twin Rivers (Barham 2000:197) and Kalambo Falls (Clark 2001:89). The presence of backed flakes in the Broken Hill assemblage is also noteworthy given the low but persistent frequency of this artefact type in the Lupemban (Barham in press). These tentative links between Broken Hill, Twin Rivers and Kalambo Falls support a late Middle Pleistocene age range (~300-130 ka) for the No1 Kopje deposits.

If this age estimate is correct and the fauna, hominids and artefacts are all contemporary, then the age estimates based on faunal comparisons with Olduvai Bed IV should be re-examined because they are clearly too old. Alternatively, the Broken Hill deposits may have contained a sequence of human and carnivore use of the cave that spanned a much longer period of the Lower to Middle Pleistocene than the artefacts alone would suggest. The unsystematic removal of deposits at the time of discovery could have created a mixed and potentially misleading assemblage of fauna, hominids and artefacts. In this case, the fauna could represent an earlier use of the site by carnivores only, because there is no archaeological evidence for an occupation before the MSA (pre-300 ka). Perhaps hominids used the site before 300 ka, but for purposes that left little or no archaeological trace. Clark’s excavations of Acheulian and Sangoan assemblages on the edge of the Kopje shows that hominids were in the immediate area before 300 ka. On balance, the archaeological evidence, which includes the putative bone tools, is for an occupation by hominids who made flakes, flake-blades and retouched tools that are typologically early MSA. The possible bone tools are assumed here to have been made by the same hominids.
3 The ‘bone tools’

White (1908) who worked at the mine, reported finding bone tools in the cave fill, including pieces shaped for digging and a perforated piece. Another perforated bone was reported by Mennell and Chubb (1907:446) along with bones apparently with cutmarks. Much of this material is presumed lost, although a perforated tibia of an medium sized ungulate was seen by Clark in the National Museum of Southern Rhodesia (Queen Victoria Museum, Harare). Twelve possible bone tools remain in museum collections, including the one in Harare described above, five in the Livingstone Museum, and six in the Natural History Museum. These tantalising claims for bone tools at Broken Hill can no longer be accepted at face value given our awareness of the many taphonomic factors that can mimic bone tools and their production marks (eg, Villa & d’Errico 2001). Of particular relevance to Broken Hill are the effects of carnivore damage, especially the digestion of bone by hyaenas which can create pointed objects with rounded and polished tips (Andrews 1997). Hyaena remains were found at Broken Hill (Mennell & Chubb 1907; Clark et al 1947:16) and these carnivores may have been agents in creating the apparent assemblage of shaped and perforated bone tools (cf d’Errico & Villa 1997). On initial inspection, the sample studied below does not exhibit the characteristic features of hyaena chewed or digested bone as described by Andrews (1997). Unfortunately, not enough survives of the faunal collection as a whole to make meaningful statements about the extent of hyaena activity at the site and its impact on the formation of the assemblage. The criteria developed to identify hyaena dens (eg, Sutcliffe 1970, Brain 1981) cannot be applied to the small and selected Broken Hill collection. Other nonhuman agencies such as trampling and compaction may also have played a role in creating bone fragments that could be mistaken for tools or evidence of use (Behrensmeyer et al 1986; White 1992). Given the poor contextual information and the impossibility of sampling the sediments from the site, it is not possible to assess the likely influence of either process in the creation of pseudo-tools. The three putative tools do show evidence of surface alteration probably resulting from sediment abrasion and solutional weathering typical of limestone cave environments (Pinto & Andrews in press).

3.1 Analytical methodology

The analysis that follows is restricted to three bone objects collected at Broken Hill between 1907 and 1921 and now curated at the Natural History Museum. Two are described by Clark (et al 1947) as “gouges” (E1094, fig 2a,b and E702, fig 2e,f) with broad flat tips apparently shaped by cutmarks and intentional rubbing and the third is a “point” (E700, fig 2c,d), oval to circular in section and shaped by rubbing (ibid:26). One gouge (E1094) and the point were chosen for analysis because of their obvious appearance of having been shaped or used. The remaining object (E702) did not appear to the naked eye to be modified, and was selected simply as a morphologically similar specimen to E1094. It would serve as a comparative sample of unmodified bone from the site. As described below, on closer inspection E702 showed unexpected evidence of modification in the form of striations interpreted as cutmarks. The three remaining bone objects in the NHM collection will be examined at a later date for signs of modification and use.

Each piece was examined initially with a reflected light microscope to assess the integrity of the surface of the objects and locate areas where marks were visible even with low magnification. Target areas and individual striations are indicated in figure 3, and once individualised these were micrographed with magnifications up to x 100 with a Scanning Electron Microscope (SEM). Specimens to be examined by SEM must be electrically conductive and are usually coated with gold or platinum and this coating cannot be removed later. A low vacuum environmental chamber was used in this study to avoid the need for coating the bone objects. Some contamination existed on specimen E1094 as a result of glues and dirt adhering to the surfaces which caused electrical charging distortions. This problem was solved by
use of high resolution silicon elastomer moulds used successfully in dental microwear studies. These moulds or “peels” were then coated with platinum, thus avoiding the charging of the original uncoated specimen and allowing detailed examination of individual marks. Micrographs of peels were then mirror inverted to match the original. The remaining original specimens were examined and micrographed using the low vacuum environmental chamber. The images thus obtained have been directly digitised which allows adjustments to be made to contrast levels before taking photographs.

The identification of shaping techniques is based on comparative data derived from experimental replication of Upper Palaeolithic bone tools by Olsen (1984), and by comparison with a polished Later Stone Age bone point from Mumbwa Caves, Zambia. In the case of Broken Hill, it was not possible to identify the taxon of animal even to family level, and only the size class could be estimated in two cases. No experimental replication of manufacture and use was attempted because of the unknown source of the materials. Bone of similar textural consistency would be needed to ensure comparability of the samples.

In the analysis below, the convex side of each object is labelled A and the concave side is B. In figures 2 and 3 images a,c and e are side A and b,d and f are side B. Distinctive marks are highlighted on each side (fig 3 a,b,e,f) and discussed in the text.

3.1.1 Object E1094 - “tip of bone gouge”

The smallest of the three objects, (43.2 x 33.5 mm) this semicircular piece was identified as a gouge by Clark (et al 1947:26) based on its flat, broad and tapering shape (fig 2a,b and 3a,b). An abrupt transverse fracture defines the long axis and the break appears to have formed after fossilisation was complete. The object tapers away from the fracture towards a rounded end and all surfaces including the sides (in profile) appear finely polished (fig 4a,c). Weathering marks are not apparent, although discrete areas of the surface do show some postdepositional erosion. The polished areas are entirely featureless even with high magnification and this is most evident towards the point and edges of the object. The main features on each side are shown in figures 4a and b and were micrographed in greater detail.

Striations are visible to the naked eye chiefly on the edge of the object and also covering the surface of side B. On side B (figs 2b,3b), the striations run from the “gouge” point downwards. These resemble cutmarks in the well-defined

Figure 2. Photographs of sides A and B of each specimen examined in this study. a,b='gouge' (E1094); c,d='point' (E700); and e,f='gouge' (E702). Scales in millimetres.
beginning and abrupt termination (fig 4a), with one lip of the striation forming a straight cut whilst the other appears more rounded. Some present a V-shaped profile and some a U-shaped profile. At the base of all these marks smaller scale parallel substriations occur and resemble those produced by a stone edge on bone (fig 4b) (Shipman & Rose 1984). These cutmark-like striations are rougher than those observed on Upper Palaeolithic bone points and obtained experimentally when polishing the object with a lithic implement (Olsen 1984). On the same side, figure 4a shows some striations

![Figure 3](image_url)
near the left polished edge (peel), figure 4b shows the striated base of the marks, and figure 4c is a micrograph of the top edge of side B showing a fine featureless polishing (peel). Some polish on this specimen can be attributed to sediment abrasion, but the concentration of polish on the edges

Figure 4. SEM micrographs of peels from object E1094, all mirror inverted to match orientation of original specimen: a, cutmark-like striations near the polished edge; b, detail of the bottom of the marks showing parallel micro-striations resembling those produced by stone tools; c, fine featureless polishing of the tip edge on side B; d, general view of the side with parallel striations covering the surface possibly produced during the initial stages of shaping the tool; e, detail of the striations on 4d; f, gouge-like marks at the edge of the object.
is inconsistent with the process of sediment rubbing which affects all surfaces equally. The polished edges are also indicative of tool use before burial.

The striations on both sides of the objects are similar in shape, although there are fewer striations on side A which is more polished (fig 3a). More homogeneous are the fine striations observed on the edge of the object (left edge when facing side B). Figure 4d is a general view of the edge. Figure 4e shows the fine striations on the edge of the object and figure 4f shows gouge-like marks on the same area. Striations on the edge are all uniformly oriented obliquely to the vertical axis of the specimen.

The morphology of the marks in general matches those of intentional cut marks made by scraping bone with a stone tool. Olsen (1984:134) replicated this process experimentally and observed “in the case of most flakes or scrapers it is difficult to reverse directions in a reciprocal motion. The sharp edge of the stone tool held at a relatively high angle of attack causes microcutting of the bone surface. Asperities in the edge of the stone tool create (characteristic) striations.” The striations on this object could have been made in the initial shaping, during use or by using the object as a surface on which to shape another object. The first option seems the most likely. The intentionality of the marks, where pressure and direction are evident, is indicative of the direct application of a stone tool, hand pressure and unidirectional movement repeatedly on the surface. These actions would have taken place when shaping the prospective tool. The surface polishing appears as a later process that obliterates most of the striations present. A certain degree of polishing affects the whole surface of this specimen, but this is clearly more pronounced on the tip and edges. Although some polishing can be expected to be a product of sediment rubbing, the intense polish and featureless surfaces on the tip and edges are indicative of tool use before burial.

3.1.2 Object E702 - “gouge-like tool”

This the largest of the objects (137.5 x 52.0 mm) was described by Clark (et al 1947:26) as the “working end of a gouge-like tool made from a long bone of a large animal split lengthwise” (fig 2a,b). By current descriptive standards, the animal was large and would fall in size class III or IV (Brain 1981). A similar source of bone can be extrapolated for E1094 given the comparable size and morphology of the object. Longitudinal splits run along the bone probably as a result of postdepositional processes. The original cortex is almost completely missing, and only a few intact areas could be detected with the light microscope as shown in fig 3e,f. The loss of the surface bone could be related to the general weathering responsible for the splitting.

On the intact surface, sub-parallel striations are visible in the micrographs (fig 5a,b,c). These striations run from the tip downwards on both sides and closely resemble in morphology and regularity those on the edge of E1094. As with E1094, this object is interpreted as an intentionally shaped tool, but one that has been badly damaged by weathering or some other taphonomic process.

3.1.3 E700 - “bone point”

Clark interpreted this object as a polished point probably made on a rib fragment. The piece is fractured at the base and tapers to a pointed tip that is damaged and blunted (77.1 x 17.8 mm)(fig 2c,d;fig 3c,d). The specimen has been fractured subsequently to its illustration in Clark et al 1947, with a break perpendicular to the long axis located approximately 25mm from the tip and with three flakes of bone now missing (fig 2d). No evidence of modification is visible with a light microscope, but SEM analysis reveals numerous small parallel longitudinal striations (fig 5d,e). The striations resemble those on a Later Stone Age bone point from Mumbwa Caves (fig 5f). Olsen (1984:144) produced similar fine parallel striations by polishing bone with sandstone and rubbing with wet leather. No evidence of an initial shaping stage has been observed.
Figure 5. Micrographs of E702, E700 and of comparative specimen of a bone point: a, E702, side B, parallel striations and evidence of polishing and postdepositional damage on one of the few areas where the original surface of the object survives intact; b, E702, side B, parallel striations on an intact surface and resembling marks made during experimental shaping of bone using stone tools (Olsen 1984); c, E702, detail of side A with parallel striations similar to those on side B. d, detail of side A on E700, showing probable polishing marks resembling those produced experimentally (Olsen 1984) and on the Mumbwa Caves point (4e); e, E700, detail of side A showing parallel striations; f, detail of polishing marks on a Later Stone Age bone point from Mumbwa Caves, Zambia.
4 Interpretation

All three objects are intentionally shaped tools that show evidence of planning in their manufacture rather than objects informally shaped through use (eg, Backwell & d’Errico 2001). Each piece has probably undergone initial shaping by cutting with a stone tool followed by polishing and then further abrasion derived from the burial context. This sequence is evident in E702 and inferred for the similarly shaped specimen E1094. These two pieces with their semicircular working ends resemble “spatulas” found in Late Glacial and Holocene Later Stone Age sites in southern Africa (Deacon 1984:298). At the coastal site of Nelson Bay Cave (Inskeep 1987:159-164) the relatively large sample (n=30) reveals a link between tool size and choice of bone blank. The larger pieces are made on long bone splinters and the small spatulas on rib bones (ibid:159). The working ends tend to be semicircular on the long bone based spatulas and squared on those made from ribs. The Broken Hill sample accords with the correlation between large limb fragments and the shape of the working edge. The size of E1094 falls in the range of the Late Glacial/early Holocene sample at Nelson Bay Cave where limb bones were the preferred material.

The term spatula carries no agreed connotations about use. Clark (1959b:237) reported that Bushmen used these tools in hide preparation with the rounded edge either used to remove hair or soften skins by working in fat and herbs. Semenov (1964:175-179) reached a similar conclusion, but based on his use-wear studies of archaeological specimens from the Russian Palaeolithic. The skin working model could be tested experimentally and applied to the Broken Hill specimens.

Object E700 is a polished tool, and based on its overall symmetry and extensive polishing on all surfaces, it resembles bone projectile points described from Later Stone Age contexts in Zambia (eg, Barham 2000:124) and from southern Africa (eg, Inskeep 1987). It also resembles bone points identified from the 70 ka and older MSA levels at Blombos Cave, South Africa (Henshilwood et al 2001). Inskeep (1987:156) distinguishes bone points from other pointed tools by the shape of the cross section which is round to oval. Awls by contrast tend to be asymmetrical or elliptical in cross section. Henshilwood et al (2001:663) have quantified the distinction by comparing width/thickness ratios measured 30 mm from the tool tip. Points have a nearly equal ratio (1.1-1.3) whereas awls tend to be wider (>1.3). The point from Broken Hill has a width:thickness ratio of 1.3 which matches that of three MSA objects classified as bone points at Blombos (ibid:table 8). The maximum width:thickness ratio is also used to distinguish points from awls (ibid:663) and in the case of specimen E700 the ratio of 1.5 falls within the range for MSA points at Blombos. Among historic and recent hunter-gatherers in the Kalahari, bone tipped arrows were a commonly used armature (Deacon 1984:289). If the Broken Hill specimen is indeed a point, then early MSA hominids can be said to have used bone as well as stone in their composite tool technology (Mode 3).

5 Summary and conclusions

The SEM analysis of the three bone objects from Broken Hill confirms Clark’s original interpretation that these were deliberately shaped tools. He observed that they were the first tools in the region to be found in an MSA context (Clark et al 1947:24). The age range of the Broken Hill deposits remains problematic, but the archaeological evidence from the site, and from others in the region (eg, Twin Rivers, Kalambo Falls) supports an early MSA attribution for the tool assemblage. The early MSA in south central Africa can now be bracketed between 300-140 ka (Barham 2001). Bone tools have since been reported from other MSA sites in southern and central Africa (eg, Singer & Wymer 1982; Yellen et al 1995; Henshilwood & Sealy 1997; Barham 2000), but all dating to the Late Pleistocene. Broken Hill stands alone, at the moment, as the exception to the emerging pattern of formalised bone tool making after 120 ka (see Henshilwood et al 2001 for summary of current data). Bone tools are just one of a list of archaeological signals for modern behaviour that...
develop in the MSA (see McBrearty & Brooks 2000:491-493) at differing times and places. The early MSA is of particular importance because it marks the emergence of new lithic technologies including blades and backed tools (Barham 2001, in press; Clark 2001) linked with the development of hafting and composite tools. Indirect evidence for symbolic behaviour is also evident with the first regionally distinct artefact styles (eg, Lupemban Industry) and the systematic use of pigments which together may reflect socially constructed standards of behaviour based on syntactic language (Barham 2002). The making of bone tools at Broken Hill now seems less of a behavioural oddity. In answer to the rhetorical question posed by McBrearty & Brooks at the outset, our interpretation of the evidence from Broken Hill suggests that the carving and polishing of a bone point was indeed well within the capabilities of humans who made Levallois flakes.

Although the association of the Broken Hill fossil human remains assigned to *H. heidelbergensis* and the artefacts is not secure, the possibility of an association raises several questions that may only be answered when independent dating evidence is available. First, it might imply that Mode 3 artefacts were made by a late form of *H. heidelbergensis*, as well as by early forms of *H. sapiens* and *H. neanderthalensis*. Second, the putatively associated artefacts included some relatively advanced bone tools. Third, a relatively late date for the human fossils might imply the survival of *heidelbergensis* alongside early members of the *H. sapiens* clade in late Middle Pleistocene Africa, increasing the complexity of human evolution. Fourth, if such co-existence did occur, it would in turn provide an alternative association for the artefacts in that the more advanced technology might, after all, be the product of contemporaneous archaic *sapiens* populations.

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