

Poison arrows and bone utensils in late Pleistocene eastern Africa: evidence from Kuumbi Cave, Zanzibar

Michelle C. Langley, Mary E. Prendergast, Ceri Shipton, Eréndira M. Quintana Morales, Alison Crowther & Nicole Boivin

To cite this article: Michelle C. Langley, Mary E. Prendergast, Ceri Shipton, Eréndira M. Quintana Morales, Alison Crowther & Nicole Boivin (2016): Poison arrows and bone utensils in late Pleistocene eastern Africa: evidence from Kuumbi Cave, Zanzibar, *Azania: Archaeological Research in Africa*, DOI: [10.1080/0067270X.2016.1173302](https://doi.org/10.1080/0067270X.2016.1173302)

To link to this article: <http://dx.doi.org/10.1080/0067270X.2016.1173302>



© 2016 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 20 May 2016.



Submit your article to this journal [↗](#)



Article views: 87




View related articles [↗](#)



View Crossmark data [↗](#)

Poison arrows and bone utensils in late Pleistocene eastern Africa: evidence from Kuumbi Cave, Zanzibar

Michelle C. Langley^a , Mary E. Prendergast^b, Ceri Shipton^c, Eréndira M. Quintana Morales^d, Alison Crowther^e and Nicole Boivin^f

^aArchaeology and Natural History, School of Culture History and Language, College of Asia and the Pacific, Australian National University, Canberra, Australia; ^bDepartment of Sociology and Anthropology, St. Louis University in Madrid, Avenida de Valle 34, 28003 Madrid, Spain; ^cMcDonald Institute for Archaeological Research, Downing Street, Cambridge, CB2 3ER, United Kingdom and British Institute in Eastern Africa, PO Box 30710, Nairobi, Kenya; ^dDepartment of Anthropology, Rice University, Houston, TX 77251, United States of America; ^eSchool of Social Science, The University of Queensland, Brisbane, 4072, Australia; ^fResearch Laboratory for Archaeology and the History of Art, University of Oxford, South Parks Road, Oxford, OX1 3QY, United Kingdom and Department of Archaeology, Max Planck Institute for the Science of Human History, Jena, D-007743, Germany

ABSTRACT

Most of our current knowledge of late Pleistocene African bone technology is drawn from southern African sites, with recent discoveries indicating that bone- and stone-tipped arrows (propelled by a bow) were in use prior to 60,000 years BP. Integration of archaeological with ethnographic data similarly suggests that hunting with poison-tipped arrows on the African continent has an antiquity of at least 24,000 years. Unfortunately, similar analysis of material from eastern Africa is largely absent and consequently, with the sole exception of barbed points, we know very little regarding osseous technology in this region and how similar or dissimilar it is to contexts located further south. This paper presents a small assemblage of seven bone artefacts recovered from the late Pleistocene deposits of Kuumbi Cave, Zanzibar. Comparison of the bone projectile points, a bone awl and a notched bone tube with ethnographic and archaeological material from throughout the Sub-Saharan region suggests that, as elsewhere in Africa, bone technology was a central element in the Later Stone Age material culture repertoire of Kuumbi Cave's inhabitants. It also suggests that arrow points coated with poison were in use in eastern Africa around 13,000 years BP.

ABSTRACT

Actuellement, la plupart de nos connaissances concernant la technologie des os en Afrique à la fin du Pléistocène dérivent de sites d'Afrique australe, avec des découvertes récentes qui indiquent que les flèches avec des pointes en os ou en pierre, propulsées par un arc, étaient en usage avant 60,000 ans BP. En outre, l'intégration des données archéologiques et ethnographiques suggère que la chasse avec des flèches

ARTICLE HISTORY

Received 15 June 2015
Accepted 24 August 2015

KEYWORDS

Zanzibar; osseous technology; eastern Africa; awl; bone tube; poison arrow

CONTACT Michelle C. Langley  michelle.langley@anu.edu.au

© 2016 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

empoisonnées date d'au moins 24,000 ans sur le continent africain. Malheureusement, nous manquons d'analyses similaires pour des contextes d'Afrique orientale. Par conséquent, à la seule exception des pointes crénelées, nous savons très peu au sujet de la technologie osseuse dans cette partie du continent, et nous ignorons à quel degré elle diffère de, ou ressemble à, celle de contextes plus méridionaux. Cet article présente un petit assemblage de sept artefacts en os, retrouvés dans des dépôts de la fin du Pléistocène à Kuumbi Cave, Zanzibar. Ces objets — des pointes de projectile en os, un poinçon en os et un tube en os cranté — ont été comparés avec des données ethnographiques et archéologiques provenant de toute la région subsaharienne. Cette étude indique que, comme fut le cas ailleurs en Afrique, la technologie de l'os fut un élément central dans la culture matérielle du Later Stone Age à Kuumbi Cave. Elle suggère également que les pointes de flèche enduites de poison étaient en usage en Afrique orientale il y a 13,000 ans environ.

Introduction

With the exception of barbed bone points (see Yellen 1998 for an overview), late Pleistocene and early Holocene osseous (bone, antler, ivory) technologies are poorly reported for eastern African sites (but see Robertshaw *et al.* 1983; Robertshaw 1991). Consequently, most of our current knowledge of pointed bone technology comes from southern Africa, where a handful of Later Stone Age (LSA) sites including Nelson Bay Cave (J. Deacon 1984; Inskeep 1987; Bradfield 2012), Melkhoutboom (H. Deacon 1976), Kasteelberg (Smith and Poggenpoel 1988), Die Kelders (Schweitzer 1979), Jubilee Shelter (Bradfield 2012), Rose Cottage Cave (Wadley 1987, 2000a, 2000b; Bradfield 2012) and Sehonghong (Mitchell 1995, 1996), provide the majority of available data, with Blombos extending these far back into the Pleistocene (Henshilwood *et al.* 2001). At these sites, a variety of pointed bone tool types have been recovered — including 'bone points', 'arrow points', 'spear points', 'link-shafts', 'awls' and 'needles' — the names being assigned on the basis of comparison with ethnographic items drawn from the broader southern African region. Such comparisons have led to a recent argument for a degree of continuity in the San material culture tradition over *c.* 44,000 years (d'Errico *et al.* 2012; cf. Mitchell 2012).

Over the past almost 20 years, it has been established that bone points to tip hunting weapons were present in Africa in the late Pleistocene (Henshilwood *et al.* 2001; d'Errico and Henshilwood 2007; Backwell *et al.* 2008). Prior to this time, it was thought that this technology was introduced in Africa only at or after 12,000 BP (H. Deacon 1976, 1995; J. Deacon 1984; Inskeep 1987; Klein 1987, 1999, 2000; Opperman 1987; Mazel 1988; Mitchell 1988). Similarly, bow-and-arrow technology is now hypothesised to have been utilised from around 60,000 years ago, with arrows being tipped with both bone and stone points (Backwell *et al.* 2008; Lombard and Phillipson 2010; Villa *et al.* 2010; Lombard 2011). With bow-and-arrow technology likely established during the Middle Stone Age (MSA; the Howiesons Poort in particular), current evidence suggests that poison-tipped arrows were one of the key innovations of the LSA (Backwell *et al.* 2008). Previously thought to have been utilised only after about 8000 BP (Deacon 1976;

Opperman 1987; Mitchell 2002), the possible use of plant-based poisons is now suggested to have an antiquity of at least 24,000 years owing to the recovery of a possible wooden poison applicator from Border Cave, South Africa (d'Errico *et al.* 2012; cf. Evans 2012).

This understanding of southern African MSA and LSA bone technology is largely based on analytical methods such as microscopy and residue analysis, which have become commonplace over the past two decades. Unfortunately, similar intensive study of recovered osseous artefacts (excepting barbed points or harpoons) is lacking for assemblages recovered from eastern Africa. Consequently, our understanding of how geographically widespread poison-tipped arrow hunting technologies — among other bone-based technologies — were during the LSA is relatively poor.

In this paper, we describe seven bone artefacts recovered from contexts dating back to at least *c.* 13,000 years cal. BP from Kuumbi Cave, Zanzibar, Tanzania. These artefacts include five projectile point tips, an awl and a notched piece, the last of which may represent a fragment of a 'bone tube'. We compare these artefacts to published ethnographic and archaeological assemblages originating from both eastern and southern Africa in an attempt to add to our knowledge of eastern African bone technology, as well as to place them into the wider African LSA narrative.

Archaeological context

Kuumbi is a large limestone solutional cave situated in the southeast of the island of Unguja in the Zanzibar archipelago of Tanzania about 2 km from the coast (Figure 1). The cave consists of two main chambers with smaller passages leading off in various directions. Large sinkholes in the roof let in plenty of natural light and a spring at the back of the cave makes it eminently habitable for humans. Prior excavations at the site revealed occupation dating back to the late Pleistocene (Sinclair *et al.* 2006; Chami 2009) and more recent excavations were undertaken by the Sealinks Project (Shipton *et al.* 2016). This paper focuses on the bone artefacts recovered during this most recent phase of excavations.

The artefacts described here were recovered from Trench 10, from layers in the lower half of the stratigraphy, between Contexts 1022 and 1015 and are securely dated to the late Pleistocene period of the cave's occupation (Figure 1). These occupation phases post-date a sterile basal context (1025) dated to 20,240–19,880 cal. BP¹ (Wk-40633: 16,656 ± 56 uncal. BP). The earliest definitive occupation context (1024) is undated and does not contain any bone artefacts, although two dates from the overlying context, Context 1019, are available. One is on land snail shell (18,830–18,555 cal. BP [OxA-30467: 15,460 ± 65 uncal. BP]) and the other on charcoal (17,485–17,080 cal. BP [Wk-40632: 14,221 ± 62 uncal. BP]) and they suggest that occupation of Kuumbi Cave began soon after 20,000 BP. Context 1019 is overlain by another occupation layer (Context 1018), but between this and the next occupation (Context 1017) there is a small channel, which has eroded some of the sediment. The fill of this channel (Contexts 1020, 1022 and 1023) is undated, but contains LSA artefacts. The next four dates are for Contexts 1015, 1016 and 1017 and all cluster between 13,040 and 11,340 cal. BP (Shipton *et al.* 2016). The lithic artefacts from these contexts comprise small quartz bipolar pieces that are consistent with East African LSA technology, which is currently known to begin well before 40,000 BP (such as at Mumba Rockshelter, Tanzania; Mehlman 1989; McBrearty and Brooks 2000; Díez-Martín *et al.* 2009; Gliganic *et al.* 2012).

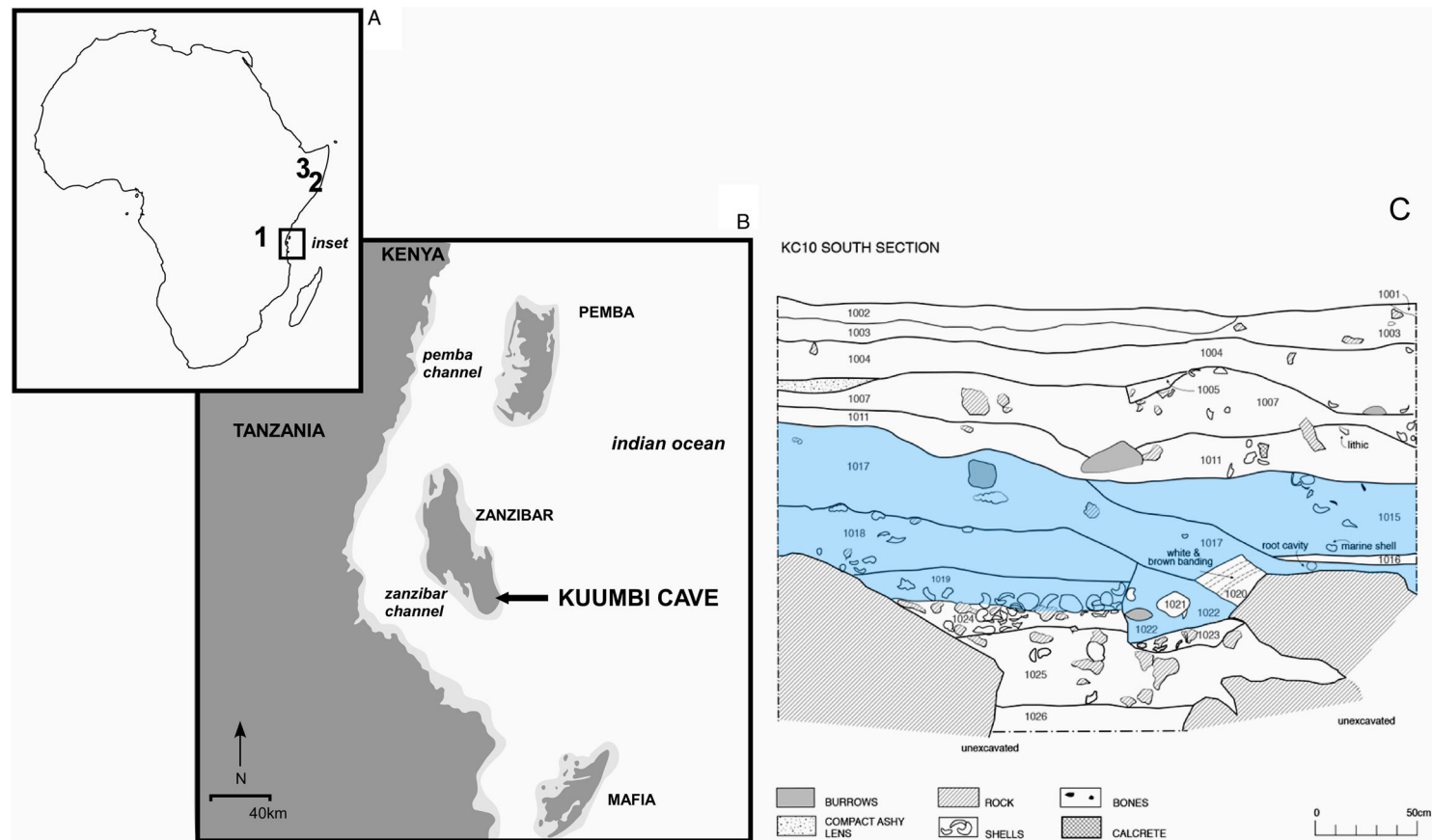


Figure 1. Location of Kuumbi Cave and the south section of Trench 10 indicating (in blue) the contexts from which the bone technologies discussed were recovered.

The LSA occupation at Kuumbi can thus be broadly characterised as spanning the period from 19,000 to 11,000 cal. BP.

Method

Each of the bone artefacts described below was first photographed at high resolution with a Canon EOS 400D digital camera before being examined with a Zeiss 2000-C stereo microscope fitted with a AxioCam MRc5 camera, along with a Dino-Lite Pro AM413ZTAS digital microscope for traces of anthropogenic modification. The identification of both taphonomic and anthropogenic marks was based on criteria defined in the literature (e.g. d'Errico 1991; Fisher 1995; Villa and d'Errico 2001; d'Errico and Henshilwood 2007). Identification of shaping techniques and use wear (including diagnostic impact fractures) is based on comparison with experimental replication of manufacture and use (Newcomer 1974; d'Errico *et al.* 1984; Fischer *et al.* 1984; d'Errico and Backwell 2003; Villa *et al.* 2009; Yaroshevich *et al.* 2010), as well as previously published examples of similar artefacts (J. Deacon 1984; d'Errico and Henshilwood 2007; Bradfield and Lombard 2011; Bradfield 2012). Section descriptions of the pointed artefacts follow the work of Knetch (1991) and Pétilion (2006).

As five of the seven artefacts described below are considered to be fragments of projectile points, it is important to note that recent work with replicated African bone points has demonstrated that spin-off fractures measuring more than 6 mm in length are particularly diagnostic when attempting to identify projectile tips recovered from the archaeological record (Bradfield and Lombard 2011; Pargeter and Bradfield 2012; Bradfield and Brand 2015). A spin-off fracture can be defined as a secondary fracture originating from the surface of a bending (hinge or step terminating) fracture. These fractures occur when already broken pieces of a projectile element are pressed together as a result of kinetic energy stored in the shaft during impact with a target (Yaroshevich *et al.* 2010); several examples of this specific type of fracture were observed on the Kuumbi Cave points. These same experiments also found that hinge termination, step terminating and tip crushing were also common occurrences for points used as arrow heads, with snap fractures occurring less frequently (Bradfield and Lombard 2011; Pargeter and Bradfield 2012; Bradfield and Brand 2015). Tip rounding, which has long thought to constitute another impact trace (e.g. Tyzzer 1936; Arndt and Newcomer 1986; Buc 2010), however, was not recorded in Bradfield and Lombard's (2011) recent hunting experiment. This type of use wear is known to form during other activities such as use as an awl (Newcomer 1974; d'Errico *et al.* 2012; Bradfield and Brand 2015), or as a result of post-depositional trampling (Pargeter and Bradfield 2012). Significantly, experiments have found that multiple fractures on single tools are more often the result of hunting than post-depositional trampling (Pargeter and Bradfield 2012).

Bone projectile points

Five distal-mesial fragments of pointed bone tools were recovered from Contexts 1015 (N = 1), 1017 (N = 1), 1018 (N = 2), and 1022 (N = 1) (Figures 2 and 3). The morphology and use wear on all five pieces are consistent with their use as projectile points.

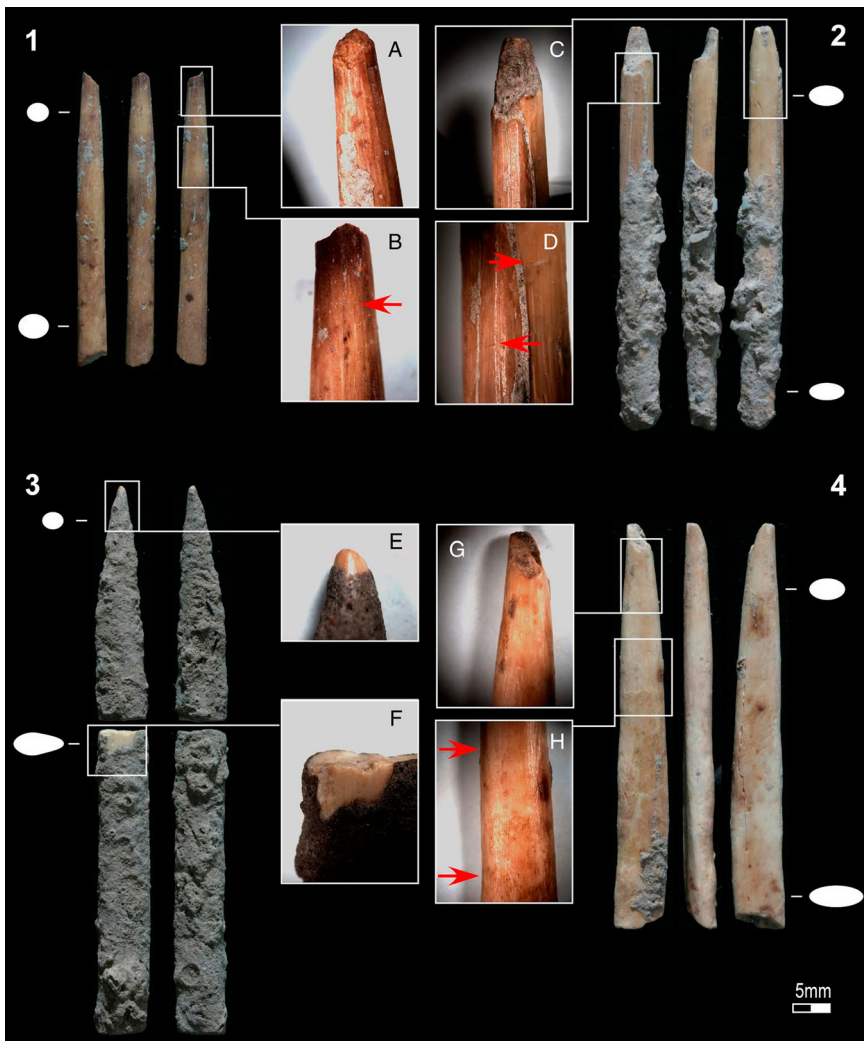


Figure 2. Four of the projectile point fragments recovered from Kuumbi Cave: (A, C and G) impact fractures; (B and D) possible retrieval cut marks; (E) rounded tip; (F) post-depositional fracture revealing bone surface; (H) change in surface appearance. Magnification: A, C, G, and H at 65x; B at 85x; D at 100x; E at 200x.

Each of these five artefacts displays multiple striations, visible under low magnification, resulting from longitudinal scraping with a lithic edge (Figure 2: A, H). Four of the points (2, 3, and 4 in Figure 2; Figure 3) have a flattened oval section, with the last (number 1 in Figure 2) being sub-circular in section. With no eastern African late Pleistocene bone points available for comparison and only late Holocene examples having been published previously (Robertshaw *et al.* 1983; Robertshaw 1991), we turned to the larger datasets recovered from southern Africa for further analysis. Comparison finds that the Kuumbi Cave points are similar in dimensions and morphology to LSA points recovered from sites such as Nelson Bay Cave, Jubilee Shelter and Rose Cottage Cave (Bradfield 2012: Fig. 6): circular to oval sections, point width (10 mm down from the distal tip) between

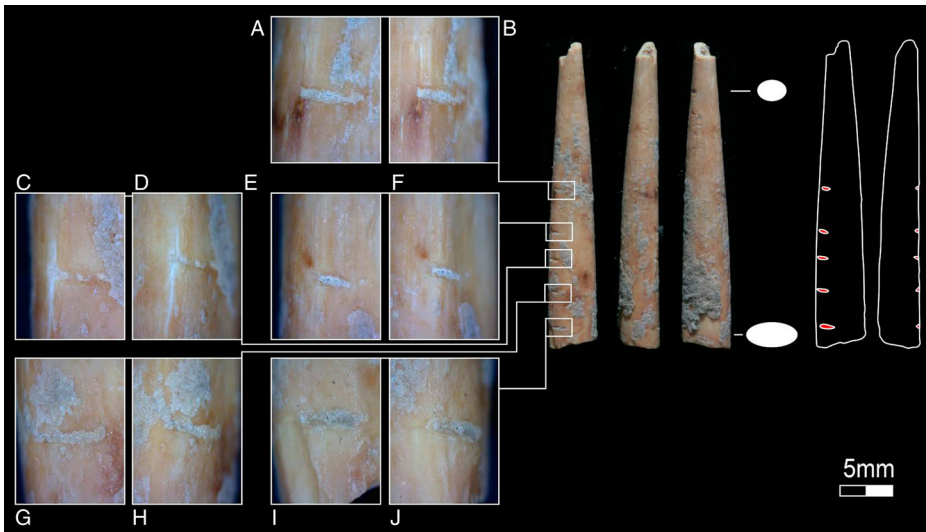


Figure 3. Bone projectile point tip with five horizontal incisions down left side: view of incisions from the dorsal aspect (A, C, E, G, I); view of incisions from the left side (B, D, F, H, J). Magnification: 150x.

2 and 4 mm (averaging around 3 mm) (see [Table 1](#) below for metric data on the Kuumbi Cave points) and terminating in hinge, step or snap fractures (both with or without spin-off fractures). These points are commonly interpreted as tips of arrows rather than spears or darts (propelled with a spear-thrower), owing to their small size and to the fact that blowpipes are not known to have been used in Sub-Saharan Africa.

Points 1 and 2 in [Figure 2](#) also display marks that are consistent with ‘retrieval cut marks’. These marks are short, oblique and often isolated incisions found on the surfaces of the distal-mesial section of a projectile point that result from the accidental cutting of the tip while it is being retrieved from inside a carcass (Pétillon 2006; Letourneux and Pétillon 2008; Langley 2013). These marks are indicated by red arrows in [Figure 2](#) (B and D).

Small specks of red ochre visible on the surfaces of two of the artefacts (1 and 2 in [Figure 2](#) recovered from Contexts 1018 and 1017 respectively) are probably the result of post-depositional adherence rather than the result of shaping (ochre is sometimes used as an abrasive in polishing) or use. Red ochre was recovered from Context 1017, and similar light ochre specks are visible in the breccia adhering to three of the bone points.

While each of the points displays fractures (snap fractures and step terminating fractures, along with several examples of spin-off fractures) and wear (crushing, rounding,

Table 1. Metrics for the five Kuumbi Cave (Trench 10) bone projectile points.

Artefact	Context	Total length (mm)	Width 10 mm from distal tip (mm)	Maximum width (mm)	Maximum thickness (mm)
Figure 2-1	1018	28.55	2.49	4.18	2.77
Figure 2-2	1022	33.84	2.73	3.38	3.07
Figure 2-3	1015	63.55	3.75	5.86	3.62
Figure 2-4	1018	49.13	4.39	6.11	3.19
Figure 3	1017	47.90	3.88	4.81	2.77

chipping of the distal edge) consistent with use as tips for projectile weapons, only one has a set of deliberate incisions carved into its side. This artefact (Figure 3), exhibits five short, horizontal lines down its left side, which were made after scraping (shaping) of the point was completed. Starting from 1.25 mm from the proximal edge, the last line is incised 14.14 mm above the first. These incisions are evenly spaced (ranging between 1.97 and 3.34 mm between each line) and each line was incised from the superior surface down towards the inferior surface in a single stroke. Each of the five lines shares several characteristics (total length, angle of execution and profile; d'Errico 1991, 1998) suggesting that they were executed with a single unretouched lithic cutting edge that was applied with varying amounts of pressure. Order of execution appears to be successive (either from bottom to top or from top to bottom), as suggested by the presence of an indent on the left side of the incision initiation point (particularly on numbers one, two and four from the top), which becomes more pronounced on each stroke from bottom to top of the piece.

Lines incised in a series such as this Kuumbi Cave example have been observed on a number of points recovered from archaeological contexts from southern Africa, including MSA examples from Blombos Cave (d'Errico *et al.* 2001; Henshilwood *et al.* 2001), MSA or LSA levels at Peers (Skildergatkop) Cave (d'Errico and Henshilwood 2007) and LSA levels at Jubilee Shelter (Wadley 1987), though not from geographically closer sites such as White Rock Point (Robertshaw *et al.* 1983). Since these lines are barely visible to the naked eye, it seems unlikely that they constitute decoration of the projectile for aesthetic purposes, as is the case for many European Upper Palaeolithic osseous points (Conkey 1980; Julien 1982; Clotte 1990; Buisson *et al.* 1996). It is possible that these lines were cut by the maker/owner of the projectile in order to make the weapon tip identifiable, as is common practice among both San and Hadza hunter-gatherers (Woodburn 1970; Wiessner 1983; Bartram 1997; Deacon and Deacon 1999), though in these ethnographic contexts, it is the reed, bone or wooden link-shaft or shaft rather than the bone tip that is usually marked by incisions, paint, or burnt designs (Woodburn 1970; Oosthuizen 1977; Deacon and Deacon 1999; Marlowe 2010).

Another possibility is that the lines were added to facilitate adherence between projectile components (Allain 1957; Allain and Rigaud 1986, 1989, 1992). Ethnographic accounts of Hadza wooden weapon tips do not, however, report the incising of striations to aid in component fixing (Woodburn 1970) and preliminary review of ethnographic and archaeological literature for other Sub-Saharan cultures similarly make sparse mention of this practice. Oosthuizen (1977: 80), though, reports that fine striations are found 'round the circumference' of most of the bone link-shafts included in two southern Bushman hunting kits curated in the KwaZulu-Natal Museum and the University of KwaZulu-Natal, South Africa, while Schapera (1930: 129) mentions that Bushman foreshafts can have a notch cut, into which a stone geometric microlith is attached with the aid of a mastic. Having said this, the lack of an ethnographic analogue does not discount this practice having been used in Zanzibar in the past and it might be proposed that the location of these incisions would make them useful for fixing (with a ligature and/or an adhesive) a bone, quill or wooden barb similar to those reported for modern Hadza wooden arrows (Woodburn 1970; Marlowe 2010).

A fourth possibility is that the lines functioned to hold poison on the point in much the same way that striations act to hold an adhesive for hafting (Allain and Rigaud 1986). The

use of poison arrows to hunt game has been frequently observed ethnographically in Sub-Saharan Africa (e.g. Woodburn 1970; Wiessner 1983; Bartram 1997; Marlowe 2010) and, as already mentioned, the antiquity of hunting with poison (at least in the south of the continent) has been suggested to have been established during the MSA (Ambrose 2002; d'Errico *et al.* 2012; Evans 2012).

Known poison arrows are manufactured from bone (ostrich, bovid), quill, wood or metal (the last in recent times) and are slender and short, generally reaching only a few centimetres in absolute length (Schapera 1930; Woodburn 1970; Oosthuizen 1977; Bartram 1997; Marlowe 2010). There is a strong connection between bone points and the use of poison in the ethnographic literature (Van Rippen 1918; Schapera 1925, 1927, 1930; van Riet Lowe 1954; Clark 1959, 1977; Lee 1979; Rudner 1979; Silberbauer 1981; J. Deacon 1984; Webley 1994), which is in sharp contrast to stone projectile points that appear to have been largely used without poison (Clark 1959, 1977; Binneman 1994; Bousman 2005). Bone poison arrows are generally more slender and diminutive than their unpoisoned bone counterparts (Backwell *et al.* 2008). In these ethnographic contexts, poison is reported to have been 'carefully smeared over' (Schapera 1930: 130) the point and, while no mention of striations cut into the point to help the poison to adhere to the penetrative section are generally mentioned, Oosthuizen (1977) does indicate that at least some of the bone points in the KwaZulu-Natal collections do exhibit incisions. Hadza poison arrows were reportedly covered with a thin piece of leather wrapped around the point both to protect people from accidentally being cut and poisoned and also to protect the poison from drying out in the sun or getting wet and thus diluted (Bartram 1997; Marlowe 2010). Those utilised by Cape Bushmen, on the other hand, were reversed into the reed arrow-shaft for safe keeping (Schapera 1925, 1930).

It is important to understand that with poisoned arrows it is not the velocity, length or thickness of the arrow, but the poison that kills the animal (Schapera 1930; Marlowe 2010). Thus, as it has been previously pointed out for other African contexts (i.e. Backwell *et al.* 2008), points of the size recovered from Kuumbi Cave cannot mortally wound a large or even medium sized animal without the use of poison, though they could potentially be effective against birds or small mammals.

Examination of Kuumbi Cave's faunal assemblages provides another useful angle from which to consider how the projectile points found at the site were used. The vertebrate faunal remains from Contexts 1018–1024 include zebra (*Equus cf. quagga*), buffalo (*Syn-cerus caffer*), waterbuck (*Kobus defassa*), common reedbuck (*Redunca redunca*), bushbuck (*Tragelaphus scriptus*) and bushpig (*Potamochoerus larvatus*). With the exception of bushpig, these large fauna are not found on Unguja today. With live weights exceeding 40 kg, all these animals are larger than those that it would normally be possible to hunt using the relatively small bone projectiles recovered from the site's late Pleistocene contexts. Poison may thus have allowed them to be used to hunt the larger prey present at Kuumbi Cave.

On the other hand, the bulk of the late Pleistocene assemblage is dominated by the same types of small bovids that are found throughout the entire sequence, namely Cephalophini (Ader's duiker and blue duiker, *Cephalophus adersi* and *C. monticola* respectively) and Neotragini (suni, *Neotragus mochatatus*); steenbok (*Raphicerus campestris*) is also found. Cephalophini are adapted to closed and mixed environments and would likely have

been found in the forested area surrounding the cave, while Neotragini are also found in the more open coral rag thicket covering much of the island (Pakenham 1984; Williams *et al.* 1996). These three species are the only wild bovids found on Unguja today.

Remains of aquatic species are few within Kuumbi Cave. A small quantity of remains recovered from Contexts 1018–1024 indicate that marine fish were consumed in the Pleistocene occupation phase, although on a small scale. From a total of 9 grams of recovered fish remains, 11 bones were attributed to family or genus. They include nearshore taxa associated with reef habitats, including parrotfish (Scaridae), jacks (Carangidae), moray eel (Muraenidae) and emperor fish (*Lethrinus* sp.), as well as estuary fish such as bonefish (*Albula* sp.) (Smith and Heemstra 1986). Two vertebrae from Context 1020 belong to shark specimens, but are difficult to attribute to a specific taxonomic category based on morphological features. Further identification, perhaps with other methods, is required to determine whether the shark represented is a coastal or oceanic species. The identified fish are today captured variously with nets, fishing lines, traps and spears. Fisheries data record the use of spears to capture certain species of jacks (i.e. *Carangoides fulvoguttatus*), parrotfish and moray eels (Fischer and Bianchi 1984). The large size of most of the archaeological specimens (estimated to be over 50 cm in length) would have made these fish an easier target for spearfishing.

Further afield, a wide range of fishing methods is documented for the East African coastal region in ethnographic, colonial and fisheries records (Ingrams 1931; Grottanelli 1955; Prins 1965; Glaesel 1997). They include the gleaning of small fish in tidal pools, the construction of elaborately woven basket traps and the capture of large, fast-swimming predatory fish with fishing lines and vessels, among other methods. Although not considered a principal form of fishing, the use of spears and poison is also recorded. Around Zanzibar, Ingrams (1931: 299–300) reports the practice of spearing fish at night from a canoe or while wading in shallow water using light to attract them, along with the use of poison derived from *Euphorbia* sap to stun fish in the water. In the Lamu area, Prins (1965: 136) recounts men using ‘*munda*, a fish spear two metres long and with a semi-barbed head of 15 cm tanged and socketed upon the shaft’ to catch lobsters, crabs, and octopus, as well as the use of a spear and *jarife* tangle net to catch shark (Prins 1965: 140–141). The latter method was carried out offshore with the aid of a large sailing vessel, but some shark species that frequent coastal waters can be caught closer to shore. Although difficult to determine with certainty, some of the fish found in the Pleistocene levels at Kuumbi Cave, particularly the large parrotfish and moray eel, could have been caught with spears and poison.

Even with the very limited ethnographic data available, it is clear that there is tremendous variation in the methods used today on both Unguja and the adjacent mainland of Tanzania to hunt and trap the terrestrial animals found in Kuumbi Cave’s deposits. Methods for hunting the animals still present on Unguja (bushpig, duikers and suni) have been reported as follows: Ingrams (1931) describes pig-hunting with spears and the construction of wooden bushpig traps, while Walsh (2007) provides a review of the capture and consumption of the duiker and suni, noting the use of wooden traps, pits and snares as documented by Ingrams (1931). Williams *et al.* (1996) observe that today nets are manufactured from palm fibre and that traps and snares are no longer employed. Trapping techniques could also have been used for the other small fauna in the Kuumbi Cave assemblage, most notably tree hyrax (*Dendrohyrax validus*), cercopithecine and

colobus monkeys (*Cercopithecus* or *Chlorocebus* spp., *Colobus* sp.) and the giant pouched rat (*Cricetomys gambianus*), which are abundant throughout the sequence. In the past, traps would likely have been made from wooden wicker, as is described for monkey traps by Ingrams (1931). It should be noted, however, that the Hadza hunt small and fast-moving prey, such as dik-dik (*Madoqua* sp.) and rock hyrax (*Procavia capensis*) with a bow and arrow and see snare construction as a foreign custom (Marlowe 2010).

Traditionally, Hadza also typically hunt zebra and large bovids with bow and arrow (Fosbrooke 1956; Kohl-Larsen 1958; Woodburn 1970). Arrows are wooden or metal, although Marlowe (2010) notes that they likely used stone or bone points in the past. For taxa as large or larger than an impala or warthog, poison is applied to the arrow, and is essential to the efficiency of Hadza big game hunting (Marlowe 2010). In this context, poison is obtained by pounding and boiling branches or seeds of certain plants ('kalakasy', 'panjube' [*Adenium obesum*], 'shanjo' [*Strophanthus eminii*]; Marlowe 2010: 77), with men carrying the produced poison in a dried ball; a mollusc shell then serves as a bowl in which to stir the poison just before applying it. Interestingly, identified taxa of charcoal recovered from Kuumbi Cave include the 'Mkunazi' plant (*Zizyphus* sp.; Shipton *et al.* 2016), the fruit of which is an ethnographically known poison, reportedly utilised as a fish poison (William 1949; Neuwinger 1996). Dobbs (1928) records that the Luo (a modern ethnic group in Nyanza, Uganda) used a narrow barbless harpoon called a *bedthi* (or *bidhi*) for fishing and that a poison made from pulverised *Euphorbia* spp. was utilised in conjunction with the points in this context (Graham 1920).

Thus, while the small size of the bone points recovered from the LSA levels of Kuumbi Cave may have been effective against the smaller (duiker and suni) terrestrial and aquatic fauna without the use of poison, its application would certainly have increased their success. The use of these points against any of the larger taxa identified at this site would most certainly have required poison to be in any way effective. Consequently, while we cannot rule out that the incisions constitute an identifying mark or a feature to facilitate the attachment of a barb, their location at the distal tip of a small weapon tip and the presence of a known hunting poison identified at the site indicates that poison arrows may have been utilised against the captured fauna at Kuumbi Cave and may therefore may testify to the use of poison arrows (perhaps for fishing) at around 13,000 BP in eastern Africa. Given that the use of poison in hunting, rather than the bow and arrow, is seen as a crucial LSA innovation for subsistence, this evidence fits well with recent findings in southern Africa (Backwell *et al.* 2008; d'Errico *et al.* 2012).

Bone awl

Context 1019 yielded a bone artefact that displays characteristics commonly attributed to awls (Schweitzer and Wilson 1982; Inskeep 1987; Henshilwood *et al.* 2001). Awls found in South Africa are generally classified as 'pieces of bone worked to a point at one or possibly both ends, generally showing signs of use (polish), which are sufficiently asymmetrical, in one or both axes, and therefore not aerodynamic, to preclude their identification as bone arrow-heads or foreshafts' (Inskeep 1987: 156). They are most commonly manufactured from splinters of mammal or bird bone, or from long bones where the point is worked out of the mesial (diaphysis) section with the epiphysis acting as a kind of handle. The piece described here is of the former type and is similar to pieces recovered from

Kuumbi Cave in earlier excavations published by Sinclair *et al.* (2006: 102) and Chami (2009: 70).

This particular artefact is made from a fragment of terrestrial bone, measuring 50.04 mm in total length and 14.19 mm at its maximum width. The distal (active) tip has an elliptical section, measures 1.56 mm by 1.46 mm and exhibits a bevel fracture with crushing, chipping and rounding of the fracture edge — use wear consistent with piercing soft materials such as hides (d’Errico *et al.* 2012; Bradfield 2015; Bradfield and Brand 2015) (Figure 4: D and E).

This piece has been worked using several techniques. Long, linear shaft fragments such as the Kuumbi Cave awl are often produced during hammerstone percussion (Henshilwood *et al.* 2001), a method used to extract marrow, and may have produced the fragment utilised to form the awl. Targeted flaking is evident at several points on the piece (Figure 4: B and C; G) and was used to form the overall shape of the pointed section. Striations resulting from scraping with a lithic edge are visible on the left side and indicate that this method was used to further shape the pointed extremity. Coarse striations are visible within the resulting facet (Figure 4: A), which reaches down to 16.79 mm from the distal tip. As small thin points such as this would be easily broken in transport, it seems most likely that this artefact was made from food waste discarded at the site.

While awls are often equated with women’s labour in the archaeological literature (e.g. Spector 1993; Conkey and Gero 1997), ethnographies instead indicate that men were often

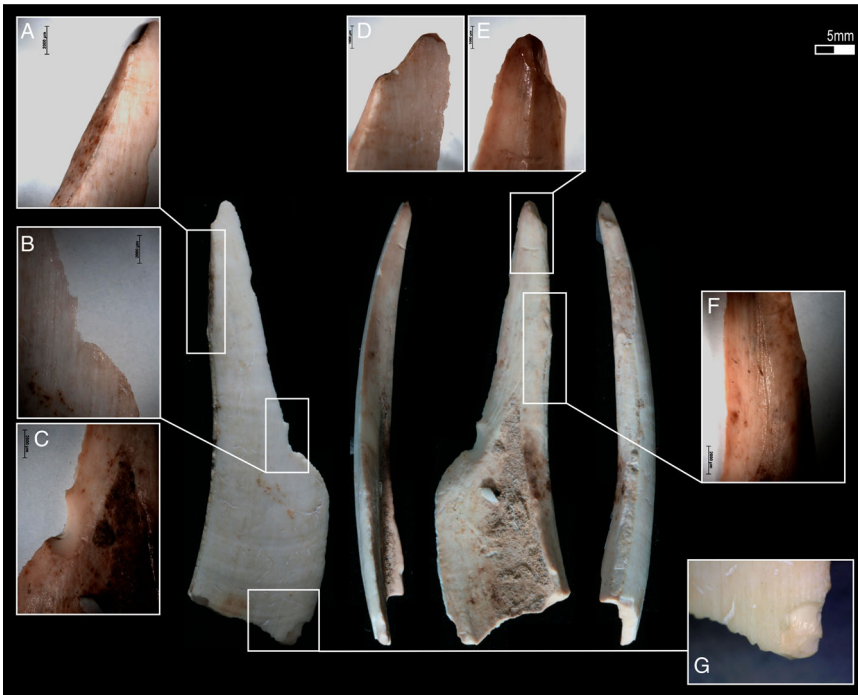


Figure 4. Artefact KC10 12706: worked cortical bone fragment: (A) facet with striations; (B-C) superior and inferior surface of flaked area; (D-E) distal tip with bevel fracture, chipping and rounding; (F) striations from working; (G) proximal tip with evidence of flaking. Magnification: A-C and F at 65x; D and E at 85x; G at 40x.

those who undertook most (or all) of the leather working in Sub-Saharan Africa (e.g. Marshall 1976; Silberbauer 1981). Thus, the presence of this awl along with those previously published from this same site, does not necessarily indicate the presence of women at Kuumbi Cave. Pointed bone tools interpreted as awls have been recovered from numerous LSA deposits throughout Sub-Saharan Africa, including Jubilee Shelter (Wadley 1987), Nelson Bay Cave (Inskeep 1987), Colwinton (Opperman 1987), Bonawe (Opperman 1987), Grassridge (Opperman 1987), Klasies River (d'Errico and Henshilwood 2007) and Blombosch Sands (d'Errico and Henshilwood 2007), all in South Africa, Midhishi 2 in Somalia (Brandt 1986) and Gogo Falls in Kenya (Robertshaw 1991), to name but a very few.

Notched bone piece (a 'bone tube'?)

The last osseous artefact to be described here is a post-depositionally fragmented artefact probably manufactured from an upper limb (possibly a femur) of a duiker-sized bovid. The fragments are here designated A [distal half] and B [proximal half] (Figure 5) and when joined measure 95.17 mm in total length and have a maximum width of 12.24 mm. This artefact was recovered from Context 1017. Another notched bovid bone was recovered previously from Kuumbi Cave, this earlier published example reaching approximately 110 mm in total length with more pronounced notches on its left and right sides (Sinclair *et al.* 2006: 103).

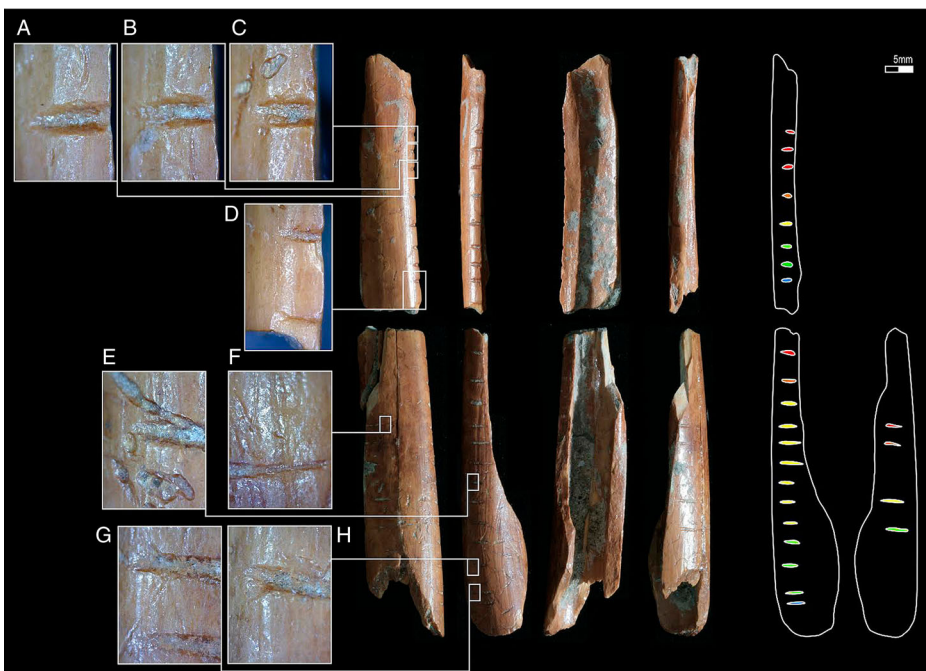


Figure 5. Artefact KC10 1017: (A-C) three incisions possibly made with the same lithic edge; (D) detail of a scraped section; (E) biochemical pitting crossing over anthropogenic incision; (F) initiation point of one of the incisions (G-H) two incisions possible made with the same lithic edge. Magnification: A-C; E-H at 160x; D at 75x. Colours indicate notches likely made with the same lithic edge.

Fragment A exhibits a splinter fracture at its distal extremity (the opposing extremity having been fractured post-depositionally) and bears a set of eight notches down its right side. Each of these notches was produced by a single incision, cut from the superior surface towards the inferior surface by an unretouched lithic edge. Examination of the morphology of each notch found that the distal three incisions (Figure 5: A–C) were likely made with the same lithic tool the edge of which dulled incrementally or was used with less force after each stroke; consequently, each notch is slightly different while sharing the same overall edge morphology. The remaining five notches on Fragment A each appear to have been made by a different unretouched lithic edge.

At the proximal end and right side of this same piece, a small section has been shaved off from the proximal end towards the distal extremity leaving a clear initiation point (Figure 5: D). The ventral surface of the artefact fractured in antiquity (indicated by the general appearance of the fracture surface) and represents the original plane of the bone splinter that was utilised. No anthropogenic incisions were found along the remaining left side. Biochemical pitting is clearly visible across the superior surface and intersects with the anthropogenic notches in several instances.

Fragment B terminates in a splinter fracture at its proximal extremity. Two smaller fragments have fractured off the distal extremity post-excavation. Two sets of regularly spaced incisions are found down the left (four notches) and right (13 notches) sides. As with Fragment A, each incision was produced by a single cut drawn from the superior surface towards the inferior surface by an unretouched lithic edge (consistent across the whole artefact). Biochemical pitting is visible across the superior surface and intersects with the anthropogenic notches in several instances (see Figure 5: E).

As observed on Fragment A, several notches may have been made with the same lithic tool, as indicated by morphological similarities between the walls of each notch (d’Errico 1991, 1998). Perhaps seven of the notches may have been made with a single unretouched lithic edge that changed slightly with use after each successive incision. As with the three notches on Fragment A, those observed on Fragment B appear to have been incised consecutively from one end towards the other. Two other lines on this fragment also appear to be produced by the same edge (Figure 5: G–H). Each of the four notches on the left side of the piece, however, appears to have been made with a different, unretouched lithic edge each.

Notched and incised bones and stones are known from numerous African archaeological contexts and have been especially reported for a range of southern African sites. Examples of notched and incised bones of Pleistocene age (>40 kya) include two notched bone fragments from Ishango, Congo-Kinshasa, (Brooks and Smith 1987; Cain 2006), two from Apollo 11 Cave, Namibia, (Wendt 1972, 1976) and two more from Klasies River, South Africa, (Singer and Wymer 1982). South Africa has also produced an incised bone from Blombos (Henshilwood and Sealy 1997), an elaborately modified bone with a set of incised notches from a transitional MSA/LSA context at Border Cave (McBrearty and Brooks 2000) and four osseous artefacts from Sibudu, each bearing a series of incised notches (d’Errico *et al.* 2012).

The Kuumbi Cave artefact is probably better compared to the ‘bone tubes’ recovered from LSA deposits in southern Africa. Inskeep (1987: Plates 14 and 15), for example, found eight bone tubes of late Holocene age that exhibited incised decorations (short, oblique lines and hatched patterns) at Nelson Bay Cave. Janette Deacon (1978: 98–99:

Figures 10 and 11) also reported ‘bone tubes’, this time in Wilton levels at the same site. Two of those pictured by her feature a continuous incised groove running around the outside of the piece. Another 28 examples of these artefacts have been recovered from the early Holocene levels at the nearby site of Matjes River Shelter (Dreyer 1933; Louw 1960), while later Holocene examples have been found at sites throughout the Fynbos and Forest Biomes of the Cape (Goodwin 1938; van Noten 1974; Deacon *et al.* 1978; Schweitzer 1979; Poggenpoel and Robertshaw 1981; Schweitzer and Wilson 1982). In Ethiopia, Brandt (1986) reports that two bone tubes were recovered from a cache which also contained over thirty pierced gastropod shells found close to an intentional burial at FeJx 2 at Lake Besaka dated to the LSA. This example was apparently undecorated (Brandt 1986: 65, Figure 7). Finally, Fagan and Van Noten (1971: 199, Figure 57: 9) describe a small hollow bone decorated with several series of small parallel incisions from Gwisho B, Zambia dating to the last 2000 or so years.

Various functions have been proposed for these bone tubes, both decorated and undecorated, including a use as flutes (Cooke and Robinson 1954; Louw 1960), tobacco pipes for those examples from more recent contexts (Stow 1905; Louw 1960; Steyn 1971; Yellen 1977; Wadley 1979; Cooke 1980), tubes for sucking water from ostrich egg containers (Dreyer 1933), poison, incense, or medicine containers, and ornaments (Inskeep 1987). One example from an unidentified cave near Plettenberg Bay (South Africa) currently held in the Albany Museum (Grahamstown), however, indicates that these tubes may have functioned as handles for lithic tools (Hewitt 1921). This particular artefact is made from bird bone and is decorated with at least two series of short, parallel lines down its length (see Lombard 2007: Figure 2c). On one end, a lump of mastic with a stone tool impression is found. A similar artefact, this one from Oakhurst (South Africa), reportedly exhibits cross-hatching and staining at one extremity suggesting that it too was once enclosed with a mastic or other form of binding (Inskeep 1987: 167), while another from Ishango retains what is left of a quartz flake fixed in one extremity (de Heinzelin 1962). Interestingly, Fagan and Van Noten (1971: 103) also suggest that the small, incised hollow tube recovered from Gwisho B might be interpreted as a handle of a composite tool.

Given the similarity in raw material, size and incised decoration it seems likely that the Kuumbi Cave artefact was a bone tube very similar in function to those recovered from other Sub-Saharan LSA contexts. That one of the suggested uses of these tubes is as containers for poison is intriguing given the discovery of *Zizyphus* sp. remains and bone points most similar to ethnographic poison arrows in these same contexts. On the other hand, a hafted tool would be equally useful in the processing of faunal or botanical products at this site.

Discussion and conclusion

The presence of bone projectile points (possibly indicating the use of bow and poison arrow), an awl and a bone tube suggests that Kuumbi Cave was the site of activities primarily belonging to the hunting or fishing sphere of LSA life and deepens our understanding of the use of the site during the late Pleistocene. Given the small number of stone tools recovered from Trench 10, bone and perhaps other organic technologies (relying on materials like wood and rope, perhaps to make traps, snares and nets) may have been

more important for the site's inhabitants, making it critical to try to develop a better understanding of Kuumbi Cave's non-lithic technologies.

Unbarbed bone points recovered in this eastern region of Africa appear far less frequently in the archaeological literature than their counterparts from southern African contexts. Robertshaw *et al.* (1983: Figure 1: 1) report small numbers of fragmented bone points from the shell midden sites excavated on the shores of Lake Victoria (23 fragments of bone points from White Rock Point, four from Luanda, four from Kanjera West and three from Kanam East). They speculate that the bone points recovered were used as tips for fishing spears (Robertshaw *et al.* 1983: 33) and note that while there is no direct evidence for this use in the investigated archaeological sites local ethnography documents similar points for fishing that were poisoned (Graham 1920; Dobbs 1928). From the drawings provided, these points appear to be of similar morphology and dimensions to the Kuumbi examples and mostly consist of distal-mesial fragments, though none display incisions of any kind.

Robertshaw (1991) also reports ten bone points recovered from Gogo Falls just to the east of Lake Victoria in association with Oltome (Kansyore) and Elmenteitan pottery. Based on the drawings provided, it appears that not all of these points may have functioned as projectile tips (some seeming better suited morphologically as awls). Prendergast (2008) mentions two bone points from Pundo (also in the Lake Victoria Basin), although these also have a different morphology to the Kuumbi points (a wider, circular section and no incisions). Mehlman (1989) mentions a single bone point, which appears from the accompanying drawing to be of similar dimensions and morphology to the Kuumbi examples, although no description is provided in text. Finally, Brandt (1986: (Figure 1: 2) mentions LSA 'bone tools' from the Somalian sites of Gogoshiis Qabe (associated with dates of 9180 ± 100 cal. BP [UGa-5] from the lower levels, and 6900 ± 350 BP [Beta-7474] and 5210 ± 90 [Beta-7473] for the upper levels), Guli Waabayo and Guli Garesso, along with others from Lake Besaka in the southern Afar Rift, Ethiopia (Brandt 1986: Figure 1: 3).

The association of unbarbed bone points in eastern Africa with aquatic (large water body) environments (Lake Victoria and the Indian Ocean), and the apparent absence of this same technology (in significant numbers) from dry interior locations, suggests that this technology may have functioned as part of a fishing toolkit, perhaps including the use of poison as recorded ethnographically. Certainly, this tentative correlation merits further focused investigation in the future.

Further comparison of the few osseous artefacts recovered from Kuumbi Cave with other eastern African — and indeed Sub-Saharan — assemblages will allow us to continue to construct a greater understanding of bone artefact traditions and their antiquity in this area. In particular, testing for the presence and composition of any organic residues remaining on the bone points and the bone tube may shed light on the function/s of these artefacts and on how they compare to similar examples in various cultural contexts throughout Sub-Saharan Africa.

In conclusion, despite the setbacks of sparse ethnographic and archaeological comparative datasets, we were able to identify the similarities of the Kuumbi Cave bone technologies with other LSA assemblages recovered from various Sub-Saharan sites. The identified bone projectile points fit well with ethnographically and archaeologically known poison arrows, which, when taken in conjunction with the presence of charcoal

from a known poisonous taxon in the site's deposits, appears to suggest that this hunting technology, better known from southern Africa, may also have been used by 13,000 cal. BP in eastern Africa.

Note

1. All radiocarbon dates reported in this paper have been calibrated using a mixed Southern and Northern Hemisphere calibration curve (70% ShCal13, 30% IntCal13, 2σ), an annually updated interim curve and the OxCal platform (Bronk Ramsey 2009) as described further by Shipton *et al.* (2016).

Acknowledgements

This work was completed as part of the Sealinks Project, which is funded by a European Research Council (ERC) grant to Nicole Boivin (Starter Grant 206148, 'SEALINKS') under the 'Ideas' specific Programme of the 7th Framework Programme (FP7). The analysis of fish remains was undertaken by Eréndira Quintana Morales, funded by a Fondation Fyssen Postdoctoral Study Grant (2014). Ceri Shipton is funded by the British Institute in Eastern Africa and the McDonald Institute for Archaeological Research, University of Cambridge, and Alison Crowther by postdoctoral fellowships from the British Academy and The University of Queensland. Fieldwork at Kuumbi Cave was carried out under a Research Permit issued by the Office of Chief Government Statistician, Zanzibar Research Committee, and an excavation license issued by the Zanzibar Department of Museums and Antiquities. We gratefully acknowledge the support of the Zanzibar Department of Antiquities, particularly Amina Issa and Abdallah Khamis. The work was also undertaken with the permission and collaboration of the cave's local custodians, particularly: Bandari Ame Haji, Asha Ali Makame, Meja Haji Nyonje, Nyonje Pandu Nyonje and Hassan Ali. Finally we should like to thank the two anonymous reviewers for their very constructive comments on the draft of this manuscript.

Notes on contributors

Michelle C. Langley is a post-doctoral researcher on the Australian Research Council Laureate Project 'Understanding modern human dispersal, adaption and behaviour en route to Australia' led by Prof. Sue O'Connor at the Australian National University. Her research interests focus around the manufacture and use of osseous technologies by early human communities.

Mary E. Prendergast is a professor in the Department of Sociology and Anthropology at Saint Louis University in Madrid, Spain. Her research focuses on Holocene subsistence strategies and forager-food producer relationships. She has conducted fieldwork and zooarchaeological analyses in Kenya and Tanzania since 2005.

Ceri Shipton is Fellow in East African Archaeology at the University of Cambridge and the British Institute in Eastern Africa. His research on lithic technology spans several of the major transitions in human behaviour from the Acheulean to the Iron Age.

Eréndira M. Quintana Morales conducts research on the role of fishing and fish consumption in past societies along the Eastern African coastline. She was funded by a Fondation Fyssen Postdoctoral Study Grant at the Muséum Nationale d'Histoire Naturelle (UMR 7209) in Paris during 2014 and is currently a National Science Foundation-funded SBE Postdoctoral Research Fellow at Rice University, Houston, Texas.

Alison Crowther is a Postdoctoral Research Fellow in the School of Social Science, The University of Queensland. Her research interests include the archaeobotany of early agriculture in East Africa, Indian Ocean crop transfers and ancient food processing technologies.

Nicole Boivin is a Senior Research Fellow in the School of Archaeology, University of Oxford, and a Fellow of Jesus College, Oxford. She has research interests in early trade, biological exchange and the Indian Ocean and has conducted fieldwork in South Asia and Africa. She is currently Principal Investigator of the European Research Council-funded Sealinks Project.

ORCID

Michelle C. Langley  <http://orcid.org/0000-0002-0299-5561>

References

- Allain, J. 1957. "Contribution a l'étude des techniques magdaléniennes. Les navettes." *Bulletin de la Société Préhistorique Française* 54: 218–222.
- Allain, J. and Rigaud, A. 1986. "Décor et fonction. Quelques exemples tirés du Magdalénien." *L'Anthropologie* 90: 713–738.
- Allain, J. and Rigaud, A. 1989. "Colles et mastics au Magdalénien". In *Nature et Fonction des Foyers Préhistoriques*, edited by M. Olive and Y. Taborin, 221–223. Nemours: APRAIF Mémoires du Musée de Préhistoire d'Ile-de-France.
- Allain, J. and Rigaud, A. 1992. "Les petites pointes dans l'industrie osseuse de La Garenne: fonction et figuration." *L'Anthropologie* 96: 135–162.
- Ambrose, S.H. 2002. "Small things remembered: origins of early microlithic industries in Sub-Saharan Africa." *Archaeological Papers of the American Anthropological Association* 12: 9–29.
- Arndt, S.H. and Newcomer, M. 1986. "Breakage patterns of prehistoric bone points: an experimental study." In *Studies in the Upper Palaeolithic of Britain and Northwest Europe*, edited by D.A. Roe, 165–173. Oxford: British Archaeological Reports.
- Backwell, L., d'Errico, F. and Wadley, L. 2008. "Middle Stone Age bone tools from the Howiesons Poort layers, Sibudu Cave, South Africa." *Journal of Archaeological Science* 35: 1566–1580.
- Bartram, L.E. 1997. "A comparison of Kua (Botswana) and Hadza (Tanzania) bow and arrow hunting." In *Projectile Technology*, edited by H. Knecht, 321–344. New York: Plenum Press.
- Binneman, J.N.F. 1994. "A unique stone tipped arrowhead from Adam's Kranz Cave, Eastern Cape." *Southern African Field Archaeology* 3: 58–60.
- Bousman, C.B. 2005. "Coping with risk: Later Stone Age technological strategies at Blydefontein Rock Shelter, South Africa." *Journal of Anthropological Archaeology* 24: 193–226.
- Bradfield, J. 2012. "A comparison of three Later Stone Age bone point assemblages from South Africa." *South African Archaeological Bulletin* 67: 32–45.
- Bradfield, J. 2015. "Use-trace analysis of bone tools: a brief overview of four methodological approaches." *South African Archaeological Bulletin* 70: 3–14.
- Bradfield, J. and Brand, T. 2015. "Results of utilitarian and accidental breakage experiments on bone points." *Archaeological and Anthropological Sciences* 7: 27–38.
- Bradfield, J. and Lombard, M. 2011. "A macrofracture study of bone points used in experimental hunting with reference to the South African Middle Stone Age." *South African Archaeological Bulletin* 66: 67–76.
- Brandt, S.A. 1986. "The Upper Pleistocene and early Holocene prehistory of the Horn of Africa." *African Archaeological Review* 4: 41–82.
- Bronk Ramsey, C. 2009. "Bayesian analysis of radiocarbon dates." *Radiocarbon* 51: 337–360.
- Brooks, A.S. and Smith, C.C. 1987. "Ishango revisited: new age determinations and cultural interpretations." *African Archaeological Review* 5: 65–78.
- Buc, N. 2011. "Experimental series and use-wear in bone tools." *Journal of Archaeological Science* 38: 546–557.
- Buisson, D., Fritz, C., Kandel, D., Pincon, G. and Sauvet, G. 1996. "Les contours découpés de têtes de chevaux et leur contribution à la connaissance du Magdalénien moyen." *Antiquités Nationales* 28: 99–128.

- Cain, C.R. 2006. "Implications of the marked artifacts of the Middle Stone Age of Africa." *Current Anthropology* 47: 675–681.
- Chami, F.A. 2009. *Zanzibar and the Swahili Coast from c. 30,000 Years Ago*. Dar es Salaam: E&D Vision Publishing.
- Clark, J.D. 1959. *The Prehistory of Southern Africa*. London: Pelican Books Ltd.
- Clark, J.D. 1977. "Interpretations of prehistoric technology from ancient Egyptian and other sources. Part II: prehistoric arrow forms in Africa as shown by surviving examples of the traditional arrows of the San Bushmen." *Paléorient* 3: 127–150.
- Clotte, J. 1990. *L'Art des Objets au Paléolithique*. Paris: Ministère de la Culture.
- Conkey, M.W. 1980. "The identification of prehistoric hunter-gatherer aggregation: the case of Altamira." *Current Anthropology* 21: 609–630.
- Conkey, M.W., and Gero, J.M. 1997. "Programme to practice: gender and feminism in archaeology." *Annual Review of Anthropology* 26: 411–437.
- Cooke, C.K. 1980. "Wooden and bone artefacts: Pomongwe Cave Matobo District, Zimbabwe." *South African Archaeological Bulletin* 35: 25–29.
- Cooke, C.K. and Robinson, K.R. 1954. "Excavations at Amadzimba Cave, located in the Matopo Hills, Southern Rhodesia." *Occasional Papers of the National Museum of Southern Rhodesia* 19: 699–728.
- d'Errico, F. 1991. "Microscopic and statistical criteria for the identification of prehistoric systems of notation." *Rock Art Research* 8: 83–89.
- d'Errico, F. 1998. "Palaeolithic origins of artificial memory systems: an evolutionary perspective." In *Cognition and Material Culture: The Archaeology of Symbolic Storage*, edited by A.C. Renfrew, and C. Scarre, 19–50. Cambridge: McDonald Institute for Archaeological Research.
- d'Errico, F. and Backwell, L. 2003. "Possible evidence of bone tool shaping by Swartkrans early hominids." *Journal of Archaeological Science* 30: 1559–1576.
- d'Errico, F., Backwell, L., Villa, P., Degano, I., Lucejko, J.J., Bamford, M.K., Higham, T.F.G., Colombini, M.P. and Beaumont, P.B. 2012a. "Early evidence of San material culture represented by organic artifacts from Border Cave, South Africa." *Proceedings of the National Academy of Sciences of the United States of America* 109: 13214–13219.
- d'Errico, F., Backwell, L. and Wadley, L. 2012b. "Identifying regional variability in Middle Stone Age bone technology: the case of Sibudu Cave." *Journal of Archaeological Science* 39: 2479–2495.
- d'Errico, F., Giacobini, G. and Puech, F.-F. 1984. "Varnish replicas. A new method for studying worked bone surfaces." *OSSA International Journal of Skeletal Research* 9/10: 29–51.
- d'Errico, F. and Henshilwood, C.S. 2007. "Additional evidence for bone technology in the southern African Middle Stone Age." *Journal of Human Evolution* 52: 142–163.
- d'Errico, F., Henshilwood, C.S. and Nilssen, P. 2001. "An engraved bone fragment from c. 70,000-year-old Middle Stone Age levels from Blombos Cave, South Africa: implications for the origin of symbolism and language." *Antiquity* 75: 309–318.
- de Heinzelin, J. 1962. "Ishango." *Scientific American* 26: 105–116.
- Deacon, H.J. 1976. *Where Hunters Gathered: A Study of Stone Age People in the Eastern Cape*. Claremont: South African Archaeological Society.
- Deacon, H.J. 1995. "Two Late Pleistocene-Holocene archaeological depositories from the southern Cape, South Africa." *South African Archaeological Bulletin* 50: 121–131.
- Deacon, H.J., Deacon, J., Brooker, M. and Wilson, M.L. 1978. "The evidence for herding at Boomplaas Cave in the southern Cape, South Africa." *South African Archaeological Bulletin* 33: 39–65.
- Deacon, H. J. and Deacon, J. 1999. *Human Beginnings in South Africa: Uncovering the Secrets of the Stone Age*. Cape Town: David Philip.
- Deacon, J. 1978. "Changing patterns in the late Pleistocene/early Holocene prehistory of Southern Africa as seen from the Nelson Bay Cave stone artefact sequence." *Quaternary Research* 10: 84–111.
- Deacon, J. 1984. *The Later Stone Age of Southernmost Africa*. Oxford: British Archaeological Reports.

- Díez-Martín, F., Domínguez-Rodrigo, M., Sánchez, P., Mabulla, A.Z.P., Tarrío, A., Barba, R., Prendergast, M.E. and Luque, L. 2009. "The Middle to Later Stone Age technological transition in East Africa: new data from Mumba Rockshelter Bed V (Tanzania) and their implications for the origin of modern human behavior." *Journal of African Archaeology* 7: 147–173.
- Dobbs, C.M. 1928. "Fishing in the Kavirondo Gulf, Lake Victoria." *Journal of the East African and Uganda Natural History Society* 30: 97–109.
- Dreyer, T.F. 1933. "The archaeology of the Matjes River rock shelter." *Transactions of the Royal Society of South Africa* 21: 187–209.
- Evans, A.A. 2012. "Poisons in the Palaeolithic?" *Proceedings of the National Academy of Sciences of the United States of America* 109: E3290.
- Fagan, B.M. and Van Noten, F.L. 1971. *The Hunter-Gatherers of Gwisho*. Tervuren: Musée Royal de l'Afrique Centrale.
- Fischer, A., Vemming Hansen, P. and Rasmussen, P. 1984. "Macro and micro wear traces on lithic projectile points. Experimental results and prehistoric examples." *Journal of Danish Archaeology* 3: 19–46.
- Fischer, W. and Bianchi, G. 1984. *FAO Species Identification Sheets for Fishery Purposes: Western Indian Ocean (Fishing Area 51)*. Rome: Food and Agriculture Organisation of the United Nations.
- Fisher, J.W. 1995. "Bone surface modifications in zooarchaeology." *Journal of Archaeological Method and Theory* 2: 7–68.
- Fosbrooke, H. 1956. "A Stone Age tribe in Tanganyika." *South African Archaeological Bulletin* 11: 41.
- Glaesel, H. 1997. "Fishers, parks, and power: the socio-environmental dimensions of marine resource decline and protection on the Kenya coast." PhD diss., University of Wisconsin.
- Gliganic, L.A., Jacobs, Z., Roberts, R.G., Domínguez-Rodrigo, M. and Mabulla, A.Z.P. 2012. "New ages for Middle and Later Stone Age deposits at Mumba rockshelter, Tanzania: optically stimulated luminescence dating of quartz and feldspar grains." *Journal of Human Evolution* 62: 533–547.
- Goodwin, A.J.H. 1938. "Archaeology of the Oakhurst Shelter, George." *Transactions of the Royal Society of South Africa* 25: 229–24.
- Graham, M. 1920. *The Victoria Nyanza and its Fisheries*. London: Crown Agents for the Colonies.
- Grottanelli, V.L. 1955. *Pescatori dell'Oceano Indiano: Saggio Etnologico Preliminare sui Bagiumi, Bantu Costieri dell'Oltregiuba*. Roma: Cremonese.
- Henshilwood, C.S., d'Errico, F., Marean, C.W., Milo, R.G., and Yates, R. 2001. "An early bone tool industry from the Middle Stone Age at Blombos Cave, South Africa: implications for the origins of modern human behaviour, symposium and language." *Journal of Human Evolution* 41: 631–678.
- Henshilwood, C.S. and Sealy, J.C. 1997. "Bone artefacts from the Middle Stone Age at Blombos Cave, southern Cape, South Africa." *Current Anthropology* 38: 890–895.
- Hewitt, J. 1921. "Note on a fire-flint of Strandloper origin." *Transactions of the Royal Society of South Africa* 10:49–53.
- Ingrams, W.H. 1931. *Zanzibar: Its History and Its People*. London: Frank Cass.
- Inskeep, R.R. 1987. *Nelson Bay Cave, Cape Province, South Africa: The Holocene Levels*. Oxford: British Archaeological Reports.
- Julien, M. 1982. *Les Harpons Magdaléniens*. Paris: CNRS.
- Klein, R.G. 1987. "Early exploitation of animals." In *The Evolution of Human Hunting*, edited by M. Nitecki, and D. Nitecki, 30–45. London: Plenum Press.
- Klein, R.G. 1999. *The Human Career: Human Biological and Cultural Origins*. Chicago: University of Chicago Press.
- Klein, R.G. 2000. "Archaeology and the evolution of human behaviour." *Evolutionary Anthropology* 9: 17–36.
- Knecht, H. 1991. "Technological innovation and design during the Early Upper Paleolithic: a study of organic projectile technologies." PhD diss., New York University.

- Kohl-Larsen, L. 1958. *Wildbeuter in Ost-Afrika: Die Tindiga, ein Jäger- und Sammlervolk*. Berlin: Dietrich Reimer.
- Langley, M.C. 2013. "Investigating maintenance and discard patterns for Middle to Late Magdalenian antler projectile points: inter-site and inter-regional comparisons. DPhil. diss., University of Oxford.
- Lee, R.B. 1979. *The !Kung San: Men, Women and Work in a Foraging Society*. Cambridge: Cambridge University Press.
- Letourneau, C. and Pétilion, J.M. 2008. "Hunting lesions caused by osseous projectile points: experimental results and archaeological implications." *Journal of Archaeological Science* 35: 2849–2862.
- Lombard, M. 2007. "The gripping nature of ochre: the association of ochre with Howiesons Poort adhesives and Later Stone Age mastics from South Africa." *Journal of Human Evolution* 53: 406–419.
- Lombard, M. 2011. "Quartz-tipped arrows older than 60 ka: further use-trace evidence from Sibudu, KwaZulu-Natal, South Africa." *Journal of Archaeological Science* 38: 1918–1930.
- Lombard, M. and Phillipson, L. 2010. "Indications of bone and stone-tipped arrow use 64 000 years ago in KwaZulu-Natal, South Africa." *Antiquity* 84: 635–648.
- Louw, J.T. 1960. "Prehistory of the Matjes River Shelter." *Memoirs of the National Museum, Bloemfontein* 1: 1–143.
- Marlowe, F. 2010. *The Hadza: Hunter-Gatherers of Tanzania*. Berkeley: University of California Press.
- Marshall, L. 1976. *The !Kung of Nyae Nyae*. Cambridge: Harvard University Press.
- Mazel, A.D. 1988. "Nkupe Shelter: report on excavations in the eastern Biggarsberg, Thukela Basin, Natal, South Africa." *Annals of the Natal Museum* 29(2): 321–377.
- McBrearty, S. and Brooks, A.S. 2000. "The revolution that wasn't: a new interpretation of the origin of modern human behaviour." *Journal of Human Evolution* 39: 453–563.
- Mehlman, M. J. 1989. "Late Quaternary archaeological sequences in northern Tanzania". Ph.D. diss., University of Illinois.
- Mitchell, P.J. 1988. *The Early Microlithic Assemblages of Southern Africa*. Oxford British Archaeological Reports.
- Mitchell, P.J. 1995. "Revisiting the Robberg: new results and a revision of old ideas at Sehonghong Rock Shelter, Lesotho." *South African Archaeological Bulletin* 50: 28–38.
- Mitchell, P.J. 1996. "Sehonghong: the late Holocene assemblages with pottery." *South African Archaeological Bulletin* 163: 17–25.
- Mitchell, P.J. 2002. *The Archaeology of Southern Africa*. Cambridge: Cambridge University Press.
- Mitchell, P.J. 2012. "San origins and transition to the Later Stone Age: new research from Border Cave, South Africa." *South African Journal of Science* 108: 1–2.
- Neuwinger, H.D. 1996. *African Ethnobotany: Poisons and Drugs: Chemistry, Pharmacology, Toxicology*. London: Chapman and Hall.
- Newcomer, M.H. 1974. "Study and replication of bone tools from Ksar Akil (Lebanon)." *World Archaeology* 6: 138–153.
- Oosthuizen, M. 1977. "The description of an unusual hunting kit considered to be of Southern Bushman origin." *Annals of the Natal Museum* 23: 75–85.
- Opperman, H. 1987. *The Later Stone Age of the Drakensberg Range and its Foothills*. Oxford: British Archaeological Reports.
- Pakenham, R.H.W. 1984. *The Mammals of Zanzibar and Pemba Islands*. Harpenden.
- Pargeter, J. and Bradfield, J. 2012. "The effects of Class I and II sized bovids on macrofracture formation and tool displacement: results of a trampling experiment in a southern African Stone Age context." *Journal of Field Archaeology* 37: 238–251.
- Pétilion, J.-M. 2006. *Des Magdaleniens en Arms. Technologie des Armatures de Projectile en Bois de Cervide du Magdalenien Supérieur de la Grotte d'Isturitz (Pyrenées-Atlantiques)*. Treignes: Centre d'Etudes et de Documentation Archéologiques.
- Poggenpoel, C.A. and Robertshaw, P.T. 1981. "The excavation of Smitswinkelbaai Cave, Cape Peninsula." *South African Archaeological Bulletin* 36: 29–35.

- Prendergast, M.E. 2008. "Forager variability and transitions to food production in secondary settings: Kansyore and Pastoral Neolithic economies in East Africa." PhD diss., Harvard University.
- Prins, A.H.J. 1965. *Sailing from Lamu: A Study of Maritime Culture in Islamic East Africa*. Assen: Van Gorcum.
- Robertshaw, P.T. 1991. "Gogo Falls. Excavations at a complex archaeological site east of Lake Victoria." *Azania* 26: 64–195.
- Robertshaw, P.T., Collett, D., Gifford, D. and Mbae, N.B. 1983. "Shell middens on the shores of Lake Victoria." *Azania* 18: 1–43.
- Rudner, J. 1979. "The use of stone artefacts and pottery among the Khoisan peoples in historic and protohistoric times." *South African Archaeological Bulletin* 34: 3–17.
- Schapera, I. 1925. "Bushman arrow poisons." *Bantu Studies* 2: 199–214.
- Schapera, I. 1927. "Bows and arrows of Bushmen." *Man* 71/72: 113–117.
- Schapera, I. 1930. *The Khoisan Peoples of South Africa*. London: George Routledge and Sons Ltd.
- Schweitzer, F.R. 1979. "Excavations at Die Kelders, Cape Province, South Africa, the Holocene deposits." *Annals of the South African Museum* 78: 101–233.
- Schweitzer, F.R. and Wilson, M.L. 1982. "Byneskranskop 1. A late Quaternary living site in the southern Cape Province, South Africa." *Annals of the South African Museum* 88: 1–203.
- Silberbauer, G.B. 1981. *Hunter and Habitat in the Central Kalahari Desert*. Cambridge: Cambridge University Press.
- Sinclair, P.J.J., Juma, A., and Chami, F. 2006. "Excavations at Kuumbi Cave on Zanzibar in 2005." *Studies in the African Past* 5: 95–106.
- Singer, R. and Wymer, J. 1982. *The Middle Stone Age at Klasies River Mouth in South Africa*. Chicago: University of Chicago Press.
- Smith, A.B. and Poggenpoel, C.A. 1988. "The technology of bone tool fabrication in the south-western Cape, South Africa." *World Archaeology* 20: 103–114.
- Smith, M.M. and Heemstra, P.C. 1986. *Smiths' Sea Fishes*. Berlin: Springer.
- Spector, J.D. 1993. *What This Awl Means. Feminist Archaeology at a Wahpeton Dakota Village*. St Paul: Minnesota Historical Society Press.
- Steyn, H.P. 1971. "Aspects of economic life of some of the nomadic Nharo Bushman groups." *Annals of the South African Museum* 56: 275–322.
- Stow, G.W. 1905. *The Native Races of South Africa*. London: Swan Sonnenschein & Co. Ltd.
- Tyzzar, E.E. 1936. "The 'simple bone point' of the shell-heaps of the northeastern Algonkian area and its probably significance." *American Antiquity* 1: 261–279.
- Van Noten, F.L. 1974. "Excavations at the Gordon's Bay shell midden, south-western Cape." *South African Archaeological Bulletin* 29: 122–142.
- van Riet Lowe, C. 1954. "An interesting Bushman arrowhead." *South African Archaeological Bulletin* 35: 88.
- Van Rippen, B. 1918. "Notes on some Bushman implements." *Memoirs of the American Anthropological Association* 5: 75–97.
- Villa, P. and d'Errico, F. 2001. "Bone and ivory points in the Lower and Middle Palaeolithic of Europe." *Journal of Human Evolution* 41: 69–112.
- Villa, P., Soressi, M., Henshilwood, C.S. and Mourre, V. 2009. "The Still Bay points of Blombos Cave (South Africa)." *Journal of Archaeological Science* 36: 441–460.
- Villa, P., Soriano, S., Teyssandier, N., and Wurz, S. 2010. "The Howiesons Poort and MSA III at Klasies River main site, Cave 1A." *Journal of Archaeological Science* 37: 630–655.
- Wadley, L. 1979. "Big Elephant Shelter and its role in the Holocene prehistory of central South West Africa." *Cimbebasia B* 3(1): 1–76.
- Wadley, L. 1987. *Later Stone Age Hunter-Gatherers of the Southern Transvaal: Social and Ecological Interpretations*. Oxford: British Archaeological Reports.
- Wadley, L. 2000a. "The early Holocene layers at Rose Cottage Cave, eastern Free State: technology, spatial patterns and environment." *South African Archaeological Bulletin* 55: 18–31.
- Wadley, L. 2000b. "The Wilton and Pre-Ceramic Post-Classic Wilton industries at Rose Cottage Cave and their context in the South African sequence." *South African Archaeological Bulletin* 55: 90–106.

- Walsh, M.T. 2007. "Island subsistence: hunting, trapping and the translocation of wildlife in the Western Indian Ocean." *Azania* 42: 83–113.
- Webley, L. 1994. "A short note on the Namaqualand diary entries of W.G. Atherstone relating to Bushmen bows and arrows." *Southern African Field Archaeology* 3: 60–62.
- Wendt, W.E. 1972. "'Art mobilier' aus der Apollo 11-Grotte in Südwest-Afrika: die ältesten datierten Kunstwerke Afrikas." *Acta Praehistorica et Archaeologica* 5: 1–42.
- Wendt, W.E. 1976. "Art mobilier from the Apollo 11 Cave, southwest Africa: Africa's oldest dated works of art." *South African Archaeological Bulletin* 31: 5–11.
- Wiessner, P. 1983. "Style and social information in Kalahari San projectile points." *American Antiquity* 48: 253–276.
- Williams, R.O. 1949. *The Useful and Ornamental Plants in Zanzibar and Pemba*. Zanzibar: Zanzibar Protectorate.
- Williams, A., Mwinyi, A.A. and Ali, S.J. 1996. "A population survey of the mini-antelope — Ader's duiker (*Cephalophus adersi*), Zanzibar blue duiker (*Cephalophus monticola sundevalli*), Suni (*Neotragus moschatus moschatus*) — of Unguja, Zanzibar." Zanzibar: Zanzibar Forestry Technical Paper 27, Commission for Natural Resources, Zanzibar.
- Woodburn, J. 1970. *Hunters and Gatherers: Material Culture of the Nomadic Hadza*. London: The British Museum.
- Yaroshevich, A., Kaufman, D., Nuzhnyy, D., Bar-Yosef, O. and Weinstein-Evron, M. 2010. "Design and performance of microlithic implemented projectiles during the Middle and Late Epipaleolithic of the Levant: experimental and archaeological evidence." *Journal of Archaeological Science* 37: 368–388.
- Yellen, J.E. 1977. *Archaeological Approaches to the Present: Models for Reconstructing the Past*. New York: Academic Press.
- Yellen, J.E. 1998. "Barbed bone points: tradition and continuity in Saharan and Sub-Saharan Africa." *African Archaeological Review* 15: 173–198.