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Ma'anshan cave and the origin of bone tool technology in China

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ABSTRACT

Here we present the results of a techno-functional analysis of 17 bone tools recovered from strata 6, 5 and 3 of the Palaeolithic site of Ma'anshan Cave, Guizhou Province, southern China. Stratum 6, dated to c. 35 cal kyr BP, has yielded three sharp awls. From Stratum 5, dated to c. 34 cal kyr BP, come six probable spear points, awls and a cutting tool. Separated from these layers by a sterile horizon, Stratum 3, dated 23 cal kyr BP to 18 cal kyr BP, has yielded barbed points of two types. Bone tools were shaped by scraping, grinding, and in strata 5 and 3, finished by polishing. Ma'anshan Cave records the oldest formal bone tools from China, and amongst the oldest known evidence of indisputable barbed point manufacture outside Africa. Change in the hunting toolkit between strata 5 and 3 may indicate a shift in prey preference from medium to small size mammals and fish, which needs to be verified by supplementary analyses. The significance of this evidence is discussed in the context of what is known about the origin of bone tool technology in Africa and Eurasia.

1. Introduction

The use of bone as a raw material for the production of various artefact categories has a long and ancient history, particularly in Africa. Early instances of bone technology in other areas of the Old World such as China, are however still rare, and those that are known are often insufficiently documented. This paper aims at filling this gap by reviewing current evidence from this part of the world, and documenting changes in bone technology at the key site of Ma'anshan Cave, South China.

The production of formal bone tools, defined as artefacts that were cut, carved, polished or otherwise modified to produce fully shaped points, awls, harpoons and wedges (Klein, 1999; McBrearty and Brooks, 2000), appears relatively late in human history, and is only recorded at a handful of African sites prior to 45 ka. Examples of formal bone tool production in Africa come mostly from coastal or near-coastal South African Middle Stone Age (MSA) sites, including Blombos Cave, (d'Errico and Henshilwood, 2007; Henshilwood et al., 2001), Klasies River (d'Errico and Henshilwood, 2007), Sibudu Cave (Backwell et al., 2008; d'Errico et al., 2012a), and Border Cave (Backwell et al., 2008; d'Errico et al., 2012a). A point tip, a mesial fragment, an almost complete spear point, a tanged bone point and 26 awls are reported from M1 and M2 layers at Blombos Cave, with ages of ~84–72 ka (Henshilwood et al., 2001). A single massive point was recovered in the dune sand layer, with an age of ~70 ka (d'Errico and Henshilwood, 2007). An awl comes from the Blombos M3 phase, with an age of 98.9 ± 4.5 ka (Jacobs et al., 2006). A single bone point was discovered at Klasies River in layer 19 of Shelter 1a at the base of the Howiesons Poort layers of this site, dated to approximately 70 ka (d'Errico and Henshilwood, 2007). Twenty-three pins, notched pieces, smoothers, *pièces esquillées*, pressure flakers, projectile points, awls and wedges have recently been reported at Sibudu Cave in archaeological layers spanning 77–72 ka to 38 ka (d'Errico et al., 2012b). Tusks of warthog or bushpig, first split and subsequently worked by grinding and scraping to produce robust awls and projectile points, were recovered at Border Cave from layers dated to between 60 ka and 42 ka (d'Errico et al., 2012a). In

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North Africa, complete or longitudinally split ribs of large herbivores, thinned by scraping and grinding, come from layer 5 of El Mnasra, dated by optically stimulated luminescence (OSL) to 107 ± 6.6 and 106 ± 6.6 kya (Campmas et al., 2015; Jacobs et al., 2012). In the interior of Africa, barbed and un-barbed bone points, interpreted as harpoons, were retrieved from the Katanda sites, located in the Semliki Valley, Democratic Republic of the Congo (Brooks et al., 1995; Yellen et al., 1995). They are attributed an age of ~90–60 ka based on Electron Spin Resonance (ESR), Thermoluminescence (TL), and OSL dating methods (Feathers and Migliorini, 2001). White Paintings Rock Shelter in Botswana has recently produced ancient bone arrow points, OSL dated from their association with sediments to between 37 ka and 35 ka (Robbins et al., 2012).

A reappraisal of the Border Cave material culture has shown that the suite of complex and varied technical and symbolic items that characterize recent Later Stone Age (LSA) and historical San material culture was in place 44 cal kyr BP (d'Errico et al., 2012; Villa et al., 2012). Items include bone points identical to San poisoned arrow heads, one of which is incised with a mark of ownership. A notched stick similar to San poison applicators, directly dated to 24 cal kyr BP, retains residues of a heated toxic compound. At about the same time, the production of formal bone tools became an inherent component of European and West Asian hunter-gatherer toolkits, as documented in Châtelperronian, Uluzzian, Proto- and Early Aurignacian sites (d'Errico et al., 2012c; d'Errico et al., 2003; Conard and Bolus, 2006; Tartar, 2009). Firm evidence of worked, and in some cases decorated, bone awls come from Châtelperronian and Uluzzian sites in France and Italy, dated 44–40 cal kyr BP (d'Errico et al., 2012c; d'Errico et al., 2003). Rich and varied arrays of fully shaped tools made of antler, bone, and ivory are associated with the Early Aurignacian of Europe, between 40 cal kyr BP and 35 cal kyr BP (d'Errico and Banks, 2014).

1.1. Asian bone tools and the "behavioural modernity' debate

Sites with formal bone tools predating 44 cal kyr BP present a challenge to those (Klein, 2009; Conard and Bolus, 2003, 2006) who consider the production of formal bone tools, together with the production of personal ornaments, engravings, depictional art, etc., as the outcome of a sudden change in human cognition. If such was the case, why then have MSA sites yielded evidence of complex bone technology? Why is no regional continuity observed, with more recent sites in the same areas not recording any bone tools? Why is bone tool technology predating 44 cal kyr BP virtually absent from most of North Africa, where other aspects of 'modernity' such as personal ornaments and use of pigment are attested very early? Some authors argue that the emergence of key cultural innovations in our lineage, including complex bone technology, is not the direct consequence of the emergence of anatomically modern humans in Africa. The emergence, disappearance, and re-emergence of behavioural innovations among both African and Eurasian populations should instead be attributed to demographic and social events, triggered partially by climatic factors (Backwell et al., 2008; d'Errico, 2003; d'Errico and Banks, 2013; d'Errico and Stringer, 2011; Hovers and Belfer-Cohen, 2006; Powell et al., 2009). For these authors, the evolution of human societies in the last 300 ka has followed many paths, not necessarily progressive or incremental in nature, in which the material expression of modern cognition is represented by different mosaics of cultural innovation, which need to be understood and traced at a regional scale. In this respect, documenting the emergence and type of cultural innovations recorded in Asia is key to gaining a better understanding of the distribution of evidence of complex cognition in the archaeological record, to gauge where it emerged, and the mechanisms behind its origin(s) and spread.

Evidence for a Late Pleistocene bone tool technology is found in Southeast Asia at 12 sites (Piper and Rabett, 2009; Rabett, 2005; Rabett and Piper, 2012). At two sites, Niah Caves (Hell) and Lang Rongrien, the tools, consisting of worked suid canines, bone points, and bone notched to apply a groove-and-snap technique, are found in layers dated to between 45 cal kyr BP and 42 cal kyr BP. Ten other sites (Xom Trai, Liang Lemdubu, Gua Balambangan, Niah Caves (Area A, Lobang Hangus, Gua Braholo, Hang Boi, Gua Musang, Moh Khiew, Agop Atas, Agop Sarapad, Con Moong), dated between 22 cal kyr BP and 12 cal kyr BP, have yielded worked pig tusks, awls, projectile armatures, hafted bevelled implements, and long bones reduced by the groove-and-snap technique. Both scraping and grinding techniques are attested. A broken butt of a formerly hafted projectile point, found in a layer dated to c. 35 cal kyr BP at Matja Kuru 2, on the island of Timor, preserves evidence of complex hafting consisting of closely spaced notches (O'Connor et al., 2014). In addition, a large bone point assemblage is reported from the Sri Lankan site of Batadomba-lena, dated to 35.9 cal kyr BP (Perera, 2010; Perera et al., 2011), and at more recent sites from this region. An object interpreted as a fragment of harpoon, but bearing no compelling evidence of manufacture, comes from layers dated to c. 35 cal kyr BP at Jwalapuram Locality 9, southern India (Clarkson et al., 2009). Bone technology is attested in Siberia from at least 42 cal kyr BP as demonstrated by various categories of artefacts from Denisova Cave layers 9 and 11 (Derevianko, 2010).

The origin of complex bone tool technologies in China represents a good example of the uncertainties still surrounding the early instances of a crucial modern feature in a key region of the world. In their recent review of the archaeological signatures of modern human behaviour in China, Norton and Jin (2009) consider art and symbolism, burials, specialized stone tools, long-distance exchange networks, seafaring, and adaptation to high altitudes, but not complex bone technology. The reason for this lies in the reliability of available information. Discoveries of bone implements are reported at dozens of Palaeolithic sites from this region (Mao and Cao, 2012 and references therein), but very few of the purported bone tool industries have been described in detail and submitted to technological and functional analyses. Conclusive evidence for the production of formal bone tools in northern China comes from Zhoukoudian Upper Cave (Pei, 1939), Xiaogushan (Huang et al., 1986; Zhang et al., 1985, 2010a) and the newly discovered Shuidonggou Locality 12 (Pei et al., 2012; Yi et al., 2013), while sites from southern China include Chuandong (Mao and Cao, 2012; Zhang, 1995), Maomaodong (Cao, 1982) and Zhadong (Chen et al., 2004). Here we present the first systematic analysis of the Late Pleistocene bone industry from the site of Ma'anshan, Guizhou Province, South China, a multi-layered archaeological sequence that has yielded a varied array of well-preserved formal bone artefacts from different archaeological horizons. Our aim is to document the stratigraphic provenance and chronology of these artefacts, identify and describe bone-manufacturing techniques, and discuss the significance of this material for the emergence of modern cultures in Asia.

2. Background to the Ma'anshan site

Ma'anshan Cave is located 2 km southeast of Tongzi County, northwest Guizhou Province (Fig. 1). The cave lies at an altitude of 960 m above sea level, and 40 m above the nearby Tianmen River. Ma'anshan Cave was systematically excavated in 1986 and 1990 by a team from the Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, led by Zhang in 1986, and by Long in 1990 (Long, 1992). An approximately rectangular area of 25 m^2 was excavated to a depth of ca. 2.20 m in 1986 in the eastern part of the