



Nassarius kraussianus shell beads from Blombos Cave: evidence for symbolic behaviour in the Middle Stone Age

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Abstract

Since 1991, excavations at Blombos Cave have yielded a well-preserved sample of faunal and cultural material in Middle Stone Age (MSA) levels. The uppermost MSA phase, M1, is dated to c. 75 ka by optically stimulated luminescence (OSL) and thermoluminescence, and the middle M2 phase to a provisional c. 78 ka. Artefacts unusual in a MSA context from these phases include bifacial points, bone tools, engraved ochre and engraved bone. In this paper, we describe forty-one marine tick shell beads recovered from these MSA phases and tick shell beads from Later Stone Age (LSA) levels at Blombos Cave and the Die Kelders site. Thirty-nine shell beads come from the upper M1 phase and two from M2. Morphometric, taphonomic and microscopic analysis of modern assemblages of living and dead tick shell demonstrate that the presence of perforated *Nassarius kraussianus* shells in the Blombos MSA levels cannot be due to natural processes or accidental transport by humans. The types of perforation seen on the MSA shells are absent on modern accumulations of dead shells and not attributable to post-depositional damage. Their location, size, and microscopic features are similar to those obtained experimentally by piercing the shell wall, through the aperture, with a sharp bone point. Use-wear, recorded on the perforation edge, the outer lip, and the parietal wall of the aperture indicates the shells having being strung and worn. MSA shell beads differ significantly in size, perforation type, wear pattern and shade compared to LSA beads and this eliminates the possibility of mixing across respective levels.

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Thirty-one beads were found in four groups of five to twelve beads, each group being recovered in a single square or in two adjacent sub-squares during a single excavation day. Within a group, shells display a similar shade, use-wear pattern and perforation size suggesting their provenance from the same beadwork item, lost or disposed during a single event. The likely symbolic significance of these finds suggests levels of cognitively modern behaviour not previously associated with MSA people.

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Introduction

Human remains from Herto, Ethiopia demonstrate that *Homo sapiens* in Africa was anatomically modern at 160 ka (White *et al.*, 2003), but the debate continues over when and where humans first became behaviourally modern.

Four contradictory models of human cognitive evolution are proposed to account for the emergence of modern traits. First, a cultural “revolution” linked to anatomically modern humans (AMH) in Europe at c. 40 ka and coinciding with the first arrival of our species in these regions (Stringer & Gamble, 1993; Mellars, 1996; Mithen, 1996; Bar-Yosef, 1998, 2002; Conard & Bolus, 2003). The sudden character of this change is demonstrated by the appearance in the archaeological record of a previously unseen production of carvings, personal ornaments, and musical instruments, depictions on cave walls, new stone and bone technology. A second model describes behavioural modernity resulting from a rapid biological change – a brain mutation that produces no apparent modification of the skull anatomy. This mutation, the authors suggest, most probably took place in Africa at c. 50,000 years ago (Klein, 1995, 1999, 2000; Klein & Edgar, 2002; cf. Ambrose, 1998, and Wadley, 2001, 2003, for the archaeological counterpart of this hypothesis).

A third scenario considers behavioural modernity as the outcome of a gradual process taking place in Africa (McBrearty & Brooks, 2000; cf. also Barham, 1998, 2002; Watts, 1999; Henshilwood *et al.*, 2002; Henshilwood & Marean, 2003). This accounts for the technological and material culture changes observed through the African Middle Stone Age (MSA) starting at c. 250 ka, at the very end of the Acheulean, and continuing

until the transition from the MSA to the Later Stone Age (LSA) at c. 40–30 ka. The fourth model acknowledges an early gradual emergence of modern behaviour in Africa but the authors argue that comparable trends are also detected in contemporary or later Neandertal material culture from Europe and the Near East (d'Errico *et al.* 1998; Zilhão, 2001, d'Errico, 2003; Zilhão & d'Errico, 2003a,b). This suggests that the traits defining behavioural modernity are not peculiar to AMH and may have arisen over a long period among different human populations.

Most of these authors caution on the criteria used to identify modernity in the archaeological record. Symbolically mediated behaviour, however, has emerged as one of the few unchallenged and universally accepted markers of modernity (Chase & Dibble, 1987; McBrearty & Brooks, 2000; Wadley, 2001; d'Errico, 2003; Klein & Edgar, 2002; Hovers *et al.*, 2003; Henshilwood & Marean, 2003; d'Errico *et al.*, 2003). The core of the debate focuses on how symbolism is reliably recognized in an ancient artefact (Wadley, 2001; Henshilwood & Marean, 2003). A key characteristic of all symbols is that their meaning is assigned by arbitrary, socially constructed conventions (Chase & Dibble, 1987). Perhaps the greatest benefit of symbolically mediated behaviour is that it permits the storage and display of information external to the human brain (Donald, 1991; Wadley, 2001; Henshilwood & Marean, 2003; Hovers *et al.*, 2003). It is notable that in all the above models, personal ornaments and art are unquestioned expressions of symbolism that equate with modern human behaviour.

The earliest unresolved evidence for bead use comes from the c. 90 ka Mousterian levels at Qafzeh Cave in Israel (Taborin, 2003). Four *Glycymeris* shells from the site with natural

perforations and ochre traces may be beads, or alternately pigment containers.

The oldest personal ornaments from Eurasia, generally used to endorse the first model, includes c. 43 ka perforated teeth from Bacho Kiro in Bulgaria (Kozłowski, 2000) and c. 41 ka marine shell beads from Üçağızlı in Turkey (Kuhn et al., 2001). Less precisely dated are shell beads from Ksar' Akil in Lebanon (Mellars & Tixier, 1989) stratigraphically lying between layers dated to c. 43.75 ka and 32 ka BP. At Kostienki 14 (Markina gora), a *Columbella* shell with two holes has been recovered from a level with radiocarbon dates of 36.5 ka and 32.6 ka BP (Sinitsyn, 2003). Ostrich eggshell beads have been recently signaled at the Mongolian site of Dörölj 1 (Jaubert et al., 2004) and perforated teeth at that of Kara Bom, Altai region (Derevianko & Rybin, 2003). Both finds come from levels attributed to the Early Upper Palaeolithic. In Western Europe the dating for the oldest beads is controversial. Conard & Bolus (2003) attribute an age of 40 ka BP to the earliest Aurignacian sites from the Swabian Jura and the associated beads, but Zilhão & d'Errico (2003a,b) consider a post 36 ka BP date more plausible. Support for the fourth model comes from evidence that Chatelperronian and Uluzzian Neandertals from Western Europe produced and wore a variety of personal ornaments (d'Errico et al., 1998; Zilhão & d'Errico, 2003a,b). *Dentalium* sp. shells come from the Uluzzian layers of Klisoura cave, Greece (Koumouzelis et al., 2001). The same shell species as well as *Natica* sp., *Trochus* sp. and *Glycymeris* sp. shells were recovered from the contemporaneous site of Grotta del Cavallo in the south of Italy (Palma di Cesnola, 1993). The Uluzzian layers of Castelcivita, in the same area, yielded a *Pecten* sp. shell (Palma di Cesnola, 1993). In France, a varied collection of perforated or gouged beads is reported from the Chatelperronian layers of Grotte du Renne, in the Yonne region. These comprise eight fox canines, four bovid incisors, three reindeer incisors, two bear incisors, two marmot incisors, one red deer canine, five bone pendants, three ivory beads and two fossil belemnites (Leroi-Gourhan & Leroi-Gourhan, 1965; d'Errico et al., 1998, White, 2000). Perforated wolf, fox and red deer

canines were also found in the Chatelperronian layers of Quinçay cave (Granger & Lévêque, 1997), a perforated fox canine at the eponymous site of Chatelperron (White, 2000). Bovid incisors and an ivory ring come from the contemporary layers at Roche au Loup (White, 2000), a bear incisor and a *Pecten* sp. shell from the Trilobite cave (Taborin, 1993), a *Turitella* sp. shell from Cauna de Belvis cave (Taborin, 1993). *Dentalium* sp. shells may come from Saint-Césaire (Lévêque in d'Errico et al., 1998), and a carnivore canine, identified as a lynx canine, from Roc de Combe (de Sonneville-Bordes, 2002).

Personal ornaments, often cited as support for the second model above, are reported from eight South and East African MSA sites. A complete and an unfinished ostrich eggshell bead (OESB) come from the OLP member of Boomplaas, Cape Province (Deacon, 1995). Three ^{14}C dates, one U/Th, and one amino acid racemization (AAR) date are available for this member. Two ^{14}C dates on charcoal give an age of > 40 ka (UW 305) (Fairhall et al., 1976) and 37.4 ± 1.37 ka (Pta-1811) (Vogel, 2000) respectively; the third ^{14}C date, obtained from a speleothem, provides an age of 31.68 ± 5.5 ka (Pta-2302) (Vogel, 2000). The U/Th dating, also on speleothem, gives 35.2 ± 2.6 ka (U-366) (Vogel, 2000). Dating by AAR on an ostrich eggshell fragment gives an age of 44 ± 4 ka (Miller et al., 1999). A fragment of a stone ring made of micaceous schist comes from a MSA layer at Zombepata cave, Zimbabwe (Cooke, 1971). The weight (28 g) and small size of the fragment, now a third of the original object, contradicts its use as a digging stick weight and suggests rather its use as an ornament. The ^{14}C date for this layer, 40.72 ± 1.62 ka BP (SR 190) (Cooke, 1971), should probably be considered as a minimum age. A second similar fragment was found in an undated deeper layer from the same site.

OESB's and OESB come from undated MSA contexts at Bushman Rock Shelter (Plug, 1982), and Cave of Hearths (Mason, 1962, 1993; Mason et al., 1988). Two OESB's are recently reported from the MSA site of Loiyangalani, Tanzania (Thompson et al. 2004) for which no radiometric dating is so far available. OESB are found also at Border Cave in "Early LSA" layers (Beaumont

et al., 1978). The twenty-four ^{14}C dates from these layers, ranging between 33 ka and 39.8 ka, are consistent with ESR dates for the same layers (Grün & Beaumont, 2001).

Two other sites in East Africa, Kisele II (Inskeep, 1962) and Mumba (Mehlman, 1989, 1991; Brooks & Robertshaw, 1990), have yielded OESB's associated with transitional MSA/LSA lithic industries. Radiocarbon dating of an ostrich eggshell from the former site gave an age of 31.48 ka BP (Deacon, 1995); direct AMS ^{14}C dates on beads from the latter site range between 29 ka and 33 ka (Conard, in press) while bone and snails from the same layer range between 29.57 ± 1.4 ka and > 37 ka BP (Mehlman, 1989, 1991). An older age for this layer (46.6 - 65.6 ka) is indicated by U/Th dating of bone (Mehlman, 1989, 1991) and AAR (52 ka) on OESB (Hare et al., 1993).

At the Kenyan site of Enkapune Ya Muto, 13 complete OESB's, 12 perforated OESB preforms, and 593 ostrich eggshell fragments were found in a stratigraphical unit (DBL1) containing an "Early LSA" lithic assemblage (Ambrose, 1998; Klein & Edgar, 2002). The ^{14}C date obtained from one fragment, 39.9 ± 1.6 ka BP (Pta-4889 F2), consistent with those from the enclosing archaeological layers, convincingly supports the view of an East African bead-working tradition dating back to at least 40 ka BP. In North Africa, a perforated *Nassarius gibbosulus* comes from the Aterian levels of Oued Djebanna, Algeria (Morel, 1974). The oldest securely dated personal ornaments from Asia and Oceania are the twenty-two *Conus* sp. shells and modified fragments (Morse, 1993) from Mandu Mandu Creek rock-shelter, Western Australia, coming from a layer dated to between 35.2 ± 1 (Wk-1513) and 30.9 ± 0.8 ka (Wk-1576).

In a recent article (Henshilwood et al., 2004) we report on marine shells manufactured into beads by MSA populations at Blombos Cave, South Africa at c. 75 ka. Brevity did not permit the inclusion of contextual data and other findings that supports our interpretation. In an accompanying article, in the same journal, Klein and White (cited in Holden, 2004) question the anthropogenic origin of the perforations and use-wear on these beads. In this paper, we address these questions and present the full suite of evidence supporting our contentions.

Archaeological context and dating

Blombos Cave (BBC) is located 300 km east of Cape Town at $34^{\circ}24.857'S$, $21^{\circ}13.371'E$ on the southern Cape shoreline of the Indian Ocean (Fig. 1a). The cave is 34.5 m above sea level, some 100 m from the ocean, and formed during Plio-Pleistocene wave cutting of the calcarenite cliff that lies above a basal layer of Table Mountain Sandstone of the Cape Supergroup. Deposits within the cave extend over about 50 m^2 with a further 18 m^2 of deposit forward of the drip line. Excavations extend over seven field seasons between 1991–2004 (Fig. 1b). Aeolian dune sand, 5–50 cm thick (Fig. 1c), separates the < 2 ka LSA layers from the uppermost MSA phase (Henshilwood et al., 2001a,b). Optically stimulated luminescence (OSL) signals from single aliquots and 1,892 individual quartz grains were measured on three samples from this Hiatus dune layer. This gave ages of 69.2 ± 3.9 ka, 69.6 ± 3.5 ka and 70.9 ± 2.8 ka (Jacobs et al., 2003a).

The top MSA phase, M1, contains more than 400 bifacially worked lanceolate points, the *fossile directeur* of the Still Bay Industry (Goodwin & Van Riet Lowe, 1929), at least ten bone tools and one bone fragment bearing longitudinal engraved lines (d'Errico et al., 2001). Hundreds of pieces of ochre came from this layer of which at least two are deliberately engraved with an abstract cross-hatched pattern (Henshilwood et al., 2002). A further seven engraved ochre pieces are under study. Two quartz samples from the M1 phase yielded a combined OSL age of 75.6 ± 3.4 ka based on measurements from both single aliquots and 4,800 individual quartz grains (Henshilwood et al., 2004). Thermoluminescence (TL) dates for five burnt lithic samples from the M1 phase have provided ages ranging between 67 ± 7 ka and 82 ± 8 ka with a mean of 77 ± 6 ka (Henshilwood et al., 2002; Tribolo, 2003).

The M2 phase contains at least twenty shaped bone tools and few bifacial points (Henshilwood et al., 2001b). Two burnt lithic samples from M2 provided TL dates of 76 ± 7 ka and 105 ± 9 ka (Tribolo, 2003). A provisional OSL date for the M2 phase is 78 ka and dates for the M3 phase are likely greater than 100 ka (Jacobs, pers. comm.).

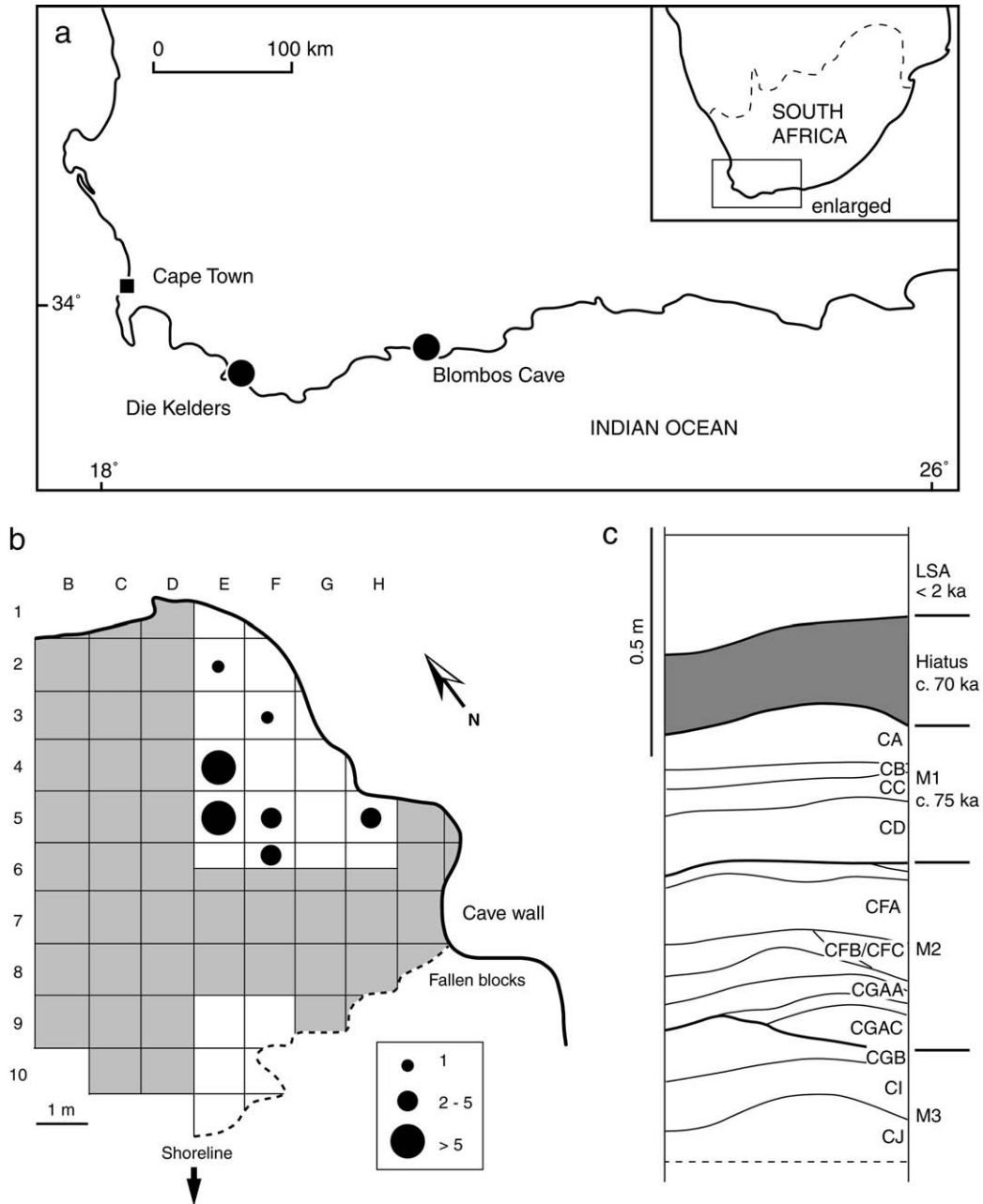


Fig. 1. (a) location of Blombos Cave and Die Kelders; (b) map of the excavated area (white) with density of MSA shell beads per m²; (c) stratigraphy of Blombos Cave in square H6.

M3 is predominantly a dense shell midden although marine shells occur in relatively high quantities in all the MSA phases. More than 8,000 pieces of ochre, often modified by scraping and

grinding, occur throughout the sequence with the highest concentrations in phase M3. Recovered faunal remains indicate that subsistence strategies of the MSA people were wide ranging and

included hunting large and small mammals, shellfishing, obtaining marine mammals perhaps by hunting and/or scavenging, and catching large fish and reptiles (Henshilwood *et al.*, 2001a).

In the MSA levels at BBC forty-one perforated *Nassarius kraussianus* (Dunker) shell beads were recovered during 1992–2002 (Fig. 2). Thirty-nine shell beads come from the upper MSA phase, M1, two derive from the M2 phase (Fig. 1c, Table 1). All the M1 levels yielded beads and those from M2 come from the uppermost level, CF. Beads came from seven out of the twenty excavated squares (Fig. 1b). During the course of excavations

between 1992–2004 the excavated matrix from each quadrat was dry or water sieved through a 1.5 mm grid and the beads not recovered *in situ* were later retrieved during sorting of the sieved fraction. The exception is some yet to be sieved and sorted material recovered in 2000, 2002 and 2004. Some MSA stratigraphic units recovered adjacent to the rear cave wall were contaminated with LSA material (Henshilwood *et al.*, 2001b: 639–40) and these units were discarded when attributing shell beads to MSA levels.

Half of the shell beads recovered from the M1 phase come from square E4 and a quarter from

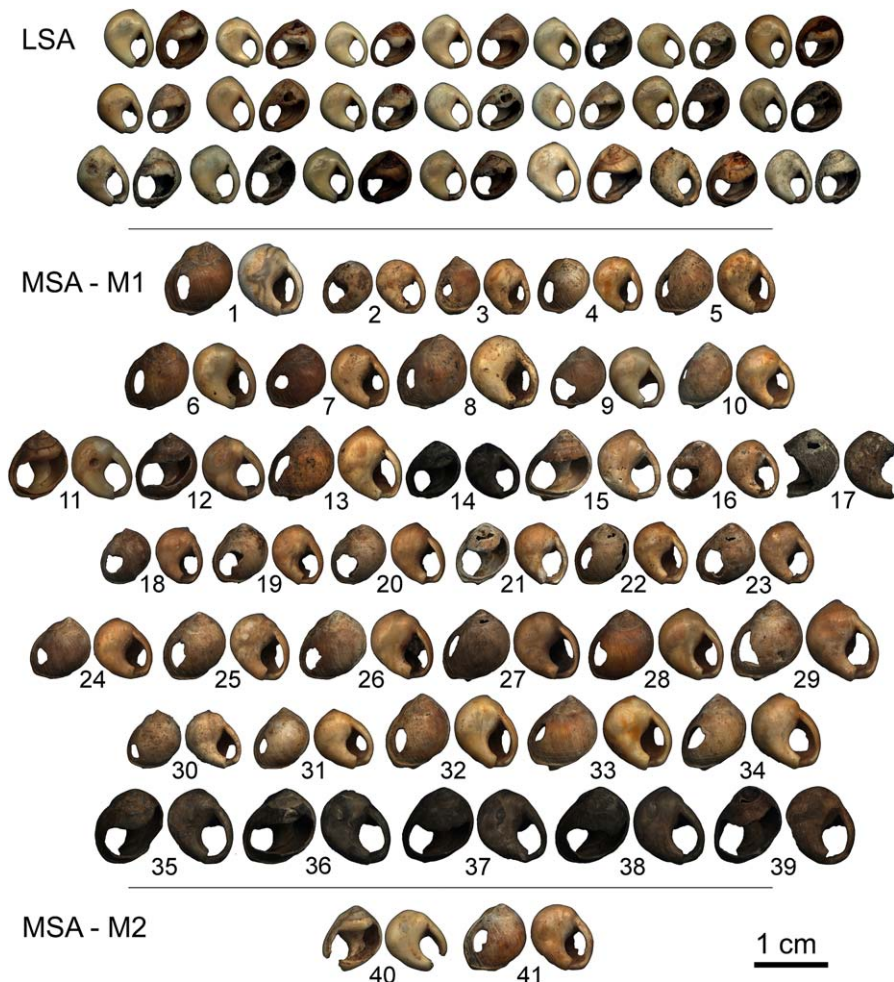


Fig. 2. Perforated *Nassarius kraussianus* beads from LSA layers and MSA Phases M1 and M2 at Blombos Cave. Numbers refer to Table 1.

Table 1

Contextual and descriptive data on *Nassarius kraussianus* shell beads from the Middle Stone Age levels of Blombos Cave. Shells are listed in stratigraphic order. Figures in the “Group” column associate shells recovered in a single square or in two adjacent sub-squares during a single excavation day, interpreted as lost or disposed beadwork items. Perforation types are those illustrated in Fig. 3b

Number in Fig. 2	Date of excavation	Phase	Level	Square	Group	Length (mm)	Perforation type	Usewearer location
1	2/2/1999	M1	CAA	F5c	*	9.56	6	P
2	2/9/1998	M1	CA	E5b	1	6.83	6	P
3	2/9/1998	M1	CA	E5b	1	7.18	6	
4	2/9/1998	M1	CA	E5b	1	7.26	6	P
5	2/9/1998	M1	CA	E5b	1	8.39	6	
6	2/9/1998	M1	CA	F5a	1	9.03	6	P
7	2/9/1998	M1	CBA	E5	1	8.49	6	P
8	2/9/1998	M1	CBA	E5	1	9.78	6	
9	2/9/1998	M1	CB	F5a	2	7.85	6	P, L
10	2/9/1998	M1	CB	F5a	2	8.34	6	P, L
11	1/28/1999	M1	CB	F6b	*	8.71	8	P, L, W
12	2/5/1999	M1	CB	F6a	*	8.69	8	L, W
13	2/6/1998	M1	CB	E5b	*	9.63	6	P, L
14	2/5/1997	M1	CA-CC	F3	*	7.57	8	P, L, W
15	2/6/1997	M1	CA-CC	E2	*	9.17	8	P, L, W
16	11/11/1997	M1	CA-CC	E4	3	7.49	6	L
17	11/11/1997	M1	CA-CC	E4	3	9.43	7	
18	2/7/1997	M1	CA-CC	E4	4	7.35	6	P
19	2/7/1997	M1	CA-CC	E4	4	7.57	6	P
20	2/7/1997	M1	CA-CC	E4	4	7.86	6	P
21	2/7/1997	M1	CA-CC	E4	4	8	9	
22	2/7/1997	M1	CA-CC	E4	4	8.01	7	P, L, W
23	2/7/1997	M1	CA-CC	E4	4	8.1	7	P, L, W
24	2/7/1997	M1	CA-CC	E4	4	8.19	6	L
25	2/7/1997	M1	CA-CC	E4	4	8.83	6	
26	2/7/1997	M1	CA-CC	E4	4	8.93	6	
27	2/7/1997	M1	CA-CC	E4	4	9.1	7	P
28	2/7/1997	M1	CA-CC	E4	4	9.35	6	P, L, W
29	2/7/1997	M1	CA-CC	E4	4	10.4	6	
30	2/10/1997	M1	CA-CC	E4	5	7.67	6	P, L
31	2/10/1997	M1	CA-CC	E4	5	7.99	6	P, L, W
32	2/10/1997	M1	CA-CC	E4	5	9.52	6	L
33	2/10/1997	M1	CA-CC	E4	5	9.68	6	
34	2/10/1997	M1	CA-CC	E4	5	9.86	6	P
35	2/16/2000	M1	CC	H5a	6	9.42	8	P, L, W
36	2/16/2000	M1	CC	H5a	6	10	8	P, L, W
37	2/16/2000	M1	CC	H5a	6	10.05	8	P, L, W
38	2/16/2000	M1	CC	H5a	6	10.42	8	P, L, W
39	2/16/2000	M1	CC	H5c	6	10.24	8	P, L, W
40	2/6/1998	M2	CFA	E4a	*	8.18	8	P
41	2/9/1998	M2	CF	E5b	*	8.75	6	L

* = isolated recovery, P = perforation edge, L = lip, W = parietal wall

square E5 (Fig. 1b). The two shell beads found in M2 may be intrusive due to slumping of the deposits in the recovery area and probably originate from the overlying M1 phase.

Thirty-three beads were found in six groups of two to twelve beads, each group being recovered in a single square or in two adjacent sub-squares during a single excavation day (Table 1). Two of

these groups, composed of twelve and five specimens respectively, include beads found in the same square and phase on the same and subsequent excavation days. Eight beads are isolated recoveries.

The bead evidence

Determining whether the *N. kraussianus* shells from the c. 75 ka levels at BBC are MSA beads requires evidence for: i) human agency in their selection, transport and accumulation; ii) manufacturing and/or use wear, and iii) absence of contamination from the LSA layers. Here we demonstrate human involvement in the shells collection, perforation and use as beads, and provide absolute evidence that the beads derive from the MSA levels.

Taphonomic analysis

N. kraussianus, the tick shell, is a scavenging gastropod adapted to estuarine environments (Palmer, 1980). The closest estuaries today are those of the Duiwenhoks and Goukou Rivers, located 20 km west and east of BBC respectively. Although sea levels may have dropped to –25 m (Ramsey & Cooper, 2002) during the Still Bay occupation (OIS 5a) the coastline remained less than 3 km from the cave, and no evidence exists for closer paleo-estuaries in the regional onshore and offshore topography (Van Andel, 1989).

The archaeological tick shells cannot derive from the Mio-Pliocene De Hoop Formation in which the cave is situated (Rogers, 1988). They were not brought to the site accidentally by animals. *Natica tecta*, the only known predator, is a gastropod confined to the same biotope as *N. kraussianus* (Palmer, 1980). No other natural agent is known to accumulate tick shells far from estuarine environments. Storms are known to generate or destroy shell deposits (Bird, 1992; Claassen, 1998) but shells re-deposited by this agent are often broken and rounded (Hughes & Sullivan, 1974), which is not the case for the *N. kraussianus* from BBC (see below). Additionally, the cave mouth is 34.5 m above sea level and

way above the reach of storm waves during the Pleistocene/Holocene.

It is possible that the MSA inhabitants consumed tick shell flesh but highly unlikely this was the principle reason for collecting them. In a controlled test, it took us c. 20 minutes to collect 100 living shells and 20 minutes to extract the meat. The dry weight of the soft tissue, 0.814 g, is insufficient to warrant their collection as food.

Shellfish provides a valuable source of fatty acids, essential for brain development (Gibbons, 2002). These amino acids, however, were effectively obtained through the consumption of much bigger shell species and fish (Henshilwood et al., 2001a).

Wracks of dead *Zostera capensis*, an estuarine grass, accumulate on the drift zone with live tick shells seeking shelter beneath. On the Cape west coast such wracks, which could include tick shells, were collected and used by LSA hunter-gatherers for bedding (Liengme, 1987; Parkington, pers. comm.). Two reasons contra-indicate that this was the mode of transport for the *N. kraussianus* found in the BBC MSA levels. First, it is unlikely that these wracks were transported 20 km to the site and, second, all age classes of the gastropod would be present. Juveniles (stage 1), and sub-adults (stage 2-4), account respectively for 25% and 26% of a sieved living population from the Duiwenhoks estuary. In contrast, all tick shells found in the MSA level at BBC are adult (Fig. 3a, stage 5). A χ^2 test confirms ($p < .0001$) a statistically significant difference in age class representation between the MSA shell beads and our reference sample. Juveniles cannot be lacking for taphonomic reasons (i.e. differential degradation of their thinner shell). Adults are perfectly preserved and fragile gastropods, with shells thinner than *N. kraussianus* juveniles, are well represented and preserved in the MSA levels.

Non-human taphonomic processes are known to produce pseudo personal ornaments that appear morphologically similar to human-modified and used beads (d'Errico & Villa, 1997; d'Errico et al., 1993; Claassen, 1998). To address this issue we gathered modern *N. kraussianus* shells for a comparative collection from two estuaries closest to BBC. One morphometric (shell length)

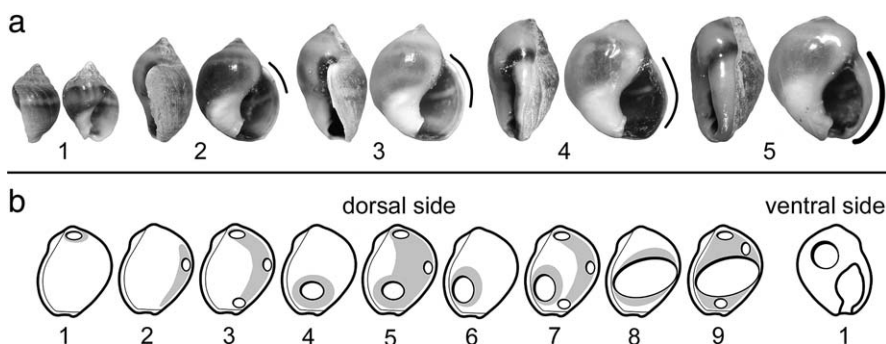


Fig. 3. (a) Juvenile (1), sub-adult (2-4) and adult (5) *Nassarius kraussianus* shells from the modern biocenosis of Duiwenhoks estuary (Cape Province, South Africa) showing gradual size increase and thickening of the lip (solid line); (b) perforation types observed on *N. kraussianus* shells from modern and archaeological collections. The shaded area indicates the variability in hole location.

and four morphological variables (age class, perforation type on the dorsal side of the shell, the presence of carnivore drill, state of preservation of the lip) were recorded on tick shells from the reference collections, on archaeological specimens from the BBC MSA, and on LSA tick shell beads from BBC and Die Kelders site.

N. kraussianus shells with keyhole perforations on the dorsal side do not exceed 0.4% in living and 30.6% in dead populations (Table 2). These perforations vary considerably in number, size, and location (Fig. 3b, Table 2). In contrast, all recovered MSA shells are perforated, and 88%

have unique medium size perforations located near the lip (Fig. 3b Type 6, Table 2), or larger perforations extending from the lip toward the right edge (Fig. 3b Type 8, Table 2). The remainder have one of these two types, plus small perforations due to post-depositional damage (Fig. 3b Types 7 and 9, Table 2). Both of these perforation types (6 and 8) are absent in living populations and only account for between 5.4% and 8.6% in modern thanatocoenoses. χ^2 statistical analysis formally rules out the possibility that an assemblage with perforation types observed on the MSA shells can be gathered by chance in living

Table 2

Frequency of perforation types (see Fig. 3b) on the dorsal and the ventral side of *Nassarius kraussianus* shells from modern and archaeological assemblages

<i>Nassarius kraussianus</i> assemblages	n	Dorsal side (%)									Ventral side (%)
		1	2	3	4	5	6	7	8	9	1
Modern											
Duivenhoks*	728	4.9	2.9	1.5	1.4	0.7	1.9	2.7	3.8	2.9	51.5
Duivenhoks†	183	1.1	4.9	—	0.5	0.5	1.6	2.2	3.8	3.3	89.1
Goukou*	925	3.4	3	1.1	2.9	1.2	4	3.4	4.6	7	37.7
Goukou‡	751	0.3	0.1	—	—	—	—	—	—	—	—
Archaeological											
BBC MSA	41	—	—	—	—	—	63.4	9.8	24.4	2.4	—
BBC LSA	1003	—	0.2	—	0.2	—	0.8	0.1	75.5	7.3	0.6
DK LSA	1095	—	—	1.5	17	5.4	10.4	0.4	35.3	30	3.5

DK = Die Kelders

* modern thanatocoenosis hand gathered throughout the estuary

† modern thanatocoenosis found accumulated at a single spot

‡ hand gathered living population

($p < .0001$) or dead ($p < .0001$) natural populations.

No MSA tick shells have evidence on the ventral side of holes typically drilled by *Natica tecta*, while these perforations (Fig. 4a-b) are found on 38% to 89% of shells from modern thanatocoenoses. One MSA specimen (Fig. 2 n. 11) shows the shallow pit resulting from an unsuccessful boring by *Natica tecta*. Some tick shells escape this predator by extending their foot and rolling away (Palmer, 1980).

It can be argued that *N. kraussianus* shells were, brought to the site by MSA people, and that the peculiar perforation types seen on them were produced by post-depositional taphonomic processes such as decalcification, trampling, and/or

sediment compaction. Decalcification is discarded in the light of our analysis of modern thanatocoenoses. Considering the sedimentary environment of *N. kraussianus* thanatocoenoses (mud in brackish calm water), decalcification is considered the only post-mortem agent of alteration on modern shells. Of the various assemblages of dead shells we collected in the estuaries, between 17.9% and 30.6% had keyhole perforations due to gradual decalcification. Decalcification first affects the tip (smallest spiral whorls), then base and lateral area of the dorsal side producing one or more sub-millimetric perforations because here the shell wall is thinnest (Fig. 3b Types 1-3). The process then continues to enlarge these holes (Fig. 3b Types 4-7) until they join (Fig. 3b Type 8). In the final stage of

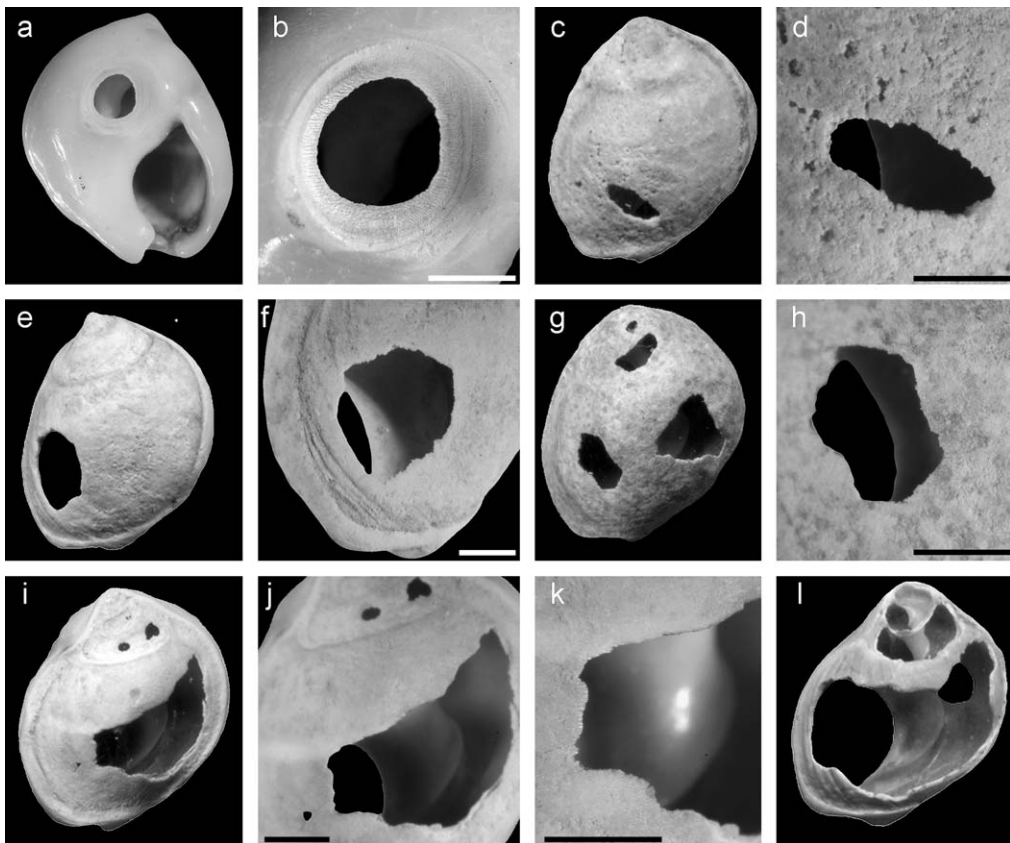


Fig. 4. (a) ventral aspect and (b) close-up view of a modern *N. kraussianus* with hole drilled by *Natica tecta*; (c-l) dorsal aspects and close-up views of shells from Goukou estuary showing perforations corresponding to different stages of natural erosion. Scale bars = 1 mm.

decalcification (Fig. 3b Type 9) the dorsal aspect of all three spiral whorls is removed, perforations also appear on the thicker ventral side, and the lip eventually breaks. At all stages, the perforations have linear thin edges linked to thinning and weakening of the shell wall (Fig. 4c-l).

MSA shells, in contrast, are all perforated, the most common being Type 6, and do not show the initial stages of alteration typical of modern thanatocoenoses (Table 2); the surfaces of the shells on which the MSA perforations were made are still perfectly preserved (Fig. 5a-p), a feature very rare in modern assemblages. Additionally, and contrary to naturally perforated shells, the edge of the shell is thick where the perforation was made, and exhibits a well-preserved chipping out of the prismatic layer.

It is unlikely that natural mechanical processes repeatedly produced the perforations observed on the beads. Marine gastropods from MSA levels that are similar in size to *N. kraussianus* do not have the perforations observed on the MSA beads. They show no evidence of sedimentary abrasion (Fig. 6) in form of muted shell sculpture, polished surfaces and rounded edges typical of this taphonomic process (Claassen, 1998). A few have traces of limited chemical alteration that produces the sub-millimetric thin edged perforations similar to those observed on modern tick shell thanatocoenoses. Also, if mechanical abrasion was responsible for the perforations, they should occur at the part most exposed and weakest, and neighbouring exposed areas should show evidence of abrasion. Contrary to this pattern, most of the perforations on the MSA shells occur in a relatively well-protected area, close to the lip, and show no traces of abrasion (Figs. 2 and 5a-j). A percentage of 16.3% and 23.9% of *N. kraussianus* shells from the LSA levels at BBC and Die Kelders respectively are not perforated, indicating that some shells were brought to the caves intact, probably for the manufacture of beads. If mechanical damage was responsible for the perforation type most commonly present on the BBC MSA tick shells (Fig. 3b Type 6), then we should expect it to also be consistently present on LSA tick shells. At BBC this perforation type is present on less than 1% of the LSA shells.

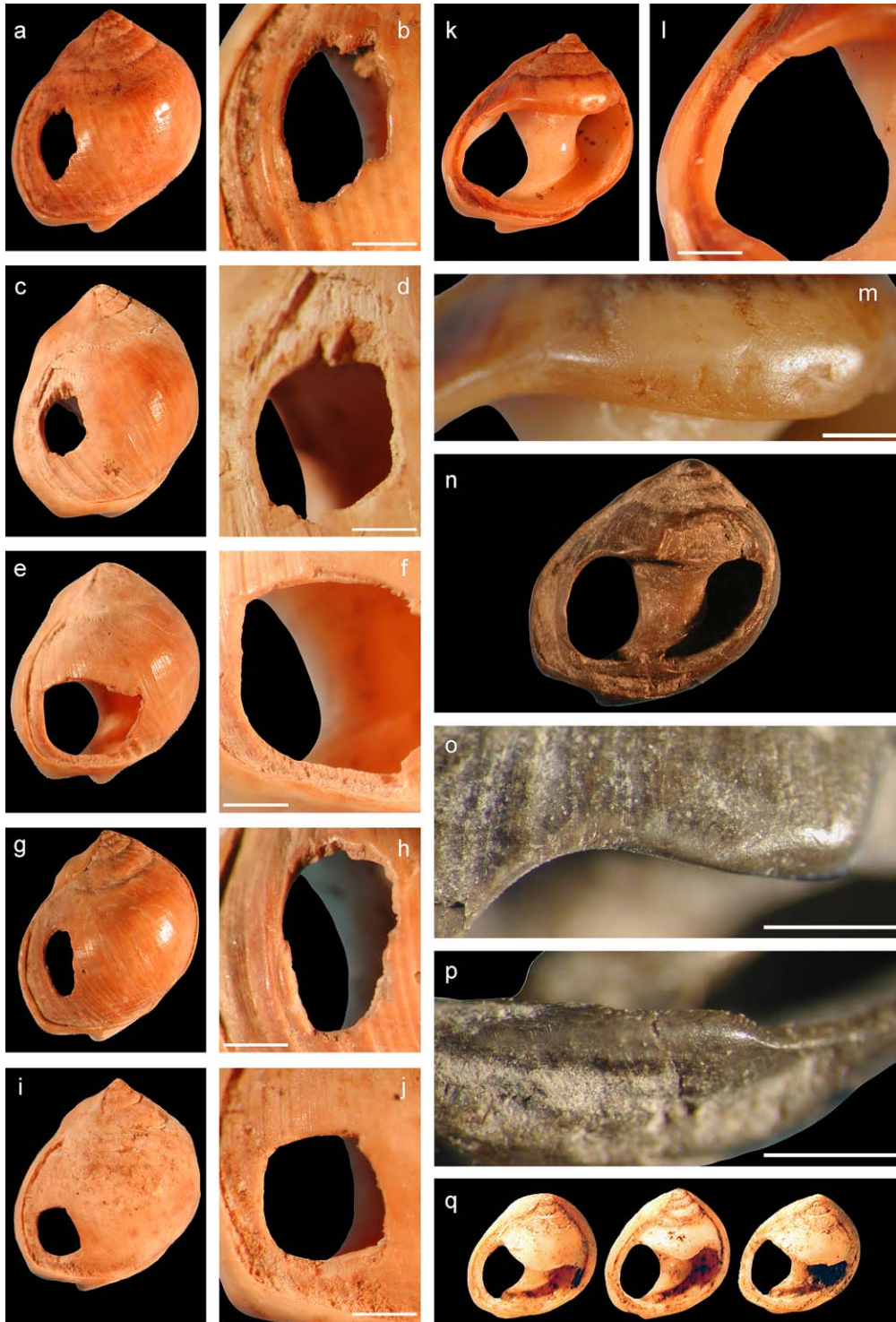
Finally, none of the beads shows the linear pits or sinuous features typical of root etching (Andrews, 1990; Fisher, 1995), nor of other traces pointing to a natural process for the origin of the perforations.

Perforation technique

Since the main type of perforation (Type 6) on MSA shells is rare in nature and difficult to explain as result of natural processes, we examined whether human agency was responsible for these perforations. Two techniques were tested – first, punching the body whorl through the aperture and second from the outer dorsal side. Three types of tools were used; retouched lithic points, bone awls, and pincer claws of a small crab that lives in the same habitat as *N. kraussianus*. In each case, we recorded the location, morphology, size and microscopic features of the resulting perforations. Four persons, (male and female), punched holes to assess if personal variability was a factor.

Piercing the shell through the aperture with a lithic point mostly resulted in the shell lip (Fig. 7a-c) or the tool tip breaking. Only very thin, sharp stone points made contact with the shell wall without damaging the aperture, and when they did, they invariably broke after producing perforations with an irregular outline (Fig. 7d-e). Piercing the outside of the shell with a crab claw was also ineffective as the pressure exerted on the claw broke it before a hole was made. Piercing the shell with a thin, sharp stone tool (Fig. 7f-h) or a bone awl (Fig. 7i-k) from the outside resulted in micro-chipping of the internal edge of the perforation (Fig. 7h and k), a feature not seen on MSA shells. The pressure needed to pierce the shell with this technique systematically broke the tip of the bone point, which then needed sharpening for re-use.

Piercing the shell through its aperture with a bone awl (Fig. 7l-o) or crab claw (Fig. 7p) was the most effective way to perforate a keyhole as it required little pressure, no re-sharpening of the tool, and did not break the lip. The result was micro chipping of the outer prismatic layer (Fig. 7m-o), similar to that present on most MSA shells (Fig. 5a-j), and the resultant location



of the perforation, is particularly consistent with that observed archaeologically. Perforations made this way are systematically a short distance from the lip, and in the middle or lower portion of the body whorl, because this is the only area where a straight, pointed tool punching through the aperture can intersect the shell wall.

On well-preserved MSA shells, perforations close to the lip (Type 6) are often elliptical in shape and oriented parallel to the lip. This shape and orientation occurs experimentally when the bone point used to pierce the hole from inside is slightly elliptical in section. This contradicts the hypothesis that, after piercing, the perforation was enlarged and regularised by rotation of the tool. The results of our experiments show that the location, shape, size, and associated microscopic features of perforations on MSA shells are consistent with piercing the shell through the aperture with a sharp tool that is elliptical in section. We conclude that the perforations on well preserved MSA shells are anthropogenic in origin and very probably made using this technique. Piercing activities are clearly a part of M1 technology and some of the MSA bone tools are very similar to the experimental bone tools we used to perforate the shells. A natural origin for the remainder of the perforation types observed on the MSA shells (Type 7-9) can also be discarded. The large perforation on the dorsal side of the shell (Type 8), which is the most frequent (24%) among these three types, occurs on shells with no signs of chemical alteration. This indicates that such a taphonomic process is not the agent of these perforations. Shells of this type generally show acute wear of the perforated edge (Fig. 5k-p) that does not extend to the remainder of the shell surface, as would be expected if the perforation was the result of post-depositional mechanical abrasion. A likely explanation for these large perforations and localised wear is that they are the consequence of a gradual enlargement of

perforations of Type 6 due to the prolonged use of the shells as threaded beads. The few *N. kraussianus* with Type 7 and 9 perforations likely represent Types 6 or 8 that have undergone post-excavation damage. Here, most of the shell surface and original perforation preserves pristine dun colouring while the edges of the post-depositional altered area are white and frayed.

Use-wear

Nassarius shells regularly used as beads should display use-wear traces consistent with this practice. We systematically recorded the appearance and location of worn areas on all MSA tick shells, and a sample of LSA tick shell beads, from BBC with a M3C Wild microscope equipped with a digital camera. A sample of recently harvested modern shells was also analysed for comparison. Worn areas on a sample of seven MSA, LSA and modern shells was inspected using a JEOL 5800LV variable pressure scanning electron microscope (SEM) at the Laboratory of Microscopy and Micro-analysis, University of Pretoria. This SEM allows high quality photographs of microscopic features without samples being damaged by vacuum metal coating.

Our aim was to determine whether use-wear traces show that the MSA shells were strung beads. Use-wear was recorded on the edge of the keyhole perforation, the outer lip, and the parietal wall of the aperture. On MSA shells with Type 6 perforations, a type virtually absent in the LSA, wear gently smoothes the edge of the perforation close to the lip (Fig. 5a-j). Wear is present all along the keyhole edge of MSA and LSA shells with large perforations (Fig. 3b, Type 8 and well preserved Type 9), but is most intense on the margin close to the lip (Fig. 5l), the suture between the first and second spiral whorls (Fig. 5m and o), and the edge close to the anterior canal (Fig. 5p). Through wear, the first body whorl is removed

Fig. 5. (a-j) MSA *Nassarius kraussianus* shell beads from Blombos Cave with perforations close to the lip. Close-up views show micro-chipping and smoothing of the perforation edge; (k-p) MSA *N. kraussianus* beads from Blombos Cave with large perforations. Close-up views show heavy smoothing on the perforation edges; (q) typical LSA beads from the same site with large perforations and white shade. Scale bars = 1 mm.

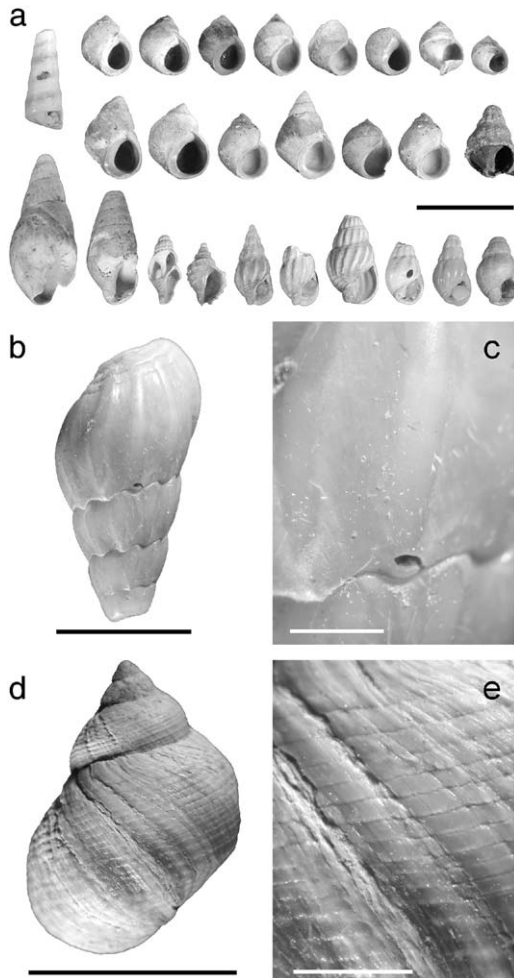


Fig. 6. (a) marine gastropods from Blombos Cave M1 phase, layer CC; (b–e) macro- and microscopic views of two shells revealing no signs of abrasion. a: scale bar = 1 cm, b and d: scale bar = 5 mm, c and e: scale bar = 1 mm.

completely on most LSA beads (Figs. 2 and 5q) and has transformed the lip into a thin bridge. This feature is also present on seven MSA beads (Fig. 5k and n).

Microscopic analysis of MSA tick shells reveals a distinct use-wear, absent on LSA beads and natural shells, consisting of facets that flatten the outer lip or create a concave surface on the lip close to the anterior canal (Fig. 8). A similar concave facet is seen often opposite the first on the parietal wall of the aperture (Fig. 9).

We considered whether such facets may be natural due to twisting or flattening of the lip that might occur in the final growth stage of exceptionally large adult shells. We reject this hypothesis. Facets resulting from wear occur also on small MSA perforated tick shells but are absent on the largest LSA beads from BBC, Die Kelders, and modern specimens that are similarly sized to the largest BBC MSA shells. Optical and SEM analysis of the facets clearly indicates correspondence with localised abrasion of the shell nacreous structure that intercepts the crystal shell layers in these areas (Fig. 9a–b). Wear facets do not show the same shiny appearance exhibited by unmodified parietal wall and lip surfaces, and are covered by distinctly oriented 1 μm wide striations (Figs. 9c–d, 10d–f), absent on natural and LSA surfaces (Fig. 10a–c). The use-wear patterns we recorded on the BBC MSA shells are consistent with friction from rubbing against thread, skin, or other beads (d'Errico et al., 1993). This is one of the principal factors that define the MSA shells as beads.

Four of the shells show microscopic traces of red ochre within the shell and on the outer surface. Deposition of the ochre may have occurred during the manufacturing process if the perforating tool was ochred. It can be due to rubbing against ochred skin, thread or deliberate colouring of the beads. No ochre residues occur on other gastropods found in MSA layers (Fig. 6).

Cultural attribution of the MSA shell beads

In the LSA levels 1003 tick shells were recovered. We investigated whether the tick shell beads found in the MSA could derive from LSA levels. Small objects may be easily displaced by percolating through archaeological layers (Villa & Courtin, 1983). OSL measurements on single quartz grains from the dune layer that separates the MSA and LSA, and the underlying M1 layer (Fig. 1c) indicate that sand from these layers is not contaminated by grains of different ages as would be the case if mixing had occurred (Jacobs et al., 2003b; Jacobs, pers. comm.). This provides one check for the integrity of the underlying archaeological layers and artefacts.



Fig. 7. *Nassarius kraussianus* shells experimentally perforated by punching through the aperture with a lithic point (a-e); from the outside with a lithic point (f-h), from the outside with a bone point (i-k), through the aperture with a bone point (l-o) and a crab claw (p); (h and k) micro-chipping on the internal shell wall, (d-e, m-p): micro-chipping on the outer shell wall.

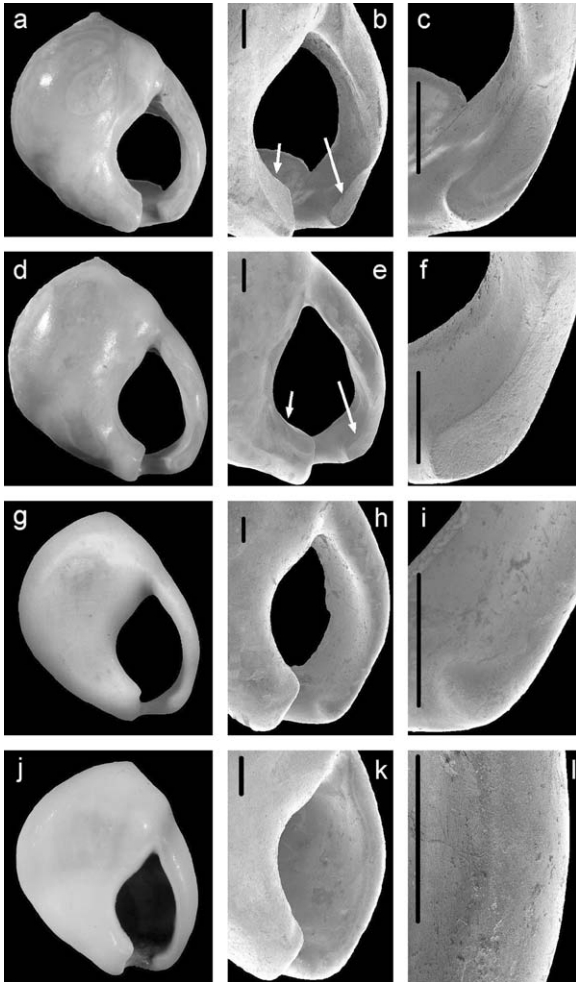


Fig. 8. *Nassarius kraussianus* from MSA (a and d), LSA (g) levels at Blombos Cave, and Goukou estuary (j). SEM micrographs (b–c and e–f) reveal on MSA specimens wear facets (arrows) that flatten the parietal wall and the lip close to the anterior canal absent on LSA and modern shells (h–i and k–l). Scale bars = 1 mm.

The MSA tick shells also cannot derive from the LSA layers because their size distribution is significantly different, as confirmed by a Mann-Whitney U-test ($p < .0001$), from that of the LSA shells (Fig. 11). Most LSA tick shells from BBC and Die Kelders are overall similar in size to those of modern populations, indicating that *N. kraussianus* was randomly collected by the sites occupants. In contrast, the leptokurtic distribution observed for the BBC MSA shells probably

reflects, considering the size range of the species, a conscious choice for collecting exceptionally large specimens. All the MSA tick shells are perforated, while a consistent proportion (16%) of BBC LSA *N. kraussianus* are not, and the most common MSA perforation type (Type 6) is present on less than 1% of the LSA beads. *N. kraussianus* beads from LSA levels do not have wear facets similar to those on MSA beads, perhaps because LSA beads were threaded or worn in a different way to those in the MSA. Shell beads from the MSA are dark orange or black in colour (Fig. 5a–m), those from the LSA are white or pale beige (Fig. 5q); 52% of the LSA shell beads have broken lips while this is observed on only two MSA specimens (<5%).

Further evidence that the shell beads derive from the MSA is that specimens recovered during excavation on the same day and in the same square or neighbouring sub-squares, can be distinctly grouped by size, shade, type of perforation and use-wear pattern (Table 1). This suggests each cluster recovered represents beads coming from the same beadwork item, lost or disposed during a single event and later subjected to minimal post-depositional displacement.

Summary and conclusion

Taphonomic, morphometric and microscopic analysis of MSA, LSA, modern, and experimentally modified *N. kraussianus* shells provides clear evidence that the shells from the MSA layers at BBC were deliberately perforated and worn as personal ornaments. The deliberate choice of large shell specimens in the MSA, rare in modern and LSA assemblages, indicates that the acquisition of these shells must have been a planned yet time consuming activity. Reconstruction of the method of perforation indicates the motions were careful and controlled. Evidence of heavily worn perforations and apertures indicates beads were worn for prolonged periods and probably in daily use. This observation and the recovery in different MSA layers of six groups of beads and eight isolated examples, probably representing fourteen events of beads use, contradict the hypothesis that

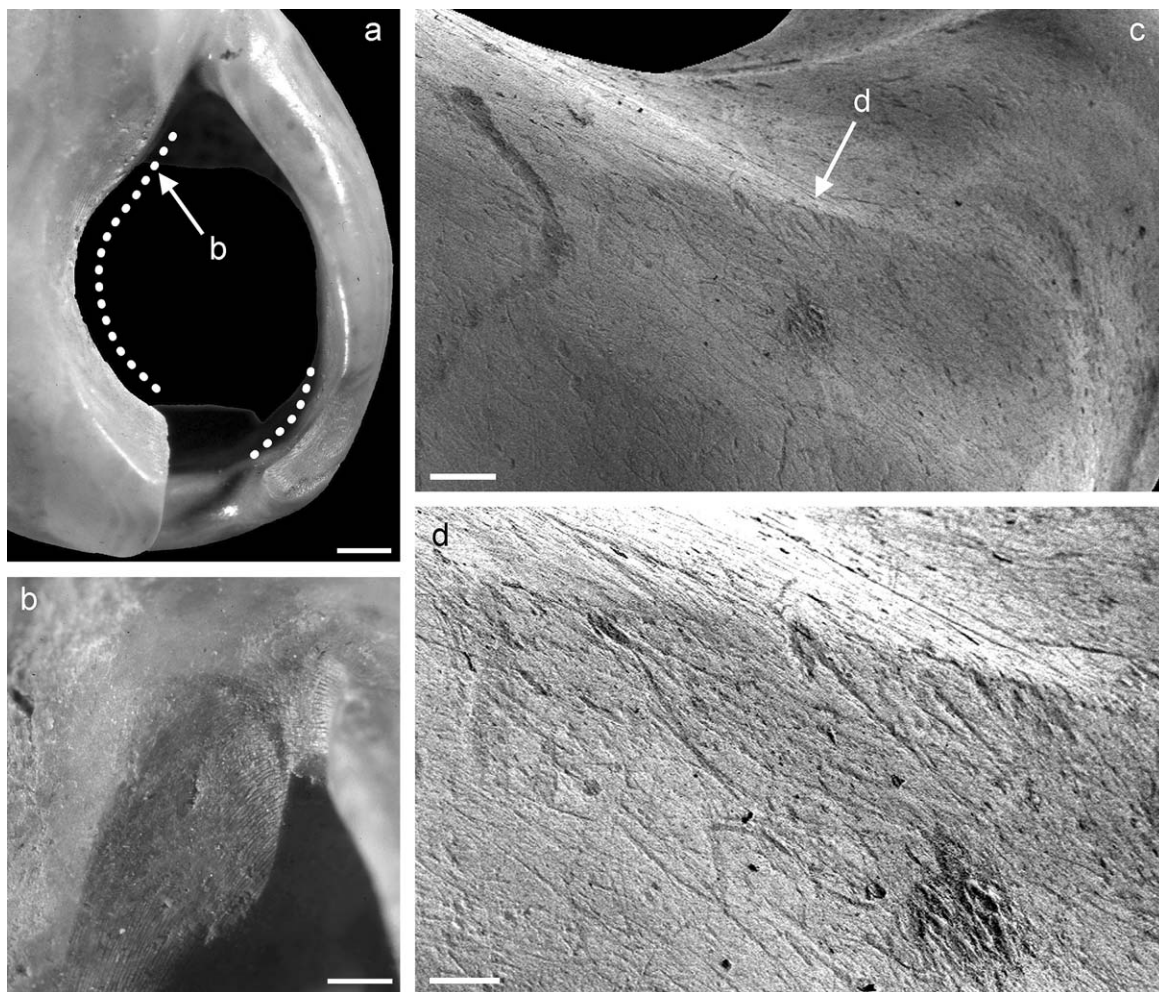


Fig. 9. (a) Close-up view of an MSA *Nassarius kraussianus* with wear facets (dotted lines) located on the parietal wall and the lip close to the anterior canal; (b) wear facet revealing the inner structure of the shell; (c-d) SEM micrographs of a wear facet on the parietal wall close to anterior canal showing distinctly oriented 1 μm wide striations; a: scale bar = 1 mm, b: scale bar = 250 μm , c: scale bar = 200 μm , d: scale bar = 500 μm .

bead making at BBC was the result of idiosyncratic behaviour, and support an argument for a bead-making tradition integral to the material culture of these people.

Evidence for an early origin of modern human behaviour in Africa has long remained elusive. Recent finds in > 70 ka African sites of objects bearing abstract engravings, large quantities of pigment and formal bone tools (Yellen *et al.*, 1995; McBrearty & Brooks, 2000; Henshilwood *et al.*, 2001a,b, 2002) have been rejected as clear-cut

evidence for behavioural modernity on the grounds of context, dating and/or because deliberate symbolic intent could not be warranted (Wadley, 2001, 2003; Klein, 2000; Ambrose, 2001). The discovery of personal ornaments in the c. 75 ka MSA layers at BBC adds an unambiguous marker of symbolically mediated behaviour to the list of innovations already identified in the MSA.

Since syntactical language is the only means of communication bearing a built-in meta-language that permits creation and transmission of other

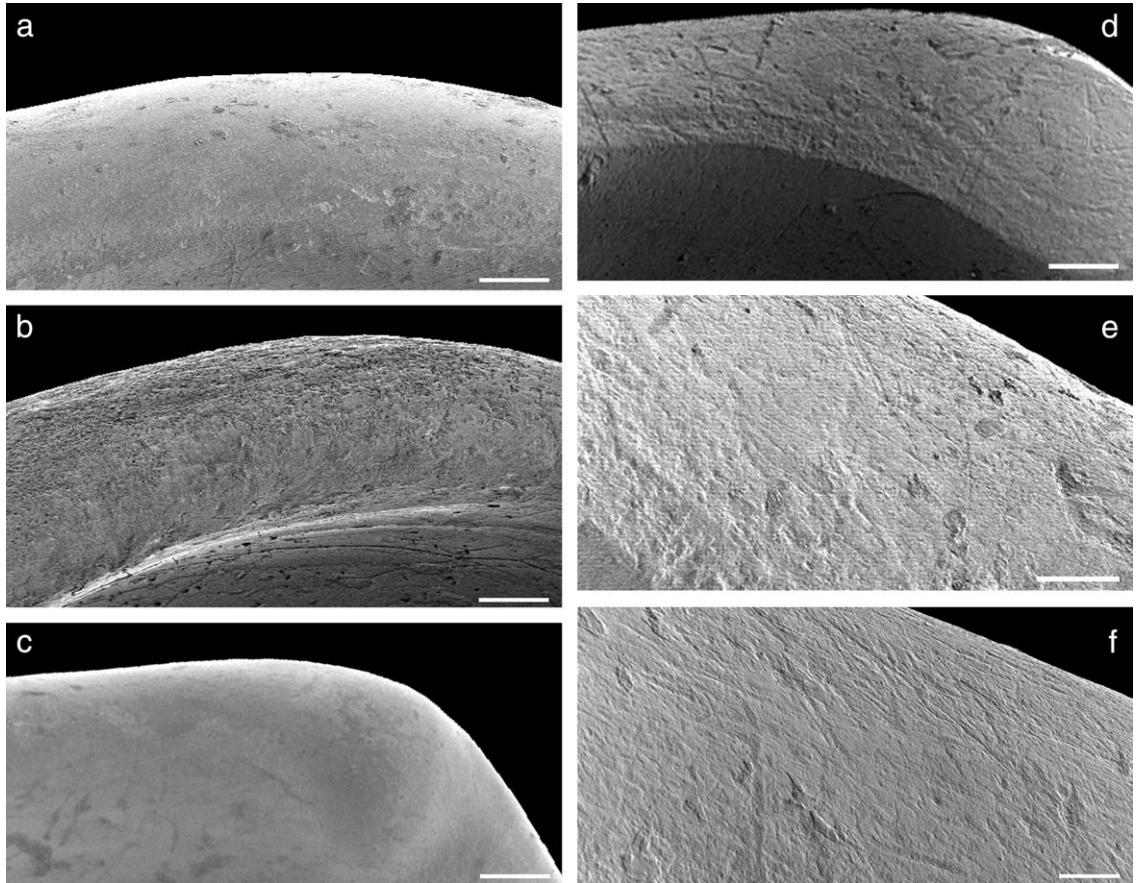


Fig. 10. SEM micrographs of *Nassarius kraussianus* lips. (a) modern biocoenosis, (b) modern thanathocoenosis, (c) LSA and (d-f) MSA assemblages from Blombos Cave. MSA. Wear facets on MSA shells show 1 μm wide striations absent on modern and LSA shells. Scale bars = 200 μm .

symbolic codes (Aiello, 1998), beadwork represents a reliable proxy for the acquisition of language and fully modern cognitive abilities by southern African populations 75,000 years ago.

Of the four scenarios proposed to account for the emergence of behavioural modernity, this discovery falsifies the first and the second, supports the third and does not refute the fourth. The BBC beads clearly predate the arrival of AMH in Europe and the 50,000 years old rapid neural mutation that would have qualitatively changed, according to some authors, human cognition. Since personal ornaments cannot be considered the only hallmark of modernity, are

not the only means human cultures use for body decoration, and are often made out of perishable raw material we can hardly deny modernity to contemporary Neandertals on these grounds nor rule out that *H. sapiens* were behaviourally modern before 75 ka. Neandertals show cultural innovations such as burials, pigment use and, at a later stage, personal ornaments suggesting their ability to create symbolic cultures.

Future research needs to establish a geography and precise chronology for behavioural innovations in Africa and Eurasia with the aim of understanding the role played by each in the emergence of modern humanity.

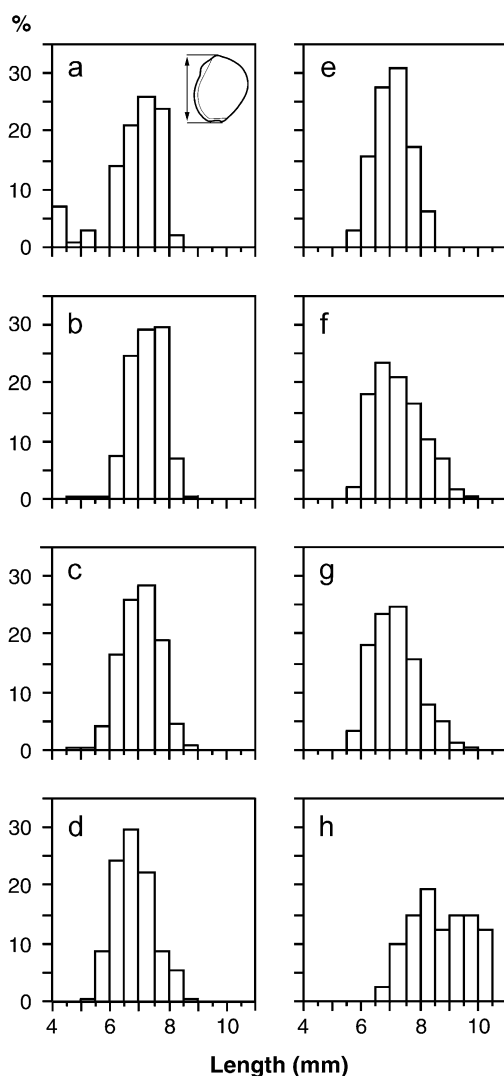


Fig. 11. Length distribution of *N. kraussianus* shells; (a) living population collected by sieving at the Duiwenhoks estuary; (b) hand-gathered living population from the Goukou estuary; (c) hand-gathered modern thanatocoenosis from Duiwenhoks estuary; (d) hand-gathered modern thanatocoenosis from Goukou estuary; (e) accumulation of *N. kraussianus* shells drilled by *Natica tecta* from Duiwenhoks estuary; (f) archaeological *N. kraussianus* from the LSA at Die Kelders Cave; (g) archaeological *N. kraussianus* from the LSA at Blombos Cave; (h) archaeological *N. kraussianus* from the MSA at Blombos Cave. Figures for each population are provided in Table 2.

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