Variability in Middle Stone Age symbolic traditions: the marine shell beads from Sibudu Cave, South Africa

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Highlights

- We analyse marine gastropods from Sibudu dated to between 70 ka and 46 ka
- We study present day gastropod biocoenoses and thanatocoenoses along the KwaZulu Natal coast
- *Nassarius kraussianus* shells were used as beads at Sibudu 46 ka
- *Mancinella capensis* and *Afrolittorina africana* may have been used as beads 70 ka
- Observed differences in perforated taxa over time suggests variability in symbolic traditions

Abstract

Located in the KwaZulu-Natal, 15 km from the coast, Sibudu has yielded twenty-three marine gastropods, nine of which perforated. At 70.5 ± 2.0 ka, in a Still Bay Industry, there is a cluster of perforated *Afrolittorina africana* shells, one of which has red ochre stains. There is also a perforated *Mancinella capensis* and some unperforated shells of both *A. africana* and *M. capensis*. The cluster may represent an area where the shells were processed or where apparel to which shells were attached was lost. In a Howiesons Poort layer, 64.7 ± 1.9 ka, there is a single perforated *Afrolittorina africana* shell. This shell may be from the Still Bay and may have been dislodged by rock fall. Two *Nassarius kraussianus* shells, one of them perforated and bearing traces of utilisation as a bead, were found in a late Middle Stone Age layer with an OSL age of 46.6 ± 2.3 ka. *N. kraussianus* was not found in older layers, even though this taxon occurs in southern Cape sites during the Middle Stone Age. Where the perforations are undamaged and suitable for microscopy, they appear to have been made by punching the shells with a pointed tool made of bone or hard wood. Such perforations have been replicated experimentally. Unlike the Blombos beads, the Sibudu shells from the Still Bay and Howiesons Poort layers bear no compelling evidence of use wear in their perforations. We therefore cannot be certain that they were suspended. However, if the Sibudu shells were beads, the changing use of taxa through time suggests variability in symbolic traditions.

Keywords

Middle Stone Age, marine shell ornaments, microscopy, taphonomy

1. Introduction

Early instances of personal decoration (e.g. Deacon, 1995; Ambrose, 1998; Kuhn et al., 2001; Henshilwood et al., 2004; Vanhaeren et al. 2006; Bouzouggar et al., 2007; Bar-Yosef Mayer et al., 2009; d´Errico et al. 2009; Conard, 2010; d´Errico and Backwell, 2016; Bicho et al., 2018; see Steele et al. 2019 for a review) have attracted the attention of archaeologists interested in the emergence of modern cultural traits because they are generally considered a convincing hallmark of symbolically mediated behaviour and, by extension, a reflection of cultures comparable to those known today (e.g. McBrearty and Brooks, 2000; Wadley, 2003; Kuhn and Stiner, 2007; Henshilwood and Dubreuil, 2011; d'Errico et al., 2003; d'Errico and Stringer, 2011; Shipton et al., 2018). The discovery, more than a decade ago, of marine shells used as beads at the southern African Middle Stone Age (MSA) site of Blombos Cave, in layers dated to ca 72 ka (Henshilwood et al., 2004; d'Errico et al., 2005; Vanhaeren et al., 2013) has challenged the longstanding paradigm according to which personal decoration did not occur before 40 ka. Additional marine shell beads dated to between ca 100 ka and 70 ka were identified in subsequent years at seven Aterian and Levantine Mousterian sites of North Africa and Western Asia (Vanhaeren et al., 2006; Bouzouggar et al., 2007; d'Errico et al., 2009; Bar-Yosef et al., 2009) and in the Howiesons Poort of Border Cave in South Africa (d'Errico and Backwell, 2016). At each of these sites personal ornaments consist of perforated shells belonging almost exclusively to a single species: *Nassarius gibbosulus* in Morocco and Algeria, this species and *Glycymeris* sp. in Israel, and *Nassarius kraussianus* and *Conus ebraeus* shells in South Africa. Taphonomic analysis and experimental reproduction of the modifications recorded on the shells have shown that *N. kraussianus* were collected alive, whereas *N. gibbosulus* and *Glycymeris* sp. were gathered dead on the shores. Some of these beads bear traces of pigment and intense use-wear. Experimental reproduction of use-wear recorded on *Nassarius kraussianus* shell beads from Blombos Cave has recently shown that a clear change in the way of stringing beads and the visual appearance of the resulting beadwork occurred at Blombos Cave between lower and upper Still Bay layers (Vanhaeren et al., 2013). It has also been shown that these changes were coincident with environmental change and the way in which the habitation space was used. When recovered at sites excavated with modern standards these shell beads often bear traces of red pigment. Some of them are blackened by heating either accidentally or for the purpose of changing their colour (d'Errico et al., 2015).

While confirming the existence of early bead-using traditions these discoveries have also raised questions about the mechanisms that have led to the emergence and maintenance of such innovation. On the one hand, no personal ornaments have been so far reported from sites securely dated to between 70 ka and 50 ka and the ornaments attested in Africa at ca. 45 ka (Ambrose, 1998; d'Errico et al., 2012; Gliganic et al., 2012; Miller and Willoughby, 2014), almost exclusively consisting of ostrich egg shell and stone beads, suggests cultural discontinuity with previous traditions. This contradicts (d'Errico and Stringer, 2011) the scenario according to which the emergence of cultural complexity would be reflected by a process of continuous accretion and implementation of cultural innovations. On the other hand, although convincing and associated with other striking evidence of cultural complexity, the Blombos and Border Cave shell beads were, until now, the only reliable instance of personal ornamentation prior to 70 ka for the southern African continent.

In a previous paper we reported the presence of possible shell beads in the Still Bay layers at Sibudu Cave, KwaZulu-Natal, South Africa (d'Errico et al., 2008). They consist of six *Afrolittorina africana*, five of which were recovered in the Still Bay and one in the lowermost Howiesons Poort layer of this site. Three of these shells bear perforations, one has residues of red pigment, and three are blackened by heating. One shell bears a complete and a broken perforation that can correspond to a repair after a first break. Taphonomic analysis of the archaeological specimens based on present day *Afrolittorina africana* biocoenoses, microscopic examination, experimental perforation of modern shells, and a review of the natural agents that may accumulate marine shells at inland sites such as Sibudu has suggested to us probable human involvement in the collection, transport, modification, and abandonment of Sibudu's *Afrolittorina africana*. Here we report on the discovery of an extended collection of marine shells from the late Middle Stone Age (MSA), Howiesons Poort (HP), Still Bay (SB), and pre-Still Bay (pre-SB) layers of this site. These shells belong to three species (*Afrolittorina africana*, *Mancinella capensis* and *Nassarius kraussianus*); some are perforated, heated, and bear red pigment residues. Study of archaeological and experimentally perforated shells, and comparison with shells from modern biocoenoses (*i.e.* living assemblages) and thanatocoenoses (*i.e.* dead assemblages) of the Ballito Bay shores, allows us to reinforce the argument for their being purposely collected, modified and used as beads. A detailed description of this material and related behavioural correlates is key to assessing recent claims according to which the production of personal ornaments would have little implication for the emergence of complex human cognition (Haidle et al., 2015; Garofoli, 2014).

2. Background to Sibudu

Sibudu is a large rock shelter above the uThongathi River, about 40 km north of Durban in KwaZulu-Natal, South Africa (Fig. 1). At present the shelter is about 15 km inland of the coast and the maximum distance from the coast during the last glacial episode is likely to have been about 20 km.

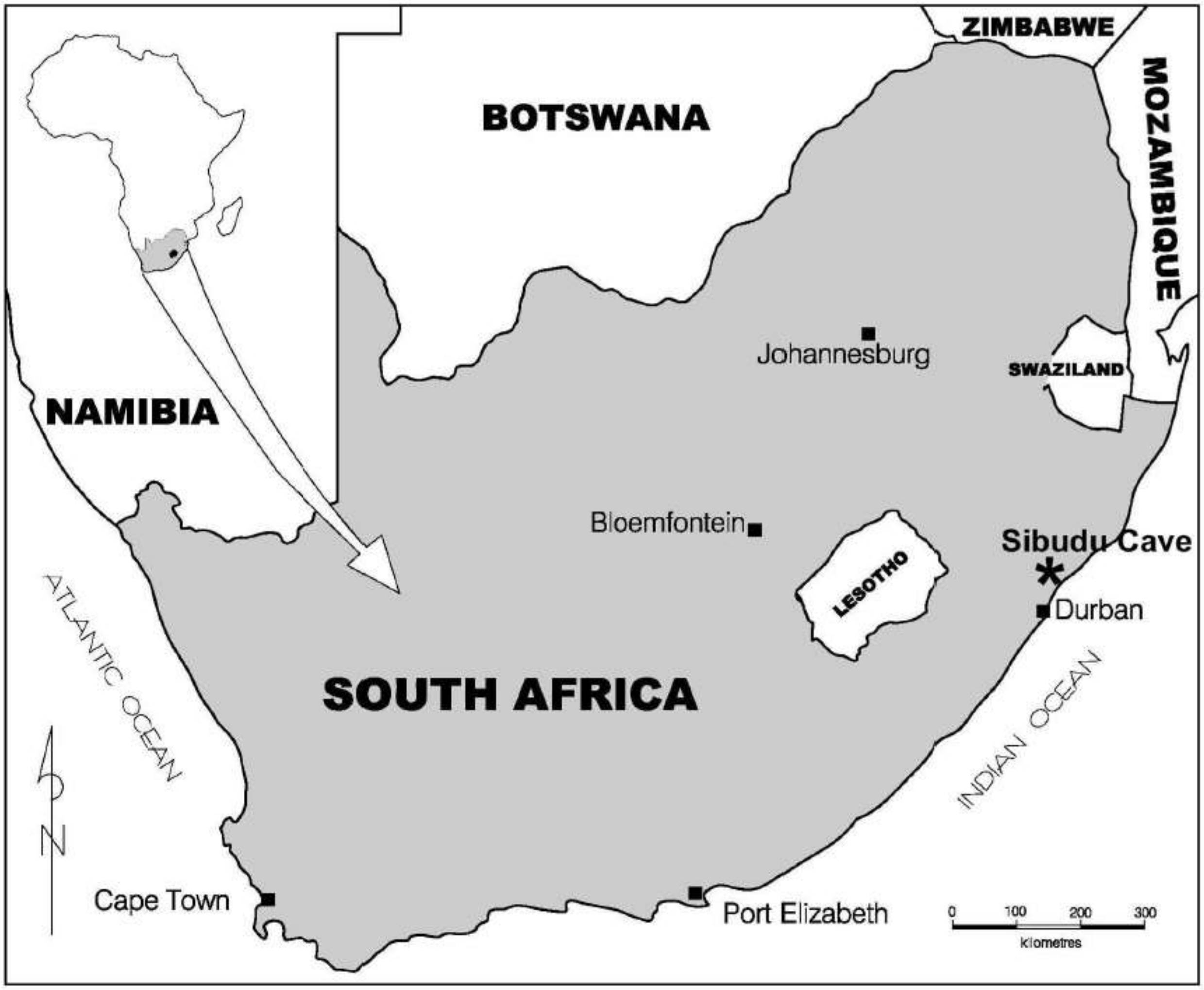


Figure 1. Location of Sibudu Cave.

The site was excavated under the directorship of Lyn Wadley between 1998 and 2011. Since 2011 the site has been excavated by Nicholas Conard, University of Tübingen. A long and detailed Middle Stone Age (MSA) sequence with good organic preservation occurs within its three metre deep sediments. The site's cultural succession (Lombard 2004, 2005, 2006a, 2006b, 2007, 2011; Wadley, 2004, 2005, 2006, 2007, 2010a,b; Villa et al., 2005; Cochrane, 2006, 2008; Delagnes et al., 2006; Villa and Lenoir, 2006; Backwell et al., 2008; d'Errico et al., 2008; Wadley and Mohapi, 2008; Wadley et al., 2009, 2011; Wadley and Kempson, 2011; d'Errico et al., 2012b; de la Peña et al. 2013; de la Peña and Wadley, 2014a, b, 2017; de la Peña, 2015; Soriano et al. 2015; Wozcieszak and Wadley, 2018), chronology and micromorphology ((Schiegl et al., 2004; Pickering, 2006; Schiegl and Conard, 2006; Wadley and Jacobs 2006; Jacobs et al., 2008a, b; Goldberg et al., 2009) and environmental context (Cain, 2004, 2006; Plug, 2004, 2006; Allott, 2006; Glenny, 2006; Herries, 2006; Renaut and Bamford, 2006; Reynolds, 2006; Sievers, 2006; Wells, 2006; Clark and Plug, 2008; Wadley et al., 2008; Robinson and Wadley, 2018; Clark 2019) are already published extensively elsewhere.

The Wadley excavation method is described in detail in Wadley and Jacobs (2006). In brief, the sediment was excavated in 50 cm quadrants (*a*-*d*) within each metre square. Quadrant *a* is the north-east quadrant in each metre square and B4a, for example, describes quadrant *a* in square B4. Twenty-one square metres of deposit were excavated into the ~58 ka occupations and six square metres were excavated as a deep sounding into older occupations with ages between 77.2 ± 2.1 and 61.7 ± 1.5 ka (Fig. 2). The ages are derived from single-grain optically stimulated luminescence (OSL) analysis of sedimentary quartz grains (Jacobs et al., 2008a, b). The deepest layers contain assemblages that are informally called pre-Still Bay, while Still Bay, Howiesons Poort and late MSA Industries occur more recently. Occupations at Sibudu were discontinuous, with hiatuses that, in layers more recent than 58 ka, were sometimes as long as 10,000 years. The final Wadley excavations of 2011 reached a layer called BS16 (Brown Sand 16), which is undated, but older than 77 ka. Characteristic finds, constituent stratigraphic units, date intervals of the different cultural assemblages and OSL ages for the stratigraphic units are summarised in Figure 2.

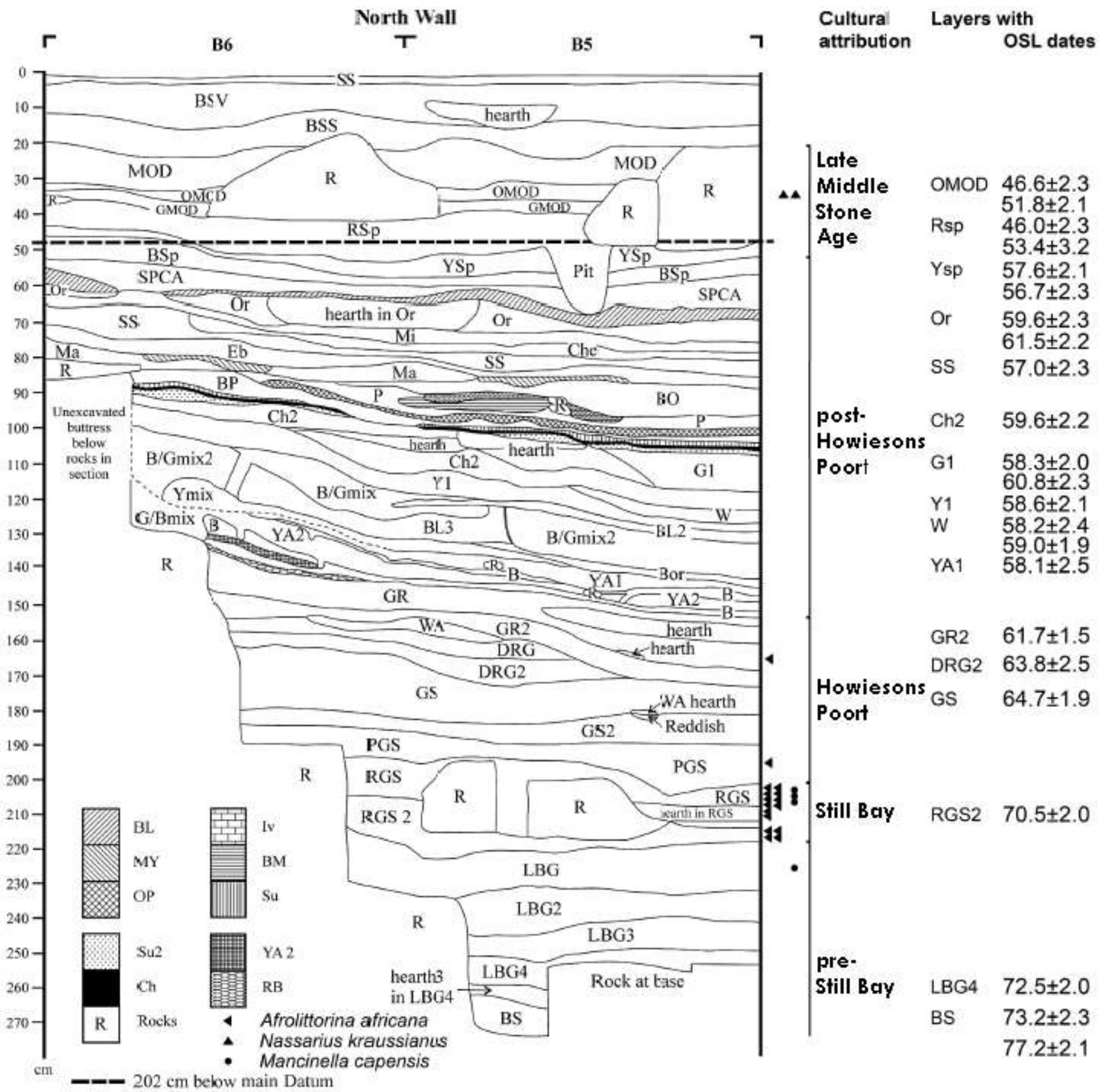


Figure 2. Stratigraphy of Sibudu Cave along the North section with indication of the stratigraphic layers, their cultural attribution, and optically stimulated luminescence (OSL) dates after Wadley and Jacobs, 2006 and Jacobs et al., 2008a,b.

In the lower most stratigraphic unit BS16 BS16 of the Wadley excavation, a long bifacial point was recovered (Wadley, 2012). It is narrow and thin, but has a rounded base, not a pointed one like a ‘classic’ Still Bay point. The Conard excavations below BS16 recovered more bifacial points, some serrate (Rots et al. 2017). The uppermost BS layer has an OSL age of 77.2 ± 2.1 ka. The BS member varies between 30 and 40 cm in thickness and, apart from the basal layer BS16, contains an informal assemblage with only rare retouched pieces. The LBG (Light Brownish

Sand) member above this is about 50 cm thick and it comprises four layers with two available OSL ages, 73.2 ± 2.3 and 72.5 ± 2.0 ka (Jacobs et al., 2008b). The informal lithic assemblage in these layers has only rare examples of retouched pieces and has been designated pre-Still Bay. Bone tools with double bevel working ends come from the pre-Still Bay layers.-Some ochre pieces with groups of lines forming fan-shaped motifs that may have been deliberately scored come from the pre-Still Bay layers (Hodgskiss, 2012, 2013).

The Still Bay Industry at the site is therefore immediately preceded by a deep sequence that extends about 80 cm in the Wadley excavation and even farther in the recent Conard one. The Still Bay occurs in the member Reddish Grey Sand (RGS), a loose, sandy sediment named after the Munsell colour reading 5YR 5/2 Reddish-Grey. Two layers, RGS2 and RGS have been named although the division between the two is not distinct, and the entire member is seldom more than 20 cm thick (Fig. 2). Several separate lenses have been distinguished by subtle colour changes within RGS2 and RGS. RGS, at the top of the sequence, has an OSL age of 70.5 ± 2.0 ka, and the entire Still Bay seems to represent a short pulse of occupation at Sibudu. Since the RGS layer is directly below a Howiesons Poort layer (PGS) with an OSL age of 64.7 ± 1.9 ka, an occupation hiatus of about five thousand years seems to occur at Sibudu between the Still Bay and the Howiesons Poort. Excavation of the Still Bay layers was hampered by extensive rock fall that began in the BS member and continued, perhaps intermittently, until about 65 ka. The rock fall has encroached on the six square metres of the deep sounding and this has resulted in restricted areas of occupation within the SB and HP Industries. Perhaps because of the extensive rockfall, the combustion features in Layer RGS are concentrated in squares B4 and C4 and in a single quadrant in square B5 where fewer rocks occur (Fig. 3). At least three of the ashy features appear to be hearths. All lithics and bone fragments larger than 20 mm were piece-plotted during the excavation of the Still Bay layers, as well as shells, bifacial tools and worked ochre. The Still Bay Industry at Sibudu, like that occurring in MSA sites along the South African Cape coast, is marked by the presence of bifacial tools with invasive retouch, including some rare lanceolate points. Whole bifacial points are relatively uncommon at the site, but bifacial point fragments are abundant, as is also the case at other Still Bay sites, such as Blombos (Henshilwood et al., 2001) and Hollow Rock (Evans, 1994). This pattern is probably due to the vulnerability of the long, thin bifacial points. In a preliminary study, bifacially worked tools comprised 44% of all the retouched pieces in the RGS member (Wadley, 2007). A more detailed analysis (Soriano et al., 2015) showed that stone knapping in RGS and RGS2 was mostly intended for the production of bifacial foliate points and that most were broken during utilization, sharpening or resharpening, so that many discarded tips and tip flakes were found. Dolerite, quartzite and hornfels were used for the manufacture of the points. Residue and use-trace analysis of a few Sibudu Still Bay bifacial points and point fragments suggests that they were mostly pointed hunting weapons, but at least one of the points was a cutting tool (Lombard, 2006a) and the majority of points studied by Soriano and colleagues seem to have been cutting tools. Raman Spectroscopy and Scanning Electron Microscopy (Wozcieszak and Wadley, 2018) support the original interpretation that the tools were hafted with an adhesive containing ochre powder. Other lithics in the Still Bay assemblage include splintered pieces, a few segments and unifacial points, and scrapers of various types (Wadley, 2007). Worked ochre is less common in the Still Bay than elsewhere in the site (Hodgskiss, 2013). No worked bone has yet been found in the Still Bay layers at Sibudu. In contrast, worked bone is extremely common in the younger Howiesons Poort Industry, including pointed forms, awls, smoothers, *pièces esquillées* and pressure flakers (d'Errico et al., 2012b). The use of bone pressure flakers during the Howiesons Poort at Sibudu has been recently supported by analysis of quartz bifacial points (de la Peña et al., 2013). The layers associated with the Howiesons Poort are (from the base to the top): Pinkish Grey Sand (PGS), Grey Sand (GS, GS2 and GS3), Dark Reddish Grey (DRG) and Grey Rocky (GR and GR2) (Wadley and Jacobs, 2006). The stratigraphy is clear, but the rock fall mentioned earlier has caused some disturbance to the oldest Howiesons Poort layer, PGS, as well as to the Still Bay layers. PGS has an OSL age of 64.7 ± 1.9 ka, while the younger Howiesons Poort layer, GR2, has an OSL age of 61.7 ± 2 ka (Jacobs et al., 2008b). GR2 is an artificial spit to divide the light, brownish-grey silt of GR. There are several hearths in GR. The Howiesons Poort layers have rich lithic assemblages with many backed tools and small bladelets (Wadley and Mohapi, 2008; de la Peña and Wadley, 2014). Worked ochre is more common in the Howiesons Poort than in the Still Bay (Hodgskiss, 2013).

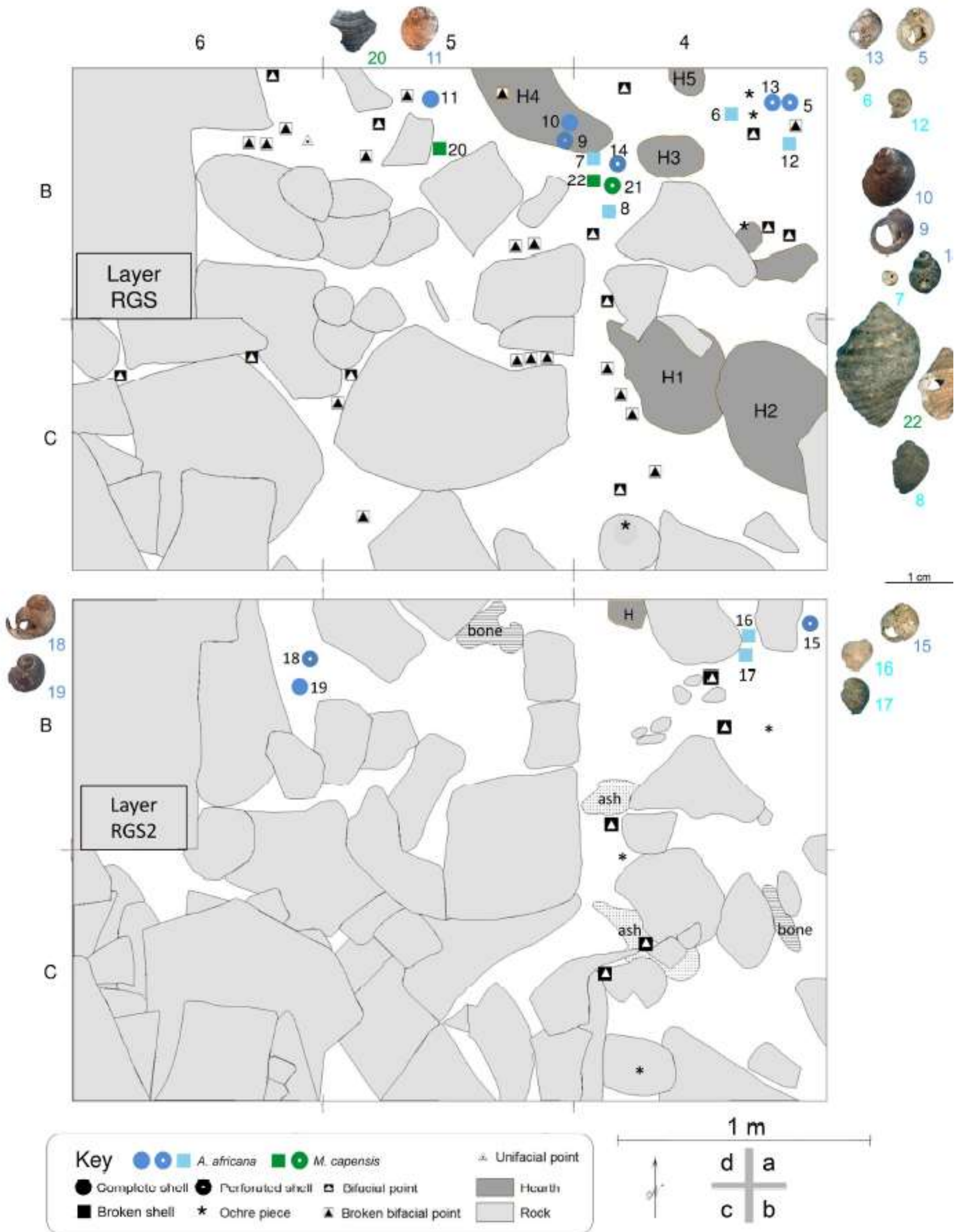


Figure 3. Spatial distribution of selected archaeological finds, rocks and ash lenses in squares B-C/4-6 within layer RGS (top) and RGS 2 (bottom). Colors and symbols identify find category, shell taxa and state of completeness. See Table 1 for descriptive information on the illustrated

and numbered marine shell finds.

A long sequence of post-Howiesons Poort (post-HP) layers occurs after the HP; these are about 100 cm in depth and they contain many strata wherein the inhabitants burnt bedding layers made of plant material (Goldberg et al., 2009; Wadley et al., 2011). The weighted mean age of the post-HP is 58.5 ± 1.4 ka (Jacobs et al., 2008a). Some post-HP lithics have been described (Cochrane, 2006; Villa et al., 2005; Conard et al., 2012; de la Peña and Wadley, 2017), as has the rich fauna (Clark and Plug, 2008). Layer BSp is the youngest of the post-HP layers and the late MSA succeeds the post-HP. The Late MSA layer OMOD (Orange Mottled Deposit) has an age estimate of 46.6 ± 2.3 ka. Lithics in OMOD include bifacial and unifacial points, scrapers and convergent flakes.

The GIS-based Coexistence Approach (CA_{GIS}) analysis demonstrates that the late MSA was warmer in winter than was previously the case, summer precipitation increased and vegetation became more closed (Bruch et al., 2012). *Podocarpus* sp. was consequently present in layer OMOD (Hall et al., 2014). Furthermore, as was the case in the earlier SB and HP occupations where vegetation was closed, small bovids like *Philantomba monticola* (blue duiker), *Cephalophus natalensis* (red duiker) and *Raphicerus campestris* (steenbok) occurred (Wadley et al., 2008). Nonetheless, large animals like *Tragelaphus oryx* (eland), *Equus quagga* (zebra) and *Syncerus caffer* (buffalo) were still present. Stable carbon and oxygen isotope data were retrieved from faunal tooth enamel throughout the sequence (Robinson and Wadley, 2018). The pre-SB seems to have been dominated by more closed environments than at other times, and was likely forested and mesic. More open and perhaps drier conditions occurred between ∼48–38 ka ago, but the remaining periods were not dissimilar from today (Robinson and Wadley, 2018).

Throughout the Sibudu sequence there is bone preservation, though it is often burnt. People collected many suids and a diverse assemblage of small game in the pre-SB (Clark, 2019). High frequencies of blue duiker (*Philantomba monticola*) in the SB and before suggest the early use of remote capture technology (Clark 2019). In HP layers, and even earlier, there are remains of large bovids and bushpig, and small creatures are well-represented (Clark and Plug, 2008; Plug personal communication 2009), including *Philantomba monticola* (blue duiker) and *Chlorocebus pygerythrus* (vervet monkey). In the upper part of the post-HP, there is an increase in plains game such as zebra and small bovids become rare (Clark and Plug, 2008). Birds, reptiles, rodents and fish occur throughout the sequence, as well as fresh water and marine molluscs (Plug, 2006). Marine species include turtles, fish, crustaceans and molluscs (Plug, 2006).

Since most of the shells that we describe here come from the SB layers of Sibudu, we provide more detail on the broad context of this Industry.

3. The Still Bay

The southern African Still Bay (Goodwin and van Riet Lowe, 1929; Sampson, 1974) has the lanceolate, bifacially shaped, point as its *fossile directeur*, but it also contains thin, long bifacial points of other shapes. The thin Still Bay points tended to break easily both during manufacture and use. The Industry at Blombos Cave on the coast in the Cape, more than 1000 km from Sibudu, has a well-known and remarkable Still Bay sequence with many bifacial points. Heat treatment of silcrete was used at this site to improve its quality for production, sometimes through pressure flaking, of the fine points (Brown et al., 2009; Mourre et al., 2010; Villa et al., 2009; Soriano et al., 2015). Bone tools in the form of fully shaped points and awls produced by scraping were found in Still Bay layers at Blombos and Peers Caves (d'Errico and Henshilwood, 2007). Modified red ochre is common at Still Bay sites (Henshilwood et al., 2009; Dayet et al., 2013) and, at Blombos, fragments of hematite are engraved with abstract motifs (Henshilwood et al., 2009). Perforated *Nassarius kraussianus* shells were used as beads by the Still Bay inhabitants of Blombos Cave during the M1 archaeological phase (Henshilwood et al., 2004; d'Errico et al., 2005; Vanhaeren et al., 2013).

Little is known about the origin of the Still Bay. At Sibudu and Blombos archaeological layers immediately below the Still Bay contain relatively simple flake-based assemblages with few retouched tools. In contrast, pre-Still Bay layers at Diepkloof and Klasies River contain unifacial and bifacial pieces shaped with invasive retouch that appear to announce the technical complexity of the Still Bay (Porraz et al., 2013).

To date, four sites – Sibudu (Wadley, 2007) and Umhlatuzana in KwaZulu-Natal Province (Lombard et al., 2010; Mohapi, 2013), Diepkloof in the Western Cape Province (Rigaud et al., 2006; Porraz et al., 2013), and Apollo 11 in the South of Namibia (Wendt, 1974; Vogelsang et al., 2010; Lombard and Högberg, 2018) have stratigraphic sequences in which Still Bay assemblages precede Howiesons Poort ones. Chronostratigraphy, Optically stimulated luminescence (OSL) and Thermoluminescence (TL) dating of pre-Still Bay, Still Bay, and Howiesons Poort layers have, for some years, situated the Still Bay between 72 and 71 ka and, after a possible archaeological hiatus, the younger Howiesons Poort between 65 and 60 ka (Jacobs et al., 2008b, 2013; Jacobs and Roberts, 2008). This view, i.e. that the Howiesons Poort would be younger than the Still Bay, has been recently challenged by the OSL and TL dating of the Diepkloof sequence (Tribolo et al., 2009; 2013) and fired the controversy surrounding calculation of internal dose rate in OSL dating (Guérin et al., 2013, but see responses by Galbraith, 2015; Jacobs and Roberts, 2015). Tribolo and colleagues propose a mean age of 109 ±

10 ka for the Still Bay of Diepkloof, i.e. almost 40 ka older than the age estimated by Jacobs et al. (2008b) for the same site, and a duration of 50 ka (from 105 ± 10 to 65 ± 8 ka) for the Howiesons Poort. They use these age estimates to support the hypothesis that both the Still Bay and the Howiesons Poort emerged during the last interglacial and coexisted during OIS 5 and 4 in southern Africa. So far, there is no evidence in the KwaZulu-Natal region suggesting that the Howiesons Poort was contemporaneous with the Still Bay.

4. Material and Methods

4.1. Taxonomic identification

Modern and archaeological marine gastropods were identified at genus and, where possible, species level using criteria proposed by Kilburn and Rippey (1982), Branch and Branch (1981), Richards (1981), Branch et al. (1994), Marais and Seccombe (2010). Archaeological specimens were compared to modern shell reference collections hosted at the KwaZulu-Natali Museum, Pietermaritzburg. The taxonomic status of each species was checked and, where needed, corrected using the WoRMS Editorial Board (2014).

4.2. Survey of the biocoenoses

Present day availability of marine gastropod species in the intertidal zone was checked at Ballito Bay (29°32’23.52’’S, 31°13’13.22’’E) and Shaka’s Rock (29°30’49.92’’S, 31°13’57.03’’E) by shore bound surveying and snorkelling at rocky outcrops in February 2012. This led to the creation of a list of identified species and determination of their relative abundance.

4.3. Survey of the thanatocoenoses

A marine shell thanatocoenoses composed of 522 remains of marine gastropods was collected by the authors of this study in February 2012 at four locations: Shaka’s Rock (29°30’49.92’’S, 31°13’57.03’’E), Ballito Bay (29°32’23.52’’S, 31°13’13.22’’E), Emerald Cove (30°47’00.80’’S, 30°25’48.92’’E) and Umdloti Beach (29°38’56.67’’S, 31°08’00.86’’E). These four locations are found along the sandy beaches and rocky outcrops of the KwaZulu-Natal coast. Dead shells were sampled at each location for two hours during low tide between the upper beach and the strandline. Shell fragmentation was described using five grades: 1) complete, 2) 99-75%, 3) 74-50%, 4) 49-25%, 5) <24% preserved. Fragmentation properties were also described independently of their location, according to genus by using a ternary taphogram (Kowalewski et al., 1995) in which the three states are represented by complete or almost complete specimens (grades 1 and 2), damaged specimens (grades 3 and 4), and fragments (grade 5). The Software PAST was used to produce the ternary taphogram.

4.4. Malacological reference collection

Our reference collection also comprises 470 *Afrolittorina africana* collected alive in September 2006 at two locations - uThongathi River mouth (29°34’22.93’’S, 31°11’07.17’’E) and Ballito Bay (29°32’23.52’’S, 31°13’13.22’’E) - on the coast of Kwa-Zulu-Natal (d’Errico et al., 2008), and four *Nassarius kraussianus* collected dead at the same time inside the river mouth and on the oceanic beach close to the uThongathi River (Fig. 4). An additional five and nine dead *N. kraussianus* were collected respectively in February 2012 and November 2013 on the oceanic beaches of Ballito Bay (Kwa-Zulu-Natal) and Die Hoop (34°29’6.76’’S, 20°29’28.16’’E) in the Western Cape). The surface of five *N. kraussianus* from Goukou (Western Cape) were also analysed: one from the biocoenosis, one from the thantatocoenosis (d’Errico et al., 2005), as well as two experimentally burned specimens and one burned and etched specimen; d’Errico et al., 2015). 3D scanning of a 877 x 660 µm representative surface of these shells was performed with a Sensofar S neox Confocal Imaging Profiler (Sensofar, Barcelone) after optical examination of the piece. Surfaces were scanned with a 20x objective allowing a lateral sampling interval of 0,645 µm and a vertical resolution of 0.02 µm.

Figure 4. Marine shells from the Pleistocene layers of Sibudu Cave. See Table 1 for contextual and descriptive information. 1-2: *Nassarius kraussianus,* 3-19: *Afrolittorina africana*; 20-23:

Mancinella capensis. Scale bar = 1 cm.

4.5. Experimental reference collections

Experimental criteria to identify techniques used to perforate *A. africana* are known in the literature (d'Errico et al., 2008). We have applied a similar approach to the other perforated gastropod species found at Sibudu, *Mancinella capensis.* Seven types of tools were used to perforate modern specimens of this species: a retouched lithic point, a small crab claw, a small pebble, and bone and wooden awls of two sizes. Shells were perforated by punching the body whorl through the aperture and from the outer dorsal side. The pebble was only used on the outer dorsal side. For all experimentally perforated shells we recorded the location, morphology, size, maximum diameter, and orientation of the perforations, the location of micro-chipping, and the height of the shell aperture.

Three fresh and two dead *Mancinella* shells were experimentally heated in a fire made from a large sheaf of *Cyperus involucratus* culms. The fire combusted the culms rapidly; the maximum temperate was in excess of 800ºC for five minutes, then the fire died immediately.

4.6. Archaeological shells

Both sides of the Sibudu shells were digitised at a resolution of 1200 dpi with an Epson Perfection 1660 Photo scanner. The resulting images served as a base to produce drawings of the two aspects of each shell with Adobe Illustrator. The archaeological specimens were also examined and photographed with a motorised Leica Z6 APOA equipped with a DFC420 digital camera and a Leica Application Suite (LAS) equipped with the Multifocus module. The Multifocus module is designed to acquire extended depth of field images from the microscope. Once digital images have been collected at different Z-positions, adapted algorithms combine them into one single sharp composite image that massively extends the depth of focus. Measurements were taken with a digital calliper. The location of spots of red pigment on shells was systematically recorded and selected spots were analysed with a Jobin-Yvon T64000 Raman spectrometer operated in triple subtractive mode. The 514.5 nm line of an argon ion laser was used as the excitation source. Backscattered spectra were collected via an Olympus BX40 microscope Raman attachment, and the light dispersed via 1800 lines/mm gratings onto a liquid-nitrogen cooled CCD detector. Power for the sample was kept fairly low (1.2mW) to minimize localised heating effects. A narrow bandpass filter was used to remove laser plasma lines from the spectra. 3D scanning with a Confocal Imaging Profiler of a surface of a *N. kraussianus* from

Sibudu was performed as described above.

5. Results

5.1. Taxonomic identification

Twenty-three marine gastropods were recovered in the Pleistocene layers of Sibudu Cave (Table 1, Fig. 4). They belong to three species (*Afrolittorina africana*, *Mancinella capensis* and *Nassarius kraussianus*) living in different habitats and having a different diet. *Afrolittorina africana* (Krauss in Philippi, 1847) lives on exposed rocks located at the top of the intertidal shore along the coast or in the mouth of estuaries; they shelter in little pools and moist crevices, where they can be found in vast numbers (Branch and Branch, 1981; McQuaid, 1981). Juvenile *A. africana* feed on bacteria and diatoms, adults mainly on lichens and blue–green algae. *Mancinella capensis* (Petit de la Saussaye, 1852; Claremont et al., 2013), previously called *Reishia capensis* (Petit de la Saussaye, 1852), can be found living under rocks and in rock crevices in high energy wave action shores from low neap-tide downward. It feeds on large ascidians and gastropods such as *Burnupena* spp. (Marais and Seccombe, 2010). *Nassarius kraussianus* (Dunker, 1846) is a scavenging gastropod adapted to estuarine environments (Palmer, 1980; Branch et al., 1994). Present day distribution of *A. africana* and *M. capensis* ranges from Cape Aghulas to Northern Natal. *N. kraussianus* can be found all along the South African coast, except the North-West coast.

Table 1. Taxonomic, contextual and descriptive data on the gastropod shells found in the Middle Stone Age layers of Sibudu Cave.

Layer	Cultural attribution	Square	Number	Date	Species	Perforation	Pigment	Heating	Length (mm)	Perforation max. diam. (mm)	Perforation min. diam. (mm)	Number in Fig. 5
OMOD	Late MSA	A5a Hearth	2404	30/08/2005	*N. kraussianus*	no	no	no	6,67	na	na	1
OMOD	Late MSA	C3c	na	26/08/1999	*N. kraussianus*	yes	no	yes	8.30	6.26*	3.78*	2
GR2	HP	C4b	na	14/02/2009	*A. africana*	no	no	no	6.20	na	na	3
PGS	HP	B5d	2057	10/11/2004	*A. africana*	yes	no	no	5	2.4*	2.27*	*4*
RGS	SB	B4a	na	17/11/2009	*A. africana*	yes	no	no	5.55	1.28**	1.18**	5
RGS	SB	B4a	na	13/11/2009	*A. africana*	na	no	no	na	na	na	6
RGS	SB	B4c	na	15/11/2009	*A. africana*	na	yes	no	na	na	na	7
RGS	SB	B4d	na	15/11/2009	*A. africana*	na	no	yes	8,5	na	na	8
RGS	SB	B5a Hearth	1989	11/11/2004	*A. africana*	yes	yes	yes	5.79	2.8*	2.46*	*9*
RGS	SB	B5a Hearth	1989	11/11/2004	*A. africana*	no	no	yes	7.97	na	na	*10*
RGS	SB	B5c	1991	11/11/2004	*A. africana*	no	no	no	5.33	na	na	*11*
RGS	SB	B5c	1988	11/11/2004	*M. capensis*	na	no	yes	na	na	na	20
RGS true 2	SB	B4a	na	17/11/2009	*A. africana*	na	yes	no	na	na	na	12
RGS true 2	SB	B4c	na	17/11/2009	*M. capensis*	yes	no	no	10,5	2.8	1.8	21
RGS brown	SB	B4c	na	23/11/2009	*M. capensis*	na	yes	yes	18.60	na	na	22
RGS brown 2	SB	B4a	na	24/11/2009	*A. africana*	yes	no	no	6.20	2.91	2.40	13
RGS brown 2	SB	B4c	na	25/11/2009	*A. africana*	yes	no	yes	6.15	1.75	1.22	14
RGS2	SB	B4a	na	27/11/2009	*A. africana*	yes	no	no	6.11	2.23	1.52	15
RGS2	SB	B4a	na	27/11/2009	*A. africana*	no	yes	no	na	na	na	16
RGS2	SB	B4a	na	27/11/2009	*A. africana*	na	no	yes	na	na	na	17
RGS2	SB	B6a	na	16/11/2004	*A. africana*	yes	no	yes	6.14	2.27	1.67	*18*
RGS2	SB	B6a	na	16/11/2004	*A. africana*	no	no	yes	na	na	na	*19*
LBG	pre-SB	B5a	2062	14-18/11/2004	*M. capensis*	na	yes	no	na	na	na	23

*N.: Nassarius; A: Afrolittorina; M.: Mancinella; na: not applicable; *perforation with post-depositional damage; **perforation produced by chemical alteration;*
MSA: Middle Stone Age, HP: Howiesons Poorts, SB: Still Bay, figure numbers in ***italics*** indicate shells published in d'Errico *et al.* 2008.

Table 1. Taxonomic, contextual and descriptive data on the gastropod shells found in the Middle Stone Age layers of Sibudu Cave.

5.2. Analysis of the biocoenoses and thanatocoenoses

The survey of two marine shell biocoenoses along the Dolphin coast allowed for the identification of marine gastropods belonging to 18 genera, among which *Afrolittorina*, *Cypraea*, *Littorina*, *Nerita*, *Nodilittorina* and *Turbo* are the most represented (Table 2).

Table 2. Marine gastropods collected in modern bio- and thanatocoenoses on the Dolphin coast of Kwa-Zulu-Natal

	Biocoenosis		Thanatocoenosis						Fragmentation					Sibudu				
Genus	Ballito	Shaka	Ballito	Shaka	Emerald	Umdloti	N	%	1	2	3	4	5	R	PHP	HP	SB	PSB
Afrolittorina*	•••	•••	-	-	5	-	5	1,1	5	-	-	-	-	-	-	-	2	-
Agrobuccinum	-	-	1	2	-	1	4	0,9	-	-	-	2	2	-	-	-	-	-
Buffonaria	-	-	4	4	-	5	13	2,9	-	-	1	3	9	-	-	-	-	-
Bullia	-	-	52	-	-	9****	61	13,4	38	14	6	3	-	-	-	-	-	-
Burnupena	••	-	13	26	-	10	49	10,8	-	1	6	8	34	-	-	-	-	-
Bursa	•	•	-	-	-	3	3	0,7	-	-	-	1	2	-	-	-	-	-
Charonia	-	-	-	-	2	4	6	1,3	-	-	-	3	3	-	-	-	-	-
Conus	-	•	2	1	14	4	21	4,6	-	-	-	3	18	-	-	-	-	-
Crepidula	-	-	1	-	-	1	2	0,4	1	1	-	-	-	-	-	-	-	-
Cronia	••	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cymatium	-	-	15	8	14	6	43	9,5	1	2	2	5	33	-	-	-	-	-
Cypraea	-	•••	2	5	7	10	24	5,3	7	-	-	5	12	-	-	-	-	-
Epitonium	-	-	1	-	-	1	2	0,4	-	2	-	-	-	-	-	-	-	-
Ficus	-	-	2	1	-	-	3	0,7	-	-	1	1	1	-	-	-	-	-
Fusinus	-	-	-	-	-	1	1	0,2	-	-	-	-	1	-	-	-	-	-
Hydatina	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Janthina	-	-	2	-	3	4	9	2,0	-	7	2	-	-	-	-	-	-	-
Littorina	••	••	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mancinella***	••	-	8	44	6	-	58	12,7	-	-	-	4	54	-	-	-	3	1?
Minolia	-	-	3	-	-	-	3	0,7	1	1	1	-	-	-	-	-	-	-
Morula	•••	-	-	2	1	-	3	0,7	1	-	-	1	1	-	-	-	-	-
Natica	-	-	-	1	-	-	1	0,2	-	-	-	-	1	-	-	-	-	-
Nassarius**	-	-	5	-	-	-	5	1,1	3	2	-	-	-	-	2	-	-	-
Nerita	•••	•••	6	12	-	-	18	4,0	3	2	7	4	2	-	-	-	-	-
Nodilittorina	••	••	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oliva	-	-	-	2	1	3	6	1,3	-	3	-	1	2	-	-	-	-	-
Oxystele	-	-	17	13	-	8	38	8,4	24	8	2	1	3	-	-	-	2	-
Peristernea	•••	-	-	1	1	1	3	0,7	2	-	-	-	1	-	-	-	-	-
Phalium	-	-	-	3	1	-	4	0,9	-	-	-	-	4	-	-	-	-	-
Philippia	-	-	-	-	1	-	1	0,2	-	1	-	-	-	-	-	-	-	-
Purpura	-	-	-	2	-	-	2	0,4	-	-	-	-	2	-	-	-	-	-
Ranella	-	•	4	-	8	8	20	4,4	-	-	1	-	19	-	-	-	-	-
Strombus	-	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thais	•	-	2	5	4	1	12	2,6	1	2	-	2	7	-	-	7		-
Throchus	•	•	2	-	1	1	4	0,9	1	2	1	-	-	-	-	-	-	-
Tonna	-	-	1	2	4	5	12	2,6	-	-	-	4	8	-	-	-	1	-
Tricolia	-	-	12	-	3	2	17	3,7	16	1	-	-	-	-	-	2	3	1
Turbo	•••	•••	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turritella	-	-	-	-	-	2	2	0,4	-	2	-	-	-	-	-	-	-	-
Total	-	-	155	134	76	81	455		104	51	30	51	219	-	2	9	11	1
Indetermined	-	-	11	37	10	13	70	13,4	-	-	-	2	67	1	4	36	1	7

•: present, ••: abundant, •••: very abundant, R: recent, HP: Howiesons Poort, SB: Still Bay, PHP: Post Howiesons Poort, PSB: Pre-Still Bay
*: *Afrolittorina africana*, **: *Nassarius kraussianus* , ***: *Mancinella capensis* , ****: one specimen bears a perforation on the body whorl

Table 2. Marin gastropods collected in modern bio- and thanatocoenoses on the Dolphin coast of KwaZulu Natal.

Analysis of four thanatocoenoses along the same coast identified between 17 and 22 genera (Table 2). *Conu*s, *Cymathium*, *Cypraea*, *Thais* and *Tonna* are found in all samples. Of the three shell species found at Sibudu, only two, *A. africana* and *M. capensis*, are found alive on present day shores of the Ballito Bay area (Table 2, Fig. 4). Although the biocoenosis of this species was not surveyed by us, *N. kraussianus* is likely living in local estuaries and reported from the Mzingazi in Richards Bay, 120 km up north (Teske et al., 2007). The scarcity of dead *A. africana* and the fragmentary state of *M. capensis* are probably due to the strong wave action, which crushes or breaks them as soon as they are dislodged by waves. *N. kraussianus* is apparently more resistant to wave action as we found it on the Ballito Bay shores, 5 km away from the closest estuary. The degree of fragmentation varies according to genera (Table 2, Fig. 5).

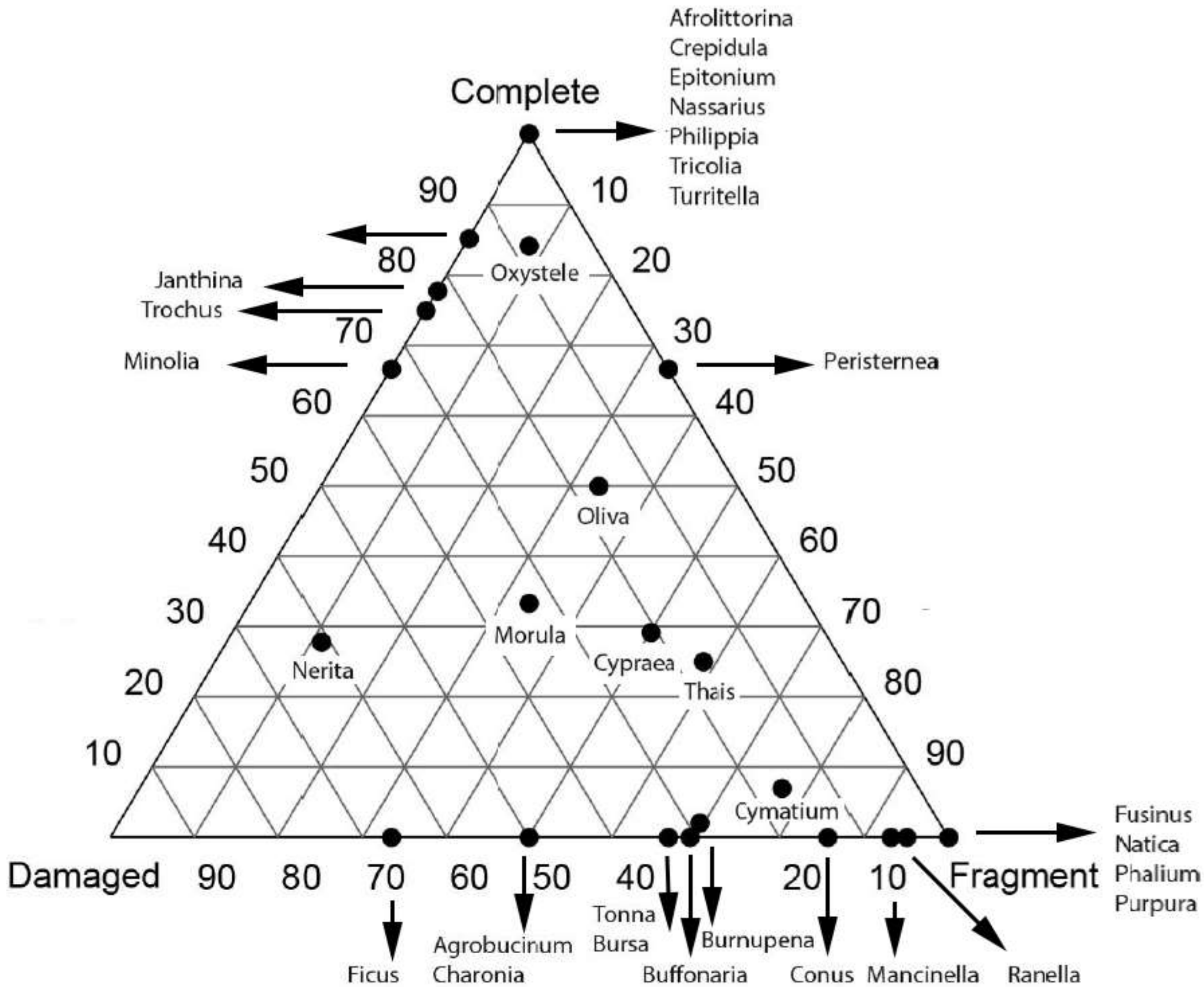


Figure 5. Ternary taphogram showing the state of fragmentation of identified marine shells genera found on the Dolphine's coast beaches. See methods and Table 2 for information on how the taphogram was made and on which malacological reference collections were included.

Afrolittorina, Bullia, Crepidula, Epitonium, Nassarius, Oxystele, Peristernia, Philippia, Tricolia and *Turritella* are most often complete, while *Agrobuccinum, Buffonaria, Burnupena, Bursa, Charonia, Conus, Ficus, Fusinus, Mancinella, Natica, Phalium, Purpura, Ranella*, and *Tonna,* are only found as damaged specimens or fragments. The remainder of the genera are represented by at least one complete or almost complete specimen.

Natural perforations only occur on two species, *Nassarius* and *Burnupen*a. Nine out of ten *Nassarius* found on Ballito Bay and Thongathi beaches bear perforations, three on the ventral and seven on the dorsal side. Perforations on the ventral aspect of the recovered *Nassarius* consist of worn holes bored into the shell by *Natica* (Palmer, 1980), those on the dorsal aspect result from mechanical abrasion by sand and wave action on the beach (Fig. 6).

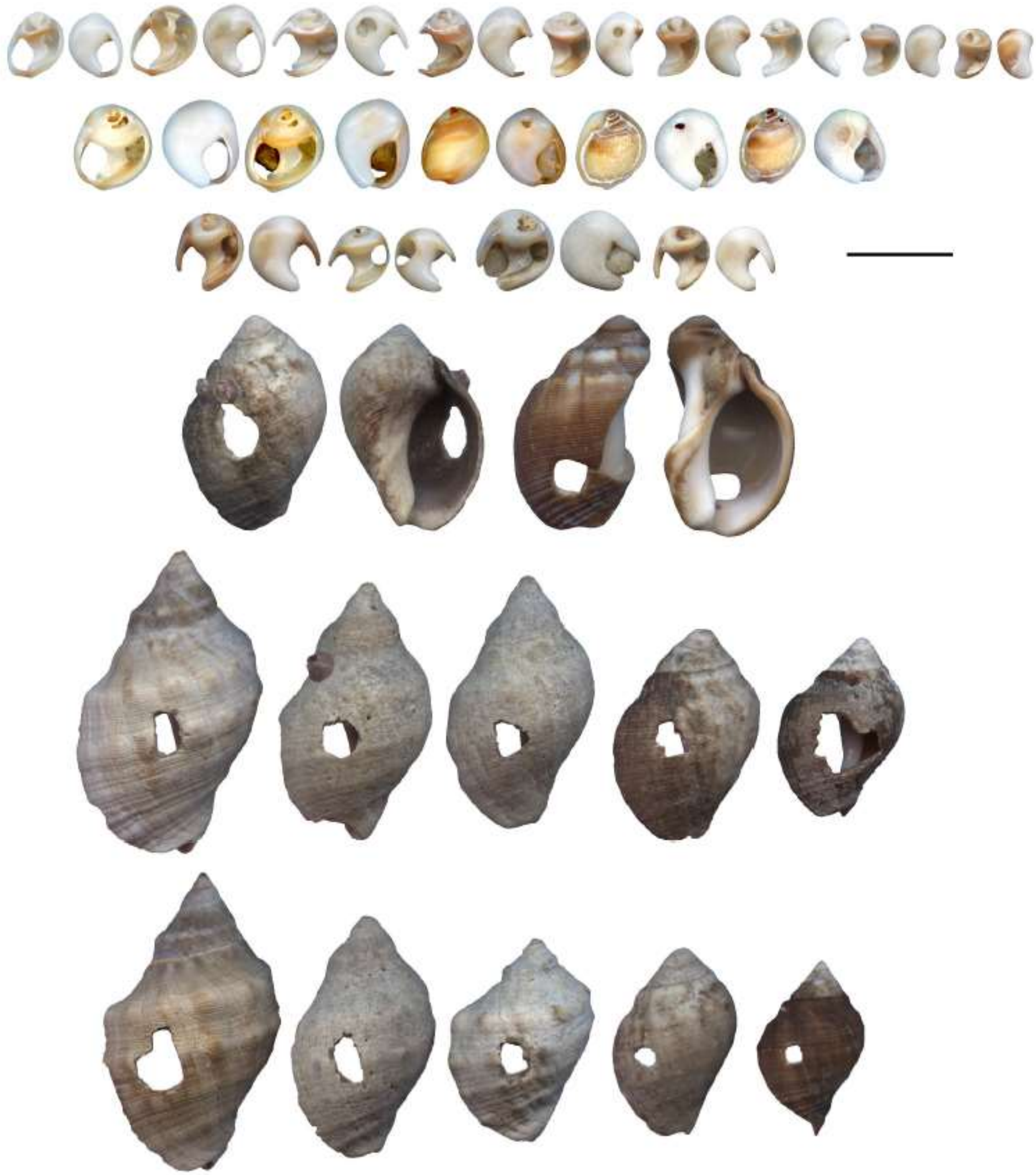
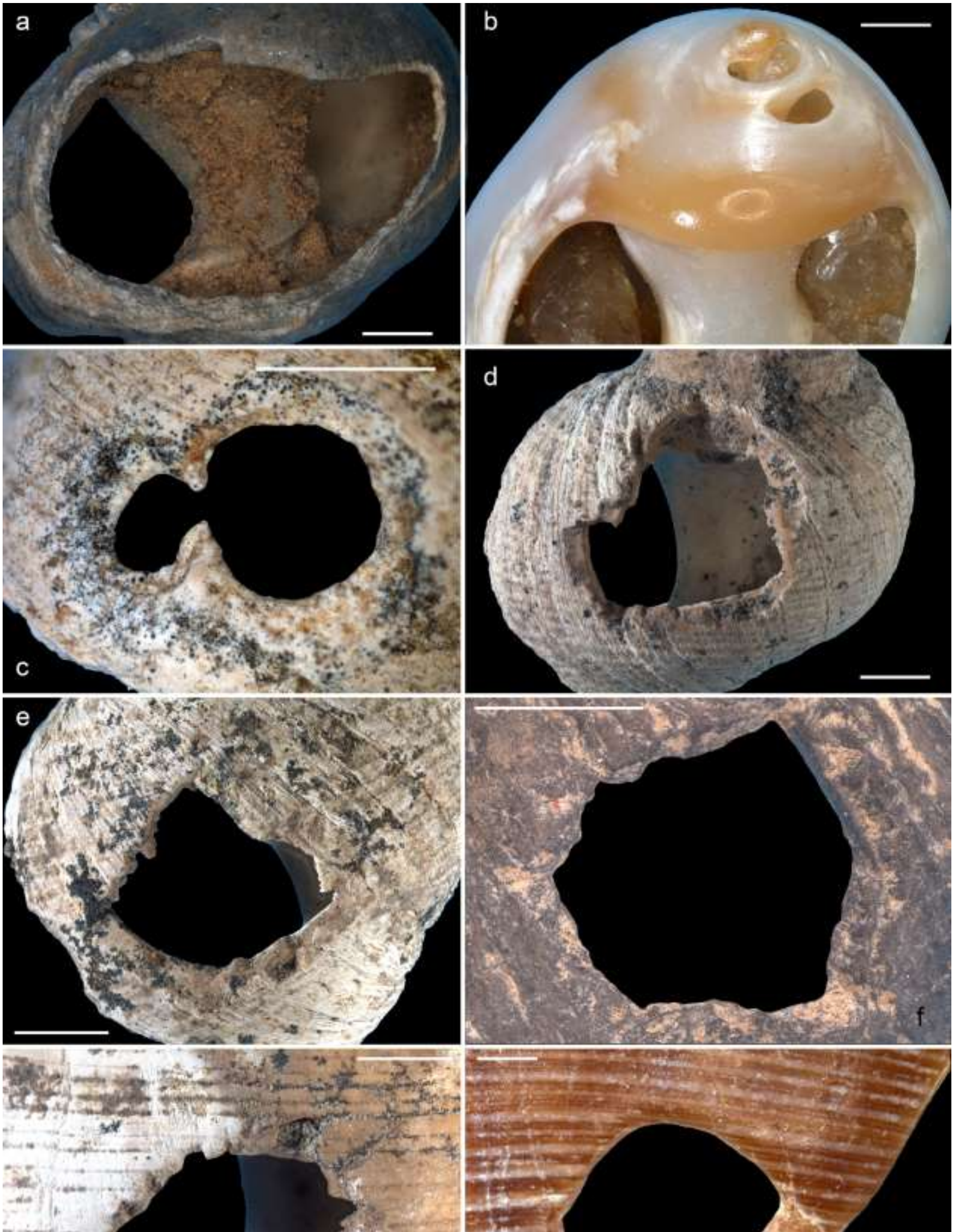


Figure 6. Top: *Nassarius kraussianus* collected dead on the sandy beaches of Die Hoop in the top row, Ballito Bay in the middle row and close to the uThongathi River in the bottom row. Bottom: *Mancinella capensis* and *Burnupena burnupena* with natural perforations (top row) and experimental perforations made with a stone (middle row) and a bone tool (bottom row) exerting pressure on the inside of the shell through its aperture.

All perforated beached *Nassarius* display granules firmly stuck within the shell's interior. Alterations on *Nassarius* from Ballito and Thongathi thanatocoenoses differ from those recorded on dead *Nassarius* from estuarine environments (d'Errico et al., 2005: 12, fig.4) where gradual decalcification in calm waters is the main taphonomic agent. The latter are porous and display perforations with thin, crenulated edges resulting from the gradual weakening of the shell wall whereas Ballito and Thongathi *Nassarius* are not etched, have smooth hole-edges and a shiny appearance (Fig. 6). At microscopic scale, micro-pits due to impacts are observed (Fig. 7b). Abrasion first produces sub-millimetric perforations on the spire, then causes an enlargement of that perforation, the opening of a second millimetric perforation on the spire, the removal of the apex and the opening of a wide perforation on the body whorl that increases its size until partial removal of the shell's lip. The surviving segment of the lip takes a typical pointed morphology characteristic of beach worn *Nassarius* (Fig. 6). Only one fragment of *Burnupena* over the 49 collected bears a sub-circular worn perforation of unknown origin (Fig. 7h).


a
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h

Figure 7. Macro photos of a) the perforated *Nassarius kraussianus* from Sibudu (Fig. 4 n°2), b) a beach worn *Nassarius kraussianus*, c) two very small juxtaposed perforations interpreted as resulting from a chemical alteration on *Afrolittorina africana* (Fig. 4 n°5), d-e) perforations on *Afrolittorina africana* (Fig. 4 n°15 and 14) that must result from pressure on the inside of the shell, g) perforation on *Mancinella capensis* (Fig. 4 n°21), and h) natural perforation on Burnupena from Umdloti.

5.3. Stratigraphic and spatial distribution.

Marine gastropods were recovered in the pre-Still Bay, Still Bay, Howiesons Poort and late MSA layers (Table 1). *N. kraussianus* is only found in the late MSA, *A. africana* in different Howiesons Poort and Still Bay layers, *M. capensis* in the Still Bay and possibly in the pre-Still Bay. The discovery of a single *A. africana* in the lowermost Howiesons Poort layer PGS and the nature and thickness of this layer has suggested (d'Errico et al., 2008) that this specimen may have derived from the underlying Still Bay layer RGS, where most of the other shells were found. The enlarged collection of marine gastropods described here includes another *A. africana* from Howiesons Poort layer GR2, which confirms the presence of marine gastropods in Sibudu Howiesons Poort layers.

In Still Bay layers two clusters of five and four perforated *A. africana* shells were found in the same lens subdivided in three sub-units of different colour (RGS, RGS brown, RGS true). The first cluster is associated with two hearths (H3-4); the other is located East of hearths H3 and H5 (Fig. 3). Two lumps of ochre occur together with the second cluster in B4a (Fig. 3). Two other clusters of three and two shells were found in the underlying lens RGS2: one in the same location as the second cluster of the overlying lens RGS; the other in sub-square B6a (Fig. 3). Another piece of ochre is found nearby and a fourth one at one meter in square C4 (Fig. 3). The three Still Bay *M. capensis* were found within the first cluster of lens RGS (Fig. 3). This clustering of the perforated shells contrasts with the dispersed distribution of bifacial points and point fragments in the same layer (Fig. 3).

5.4. Taphonomic and technological analysis

The absence of features diagnostic of estuarine (d'Errico et al., 2005) or beach induced alterations (Fig. 6, 7) suggests that the two *N. kraussianus* from the late MSA layer OMOD were either collected alive or within an estuarine thanatocoenosis soon after their death. One is complete

(Fig. 4 n°1), the other (Fig. 4 n°2) bears a perforation on the dorsal aspect and traces of heating that caused blackening and weakening of the shell (d'Errico et al., 2015). The latter has probably favoured the micro breakage of most of the perforation edge (Fig. 7a). A portion of the original perforation edge is nevertheless preserved and reveals a smooth appearance comparable to that produced on experimentally worn *N. kraussianus* (Vanhaeren et al. 2013). Although the smoothing visible on the preserved portion of the original perforation edge is comparable to that observed on highly abraded beach worn *N. krausianus*, such a taphonomic process can be discarded for this archaeological specimen since it would entail advanced damage, not observed here, on the spire.

Of the 17 *A. africana*, four are complete or only slightly damaged (Fig. 4 n°3,10,11 and 19), seven have a perforation on the body whorl (Fig. 4 n°4,5,9,13-15 and 18), two have their body whorl partially removed by breakage (Fig. 4 n° 8 and 17), three are apical fragments (Fig. 4 n°6-7 and 12), and one consists of a portion of the body whorl (Fig. 4 n°16). Seven are blackened by heating and four bear micro-residues of red material (Table 1). Among the seven perforated shells, one displays two conical contiguous perforations with evidence of etching suggesting chemical dissolution (Fig. n°7c). The perforations on the other *A. africana* (Fig. 7d-f) are similar to those produced experimentally by punching the inner aspect of the body whorl, i.e. through the aperture, with a pointed tool (d'Errico et al., 2008, Fig. 7-8). This is suggested by their location and the presence of micro-chipping around the perforation edge on the outer surface of the shell. In one case (Fig. 4 n°18) this action was performed twice (d'Errico et al., 2008), probably to re-use the shell after breakage of the first perforation. In two cases, post-depositional damage of the original perforation (fig. 4 n°4 et 9) prevents identifying the morphology of the tool-tip used to produce the holes. The hole morphology and location on the other specimens support the use of a thin point made of bone or hard wood. Microscopic analysis of these perforations reveals no obvious traces of use-wear (Fig. 7).

Of the three (Fig. 4 n°20-22), possibly four (Fig. 4 n°23), *M. capensis*, one (Fig. 4 n°22) is well preserved, blackened by heating, and misses its outer lip and a part of the adjacent body whorl. A second (Fig. 4 n°21) exhibits a perforation on the body whorl, a broken outer lip with post depositional damage, and misses its apex. A third (Fig.4 n°20) is only represented by a small portion of a body whorl which is blackened by heating and displays crenulated edges identical to those observed on specimens of the same species experimentally broken by intense heating. The fourth specimen, possibly *M. capensis* (Fig. 4 n°23), consists of a fragment which displays, on one side, a crenulated edge similar to the one described for the third specimen. On the other sides, it has smoothed edges as well as an orange stain on the dorsal and the ventral aspect which contrasts with the light brownish grey colour of the sediment of layer LGB.

Experimental attempts to perforate *M. capensis* shells reveal that punching the shell from the outer surface is ineffective whatever tool-type (bone or lithic point) used. Pressure through the aperture with a bone or lithic point resulted in sub-rectangular perforations with edges exposing the inner prismatic layer and occasional micro-chipping (Fig. 6). These features are also found on the single perforated *M. capensis* from Sibudu (Fig. 4 n°21). As with the *A. africana*, the perforation on the *M. capensis* shows no compelling evidence of usewear.

6. Discussion

In previous papers we reviewed the potential causes for the accumulation of marine gastropods at inland southern African sites (d'Errico et al., 2005, 2008) and concluded that humans were to be considered the more likely agent responsible for the accumulation and modification of six *A. africana* found at Sibudu (d'Errico et al., 2008). Analyses of 17 supplementary gastropods (*A. africana, N. kraussianus and M. capensis*) from Sibudu MSA layers, local bio- and thanatocoenoses, and additional perforation experiments allow us to assess this diagnosis anew. The distance of Sibudu from the sea during its Pleistocene occupation rules out the possibility that these marine shells were accumulated by natural processes. The survey and fragmentation analysis of natural gastropod assemblages confirm that the Sibudu gastropod collection is not representative of present day biocoenoses or thanatocoenoses of the Dolphin Coast. Taxa well represented in the biocoenoses such as *Burnupena, Littorina, Morula, Nerita, Nodilittorina, and Peristerna*, are absent at Sibudu. Similary, *Bullia, Burnupena, Cymatium, Oxystele*, and *Ranella*, representing 50% of present day thanatocoenoses, are absent at Sibudu. It is unlikely that the Sibudu gastropods were collected for consumption or to be used as tools. Almost all of them are tiny gastropods with low caloric value (2 kcal for 0.4 g of dry soft tissue extracted from 100 *A. africana* and 4 kcal for 0.8 g extracted from 100 *N. kraussianus*; d'Errico et al., 2005, 2008) which makes a subsistence strategy based on transporting them for 15 km ineffective. Although the bivalves, like *Perna perna*, which is present at the site, and a few gastropods found at Sibudu could have been transported for food, their low numbers suggest that the consumption of seafood, if it did occur, was only occasional at the site (Plug, 2006). The small size of the gastropods is also in contradiction with their use as tools (e.g. containers).

Sibudu *N. kraussianus* shells bear surface features that are incompatible with a gathering of dead specimens on beaches and rather point to a collection of living specimens or a thanatocoenosis

soon after the death of the organisms in their estuarine habitat. *N. kraussianus* is listed among the 64 species of marine shells found in the stomach of a loggerhead sea turtle (*Caretta caretta*) (Hughes, 1974). The identification of remains of this species in the MSA layers of Sibudu (Plug, 2006) opens the possibility that *N. kraussianus* reached the site accidentally in the stomach of prey. *Caretta caretta* crushes large gastropod shells before ingurgitating them as they are only found in the form of fragments in the turtle's stomach (Hughes, pers. com.). Small gastropods, such as *N. kraussianus*, are probably swallowed whole. However, it is unlikely that *Caretta caretta* made the keyhole perforation on one of the two Sibudu *N. kraussianus*. This perforation type is rarely found in estuarine thanatocoenoses and when it does it only occurs on decalcified shells (d'Errico et al., 2005), which is not the case for the Sibudu specimen. The state of preservation of this archaeological specimen is also incompatible with the use-wear observed on beach worn *Nassarius*. In contrast, even if damaged, the use wear on a well preserved portion of the perforation edge is comparable to that observed on archaeological and experimental *N. kraussianus* shells used as beads (Vanhaeren et al., 2013). The use of *N. kraussianus* as beads is documented in the Still Bay of Blombos Cave, dated to ca. 72 ka (Henshilwood et al., 2004) and in the Early Later Stone Age of Border Cave, dated to between 42-44 ka cal BP (d'Errico et al., 2012). The perforated Sibudu *N. kraussianus* comes from a layer dated 46.6 ± 2.3 ka (Jacobs 2008a). Transport in the stomach of a turtle cannot be discarded for the complete *N. kraussianus*. Its occurrence in the same late MSA layer as the perforated specimen makes it however equally possible that it corresponds to a shell lost or discarded before being perforated to be used as bead.
No natural agents are known to bring *A. africana* or *M. capensis* to inland sites and neither of these two species is reported as being found in the stomach of identified prey at Sibudu.
Littorinidae are present in the Still Bay layers of Blombos Cave (d'Errico et al., 2005) and the MSA layers of Klasies River (Thackeray, 1988). Due to lack of clear human induced modifications, they have been interpreted as "incidental shells" which came to the site accidentally with seafood (e.g. attached to the byssus of mussels). This is unlikely for the *A. africana* from Sibudu considering the scarcity of shellfish consumption at this site. Also, none of these Littorinidae from Blombos or Klasies River are perforated, while a third of those from Sibudu are, and another third may have been perforated before post-depositional damage.
The spatial distribution of *A. africana* and *M. capensis* provides clues for discussing the reasons for their presence at the site. Contrary to the lithic bifacial points, found all over the excavated area, perforated and clearly unperforated gastropods are found in clusters associated with some hearths and are absent around other hearths (Fig. 3). This indicates that different spatial use and

patterns of discard applied to the shells and the points. It also suggests that the loss or disposal of the shells is the consequence of an activity conducted close to hearths but that this activity did not systematically occur every time a hearth was created and maintained. This pattern also contradicts the hypothesis according to which the shells found at the site correspond to accidental losses of individual beads during a variety of everyday activities. If this was the case, one would expect to find a more widespread if not random distribution of exclusively perforated or broken shells. The observed spatial distribution is compatible with an occasional subsistence activity or the manufacture or maintenance of beadwork.

The perforations observed on the Sibudu *A. africana* are of three types: 1) natural perforation either made by a scavenger or by post-depositional chemical dissolution (Fig. 4 n°5), 2) perforations produced and/or enlarged by post-depositional processes for which an anthropogenic intervention is difficult to prove (Fig. 4 n°4 and 9) and 3) small perforations with features implying that they have been produced by punching the shell through its aperture (Fig. 4 n°13-15 and 18). The only perforated *M. capensis* (Fig. 4 n°21) falls in this last category.

Considering the small caloric value of *A. africana*, shells belonging to this last category could well have been intended for beads. Microscopic analysis of their perforation edges identifies no or undiagnostic use-wear that would unambiguously demonstrate their use as beads. The absence of use-wear could be explained by the fact that 1) they have been lost or disposed before use-wear could develop, 2) they were attached in such a way that use-wear could not develop, 3) their use as beads produced breakage of the perforation edges rather than identifiable wear, 4) they have been perforated by humans for an unknown reason, and 5) the perforations were made by an unknown natural agent. The first two hypotheses are consistent with the spatial distribution of archaeological finds within layer RGS and RGS2. The third hypothesis is contradicted by the presence, among the perforated specimens, of small perforations that can hardly result from enlargement of previously even tinier holes (Fig.4 n°14). The fourth and fifth hypotheses are difficult to test at present as they would require a larger assemblage and, probably, the creation of an experimental protocol seeking to explore the impact of post-depositional damage on shells incorporated in Southern Africa multi-layered MSA sequences in shelters and cave.

7. Conclusions

Three species of perforated marine shell were found in MSA layers of Sibudu: *Nassarius kraussianus, Afrolittorina africana* and *Mancinella capensis*. *Nassarius kraussianus* was found only in the late MSA in OMOD layer dated to ca 47 ka; it did not occur in Howiesons Poort or earlier industries. A *N. kraussianus* shell bead and an unperforated shell belonging to the same species were recovered from OMOD. The perforated shell had been heated. *N. kraussianus* was found at Border Cave, north of Sibudu, in early LSA contexts. It was first used as a personal ornament in the Western Cape Still Bay. Sibudu confirms what has been recently highlighted at Border Cave (d'Errico et al., 2012): after an early introduction, for example at Blombos, this species was subsequently used to produce beads at late MSA/early LSA sites located along the eastern flank of South Africa. The absence, at Sibudu, of ostrich eggshell beads, found at Border Cave in association with the *N. kraussianus*, may indicate that ostrich eggshell beads are an intrusive phenomenon in this part of southern Africa and that in the earliest phases of their spread their distribution may have been restricted to north-east KwaZulu-Natal. Ostrich did not, and does not, occur in the Sibudu area, and no ostrich bones or eggshell occur in the MSA layers of the site.

Seven perforated *A. africana* shells were found in Sibudu, as well as ten unperforated *A. africana* shells. Six perforated *A. africana* shells were from the Still Bay and one from the Howiesons Poort, though the Howiesons Poort one may be misplaced from the Still Bay as the result of rock fall disturbance. Three of the unperforated and one perforated shell showed traces of pigment, while three perforated and four unperforated shells had been heated. The only perforated *M. capensis* shell was found in the Still Bay and this shell's small perforation has features implying that it was produced by punching the shell through its aperture. Three unperforated *M. capensis* shells were found in the Still Bay; two had traces of pigment in them and two had been heated.

The interpretation of Sibudu's *A. africana* shells as beads used for a short time only, together with unused shells, or shells intended for perforation represents, at present, the most parsimonious explanation for this evidence. However, we are still far from the degree of certainty attained at other MSA sites from northern and southern Africa where the larger number of specimens found, and the consistency in traces of manufacture and utilisation make the diagnosis more robust. If formally demonstrated, the use of shell beads at Sibudu during the late MSA, Howiesons Poort and Still Bay occupations would represent supporting evidence for shell bead use in the Howiesons Poort and early LSA, already suggested for Border Cave (d'Errico et al. 2012; Beaumont and Bednarik, 2013). Furthermore, it would corroborate the evidence for comparable behaviour by Still Bay populations, attested at Blombos Cave (Henshilwood et al., 2004). The use of different shell species for making beads at Sibudu suggests that the Howiesons Poort and the Still Bay are not a homogeneous cultural phenomenon. Instead, these entities are associated, in different regions of southern Africa, with distinct bone tool technologies (d'Errico et al. 2012) as well as personal ornament traditions (d'Errico and Backwell, 2016). Moreover, the presence of *N. kraussianus* beads in Sibudu's final MSA and Border Cave's early LSA points to dynamically changing traditions through time.

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