Filling-in the gaps and testing past scenarios on the central West Coast: hunter-gatherer subsistence and mobility...

Article *in* The South African Archaeological Bulletin · June 2016

Antonieta Jerardino
University of South Africa

Field and Technical Report

FILLING IN THE GAPS AND TESTING PAST SCENARIOS ON THE CENTRAL WEST COAST: HUNTER-GATHERER SUBSISTENCE AND MOBILITY AT 'DEURSPRING 16' SHELL MIDDEN, LAMBERTS BAY, SOUTH AFRICA

ANTONIETA JERARDINO[1,2]*, JONATHAN KAPLAN[3], RENÉ NAVARRO[4] &
PETER NILSSEN[5]

[1]*Department of Anthropology, Faculty of Social Sciences, University of Chile, Av. Capitán Ignacio Carrera Pinto 1045, Santiago, Chile*
[2]*Department of Anthropology & Archaeology, School of Humanities, University of South Africa, P.O. Box 392, UNISA, Pretoria, 0003, South Africa*
**Corresponding author. E-mail: amsjerardino@gmail.com*
[3]*Agency for Cultural Resource Management, 5 Stuart Road, Rondebosch, 7700, South Africa*
[4]*Animal Demography Unit, Department of Biological Sciences, University of Cape Town, Rondebosch, 7701, South Africa*
[5]*Point of Human Origins, P.O. Box 2635, Mossel Bay, 6500, South Africa*

(Received December 2015. Revised February 2016)

ABSTRACT

This paper presents the first detailed report on mid-Holocene faunal and artefactual observations from Deurspring 16 (DSP16) shell midden situated on the central West Coast of South Africa. DSP16 also yielded late Holocene material. Until recently, the mid-Holocene record eschewed most but not all research efforts. Likewise, systematic studies on the abundant late-Holocene record of this region suggest a trajectory of hunter-gatherer resource intensification and limited group mobility. DSP16 observations show that mid-Holocene group mobility involved long distances and that visits were either brief and/or undertaken by small groups. People procured large and small terrestrial prey, and shellfish were a dietary complement. Stone tool kits were manufactured on mostly exotic silcrete, with scrapers and backed pieces being dominant among formal tools. Subsequent late-Holocene patterns shifted radically: site visits were probably longer, mobility became increasingly circumscribed to the coast and Sandveld, and subsistence relied heavily on marine resources while small terrestrial prey was also procured. Locally-available quartz and quartzite was favoured over silcrete in stone tool production, and backed pieces were gradually dropped in favour of scrapers among formal tools. These results and those from other sites show that i) the central West Coast was not as uninhabited during the mid-Holocene as previously thought, and that ii) a late-Holocene resource intensification model adequately accounts for the settlement and subsistence trends in this region.

Key words: hunter-gatherer subsistence, mobility, mid and late Holocene, shell middens, Deurspring 16.

INTRODUCTION

Long-term archaeological research projects in any region of the world should aim at establishing a cultural sequence with as many observations as possible and adequate chronometric control. In this respect, much has been done in the Elands Bay and Lamberts Bay areas (central West Coast of South Africa) over the last thirty-five years, but temporal gaps and uneven representation of time slices among studied sites still remain (Parkington *et al*. 1988; Jerardino *et al*. 2013). The Pleistocene/Holocene transition and early Holocene record, for instance, is mainly reflected at Elands Bay Cave, with additional observations being made at Tortoise Cave (Parkington *et al*. 1988; Robey 1987; Jerardino *et al*. 2013). Unlike the longer sequences in these caves, the majority of other studied sites in the area were dated to within the last 4000 years.

The longer sequences at Elands Bay Cave and Tortoise Cave enabled the identification of an apparent mid-Holocene occupational hiatus dating between 8000 and 4400 BP. The hiatus was interpreted as having occurred as a result of a climatologically-driven decline in human demography and/or infrequent visits to the coast brought about by a combination of lower rainfall, higher atmospheric temperatures and the drowning of nearby productive intertidal reefs due to higher sea levels. A similar mid-Holocene occupational hiatus appeared to be present in parts of the dry interior Karoo region of South Africa (Deacon 1974), although archaeological sites in the better watered regions of the south and east coasts were occupied throughout this temporal gap (see Deacon & Deacon 1999; Binneman 2004/2005; Sealy *et al*. 2006). Similar explanations for low radiocarbon date frequencies in other dryland or climatically sensitive regions of the world have also been proposed (e.g. Conaty & Leach 1987; Glassow 1997; Helmer 1987; Gil *et al*. 2005; Méndez *et al*. 2015).

Subsequent excavations in the central West Coast (Kaplan 1994a,b; Jerardino & Swanepoel 1999; Orton & Compton 2006), however, suggest that at least some gaps in the occupational sequence reflect a sampling problem. Important taphonomic considerations also appear relevant when explaining this apparent gap as unravelled by geoarchaeological studies (Compton & Franceschini 2005). Available radiocarbon dates have for some time suggested this, but very little archaeological evidence informing on hunter-gatherer subsistence, technology, mobility and overall settlement patterns between 8000 and 4000 years ago has been published up to now. Such evidence would help to reveal how coastal hunter-gatherers reconfigured their adaptive strategies in the face of important shifts in the overall productivity of terrestrial and coastal ecosystems. Moreover, further observations for the last 4000 years would help test a scenario of population increase, circumscription of mobility and resource intensification put forward for the late Holocene (3800–2000 calibrated years before present [cal BP]) in the central West Coast (Jerardino 2010, 2012, 2013a,b; Jerardino *et al*. 2013). Consequently, the objective of this paper

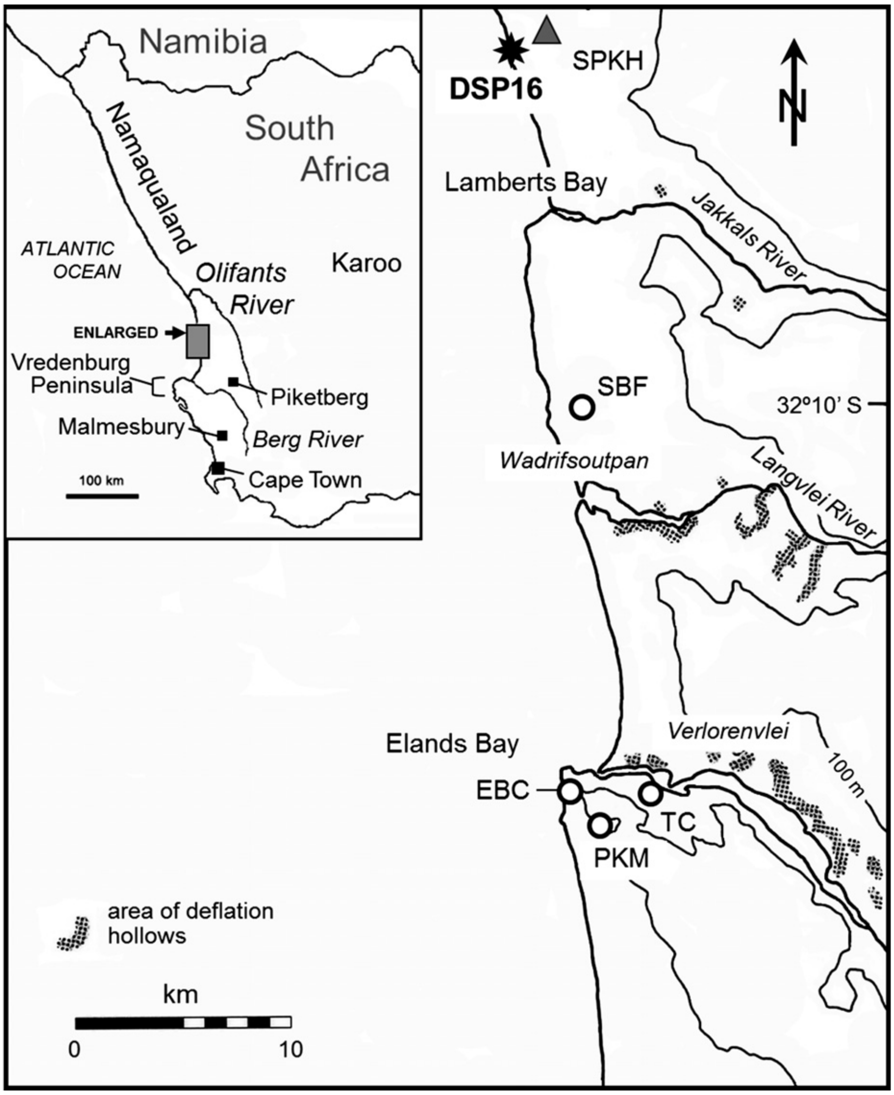

FIG. 1. *Map of the West Coast and study area showing location of sites and places mentioned in the text. Deurspring 16, DSP16; Elands Bay Cave, EBC; Pancho's Kitchen Midden, PKM; Soutpansklipheuwel, SPKH; Steenbokfontein Cave, SBF; Tortoise Cave, TC.*

is to present some of the first detailed observations on the mid- and late-Holocene faunal and artefactual material from Deurspring 16 (DSP16) shell midden, a site situated on the central South African West Coast. The emerging picture is that of an adaptive process that is integral to the remarkable resilience with which coastal groups ensured their existence on the West Coast despite significant environmental and demographic changes.

ENVIRONMENTAL BACKGROUND

THE ENVIRONMENT TODAY

The so-called Sandveld region in the Lamberts Bay area (hereafter referred to as the study area) is a gently undulating landscape rising inland to heights of approximately 100–120 m above sea level. Several sandstone outcrops or *koppies* of varying size are scattered within 5 km of the coast, among them is Soutpansklipheuwel (Fig. 1; Jerardino *et al.* 2014) some 3.5 km to the east of DSP16. The local environment is characterised today by a mixture of coastal fynbos and karroid shrub vegetation (Acocks 1975; Mucina & Rutherford 2006). Further north, the vegetation grades into the more arid Namaqualand Strandveld of the Succulent Karoo biome. Rainfall is relatively low at 150–120 mm (Chase & Meadows 2007) and falls mostly during the autumn and winter months (May–August), but plants also benefit from the seasonal moisture-bearing coastal fogs. A range of succulent and non-succulent shrubs with deciduous leaved geophytes are frequent on littoral dunes, while grasses are also locally common in places. Despite increasing agricultural activity, a few species of small, solitary browsing bovids, tortoises, colonies of rock hyrax (*dassie*), porcupines, hares and small carnivores still occur. In the recent past, these species were supplemented by larger animals such as eland and hartebeest (Skead 1980).

The cold Benguela Current exerts a strong influence on the West Coast environment (Shannon 1985). Generally cold waters (8–14°C), and a persistent upwelling cell on the northern edge of Cape Columbine, supports a high biomass and a diverse range of fauna and flora (Fig. 1). Subtidal kelp forests are the primary producers and the fronds and comminuted detritus support extensive shellfish beds (i.e. mussels, limpets, whelks and topshells), other species that prey on the molluscs (marine fish and birds) and top predators (Cape rock lobster, Cape fur seals, and humans) (Branch & Branch 1982). The shore at Deurspring displays a combination of extensive semi-vertical rock walls and flatter profile rocky platforms that receive the full impact of the Atlantic swells. Although no studies of the Deurspring shellfish community are known to us, it ought to follow the distributions of species richness and biomass reported for equivalent shores elsewhere on the West Coast (Bustamante

& Branch 1996; Bustamante *et al*. 1995, 1997). Filter feeders, such as rocky shore mussels and barnacles, would generally reach a high biomass on exposed shores such as this one, and the medium to large-sized low-intertidal *Scutellastra argenvillei* limpets would find the best conditions for their growth on the steeper rocks that characterise these reefs (Kilburn & Rippey 1992).

PALAEOENVIRONMENTAL SUMMARY

Moist conditions in the Elands Bay area around 13 000–10 000 cal BP (Chase & Meadows 2007; Parkington *et al*. 2000) gave way to opposite climatic trends *c*. 8300–4400 cal BP. This subsequent period is known as the 'Holocene Altithermal' or 'Climatic Optimum' and was characterised by a 2–3-metre sea level high stand with a brief regression *c*. 5400 cal BP (Fig. 2). Higher atmospheric temperatures (1–3°C), and general reduction in precipitation and vegetation cover at this time facilitated the movement of aeolian sands in coastal and near coastal environments (Compton 2001, 2006; Chase & Meadows 2007). Higher sea levels (*c*. 7800–6000 cal BP) situated the shoreline tens, if not a few hundred, metres further inland than at present (see Orton & Compton 2006) (Fig. 2). About 30 km to the south of DSP16, palaeoenvironmental records show that the present coastal lake of Verlorenvlei (Fig. 1) became an open and sheltered estuary (Miller *et al*. 1993, 1995; Compton 2001, 2006). It is possible that the existing sand barriers that closed off the sea access to the Jakkals River mouth in Lamberts Bay and to the current hypersaline wetland of Wadrifsoutpan (Fig. 1) were likely breached as a result of higher sea levels. Three Neoglacial episodes and a second and short, but important, warming trend punctuate the environmental history in the last 4400 years. These episodes occurred *c*. 4200 cal BP and between *c*. 2500 and 1800 cal BP and were characterised by atmospheric and sea surface cooling phases (Cohen *et al*. 1992; Jerardino 1995a). Minor but noticeable northward latitudinal shifts of moisture-bearing frontal systems and expansions of polar waters into the Benguela Current were probably part of the driving mechanisms.

EXCAVATIONS, STRATIGRAPHY AND DATING

DSP16 is an open shell midden located approximately 80 m from a rocky coastal headland with the same name, and about 8 km north of the town of Lamberts Bay (Fig. 1). The area known as 'Deurspring north' was first studied to determine the impact of a proposed housing development, during which DSP16 was identified and mitigation proposed. A permit for the archaeological work was issued by the National Monuments Council, and three excavation seasons were undertaken by the Agency for Cultural Resource Management (ACRM) between 22 February and 24 August 1994 (Kaplan 1994a,b). Due to the significance of the initial findings, a fourth excavation season was undertaken in March 1996 by the Archaeology Contracts Office (ACO) in conjunction with ACRM. This paper reports on this latter excavation and previous field seasons. Reaching depths that varied from 1–1.2 m, a total of 26 m^2 were excavated down to sterile sands. A total of eight squares (I6, I7, J7, J8, K8, L8, M8 and N8) were excavated in 1994 and an additional 18 squares (K9–K15, L9–L13, J11–J14, M11 and M12) were excavated in 1996. Disturbed material, such as rodent burrows, was isolated from the rest of the deposit and the spatial and stratigraphic provenance was mapped. A volume record of the removed deposit (bucket book) was kept during all excavation seasons (but see Layer 1 below). Some of the excavated material was sorted on site in 1994, but the majority of the 1996 material was sorted in the laboratory of the then existing Spatial Archaeology Research Unit at the Department of Archaeology, University of Cape Town.

The DSP16 stratigraphy is a succession of nearly horizontal shell midden strata of variable density and composition. The contents of the layers were excavated following natural stratigraphy whenever possible, although 50 mm spits were used regularly during the 1994 seasons. Upon inspection of section drawings and field notes, excavated units and spits were grouped into five main stratigraphic layers. It is important to note that Layers 1 and 2 appearing in initial excavation reports (Kaplan 1994a, b) correspond to Layer 1 reported here. Layers 3 and 4 are largely equivalent for both excavation years. The shell

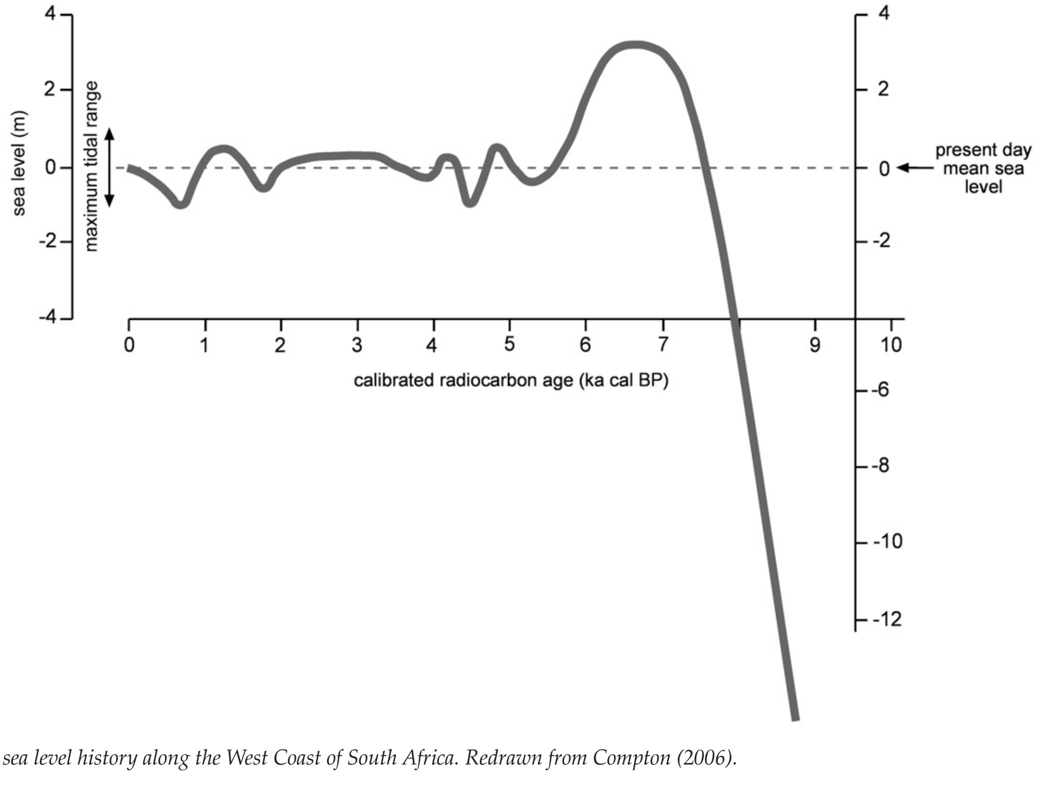

FIG. 2. *Holocene sea level history along the West Coast of South Africa. Redrawn from Compton (2006).*

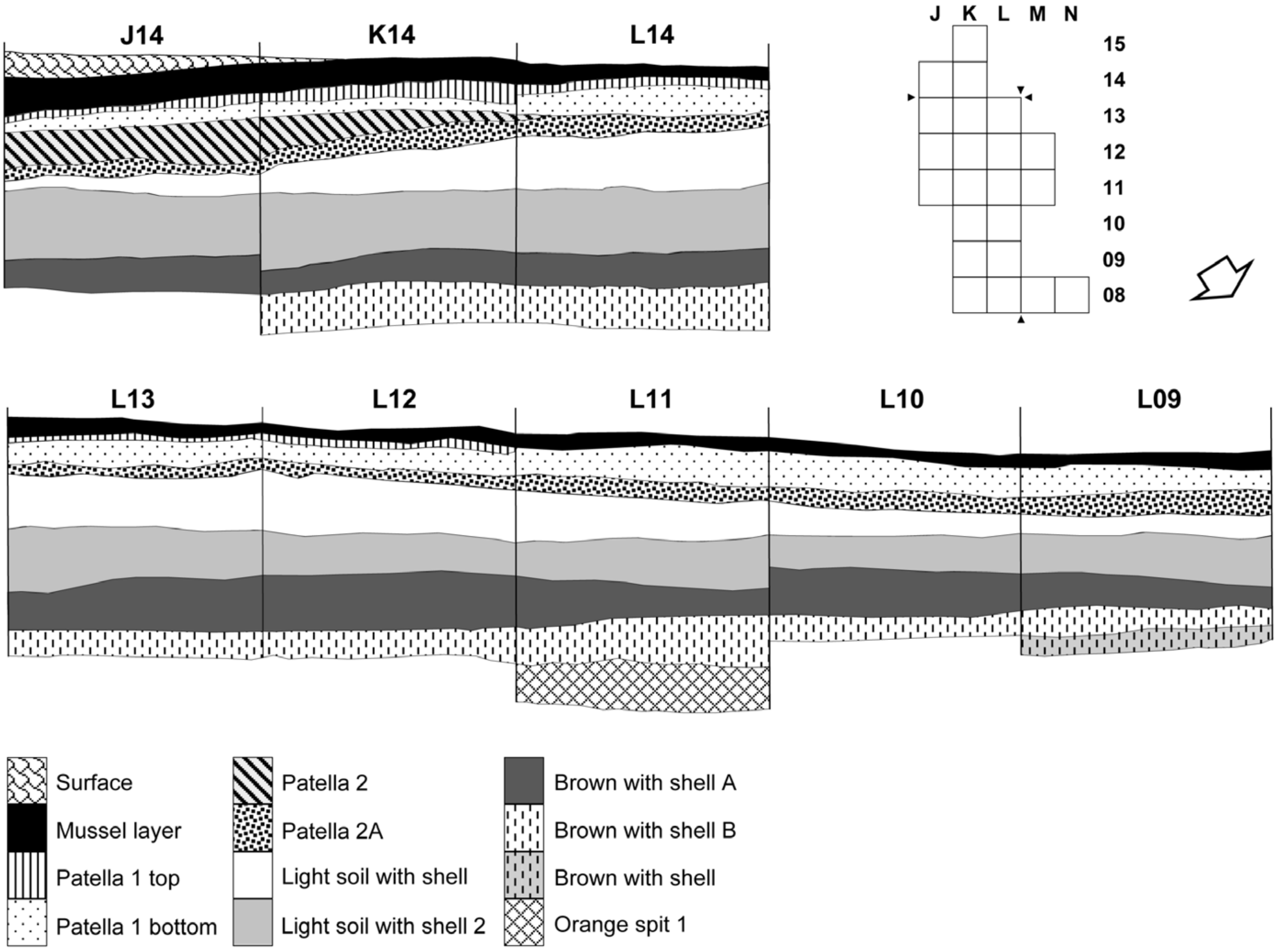

FIG. 3. *Plan view of excavations and stratigraphy at Deurspring 16. Section drawings correspond to* (**a**) *west facing view of squares L9 to L13, and* (**b**) *to south view of squares J14, K14 and L14.*

lenses comprising Layer 2 reported here were encountered for the most part in 1996. Likewise, the stratigraphic components of Layer 5 were identified only during the 1996 field season and are restricted to squares L11, L12 and J14.

LAYER 1

Below loose vegetated surface material, this layer reaches depths of 50–120 mm depending on the square (Fig. 3). The top 50–80 mm of this layer comprises of loose white sands with fragmented shell and roots. During the 1994 excavations, these deposits consisted of stratigraphic units HRF (Humus with Rodent Faeces) and FSL (Fragmented Shell Layer). HRF was made up of sands with humus, rodent faeces, roots, fragmented shell and charcoal. In 1994, FSL was encountered below HRF and consisted of dark grey to black deposit containing mainly compacted black mussel (*Chromytilus meridionalis*) shells. Charcoal fragments were conspicuous in FSL, but only isolated bone fragments and lithic remains were encountered. Shell was noticeably fragmented near the top of this unit, but less so towards the bottom. During the 1996 excavations, Layer 1 was excavated entirely as one stratigraphic unit named Mussel Layer (ML), which is largely equivalent to FSL. During both years, excavators noticed a modest but consistent increase in limpet numbers at the bottom-most levels of Layer 1, before the matrix changed radically to a limpet-rich Layer 2 below. FSL and ML slope down gently across the site in a west to east direction. These units become thickest in the easternmost extent of the excavations, particularly in squares I6 and I7. A total of 0.7 m^3 was removed and retained, while perhaps another 50% of this volume (all layer ML) from squares K14, K15 and from rows J, L and M was not sieved, retained or accounted for in the bucket book. A sample of marine shell (*C. meridionalis*) from unit ML in square K11, at a depth of 70 mm yielded a mid-point radiocarbon date of 2300 cal BP (Table 1).

LAYER 2

These deposits show markedly lower densities of shell than Layer 1 and consist of grey, soft and sandy material, visibly dominated by limpets (mainly *Cymbula granatina* and *Scutellastra granularis* with fewer *S. argenvillei*) and very few black mussels (Fig. 3). Many of the limpet shells were whole or only minimally broken. Roots continued to be present in this layer but less so than in the upper deposit. Damp patches were noted and a few burrows were isolated during excavation. Fauna and lithic artefacts in quartz and silcrete were observed with seemingly greater frequency than in the overlying material. Several thin (±50 mm) limpet shell lenses (i.e. Patella 1 [Top, Bottom], Patella 2, Patella 2A) were discerned within the full depth of this layer ranging from 60–160 mm. As indicated above, most of the material recognised as Layer 2 was encountered during the 1996 field season, although a small amount of the same material was encountered in squares M8 and N8 during excavations in 1994. A total of 4.8 m^3 was removed from Layer 2. A sample of marine shell (*C. granatina*) from unit Patella 1 Bottom in square K12 from a depth of 200 mm was radiocarbon dated to 3435 cal BP mid-point (Table 1).

TABLE 1. *Radiocarbon dates obtained for Deurspring 16. All uncalibrated dates are corrected for δ¹³C. Marine shell dates are calibrated with OxCal program (https://c14.arch.ox.ac.uk) using the Marine 09.14c curve (Reimer* et al. *2009) and calculated with an added local marine reservoir effect ΔR = 146 ± 85 ¹⁴C years (Dewar* et al. *2012).*

Layer	Stratigraphic unit	Square	Material	Uncalibrated date (yrs BP) (corrected for δ^{13}C)	δ^{13}C	Cal yrs BP (mean)	Cal yrs BP 1σ	Cal yrs BP 2σ	Laboratory number
1	Mussel	K11	Marine shell	2760 ± 45	+0.3	2300	2415–2148	2608–2040	Pta-7129
2	Patella 1 bottom	K12	Marine shell	3690 ± 50	–0.1	3435	3561–3326	3680–3185	Pta-7387
3	SSWS2	M8	Marine shell	4490 ± 35	+0.1	4490	4624–4352	4777–4238	Pta-6742
3	LSWS2	J13	Marine shell	4800 ± 60	–0.5	4900	5045–4730	5226–4604	Pta-7131
4	DPSSWS6/7	M8	Marine shell	5530 ± 50	+0.1	5755	5866–5651	5970–5565	Pta-6740
4	BWSB	L12	Marine shell	5390 ± 70	+0.1	5610	5723–5475	5870–5334	Pta-7132
5	Undated	–	–	–	–	–	–	–	–

LAYER 3

This layer is characterised by low density deposits consisting of light grey soil and sands with interspersed shells, although in some squares it became darker and browner or brown-yellow, probably as a result of variable moisture content. The marine shell was comprised mainly of limpets (many unbroken) and noticeable numbers of whelks (*Burnupena* spp. and *Nucella* spp.) and small quantities of black mussels. Damp patches and fewer rootlets were noticed, and a number of burrows were isolated. In 1994, Layer 3 was excavated largely as four 50 mm spits under the overall label of 'Soft Sand With Shell' (SSWS, SSWS1, SSWS2, SSWS3). In 1996, the material equivalent to these four spits was excavated as three stratigraphic units following changes in sediment colour, texture and composition and were labelled as 'Light Soil With Shell' (LSWS, followed by numbers 1 and 2 or I and II) and 'Shell Patch in LSWS' (a restricted circular shell patch overlapping squares J14, K14 and K15). Several thin shell lenses were identified within the LSWS units, but these were difficult to follow across squares. A hearth feature containing limpets, charcoal and burnt bone was identified in this latter unit in square J14. According to section observations drawn on site, LSWS 2 was over-excavated by 50–100 mm in squares K12, K13, and in the southern extent of K14 and L11. Taken as a whole, Layer 3 contained relatively large quantities of artefactual material, including lithics (formal tools and debitage, often in silcrete), ostrich eggshell (OES) beads, as well as OES fragments, moderate quantities of bone (tortoise in particular) and noticeable quantities of the calcareous mandibles of Cape rock lobster (*Jasus lalandii*). Occasional unidentified land snail shells were also observed. The thickness of LSWS units varied spatially but on average ranged between 100 mm and 130 mm (Fig. 3). Layer 3 slopes down gradually across the site in a south to north direction and is thickest and densest in the southernmost extent of the excavation in squares J13 and J14. A total of 10.5 m^3 was excavated from Layer 3 and two samples of marine shell, one each from the 1994 and 1996 excavation seasons, namely unit SSWS2 (species unknown) in square M8 from a depth of 400–500 mm, and from unit LSWS2 (*C. meridionalis*) in square J13 from a depth of 900 mm, were radiocarbon dated. The respective mid-point dates obtained were 4490 cal BP and 4900 cal BP (Table 1). Taking into account these two radiocarbon ages, we consider that Layer 3 dates to *c.* 4700 cal BP.

LAYER 4

This layer also consists of low density deposits of soft soil and sands with interspersed shell dominated by whole or nearly whole limpets (*C. granatina*, *S. granularis* and *S. argenvillei*). Rootlets were encountered, but fewer than in layers above. In 1994, Layer 4 was excavated as four consecutive spits (SSWS4–7). Also part of Layer 4, a shell concentration restricted to squares L8 and M8 (Dark Patch [DP] in SSWS6/7) and a lower-most 100 mm thick spit named Moist Orange Sand with Shell (MOSS) were excavated in squares J8 and L8. The extremely low density and paucity of anthropogenic material in MOSS suggested that it might well originate from SSWS spits above. In contrast, DP in SSWS6/7 was a clearly visible small dark circular hollow approximately 700 mm across and about 150–200 mm deep packed with limpet shells, from which some stone, bone and two OES beads were recovered. It was also noted then that SSWS4–7 was of darker brown colour than the spits that characterised the layer above. This was also evident in 1996 when the equivalent material to SSWS4–7 was excavated as a series of Brown Soil With Shell (BSWS) units, which at times was differentiated into separate lenses or spits labelled alphabetically (BSWS A, BSWS B) depending on the square (Fig. 3). BSWS A is slightly greyer in colour and contains more fragmented shell than the material below. The more orange-brown colour contained in some of these shell lenses may be due to a drop in the density of anthropogenic contents, particularly towards the bottom of BSWS B. It is suspected that a spatially restricted shell pocket, namely Grey Patch in BSWS B in square L10 that was isolated in 1996, might reflect animal burrowing. A few other clearly identified burrows were encountered and isolated and moist patches were also noted in several squares. Excavators noticed a higher incidence of vertebrate fauna (tortoise and bird) and stone artefacts in Layer 4 than in layers above. Formal tools and debitage were often made of silcrete and quartz, and in several instances fauna showed traces of burning. A total of 10.7 m^3 was removed from Layer 4 and two samples of marine shells were removed for radiocarbon dating, one each from the 1994 and 1996 excavations. These are unit DP in SSWS6/7 (species unknown) in square M8 from a depth of 800–900 mm, and unit BSWS B (*C. meridionalis*) in square L12 from a depth of 900 mm. The respective mid-point dates obtained were 5755 cal BP and 5610 cal BP (Table 1). Taking into account these two radiocarbon ages, we consider that Layer 4 dates to *c.* 5700 cal BP.

LAYER 5

Layer 5 deposits were excavated as spits in 1996 (Orange Spit 1, 2 or I, II, and Orange Spit 1+2) in squares J14, L11 and L12. Orange Spit 1 (or I) is basically equivalent to the 100 mm thick spit excavated in 1994 as unit MOSS (Layer 4, see above) and is characterised by extremely low densities of shell, bones and isolated artefacts. A total of 0.65 m^3 was removed from Layer 5. As noted, field observations and section drawings collected during both years suggest that this material reflects the beginnings or base of Layer 4. However, the possibility that Layer 5 represents earlier visits to DSP16 still remains. Hence, until this small amount of material equivalent to a handful of shells and bones is radiocarbon dated, it will be regarded as a separate stratigraphic entity. Water-worn shell and pebbles, and better preserved lighter coloured shell than that found in younger layers were encountered. It is possible that this beach-worn material could be remnants of storm beach and/or the mid-Holocene high sea level stand. A silcrete flake, an OES bead, few fragments of microfauna, tortoise and bird bones as well as a Cape rock lobster mandible were recovered while sieving this material. A deeper probe made below Orange Spit 1 and 2 in square J14 *via* an 800 mm deep sounding only revealed sterile sands. Due to the chrono-stratigraphic uncertainty and minimal quantities of material recovered, the following paragraphs are focussed on the contents of Layers 1–4 only.

LABORATORY ANALYSES

Identification of vertebrate remains was undertaken 20 years ago following available reference collections at Iziko South African Museum and the University of Cape Town. At the time of writing, the faunal remains from the 1996 excavation could not be located in order to quantify them in terms of weights. Hence, weight densities were calculated based on observations only from the 1994 field seasons. As Layer 2 was almost entirely excavated in 1996, its weight-based faunal densities could not be reflected. Consequently, we used an alternative measure of faunal (bone) density based on Number of Identified Specimens (NISP) (from all excavation seasons) per cubic metre (m^3). An additional and alternative measure of density was also established for marine remains (Cape rock lobsters and molluscs), using Minimum Number of Individuals (MNI/m^3).

Marine shell remains (whole specimens and fragments) were sorted and identified wherever possible to generic or specific level, whereupon MNIs and weights were determined following methods outlined by Jerardino (1997). MNIs from large barnacle remains (*Austromegabalanus cylindricus*) were not established as they are often in a very fragmentary state, including their countable parts. Two large shell samples (weight: 2.3–9.5 kg; MNI: 517–1737) per stratigraphic layer were analysed.

Size observations were obtained for black mussel (*C. meridionalis*) shells by measuring the maximum prismatic band widths of both left and right valves and applying reconstructive morphometric equations (Buchanan 1985). Whole and fragmented limpet shells were also measured for the same purpose, and morphometric equations (Jerardino & Navarro 2008) were applied to measurements on fragmentary shells for reconstructing full shell lengths. Measurements on calcareous mandibles of Cape rock lobsters were obtained and carapace lengths were reconstructed using established morphometric equations (Jerardino *et al.* 2001). Analyses of variance (ANOVA; Sokal & Rohlf 1969) were conducted on molluscs and Cape rock lobster size data with R statistical software, version 2.15.0 (R Development Core Team 2012).

RESULTS

SETTLEMENT, DOMESTIC ACTIVITIES AND SUBSISTENCE

Densities of different categories of archaeological remains can inform on the predominant activities undertaken during each occupation, and their ratios allow the comparison of these activities between occupations. Table 2 shows density values for flaked stone artefacts, ochre, OES beads (finished and unfinished) and charcoal in each stratigraphic layer. Only three unfinished beads were recovered from Layer 4 during the 1994 excavations. Both flaked stones and OES bead densities peak in Layer 2. Ochre, on the other hand, is most abundant at the onset of the occupation in Layer 4, showing moderate values in Layer 3. Charcoal densities increase steadily and by one order of magnitude between Layers 4 and 2, and reach maximum values in Layer 1.

Table 3 shows density values for mammals of dietary importance (henceforth, carnivores are excluded), tortoises, birds (marine species, see below), ostrich eggshell (OES) remains, microfauna (rodents, shrews), other reptiles (snakes and lizards), marine shell and Cape rock lobsters. Fish densities are excluded as bone weights amount to no more than 1.0 g per stratigraphic layer. Pairs of weight-based and NISP-based densities for each faunal category tend to show the same trends across the stratigraphic sequence, although this is less clear for mammals, birds and other reptiles (Table 3). It is interesting to note that densities of microfaunal remains co-vary with those of prey most likely procured by people. This point will be discussed later, but

TABLE 2. *Densities of flaked stone artefacts, ochre, ostrich eggshell (OES) beads (finished and unfinished), and charcoal at Deurspring 16. The latter values were calculated only with material retrieved from the 1996 field season (see text).*

Layer	Flaked stone artefacts (*n*/m^3)	Ochre (*n*/m^3)	OES beads (*n*/m^3) finished and unfinished	Charcoal (g/m^3)
1	57.1	0.0	0.8	151.1
2	130.0	0.2	4.2	114.3
3	70.7	2.5	0.6	17.5
4	51.6	7.1	0.7	6.8

TABLE 3. *Densities of terrestrial and marine faunal remains at Deurspring 16 shell midden. Terrestrial fauna and birds are quantified as (kg bone/m^3 and as NISP/m^3. Marine shell densities are quantified as (kg shell/m^3) and as (MNIs/m^3) × 1000 and Cape rock lobster densities as MNIs/m^3. An asterisk (*) indicates observation not available.*

Layer	Mammals (kg/m^3)	Mammals (NISP/m^3)	Tortoises (kg/m^3)	Tortoises (NISP/m^3)	OES (g/m^3)	Other reptiles (g/m^3)	Other reptiles (NISP/m^3)	Microfauna (g/m^3)	Microfauna (NISP/m^3)	Birds (kg/m^3)	Birds (NISP/m^3)	Marine shell (kg/m^3)	Marine shell (MNI/m^3) × 1000	Cape rock lobster (MNI/m^3)
1	5.5	6.3	13.7	51.3	0.29	0.1	5.0	0.7	9.6	3.3	5.8	102.0	12.84	4.58
2	*	8.5	*	357.1	0.04	*	19.8	*	56.7	*	10.4	100.8	16.92	18.96
3	23.2	29.0	102.2	656.9	0.47	0.3	28.0	1.6	51.0	7.0	11.4	47.4	10.42	13.52
4	47.1	27.8	56.4	310.0	0.47	0.7	6.8	2.0	14.7	6.5	5.8	19.5	3.94	9.44

for the purpose of further data presentation, microfauna at DSP16 is considered to have largely been procured by people (see Dewar & Jerardino 2007).

Common and broad temporal trends are apparent, particularly when comparing the terrestrial (mammals, tortoises, OES, other reptiles and microfauna) and marine components (birds, marine shell and Cape rock lobster) of the faunal record (Table 3). The remains of terrestrial prey are generally more abundant in Layers 3 and 4. Tortoise weight-densities are markedly high in Layer 3. On the other hand, marine shell densities are highest in Layers 1 and 2, while the densities of other marine prey tend to peak in Layers 2 and 3. Density ratios of tortoises *versus* mammals show an increasing emphasis in the discard of tortoise remains during the period between Layers 4 to 2 (*c.* 5700– 3440 cal BP). When weight-based density ratios of marine (shell + birds) *versus* terrestrial prey (mammals + tortoises) are compared, highest values are recorded in Layer 1 (Table 4).

DSP16 faunal sample consists of 14469 bone fragments with approximately 86% identified to genus or species level. This proportion drops to 3% if tortoise remains are not considered to be dominated by mostly one species (see below). Bones throughout the sequence are highly fragmented and many pieces are burnt. Excluding microfauna, only nine specimens (one in Layer 1, two in Layer 2, three in Layer 3 and another three in Layer 4) represent the remains from juvenile animals. Evidence of butchery is very rare, but two bones from Layer 4 display cut marks. One of these consists of a long bone shaft fragment with multiple cut marks associated with an area of muscle attachment. Layer 3 contains a bone flake which may indicate damage resulting from marrow extraction. Male tortoise epiplastra are well represented at DSP16.

Table 5 shows a quantified assessment of marine and terrestrial vertebrate species present at DSP16. Tortoise remains were identified as predominantly those of the angulate tortoise (*Chersina angulata*), but some specimens may represent the speckled padloper (*Homopus s. peersi* and *H. s. signatus*). Tortoises, small bovids (*Raphicerus* spp.) and small-medium bovids are abundant in all layers. Medium to large bovids, and even larger prey, such as black rhinoceros (*Diceros bicornis*), are rare but appear mostly in Layer 4. Cape fur seals (*Arctocephalus pusillus*) and marine bird species (cormorants, penguins, Cape gannet and kelp gull) are most common in Layers 2 to 4 (Table 5). Modest amounts of small and fairly mobile terrestrial prey, such as rock hyrax (*Procavia capensis*), Cape hare (*Lepus capensis*) and to some extent dune mole rat (*Bathyergus suillus*) are limited to Layers 2 and 3.

The percentages and total sample sizes of marine shell species in terms of weights and MNI are shown in Tables 6 and 7, respectively. Fifteen shellfish taxa were identified to species and genus level, with only a minor proportion (<1.5%) of marine shell remains (unidentified limpets) identified only to a broad level. A most startling pattern is a change in the most dominant species. While limpets and whelk species dominate

TABLE 4. *Density ratios of different categories of faunal remains from Deurspring 16. The marine component excludes crayfish due to different quantification method.*

Layer	Tortoise/mammal (mass)	Tortoise/mammal (NISP)	Marine (birds + shell)/ terrestrial (mass)
1	2.5	8.2	5.5
2	*	41.8	*
3	4.4	22.6	0.4
4	1.2	11.2	0.3

TABLE 5. *Number of identified specimens/minimum number of individuals (NISP/MNI) of vertebrate taxa identified at Deurspring 16 shell midden.*

		Layers			
		1	2	3	4
Linnaean names	Vernacular names	NISP/MNI	NISP/MNI	NISP/MNI	NISP/MNI
Mammalia					
Lepus capensis	Cape hare		2/1		
Bathyergus suillus	Cape dune molerat		2/1	56/4	
Papio ursinus	Chacma baboon				1/1
Canis mesomelas	Black-backed jackal		2/1	1/1	3/1
Vulpes chama	Cape fox		1/1		
	Carnivore indet.		2/1		4/1
Felis caracal aut serval	Caracal or serval				1/1
Arctocephalus pusillus	Cape fur seal		1/1	14/2	17/1
Procavia capensis	Rock hyrax		1/1	1/1	
Raphicerus spp.	Steenbok/grysbok	3/1	11/1	108/2	36/2
Diceros bicornis	Black rhinoceros				1/1
	Small bovid(s)	7/1	16/1	79/1	128/2
	Small-medium bovid(s)	2/1	2/1	18/1	36/1
	Medium bovid		2/1		10/1
	Large-medium bovid(s)				3/1
	Large bovid(s)		1/1		1/1
	Small mammal indet.	3/1	3/1	29/1	65/1
	Microfauna	23/2	272/19	536/30	157/5
Reptilia	Tortoise	123/3	1714/7	6897/12	3317/8
	Snake/lizard	12/1	95/2	294/2	73/2
Aves					
Phalacrocorax capensis	Cape cormorant	7/1	13/2	10/2	16/2
Phalacrocorax carbo	White breasted cormorant		1/1	3/1	1/1
Spheniscus demersus	African penguin	1/1	18/3	93/5	28/3
Morus capensis	Cape gannet			1/1	
Larus dominicanus	Kelp gull				2/1
	Bird indeterminate	6/1	18/1	13/1	15/1
Fish indeterminate			4/1	22/1	15/1
TOTAL NISP		192	2181	8174	3922

Layers 2 to 4 with total percentages of 83.1–93.5% (% weight) and 89.8–97.3% (% MNI), black mussels dominate in Layer 1 (% weight: 89.0–83.3%; % MNI: 65.0–68.4%). Large barnacles from the lower-most intertidal and shallow subtidal (Branch *et al.* 2010), while not frequently represented, are clearly and consistently found in greater numbers in Layers 1 and 2 (Table 5). The mid-intertidal *C. granatina* and mid- to high-intertidal *S. granularis* are the most common limpet species throughout the sequence while the large *S. argenvillei* limpet, collected mostly from the exposed low-intertidal zone (Branch *et al.* 2010), is most common in Layers 2 to 4. Another low-intertidal limpet, namely *S. barbara*, follows a similar trend to *S. argenvillei*, although relative frequencies of the former are at least two to five times smaller than the percentages of the latter (Tables 6 & 7).

Descriptive statistical parameters of mollusc shells sizes are presented in Table 8. AVOVA results show statistically significant trends in time for some species but not for others. *S. argenvillei* shell mean sizes decline significantly throughout the sequence, with smallest shell sizes registered in Layer 1 (F = 12.03, d.f. = 1,106, $P < 0.001$) (Fig. 4). Although *C. granatina* shell sizes do not change between the three lower-most stratigraphic layers (Fig. 5), mean sizes are significantly smaller in Layer 1 when compared to data from preceding strata (F = 4.3, d.f .= 1,476, $P < 0.037$). *S. granularis* shows the same overall pattern and significantly smaller shell sizes in Layer 1 (Fig. 6) (F = 25.12, d.f. = 1,1349, $P < 0.0001$). No statistical differences were observed between strata for either *C. meridionalis* or *S. barbara*.

Table 9 reports on basic descriptive statistics on the remains of Cape rock lobsters. The total number of left and right calcareous mandibles varies in a similar way from one layer to the next and the proportion of whole left mandibles is also comparable between them (left: 18.2–36.6%; right: 16.2–36.4%). Layer 1 has the smallest number of mandibles and also the smallest average carapace sizes. Mean sizes of Cape rock lobsters for Layers 2–4 have been reported previously (Jerardino 2010: fig. 6), and the minor changes observed are not statistically significant. Although Cape rock lobster carapace sizes in Layer 1 are smaller when compared to older strata, it was not possible to conduct any statistical analyses due to their extremely small sample size (n = 5).

STONE ARTEFACTS

DSP16 stone artefacts exhibit the general microlithic characteristics of Wilton and final Later Stone Age (LSA) assemblages (Lombard *et al.* 2012) (Table 10). As expected, the assemblage is dominated by stone debitage (94.3–98.5%). Although cores are rare overall and absent in Layer 1, bipolar, bladelet and irregular core types are represented. Although sample size is acknowledged to be somewhat limited when compared with Tortoise Cave (TC) and Steenbokfontein Cave (SBF), blades and bladelets are together more common in Layer 4 dating to the mid-Holocene. Utilised pieces are uncommon though marginally better represented in Layer 1. Percentages of formal tools vary between 1.3% and 3.2% where present (Table 10). Formal tools are absent from Layer 1. Non-flaked stone artefact frequencies and manuports are rare additions to

TABLE 6. *Marine mollusc species frequencies (%) by weight for each layer and two different squares at Deurspring 16 shell midden.*

		Layer 1 % weight		Layer 2 % weight		Layer 3 % weight		Layer 4 % weight	
Linnaean Names	Vernacular names	sq. K9	sq. K13	sq. J13	sq. K13	sq. K10	sq. K11	sq. K11	sq. K12
Choromytilus meridionalis	Black mussel	89.0	83.3	16.5	12.7	7.7	8.6	7.5	6.3
Aulacomya ater	Ribbed mussel	0.1	0.2	0.0	0.0	0.0	0.1	0.0	0.1
Cymbula granatina	Granite limpet	4.7	5.9	29.6	34.6	38.6	41.3	39.8	37.6
Scutellastra granularis	Granular limpet	2.4	3.8	20.8	20.3	22.3	23.3	21.4	31.7
S.barbara	Bearded limpet	0.2	0.1	1.0	2.1	2.1	3.1	4.9	6.1
S.argenvillei	Argenville's limpet	0.5	2.4	7.7	11.2	13.1	6.6	16.8	14.2
S. cochlear	Pear limpet	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
C. miniata	Pink-rayed limpet	0.1	0.0	0.0	0.3	1.3	0.1	0.7	0.1
Limpets unidentified		0.1	0.1	0.2	0.4	0.7	0.4	0.7	0.3
TOTAL LIMPETS		7.9	12.3	59.3	69.0	78.1	74.8	84.1	89.9
Burnupena spp. & *Nucella* spp.	Burnupenas & dogwhelks	1.8	3.2	22.0	17.2	13.4	15.7	7.7	3.1
Argobuccinum pustulosum	Pustular triton	0.1	0.4	1.7	0.8	0.6	0.6	0.5	0.4
Oxystele spp.	Topshells	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
TOTAL WHELKS		1.9	3.7	23.8	18.0	14.1	16.3	8.2	3.5
Austromegabalanus cylindricus	Giant barnacle	0.9	0.3	0.4	0.3	0.0	0.1	0.1	0.0
Venerupis corrugata	Corrugated Venus	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.0
Bullia spp.	Plough shells	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Donax serra	White mussel	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
TOTALS		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total weight (kg)		5.7	5.2	4.4	9.5	5.7	5.2	6.3	2.3

the overall lithic assemblage, but are present in all layers, while almost all ochre pieces are present in Layers 3 and 4 (Table 10).

One of the most important observations is the change in the formal tool repertoire through this sequence (Table 11). Overall, scrapers are the dominant formal tools, with backed scrapers being the most common type. Scraper percentages increase steadily after the start of DSP16 occupation (*c.* 5700) until Layer 2 (*c.* 3440 cal BP). Backed pieces, on the other hand, show the exact opposite trend during the same period. Miscellaneous Retouched Pieces (MRPs) are also present although they show no particular chronological pattern (Table 11). Neither adzes nor drills were identified.

Lithic raw material usage through time is shown in Table 12. Locally available rock types such as quartz and quartzite were increasingly used throughout the DSP16 occupation, while the use of fine-grained exotic raw materials such as silcrete shows the opposite trend (see Jerardino [2013b: 191] for criteria on local *versus* exotic raw materials). Cryptocrystalline silica (CCS)

TABLE 7. *Marine mollusc species frequencies (%) by MNI for each layer and two different squares at Deurspring 16 shell midden.*

		Layer 1 % MNI		Layer 2 % MNI		Layer 3 % MNI		Layer 4 % MNI	
Linnaean names	Vernacular names	sq. K9	sq. K13	sq. J13	sq. K13	sq. K10	sq. K11	sq. K11	sq. K12
Choromytilus meridionalis	Black mussel	68.4	65.0	10.0	6.9	4.0	3.7	3.7	2.1
Aulacomya ater	Ribbed mussel	0.7	0.5	0.0	0.1	0.0	0.1	0.1	0.2
Cymbula granatina	Granite limpet	5.6	6.1	20.3	21.1	31.2	17.9	26.0	19.1
Scutellastra granularis	Granular limpet	16.3	16.8	19.2	41.2	43.0	51.9	53.1	68.1
S.barbara	Bearded limpet	0.2	0.0	0.2	0.5	0.4	0.4	0.6	1.0
S.argenvillei	Argenville's limpet	0.2	0.9	0.5	1.8	1.9	1.1	2.4	2.3
S. cochlear	Pear limpet	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
C. miniata	Pink-rayed limpet	0.2	0.0	0.2	0.1	0.1	0.1	0.2	0.2
Limpets unidentified		1.4	0.1	0.8	1.0	0.6	1.4	0.4	1.0
TOTAL LIMPETS		23.8	24.0	41.1	65.7	77.3	72.8	82.7	91.7
Burnupena spp. & *Nucella* spp.	Burnupenas & dogwhelks	5.6	8.8	47.4	26.8	18.3	22.9	12.7	5.2
Argobuccinum pustulosum	Pustular triton	0.2	0.3	0.6	0.2	0.1	0.1	0.3	0.2
Oxystele spp.	Topshells	0.0	0.9	0.6	0.2	0.2	0.1	0.2	0.2
TOTAL WHELKS		5.7	9.9	48.7	27.3	18.6	23.1	13.1	5.6
Austromegabalanus cylindricus	Giant barnacle	–	–	–	–	–	–	–	–
Venerupis corrugata	Corrugated Venus	1.0	0.5	0.2	0.1	0.1	0.1	0.4	0.2
Bullia spp.	Plough shells	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Donax serra	White mussel	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.2
TOTALS		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total MNI		576	754	620	1737	1370	1046	1183	517

TABLE 8. *Basic descriptive statistics of shell size measurements on four of the most frequent mollusc species at Deurspring 16. All data are for full shell sizes (lengths) measured in millimetres (mm).*

Species	Layer 1					Layer 2					Layer 3					Layer 4				
	n	Min	Max	Median	Mean ± S.D.	*n*	Min	Max	Median	Mean ± S.D.	*n*	Min	Max	Median	Mean ± S.D.	*n*	Min	Max	Median	Mean ± S.D.
C. meridionalis (L)	496	44.9	99.5	67.6	68.3 ± 11.3	118	44.9	101.6	68.6	68.5 ± 12.7	176	44.9	101.6	67.6	68.0 ± 10.9	101	45.9	108.8	67.6	68.0 ± 12.0
C. meridionalis (R)	523	43.8	100.6	66.5	67.4 ± 11.2	132	44.9	110.9	66.5	67.3 ± 12.5	207	45.9	92.3	66.5	66.9 ± 11.1	109	44.9	98.5	64.5	65.8 ± 11.4
C. granatina	20	38.2	68.5	49.7	51.9 ± 9.6	137	33.6	83.2	57.8	57.9 ± 12.1	161	37.0	88.5	57.5	58.1 ± 10.8	160	31.9	79.2	55.4	55.5 ± 9.8
S. granularis	64	24.9	47.9	32.4	33.6 ± 5.1	405	24.4	60.0	36.7	37.1 ± 5.3	493	25.5	60.7	36.7	37.0 ± 5.0	389	25.3	52.1	35.8	36.3 ± 4.8
S. argenvillei	5	57.9	76.7	64.7	65.32 ± 6.9	37	53.7	81.9	72.2	71.1 ± 7.6	33	46.0	89.6	76.3	74.5 ± 9.2	33	60.2	88.6	76.4	76.2 ± 7.4
S. barbara	0	–	–	–	–	8	60.4	80.4	73.3	72.7 ± 6.3	10	63.9	87.9	75.3	74.8 ± 7.0	11	63.4	93.8	74.2	77.2 ± 10.1

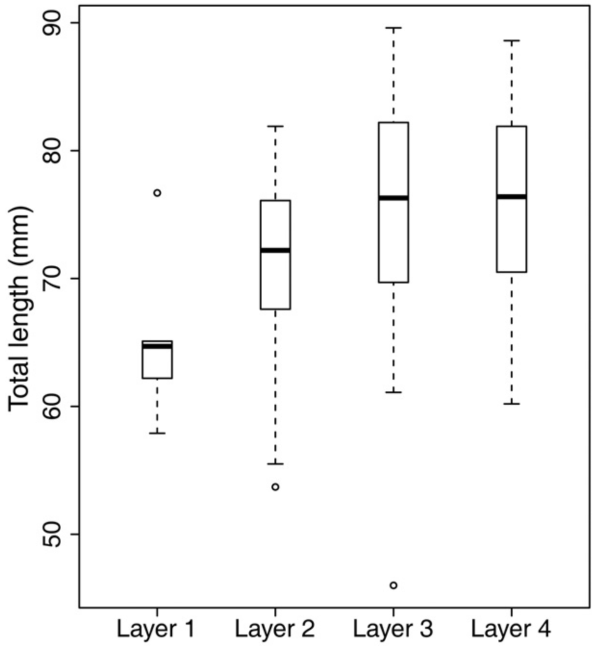

FIG. 4. *Changes in mean sizes of Argenville's limpet* (Scutellastra argenvillei) *at Deurspring 16. Mean sizes are represented by short horizontal lines, boxes indicate 95% confidence limits, and the vertical lines dissecting these reflect the full range of shell values. Small circles indicate extreme values.*

is most common in Layer 3. No indurated shale or hornfels was identified in the sample. The change in the dominance of local over exotic lithic raw materials occurs between Layers 4 and 3 (*c.* 4700 cal BP), although a further reduction of one order of magnitude follows between Layers 3 and 2 (*c.* 3440 cal BP).

DISCUSSION

SETTLEMENT

The manufacture of OES beads among southern African Khoisan foragers is a very time consuming task (Silberbauer 1965; Marshall 1976), and it is likely that such an activity was undertaken in the past during longer occupations of a camp site. Likewise, under circumstances of multi-task activity which characterise longer periods of residence in a camp (Yellen 1977), there is a higher risk of losing a piece of personal ornamentation due to wear and accident (Jerardino 1995b). More people would also lose more OES beads during such visits. Consequently, an increase in residential permanence and/or group size at a given site ought to be identifiable by relatively high quantities of unfinished OES beads and finished beads when compared to other site contents.

Comparison between stratigraphic units should, however, be undertaken on the basis of deposition rates as densities between strata can vary for reasons other than settlement patterns, such as geomorphological context and other factors behind changes in the main matrix component (Jerardino 1995b, 2016). The geomorphological context (beach foredunes) was apparently not altered during the entire DSP16 occupation. The main matrix component did not change between Layer 3 and 4 (mostly sand), only somewhat in Layer 2 (mostly sand with some more shell), but very definitely so in Layer 1 (dense shell lens) (Table 3). Although we have no observations on deposition rates for individual strata in DSP16, it is likely that the one order of magnitude increase in OES beads densities in Layer 2 is meaningful in terms of settlement when compared to the preceding strata with similar depositional context (Table 2). Moreover, OES beads were recovered from

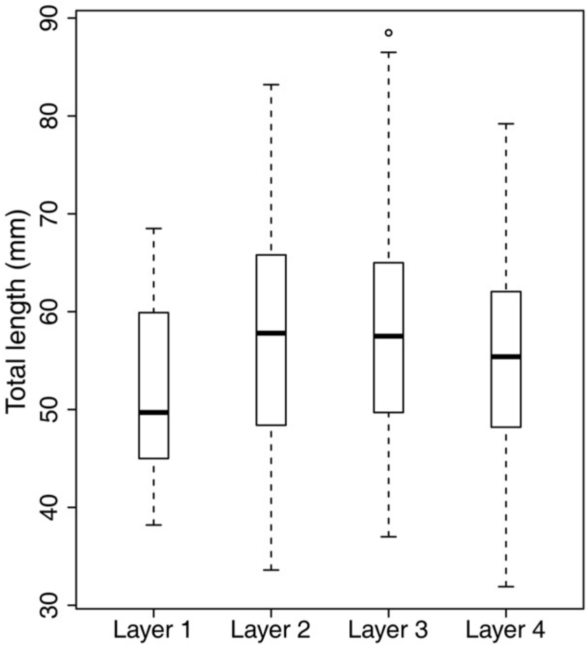

FIG. 5. *Changes in mean sizes of Granite limpet* (Cymbula granatina) *at Deurspring 16. Mean sizes are represented by short horizontal lines, boxes indicate 95% confidence limits, and the vertical lines dissecting these reflect the full range of shell values. Small circle indicates extreme value.*

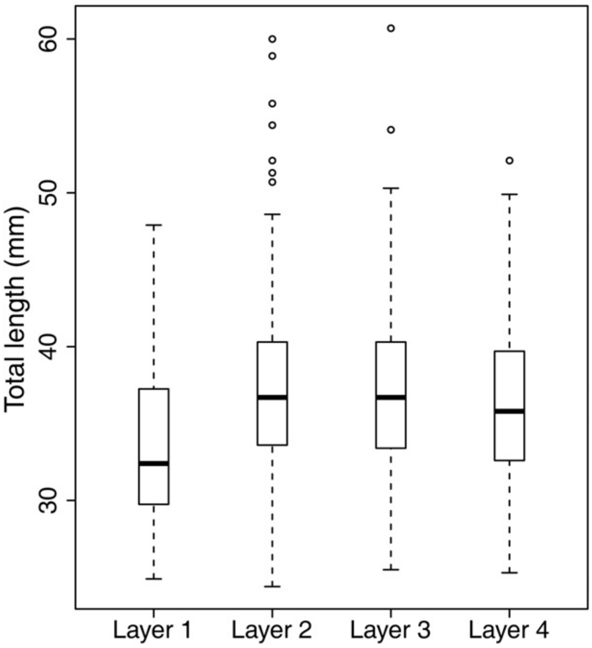

FIG. 6. *Changes in mean sizes of Granular limpet* (Scutellastra granularis) *at Deurspring 16. Mean sizes are represented by short horizontal lines, boxes indicate 95% confidence limits, and the vertical lines dissecting these reflect the full range of shell values. Small circles indicate extreme values.*

almost all excavated squares in Layers 4 to 2, thus minimising the possibility that a broken necklace in Layer 2 is responsible for the observed pattern. This observation is also supported by the flaked stone artefacts and charcoal densities, as these also increase by one order of magnitude in Layer 2 when compared to older strata. We therefore conclude that visits were probably longer and/or included larger groups during the accumulation of Layer 2 *c.* 3440 cal BP when compared to mid-Holocene visits (*c.* 5700–4700 cal BP). OES bead densities diminish markedly in Layer 1, but this change is difficult to interpret in terms of settlement patterns because the main matrix component has changed very radically and we have no data on deposition rates for this stratum either. Overall, these preliminary observations confirm earlier reconstructions that demonstrate visits to the study area during the mid-Holocene were relatively brief and/or carried out by small groups of people, but these become longer and/ or carried out by more people between 4000 and 3000 BP than before. These trends take place when new sites became occupied for the first time in the study area and overall deposition rates were generally on the rise (Jerardino 2010, 2012, 2013a,b; Jerardino *et al*. 2013).

SUBSISTENCE

As mentioned above, densities of microfaunal remains co-vary with those of prey most likely procured by people. Birds of prey and other carnivores are usually regarded as the agents behind their introduction into sites (Matthews 1999), although there is some evidence from Namaqualand dating to the third millennium BP indicating that people are also likely to have consumed them in the past (Dewar & Jerardino 2007). Observations from DSP16 seem to extend this subsistence choice back by two millennia.

Density ratios suggest an increasing consumption of tortoises over terrestrial mammals between *c.* 5700 and 3440 cal BP, but this emphasis seems to have waned by *c.* 2300 cal BP. The first part of this trend is reflected at other local sites (Fig. 1: SBF and Pancho's Kitchen Midden [PKM]) occupied before and during the third millennium BP (also known as the 'megamidden period'), although tortoises were increasingly procured after *c.* 2800 cal BP at these latter sites. In any case, the contribution of terrestrial resources to forager diet at DSP16 decreased through time, and marine resources became most important during the megamidden period, an observation consistent with SBF and PKM records.

Despite the many squares excavated, the DSP16 vertebrate assemblage is small due to the low density in which bones were encountered (Tables 3 & 5; Fig. 2). Even so, it is interesting to note that large and wide-ranging prey, such as large and large-medium bovid and black rhinoceros are most common in Layer 4 during the earliest mid-Holocene occupations (*c.* 5700 cal BP), while smaller prey (rock hyrax, hares and small bovids) and burrowing small mammals are relatively more frequent in

TABLE 9. *Basic descriptive statistics and metrical observations (reconstructed carapace length and standard deviation) of Cape rock lobster* (Jasus lalandii) *calcareous mandibles from Deurspring 16.*

Layer	Left mandibles			Right mandibles		
	Total *n*	% Measurables	Carapace size (mm)	Total *n*	% Measurables	Carapace size (mm)
1	11	18.2	54.8 ± 10.6	11	36.4	75.0 ± 8.2
2	91	19.8	83.9 ± 18.7	68	22.1	84.2 ± 16.8
3	142	23.9	82.4 ± 22.7	136	16.2	83.5 ± 25.9
4	101	36.6	77.3 ± 15.6	100	27.0	80.5 ± 16.9

TABLE 10. *Inventory of flaked stone artefacts from Deurspring 16 (MRPs: miscellaneous retouched pieces).*

	Layer							
	1		2		3		4	
	n	%	*n*	%	*n*	%	*n*	%
WASTE								
Chunks	14	10.2	46	7.4	47	6.3	29	5.3
Chips	78	56.9	353	56.6	424	57.1	229	41.5
Flake	41	29.9	184	29.5	193	26.0	204	37.0
Blade	0	0.0	8	1.3	8	1.1	16	2.9
Bladelet	1	0.7	9	1.4	16	2.2	44	8.0
Bipolar flake	0	0.0	1	0.2	1	0.1	0	0.0
Cortical flake	1	0.7	5	0.8	12	1.6	2	0.4
Subtotal waste	135	98.5	606	97.1	701	94.3	524	94.9
CORES								
Bipolar	0	0.0	7	1.1	4	0.5	2	0.4
Bladelet	0	0.0	0	0.0	5	0.7	4	0.7
Irregular	0	0.0	2	0.3	2	0.3	5	0.9
Regular	0	0.0	0	0.0	1	0.1	0	0.0
Minimal	0	0.0	1	0.2	1	0.1	0	0.0
Subtotal cores	0	0.0	10	1.6	13	1.7	11	2.0
UTILISED PIECES	2	1.5	0	0.0	5	0.7	3	0.5
FORMAL TOOLS								
Convex scraper	0	0.0	4	0.6	9	1.2	4	0.7
Backed scraper	0	0.0	1	0.2	0	0.0	0	0.0
Boat-shaped scraper	0	0.0	0	0.0	1	0.1	0	0.0
Subtotal scrapers	0	0.0	5	0.8	10	1.3	4	0.7
Segment	0	0.0	1	0.2	1	0.1	1	0.2
Backed blade	0	0.0	0	0.0	2	0.3	1	0.2
Backed point	0	0.0	0	0.0	1	0.1	0	0.0
Misc. backed	0	0.0	0	0.0	4	0.5	4	0.7
Subtotal backed	0	0.0	1	0.2	8	1.1	6	1.1
MRPs	0	0.0	2	0.3	6	0.8	4	0.7
Subtotal formal	0	0.0	8	1.3	24	3.2	14	2.5
TOTAL FLAKED	137		624		743		552	
Grindstone upper	0		0		0		1	
Grindstone lower	0		1		0		0	
Hammerstone	0		1		0		0	
Manuport	1		2		2		1	
Ochre	0		1		26		76	
GRAND TOTAL	**138**		**629**		**771**		**628**	

Layers 2 and 3 during subsequent visits (*c.* 4700–3440 cal BP). Perhaps this could reflect a shrinkage in foraging radii and/or a risk reduction strategy in prey procurement, whereby hunting of large and wide-ranging prey became largely discontinued and the focus was placed on smaller prey (rock hyrax, hares, dune mole rats and small bovids) found mostly within fairly predictable habitats (rocky outcrops, open dry grass/shrub land, underground burrows) and/or within confined territories patrolled by them. Net returns of smaller mammals would have been lower than for larger prey, but the smaller prey reproduce much faster and would likely have tolerated higher predation rates than larger prey (see Stiner *et al*. 2000).

These shifts in the procurement of terrestrial prey (*c.* 4700–3440 cal BP) were followed, and partly overlapped, by a reformulation in the acquisition of marine sessile prey towards the end of this period as revealed by marked changes in shellfish species abundances from *c.* 3440 cal BP to *c.* 2300 cal BP (Tables 6 & 7). Likewise, percentages of black mussels in mid-Holocene levels at SBF dated *c.* 6900 to 4400 cal BP (% weight = 49.0–56.3; %MNI = 35.0–38.6) are substantially lower than those contemporary with Layer 1 in DSP16 (% weight = 78.2–82.8; %MNI = 68.3–75.0). The remainder of SBF shellfish assemblages is largely comprised of limpets and whelks (Jerardino 2010; Antonieta Jerardino, pers. obs. 2015). In general, the percentage of black mussels at SBF is higher than those of contemporary DSP16 levels (Tables 6 & 7). Nevertheless, transport decisions favouring relatively more black mussels over limpets and whelks for consumption at sites removed from the coast, such as SBF, may explain this difference (Parkington *et al*. 1988; Jerardino 2016). A more detailed discussion on these differences is, however, beyond the scope of this paper, but see Jerardino (2016).

As attested also at other contemporary sites in the Lamberts Bay area, the collection of shellfish shifted largely away from lower caloric-yielding limpets (3750 kJ/person/h) and whelks (3970–1260 kJ/person/h), with a distribution in the mid-intertidal to focusing almost entirely on the denser and higher yielding black mussels (6125–4700 kJ/person/h) (Jerardino 2010: 2299) found mostly in the low-intertidal and subtidal zones (Branch *et al*. 2010). Although very small (<1%), the abundance of large shore barnacles found in the lowermost intertidal and subtidal (growing on rocks and large black mussels) follow the

TABLE 11. *Inventory of formal tools from Deurspring 16 (MRPs: miscellaneous retouched pieces).*

	Layer							
	1		2		3		4	
	n	%	*n*	%	*n*	%	*n*	%
Scrapers								
Convex scraper	0	0	4	50.0	9	37.5	4	28.6
Backed scraper	0	0	1	12.5	0	0.0	0	0.0
Boat-shaped scraper	0	0	0	0.0	1	4.2	0	0.0
Subtotal scrapers	0	0	5	62.5	10	41.7	4	28.6
Backed pieces								
Segment	0	0	1	12.5	1	4.2	1	7.1
Backed blade	0	0	0	0.0	2	8.3	1	7.1
Backed point	0	0	0	0.0	1	4.2	0	0.0
Miscellaneous backed	0	0	0	0.0	4	16.7	4	28.6
Subtotal backed	0	0	1	12.5	8	33.3	6	42.9
MRPs	0	0	2	25.0	6	25.0	4	28.6
TOTAL	0	0	8	100.0	24	100.0	14	100.0

TABLE 12. *Raw material composition of flaked stone artefacts from Deurspring 16.*

	Layer							
	1		2		3		4	
	n	%	*n*	%	*n*	%	*n*	%
Quartz	128	93.4	564	90.4	498	67.0	117	21.2
Quartzite	5	3.6	34	5.4	9	1.2	4	0.7
Silcrete	4	2.9	21	3.4	211	28.4	418	75.7
CCS	0	0.0	5	0.8	17	2.3	3	0.5
Other	0	0.0	0	0.0	8	1.1	10	1.8
TOTAL	137	100.0	624	100.0	743	100.0	552	100.0

trend of increasing quantities of black mussels (Table 6). This suggests that foragers moved much of their procurement effort towards the lower reaches of the intertidal, perhaps, making their collection coincide with some of the lowest of weekly and/or monthly low tides whenever they could (see Jerardino 2014). West Coast rocky shore mussels grow faster than limpets and have an average biomass per unit surface area more than double that of limpets and whelks (McQuaid & Branch 1984; Eekhout *et al*. 1992; Van Erkom Schurink & Griffiths 1993; Bustamante & Branch 1996), highlighting their greater resilience to harvesting when compared to limpets. Within this context, black mussels became the prime 'intensifiable' resource (Stiner *et al*. 2000). This is clearly exemplified by the statistically significant reduction in the sizes of the most commonly collected limpet species at DSP16 (*C. ganatina*, *S. granularis* and *S. argenvillei*) (Figs 4–6), while no such change was observed for black mussels. Predation intensity on black mussels and/or their vulnerability to intense harvesting might well have varied along the coast, as localised reductions in black mussel sizes during the megamidden period have also been recorded elsewhere in the Lamberts Bay area (Jerardino 2010). Same sites show also shrinking *C. granatina* mean sizes during the megamidden period.

THE LOCAL STONE ARTEFACT SEQUENCE

The percentage of formal tools at DSP16 (1.3–3.2%) is within the range observed among other contemporary sites in the study area if not somewhat lower (Table 10) (Jerardino 1998, 2013b; Orton 2006). A general pattern of change in formal tool categories through time is shared between DSP16 and similarly dated occupations at local sites such as TC, SBF and PKM (Fig. 1; Table 11; Jerardino 2013b). Backed pieces, thought to form part of hunting tool kits (Shea 2006), are the most frequent formal tools during the mid-Holocene (Layer 4) and decrease in importance soon thereafter, with scrapers becoming dominant during the late Holocene (Layers 2 and 3). This trend through time is echoed by blades and bladelets at DSP16 and also at TC and SBF, supporting an earlier contention that they were probably manufactured for the production of these formal tools (Jerardino 2013b: 196). Adzes are totally absent in DSP16, which is at variance with TC, SBF and PKM records that show increasing frequencies as from *c.* 3700 BP onwards. This discrepancy cannot be explained fully at this stage and may relate to the particular combination/emphasis of activities at DSP16 (situated right next to the coast) that may have differed with those carried out at the other sites (located 1.7–4.0 km away from the coast).

Locally available raw materials (quartz and quartzite) become increasingly more common during the late Holocene, while the exotic silcrete was the most preferred raw material for stone artefact production during the mid-Holocene (Table 12). In the past, sources of silcrete were available only from the Olifants River mouth situated 37 km north of DSP16 and from the Vredenburg Peninsula and Piketberg area located both within a radius of at least 85 km to the south from this site (Fig. 1; Jerardino 2013b, and references therein). As with earlier studies on TC and SBF lithic raw materials, access to lithic raw materials is interpreted here as a reflection of group mobility (Jerardino 2013b). Consequently, DSP16, TC and SBF lithic data suggest that people travelled long distances to the north and south of the study area during the mid-Holocene and until about 4700–4400 cal BP. Forager groups then reduced their mobility to the coast and adjacent Sandveld, a pattern that becomes most evident as from *c.* 3440 cal BP onwards. The total absence of indurated shale or hornfels is rather surprising, but it may indicate that groups visiting DSP16 followed mostly a restricted route parallel to the coast and not perpendicular to it as this raw material is largely sourced from the interior mountains (Olifants River valley and mouth) and the Malmesbury area (Fig. 1; see Jerardino 2013b).

The lithic evidence from DSP16, TC and SBF also has implications for age-bracketing the many undated, and perhaps, undatable, large open stone artefact scatters ('deflation hollows') (Manhire 1987) that dot the margins of the Jakkals River, Langvlei River and Verlorenvlei (Fig. 1). Deflation hollows are variably dominated by scrapers, backed pieces and lower frequencies of adzes, while silcrete features prominently in the waste and retouched tool categories. On the basis of the marked temporal patterns in stone artefact typology and raw materials, it seems likely that much of the material at the deflation hollows dates to about 6800–3700 cal BP.

CONCLUSIONS

Observations from DSP16 are now starting to fill in an erstwhile recognised gap or, rather, a period thinly represented in the local cultural sequence of the central West Coast (Jerardino *et al.* 2013; Orton & Compton 2006). These observations also provide an opportunity to test previous reconstructions that have been put forward for the late Holocene *c.* 3800 and 2000 cal BP (Jerardino 2010, 2012, 2013a).

Some real taphonomic factors may well have obscured the visibility of mid-Holocene sites in the study area (Compton & Francescini 2005), but some of the first glimpses into this period (*c.* 5700–4700 cal BP) suggest that hunter-gatherer groups moved long distances, although their visits were either relatively brief and/or group sizes were small. It is therefore not surprising that foraging areas appear extensive enough to include the hunting of large mobile prey (large bovids and rhinoceros). Nevertheless, the procurement of smaller species with more proximate distribution to the site from terrestrial and coastal environments was also common. Among the latter, the collection of shellfish included at least a dozen species, but with a clear preference for two species of limpets (*C. granatina* and *S. granularis*) found in the mid intertidal and moderate emphasis in the collection of a third species of limpet (*S. argenvillei*) that thrives in the lower intertidal. Sea levels during the onset of DSP16 occupation might have been slightly higher than today (Fig. 2), but this did not prevent people from collecting shellfish. Overall, the DSP16 record suggests an emphasis on terrestrial resources during the mid-Holocene, which is also supported by the frequent production of backed pieces at this time for hunting purposes. Given the close similarity in the formal tool typology of deflation hollows and the dated mid-Holocene assemblages from DSP16 SBF, and TC, it is possible that hunter-gatherers never stopped occupying the study area during the mid-Holocene despite increased aridity. Historical San Bushmen occupied vast expanses of deserts/dry lands in far more climatologically and ecologically challenging conditions than the ones ever to dominate the study area (Barnard 1992). Consequently, the emerging picture from the past suggests that the mid-Holocene was likely a more eventful period than is normally suspected to have been.

The late-Holocene archaeological record presents a very different and perhaps more dynamic scenario. Although some interesting variability between contemporary occupations is observed, temporal trends in subsistence and mobility are common to all late-Holocene sites. The DSP16 evidence at this time is consistent with longer visits and/or larger groups of people after *c.* 3440 cal BP that become increasingly circumscribed to the coastal plain at this time and onwards. This date also marks a turning point when subsistence was re-formulated with a focus on smaller and more predictable prey from terrestrial environments and a shift from gathering limpets common in the mid-intertidal to increasing emphasis on higher-yielding black mussels from the low intertidal shores. This shift ensured a more sustainable exploitation of some, but not all, of the resources near DSP16 as evidenced by unaffected sizes of black mussels but significant reductions in the most collected limpet species by *c.* 2300 cal BP. A marine-oriented diet characterised forager diet during this latter occupation at DSP16, which is when about a dozen very large shell middens (megamiddens) were also building up along the central West Coast. As argued elsewhere, the most likely factor accounting for these remarkable adaptive processes is that of greater population densities.

As research efforts are continued in the study area, a more complete picture of the mid-Holocene will hopefully become available. Likewise, late-Holocene resource intensification and demographic scenarios can be revised and/or further described with more nuances attached to it. Some of these new observations will probably emerge with further archaeological impact assessments, but hopefully new generations of research archaeologists will also take on the challenge.

ACKNOWLEDGEMENTS

The 1994 excavations were funded by Le Cap Projects in fulfilment of the heritage legislation and the relevant excavation permit was issued by the National Monuments Council to this end. Financial assistance for the 1996 excavation season was received from The Swan Fund (Oxford), the Centre for Science Development (while funding the former Spatial Archaeology Research Unit led by John Parkington) and the University of Cape Town. Tim Hart and David Halkett led 1996 excavations, but regrettably for reasons beyond the merit of this project, they wished not to be co-authors of this paper. The following people who helped during one or both excavation seasons are acknowledged: Sharon Amman, Gavin Anderson, Gail Euston-Brown, John Gribble, Guy Slingsby and Sarah Winter. The authors are also grateful to Jayson Orton and Genevieve Dewar for their useful comments and suggestions on an initially submitted draft. Credit is also extended for Graham Avery's assistance with the identification of bird bones. Many thanks to Francesc Conesa for compiling Fig. 2, and to David Halkett for the lithic analysis and Fig. 3. Debbie Adams and Steven Lekas undertook basic sorting of the material excavated in 1996.

REFERENCES

Acocks, J.P.H. 1975. *Veld Types of South Africa*. South African Botanical Survey Memoir 28. Pretoria: Government Printer.

Barnard, A. 1992. *Hunters and Herders of Southern Africa: a Comparative ethnography of the Khoisan Peoples*. Cambridge: Cambridge University Press.

Binneman, J. 2004/2005. Archaeological research along the south-eastern Cape coast Part I: open-air shell middens. *Southern African Field Archaeology* 13 & 14: 49–77.

Branch, M. & Branch, G.M. 1992. *The Living Shores of Southern Africa*. Cape Town: Struik.

Branch, G.M., Griffiths, C.L., Branch, M.L. & Beckley, L.E. 2010. *Two Oceans: a Guide to the Marine Life of Southern Africa*. Cape Town: Struik.

Buchanan, W. 1985. Middens and mussels: an archaeological enquiry. *South African Journal of Science* 81: 15–16.

Bustamante, R.H. & Branch, G.M. 1996. Large-scale patterns and trophic structure of southern African rocky shores: the roles of geographic variation and wave exposure. *Journal of Biogeography* 23: 339–351.

Bustamante, R.H., Branch, G.M. & Eekhout, S. 1995. Maintenance of an exceptional intertidal grazer biomass in South Africa: subsidy by subtidal kelps. *Ecology* 76: 2314–2329.

Bustamante, R.H., Branch, G.M. & Eekhout, S. 1997. The influences of physical factors on the distribution and zonation patterns of South African rocky-shore communities. *South African Journal of Marine Science* 18: 119–136.

Chase, B.M. & Meadows, M.E. 2007. Late Quaternary dynamics of southern Africa's winter rainfall zone. *Earth-Science Reviews* 84: 103–138.

Cohen, A.L., Parkington, J.E., Brundrit, G.B. & Van der Merwe, N.J. 1992. A Holocene marine climate record in mollusc shells from the southwest African coast. *Quaternary Research* 38: 379–385.

Compton, J.S. 2001. Holocene sea-level fluctuations inferred from the evolution of depositional environments of the southern Langebaan Lagoon salt marsh, South Africa. *The Holocene* 11: 395–405.

Compton, J.S. 2006. The mid-Holocene sea-level highstand at Bogenfels Pan on the southwest coast of Namibia. *Quaternary Research* 66: 303–310.

Compton, J. & Franceschini, G. 2005. Holocene geoarchaeology of the Sixteen Mile Beach barrier dunes in the Western Cape, South Africa. *Quaternary Research* 63: 99–107.

Conaty, G.T. & Leach, E.K. 1987. Resource patches and mobility strategies: archaic responses to climatic change. In: McKinnon, A. & Stuart, G.S.L. (eds) *Man and the Mid-Holocene Climatic Optimum*: 211–233. Proceedings of 17th Annual Conference of the Archaeological Association of the University of Calgary. Calgary: University of Calgary Archaeological Association.

Deacon, H.J. & Deacon, J. 1999. *Human Beginnings in South Africa: Uncovering the Secrets of the Stone Age*. Cape Town: David Phillip Publishers.

Deacon, J. 1974. Pattering in the radiocarbon dates for the Wilton/ Smithfield complex in southern Africa. *South African Archaeological Bulletin* 29: 3–18.

Dewar, G. & Jerardino, A. 2007. Micromammals: when humans are the hunters. *Journal of Taphonomy* 5(1): 1–14.

Dewar, G., Reimer, P.J., Sealy J. & Woodborne, S. 2012. Late-Holocene marine radiocarbon reservoir correction (ΔR) for the west coast of South Africa. *The Holocene* 22: 1481–1489.

Eekhout, S., Raubenheimer, C.M., Branch, G.M., Bosman A.L. & Bergh, M.O. 1992. A holistic approach to the exploitation of intertidal stocks: limpets as a case study. *South African Journal of Marine Science* 12: 1017–1029.

Gil, A., Zárate, M. & Neme, G. 2005. Mid-Holocene paleoenvironments and the archaeological record of southern Mendoza, Argentina. *Quaternary International* 132: 81–94.

Glassow, M.A. 1997. Middle Holocene cultural development in the Central Santa Barbara Channel region. In: Erlandson, J.M. & Glassow, M.A. (eds) *Archaeology of the California Coast during the Middle Holocene*: 73–90. Perspectives in California Archaeology, Volume 4. Los Angeles: Institute of Archaeology, University of California.

Helmer, J.W. 1987. Climate change and Paleoeskimo culture change: fact, fiction or feasible? In: McKinnon, A. & Stuart, G.S.L. (eds) *Man and the Mid-Holocene Climatic Optimum*: 211–233. Proceedings of 17th Annual Conference of the Archaeological Association of the University of Calgary. Calgary: University of Calgary Archaeological Association.

Jerardino, A. 1995a. Late Holocene neoglacial episodes in southern South America and southern Africa: a comparison. *The Holocene* 5(3): 361–368.

Jerardino, A. 1995b. The problem with density values in archaeological analysis: a case study from Tortoise Cave, western Cape, South Africa. *South African Archaeological Bulletin* 50(161): 21–27.

Jerardino, A. 1997. Changes in shellfish species composition and mean shell size from a late-Holocene record of the west coast of southern Africa. *Journal of Archaeological Science* 24: 1031–1044.

Jerardino, A. 1998. Excavations at Pancho's Kitchen Midden, western Cape coast, South Africa: further observations into the megamidden period. *South African Archaeological Bulletin* 53(167): 17–25.

Jerardino, A. 2010. Large shell middens in Lamberts Bay, South Africa: a case of hunter- gatherer resource intensification. *Journal of Archaeological Science* 37: 2291–2302.

Jerardino, A. 2012. Large shell middens and hunter-gatherer resource intensification along the West Coast of South Africa: the Elands Bay case study. *Journal of Island and Coastal Archaeology* 7(1): 76–101.

Jerardino, A. 2013a. Mega shell middens and hunter-gatherer resource intensification along the West Coast of South Africa. In: Bailey, G., Hardy, K. & Camara, A. (eds) *Shell Energy: Mollusc Shells as Coastal Resources*: 207–228. Oxford: Oxbow Books.

Jerardino, A. 2013b. Two complementary West Coast Holocene lithic assemblages from Elands Bay and Lamberts Bay: implications for local changes in tool kit and group mobility. *South African Archaeological Bulletin* 68(198): 188–199.

Jerardino, A. 2014. Variability in late Holocene shellfish assemblages: the significance of large shore barnacles (*Austromegabalanus cylindricus*) in South African West Coast sites. *Journal of Archaeological Science* 52: 56–63.

Jerardino, A. 2016. Shell density as proxy for reconstructing prehistoric aquatic resource exploitation and transport, perspectives from southern Africa. *Journal of Archaeological Science: Reports* 6: 637–644.

Jerardino, A., Klein, R.G., Navarro, R., Orton, J. & Horwitz, L.K. 2013. Settlement and subsistence patterns since the terminal Pleistocene in the Elands Bay and Lamberts Bay areas. In: Jerardino, A., Malan, A. & Braun, D. (eds) *The Archaeology of the West Coast of South Africa*: 85–108. Oxford: Archaeopress.

Jerardino, A. & Navarro, R. 2008. Shell morphometry of seven limpet species from coastal shell middens in southern Africa. *Journal of Archaeological Science* 35(4): 1023–1029.

Jerardino, A., Navarro, R. & Nilssen, P. 2001. Cape rock lobster (*Jasus lalandii*) exploitation in the past: estimating carapace length from mandible sizes. *South African Journal of Science* 97: 59–62.

Jerardino, A. & Swanepoel, N. 1999. Painted slabs from Steenbokfontein Cave: the oldest known parietal art in southern Africa. *Current Anthropology* 40(4): 542–548.

Jerardino, A., Wiltshire, N., Webley, L., Tusenius, M., Halkett, D., Hoffman, M. T. & Maggs, T. 2014. Site distribution and chronology at Soutpansklipheuwel, a rocky outcrop on the West Coast of South Africa. *Journal of Island and Coastal Archaeology* 9: 88–110.

Kaplan, J. 1994a. Archaeological excavations at Doorspring, Lamberts Bay. Unpublished report prepared for Le Cape Projects. Agency for Cultural Resource Management.

Kaplan, J. 1994b. Archaeological excavations at Doorspring, Lamberts Bay: final season. Unpublished report prepared for Le Cape Projects. Agency for Cultural Resource Management.

Kilburn, R. & Rippey, E. 1982. *Sea Shells of Southern Africa*. Johannesburg: Macmillan.

Lombard, M., Wadley, L., Deacon, J., Wurz, S., Parsons, I., Mohapi, M., Swart J. & Mitchell, P. 2012. South African and Lesotho Stone Age sequence updated (I). *South African Archaeological Bulletin* 67(195): 120–144.

Manhire, A. 1987. *Later Stone Age Settlement Patterns in the Sandveld of the South-western Cape Province, South Africa*. Oxford: British Archaeological Reports International Series 351.

Marshall, L. 1976. *The !Kung of Nyae Nyae*. Cambridge: Harvard University Press.

Matthews, T. 1999. Taphonomy and the micromammals from Elands Bay Cave. *South African Archaeological Bulletin* 54(170): 133–140.

McQuaid, C.D. & Branch, G.M. 1984. Influence of sea temperature, substratum and wave exposure on rocky intertidal communities: an analysis of faunal and floral biomass. *Marine Ecology Progress Series* 19, 145–151.

Méndez, C., Prates, L. & Yacobaccio, H. 2015. Palaeodemography in southern South America. *Quaternary International* 356: 1–3.

Miller, D.E., Yates, R.J., Jerardino, A. & Parkington J.E. 1995. Late Holocene coastal change in the southwestern Cape, South Africa. *Quaternary International* 29/30: 3–10.

Miller, D.E., Yates, R.J., Parkington J.E. & Vogel, J.C. 1993. Radiocarbon-dated evidence relating to a mid-Holocene relative high sea-level on the south-western Cape coast, South Africa. *South African Journal of Science* 89: 35–44.

Mucina, L. & Rutherford M.C. (eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. Pretoria: South African National Biodiversity Institute.

Orton, J. 2006. The Later Stone Age lithic sequence at Elands Bay, Western Cape, SouthAfrica: raw materials, artefacts and sporadic change. *Southern African Humanities* 18: 1–28.

Orton, J. & Compton, J. 2006. A reworked mid-Holocene lithic assemblage at Dunefield Midden 1, Elands Bay, South Africa. *South African Archaeological Bulletin* 61: 90–95.

Parkington, J., Cartwright, C., Cowling, R.M., Baxter, A. & Meadows, M. 2000. Palaeovegetation at the Last Glacial Maximum in the Western Cape, South Africa: wood charcoal and pollen evidence from Elands Bay Cave. *South African Journal of Science* 96: 543–546.

Parkington, J.E., Poggenpoel, C., Buchanan, W., Robey, T., Manhire, A. & Sealy, J. 1988. Holocene coastal settlement patterns in theWestern Cape. In: Bailey, G. & Parkington, J.E. (eds) *The Archaeology of Prehistoric Coastlines*: 22–41. Cambridge: Cambridge University Press.

R Development Core Team. 2012. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna. http://www.Rproject.org/.

Robey, T. 1987. The stratigraphic and cultural sequence at Tortoise Cave, Verlorenvlei. In: Parkington, J.E. & Hall, M. (eds) *Papers in the prehistory of the western Cape, South Africa*: 294–325. Oxford: British Archaeological Reports International Series 332(ii).

Sealy, J., Ludwig, B. & Henderson, Z. 2006. New radiocarbon dates for Matjes River Rock Shelter. *South African Archaeological Bulletin* 61(183): 98–101.

Shannon, L.V. 1985. The Benguela ecosystem part I: evolution of the Benguela, physical features and processes. *Oceanography and Marine Biology Annual Review* 23: 105–183.

Shea, J.J. 2006. The origins of lithic projectile point technology: evidence from Africa, the Levant, and Europe. *Journal of Archaeological Science* 33: 823–846.

Silberbauer, G. 1965. Report to the Government of Bechuanaland on the Bushman survey. Gaberones: Bechuanaland Government.

Skead, C.J. 1980. *Historical Mammal Incidence in the Cape Province*. Vol. 1. Cape Town: Department of Environmental Conservation.

Sokal, R.R. & Rohlf, F.J. 1969. *Biometry*. San Francisco: Freeman Press.

Stiner, M.C., Munro, N.D. & Surovell, T. 2000. The tortoise and the hare: small-game use, the broad spectrum revolution, and Paleolithic demography. *Current Anthropology* 41: 39–74.

Van Erkom Schurink, C. & Griffiths, C.L. 1993. Factors affecting relative rates of growth in four South African mussel species. *Aquaculture* 109: 257–273.

Yellen, J.E. 1977. *Archaeological Approaches to the Present*. New York: Academic Press.