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The Middle and Later Stone Age faunal remains from Diepkloof Rock Shelter, Western Cape, South Africa

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ABSTRACT

The faunal sample from the Middle Stone Age (MSA) and overlying Later Stone Age (LSA) deposits of Diepkloof Rock Shelter (Western Cape Province, South Africa) includes at least 40 taxa, mostly mammals, but also tortoises, snakes, birds (especially ostrich represented by eggshell), and intertidal mollusks. The LSA sample contains only species that occurred nearby historically, including domestic sheep, which LSA people introduced to the region by 1800 years ago. In contrast, like other Western Cape MSA faunas, the Diepkloof MSA sample has more species and it is especially notable for five large extralimital grazing species. These imply a greater-than-historic role for grasses in the local vegetation, particularly in the post-Howiesons Poort (latest MSA) interval where the grazers appear most abundant. Extreme fragmentation and dark-staining impedes analysis of the MSA bones, but cut-marks, abundant burning, and numerous associated artifacts suggest that people were the main accumulators. Rare coprolites imply that carnivores could have contributed some bones, and concentrations of small mammal bones, particularly near the bottom of the MSA sequence, suggest a role for raptors. Tortoise bones are common throughout the sequence, and the MSA specimens tend to be especially large, as in other MSA assemblages. The LSA specimens are smaller, probably because LSA human populations were denser and preyed on tortoises more intensively. The most surprising aspect of the Diepkloof assemblage is its marine component. The coast is currently 14 km away and it would have been even more distant during much of the MSA when sea levels were often lower. Intertidal mollusks, particularly black mussels and granite limpets, are concentrated in the LSA and in the Late and Post-Howiesons Poort layers. Only LSA shells are complete enough for measurement, and the limpets are small as at other LSA sites. The implication is again for more intense LSA collection by relatively dense human populations. Both the LSA and MSA deposits also contain bones of shorebirds and Cape fur seals. Whale barnacles and occasional dolphin bones indicate that MSA people scavenged beached cetaceans.

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1. Diepkloof Rock Shelter: history of excavation, stratigraphy, and dating

Diepkloof Rock Shelter is located about 180 km north of Cape Town in the Western Cape Province of South Africa (Fig. 1). It faces northeastwards atop an isolated outcrop of quartzitic sandstone, 120 m above the southern bank of the Verlorenvlei River, which flows into the Atlantic Ocean about 14 km to the northwest. A quartzitic sill partially dams the river at the mouth, broadening it into a narrow coastal lake that extends from the coast to Diepkloof.

The vegetation nearby comprises semi-arid shrublands adapted to long hot summers and short cool winters. Rainfall comes almost entirely in winter. Historically, wildlife flourished nearby, due to the lake and to perennial spring-fed marshes in the valley to the east.

The shelter floor measures 25 m across the mouth and 17–22 m from dripline to rear wall. It is largely surrounded by fallen boulders that provide about 200 sq m of protected space. Excavation began in 1973 and initially focused on the Later Stone Age (LSA) deposits, which were exposed at the surface in the form of a central ash spread and overlapping wads of grass bedding along the rear wall (Parkington and Poggenpoel, 1987). The bedding filled shallow basins that the LSA occupants had dug into underlying Middle Stone Age (MSA) deposits. The excavation produced reed and wooden artifacts and abundant faunal remains including numerous bones of domestic sheep. The principal stone artifacts were pieces that the LSA people had scuffed or pitted from the

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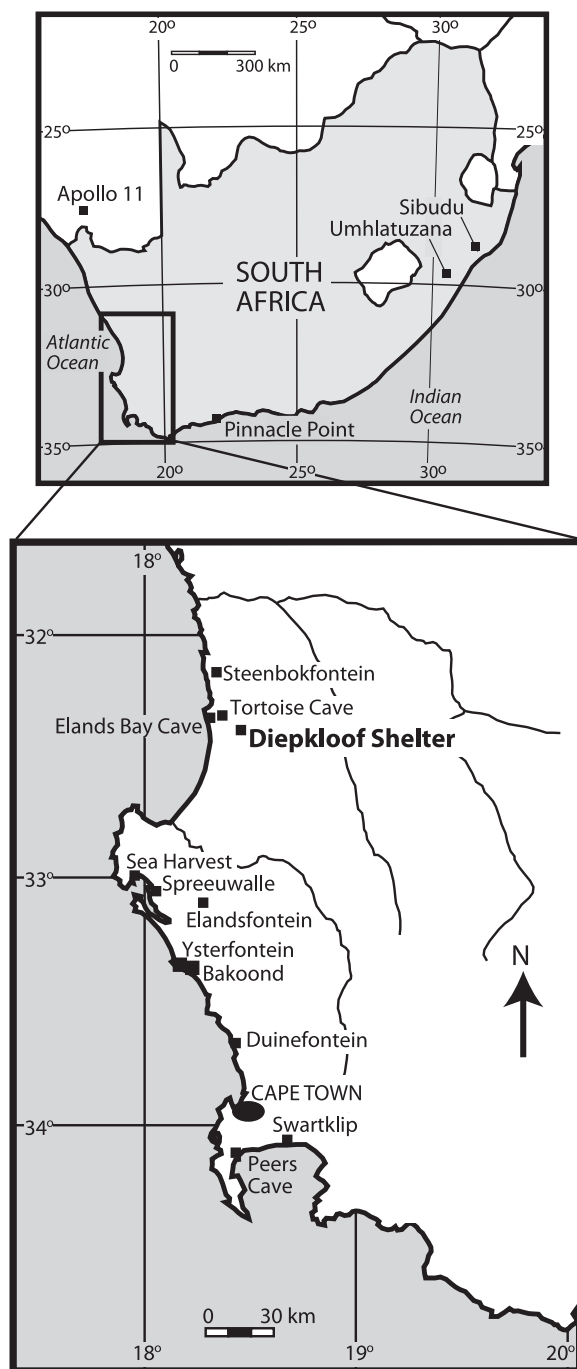[1] Tel.: +1 650 725 9819.

Fig. 1. Approximate locations of the sites mentioned in the text.

and technology have been used to group the SUs into nine complexes (from bottom to top): a lower MSA; the technologically distinct MSA-Mike and Pre-Still Bay Lynn; Still Bay (SB); Early Howiesons Poort (HP); the technologically distinct MSA-Jack; Intermediate HP; Late HP; and finally Post-HP (Porraz et al., 2013). Elsewhere in southern Africa, Still Bay and Howiesons Poort occupations are stratified together only at Apollo 11 Shelter (Vogelsang et al., 2010), Peers Cave (Volman, 1984), Sibudu Cave (Wadley, 2007, 2010), and Umhlatuzana Cave (Lombard et al., 2010). Among these sites, only Sibudu has provided faunal samples that compare in size to those from Diepkloof (Clark and Plug, 2008; Plug, 2004).

Twenty-eight burnt stone artifacts and five sediment samples from the current Diepkloof excavation have been dated by thermoluminescence (TL) and optically stimulated luminescence (OSL) respectively (Tribolo et al., 2013). The dates suggest mean ages of 100 ± 10 ka and 107 ± 11 ka for the lower MSA (SUs Noël and Mark), 100 ± 10 ka for MSA type Lynn (SU Lynn-Leo), 109 ± 10 ka for the SB (SUs Kim-Larry), 105 ± 10 ka and 109 ± 10 ka for the early HP (SUs Kerry-Kate and Jess), 89 ± 8 for the MSA type Jack (SU Jude), 77 ± 8 ka, 85 ± 9 ka, 83 ± 8 ka and 65 ± 8 ka for the Intermediate HP (SUs John, Fox, Fred and OB5), and 52 ± 5 ka for the Late HP (SUs OB2-4). Previous OSL readings on quartz grains provided ages of $97-82$ ka for the lower MSA (Pre-SB), $76-69$ ka for the SB, $65-59$ ka for the HP, and $57-46$ ka for the Post-HP (Jacobs et al., 2008), but one of the SUs included as Still Bay (Kerry, with a date of 70.8 ± 1.8 ka) has now been reassigned to the Early HP (Porraz et al., 2013). Tribolo et al. (2013) believe that Jacobs et al. (2008) used incorrect parameters to calculate equivalent doses and thus underestimated the ages of the deepest samples by 10% or more, explaining the discrepancy between the two studies. OSL dating of sediments has provided SB ages ranging from 68.8 ± 4.6 ka to 75.7 ± 4.8 ka for Blombos Cave (Jacobs et al., 2013), 70.5 ± 2.4 ka for Sibudu Cave (Jacobs et al., 2008) and 70.5 ± 4.7 ka for Umhlatuzana Cave (Lombard et al., 2010). Using samples from multiple sites (but including the erroneously assigned DRS sample), Jacobs et al. (2013) constrain the SB to between 75.5 and 67.8 ka. OSL dating suggests that HP assemblages at various sites accumulated between about 64.8 and 59.5 ka (Jacobs et al., 2008), which is consistent with paleoenvironmental indications that associate the HP largely with Marine Isotope Stage (MIS) 4 (Deacon, 1989). However, it may be necessary to consider how this global cooling manifested itself locally (Blome et al., 2012), and the available HP samples come from multiple modern environmental zones (Jacobs et al., 2008). If all the dates are taken at face value, they may imply that the SB and HP overlapped extensively in time. However additional studies are needed, especially OSL dating by multiple laboratories and the extension of TL to other sites.

2. The faunal sample: recovery and processing

The excavators divided the shelter surface into 1×1 m squares, most of which were further divided into quadrants. They excavated with small trowels and brushes and removed the deposit according to the natural stratigraphy. From 1998, when the French team joined the excavation, finds with a dimension of >20 mm were assigned individual numbers and plotted in three dimensions. Smaller finds were recovered by square or quadrant from 5-mm mesh screens. Bones and shells were separated from artifacts partly in the field and partly afterward at the University of Cape Town. We analyzed the bones and shells yearly in the Iziko South African Museum. The results reported here cover almost all items excavated through to November/December 2011.

The LSA bones and shells from the 1973 excavation are relatively fresh looking and complete, but the overwhelming majority of MSA

underlying MSA deposit. Radiocarbon placed the LSA occupation between 1478 ± 50 years cal BP (1590 ± 45 14C-age BP) and 426 ± 69 years cal BP (390 ± 30 14C-age BP) (Parkington and Poggenpoel, 1987).

Subsequent excavation, first by the University of Cape Town and from 1998 by a joint South African–French team has focused on the deeply stratified MSA sequence (Parkington et al., 2013). The MSA deposits reach a depth of about 3.1 m and comprise approximately 160 named stratigraphic units or "SU's" that suggest persistent utilization with minimal significant hiatuses (Miller et al., 2013). Bone, shell, and well-preserved charcoal occur more or less throughout. Differences in artifact typology

specimens are small fragments that have been chemically altered in the deposit. The MSA faunal remains were therefore much more difficult to analyze. However, we applied the same analytic protocol to LSA and MSA specimens, and we examined any we could identify below the level of Linnaean class for visible damage, which comprised mainly rodent and carnivore tooth marks, stone tool cut marks, gastric-acid etching, and burning. For each mammalian specimen that we could identify to the family level or below, we recorded the skeletal part, and where relevant, its side, portion (mainly proximal or distal), state of epiphyseal fusion, and again, any visible surface damage (using a strong primary light source). We entered the individual specimens into a database from which a custom computer program calculated the Number of Identifiable Specimens (NISP) per taxon and the Minimum Number of Individuals (MNI) they must represent (see Klein and Cruz-Uribe, 1984 for details of how the calculations are made) within each artifactually defined stratigraphic group. We quantified the tortoises mainly from their distal humeri and femora, which we also measured to estimate median individual size in each stratigraphic group. The intertidal shells were generally too fragmented to estimate taxonomic abundance from counts, and for quantification, we have relied on weights.

3. Results

In our analysis, we have ignored a concentration of microfaunal bones that occurred below a likely owl roost on and within an LSA bedding patch in the northwestern corner of the shelter. The species remain unidentified, but M. Avery, reported in Parkington (1987), found small rodents, insectivores, lizards, frogs, and small passerine birds.

The LSA and MSA faunal samples we examined contain at least 40 taxa. Mammals dominate, but there are also tortoises, snakes, birds (especially ostrich represented by eggshell), and intertidal mollusks. To date, excluding ostrich eggshell, some of which is decorated (Texier et al., 2013, 2010) and not part of our current analysis, the specimens we identified include 4614 mammalian bones, 2055 tortoise humeri, 1588 tortoise femora, 400 snake vertebrae, eight bird bones, two fish bones, and 3.3 kg of intertidal shell. The mammal total includes two MSA human phalanges and an MSA human tooth that Verna et al. (2013) describe. The shell weight is a slight underestimate, since it includes only pieces that were separated before we received the fauna and excludes the occasional pieces we encountered in our sorting. The present analysis is based on only about 70% of the identified bones and shells, since we could not assign the remaining 30% to one of the nine successive culture-stratigraphic units listed previously. Some of the unassigned items originate from cleanings or disturbances, but the majority come from a part of the excavation to which the current artifact-based stratigraphic scheme has yet to be applied. It's likely that most, if not all unassigned items from this part of the site came from the broader Howiesons Poort complex.

3.1. Mammals

Analysis of the Diepkloof MSA mammal bones is challenging, because most were fragmented, by burning and often subsequent trampling, and chemically degraded in the deposit (see Miller et al., 2013 for additional details). Fig. 2 illustrates two partial exceptions: (2A) a small bovid (steenbok) mandible on which crystals have formed, and (2B) a heavily leached, fragmentary large bovid (eland) mandible. Many other bones were probably leached away entirely, and like the specimen in Fig. 2B, those that remain were often stained dark-brown or black by the surrounding sediment. Intact
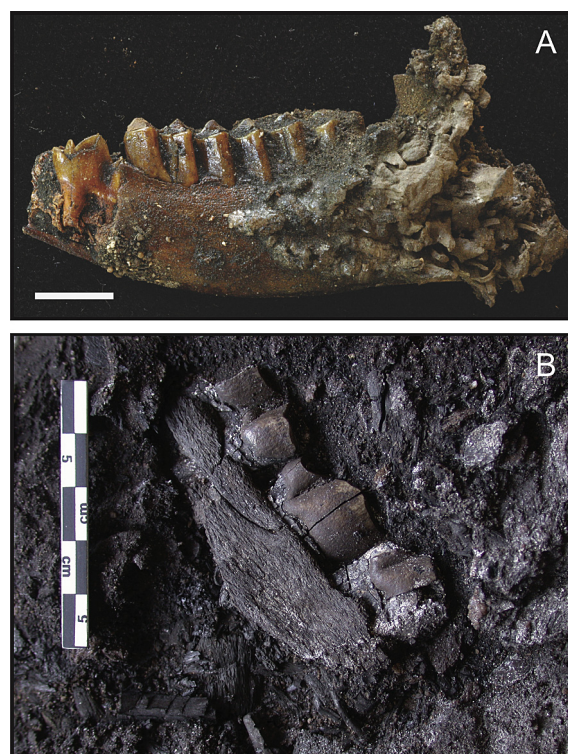

Fig. 2. Specimens that illustrate the quality of bone preservation in the MSA layers: A) steenbok mandible from the Intermediate-HP (SU Jeff) with crystals and B) eland mandible from the Intermediate-HP (SU OB5). Photos courtesy of Pierre-Jean Texier.

teeth are particularly rare, because teeth were often shattered by the growth of gypsum crystals.

3.1.1. Identification and taxonomy

Table 1 lists the mammalian species that we identified, together with the Number of Identified Specimens (NISP) we assigned to each and the Minimum Number of Individuals (MNI) from which the specimens must come. The table uses the taxonomic nomenclature in Skinner and Chimimba (2005). We provide Linnaean names in the text only where they are not listed in the table.

African archaeological faunas often contain closely related species that are difficult to separate on bones alone, and extreme fragmentation in the MSA layers exacerbates the problem for Diepkloof. Teeth show that multiple bovid species are represented, but for the most part, we could assign fragmentary bovid postcranial bones only to size categories. The categories are small, small-medium, large-medium, and large, which we have employed in the same way at other sites, including for example, Elands Bay Cave, Sea Harvest, and Ysterfontein 1, to which we refer below. With respect to the species identified at Diepkloof, small bovids include steenbok, grysbok, and klipspringer; small-medium bovids include sheep, springbok, southern reedbuck, and grey rhebuck; large-medium bovids include blue antelope and black wildebeest and/ or Cape hartebeest; and large bovids include eland and buffalo(s). We could not always distinguish steenbok from grysbok, so Table 1 lists a composite category, *Raphicerus* spp., for specimens we could identify to species and those we could not. The table lumps black wildebeest and Cape hartebeest, because their worn teeth are impossible to distinguish, but based on greater crown height, only black wildebeest is represented among the few lightly worn specimens. Between the two possible buffalo species, only the extinct long-horned species is definitely present, but three dental fragments could conceivably represent the extant Cape buffalo

Table 1
The Number of Identified Specimens (NISP)/the Minimum Number of Individuals (MNI) they must represent for each mammal species in each Diepkloof Rock Shelter culture-stratigraphic unit. "Other" includes specimens from units that have not or could not be attributed to the present cultural stratigraphy. The category "ALL" includes all bones, regardless of provenience within the site. The MNIs were calculated for each culture-stratigraphic unit as if the same individuals could be represented in all the included field units.

Linnaean names	Vernacular names	LSA	Post-HP	Late HP	Inter HP	MSA-Jack	Early HP	Still Bay	Pre-SB Lynn	MSA-Mike	Lower MSA	Other	ALL
Erinaceus frontalis	Hedgehog		3/2				1/1		1/1			3/2	8/5
Leporidae gen. et sp. indet.	Hares	14/2	43/3	250/11	152/7	23/4	46/3	19/1	1/1	5/1	6/1	185/12	744/35
Bathyergus suillus	Cape dune mole rat	2/1	7/2	12/1	183/16	2/1	2/1	7/2	4/1	14/2	226/11	139/13	598/30
Hystrix africaeaustralis	Porcupine		3/1	3/1	6/2							1/1	13/2
Papio ursinus	Chacma baboon			2/1			1/1	1/1			1/1		5/1
Homo sapiens	People		2/1	1/1									3/1
Vulpes chama	Cape fox		1/1										1/1
Canis mesomelas	Black-backed jackal			8/1	2/1							3/1	13/2
Mellivora capensis	Honey badger									1/1			1/1
Galerella pulverulenta	Cape gray mongoose		1/1	2/1	3/1			1/1				6/1	13/2
Genetta sp.	Genet				1/1			1/1					2/1
Felis silvestris libyca	Wildcat	5/1	7/1	16/2	12/1	3/1	7/1	3/1		2/1	1/1	17/2	73/5
Caracal caracal and/or *Leptailurus serval*	Caracal and/or serval		7/1	15/2	9/1	1/1	3/1	1/1		1/1	2/1	11/1	50/3
Panthera pardus	Leopard		4/1	3/1		2/1				1/1		3/1	13/2
Hyaenidae gen. et sp. indet.	Hyena		6/1	1/1			1/1						8/1
Arctocephalus pusillus	Cape fur seal			2/1	1/1								3/1
Orycteropus afer	Aardvark											1/1	1/1
Procavia capensis	Rock hyrax	17/2	41/4	42/4	82/11	15/3	33/4	17/2	7/1	11/2	11/3	80/8	356/26
Equus capensis	Cape zebra		10/2	5/1	1/1			6/1	1/1	1/1	1/1	6/1	31/4
Equus zebra and/or *E. quagga*	Mountain zebra and/or quagga										1/1	1/1	2/1
Equus spp.	Equids		26/2	8/1	3/1	1/1		7/1	2/1	1/1	1/1	11/1	66/4
Rhinocerotidae gen. et sp. indet.	Rhinoceros(es)		7/1	9/1	10/1	1/1	2/1	8/1	1/1	1/1		5/1	44/2
Hippopotamus amphibius	Hippopotamus		1/1	3/1	1/1	1/1	2/1	10/1				1/1	19/1
Taurotragus oryx	Eland		4/1	5/1	3/1		4/2	6/1		3/1	1/1	3/1	29/3
Hippotragus leucophaeus	Blue antelope		3/1	1/1	2/1	1/1	1/1	1/1	1/1	1/1	3/1		14/2
Connochaetegnou and/or *Alcelaphus buselaphus*	Black wildebeest and/or Cape hartebeest		6/2	4/1	2/1							1/1	13/2
Pelea capreolus	Vaalribbok	1/1		3/1	1/1								5/1
Redunca arundinum	Southern reedbuck		3/1	4/1	1/1		3/1					2/1	13/3
Oreotragus oreotragus	Klipspringer	1/1	3/1	5/1	4/1		1/1					4/1	18/2
Raphicerus campestris	Steenbok		1/1	2/2	1/1		2/1					2/2	8/3
Raphicerus melanotis	Grysbok				1/1								1/1
Raphicerus sp(p.)	Grysbok/steenbok	13/2	13/2	14/3	20/3	5/2	11/3	7/2	2/1			20/4	109/13
Antidorcas sp.	Springbok		1/1										1/1
Ovis aries	Sheep	65/6											65/6
Pelorovis antiquus	Long-horned buffalo		3/1	1/1			1/1					4/1	9/1
	Small bovid(s)	93/5	100/3	319/7	339/9	31/2	108/4	43/2	11/1	13/2	22/3	363/6	1442/26
	Small-medium bovid(s)	208/6	53/2	110/3	39/2	4/1	9/1	2/1	2/1	2/1	4/1	52/2	485/8
	Large-medium bovid(s)	17/1	88/3	112/3	50/2	11/1	24/1	15/1	2/1	1/1	11/1	70/2	408/5
	Large bovid(s)	5/1	34/2	61/2	27/1	11/1	27/2	11/1	2/1	5/1	5/1	45/1	205/5
Delphinidae gen. et sp. indet	Dolphin(s)					2/1							2/1

(*Syncerus caffer*). Similarly, some of the smaller teeth or dental fragments we assigned to eland might come from large kudu (*Tragelaphus strepsiceros*). We identified sheep conclusively from four horn core fragments. We saw no specimens of goat (*Capra hircus*).

A similar problem of species identification affects the rhinocerotids (rhinos), equids ("horses") and leporids (hares). We could not distinguish the fragmentary bones of rhinoceros between ones that could come from black rhino (*Diceros bicornis*) and ones that might represent white rhino (*Ceratotherium simum*). Only black rhino was known nearby historically, but white rhino occurs in other Western Cape Pleistocene sites. Dental and postcranial size differences show that at least two equid species occur in the MSA fauna and there could be three. Most of the identifiable specimens are extremely large and must represent the Cape zebra (*Equus capensis*), but some smaller elements could come from either mountain zebra (*Equus zebra*) or quagga (*Equus quagga*). We have therefore listed the smaller bones as *E. zebra* and/or *E. quagga*, and we have lumped all equid bones — both those we could identify on size and a number of fragments we could not — in a composite equid category. Faced with extreme fragmentation and a lack of

dentitions, we have further lumped all the Diepkloof hare bones into a leporid category, but they could variously represent Cape hare (*Lepus capensis*), scrub hare (*Lepus saxatilis*), red rock rabbit (*Pronolagus rupestris*), or least likely based on geography, riverine rabbit (*Bunolagus monticularis*).

3.1.2. Bone damage and the collector(s)

Extensive post-depositional alteration impeded our attempt to quantify bone damage, but we recorded occasional cut marks and percussion notching from human butchery and marrow extraction. Use-wear studies of a sample of Early HP artifacts also indicate their involvement with animal butchery (Igreja and Porraz, 2013). Most of the cut-marks were on bones of large-medium bovids: one from the Intermediate HP (SU Fred), three from the SB (SUs Larry and Kim), one from Mike (SU Lauren), and one from the Pre-SB (SU Maggie). Cut marks also occurred on a large bovid bone from the Late HP (SU Frans), on a bone of indeterminate taxon from the Intermediate HP (SU OB3) and one from Jack (SU Jack), and on a jackal ulna from the Intermediate HP (SU Fred). The latter is noteworthy, since cut-marked carnivore bones are rare in MSA assemblages. We also observed numerous apparently burned

bones, but we offer no numbers, because we had difficulty consistently distinguishing burning from the dark staining that the bones commonly acquired in the deposit. However, Diepkloof preserves abundant evidence of hearths, visible in both the macro- and micro-stratigraphy (Miller et al., 2013).

We found no carnivore chewed bones, but we observed apparent gastric acid damage on three small bovid elements from the Intermediate HP (SUs OB4, OB5 and John), one from the Post-HP (SU Becky), and one from Jack (SU Jack), on a leporid bone from Mike (SU Mike), on a hyrax bone from the SB (SU Logan), and on a large-medium bovid specimen from the LSA (SU Below Bedding K). In addition, six coprolites from the Post-HP levels (four in SU Gladys, two in SU Hearth below Gladys) and one from the Early HP (SU Julia) demonstrate that hyenas visited the shelter. Since carnivore bones, especially ones from jackals and from hyenas themselves, tend to be common where hyenas were active bone accumulators (Cruz-Uribe, 1991), the infrequency of jackal and hyena elements (Fig. 3 and Table 1) suggests that hyena visits to Diepkloof were occasional and short-lived, and we conclude that people introduced most bones of larger animals. We cannot rule out that raptors introduced many bones from smaller species, especially hares, dune mole rats, and hyraxes. Raptor digestion could explain the acid etching on the leporid bone and even some of the small bovid bones, and raptor as opposed to human (MSA) collection must be particularly considered where bones of small species dominate, as in the Pre-SB. The low density of lithic material and micro-stratigraphic analysis of the deepest deposits supports a minimal role for humans in accumulating these materials (Miller et al., 2013, Porraz et al., 2013).

3.1.3. Paleoenvironment

Based on NISPs, Fig. 3 summarizes the taxonomic composition of the Diepkloof mammal fauna in comparison to the fauna from terminal Pleistocene and Holocene LSA layers at Elands Bay Cave (Klein and Cruz-Uribe, 1987), which is located in a similar setting near the mouth of the Verlorenvlei. The figure shows that the Diepkloof and Elands Bay faunas have much in common, including the shared abundance of small bovids and the consistent presence of hares, dune mole rats, and hyraxes. The dune mole rats underscore the shared proximity of sandy soils, and hyraxes (along with baboons, klipspringer, and grey rhebuck) of rocky slopes. Hares appear to be more numerous at Diepkloof. We noted previously that extreme bone fragmentation prevented us from identifying hares below the family level, but an often grassier environment at Diepkloof may have particularly favored one or more species. The consistent presence of water-dependent species, such as hippopotamus, in the Diepkloof assemblage highlights the proximity and persistence of the nearby vlei, where the human inhabitants exploited both faunal and floral resources (Cartwright, 2013).

Overall, the Diepkloof and Elands Bay faunas differ most conspicuously in the much higher frequency of seals at Elands Bay. The difference was expected, since Elands Bay is currently only 200 m from the sea, and 11 ka, when seal bones began to accumulate there, it was probably no more than 4 km. In contrast, the coast was surely always much further from Diepkloof, and it is perhaps surprising that Diepkloof has provided any seal bones at all. The majority (NISP = 26) come from the LSA deposit, but there are also two from the Late HP (SUs Darryl and Hearth below Eve) and one from the Intermediate HP (SU John). If the OSL dates for the HP complex are accepted, the seal bones arrived during MIS 4, when sea level was probably at least as low as it was 11 ka, and the coast would have been 18 km or more to the west.

So far, the SB layers have provided no seal bones, but they have produced two dolphin vertebrae (SU Maria). The SB deposits probably formed during MIS 5 when sea levels were as high or
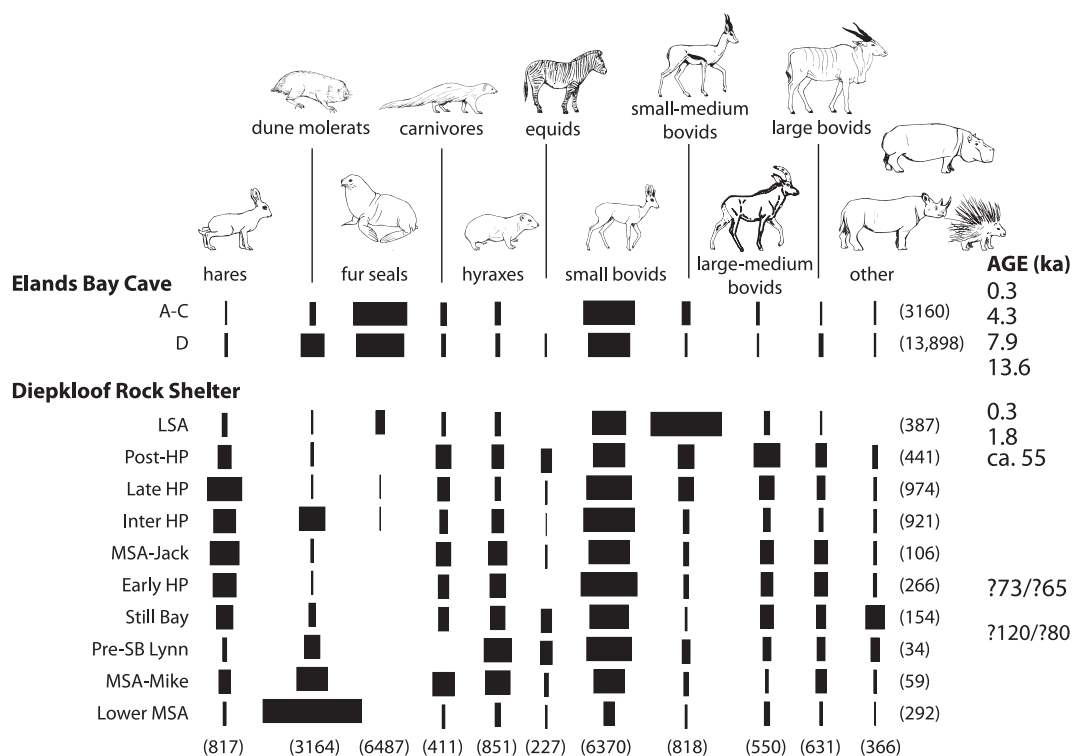

Fig. 3. Relative taxonomic abundance based on NISPs of the principal species or species groups in successive culture-stratigraphic units at Diepkloof Shelter and Elands Bay Cave [EBC A−C = Elands Bay Cave layers 1−9 and EBC D = Elands Bay Cave layers 10−19 (Klein and Cruz-Uribe, 1987; Parkington, 1981, 1987)]. Parentheses contain the raw NISPs for taxa (rows) and for culture-stratigraphic units (columns). The rightmost column presents estimated numeric ages.

higher than today. This may sometimes have encouraged dolphins and other marine species to enter the coastal lake, and dolphins could have become stranded on its shore.

For additional comparisons, it is important to emphasize a significant taxonomic contrast between the late Holocene sample from Elands Bay (labeled "A–C" in Fig. 3) and the terminal Pleistocene/early Holocene sample (labeled "D") (Klein and Cruz-Uribe, 1987). The late Holocene sample is taxonomically identical to the Diepkloof LSA sample, with which it overlaps in time. Both are notable for the presence of domestic sheep bones dated to as much as 1500 years ago, and both contain only indigenous species that were recorded nearby historically. In contrast, the older Elands Bay sample and the Diepkloof MSA sample contain ungulates that were rare or unknown in the region historically. At both sites, these are the Cape zebra, blue antelope, southern reedbuck, and black wildebeest, supplemented at Diepkloof by the long-horned ("giant") buffalo. The latest known occurrence of Cape zebra is at Elands Bay in a layer dated to about 11,000 years cal BP (9600 14C-age BP) (Klein and Cruz-Uribe, 1987). The long-horned buffalo disappeared elsewhere in southern Africa about the same time or a little earlier (Klein, 1994), and its absence at Elands Bay may reflect only the small size of the terminal Pleistocene/early Holocene ungulate sample. The extralimital and extinct species were all obligate grazers, and combined with the relative abundance of extant equids, they suggest that by Holocene standards, grasses were significantly more abundant near Elands Bay and Diepkloof in the late Pleistocene. If this is accepted, the relatively large number of teeth from grazing ungulates in the Diepkloof Post-HP layers may imply especially grassy conditions. OSL dates suggest the Post-HP deposits accumulated after 60 ka, early in MIS 3 (Jacobs et al., 2008).

An increased abundance of grazing ungulates, including the same extralimital and extinct species identified in the Diepkloof MSA and Elands Bay terminal Pleistocene samples, characterizes all other known Western Cape Pleistocene faunas, including both those from "glacial" sites (like Swartklip (Klein, 1983), Spreeuwalle (Klein et al., 2007), the Elandsfontein Bone Circle (Klein, 1983)) and "interglacial" sites (like Duinefontein 2 (Cruz-Uribe et al., 2003) and Elandsfontein Main (Klein et al., 2007)). At the glacial sites, the greater role of grasses may mainly reflect reduced evaporation, but at the interglacial sites, it must reflect higher rainfall. In either case, the difference from the Holocene is striking, and it implies that the Western Cape has been unusually dry during the Holocene, perhaps because it has been unusually warm.

The woody plants identified from MSA charcoals at Diepkloof (Cartwright, 2013) and from terminal Pleistocene charcoals at Elands Bay (Cartwright and Parkington, 1997) confirm that precipitation was generally greater or more effective, and the large average size of dune mole rats in the terminal Pleistocene/early Holocene deposits of Elands Bay provides additional support. This follows from the observation that average size in recent dune mole rats increases with rainfall (Klein, 1991). At Diepkloof, dune mole rat bones are too rare in most artifactually defined units to estimate average size, but in the SB complex and superjacent Mike where they are sufficiently common, they appear to have been intermediate in size between the large terminal Pleistocene/early Holocene specimens and the much smaller late Holocene specimens at Elands Bay (Fig. 4). This suggests that the Pre-SB units accumulated at a time (probably during a portion of MIS 5) when rainfall was less than in the terminal Pleistocene/early Holocene but greater than in the late Holocene.

In sum, the Diepkloof mammals suggest that the late Holocene (LSA) environment differed little if at all from the historic one, but that the late Pleistocene (MSA) environment was significantly grassier, because precipitation was higher, more effective, or both.
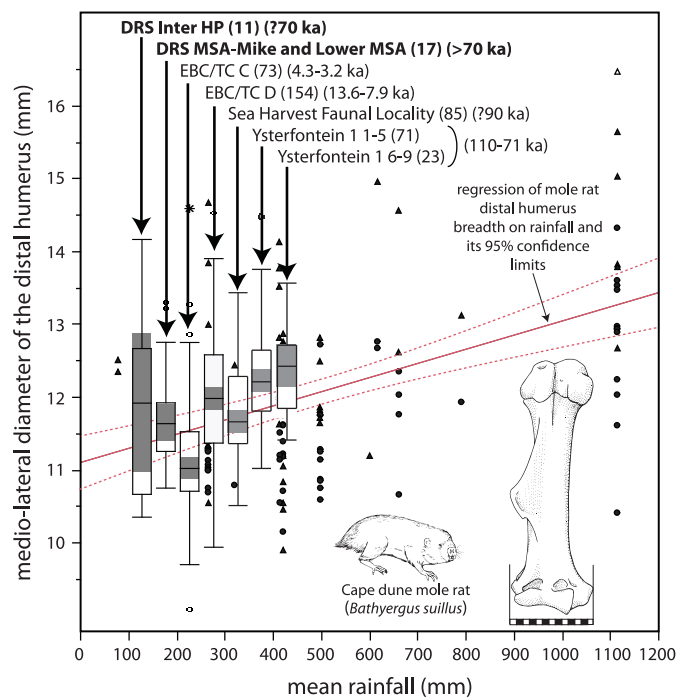

Fig. 4. The least squares regression of dune mole rat distal humerus medio-lateral diameters on rainfall, the 95% confidence limits for the regression, and boxplots summarizing distal humerus breadth in fossil samples from Diepkloof Shelter (DRS), Ysterfontein 1 (Avery et al., 2008), the Sea Harvest Faunal Locality (Grine and Klein, 1993), and two composite successive LSA occupation episodes at Elands Bay Cave (Parkington, 1981, 1987) and Tortoise Cave (Robey, 1987): EBC/TC C = Elands Bay Cave layers 6–9 plus Tortoise Cave layers 5–13A and EBC/TC D = Elands Bay Cave layers 10–19 plus Tortoise Cave layer 14. Solid circles and triangles mark humeri from modern mole rat females and males respectively. The parentheses following the site names contain the numbers of measured humeri, followed by their estimated ages. The key elements in each boxplot are the median, represented by the line near the center of each plot; the open rectangle which encloses the middle half of the data (between the 25th and 75th percentiles); the shaded rectangle which indicates the 95% confidence limits for the median; and the line bisecting each plot, which signifies the range of more or less continuous data. Starbursts and open circles mark outliers (values that are especially far from the median). Chance is unlikely to explain the difference between medians whose 95% confidence limits do not overlap. Samples whose confidence limits lie above the upper confidence limit for the regression line imply higher-than-expected rainfall; samples whose confidence limits lie below the lower limit imply lower-than-expected rainfall.

3.2. Tortoises and turtles

Tortoise bones abound at Diepkloof. The small number of carapace fragments that can be identified to species come mainly from the angulate tortoise (*Chersina angulata*), which has probably long been common nearby. Two limb bones in the Late HP (SUs Frans and E1), two in the Intermediate HP (SUs John and Jeff), and one in the Early HP (SU Jess) document the marsh terrapin or helmeted turtle (*Pelomedusa subrufa*), an indication that the Diepkloof people also exploited the nearby vlei.

At other Western Cape sites, MSA angulate tortoises tend to be significantly larger than their LSA counterparts, probably because MSA people were generally less numerous and exploited tortoises less intensively (Klein and Cruz-Uribe, 1983; Steele and Klein, 2005/06). Fig. 5 shows that the tortoises from roughly the upper half of the DRS sequence, beginning with Jack, are large like other MSA specimens, but those from further down are not and those from the SB and Lynn are especially small. One possible explanation, also perhaps implied by the exceptional abundance of mole rat and snake bones in SB and Lynn, is that a large raptor or other non-human agent introduced many of the tortoises to these units.
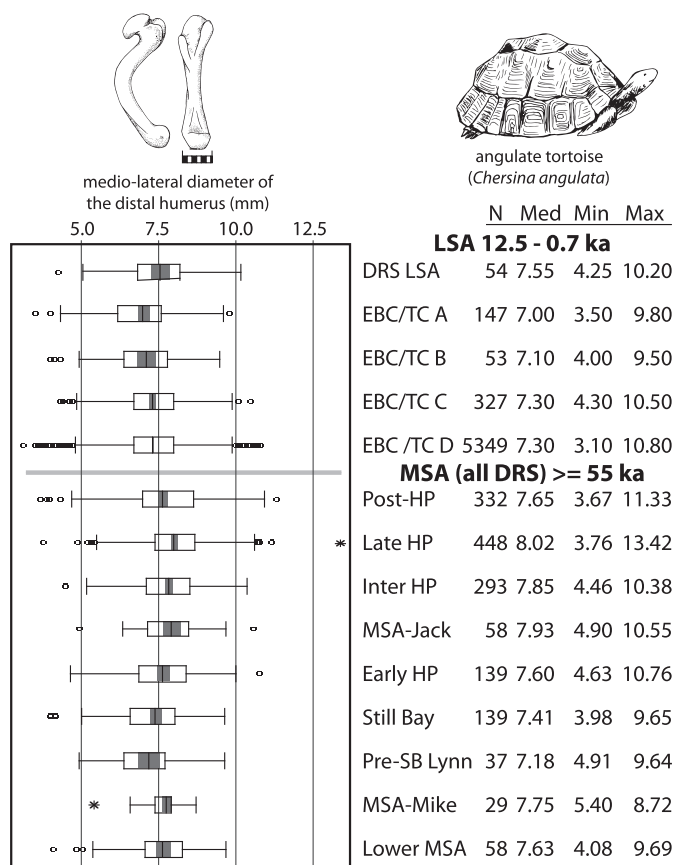
Fig. 5. Boxplots describing the medio-lateral diameter of angulate tortoise distal humeri in the MSA and LSA samples from Diepkloof Rock Shelter (DRS), compared to the LSA specimens from Elands Bay Cave (EBC) (Parkington, 1981, 1987) and Tortoise Cave (TC) (Robey, 1987). EBC/TC A = Elands Bay Cave layers 1−4 and Tortoise Cave layers 1−2A; EBC/TC B = Elands Bay Cave 5 and Tortoise Cave 2B-4; EBC/TC C = Elands Bay Cave 6−9 and Tortoise Cave 5−13A; EBC/TC D = Elands Bay Cave 10−19 and Tortoise Cave 14. The caption to Fig. 3 explains the boxplot format.

3.3. Other vertebrates

All Diepkloof units contain snake vertebrae, but they are especially common in Lynn (NISP = 25), Mike (NISP = 23), and the succeeding SB (NISP = 139). We could not identify any to species, but based on size and geography, they are most likely to come from mole snake (*Pseudaspis cana*), puff adder (*Bitis arietans*), or Cape cobra (*Naja nivea*). An Early HP unit (SU Kenny) provided a single vertebra of monitor lizard (*Varanus* sp.).

We found few bird bones. Raptors are represented by two bones from the Late HP (SU Frans) and one from the Intermediate HP (SU Fiona). Probable francolins (*Francolinus* sp(p).) are represented by one bone each from Lynn (SU Lynn), the Intermediate-HP (SU Jeff), and the Post-HP (SU Hearth below Becky). We also observed a fragmentary femur from penguin (*Spheniscus demersus*) in a unit (SU Gwen) that probably belongs within the HP complex broadly defined. To these, should be added a single element of Cape cormorant (*Phalocrocorax capensis*) from the initial LSA excavation (Parkington and Poggenpoel, 1987).

Poggenpoel (1987) identified a small number of fish bones from the initial LSA excavation to white steenbras (*Lithognathus lithognathus*) and flathead mullet (*Mugil cephalus*). Steenbras was more common, and it could have been caught in the nearby lake, even though it is primarily a saltwater fish. We observed two additional fish bones from deposits that the joint South African−French team attributed to the LSA, but neither has been identified to species. The MSA deposits have so far yielded no fish bones, perhaps because the peculiar geochemical circumstances of MSA deposits destroyed them. However, fish bones also tend to be rare or absent in other MSA deposits where bone is much better preserved (Klein et al., 2004).

3.4. Invertebrates

The initial LSA excavation recovered 17 "mandibles" (chelipeds) of rock lobster (*Jasus lalandii*) and more than 4.5 kg of well-preserved intertidal mollusk shell, mostly from black mussel (*Choromytilus meridionalis*) and granite limpet (*Cymbula granatina*) (Parkington and Poggenpoel, 1987). Our reexamination provided MNIs of 142 for the mussels and 31 for the limpets. Both species are characteristic of rocky shores, and their quantity, both absolutely and relative to mammal bones, is impressive since they had to be transported at least 14 km. Shellfish flesh turns rancid within a few hours, which means the trip had to be made quickly. The shells show no alterations to suggest they were sought for artifacts as opposed to food. The explanation for the unexpected result may be that the lake shore provided an especially easy route to the coast.

Like LSA tortoises, LSA limpets tend to be significantly smaller than their MSA counterparts, probably again because LSA populations were larger and pressed harder on limpet populations (Avery et al., 2008; Klein, 1979; Steele and Klein, 2008). Only the Diepkloof LSA deposits have provided measurable limpets, but these can be compared to limpets from various nearby coastal MSA sites. At Diepkloof and most other local sites, granite limpets tend to dominate the limpet sample, and Fig. 6 shows that the Diepkloof LSA granite limpets conform to advance size expectations. They are similar in average size to those from other regional LSA sites and
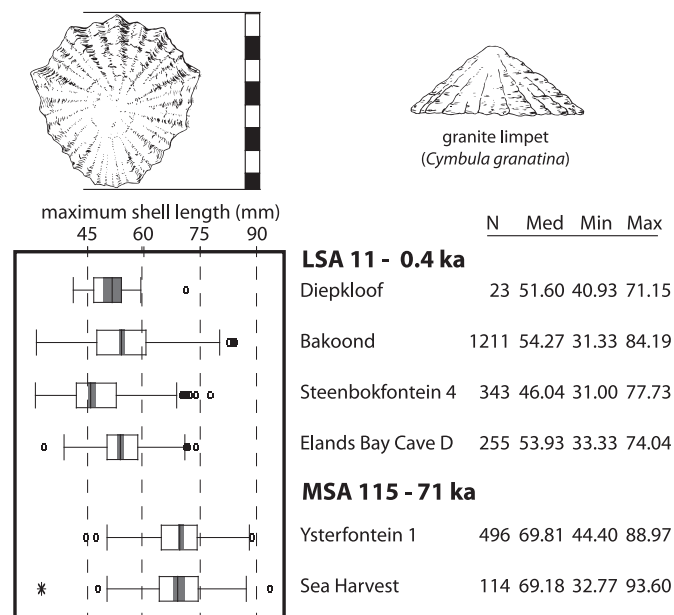

Fig. 6. Boxplots describing the maximum length of granite limpet shells from LSA layers at Diepkloof, Bakoond (Avery et al., 2008), Steenbokfontein (Jerardino and Yates, 1996), and Elands Bay Cave (Parkington, 1981, 1987), and MSA layers at Ysterfontein 1 (Avery et al., 2008) and Sea Harvest (Volman, 1978). The LSA samples span the Holocene, from roughly 11 ka to 0.4 ka. The MSA samples probably date mainly, if not entirely from the MIS 5 (the Last Interglacial) between 115 and 71 ka. The caption to Fig. 3 explains the boxplot format.

Table 2
Weights in grams of mussels, limpets, and other intertidal mollusks in each Diepkloof cultural stratigraphic unit. The text lists the taxa included in "other."

	LSA	Post-HP	Late HP	Inter HP	MSA-Jack	Early HP	Still Bay	Pre-SB Lynn	MSA-Mike	Lower MSA	Other	Grand total
Mussels	48.1	225.3	424.5	53.3	57.6	41.3	5.9			1.1	446.4	1303.5
Limpets	37.3	839.4	571.9	31.3	50.6	24.5	9.3	17.0	1.4	19.7	233.3	1835.7
Other	0.4	15.5	18.5								20.5	54.9
Unidentifiable	0.2	2.7	6.0	7.7	2.6	3.1	1.1			0.9	0.1	24.4
Grand total	**86.0**	**1082.9**	**1020.9**	**92.3**	**110.8**	**68.9**	**16.3**	**17.0**	**1.4**	**21.7**	**700.3**	**3218.5**

significantly smaller than those from local MSA sites. The LSA and MSA sites for comparison were chosen for display purposes only and other sites reveal the same pattern (see other examples in Steele and Klein, 2008).

Both absolutely and relative to mammal bones, the Diepkloof MSA deposits have provided a substantial quantity of highly fragmented, leached intertidal shell, particularly from the Late HP and Post-HP units (Table 2 and Fig. 7). The original amount was surely much greater, and it might have equaled or exceeded the amount in the LSA. Most of the readily identifiable MSA pieces represent black mussels and granite limpets, but there are also fragments of white mussels (*Donax serra*), granular limpets (*Scutellastra granularis*), Argenville's limpets (*Scutellastra argenvillei*), barnacles (Buccinidae), triton (*Argobuccinum pustulorum*), and dogwhelks (*Burnupena/Nucella*). In addition, three Diepkloof MSA units provided whale barnacles (*Coronula* sp(p).) − a complete specimen from the Intermediate HP (SU Fiona; Fig. 8) and one fragment each from the Late HP (SU Debbie) and Post-HP (SU Donovan). Whale barnacles have also been recognized in MSA deposits at the Ysterfontein 1 Rock Shelter (Avery et al., 2008) and Pinnacle Point Cave 13B (Jerardino and Marean, 2010) and in various LSA sites (Jerardino and Parkington, 1993; Kandel and Conard, 2003). Everywhere, they imply scavenging of beached whales, probably mostly the humpback whale (*Megaptera novaeangliae*) and the southern right whale (*Eubalaena australis*), both of which are particularly common in the waters off the Western Cape.

The abundant MSA shell may mean that like their LSA successors, the MSA occupants of Diepkloof discovered they could reach the coast quickly along the shore of the lake. Even if this is true, however, it's puzzling that shell is particularly abundant in the Late HP and Post-HP units, which probably formed at a time when the coast was especially distant (during MIS 4 and early MIS 3), and not in the SB units, which probably formed when the sea was closer (during MIS 5). One possible explanation is that postdepositional leaching and compaction removed progressively greater amounts of shell from the older MSA deposits. If so, however, it did not lead to conspicuous differences in the quality of shell or bone preservation between the bottom and top of the sequence. Another possibility, for which the excavators see no evidence, is that much of the shell near the top of the sequence was admixed from LSA scuffing and trampling or from bedding hollows or pits like those were seen to intrude the MSA deposits in the initial excavation.
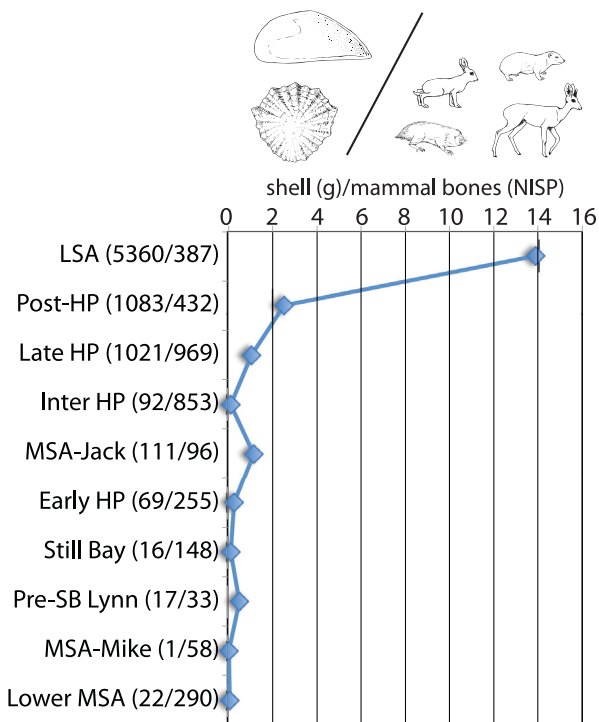
Fig. 7. The weights of mollusks in grams compared to mammal bone NISPs in successive Diepkloof culture-stratigraphic units.
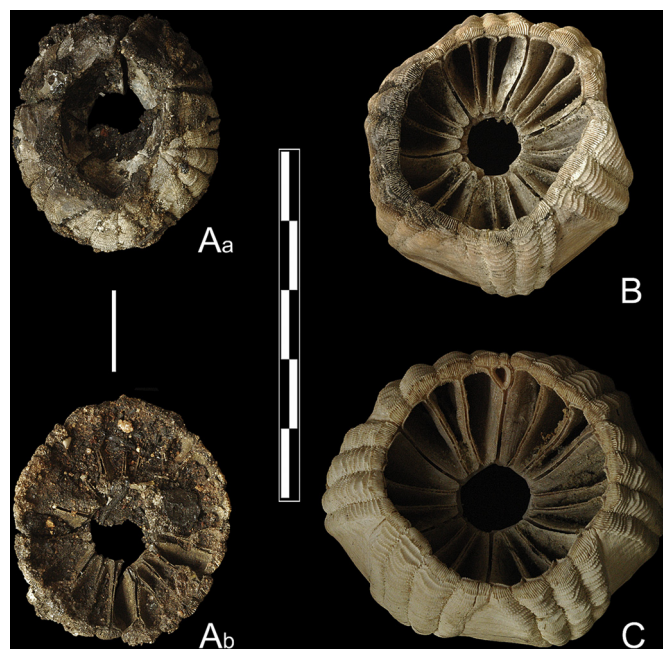
Fig. 8. The complete whale barnacle (*Coronula* sp.) from the Intermediate HP (SU Fiona) showing its top (Aa) and bottom surfaces (Ab) alongside two modern comparative specimens (B and C). Photos courtesy of Pierre-Jean Texier.

4. Conclusions

Diepkloof Rock Shelter has provided bones and shells from an LSA occupation that dates between roughly 1500 and 425 years ago and from a deeply stratified MSA sequence that probably formed from 100,000 years ago or before until 60,000 years ago or later. Within the MSA sequence, the excavators have recognized nine successive artifactually defined complexes, most notably including the Still Bay toward the bottom and variants of the Howiesons Poort toward the top. Our study reported here was based on the 70% of the faunal sample that could be associated with these nine complexes.

Analysis of the MSA bones is challenging, because leaching and post-depositional crystal-growth have reduced most pieces to small fragments. This impedes quantification of pre-depositional damage and thus our ability to identify the bone collector(s). However, we conclude tentatively that people were the principal accumulators in most units. Coprolites suggest that hyenas may have introduced some bones, but the assemblage contains few of the hyena and jackal bones that tend to mark hyena dens, and this suggests that hyena visits were brief. It is more difficult to rule out a significant contribution by large raptors, particularly to units like those near the bottom of the sequence in which small mammals are especially abundant. A raptor contribution could explain why the tortoises in these units are as small or smaller than those in local LSA occupations. At other sites, MSA tortoises tend to be significantly larger than LSA specimens, probably because MSA populations were less dense and pressed on tortoises less intensively. The tortoises from the upper part of the Diepkloof MSA occupation are large and thus conform to expectations drawn from other MSA sites.

Taxonomically, the LSA and MSA samples are similar in their shared abundance of small antelopes, hares, dune mole rats, hyraxes, tortoises, and intertidal shell. The vertebrates imply a substantial degree of long-term environmental continuity. However, unlike the LSA sample, which comprises only species that occurred nearby historically, including domestic sheep that were probably introduced locally by 1800 years ago, the MSA samples include five regionally or totally extinct grazing ungulates − Cape zebra, blue antelope, southern reedbuck, black wildebeest, and long-horned buffalo − that are unknown from any regional Holocene site. The extralimital and extinct grazers imply that grasses played a greater role in the Pleistocene vegetation. The same grazing species characterize all regional Pleistocene fossil sites, both "glacial" and "interglacial" as determined by dating, geomorphic context, or both. A greater role for grasses implies that the Western Cape was commonly moister in the Pleistocene, possibly due to reduced evaporation under glacial conditions and certainly to increased rainfall under interglacial conditions. Conversely, a more limited role for grasses suggests that the Western Cape has been unusually dry in the Holocene, perhaps because it has been unusually warm.

The moderately large average size of dune mole rats from the near the base of the Diepkloof MSA sequence confirms relatively moist conditions, probably during a portion of the Last Interglacial (MIS 5). Larger samples of dune mole rat bones might allow us to track humidity through the MSA sequence.

The most surprising aspect of the Diepkloof fauna is probably the abundance of intertidal shell throughout. The site was 14 km from the coast during the LSA occupation, and it was probably often further when MSA people were present; prehistoric people rarely moved mollusks that far. The distribution of shell within the MSA sequence is particularly puzzling, since it is least abundant near the bottom in layers that are most likely to have formed under interglacial conditions when the coast was closest, and most abundant near the top in layers that probably formed under glacial conditions when the coast was especially distant. Although the preservation of shell and bone does not change conspicuously with depth, progressive post-depositional leaching might explain why shell is less abundant near the bottom than near the top.

Acknowledgments

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