The 1992-1993 Excavations at the Die Kelders Middle and Later Stone Age Cave Site, South Africa

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The 1992–1993 Excavations at the Die Kelders Middle and Later Stone Age Cave Site, South Africa

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Renewed excavations at Die Kelders Cave 1, South Africa, have confirmed and augmented prior findings. The new excavations focused on the Middle Stone Age (MSA) deposits, but they added seeds, pips, and crayfish to the categories of Later Stone Age (LSA) food debris and artifacts recovered earlier. With respect to the MSA deposits, the principal new findings are: 1) previously unrecognized site formation processes, including phosphatization by guano, microfaults, and slippage faces, and numerous minor interruptions in sand accumulation that correspond to short occupation episodes; 2) ESR dates that place the top of the MSA sequence between 80,000 and 60,000 years b.p.; 3) fine-grained rock types, flake-blade sizes, and other features that suggest the top of the sequence contains either the Howieson's Poort or a similar, silcrete-rich variant of the MSA; 4) a pattern of artifact and bone abundance in newly recognized microstratigraphic units that suggests that eagle owls (rather than people) accumulated the dune molerat bones that dominate the MSA faunal assemblages; and 5) new human teeth that resemble previously described ones in their large size and in their basic morphological similarity to modern African homologues. The teeth need not imply that the Die Kelders MSA people were fully modern, but they are consistent with other sub-Saharan evidence suggesting that modern people evolved in Africa before 60,000 years b.p., when Neandertals were the sole inhabitants of Europe. Ongoing excavations to enlarge the MSA artifact and faunal samples should allow fresh behavioral inferences and reduce residual uncertainty about the age and industrial affiliation of the MSA layers.

Introduction

The Die Kelders site complex (34°32′S, 19°02′E) includes the adjoining caves of Die Kelders 1 (DK1) and Die Kelders 2 (DK2), approximately 120 km SE of Cape Town, on the south coast of South Africa (FIG. 1). Both caves resulted from wave action and water seepage at the contact between Tertiary Bredasdorp limestone (calcite-cemented sandstone) above and Paleozoic Table Mountain

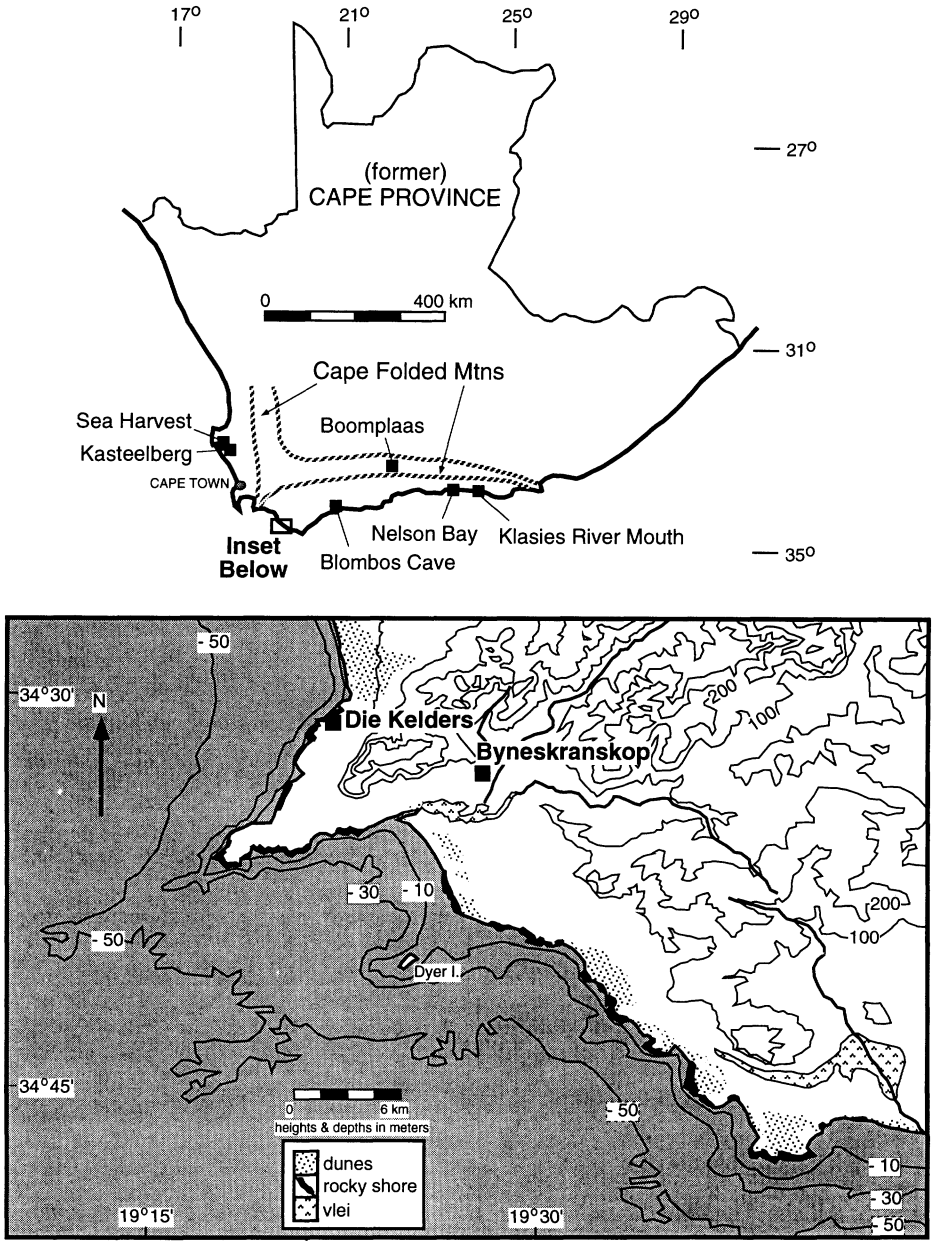


Figure 1. The approximate locations of the sites mentioned in the text (inset redrawn after Schweitzer and Wilson 1982: fig. 5).

Sandstone below. At the dripline, the cave floors are now about 8 m above sea level and 10 m from the high water mark (FIG. 2). In seven periods of work between 1969 and 1973, Schweitzer (1979) showed that DK1 contained a series of archaeologically rich Later Stone Age (LSA) middens separated by largely sterile sands from equally rich Middle Stone Age (MSA) layers below.

As reported by Schweitzer (1979), the LSA layers were particularly notable for potsherds and bones of domestic stock in direct association with typical LSA stone and bone tools, shells, and bones of indigenous animals. Radiocarbon dates placed the entire LSA sequence between roughly 2000 and 1500 years ago, which is the interval when both pottery and livestock were first introduced to southern Africa (Smith 1990, 1992; Sealy and Yates 1994). As described by Grine, Klein, and Volman (1991), the MSA layers provided stone artifacts, animal bones, and 13 isolated human teeth. Radiocarbon dates placed the entire MSA sequence beyond the 40,000–30,000 year range of the conventional radiocarbon method, while a combina-

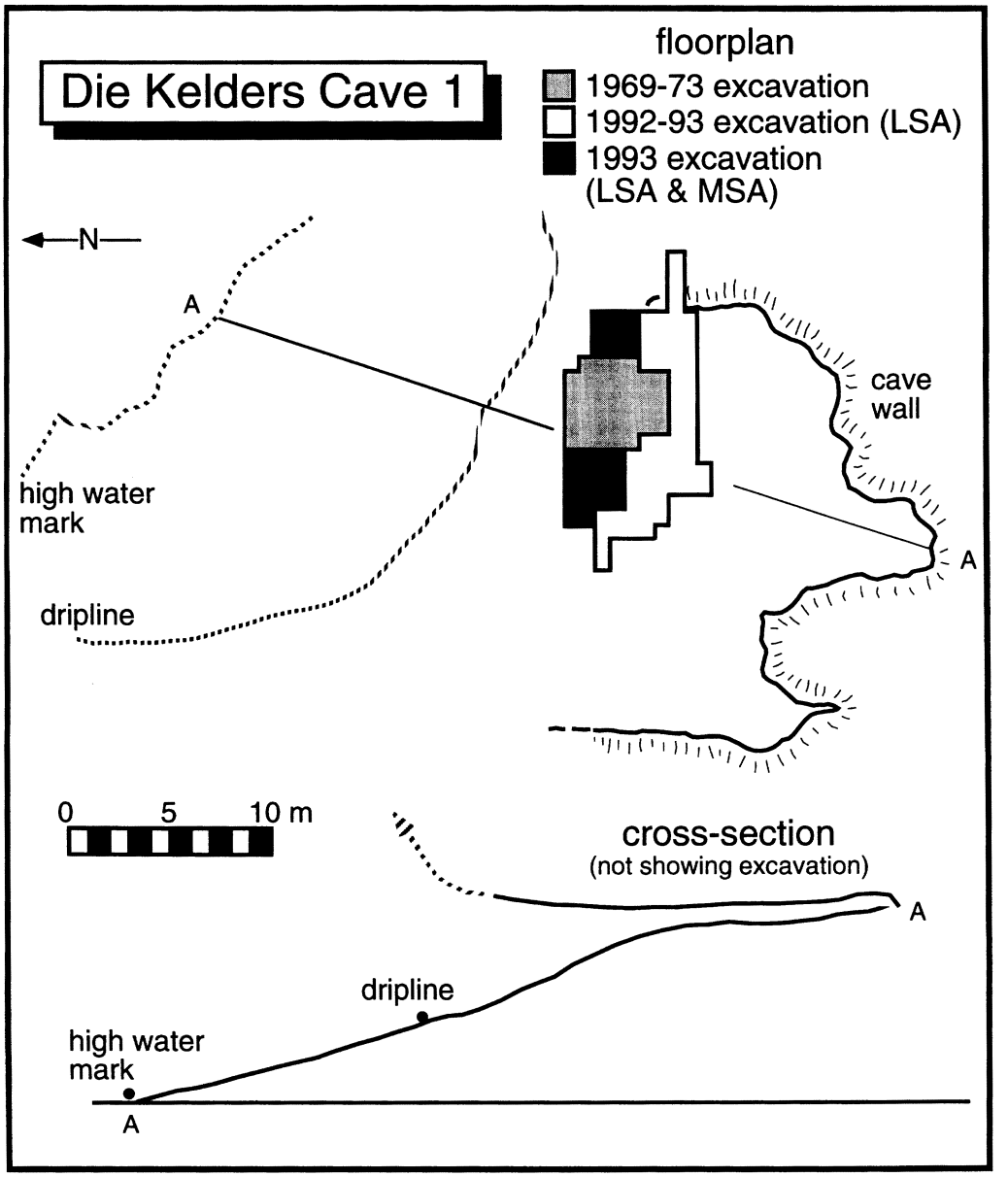


Figure 2. The floorplan and a cross-section through Die Kelders Cave 1.

tion of sedimentological and faunal evidence fixed it in a cold interval, perhaps equivalent to global oxygen-isotope stage 4, between roughly 74,000 and 59,000 years ago. Like human fossils from the Klasies River Mouth Caves and other African MSA sites, the human teeth suggested that African MSA people were more modern in appearance than their Neandertal contemporaries in Europe, while the animal bones suggested that they were less sophisticated hunter-gatherers than their LSA successors. However, both the artifact and faunal samples were too small to check several inferences about MSA behavior drawn primarily from much larger samples at Klasies River Mouth, and important questions remained about the age and origin of the DK1 MSA deposits.

In 1992, we renewed excavations in DK1 in order to obtain larger MSA artifact and faunal samples, to elucidate the age and origin of the MSA deposits, and more generally to produce information that would help resolve the lively debate over modern human origins. This report summarizes the results of two eight-week seasons in 1992 and 1993. A third season was completed in 1995 and there may be other seasons to come.

1992–1993 Excavation Procedures (CWM, FEG, and GA)

Schweitzer's excavations emphasized large-scale stratigraphic units, while we were equally concerned with smaller units that might represent discrete occupational or depositional episodes. In total, in 1992–1993 we identified 359 separate LSA units that correspond broadly to the 12 LSA layers of Schweitzer (1979) and 188 MSA units that correspond mainly to the uppermost MSA layers 4 and 5 of Tankard and Schweitzer (1974, 1976). The number of distinct units will grow dramatically, particularly as we penetrate more deeply into the MSA sequence.

In both the LSA and MSA deposits, the density of archaeological debris was far too great for piece plotting, and for horizontal control we relied mainly on one-meter squares, each of which was subdivided into four 50 cm × 50 cm subsquares designated as northwest (NW), northeast (NE), southwest (SW), and southeast (SE). We removed all excavated sediment in standardized buckets so as to estimate the sediment volume for each microstratigraphic unit in each square or subsquare. After removal, all sediment was passed through a superimposed set of 12 mm, 3 mm, and 1.5 mm sieves to ensure that even the smallest items were recovered. Most of the MSA sediment was wet-sieved.

Although we were targeting the MSA layers, our efforts in 1992 focused mainly on careful removal of overlying LSA deposit on the eastern and western sides of Schweitzer's excavation (FIG. 2). We hoped that the eastern side would prove productive: here the LSA layers were thinner, the cave roof appeared to have provided better protection for all the deposits, and we hoped to avoid the numerous large, fallen roof blocks that Schweitzer found to the west, on and in the top of the MSA sequence. We also hoped to capitalize on the recovery of MSA material already exposed in the east section of Schweitzer's excavation and, because the east wall of our excavation would eventually be bedrock, we could avoid shoring up or stepping. It was only in 1993 that we removed a significant amount of MSA deposit, mainly from the top quarter of the sequence. Additional field seasons will be necessary to substantially enlarge Schweitzer's excavation in the lowermost MSA layers.

Stratigraphy and Sedimentation (PG)

In the 1969–1973 excavations, Tankard and Schweitzer (1974, 1976) recognized 17 stratigraphically superimposed lithological units ("layers") (FIG. 3). From bottom to top, these were:

17 and 16. Incompressible horizons of quartzite beach boulders and coarse, poorly sorted interstitial quartz sand with weathered echinoid spines.

15 through 4. Alternating MSA occupation and non-occupation horizons in a mainly quartzose sand matrix. The occupation horizons (even numbers) were rich in artifacts and macrofauna and were typically highly compacted, fine-grained, and heavily organic. The non-occupation layers (odd numbers) were rich only in microfauna and were somewhat coarser grained, less organic, and often conspicuously laminated or banded. So-called frost-fractured roof debris (*éboulis*) occurred throughout, but was especially common near the bottom. Recent observations also bared small slippage faces (microfaults) and possible insect tracks throughout the MSA sequence.

3. Sterile yellow, iron-stained, fine-to-medium grained sands that rest unconformably on the MSA sequence below.

2. Shelly fine-to-medium-grained quartz sand with echinoid spines and foraminfera.

1. LSA shell middens intercalated with lenses of fine-to-medium calcareous sands.

Tankard and Schweitzer (1976) suggested that units 17 and 16 formed during relatively warm conditions when the sea stood two meters above its historical level; that the overlying MSA sequence formed mainly during an interval of much lower sea level and very cool conditions; that Layer 3 formed during a subsequent interval of relatively cool climate; and that Layers 2 and 1 formed under essentially modern conditions.

The 1992–1993 exposures confirm the major stratigraphic subdivisions of Tankard and Schweitzer, and we have retained them here. However, some additional, but tentative conclusions are now possible, thanks to fresh field observations and to preliminary laboratory examination of thin sections prepared from selected sediments.

The LSA Occupation

Schweitzer (1979) divided the LSA shell middens (Layer 1 in FIG. 3) into 12 subunits, numbered 1–12 from top to bottom. Our excavations into the west side of Schweitzer's excavation confirmed the stratigraphic integrity of his subunits 7–11 and allowed several new observations. Stratified ash dumps and thin shell lenses are a conspicuous feature in LSA subunit 7. These are overlain by relatively thick shell middens with thin ash lenses or hearths. An important finding is the occurrence of organic-rich units that are similar to the "brown soils" of Nelson Bay Cave (Klein 1972). Burning in LSA subunits 8 to 11 is extensive, suggesting that organic content was once very high. Patches of carbonized seeds are common. LSA subunit 12, which has a "brown soil" character and thus is technically

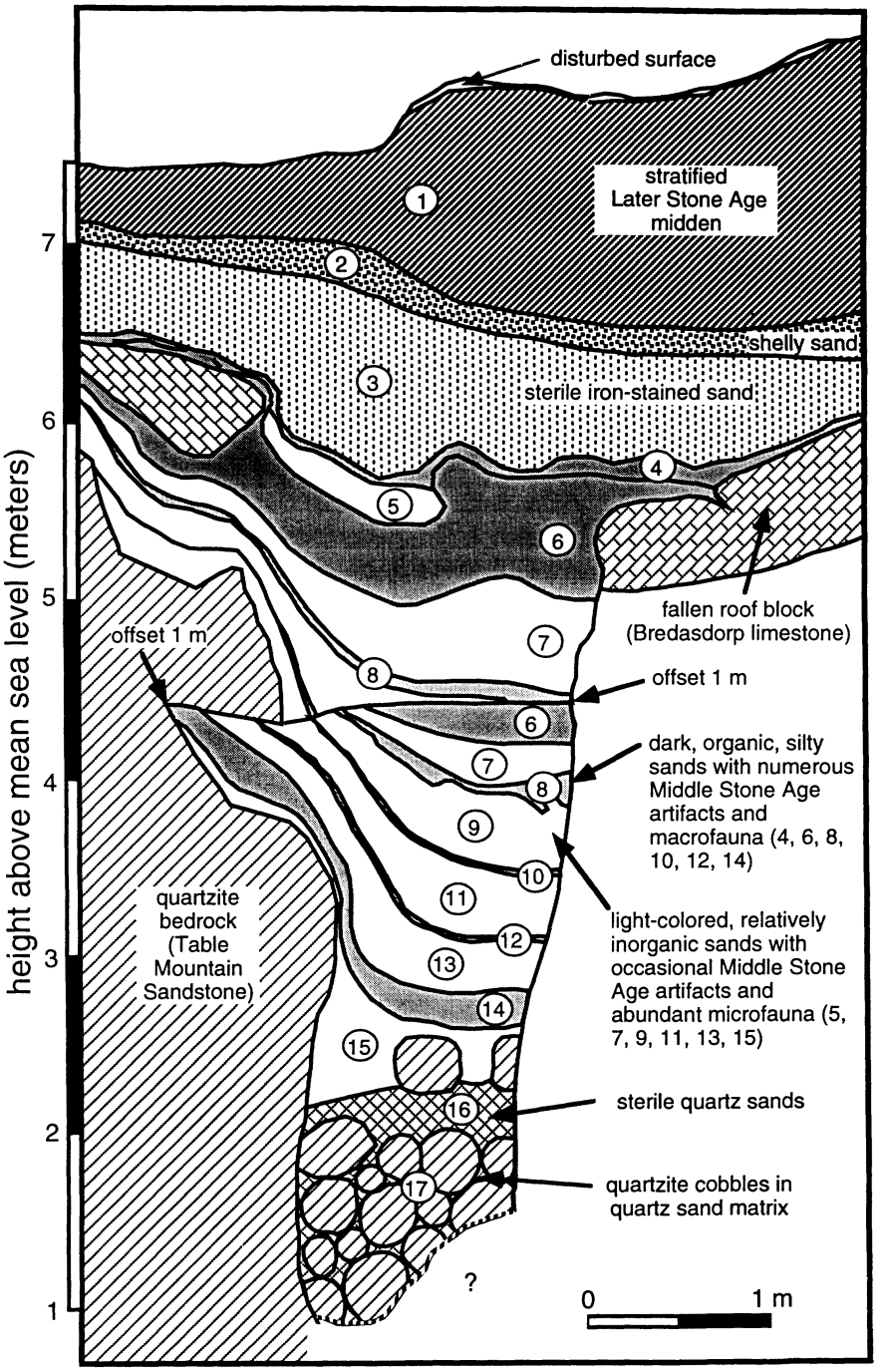


Figure 3. Profile of Die Kelders Cave 1 along the east wall of the 1969–1973 excavation. Baseline is one meter above sea level. Redrawn after Tankard and Schweitzer (1976: fig. 4).

not a shell midden, was further divided into two units except in the far western excavations where it thinned out. A new subunit dominated by abalone or perlemoen (*Haliotis midae*) appears to underlie LSA subunit 12 in the western portions of the excavations.

The middens we exposed on the eastern side of Schweitzer's excavation include his LSA subunits 1–5 or 6. Exact correlation with his layers was difficult, because the sediments we encountered were very loose and sandy, reflecting their close proximity to the cave walls. They had also been superficially disturbed by hyrax activity. On the other hand, they provided extremely well preserved bones and

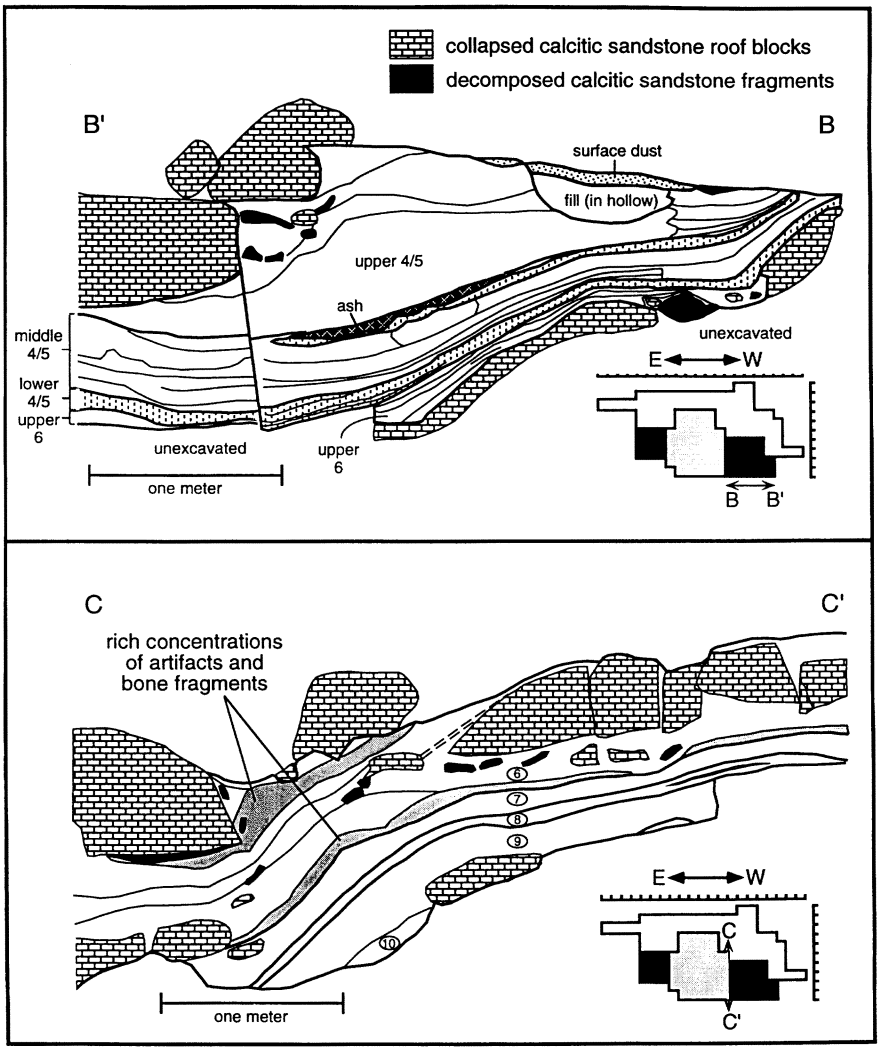


Figure 4. Top: profile through the MSA deposits along the northern edge of the 1993 excavation. Bottom: profile through the MSA deposits along the interface of the 1969–1973 and 1993 excavations showing the 1969–1973 layers (numbered).

shells, including a complete ostrich eggshell canteen, unburnt seeds (often in dense clumps that filled hollows possibly created by hyraxes), wood fragments, and human hair that may reflect a more recent occupation than any reported by Schweitzer.

The MSA Occupation Layers

The MSA occupation layers are best exposed in the western interface between the 1969–1973 and 1992–1993 excavations. The most conspicuous unit here is 1969–1973 Layer 6, which thickens to the west, where we were able to subdivide it. Our excavation mainly exposed the top part of Layer 6 (upper Layer 6 of Figure 4), which consists of dark brown friable sand with abundant lithics and bone. Interrupting the sand were numerous large fallen roof blocks. Below it were dark yellowish brown, iron-stained sands that we called lower Layer 6; we sampled only a small portion of these sediments. Throughout Layer 6, we observed ghosts of decalcified pebble- and cobble-sized limestone roof fragments, and together with the variegated black, brown, orange, and red coloration of the sand matrix, these gave the layer a distinct "fruitcake" appearance. The horizontal concentration of lithics and bones varies strongly inside Layer 6.

Thin sections of the Layer 6 matrix reveal brown to pale yellow fragments of vegetal material. In places, there are accumulations of very fine, detrital silt-size grains of calcite that exhibit weak layering around voids, indicating calcite

translocation as opposed to chemical precipitation. The origin of such translocated particles is not clear, although they must postdate the period of intense decalcification that affected the bulk of the MSA deposits. They could represent translocated crystals of ash, but their small size (≈5 to 10 μm) prevents detailed observation in thin sections, which are ≈30 μm thick. In thin section, the main reason for relating these to cultural activities is the associated abundance of bone and organic matter.

In 1992–1993 we also excavated units equivalent to Schweitzer's MSA Layers 4 and 5. Although these were relatively distinct in the east section of Schweitzer's excavation (Grine, Klein, and Volman 1991), they exhibit significant horizontal and vertical variation, and the interface between them was not always clear. They are much thicker and more complex on the western side of the excavation, and we could not unambiguously distinguish Layers 4 and 5. For this reason we presently lump them as the 4/5 complex. We excavated over 100 microstratigraphic units within this complex, and we have grouped these units into three informal subunits called upper Layer 4/5, middle Layer 4/5, and lower Layer 4/5.

Lower Layer 4/5 is a brown sand with numerous micromammal bones. The major archaeological component of the 4/5 complex is middle Layer 4/5, a reddish sand that becomes more orange deeper into the cave, thins to the east, and thickens to the west. Lamellae and vertical wasp burrows are common, and black manganese staining of sediments and small mammal bones are also present. The origin of the red color is unclear at present. MSA occupations within these reddish-orange sands tend to occur as thin lenses of artifacts, bone, and ash with some recognizable hearths. The density of lithics and bone is very low. Most of the large mammal bone is heavily weathered. There are also lenses of small mammal bone with few or no artifacts. Upper Layer 4/5 is predominantly a very pale brown to cream-colored, coarse, calcareous sand with many insect burrows. The eastern portion of the 1993 north section exhibits a relatively abrupt change to more orange sands with lenticular structures. Artifacts and bone are very rare.

Non-Occupation Layers

The "non-occupation" horizons identified by Tankard and Schweitzer are well exposed both on the western and eastern sides of the 1992–1993 excavation. The sediments are typically well-sorted quartz sands that in thin section commonly exhibit fine, pellicular coatings of clay and organic matter. These coatings locally tend to be disposed on the upper surfaces of the quartz grains, suggesting that the clayey material percolated or sifted its way through the profile. Close observation reveals that the distinction between occupation and non-occupation layers is only broadly valid. For example, in 1969–1973, Layer 13 was considered a non-occupation layer, but it contains many localized concentrations of millimeter-sized bone fragments and fine-grained, rubefied organic matter mixed with clay. Although the field observations suggest that the main occupation levels in the cave are well expressed as distinct reddish horizons of variable thickness, the microscopic observations suggest that the non-occupation horizons contain less pronounced but still clear indications of occupation, or at least of exposed surfaces upon which bones and burned organic matter and clay could accumulate. Judging from the size and scale of the microscopic features, these accumulations probably represent small-scale, brief events.

Phosphatization

In the uppermost part of the MSA section, the sediments are composed of whitish-gray calcareous sand that is faintly cross-bedded, with flaser-like, irregular bedding at the base. The whitish-gray sand overlies irregularly and thinly laminated orange, slightly silty noncalcareous medium sand. Samples from the upper part of this calcareous sand show a 2 mm band of slightly yellowish brown coloration. In thin section it appears as a decalcified zone in which calcareous bioclastic components have been dissolved and locally replaced by yellowish amber-colored phosphate that is isotropic in cross-polarized light. This same material also fills the interstices between the quartz grains and is locally a darker, reddish brown color.

Goldberg has seen similar types of phosphate in thin sections from several prehistoric caves, such as Hayonim and Kebara Caves (Israel) and Gorham's Cave (Gibraltar). At Gorham's Cave, this material was quite widespread and could be directly attributed to bird and possibly bat guano. The phosphatization probably took place below a stable substrate on which the guano-derived phosphate locally decalcified the calcareous bioclastic substrate. There is no indication of similar phosphatization in the lower MSA deposits, probably because they have been so extensively altered diagenetically.

Additional Evidence for Former Surfaces

Like the sediments from the western part of the profile, those from the eastern part provide micromorphological indicators of former surfaces. Field observations and the archaeological data indicate a temporal gap at the contact between the calcareous bioclastic sand of Layer 2 and the non-calcareous quartzitic sands of Layer 3. This is expressed micromorphologically just below this contact in

Layer 3 where the quartz sands exhibit clayey interstitial filling that decreases in abundance downwards. With depth, such interstitial fillings give way to more pellicular coatings that are found typically on the upper surfaces of the quartz grains. These observations show that interstitial clay and pellicular coatings (grain sheltering) can be used as indicators of stable surfaces below which the finer material accumulated and partly infiltrated. The origin of the clay is not clear, but probably reflects finer dust that settled out of the atmosphere at a time when sand deposition in the cave was minimal.

Other evidence of temporary, small-scale, sedimentary still-stands occurs in Layer 3 where millimeter-thick horizontal stringers of brownish clay are evident. In one instance, a clay stringer underlies quartz sand that is noticeably cleaner and coarser than the sand beneath it. This relationship points to a different sedimentary regime and small temporal hiatus.

A phenomenon related to former surfaces occurs in the uppermost sandy sediments situated below the LSA midden in the eastern part of the excavations. In Layer 2, massive sand is interrupted by two 1–2 mm thick bands of cream-colored, finely bedded sandy silt. In thin section, these silty bands exhibit graded bedding and vesicular voids within the finer laminae. Both phenomena indicate accumulation in standing water, with the vesicles produced by air bubbles forming as the sediment dried.

Summary

The detailed field observations and preliminary micromorphological data from the renewed excavations reveal some of the site formation processes that operated at DK1. These include decalcification; localized phosphatization by guano of the upper MSA deposits, corresponding to interruptions in sandy deposition; the recognition of former surfaces and corresponding diastems; and faulting and slippage planes.

A number of phenomena observed in the field and in thin sections still remain to be resolved. For example, Tankard and Schweitzer (1976: 297) argued that their Layer 3, which immediately overlies the MSA sequence, was deposited in standing water under wetter climatic conditions. They also proposed, however, that Layer 3 is archaeologically sterile because the cave mouth was blocked by an active dune, which would suggest drier conditions, probably during global-isotope stage 2. This interpretation is obviously inconsistent and demands additional field and laboratory attention.

Similarly, additional research is necessary to determine whether the leaching event associated with ponding and decalcification of the bulk of the MSA deposits is paleoclimatically significant or simply a localized phenomenon linked just to the cave. There is also the problem of interpreting the several periods of rockfall that are evident within and above Layer 6. Do they reflect earthquakes, as Tankard and Schweitzer suggested (1976: 296), or do they simply represent interruptions in the accumulation of finer sediments?

Now that several processes have been identified and are more easily recognizable, it remains to expand their inventory and at the same time integrate them into a larger spatial and temporal context. This can be accomplished only with continued excavation of the existing MSA deposits over a larger area and to greater depths. Ultimately, it should be possible to relate these observations to larger scale phenomena, such as changes in sea level and climate, as was previously done by Tankard and Schweitzer. In any case, it is worth stressing that the recognition of many of the depositional and post-depositional phenomena described above could not have been made solely on the basis of field observations. Rather, it was only feasible through careful recording of stratigraphic details in the field coupled with detailed micromorphological analysis of the sediments.

Later Stone Age Artifacts, Plant Remains, and Shellfish (MLW)

Analysis of the LSA material is not yet complete, but it can already be said that the material closely resembles the assemblages that Schweitzer (1979) reported earlier. There are, however, some differences, including some items that were not recovered before. The layer numbers in this section refer to the LSA subunits described by Schweitzer (1979).

Stone Artifacts

Lithics are mostly made from quartzite (58% of the site total), followed by quartz (41%). The quartzite comes mainly from boulders, cobbles, and pebbles on the beach below the cave and possibly from the band of conglomerate that partly forms the outer wall of adjacent DK2. The lithic assemblage includes a previously unrecorded class of mostly quartzite cobbles and pebbles (occasionally blocks) that show no evidence of utilization and must therefore be classified as manuports. There are also numerous small pebbles, no more than 2 mm across, that were probably unintended imports, possibly brought in with fresh mussels.

Schweitzer (1979) placed single- and multi-flaked cobbles in his utilized-artifact category. However, it is more likely that these were cores, and they should consequently be included in the unmodified/waste category. Formally retouched artifacts consist mostly of rather crude segments and small scrapers, as well as a backed quartz flake with

traces of mastic. Formal artifacts account for only 1% of the site total, and utilized pieces, mostly on cobbles and pebbles, for 10%. The majority (58%) of the formal tools are made on quartz, followed by chalcedony (23%) and silcrete (16%), with only two (3%) on quartzite.

Bone Artifacts

Bone artifacts comprise awls, needle-awls, points, link-shafts, and spatulas. There are also parts of tortoise-carapace bowls, sometimes ochre-stained. When the probable relationships of individual microstratigraphic units have been established, an attempt will be made to reconstruct these bowls.

Ostrich Eggshell Artifacts

Ostrich eggshell beads occur whole, broken, and partly made. There is also a complete ostrich eggshell flask with a ground-edge hole 1.5 cm in diameter at one end and several other ostrich eggshell fragments with ground circular edges, indicating that they were parts of water or honey containers.

The diameters of unbroken beads were measured from Schweitzer's LSA Layer 2 and in three samples from his Layer 12. Smith et al. (1991) argued that bead size varied between prehistoric herders and hunters in South Africa. Mean diameter in the pooled Layer 12 samples is significantly smaller than that in the LSA Layer 2 sample. An indication of the difference is that none of the LSA Layer 12 bead diameters exceeds 6.0 mm, whereas 22% of the diameters in the LSA Layer 2 sample are between 6.1–8.3 mm. The availability of comparable data from Kasteelberg and other supposed herder or hunter-gatherer sites on the west coast of South Africa (Smith et al. 1991) may eventually help us to address the issue of whether the LSA inhabitants of Die Kelders were herders, hunter-gatherers, or a mix of the two.

Marine Shell Artifacts

These comprise scrapers from valves of the white sand-mussel (*Donax serra*), segments from valves of the black mussel (*Choromytilus meridionalis*), and ornaments (pendants, beads, and buttons) from shells of the turban shell or alikreukel (*Turbo sarmaticus*) and the abalone or perlemoen (*Haliotis midae*). There are also white mussel valves that have been crudely perforated, perhaps for stringing as ornaments. Ochre-stained shells, chiefly from abalone, probably served as containers.

Pottery

Of the 1,118 sherds recovered in 1969–1973, 84.6% came from LSA Layer 12 and 10.5% from LSA Layer 2. Eight vessels from LSA Layer 12 and one from LSA Layer 2 could be wholly or partly reconstructed. The reconstructed forms of the LSA Layer 12 vessels differed markedly from that of the LSA Layer 2 pot, but the sherds from the intervening layers were inadequate for determining whether any change was gradual or abrupt.

Unfortunately, the new excavations have produced relatively few sherds, all of which appear to resemble ones that were already known. Future study will include attempts at vessel reconstruction.

Plant Remains

The only plant remains reported from the 1969–1973 excavations were small quantities of estuarine eelgrass (*Zostera capensis*). The 1992–1993 excavations have, however, yielded numerous remains of other species, mostly seeds or pips, often carbonized. These have not been thoroughly studied, but they minimally include Cape sumach or Hottentotskersie (Hottentot's cherry, *Colpoon compressum*); skilpadbessie or duinebessie (tortoise- or dune-berry, *Nylandtia spinosa*); white milkwood (*Sideroxylon inerme*); and waxberry (*Myrica cordifolia*). At least Cape sumach and skilpadbessie are known to be edible (Smith 1966), while early European colonists used the waxy covering of waxberries for candles and soap. Watt and Breyer-Brandwijk (1962) report that the "wax" is actually a fat consisting mostly of glycerides of unsaturated fatty acids. In 1773, the Swedish botanist Thunberg recorded that the Hottentots ate it like cheese (Forbes 1966). Future studies of the seeds will focus on their potential for illuminating the season of site occupation.

Cape or West Coast Rock Lobster

No rock lobster (*Jasus lalandii*) remains were reported from the 1969–1973 excavations, but the new excavations recovered several chelipeds ("mandibles"). Conceivably, some were missed even in 1992–1993, since they are difficult for inexperienced sorters to spot. Bulk samples, removed for detailed analysis in the lab, will probably provide the most accurate indication of their frequency.

Shellfish

The 1992–1993 shellfish assemblage closely resembles the one Schweitzer (1979) reported previously. The new sample includes, however, the first specimens of ribbed mussel (*Aulacomaya ater*). It is not abundant, the valves are mostly small, and they may have been accidentally introduced with the black mussel, which is the dominant shellfish species. The author's experiments show that prying black mussels from rocks with a pointed stick commonly yields other very small shellfish with little or no food value.

Preliminary observations suggest that the relatively

Table 1. Electron spin resonance (ESR) dates attained by averaging the values from two portions of a single broken eland tooth, and from another single tooth averaged with the broken tooth.

Water content (%)	*Uptake from broken tooth**		*Uptake from single tooth and broken tooth*	
	Early uptake	*Linear uptake*	*Early uptake*	*Linear uptake*
0	54 ± 1	70 ± 1	57 ± 3	73 ± 3
10	57 ± 1	76 ± 1	60 ± 3	79 ± 3
20	61 ± 2	83 ± 1	63 ± 3	85 ± 4

* Includes sample 5363 from upper Layer 6 (unit PAV, square H7, subsquare SW) and sample 5325 from middle Layer 4/5 (unit PAJ, square G7, subsquare NE)

abundant topshell opercula from DK1 and the nearby site of Byneskranskop Cave differ significantly in size, perhaps reflecting different collecting environments or changes in collecting intensity.

Dating of the Middle Stone Age Layers (HPS and WJR)

During the 1992–1993 field season, 12 teeth and a few stalagmitic samples were removed from the uppermost MSA units for electron spin resonance (ESR) and uranium series dating respectively. Teeth suitable for dating of the lower MSA levels were selected from the 1969–1973 collections. Here we report preliminary ESR dates on tooth samples from the upper MSA layers. As is commonly true in ESR dating (see Grün, Schwarcz, and Zymela 1987), the age that can be computed for a sample depends on the assumed uranium uptake, typically taken to be either early uptake (EU) or linear (continuous) uptake (LU); the EU age is always the minimum possible value for a set of data. The calculated ages depend to some extent on the water content of the sediment during the burial history of the teeth, due to absorption of gamma rays by the water.

Two of the samples were from a single eland tooth (lower second molar), conjoining fragments of which were recovered at two localities: sample 5363, from upper Layer 6 and sample 5325 from middle Layer 4/5. These two fragments gave indistinguishable ESR ages, the averaging values of which are shown in Table 1.

The errors shown are based on the spread between samples; although there is some uncertainty due to lack of knowledge of water content and the U-uptake model, the age appears to lie in a range between 70,000 and 60,000 years b.p. It is unlikely that average water content was as low as 10% throughout the history of the site. Sample 5325 also contained another eland tooth that was divided into two portions and analyzed. Taking the data for samples 5325 and 5363 together, we obtain average ages as a function of assumed water content in the sediment (TABLE 1).

Here the errors represent the uncertainties introduced by variable water content, and show again the significant influence of this variable on the calculated age. We conclude that these teeth were deposited at the site sometime between about 80,000 and 60,000 years b.p. The teeth have relatively low U contents (enamel = 0.2 ppm; dentine = 30 ppm), suggesting that U uptake has not proceeded very far, and possibly arguing for an EU model as seen, for example, in the data of McDermott et al. (1993). This would favor an age of around 60,000 years b.p. In order to define better the U-uptake model, we are currently carrying out U-series analyses of the dentine, as well as of the associated stalagmite.

An age between 80,000 and 60,000 years b.p. would place the late MSA in oxygen isotope stage 4, the opening phase of the Last Glaciation. This date would be consistent with associated sedimentological data (reported above) and faunal evidence (reported below) for cooler climatic conditions and also with the estimated age of the Howieson's Poort MSA variant that Thackeray (below) suggests may be represented in the same deposits.

Middle Stone Age Artifacts (AIT)

The new MSA lithic sample comprises 108,495 artifacts of flaked stone and two of ground stone. These came from 127 different microstratigraphic units west and east of the 1969–1973 excavation. As discussed above, most of the excavated MSA layers correlate to Schweitzer's MSA Layers 4/5 and 6. The lithological subunits defined for Layers 4/5 and 6 (FIG. 4) are used as analytical units to examine temporal changes in artifacts. Like the 1969–1973 MSA artifact sample (Grine, Klein, and Volman 1991) and samples from most other MSA sites in southern Africa, the new DK1 MSA sample contained no formal bone or shell artifacts.

Method of Analysis

The flaked stone artifacts are described according to the scheme detailed by Thackeray and Kelly (1988), which

facilitates comparisons with the well-studied MSA lithic sequence from Klasies River Mouth (Singer and Wymer 1982; Thackeray and Kelly 1988; Thackeray 1989).

Each piece was identified as a core, chunk, flake, flake-blade (an elongated flake with characteristic dorsal ridges), flake-blade section, or piece of small flaking debris (≤ 20 mm long). Flake-blades, which characterize many southern African MSA assemblages, infrequently resemble true blades in their length/width ratio, dorsal ridges, or in having strictly parallel sides. Whole flake-blades with nearly parallel sides are described here as parallel, while those with sides that converge to an approximately symmetrical point at a central dorsal ridge are described as convergent.

Excepting Howieson's Poort backed pieces, MSA artifacts rarely exhibit the highly patterned retouch found in some southern African LSA assemblages. MSA artifacts are rarely retouched, and when they are, the retouch is generally unstandardized and minimal, which precludes the assignment of retouched pieces to types. Accordingly, our descriptive terminology is based on the form of the blank and on the positioning and nature of the retouch. Both retouched and non-retouched artifacts sometimes have macroscopically visible damage, but the quartzite that was used to manufacture most DK1 artifacts forms brittle, irregular edges that could easily be chipped through use, trampling, or profile compaction. Thus, only pieces with clear or continuous damage were placed in the damaged category.

Raw Materials

As at many other MSA sites along the southern African coast, the majority of artifacts are of quartzite (TABLE 2), obtained mainly from locally available beach cobbles. Relatively homogenous, fine-grained grey quartzite appears to have been preferred; few artifacts are made on the coarser-grained quartzitic sandstone that partly encloses the cave. Smaller numbers of artifacts were made on quartz or on silcrete and other cryptocrystalline siliceous rocks. Overall, quartz artifacts are proportionally somewhat more common on the eastern side near the cave wall; on the western side of the excavation, quartz occurs predominantly in lower Layer 4/5 and upper Layer 6 (9.6% and 11.6%, respectively).

The highest percentage of silcrete occurs in lower Layer 4/5 on the western side. In these strata, nearly 5% of all artifacts are made in silcrete, but 23% of the flake-blades and nearly 20% of flake-blade sections are in silcrete (TABLE 2). Clearly, flake-blades were preferentially made of silcrete, probably because it is more easily worked and produces sharper edges. The new sample contains more

Table 2. Percentages of raw materials used in the manufacture of MSA lithic artifacts from the 1993 DK1 excavations.

Layer	*No. of artifacts*	*% quartzite**	*% quartz†*	*% silcrete‡*
All artifacts				
West Upper 4/5	2,734	95.4	3.3	1.3
West Middle 4/5	22,227	94.8	3.9	1.3
West Lower 4/5	15,369	85.6	9.6	4.8
West Upper 6	63,742	86.4	11.6	2.0
West Lower 6	88	90.9	9.1	0.0
East side	4,336	82.4	15.2	2.4
Flake-blades				
West Upper 4/5	10	90.0	0.0	10.0
West Middle 4/5	64	90.6	1.6	7.8
West Lower 4/5	100	74.0	3.0	23.0
West Upper 6	217	89.9	2.3	7.8
West Lower 6	0	–	–	–
East side	87	88.5	4.6	6.9
Flake-blade sections				
West Upper 4/5	76	89.5	2.6	7.9
West Middle 4/5	286	89.5	2.4	8.0
West Lower 4/5	545	73.8	6.4	19.8
West Upper 6	1,623	85.9	8.3	5.9
West Lower 6	0	–	–	–
East side	251	81.7	13.1	5.2

* The quartzite category includes a small percentage of the quartzitic sandstone that partly encloses the cave.
† Quartz is mainly milky but includes a negligible percentage of crystalline.
‡ Silcrete includes a negligible percentage of chalcedonic silicates.

Table 3. Summary statistics for length, width, thickness (all in millimeters), and the length-width ratio of quartzite, quartz, and silcrete flake-blades from the 1993 DK1 MSA sample.

Layer		*Length*	*Width*	*Thickness*	*Length/width*	*No.*
West Upper 4/5						
Quartzite	mean	65.5	34.2	10.8	191.6	9
	s.d.	20.7	8.2	3.2	31.1	
Silcrete	mean	48.6	22.0	5.7	220.9	1
West Middle 4/5						
Quartzite	mean	57.4	31.9	11.3	184.7	58
	s.d.	19.0	9.4	6.4	47.9	
Quartz	mean	38.9	22.4	7.8	173.7	1
Silcrete	mean	37.3	17.7	6.8	216.5	5
	s.d.	4.8	2.3	1.8	49.1	
Lower 4/5						
Quartzite	mean	48.2	25.9	9.2	192.5	74
	s.d.	15.0	7.3	3.5	52.6	
Quartz	mean	33.8	18.8	7.1	193.2	3
	s.d.	6.2	7.2	4.6	36.7	
Silcrete	mean	37.0	17.7	5.6	223.8	23
	s.d.	9.7	7.2	2.3	48.0	
Upper 6						
Quartzite	mean	47.5	24.7	8.9	202.1	195
	s.d.	1.3	7.1	2.8	55.0	
Quartz	mean	33.8	18.1	9.2	191.8	5
	s.d.	7.2	5.1	2.3	22.4	
Silcrete	mean	34.1	16.8	6.6	208.8	17
	s.d.	8.6	4.5	2.9	47.0	
East						
Quartzite	mean	54.6	28.8	9.9	195.1	77
	s.d.	15.3	7.4	3.4	53.1	
Quartz	mean	38.2	19.3	7.0	197.2	4
	s.d.	4.8	1.9	1.3	11.3	
Silcrete	mean	40.2	20.7	7.0	206.0	6
	s.d.	17.1	10.6	4.5	32.3	
All 1993 Flake-blades						
Quartzite	mean	50.7	26.9	9.6	196.4	413
	s.d.	15.0	8.1	3.8	53.2	
Quartz	mean	35.6	19.0	7.9	192.4	13
	s.d.	6.4	5.0	2.9	24.0	
Silcrete	mean	36.7	17.8	6.2	216.3	52
	s.d.	10.4	6.7	2.8	45.9	

quartz and silcrete artifacts than the 1969–1973 sample from Layer 4 reported by Grine, Klein, and Volman (1991). This may reflect the absence of small flaking debris from the earlier sample.

Grine, Klein, and Volman (1991: 368) suggested that silcrete and quartz were treated technologically and typologically in the same way as quartzite, because long flakes occurred on all three raw materials. The new sample, however, has produced only rare examples of quartz or silcrete flake-blades that are as long as those on quartzite (TABLE 3), although the same flaking methods were used for all materials. This fact suggests that quartz and silcrete were mostly available only as small nodules or cobbles, or as pieces with irregularities that precluded the production of longer artifacts.

Tiny nodules and chips of red ochre recovered from the 1 mm and 3 mm sieves are present throughout the west side strata and in a few units on the east side. These are presumably remnants of coloring materials, but there is nothing to suggest how they may have been used. The west side series also contains a few ochre-stained flakes and two ochre-stained upper grindstones, one of which is illustrated in Figure 5Q.

Products of the Flaking Process

The vast majority of stone artifacts are small flakes (≤ 20 mm long) that could have been produced during artifact manufacture, use, or discard (TABLE 4). Indeed, in most stratigraphic units, there are more than 1000 pieces that are only 1–2 mm long. These are a potential source of information on the methods of artifact manufacture and use that was not available from the earlier excavation, when such tiny pieces were not systematically collected.

Flakes form an appreciable component, while flake-

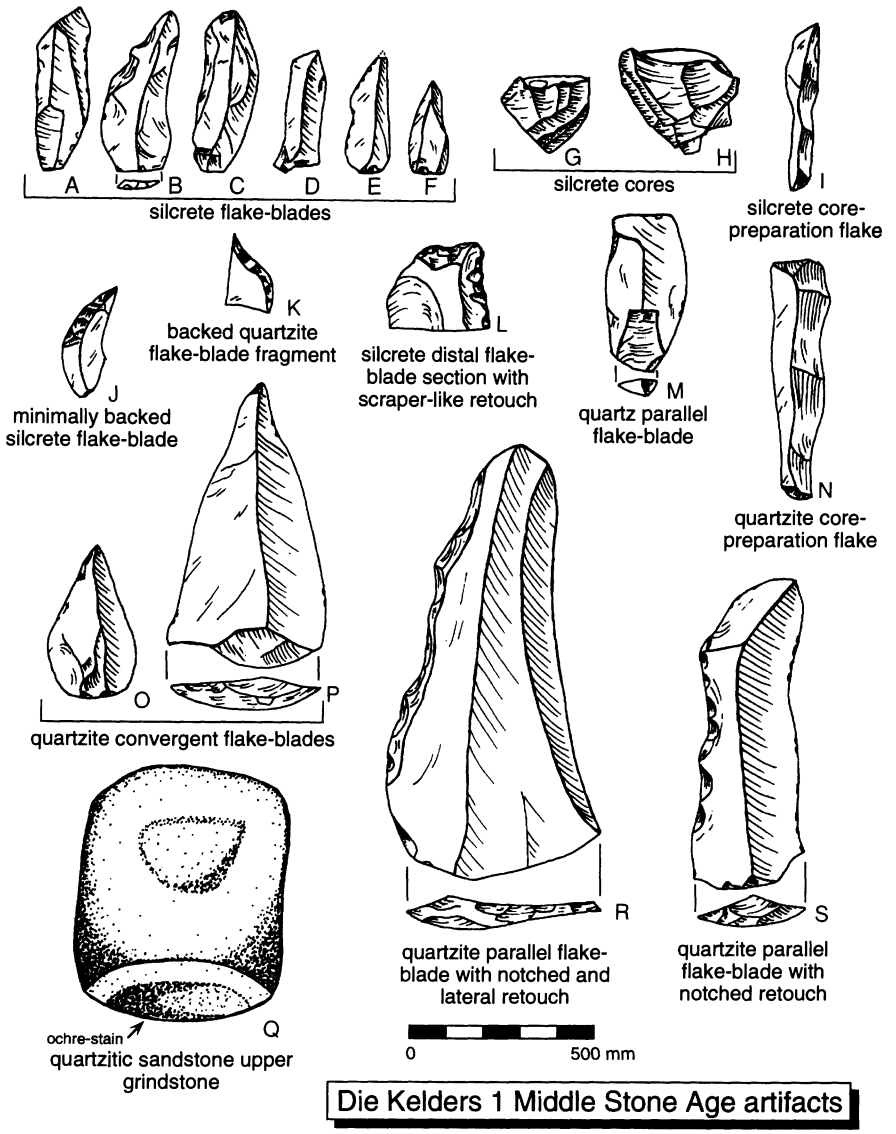


Figure 5. Middle Stone Age artifacts from the 1993 excavations at Die Kelders Cave 1. A–F, silcrete flake-blades; G, H, silcrete cores; I, silcrete core-preparation flake; J, minimally backed silcrete flake-blade; K, backed quartzite flake-blade fragment; L, silcrete distal flake-blade section with scraper-like retouch; M, quartz parallel flake-blade; N, quartzite core-preparation flake; O, P, quartzite convergent flake-blades; Q, quartzitic sandstone upper grindstone; R, quartzite parallel flake-blade with notched and lateral retouch; S, quartzite parallel flake-blade with notched retouch.

blades, flake-blade sections, cores, and chunks account for negligible percentages in each of the new stratigraphic subunits (TABLE 4). Since the proportions of these primary flaking products are essentially the same throughout, it appears that flake production and the deposition of flaking products were similar throughout the western series. The higher percentage of flakes and the correspondingly lower incidence of small debris from the east side probably reflect the fact that much of the small flaking debris from the finest mesh sieves from this side has yet to be included in the total counts.

The frequencies of cortical, partially cortical, and non-cortical flakes are also consistent throughout the western series. Since cortical flakes represent first removals from cobbles and both cortical flakes and partially cortical flakes are rare (< 3% and 10% respectively), the primary splitting of cobbles and the blocking out of cores probably occurred outside the excavated area, most likely on the beach.

The cores are generally small and "exhausted" (FIG. 5G, H). While there are numerous radial cores as in the 1969–1973 sample, the new sample contains a wide variety of other kinds of cores, including ones with single, op-

Table 4. Inventory of MSA lithic artifacts from the 1993 excavations at DK1.

Layer	*Cores*	*Chunks*	*Small flaking debris*	*Flakes*	*Flake-blade sections*	*Flake-blades*	*Grindstones*	*Totals*
West Upper 4/5								
n	3	6	2,301	353	63	8	0	2,734
%	0.1	0.2	84.2	12.9	2.3	0.3	0.0	
West Middle 4/5								
n	12	71	19,725	2,050	302	66	1	22,227
%	0.1	0.3	88.7	9.2	1.4	0.3	0.004	
West Lower 4/5								
n	27	136	11,783	2,817	515	90	1	15,369
%	0.2	0.9	76.7	18.3	3.4	0.6	0.0	
West Upper 6								
n	66	495	51,555	9,749	1,651	226	0	63,742
%	0.1	0.8	80.9	15.3	2.6	0.4	0.0	
West Lower 6								
n	0	0	78	10	0	0	0	88
%	0.0	0.0	88.6	11.4	0.0	0.0	0.0	
East side								
n	45	95	2,598	1,260	251	87	0	4,336
%	1.0	2.2	59.9	29.1	5.8	2.0	0.0	
Totals	153	803	88,040	16,239	2,782	477	2	108,496

posed, and multiple platforms, and Levallois-like cores prepared for a single major removal.

The occurrence of ridge preparation (FIG. 5I, N) and irregular flakes of flake-blade proportions (FIG. 5A–F) suggests that after a suitable nodule had been selected and its shape roughed out, much of the actual production of flake-blades occurred within the cave. Similar observations suggest the same scenario for the Klasies River Mouth Caves, and it is further supported at DK1 by the fact that approximately 10% of the flakes have been split down the length of the piece at the point of percussion to form "thick-sided," "split," or "siret" flakes. These often result when a knapper is trying to set up ridges and hits too hard when applying force to detach quartzite flakes or encounters unexpected irregularities in the material. Knapping within DK1 is also implied by the discovery that up to 33% of the chunks in some of the 1993 units represent broken-up quartz debris. In this regard, the DK1 assemblage resembles those of many other local MSA sites (Thackeray 1989, 1992; Thackeray and Kelly 1988).

Uniformity in stone artifact production throughout the western series of deposits is also reflected in the shape of the flake-blades, of which about 60% are parallel-sided and 40% are convergent, and in the relative proportions of different kinds of flake butts. Thus, some 70–80% are plain and 15–20% are faceted, while a negligible number are cortical, located at the apex of two intersecting flake scars, or shattered. Moreover, on approximately half the flake-blades and flake-blade sections with butts, the butts are faceted (FIG. 5B, P, R, S). Finally, 10–15% of flakes and 30–60% of flake-blades and flake-blade sections with butts have some form of platform preparation revealed by tiny flake removals and/or bruising or crushing along the dorsal lip.

It is unclear to what extent flake-blade sections were produced intentionally or accidentally, that is, either during attempts to make flake-blades, during use, or post-depositionally. Because there are few examples of flake-blade sections from individual excavation units that can be refitted, post-depositional fracture would appear to be limited. Also, the percentages of different kinds of flake-blade sections are uniform throughout the series considered here. Thus, 33–50% are distal ends, which are generally thinner than proximal or medial pieces (about 30% are proximal ends and 15–20% are medial sections, depending upon the stratigraphic series). The figures suggest that snapping during use played at least some part in their production.

Typological Considerations

Only 0.3–8.0% of the new artifacts are damaged and, as noted above, only a negligible proportion (0.1–1.0%) are retouched. These figures are similar to those reported for the earlier DK1 sample (Grine, Klein, and Volman 1991) and for most other southern African MSA collections. The low incidence and informality of MSA retouch limit the

use of retouch to document typological change through time.

With reference to the new sample, retouch is generally isolated on a piece, and usually consists of localized shallow notches or blunting of one or both edges on the dorsal surface. It occurs equally on flakes, flake-blades, and flake-blade sections. A few pieces have more systematic denticulate-like retouch, and rare examples have scraper-like retouch (FIG. 5L). It is possible that some of the retouch may have facilitated hafting of flake-blades as spearheads. Although no hafted MSA artifact has yet been found, hafting has been inferred from butt thinning, certain kinds of retouch, and the presence of resin on examples from other sites (Mason 1962; Wendt 1974; Singer and Wymer 1982; Volman 1984).

Of particular interest in the new sample are two pieces with vertical retouch or backing. One is a small silcrete flake-blade (FIG. 5J) from the east side, which has minimal backing; the other is a quartzite flake-blade fragment from upper Layer 6 on the west side, on which a small section of backing occurs. Unfortunately, this fragment is too small to establish the full extent or nature of retouch. Although the retouch on these two flake-blades does not resemble the continuous backing that forms the characteristic geometric shape of Howieson's Poort segments, their presence is tantalizing. Moreover, they occur in the same layers as small (20–30 mm long) quartz and/or silcrete flake-blades, which are also characteristic of Howieson's Poort collections, and there is some evidence that the two pieces are associated with a decrease in flake-blade size (regardless of raw material) down through the series on the west side (TABLE 3). Nevertheless, they are isolated and possibly idiosyncratic, and the occurrence of the Howieson's Poort variant at DK1 can be established only with enlarged samples.

Discussion

The MSA sequence at Klasies River Mouth has been subdivided on stratigraphic and typological grounds (Singer and Wymer 1982; Volman 1984), but it is difficult to assign other samples to the same MSA variants. Indeed, apart from the distinctive backed pieces, smaller flake-blades, and relatively high percentages of fine-grained raw materials that characterize the Howieson's Poort, MSA variants lack conspicuous technological and typological markers (Thackeray 1992).

The percentages of fine-grained, non-quartzite raw materials and flake-blade sizes in some 1993 microstratigraphic units are similar to percentages in the Howieson's Poort layers of sites like Klasies River Mouth and Nelson Bay Cave, as well as in DK1 MSA Layer 12 as described by Grine, Klein, and Volman (1991: 368). This pattern becomes less clear-cut, however, when the new microstratigraphic units are combined according to stratigraphic series. Grine, Klein, and Volman (1991: 369) comment that the predominance of non-quartzite artifacts in 1969–1973 Layer 12 may mark the Howieson's Poort, even though no characteristic backed pieces were found. As noted above, the presence of two admittedly equivocal backed pieces in the new sample, in units that probably correspond to MSA Layer 4, coupled with the raw material and flake-blade size data, may be idiosyncratic, but these attributes may also signal the Howieson's Poort.

The dating of the Howieson's Poort sequence is problematic. Parkington (1990) has argued that some Howieson's Poort sites may be as young as 45,000–30,000 years b.p., while the occurrences at Klasies River Mouth and other prominent sites have been provisionally dated to ca. 75,000 years b.p. (Thackeray 1992). In either case, only the Early Uptake ESR date of ca. 60,000 years b.p. reported above would be consistent with the occurrence of the Howieson's Poort at DK1. Additional dates from Die Kelders and other sites are urgently needed.

It is possible that continuing excavations at DK1 will show that southern African MSA cultural stratigraphy is more complicated than currently perceived. Even long and apparently relatively complete sequences (as at Klasies River Mouth) do not necessarily represent the full range of MSA variability that has now been observed, including in particular the silcrete-based Still Bay variant that Henshilwood (personal communication, 1994) has recently excavated at Blombos Cave, approximately 100 km east of Die Kelders (see FIG. 1). Conceivably, the new DK1 sample described here could turn out to be a previously undocumented industry of this kind.

Faunal Remains (RGK and KCU)

The DK1 fauna includes micromammals (< 0.75 kg adult weight), macromammals (> 0.75 kg adult weight), birds, tortoises, fish, and shellfish. Micromammals, comprising mostly small rodents and insectivores, occur mainly in the MSA sequence. Avery (1982: 320–322) has described the MSA micromammals from the 1969–1973 excavations and will describe the micromammals from the renewed excavations elsewhere.

Bird bones are especially numerous in the LSA deposits, where they come mainly from the Cape gannet (*Morus capensis*) and cormorants (primarily the Cape cormorant, *Phalacrocorax capensis*). Bird remains are less frequent in the MSA deposits, where jackass penguins (*Spheniscus demersus*) are significantly more common than gannets, cormorants, and other airborne species. An elevated frequency

of penguins also distinguishes the MSA layers at Klasies River Mouth, and Klein (1994: 497–502) has suggested that it reflects more limited MSA ability to acquire flying birds. Avery (1990: 105–128) described a portion of the 1969–1973 bird sample from DK1 and will describe the remainder and the new sample elsewhere.

Fish bones occur only in the LSA deposits, where they come almost exclusively from coastal species that could have been caught on baited lines, in nets, or in artificial intertidal traps. Fish are comparably rare or absent in the MSA levels at Klasies River Mouth, and there is also an absence of bone gorges, net sinkers, and other probable or possible fishing gear, which are known only from LSA sites (Klein 1979, 1994). The implication again is that MSA people exploited coastal resources less effectively. Schweitzer (1979: 195–197) described the fish from the 1969–1973 excavations. The new fish sample appears to contain essentially the same species in the same proportions and will be described elsewhere.

Shells occur in both the LSA and MSA deposits, but only the LSA specimens are well-enough preserved for easy identification and counting. Schweitzer (1979: 186–194) analyzed the 1969–1973 LSA sample. The new one is discussed briefly in the section on the LSA above.

Readily identifiable bones of macromammals and tortoises occur throughout the DK1 sequence. Schweitzer (1979) discussed the 1969–1973 LSA mammal sample analyzed by Klein and Scott. Klein and Cruz-Uribe (1983) and Klein (1994) described the 1969–1973 tortoises, while Klein (1975) and Grine, Klein, and Volman (1991) reported on the 1969–1973 MSA macromammals. Figure 6 summarizes some key characteristics of the 1969–1973 macromammals for comparison to the 1992–1993 fauna, as described here. To aid interpretation, Figure 6 also includes the macromammals from the nearby LSA site of Byneskranskop 1 (Schweitzer and Wilson 1982). The Byneskranskop fauna was also analyzed by Klein and dates mainly to the 11,000 years immediately preceding the LSA occupation at DK1. The tortoises from the 1992–1993 excavations at DK1 are described at the end of this section.

The 1992–1993 Macromammal Samples

The new LSA and MSA macromammal samples comprise 26,856 and 11,981 identifiable macromammal bones respectively, or about 50% and 10% as many as the previous LSA and MSA samples. The new samples are smaller because the renewed excavation has proceeded more slowly, with a strong emphasis on microstratigraphy.

Figure 7 shows the relative abundance of various taxa in the new LSA and MSA samples, employing the same format as Figure 6 and ignoring for present purposes the separate LSA and MSA microstratigraphic units. In both figures, the bars are directly proportional to the Minimum Number of Individuals (MNI) for each taxon or semi-taxon in each major cultural unit, and a slash separates the Number of Identifiable Specimens (NISP) assigned to each taxon and the corresponding MNI. The MNIs were calculated as if all the bones in each major cultural unit could represent the same set of individuals, that is, they are not sums of the MNIs for individual stratigraphic or microstratigraphic units. Cruz-Uribe and Klein (1986) outline the assumptions and algorithms used to compute the MNIs.

Figure 6 lumps bovid species by size so as to include the mass of fragmentary postcranial bones that could be identified only to size. In contrast, to emphasize the taxonomic composition of the 1992–1993 samples, Figure 7 presents NISPs and MNIs for individual bovid species, based strictly on readily identifiable horncores and teeth. The four size categories in Figure 6 are more or less conventional and correspond closely to the categories used by other analysts (e.g., Brain 1981; Plug 1993; Voigt 1983). In the context of the Die Kelders fauna (old and new), small bovids include Cape grysbok (*Raphicerus melanotis*), steenbok (*Raphicerus campestris*), and klipspringer (*Oreotragus oreotragus*); small-medium bovids include bushbuck (*Tragelaphus scriptus*), mountain reedbuck (*Redunca fulvorufula*), vaalribbok (*Pelea capreolus*), springbok (*Antidorcas cf. australis*), and sheep (*Ovis aries*); large-medium bovids include greater kudu (*Tragelaphus strepsiceros*), blue antelope (*Hippotragus leucophaeus*), southern reedbuck (*Redunca arundinum*), Cape hartebeest (*Alcelaphus buselaphus*), bontebok (*Damaliscus dorcas*), and black wildebeest (*Connochaetes gnou*); and large bovids include eland (*Taurotragus oryx*) and Cape buffalo (*Syncerus caffer*). A "very large" category, comprising only the long-horned buffalo (*Pelorovis antiquus*), is not represented in the figures because it occurred only in the 1969–1973 sample.

Taxonomically, the 1992–1993 LSA and MSA samples differ from the 1969–1973 samples only in the absence of a few species that were rare before. Some or all of these species will probably reappear as the new excavations resample the lower MSA layers.

Environmental Implications of the Macromammals

Both the taxonomic composition of the DK1 fauna and the average adult size of some key species can be used for paleoenvironmental reconstruction. Figures 6 and 7 show that the LSA and MSA macromammal samples are both heavily dominated by the Cape dune molerat (*Bathyergus suillus*), a large fossorial rodent that is extremely common

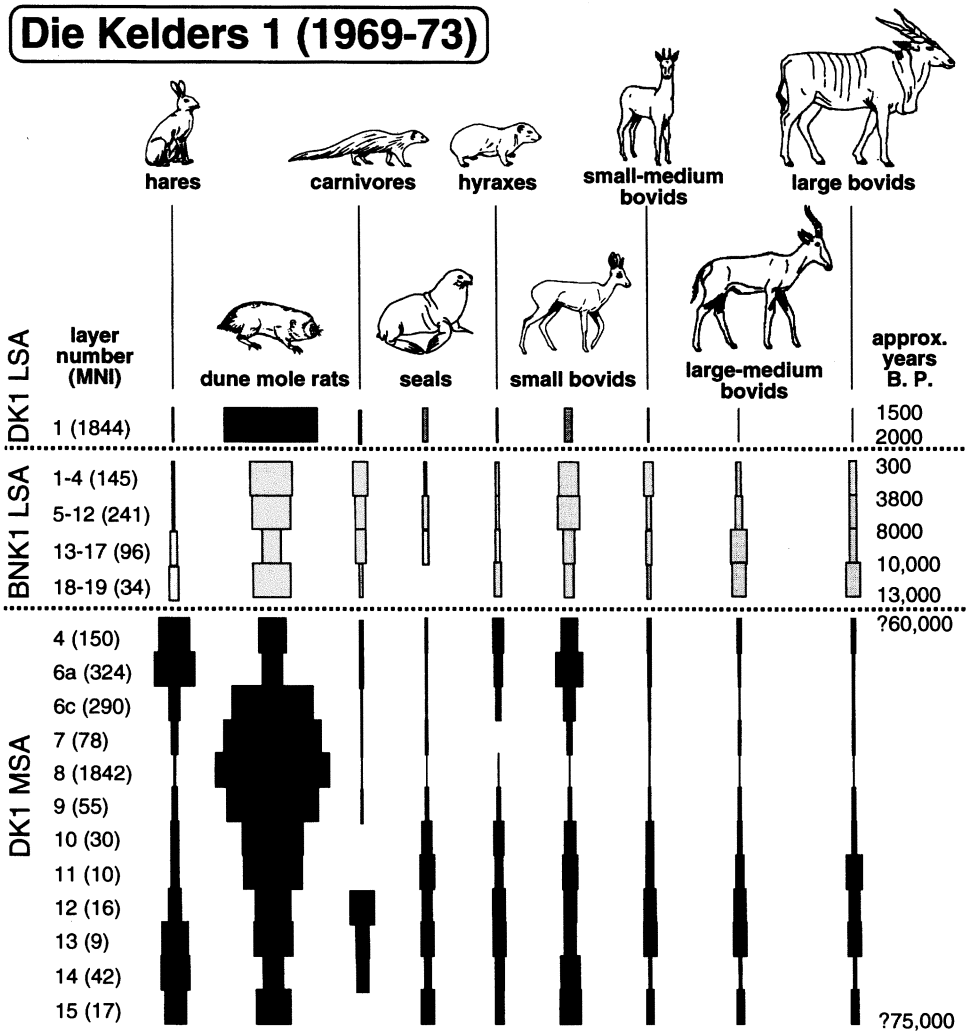


Figure 6. The relative frequencies of hares, Cape dune molerats, terrestrial carnivores, seals, hyraxes, and differently sized bovids in the 1969–1973 excavations at Die Kelders (DK) Cave 1 and in the 1974–1976 excavations of Byneskranskop (BNK) Cave 1. The horizontal bars are proportional to the Minimum Number of Individuals (MNI) by which each taxon or semi-taxon is represented in each layer at each site. Note that the Die Kelders layer numbers follow Tankard and Schweitzer (1976), who collapsed the multiple LSA layers into a single unit (Layer 1). For Die Kelders, the MNIs on which the figure is based can be found in Grine, Klein, and Volman (1991), and for Byneskranskop 1, in Schweitzer and Wilson (1982).

near Die Kelders today. Its persistence through the entire sequence (including the terminal Pleistocene/Holocene LSA deposits at Byneskranskop Cave 1) indicates fundamental continuity in suitable sandy soils and associated food plants near DK1.

Overall, neither the old nor the new LSA samples indicate that the environment differed significantly from the present one. Together, the samples comprise nearly all the macromammal species that were recorded nearby historically, and none that were not. From an historical perspective, the only conspicuous absentee is domestic cattle (*Bos taurus*), which the aboriginal Khoikhoi herder-foragers kept in large numbers (Elphick 1977; Deacon 1984; Smith 1990, 1992). A neonate bovine dentition in the 1969–1973 LSA sample could represent cattle, but it cannot be unequivocally separated from Cape buffalo, and the possibility remains that the Die Kelders LSA people kept sheep, but not cattle. Conceivably, cattle reached the southwestern tip of Africa only 1300 years ago (Smith 1990, 1992; Sealy and Yates 1994), perhaps 400–500 years after sheep and 100–200 years after LSA people ceased regular visits to DK1.

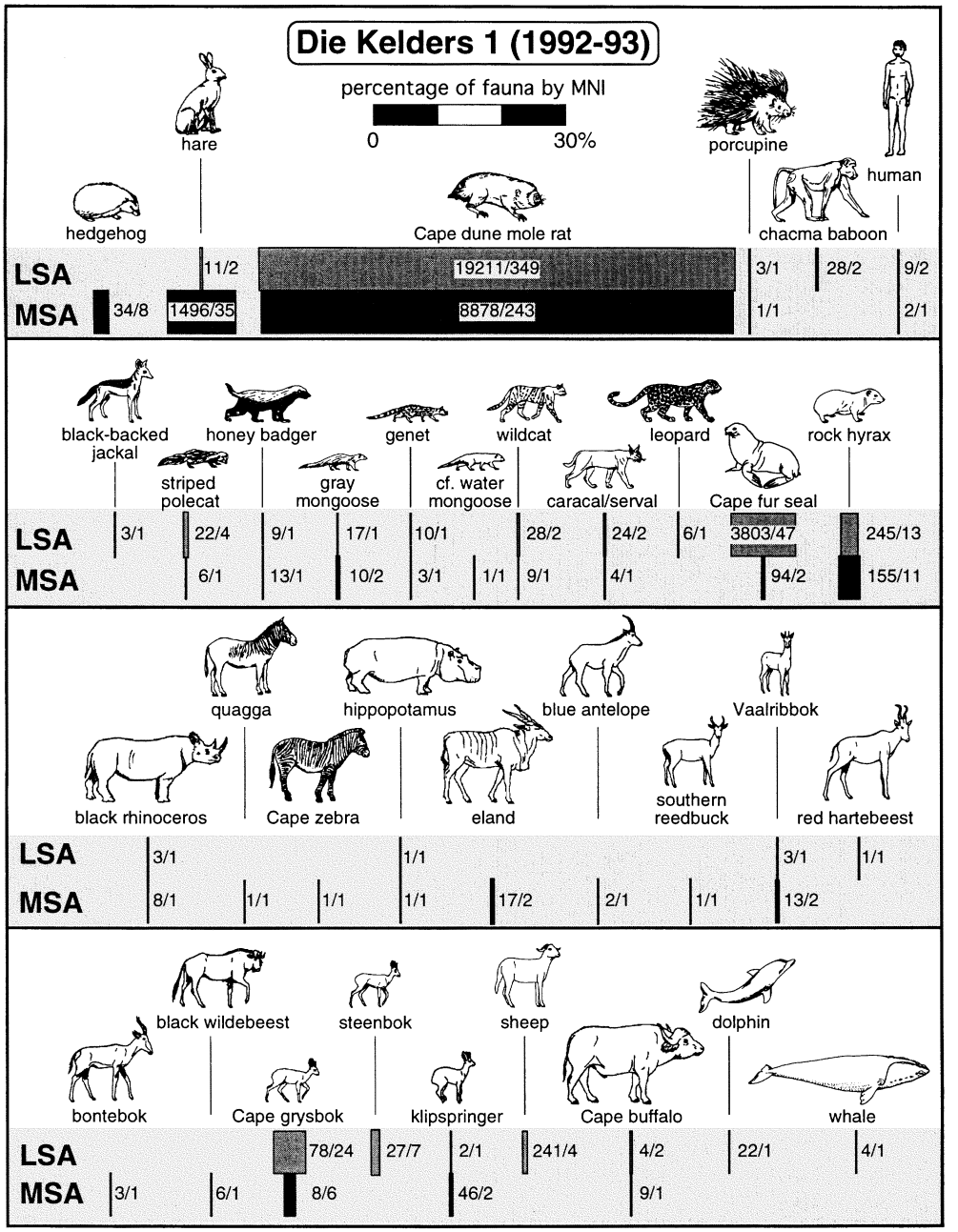


Figure 7. The relative frequencies of various taxa in the 1992–1993 faunal sample from Die Kelders 1. Slashes separate the Number of Identifiable Specimens (NISP) assigned to each species from the Minimum Number of Individuals (MNI) that could account for the specimens. The horizontal bars are proportional to the MNI for each species (as a percentage of the total MNI for all species). The formal taxonomic names for most species are given where they are first mentioned in the text. Species not mentioned there are hedgehog (*Erinaceus frontalis*), porcupine (*Hystrix africaeaustralis*), chacma baboon (*Papio ursinus*), black-backed jackal (*Canis mesomelas*), striped polecat (*Ictonyx zorilla*), honey badger (*Mellivora capensis*), genet (*Genetta sp.*), water mongoose (*Atilax paludinosus*), wildcat (*Felis libyca*), caracal/serval (*Felis caracal aut serval*), and leopard (*Panthera pardus*).

In sharp contrast to the LSA sample, the relatively small 1993 MSA sample contains several species that were not recorded near DK1 historically and are unknown in any regional faunas postdating 10,000 years ago. These extralimital species include the quagga (*Equus quagga*), which was widespread in the South African interior until the 1860s; the Cape zebra (*Equus capensis*), which apparently disappeared throughout southern Africa about

10,000 years ago; the black wildebeest, a frequent historical companion of the quagga; and the southern reedbuck, whose nearest historical occurrence was in marshy areas far to the east and north (Skead 1980; Skinner and Smithers 1990). As a group, these species and others (especially springbok) that were found only in the previous MSA sample could not prosper in the sclerophyllous scrub and bush that appear to have dominated the Die Kelders region during the last 10,000 years, and they indicate grassier vegetation in MSA times. The southern reedbuck also implies sufficient moisture to sustain a marsh or other large body of freshwater where none was present historically. Both the sediments and fauna imply relatively moist conditions more or less throughout, but the greater abundance of hares near the top and bottom of the MSA sequence may reflect drier oscillations, which are also implied by the accompanying microfauna (Avery 1982).

Faunas that contain the same historically absent grazing and moisture-loving species found in the DK1 MSA have been found at other sites throughout the southern and western Cape, often in dated contexts that correspond to glacial intervals (Klein 1983). The "glacial" character of the DK1 MSA fauna is consistent with stratigraphic evidence and preliminary ESR dates (reported above) that the MSA layers formed in the early part of the Last Glaciation (= isotope stage 4), between roughly 74,000 and 59,000 years ago.

For environmental reconstruction from mean adult size, the two most useful species at DK1 are the gray mongoose (*Galerella pulverulenta*) (abundant only in the 1969–1973 sample) and the Cape dune molerat (abundant in both the 1969–1973 and 1992–1993 samples). In living gray mongooses, adult size tends to increase with decreasing temperature (Klein 1986), while in living dune molerats it increases with increasing rainfall (Klein 1991). The Die Kelders LSA gray mongooses and dune molerats were about the same size as their historic counterparts, but the MSA specimens of both species were much larger. The sum implies once again that MSA people occupied DK1 under relatively cool, moist conditions.

Behavioral Implications of the Macromammals

At Klasies River Mouth, the MSA fauna is notable for an abundance of eland, which far outnumbers Cape buffalo, bushpig, and other species that were probably far more common near the site (Klein 1979, 1994). In sharp contrast, LSA faunas that accumulated under similar environmental conditions contain many fewer eland relative to other species. Since eland are generally far less aggressive than buffalo or bushpig, the implication is probably that enhanced technology allowed LSA people to hunt particularly dangerous species more often (Klein 1979, 1994). Eland appear similarly abundant relative to other large ungulates in the 1969–1973 and possibly the 1992–1993 MSA samples from Die Kelders (Grine, Klein, and Volman 1991; FIG. 7), but the total numbers of eland and other ungulates in the DK1 MSA sample remain too small for meaningful comparison to LSA samples like that from nearby Byneskranskop 1.

Among other behavioral issues that the DK1 fauna could address are the season(s) of the year when the site was occupied and the way in which various species were obtained (e.g., by stalking, trapping, or driving). The DK1 LSA seal sample is sufficiently large to use age at death to infer seasonality. The LSA seals exhibit a sharp peak in individuals about 9 months old, suggesting that people were present in the August–September interval when 9-month-olds are ejected from their offshore birth-rookeries and frequently wash up on mainland beaches, exhausted or dead. Essentially the same peak in 9-month-olds is obvious at all coastal LSA sites where fur seals are well represented (Klein 1994: 505). A priori, based on the absence of a similar peak in the large seal sample from the MSA deposits at Klasies River Mouth (Klein 1994), we hypothesize that none will emerge when the DK1 MSA sample is enlarged. In this case, Klasies River Mouth and DK1 together might imply that relative to LSA people, MSA foragers were less aware of seasonal resource variability or that they followed a different seasonal round.

Insights into how Stone Age people acquired a species can often be obtained from the distribution of individual ages at time of death. Unfortunately, the DK1 samples are mostly too small for meaningful analysis. The main exception are the sheep in the 1969–1973 LSA sample, where a composite mortality profile based on both age and sex determinations comprises mainly very young males and old females (Schweitzer 1974, 1979). This is consistent with flock management and suggests that the LSA occupants of DK1 were herders rather than rustlers.

For lack of space here, we postpone a discussion of skeletal part representation and bone damage to a future report. For the moment, we note that the basic pattern of ungulate skeletal part representation in both the LSA and the MSA samples resembles that at many other Stone Age sites, where smaller species are well-represented by a relatively wide variety of skeletal parts and larger ones are represented mainly by head and foot elements. With regard to bone damage, we note that macroscopic cut marks substantially outnumber animal tooth marks on seal and larger ungulate bones in both the LSA and MSA samples. The implication is that the bones of larger animals were introduced primarily by people. A detailed microscopic analysis of bone damage (cutmarks, percussion marks, and toothmarks) is currently underway and some preliminary

results are reported below. We briefly address the issue of who accumulated smaller mammal bones in the next section.

The Cape Dune Molerat: Human or Non-Human Accumulator?

The Cape dune molerat occurs in virtually every archaeological site within its historical range (Klein 1991), but nowhere is it more common than in the MSA deposits of DK1. Throughout most of the MSA sequence, dune molerats exceed 90% of the fauna (by MNI or by NISP counts), and in the very middle (Layer 8 of Figure 6), their frequency reaches 100 individuals per square meter. Historically, dune molerats were taken by both people and large raptors, including the cave-roosting Cape eagle owl (*Bubo capensis*). It is thus reasonable to ask if their extraordinary abundance in the MSA layers of DK1 reflects mainly human or eagle owl predation.

We cannot answer this question definitively, but two lines of evidence suggest that people accumulated most of the LSA dune molerats, while eagle owls accumulated most of the MSA specimens. First, burnt and cut dune molerat bones occur only in the LSA sample, while molerat bones polished or diminished by gastric acids occur only in the MSA sample. Second, in the LSA, dune-molerat-rich microstratigraphic units usually contain many other bones and artifacts, while in the MSA, dune-molerat-rich units tend to contain little else. Principal Components Analysis of bone and artifact frequencies confirms this observation: in the LSA units, dune molerat bones covary with large mammal bones, tortoise bones, and artifacts, all of which were probably or certainly introduced by people. In the MSA units, dune molerat bones vary independently of the same probable or certain humanly introduced items.

Tortoise Remains

The tortoise bones at DK1 come almost exclusively from the angulate tortoise (*Chersina angulata*), which is still very common nearby and was extensively exploited by Stone Age people throughout its western and southern Cape range (Klein and Cruz-Uribe 1983, 1987, 1989). At Die Kelders, only dune molerats rival tortoises in abundance, and the extraordinary number of tortoises in the MSA layers shows that warm, dry days must still have been seasonally common, in spite of an overall tendency toward a cooler, moister climate.

We measured DK1 tortoise humeri and femora to gauge individual tortoise size. In both the 1969–1973 and 1992–1993 samples, the MSA tortoise humeri and femora tend to be significantly larger than their LSA counterparts at either DK1 or Byneskranskop (Klein and Cruz-Uribe 1983; Klein 1994). The implication is either that MSA environmental circumstances promoted especially rapid tortoise growth, or that MSA human populations were less dense and therefore preyed less intensively on tortoises. Since the relatively cool and moist conditions under which MSA tortoises lived probably did not favor faster growth, the more likely alternative is that MSA human populations were smaller. This inference is consistent with previously cited evidence that MSA people were less competent hunter-gatherers than their LSA successors.

Taphonomy of the DK1 MSA Large Mammal Fauna (CWM)

An important part of our renewed study of DK1 is a detailed taphonomic analysis of the large mammal fauna. Our methods include an analysis of surface modification, refitting studies of limb bone shafts, the quantification of limb bone shafts following the methods and recommendations of Marean and Spencer (1991), and analyses of bone weathering (following Behrensmeyer 1978) and fragmentation (following Villa and Mahieu 1991) in concert with experimental and actualistic studies. We discuss our preliminary results here.

Preservation of the Fauna

The preservation of the DK1 fauna varies between layers and squares. This differential preservation affects the identifiability of surface modification as well as bone identifiability, but also may hold profitable clues to the formation processes of the site. Layer 4/5 tends to be more heavily weathered than the lower layers of the site. Many Layer 4/5 fragments exhibit weathering stage 2 (as defined by Behrensmeyer 1978), while few fragments in the lower layers show this degree of weathering. This suggests that Layer 4/5 bones were exposed for longer intervals than the lower layers, and may explain why the bones in Layer 4/5 are more poorly preserved compared with the lower layers.

Much of the bone in Layer 6 is heavily comminuted and, when quantified, we expect the completeness index values (Marean 1991) of the compact bones to be low. The broken nature of the compact bones, and the high frequency of transverse and right angle breaks on shafts (Villa and Mahieu 1991), indicates that much of this breakage probably resulted from dry bone breakage which suggests postdepositional destruction.

Layers 10 and 12 have excellent bone preservation. Postdepositional destruction appears insignificant because few of the shafts have transverse and right angle breaks and the compact bones, though rare, are well preserved. Refits of long bone shaft fragments are common within squares,

though we have yet to systematically examine inter-square refitting.

Generally speaking, bone preservation increases in quality with sediment depth, making the lower layers more ideal for behavioral studies and particularly for analysis of surface modification. A general pattern consistent to all the MSA layers is the low frequency of limb bone ends relative to a high frequency of middle shaft fragments. Axial elements such as vertebrae and pelves are also poorly represented compared with limb bone shafts. This pattern is consistent either with removal of these bones by carnivores (Bunn and Kroll 1986; Marean et al. 1992; Marean and Spencer 1991) or by postdepositional destruction. The latter seems unlikely in the lower layers and more likely for the upper layers, given our observations on weathering. Studies of surface modification should help resolve these issues.

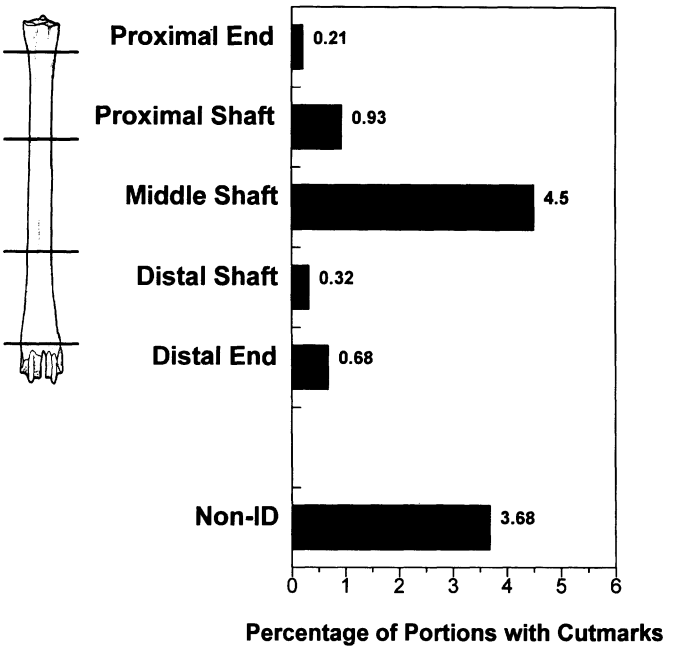


Figure 8. The bone portion classification illustrated on the metatarsal, and the percentage of cutmarks on limb bone pieces from all limb bones that occur in each portion.

Surface Modification

Surface preservation varies significantly between layers. In general, preservation of surface modification is better in the lower layers than the upper layers, and is particularly good in Layers 10 and 12. For that reason we have begun our surface modification analysis with Layer 10 and, to date, we have analyzed roughly half the material from both the 1969–1973 and our recent excavations. Our procedures for identifying and recording surface modification include examining all bone surfaces, whether identifiable or not, using high-incident light under at least 10 power. We use an Olympus 10–40× zoom binocular microscope with bifurcated light source. Thus, our data include marks that are both readily observable and identifiable without microscopy, as well as marks that may be seen only with microscopic aids. We record the numbers and positions of all surface modifications including cut marks, carnivore tooth marks, rodent gnaw marks, hammerstone percussion marks, and non-identifiable marks. Marks are recorded as either being high confidence (have all diagnostic criteria, as defined in Blumenschine, Marean, and Capaldo 1996), medium confidence (lack one or more of the diagnostic criteria), or not identifiable. The results presented here include only high confidence marks from a sample of 2802 specimens.

Cutmarks are abundant on the Layer 10 large mammal bones with about 10% of all observed fragments being cut-marked. This frequency is similar to other zooarchaeological assemblages where similar methods were employed, for example the Oldowan site FLK Zinjanthropus (Bunn and Kroll 1986) and the Kenyan LSA site Enkapune Ya Muto (Marean 1992). A preliminary analysis of the distribution of these cutmarks shows that the vast majority occur on the middle shaft of the limb bones (FIG. 8).

High confidence percussion marks are present on 11% of all observed fragments, and high confidence carnivore tooth marks are present on 13% of all observed fragments, surpassing both cut marks and percussion marks in total frequency. Tooth mark frequencies are distributed differentially on classes of bone fragments. Twenty percent of all observed limb bone epiphyseal fragments and 17% of all limb bone middle shaft fragments are tooth-marked.

Summary

Importantly, 35 fragments are both tooth-marked and percussion-marked. This pattern, along with the nearly equal frequencies of cutmarks, percussion marks, and tooth marks, demonstrates overlap in carnivore and hominid activity in DK1 MSA Layer 10. This overlap could be explained by hominids and carnivores sharing the cave, hominids scavenging from carnivores, or carnivores scavenging from food debris discarded by hominids (Blumenschine and Marean 1993).

The data from numerous experimental and actualistic studies (Bartram, Kroll, and Bunn 1991; Blumenschine 1988; Blumenschine and Selvaggio 1988; Blumenschine and Marean 1993) can be used to resolve this problem. The high frequency of cutmarks on middle shafts is consistent with hominids having early access to a carcass. The

Table 5. Die Kelders 1 MSA human remains described in this paper.

Specimen	*Element*	*Layer*	*Grid square*
DK1 AP 6264	Left upper 4th premolar	Middle 4/5	E9
DK1 AP 6267	Phalanx	Upper 6	E8
DK1 AP 6255	Right upper deciduous canine	6	B6
DK1 AP 6256	Left lower deciduous canine	6	B6
DK1 AP 6257	Right upper deciduous 2nd molar	6	E5
DK1 AP 6258	Left upper 4th premolar	11	D4

high frequency of percussion marks further substantiates this inference. The low frequency of carnivore toothmarks on middle shafts with a higher frequency of toothmarks on epiphyses is consistent with carnivores scavenging bone discarded by hominids. Thus our analysis of Layer 10 shows a pattern consistent with hominids attaining most of their animal foods through early access to carcasses, transporting remains back to the cave, and carnivores scavenging those remains after hominids discarded the bones.

The MSA Human Remains (FEG)

Grine, Klein, and Volman (1991) described nine isolated human teeth from Levels 4, 6, 14, and 15 of the 1969–1973 excavations. Three additional teeth from Layer 6 and one from Layer 11 could not be found at the time of the earlier study. These specimens are described here, together with an isolated premolar from middle Layer 4/5 and a probable middle phalanx of manual ray V from upper Layer 6 of the new excavation (TABLE 5). The teeth are illustrated in Figure 9.

Three of the five teeth reported upon here are deciduous. All but one of the nine previously described specimens are also deciduous. The 14 (11 deciduous and 3 permanent) teeth from the MSA layers of DK1 probably represent between eight and ten individuals. The phalanx might be associated with any of the individuals from subjacent Layer 6 or superjacent Layer 4.

The descriptive terminology and measurements employed here follow Grine, Klein, and Volman (1991). The mesiodistal (MD) and buccolingual (BL) diameters of the teeth described here are recorded in Table 6.

Dental Comparisons

With reference to crown size, Grine, Klein, and Volman (1991) noted that the crown dimensions of the original DK1 MSA teeth generally exceed the sample means for homologous elements of modern South African blacks. The diameters of the five new DK1 teeth also exceed the means recorded by Jacobson (1982) and Grine (1986) for recent southern African blacks, although in most instances, the MD and BL values of the DK1 crowns fall within the 95% fiducial limits of the modern samples (FIG. 10). The most notable exception is the DK1 d^c (AP 6255), which exceeds these limits in its MD and BL diameters. Comparisons of the DK1 crown dimensions with homologous data for European and Levantine Neandertal deciduous teeth (Grine, Klein, and Volman 1991: table 6) and P^4s (Bermúdez de Castro 1986: table 7) reveal that, in all instances, they fall within the fiducial limits of these later Pleistocene samples (FIG. 10). Also, with the exception of the MD diameter of the AP 6258 P^4, the DK1 crown diameters are more similar to the Neandertal sample averages. The DK1 premolars are marginally smaller than the somewhat older P^4 from Sea Harvest (MD 7.9; BL 10.2) reported by Grine and Klein (1993).

The comparatively large sizes of the DK1 teeth obviously do not indicate a closer relationship to Neandertals than to modern Africans because large tooth size is plesiomorphic, and because tooth crown reduction occurred even from comparatively recent archaeological samples to living populations (Frayer 1977; Smith 1982; Brace and Vizthum 1984). In addition, the recent South African sample means used in the present comparisons are not the largest available for indigenous African peoples (cf. data in Brabant 1963; Moss and Chase 1966; Grine 1984).

The DK1 deciduous canines (AP 6255; AP 6256) and dm^2 (AP 6257) exhibit several morphological similarities with homologues of recent southern African indigenous people. Thus, the absence of a lingual tubercle on AP 6256, its moderate lingual ridge development, its lack of lingual shovelling, and the absence of mesial and distal styles correspond with the majority of modern San and South African black homologues (Grine 1986). On the other hand, AP 6255 possesses a moderate, distally skewed lingual cingulum, whereas most San and South African black upper deciduous canines have a weak cingulum that is symmetrically disposed (Grine 1986). The dm^2 resembles modern southern African homologues in that four well-developed cusps are present in about 90% of San and South African black individuals, and about 70% possess a buccal groove that terminates gradually.

Figure 9. Human teeth from the MSA levels at Die Kelders 1. a, Occlusal view of DK1 AP 6264 LP^4; b, Mesial view of DK1 AP 6264 LP^4; c, Lingual view of DK1 AP 6255 Rd^c; d, Lingual view of DK1 AP 6256 Ld_c; e, Occlusal view of DK1 AP 6257 Rdm^2; f, Occlusal view of DK1 AP 6258 LP^4; g, Distal view of DK1 AP 6258 LP^4.

The DK1 upper premolars are morphologically unremarkable. Neither Van Reenen (1964) nor Jacobson (1982) recorded premolar crown variants for the San and South African black samples they examined. Similarly, Morris, Hughes, and Dahlberg (1978), who illustrated unusual crown morphologies of the P^3s of San and South African blacks, noted that the P^4s were unaffected.

The morphological similarities between the DK1 teeth and those of the recent indigenous peoples of southern Africa do not necessarily imply morphological modernity

Table 6. Crown diameters in millimeters of the Die Kelders MSA human teeth described in this paper.

Tooth	*Specimen*	*MD measured*	*MD estimated*	*BL measured*
Upper deciduous canine	DK1 AP 6255	7.7	7.9	7.2
Upper deciduous 2nd molar	DK1 AP 6257	9.0	9.5	10.3
Upper 4th premolar	DK1 AP 6258	7.5	7.7	9.4
Upper 4th premolar	DK1 AP 6264	7.3	7.6	10.1
Lower deciduous canine	DK1 AP 6256	6.5	6.6	5.7

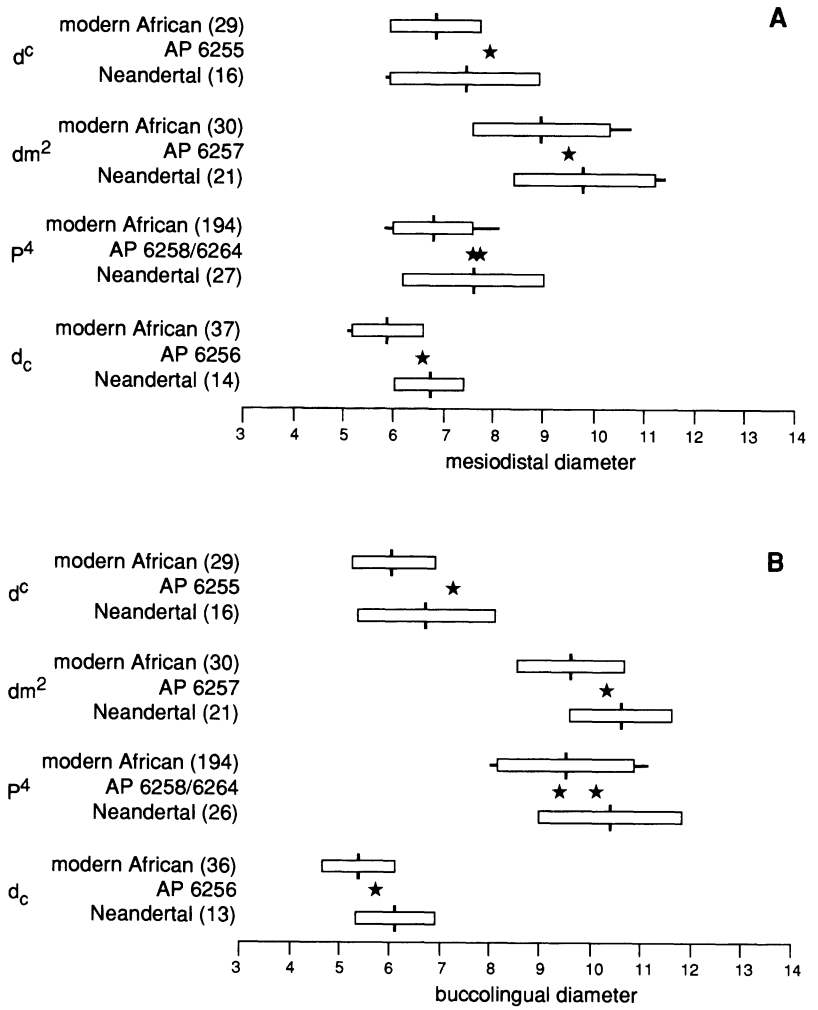
for the MSA sample. The shared features may be primitive, having characterized the teeth of Early Stone Age (ESA) populations from which the MSA inhabitants of southern Africa were derived. At the same time, if the similarities with recent homologues represent derived features, they might indicate morphological continuity of the MSA and modern inhabitants of southern Africa. Indeed, Grine, Klein, and Volman (1991) noted that several of the features in which the DK1 teeth resemble those of recent Africans also serve to differentiate modern Africans from populations in other geographic regions. Unfortunately, the currently available dental samples of ESA (and MSA) origin are not adequate to determine the significance of these morphological resemblances.

Radiographs of the P^4s (AP 6258; AP 6264) reveal unremarkable pulp chambers by comparison with modern human homologues. Although, comparative data on premolar root length are not available for modern sub-Saharan African peoples, there appears to be nothing unusual about the DK1 teeth in this regard.

Osteological Comparisons

The AP 6267 fragment represents the distal portion of a manual middle phalanx. The epicondyles are only slightly

Figure 10. Comparison of the mesiodistal and buccolingual diameters of Die Kelders, modern black South African, and Neandertal teeth. Vertical line = sample mean; horizontal rectangle = sample mean ± 2 s. d.; horizontal line = observed sample range. Numbers in parentheses = sample sizes. Modern African data from Jacobson (1982) and Grine (1986); Neandertal data from Bermúdez de Castro (1986) and Grine, Klein, and Volman (1991: table 6).



expanded beyond what appears to be the maximal waist of the shaft. Because the proximal base has been broken away, it is not possible to determine the status of epiphyseal fusion of this element. The distal end measures 7.9 mm mediolaterally across the epicondyles. Assuming that its epiphysis had fused by time of death, this dimension places it within the fiducial limits of samples of modern ray V homologues recorded by Susman (1976), who obtained means of 8.74 mm (s.d. = 0.47 mm) and 7.75 mm (s.d. = 0.29) for 20 males and 20 females respectively from the Todd Collection of the Cleveland Museum of Natural History.

Summary and Conclusions

The 1992–1993 excavations at Die Kelders have confirmed inferences drawn from the 1969–1973 excavations and have allowed some important new conclusions.

1) Fresh study of the Middle Stone Age (MSA) sediments confirms not only that they formed mainly under cool, moist conditions, but micromorphological examination shows that the formation processes included decalcification; localized phosphatization by guano during periods when sand deposition ceased; minor interruptions in sedimentation and corresponding short-lived surfaces on which archaeological debris accumulated; and repeated microfaulting and slippage.

2) ESR dating of eland dental enamel shows that the entire MSA sequence lies beyond the 40,000 year range of conventional C^{14} dating. If it is assumed that the enamel adsorbed uranium rapidly after burial (Early Uptake), the top of the sequence dates to roughly 60,000 years b.p. Alternatively, if it is assumed that adsorption continued at a relatively constant rate (Linear Uptake), the top of the sequence would be closer to 80,000 years b.p. Either date is consistent with sedimentological and faunal evidence for cooler, moister conditions, but only the 60,000 year date could pertain to the Howieson's Poort variant of the MSA, as it is known at other sites.

3) Fresh excavation of the LSA middens reconfirms that pottery is present throughout, in direct association with typical LSA stone and bone artifacts. The DK1 finds, supplemented now by those from Kasteelberg, Boomplaas, and other local sites show that pottery reached the southwestern tip of Africa between 2000 and 1500 years ago. In general, the new DK1 LSA materials closely resemble those from the 1969–1973 excavations, but they include some important additions. Chief among these are seeds and pips from a variety of plants, at least some of which were probably eaten.

4) Like most other MSA assemblages, the new Die Kelders sample contains few retouched pieces. Unretouched flake-blades, cores, and various categories of knapping debris predominate. The MSA inhabitants apparently blocked out cores elsewhere, perhaps on the nearby beach, but they routinely produced flakes and flake-blades inside the cave. The high percentage of fine-grained rock types, the dimensions of flake-blades, and the presence of two backed pieces in the 1993 MSA sample tentatively suggest that the topmost MSA layers represent the Howieson's Poort MSA industry or a similar MSA variant.

5) Like the faunal samples from the earlier excavations, the new samples suggest that LSA people occupied Die Kelders under essentially modern environmental circumstances, while MSA people experienced much cooler and moister conditions. The new LSA sample reconfirms that sheep were locally introduced between 2000 and 1500 years ago, perhaps in conjunction with pottery but a few hundred years before cattle. The mammal, bird, and tortoise remains from the new excavations continue to suggest that MSA people were less effective hunter-gatherers than their LSA successors. As in the previous excavation, dune molerat bones are extraordinarily abundant in the new MSA samples, but in the new excavations they tend to be most abundant in microstratigraphic units where bones of larger mammals, tortoises, and artifacts are rare. The implication is that they were introduced by Cape eagle owls or some other non-human agent.

6) Preliminary taphonomic analysis of the large mammal fauna from the MSA layers indicates significant vertical and horizontal variation in bone weathering and fragmentation. In general, bones are better preserved and less weathered in the lower layers (10 and 12) relative to the upper layers (4/5 and 6). A preliminary analysis of bone surface modification from Layer 10 suggests human hunting of the ungulate fauna, followed by human accumulation of bones at the site, and finally carnivore ravaging of the discarded bones.

7) The human remains from the MSA of Die Kelders comprise a number of isolated teeth and a single manual phalanx. As would be expected for specimens of such antiquity, the teeth tend to be large by comparison with recent African homologues, while several morphological attributes of the DK1 crowns are shared by the majority of modern Africans. The DK1 teeth by themselves do not necessarily suggest anatomical modernity, but they are consistent with evidence from other sites that morphologically modern people were present in sub-Saharan Africa before 60,000 years ago, when Neandertals were the sole occupants of Europe.

Ongoing excavations should pinpoint the age and industrial affiliation of the DK1 MSA sequence. In addition, the enlarged faunal and artifactual samples will probably

permit fresh behavioral inferences, and the excavators are optimistic that continuing excavations will uncover more complete MSA human remains to help resolve the lively debate over modern human origins. Prospects seem particularly good in the lower MSA deposits, where bone preservation is especially good.

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