ELSEVIER

Journal of Archaeological Science 32 (2005) 399–422

Journal of Archaeological SCIENCE

http://www.elsevier.com/locate/jas

A late Middle Stone Age artifact assemblage from Sibudu (KwaZulu-Natal): comparisons with the European Middle Paleolithic

Paola Villa[a,*], Anne Delagnes[b], Lyn Wadley[c]

[a] *University of Colorado Museum, UCB 265, Boulder, CO 80309-0265, USA*
[b] *C.N.R.S., Maison de l'Archéologie et de l'Ethnologie, 21 Allée de l'Université, 92023 Nanterre, France*
[c] *Department of Archaeology, University of the Witwatersrand, Wits 2050, South Africa*

Received 10 October 2004; received in revised form 1 November 2004

Abstract

It has been suggested that many behavioral innovations, said to appear during the late Middle Stone Age in sub-Saharan Africa, facilitated the expansion of anatomically modern humans from Africa and the Near East into Europe at about 50 kyr; the process eventually led to the replacement of Neanderthals by modern humans and the emergence of the Upper Paleolithic. However, assemblages in this time range are little known in South Africa. In fact, the transition from Middle to the Later Stone Age in Southern Africa is controversial. The early appearance in South Africa of many innovations, such as sophisticated knapping techniques (e.g. the use of soft hammer or indirect percussion in blade production, of composite tools, of microlithic and bladelet technologies) remains to be established through technological analysis.

We present here the first results of a project designed to carry out detailed technological studies of several lithic assemblages in South Africa and France dated to the transition period. At this time we have completed the study of a post-Howiesons Poort assemblage from the rock shelter site of Sibudu.

The >2 m deep stratigraphic sequence of Sibudu extends from Howiesons Poort at its base to final Middle Stone Age, directly under Iron Age layers. We have analyzed in detail layer RSP (ca. 53 kyr, 1 m above the Howiesons Poort levels) which has provided a large assemblage of several thousand stone artifacts. Compared to published MSA assemblages this industry is unusual for the very high proportions of retouched pieces (15%). The technology is not very elaborate and there is no strong standardization of the end-products. There are no flakes of predetermined shapes; retouch is used to modify irregular flakes to obtain desired edges. Knapping of flakes and blades is done by hard hammer; soft hammer is used only for retouching tools. Interestingly the older Howiesons Poort blades were produced on the same raw materials by soft hammer. Raw material (hornfels and dolerite) was procured from distances of less than 20 km. Unifacial points are the dominant type and there is strong evidence of hafting and use as spear armatures. Detailed comparisons with Middle Paleolithic assemblages of Western Europe show that the late Middle Stone Age technology in South Africa is very similar to that of the Middle Paleolithic; in fact we see no fundamental differences between the two entities, as far as lithic technology is concerned. Implications for the Out of Africa hypothesis are discussed.

Keywords: South Africa; Late MSA; Sibudu; Lithic technology

1. Introduction

This paper is a progress report on an international research program which includes South African and French archaeologists. Our project addresses issues

* Corresponding author.
E-mail addresses: villap@buffmail.colorado.edu (P. Villa), delagnes@mae.u-paris10.fr (A. Delagnes), wadleyl@geoarc.wits.ac.za (L. Wadley).

0305-4403/$ - see front matter
doi:10.1016/j.jas.2004.11.007

which are central to current Paleolithic research such as the nature, the variability and the evolution of human technologies in the time range broadly comprised between 80 and 25 kyr, a time of important changes in human behavior. The goal of our research is to investigate the transition from the Middle to the Later Stone Age in South Africa and from the Middle to the Upper Paleolithic in Western Europe, focusing on lithic technology. Comparisons of African and European data are relevant to ongoing debates on behavioral evolution during the Upper Pleistocene. What is at issue in these debates is: (a) whether advanced technologies which are a consistent feature of Upper Paleolithic and Later Stone Age (LSA) sites appear earlier in Africa than in Western Europe; (b) whether these innovations appeared together during the late Middle Stone Age (MSA), in the context of evidence of other behaviors, and played a role in the expansion of population and dispersal of anatomically modern humans from Africa into Europe at about 50 kyr; (c) whether these features appeared earlier, with the advent of the MSA, and coalesced in a slow, long-term process with a progressive increase in the complexity of behavioral patterns [1–3,35,36,65–70,79].

It should be clear that the data to be collected during this project are more relevant to questions about the origins of early Upper Paleolithic cultures and whether the LSA lithic technology appeared suddenly or as part of a continuum, than they are to the question of the origins of "behavioral modernity". Sub-Saharan Africa and Western Europe represent the beginning and the end of the hypothetical expansion of anatomically modern humans out of Africa and given the precocious appearance of features said to define "modern" behavior such as evidence of symbolic culture in South Africa and microlithic technologies in East Africa [3,57,58,60] sub-Saharan Africa has been considered a likely source of developments in Eurasia. In fact the broader subject of "behavioral modernity" is highly complex, there are fundamental disagreements over the interpretation of the archaeological record and the trait list for the recognition of cultural modernity is controversial [33,59,116,118]. Our use of the term does not imply acceptance of this concept. Our project is limited to just one of the archaeological aspects of this debate, as presented in the important synthesis of McBrearty and Brooks [79]. We concentrate on technological innovations that have been seen as having a greater time depth in Africa than in Europe thus being the probable source of the important behavioral changes that characterize the Upper Paleolithic.

We are well aware that factors such as available raw material, site function, natural processes of artifact and sediment accumulation and social and environmental context influence techniques of tool production and processes of assemblage formation. Historical links or their absence in patterns of lithic technology occurring in widely separated areas may be very hard to demonstrate. Stone tool production is controlled by responses to environments unique to each context; behaviors of adaptive significance may have changed many times as they passed from one area to the next. For these reasons we are not looking for specific artifact markers but for general trends of technical behaviors. Regardless of the meaning assigned to technical innovations, the fact remains that we lack precise information on time of appearance, patterns of persistence and even diagnosis verification of lithic innovations at the time of transition in South Africa. Although South Africa and France have provided abundant empirical data on these subjects, comparisons of South African and European assemblages have been carried out only at a general level [95,112]. The data still awaits more detailed analyses. This is the reason for our project.

2. Why technology?

Technological innovations, that are said to appear during the later MSA in sub-Saharan Africa, include long-distance transport of fine-grained lithic raw materials, blade production by soft hammer or the punch technique [37], hafting, composite tools and microlithic technologies, hypothetical use of the pressure technique, formally shaped bone tools, and greatly accelerated variation in stone artifact assemblages through time and space. Planning depth (as indicated by long distance transport of desirable high-quality raw material) and sophisticated technologies are considered important features of evolved human culture because they indicate the ability to predict future needs, the expanding home range of human groups and the ability to adapt to diverse and challenging environments by technological innovations. In contrast to Neanderthals who seemed to have been limited to hunting by close-range weapons such as hand-held spears, long range projectile technology, such as use of spearthrower darts and bows and arrows, is considered a superior way of hunting because it allows killing at a distance. Projectile technology improves the success of a hunt, diminishes the physical danger of hunting at close range and allows killing of a wider range of dangerous or fleeting prey [96]. Composite tools made by hafting small blanks of standardized dimensions are seen as an indication of human inventiveness. In sum, archaeologists view the development of technologies allowing greater flexibilities in subsistence strategies as a tangible expression of expanding hominid capabilities, directly tied to the evolution of an advanced grade of behavior.

The period around 50,000 years and right afterward is the time when shifts to Upper Paleolithic forms of behavior appear in Eurasia, yet assemblages in this time range are little known in South Africa. In fact, the transition from the Middle to the Later Stone Age in South Africa is not very well known and there is disagreement about the timing and the process of transition [79,106,111,114]. The debate is unlikely to be resolved in the immediate future without more empirical data.

Detailed technological analyses of late MSA and LSA lithic assemblages from sites with long stratigraphic sequences, such as Sibudu and Rose Cottage (both recently excavated by one of us, LW) will allow us to make comparisons with Western European assemblages dating to the same period, roughly from OIS 4 to the end of OIS 3. Analysis of MSA II to post-Howiesons Poort assemblages from Klasies River Mouth is being carried out in collaboration with Sarah Wurz (Fig. 1). Analysis of the Border Cave materials [53] is being planned. Thus our research will cast light on questions such as:

- do the South African sites, which are dated to the period just before and after the appearance of Upper Paleolithic forms in Eurasia, show evidence of continuity in technological innovations which are supposed to have facilitated the expansion of modern humans to Africa?
- does the MSA technology differ from the Middle Paleolithic and can it be considered a precursor of the Upper Paleolithic?
- are patterns of regional differentiation and diachronic variation present in the MSA but not in European assemblages of pre-Upper Paleolithic age?

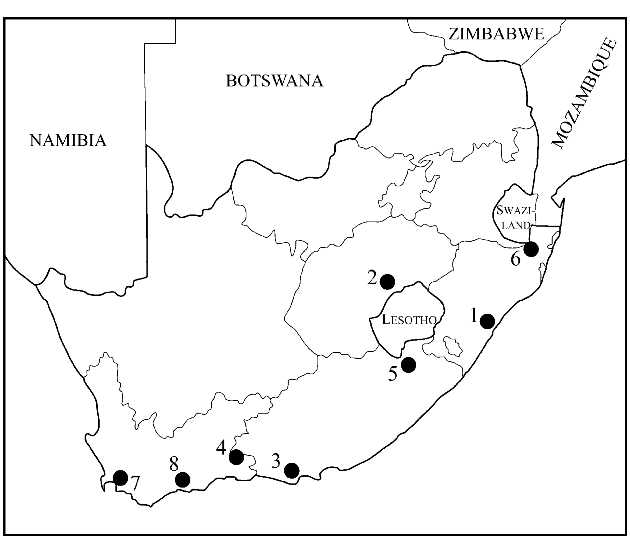

Fig. 1. Geographic map with position of sites mentioned in the text. 1, Sibudu; 2, Rose Cottage; 3, Klasies River Main; 4, Boomplaas; 5, Strathalan; 6, Border Cave; 7, Die Kelders; 8, Blombos.

No definitive answers to all of our questions can be provided at this time since our research is still in its early stages. However, we have completed a detailed technological analysis of a late MSA assemblage at Sibudu from layer RSP, dated to 53 kyr by OSL and done a preliminary analysis of other layers in the sequence. Our analysis provides information on the technology of late MSA assemblages and on similarities between the MSA and the Middle Paleolithic, thus providing an answer to two of the questions mentioned above.

3. Sibudu

This large rock shelter, approximately 40 km north of Durban and 15 km inland from the Indian Ocean, is located on a cliff above the Tongati River, in the sandstones and shales of the Natal Group (Fig. 2). In 1983 Aaron Mazel of the Natal Museum excavated one small test trench revealing Iron Age and MSA occupations. Extensive excavations started in 1998, under the direction of Lyn Wadley [117]. A grid of 18 m^2 is being excavated horizontally; at present the depth of the excavated deposits is about 70 cm, down to and

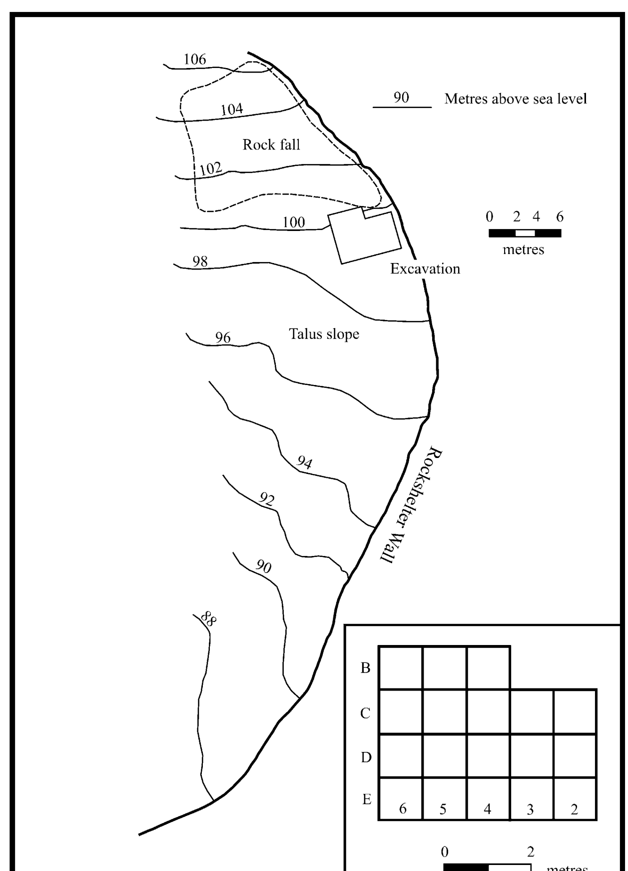

Fig. 2. Sibudu cave plan with excavation area. Modified after Wadley [117].

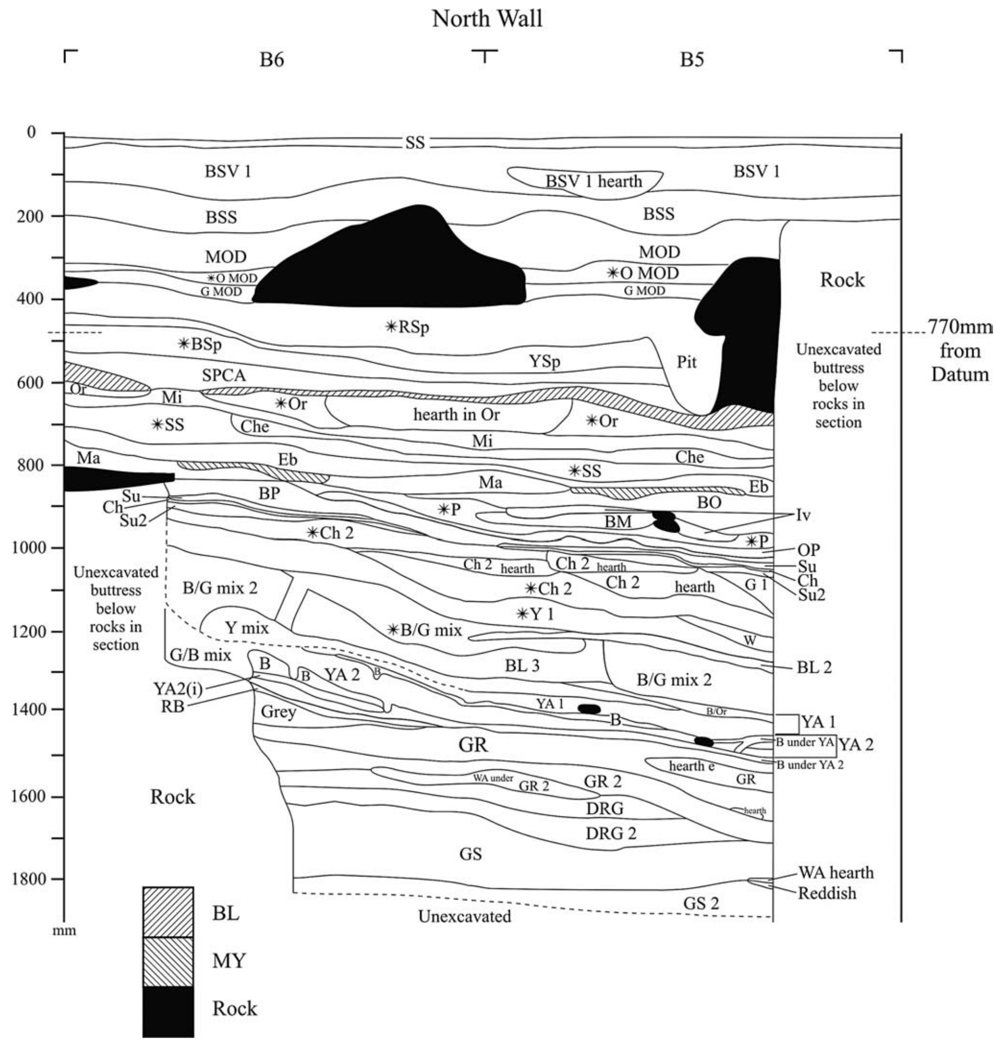

Fig. 3. Sibudu stratigraphic section, North Wall. BSS and BSV are Iron Age layers, directly overlying the MSA sequence. The Howiesons Poort levels excavated in 2003 and 2004 underlie layer YA 2 and include layers GR (Grey Rocky) to GS (Grey Sand). Asterisks indicate layers dated by OSL.

including layer SPCA (Fig. 3). A 2 m^2 trial trench in squares B5 and B6 has reached a depth of approximately 2 m; the total depth of the deposits is unknown.

The uppermost layers of the cave contain Iron Age occupations (BSV and BSS; Fig. 3) and layers immediately below contain MSA occupations. The MSA sequence consists of finely bedded, unconsolidated deposits. The main components are anthropogenic: ashes and charcoal lenses, bone and stone artifacts. Fine sand and sandstone spalls from the shelter walls form the supporting matrix. Howiesons Poort levels have been reached in the test trench in the 2002–2004 excavation seasons. The MSA layers above the Howiesons Poort levels are about 1 m in thickness and have been dated by OSL on quartz grains [119]. The OSL dated layers are indicated in Fig. 3 and their dates are listed in Table 1.

MOD, the top layer of the MSA sequence in Fig. 3, just below the Iron Age layer, has a ^{14}C date of 26,000 ± 420 BP (Pta 3765). This date was obtained on charcoal from the previous 1983 test excavation by Aaron Mazel and should be considered a minimum estimate. New luminescence dates for MOD and for Co, the top layer in the East section, are in progress by Z. Jacobs. Preliminary results indicate an age of 50 kyr for MOD (Jacobs, personal communication).

The stratigraphy of the upper MSA layers in the eastern part of the excavation (squares C2, D2, D3, E2 and E3) is different. Direct stratigraphic correlation with the sequence in the northern section has been made difficult by the Iron Age pits. The top MSA level is Co and below is Bu which has an OSL date of 35.2 ± 1.8 and a ^{14}C date of 42,300 ± 1300 BP (Pta 8017). The dates fit well with the estimated position of the Bu layer which is stratigraphically above MOD. A full report on the stratigraphy, the OSL dates and on previous radiocarbon determinations on charcoal is provided in Wadley [117] and Wadley and Jacobs [119].

Table 1
Chronology of layers at Sibudu

East section	Date	North section	OSL date (in kyr)
Co	–		
Bu	35.2 ± 1.8 kyr (OSL); 42.300 ± 1.300 (^{14}C)		
		MOD	~50 kyr (preliminary results)
		OMOD	51.8 ± 2.1
		RSP	53.4 ± 3.2
		BSP	56.7 ± 2.3
		Or	61.5 ± 2.2
		SS	57.0 ± 2.3
		P	59.6 ± 2.2
		Ch 2	60.8 ± 2.3
		Y1	59.0 ± 1.9
		B/Gmix	58.1 ± 2.5

4. The RSP lithic assemblage

The RSP layer, with an average thickness of 10 cm, is a reddish-brown layer with white ash specks. It was excavated over an area of 16 m^2 and is in fact the most extensive layer at the site. It underlies layer G MOD and is dated to 53.4 ± 3.2 kyr by OSL (Table 1). Near the cave wall a variant of RSP, called RD (Fig. 4) contains little organic material and appears to have been affected by water seepage [117]. RD is not included in this analysis.

4.1. Raw materials (Fig. 4)

Dolerite and hornfels are the two most common raw materials at Sibudu and in layer RSP. Dolerite is a coarse-grained igneous rock. Hornfels is a metamorphic rock which forms from shale or mudstone at the contact with an igneous intrusion, such as a contact with dolerite. Hornfels is very fine-grained and was the preferred raw material for formal tools (70%). Both rocks show three kinds of outer surfaces:

– fresh cortex (which implies that the blank was collected on slopes not too far away from the outcrops)
– alluvial cortex which means that cobbles were collected from a river and
– what we call natural surfaces which are unweathered or slightly weathered surfaces corresponding to fissure planes present in the rock.

This variability in cortex shows that the available blanks were very variable in shape and physical characteristics because they come from different sources. Dolerite sills and dykes are common in the area, dolerite cobbles occur in the banks of the Tongati River. Hornfels outcrops of poor quality occur within 5 km of the site; better quality hornfels occur at about 15 km from the site [117]. Further analysis of raw material sourcing is needed but it seems possible to suggest that raw material was transported over short distances. However, the low frequency of cortical flakes in both raw materials (flakes with 50–100% cortex or natural surface are 9% for dolerite and 5% for hornfels; the total of flakes with any amount of cortex or natural surface, including on the striking platform, is 34.8% for dolerite and 20.0% for hornfels) also suggests that many blanks were transported to the site already in a preformed state.

4.2. Sorting and analytical procedures

To facilitate comparisons with lithic assemblages outside South Africa, we have followed the sorting procedures used in recent years in Western Europe [24,50,77,87,93]. In excavations using modern methods, assemblages are collected following a system that assigns Cartesian coordinates to pieces larger than 2 or 3 cm, making exceptions for smaller identifiable pieces like teeth or microliths, if seen by the excavator. These pieces are bagged with individual labels with a catalogue number, square and level provenience, then marked with ink. The sediment is screened by fine-mesh water screening (generally with superimposed screen of 5 and 1 or 2 mm mesh) and the screen residues are sorted by categories and bagged by square (or by 50 cm quadrants) and excavation levels which are generally 2 cm or up to 5 cm thick but following the layer geometry and boundaries. This means that analysis of lithic assemblages concentrates on pieces larger than 2.5 or 3 cm. Pieces smaller than that size are given particular attention in cases of assemblages rich in microliths, such as Aurignacian assemblages, with Dufour bladelets 1 to 2 cm long [75] or to study tool retouching or resharpening activities at the site. Nevertheless general assemblage composition and frequencies of formal tools are calculated on the assemblage of larger pieces; debitage analysis also concentrates on the larger recognizable flakes while small lithic debris from the screen is classed in large categories.

Excavation procedures at Sibudu followed a routine common in South African archeology, adapted to the very high density of finds in cave or rock shelter sites, i.e. excavation by four separate 50 cm quadrants within a square meter and by layer or by thin levels within the stratigraphic layer, if the latter is thick [107]. All the sediment is sieved through 2 mm mesh; water-screening at Sibudu is not needed because the sediment is not clayey or lumpy and goes through the mesh quickly and completely. Lithic materials of all sizes are bagged by square, quadrant and level. The same procedures are followed for the abundant organic remains (bone, seeds, charcoal).

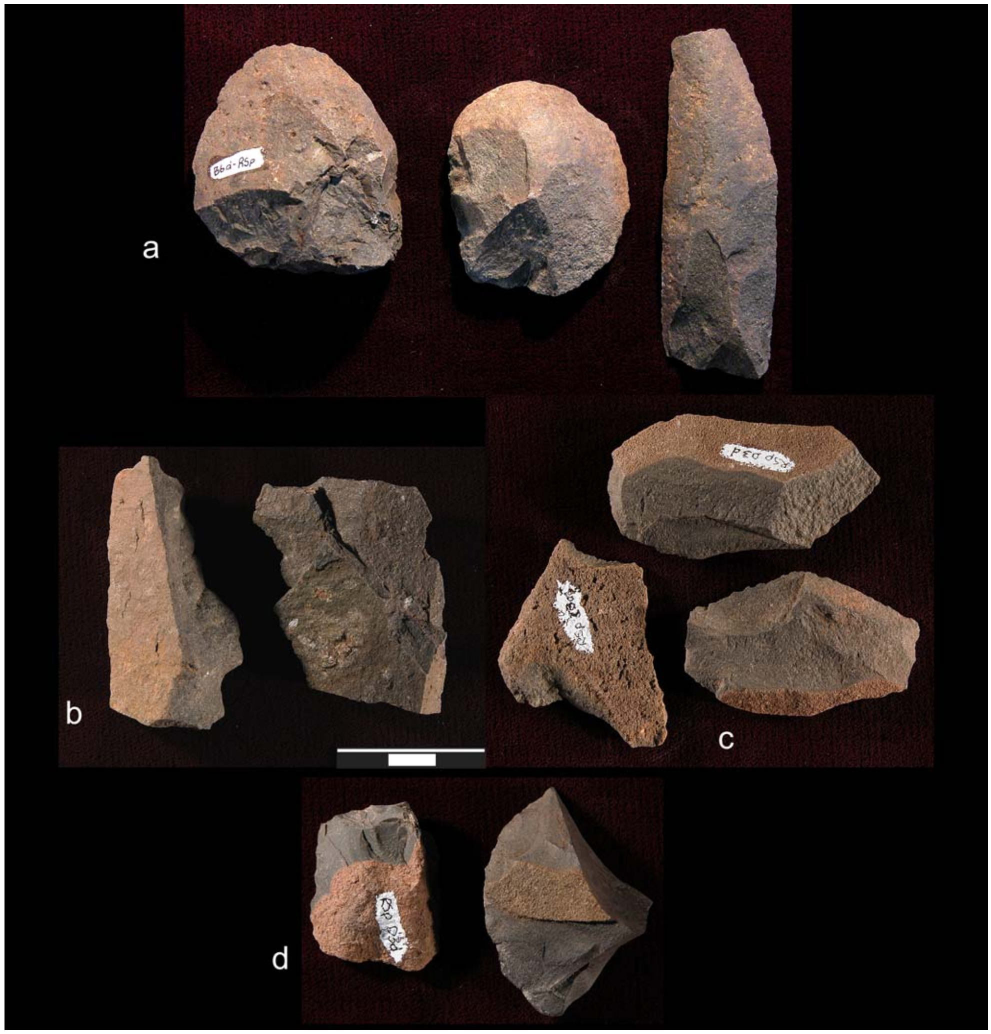

Fig. 4. Layer RSP. (a) Three dolerite flakes with alluvial cortex; (b) two dolerite flakes with natural surface; (c) three dolerite flakes with fresh cortex; (d) two hornfels flakes with fresh cortex.

The RSP layer yielded a very large quantity of lithic materials, an estimated 14,000 pieces. Almost all pieces had been previously marked with layer, square and quadrant provenience greatly facilitating sorting and analysis. A systematic metrical and category analysis of all debitage, including chips smaller than 1 cm, from 1.5 m^2 of layer RSP ($n = 1309$) showed that complete flakes and blades of hornfels are on the average 0.5 cm smaller than their counterparts in dolerite. Hence the cut-off point for sorting debitage flakes was fixed at 2 cm for hornfels and 2.5 cm for dolerite. Chunks and flake fragments (i.e. broken flakes without platform) of any size have also been excluded from the technological data base. All tools and tool fragments, blades and blade fragments of any size are included (Fig. 5 and Table 2).

Quartz is a rare raw material in RSP and 75% of quartz pieces are chunks and flake fragments from quartz pebbles. Quartz occurs in granites about 20 km NW of Sibudu [117] but the occurrence of rolled cortex on some pieces indicates collection from the river banks. Sandstone spalls (from the cave walls) were occasionally flaked but the low quality of the raw material makes a technological analysis not very informative. Quartz and sandstone have not been entered in our database but we have included quartzite which was only occasionally knapped at the site (as indicated by one broken core and a few chunks and small flakes) or transported as a finished artifact. Retouched pieces of any raw material are included.

All artifacts are fresh, unabraded; 9% are burned, occasionally disfigured by thermal scars. In some cases the artifact was retouched after burning.

4.3. Cores (Fig. 6)

Only 23 cores and broken cores are present in the assemblage. They are generally of small size; only 3 are larger than 5 cm. They do not seem to have produced

Fig. 5. All the debitage material from layer RSP laid out in the lab at the University of the Witwatersrand. Foreground: dolerite and hornfels blades and blade fragments of any size; in the background are complete flakes and proximal portions ≥ 2 cm (hornfels) and ≥ 2.5 cm (dolerite). An efficient technological analysis requires that all pieces be taken out of their separate packets, marked with square and level and/or catalogue number and spread out to speed up the process of grouping in discrete categories while also checking for consistency in classification.

a large number of flakes but the fact that several are on flakes, the occurrence of fairly amorphous core fragments and the fact that 13% of the end-products are longer than 5 cm suggest intensive core reduction.

Hornfels is the most common raw material, dolerite is represented by 5 cores and there is one broken specimen in quartzite. Two kinds of cores can be distinguished:

Table 2
Layer RSP: assemblage composition

	N	%
Debitage	1892	83.8
Formal tools	344	15.2
Cores	23	1.0
Total	2259	

Note. Hornfels and dolerite occur in similar proportions in the debitage (46.0 and 50.5%, respectively), but hornfels is the preferred raw material for formal tools (70%). Quartzite forms 3.5% of the formal tools and 3.2% of the debitage.

(1) cores with recurrent unidirectional or bidirectional flaking on a relatively flat surface with simply prepared striking platforms ($n = 6$). Sometime the debitage surface and the striking platform are inverted during debitage. With one exception (Fig. 6 (1)) there are no traces of core surface shaping, prior to removals; the lateral convexities are maintained by the removal of flakes with a cortical back from the core margins. They are abandoned when they are broken or difficult to work due to hinged flake scars; sometimes final efforts are indicated by a series of short and oblique scars. None of these cores can be classed as Levallois, according to the definition provided by Boëda [15] with the single exception of the core in Fig. 6 (1). Flakes so produced have unidirectional or bidirectional scars on the dorsal face, are relatively thin with a majority of plain or reduced (less than half of the flake width) platforms, with thin working edges all around; there are also some *débordant* flakes. These are flakes that have removed a portion of the core edge and thus have a cortical back or a back formed by prior platform preparation removals [13] (Table 3). The term *débordan*t has no exact equivalent in English; it should not be confused with overshot or plunging flake which corresponds to the French *outrepassé*. A plunging flake removes the distal edge of the core while a *débordant* flake removes the lateral edge of a core.
In general, the flake shape is variable, irregular; there are only a handful of triangular flakes that could be called Levallois and a few, occasional pseudo-Levallois points (Fig. 8 (3),(4)).

(2) Bladelet cores ($n = 6$, all of hornfels) of very small size on flake or on a thick angular fragment **(**Fig. 6**).** With one exception (Fig. 6 (7)) bladelets are made on the thickness of the blank from a striking platform prepared by a unique removal or from a fracture surface. The scars have a maximum length of 3 cm and their width is less than 6 mm.

Three cores show evidence of a change in the flaking method from flake to bladelet production toward the end of the core life. In all cases the same platform is used and bladelets are produced from the blank thickness (Fig. 6 (4)). In these cases bladelet manufacture is clearly opportunistic and simply follows core size reduction. The rest of the cores are broken or indeterminate.

4.4. Debitage (Tables 3 and 4)

Seventy percent of all flakes and blades were produced by direct percussion with a hard hammer. The rest are represented by pieces that could not be diagnosed (29.8%). Only two blades were produced by soft hammer. Soft hammer was normally used for

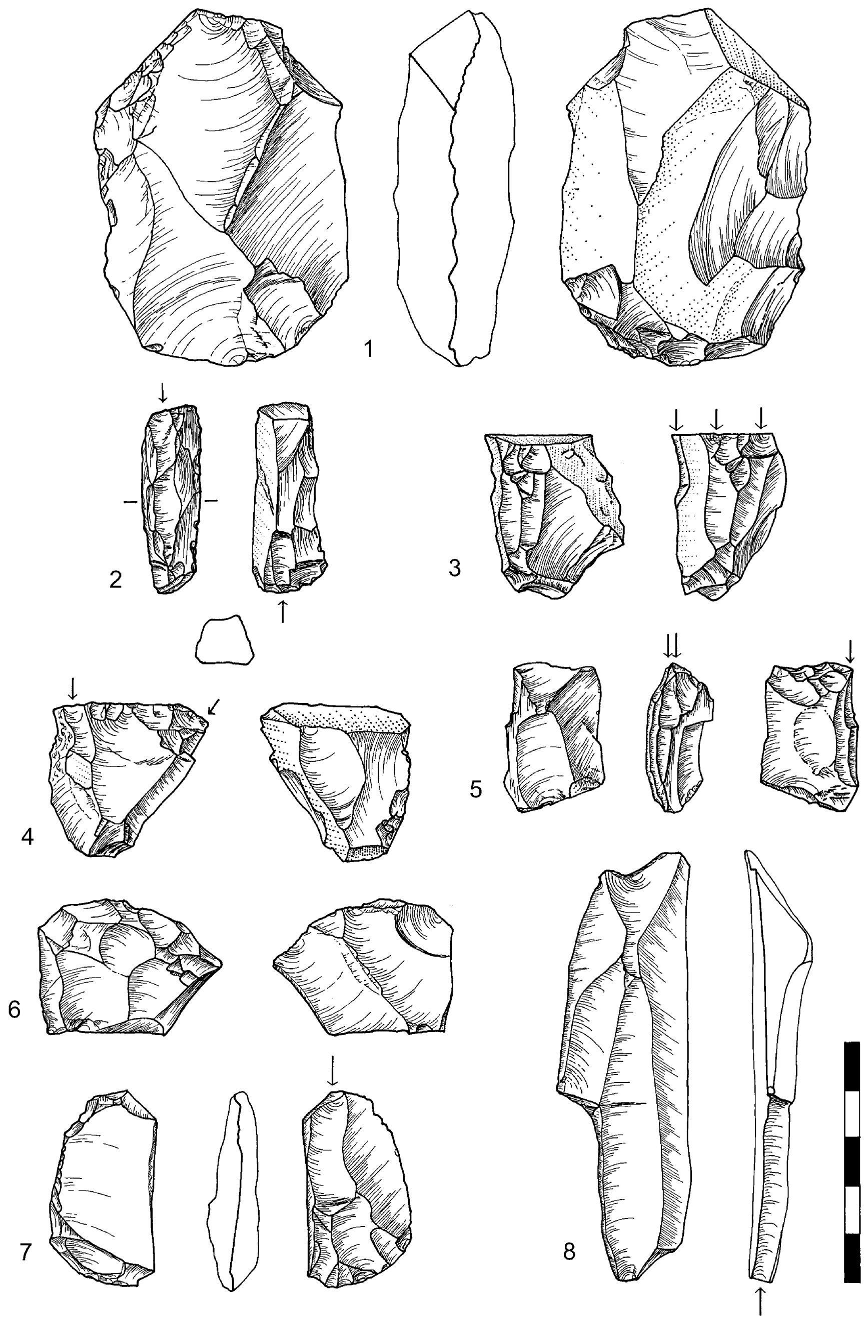

Fig. 6. Layer RSP. (1) Recurrent bidirectional Levallois core; (2)–(5), (7) bladelet cores on flake (2), (5), (7) on angular block (3) and indeterminate blank (4); arrows indicate bladelet scars; natural surfaces are indicated by stippled fading parallel lines. No. 7 f is a truncated-facetted piece. (6) Unipolar flake core with a final bladelet removal on the blank thickness. (8) Casual blade core on a blade (only one removal along the blade side).

making or reworking tools; tool retouch flakes show the characteristic diffuse bulb of percussion with no impact point and an oblique angle between the platform and the axis of percussion (Fig. 7c).

The characteristics of the bulb of percussion, striking platform and ventral face suggest that blades were produced by direct percussion with a hard hammer, with practically no exceptions (Fig. 7a,b). However, the methods for producing blades are difficult to define because of the total lack of cores showing blade removals (with the exception of bladelet cores, see above).

Blades fall into two categories: thin blades whose transverse sections show dorsal scars meeting at a wide (obtuse) angle and thick blades with a steeper (close to right) angle (Fig. 8 (1),(2)). Thus we think that there were two kinds of cores for making blades in layer RSP:

(1) cores with a flat surface producing thin and wide blades, with limited preparation of one or two

Table 3
Frequency distribution of debitage classes

End-products	*N*	By-products	*N*
Flakes with uni- or bidirectional parallel scars on the dorsal face	242	Core trimming and platform preparation flakes	288
Flakes with unidirectional convergent scars	63	Cortical flakes	249
Flakes with multidirectional scars	57	Indeterminate flakes	272
Flakes with indeterminate dorsal scar pattern	71	Flakes from pieces esquillées	48
Débordant flakes	92	Tool retouch flakes (>2 or 2.5 cm)	58
Cortical débordant flakes	31		
Blades and bladelets. This sample includes complete blades and proximal portions (275), and middle and distal portions with measurable width (53)	328	Core trimming blades (crested blades and core margin)	12
Total	884		927
Overall total = 1811			

Note. We have excluded from these counts 3 quartzite fragments and 78 distal and middle blade fragments for consistency since flake fragments (without platform) have not been counted. The inclusion of blade fragments with measurable width is an exception because it allows us to calculate the frequency of bladelets (see Table 4). ‘‘Débordant’’ flakes are defined in Section 4.3. They are included in the end-product category because their dimensions are similar to those of other end-products, although they may also have served the purpose of maintaining the lateral convexities of the core flaking surface [13].

opposing platform. We note that only few blades have individually prepared platforms (individually prepared dihedral or facetted platforms are 15.8% for hornfels blades and 21.6% for dolerite).

(2) and cores for producing thicker blades from the narrow face of a blank, either by exploiting the blank thickness (as observed on the bladelets cores) or by flaking perpendicularly around the core periphery using the rotating or semi-rotating method [40]; the platform was also not prepared or only minimally prepared. Crested blades might occur in the use of this method.

Crested blades are very rare ($n = 6$); they are very simple and partial, prepared on one side only. The proportion of blades in the debitage is rather low: 18.1% of the total debitage greater than 2.5 (dolerite) or 2.0 (hornfels) cm, i.e. 328/1811. Counts of blades here

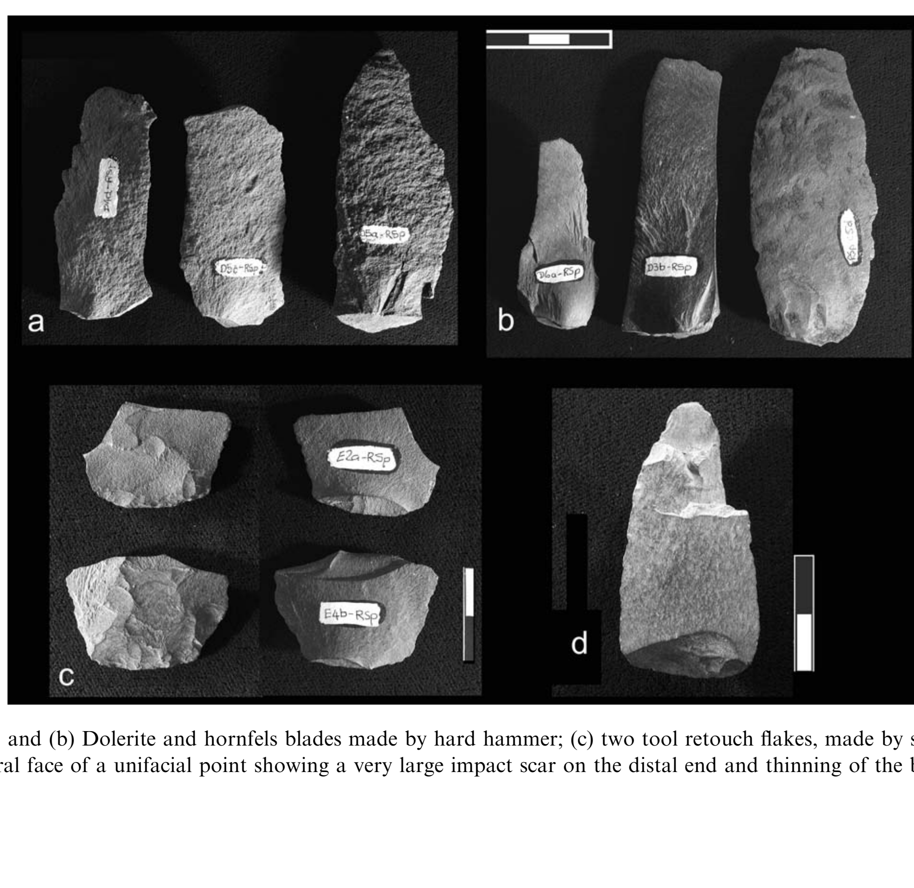

Fig. 7. Layer RSP. (a) and (b) Dolerite and hornfels blades made by hard hammer; (c) two tool retouch flakes, made by soft hammer, dorsal and ventral faces; (d) ventral face of a unifacial point showing a very large impact scar on the distal end and thinning of the base (D2c).

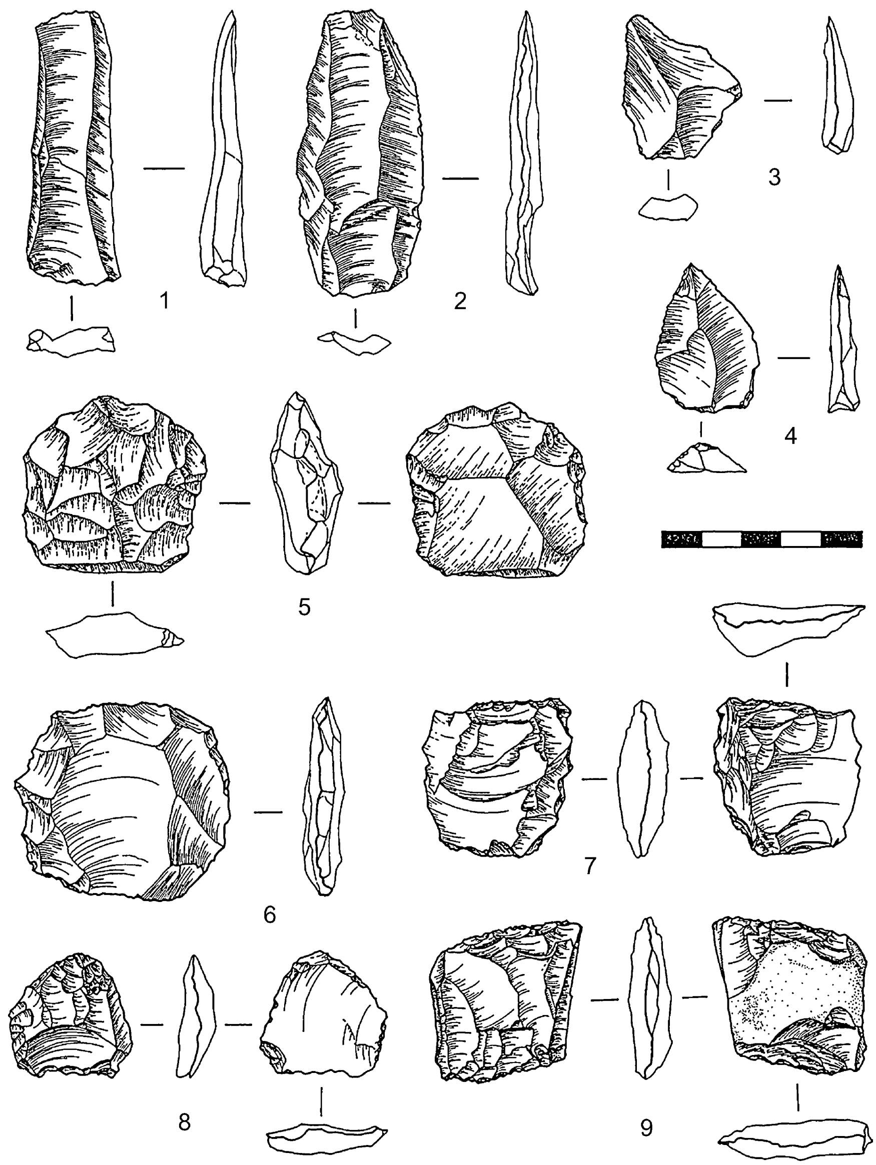

Fig. 8. Stone artifacts from layer RSP and layers above RSP. (1), (2) Two hornfels blades (RSP, D3b and C5d); (3) pseudoLevallois flake, dolerite (RSP D3b); (4) Levallois triangular flake slightly retouched at the tip, hornfels; (5) recurrent Levallois core, dolerite (layer MOD, E4c); (6) preferential Levallois core, hornfels (layer OMOD, E4); (7)–(9) three pièces esquillées, hornfels (Tan Brown lense under layer PB, above RSP; RSP B5b, RSP B5b). Drawings by Wendy Voorvelt.

include complete and proximal portion; middle or distal/middle portions are included only if the width was complete and could be measured for the purpose of defining bladelets (cf. note to Tables 3 and 4). The production of flakes is clearly predominant in this assemblage.

In sum, although blades were one of the desired end-products, their production was not systematic and took place along a size continuum. Methods of production were not clearly linked with the Levallois technology but there is also no clear evidence for the use of continuous volume exploitation around most of the core periphery as is often the case in Upper Paleolithic cores. The technology is not very elaborate but the lack of blade cores does not allow us to be more specific.

Some blades are longer than any of the crested blades and longer than any of the flakes, including cortical flakes. It seems that at least some of the larger blades were not produced at the site. The low proportions of cortical flakes (blanks with 50–100% cortex are 9% for dolerite and 5% for hornfels) also suggests that blanks were often transported to the site already partly flaked or preformed.

Only a small proportion of blades (12.3%) are retouched. Some have limited lateral retouch, others are retouched into scrapers and unifacial points.

Table 4
Frequencies of blades, blade fragments and bladelets by raw material

Raw material	Complete or almost complete	Proximal portion	Middle portion	Distal portion	Split (lateral portion)	Total
Hornfels	93	44	41	30	4	212
Dolerite	66	62	20	30	4	182
Quartzite	1	9	1	1	0	12
Total	160	115	62	61	8	406

Note. Crested blades and other core trimming blades are excluded. Bladelets, defined as having a width ≤8 mm, are 44, i.e. 10.8% of all blades (44/406); 38 are of hornfels, only 6 of dolerite. The definition of bladelets is arbitrary since the width and length of blades have a unimodal distribution. On bladelet cores the maximum width of scars is 6 mm so we have chosen a width of 8 mm which is often the mean width for Aurignacian assemblages [89] and reflects the small size of hornfels blanks. If we select width ≤12 mm as the separation between blades and bladelets, the bladelet frequency would be higher ($n = 120$) but we feel that this would be inappropriate since 12 mm is the average width of all blade products. The use of a width measurement instead of length (a length of 2.5 cm is often taken as a criterion for separating bladelets from blades) allows us to count bladelet fragments whose width (but not length) is complete, thus yielding higher counts.

4.5. Formal tools

4.5.1. Classification

Comparisons of tool and debitage morphologies between South African and European assemblages are made difficult by inconsistent terminologies (Table 5). Other people have noticed this problem [31,112,113]. For instance the term "knife" which occurs in MSA typologies may also be called by other archeologists a single side scraper, a straight side scraper or a flake-blade with lateral retouch [27]. There are also differences with respect to terms used in European and Near Eastern reports. Some of those relating to debitage present no significant problem, others are more difficult. Flake-blades are just blades; radial cores may be Levallois or discoid cores. Adzes would be called scrapers with abrupt retouch by followers of the Bordes' typology [18]; a unifacial point may be the equivalent of several types such as a Mousterian point, a convergent scraper, a *déjeté* scraper (i.e. skewed or canted scraper) [39], a slightly retouched Levallois point, a triangular flake retouched only at the tip or a borer. Sometimes the term scraper is used to mean just end-scraper and side scrapers are called knives. This is not to say that Bordes' typology is better, or that inconsistencies and misdiagnosis are not to be found in European reports. This would be far from the truth. However, these inconsistencies and differences make it difficult to rely on published counts as one may be mixing different morphotypes or technical features.

Because we are interested in interassemblage comparisons, we have adopted an extremely simplified version of Bordes' typology. Our categories do not cross-cut Bordes' types, mostly they just lump them together. For instance, we have eliminated edge shape from the definition of single, double, transverse and convergent scrapers and do not use terms such as atypical. We do not assume that our types have a specific functional meaning and we prefer to concentrate on specific variables (e.g. technical attributes) that can be isolated, recorded, interpreted and replicated by others with relative ease. In a real sense Bordes' types have been demoted to large class categories in that they do not have a major role in determining analytical objectives and are not tightly bound categories. We believe that we are justified in doing so because we are dealing with a large body of data from which we are trying to extract a few patterns. We think that ours is the least costly and easy to replicate approach to sorting and interassemblage comparisons.

Table 5
Formal tools

Formal tools	*N*	%
Pointed forms	113	32.8
Broken tips	25	7.3
Side scrapers	57	16.6
End scrapers	8	2.3
Burins	6	1.7
Denticulates and notches	10	2.9
Pieces esquillées	17	4.9
Broken tools	47	13.7
Informally retouched flakes and blades	55	16.0
Miscellaneous	6	1.7
Total	344	

4.5.2. Proportions of formal tools in the assemblage

Table 2 shows that formal tools are 15% of the assemblage. This is a high value for late MSA industries which are generally said to have very low proportions of retouched pieces [113], e.g. Strathalan, layers SWA and VBP with 0.6 and 1.8% of retouched pieces [85,86] or Die Kelders with less than 3% [107]. However, these values are not really comparable to the RSP values because the Strathalan counts include all pieces of any size, including flaking debris <15 mm, while at Die Kelders the cut-off point was 3 mm. We can calculate frequencies of retouched pieces at Rose Cottage Cave for layer Ru (final MSA dated by ^{14}C on charcoal to about 28,000 BP) using tables provided by Clark [28]. Her tables allow us to count artifacts using a cut-off point at 3 cm but including blades and bladelets of any size, as we have done. Even so retouched artifacts are only 256 on a total of 5008 (excluding cores and core fragments) which still makes no more than 5% (Fig. 9).

Since the relative frequencies of retouched tools are often used as a proxy measure of curation and residential mobility [71,92] we would like to suggest to

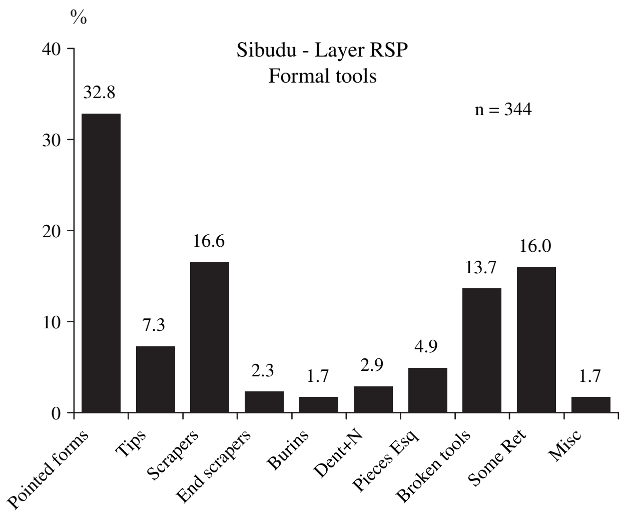

Fig. 9. Diagram with frequency distribution of formal tool classes in layer RSP.

South African archeologists that they adopt in future studies an explicit cut-off point for calculating assemblage composition. The cut-off point need not be the same between assemblages or even within the same assemblage because lithic debris and small debitage size are function of size of raw material blanks, knapping methods and postdepositional damage. In layer RSP the lithic pieces <2 or 2.5 cm include variable quantities of complete retouch flakes (from 5% to more than 30% depending on raw material), flake fragments (flakes without a platform) and small broken flakes (i.e. with a platform but incomplete length). The exclusion of lithic debris of small size from assemblage counts (but not from analysis designed to answer specific questions) has the advantage of smoothing differences in sorting precision and screen size between excavation and greatly accelerating the analysis of flaking methods by sorting out the less informative small flakes and fragments. On the other hand, the high proportions of small lithic pieces at Sibudu (about 85% for hornfels and 70% for dolerite, based on our sample, cf. the section on "Sorting and analytical procedures") clearly indicate intensive reduction and tool curation at the site.

4.5.3. Size of formal tools

In spite of the large proportions of small pieces, this is by no means a microlithic assemblage. The mean length of retouched pieces (to the exclusion of points and pointed shapes) is 40 ± 14.8 mm; the mean length of pointed forms is 42.3 ± 13.1 mm. Similar values are provided by retouched pieces and points from other post-Howiesons Poort layers. In RSP there is only one backed segment ($L = 39$ mm) and bladelets are unretouched.

The term "microlithic" is normally used in two ways: to indicate assemblages characterized by formal tools of very small size [124] or assemblages with a high frequency of geometrics and/or backed bladelets or bladelets with marginal retouch (e.g. the Dufour bladelets). Neither term applies to any of the post-Howiesons Poort assemblages at Sibudu. Note that the cut-off point established for debitage in no way affects this observation since retouched pieces and retouched piece fragments of any size and unretouched bladelets and blade fragments of any size are included in our database.

4.5.4. Pointed forms (Fig. 10)

We have included in this category all unifacial points according to Volman's and Singer and Wymer's definitions [102,112], i.e. all pieces with retouch on one or two sides to form a point. These pieces would be classed as Mousterian points, convergent scrapers or *déjeté* (= skewed or canted) scrapers in Bordes' typology. There is only one broken bifacial point in RSP, and one partly bifacial point (Figs, 11b and 13 (3)). We have included six Levallois triangular flakes that are unretouched. We use the term Levallois triangular flakes rather than Levallois points because there is no systematic production of Levallois points in this industry. None of the retouched pieces show evidence of pressure flaking, as described by experienced flintknappers, e.g. Bradley [21].

Throughout this paper we use the term point to refer to the whole artifact; tip is especially reserved for the sharp pointed end of the piece or when the piece is considered a lithic armature. This distinction, pedantic as it may seem, is needed. Most New World archaeologists use the term tip for the whole artifact because those points were definitely armatures, set at the end of a wooden shaft. Old World archaeologists more often use the term "point" because for Lower and Middle Paleolithic artifacts their diagnosis as armatures is not automatic.

4.5.5. Broken tips

There are a fairly large number of tips, i.e. distal portion of unifacial points, broken transversely (Fig. 10f). Their size varies from 8 to 25 mm. The fractures at their base are bending fractures, either feather termination or snap fractures with a curved or straight profile [47] (Fig. 11). These kinds of macrofractures are not considered diagnostic of projectile point or spear point use; they may indeed result from impact use [84,97,100] but they can also be produced by other modes of tool use or accidental processes, e.g. snap fractures can be the result of trampling. Both snap (also called lateral snap) and feather termination fractures are also quite common failures occurring in manufacturing processes [63]. Since tool making and intensive curation are documented by very high

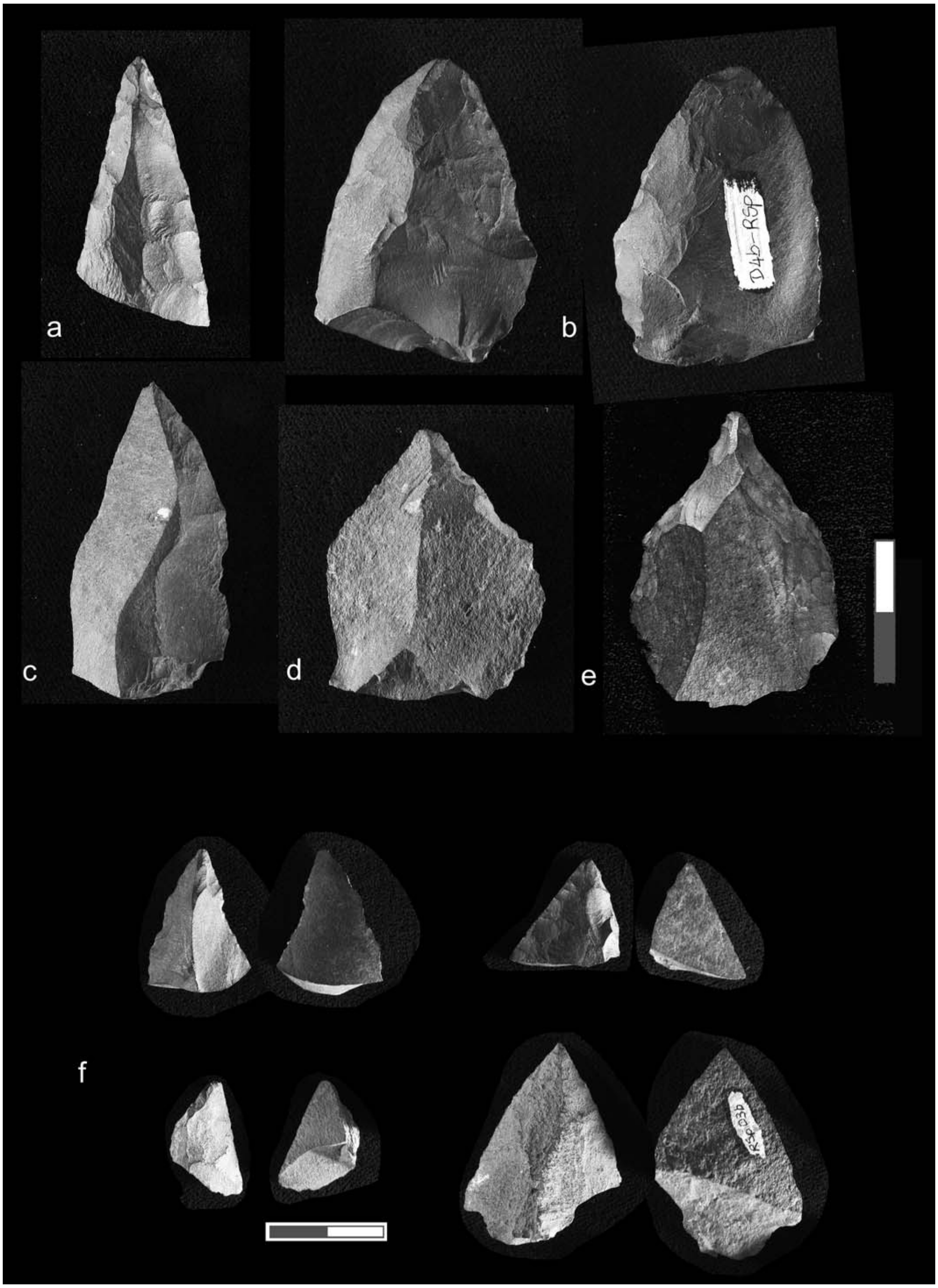

Fig. 10. Layer RSP, unifacial points. (a) Distal portion, with covering retouch, hornfels; (b) partly bifacial point, hornfels; (c), (d) points with retouch only at the tip, hornfels and dolerite; (e) sharp but thick point passing to borer, hornfels; (f) four broken tips, dorsal and ventral faces.

frequencies of small retouch flakes and lithic debris (85% and 70% of all pieces for hornfels and dolerite, cf. above) we tend to view manufacturing or reworking as a possible cause of these macrofractures. A definite diagnosis would have to be based on successful refitting work but evidence of recycling and reworking on other pieces suggests that chances of success are slim.

4.5.6. Use of points

Smaller fractures which are considered diagnostic of impact use on hafted points, such as spin-off, burin-like breaks [10] and step fractures, have been investigated by Marlize Lombard on a sample of 50 points from several layers at Sibudu, including many RSP points. Her work shows that 42% of the examined tools had diagnostic

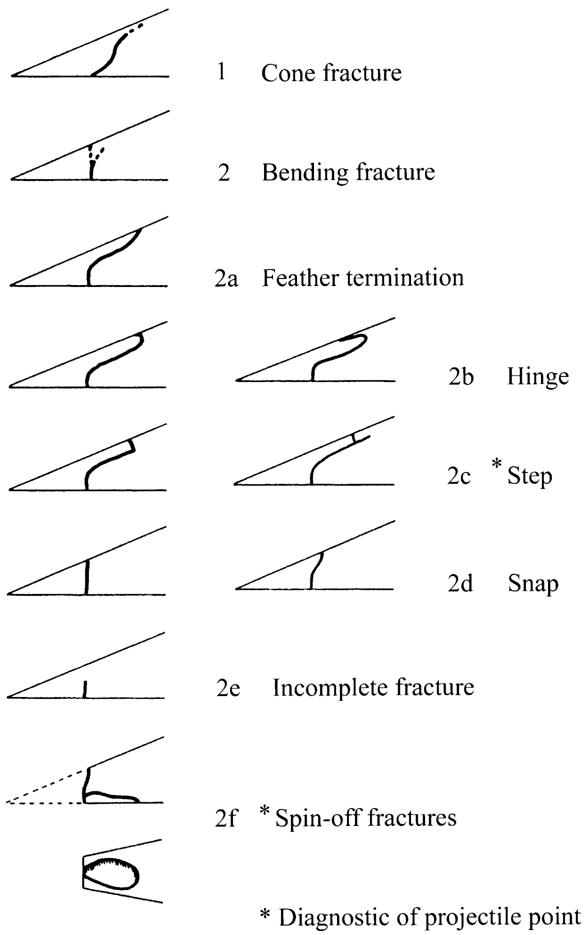

Fig. 11. Classification of macroscopic fractures on lithic points. Modified after Fischer et al. [47].

impact fractures. Evidence for hafting was based on microwear and residue analysis. These combined analyses indicate a high frequency of plant fibers, resin and ochre on the proximal portions of points suggesting that plant twine may have been used together with resin as binding material to secure the tip to the wooden haft while ochre may have been mixed with resin and used as an emulsifier [73,74,120]. It is interesting to note that 25% of all points and pointed shapes in layer RSP have a thinned base (Fig. 7d).

4.5.7. Spear points or arrowheads?

It has been suggested that some Middle Stone Age points may have been arrowheads, rather than having been used to tip thrusting or throwing spears [79]. This is unlikely to be the case for the points in RSP and generally of points in the MSA sequence at Sibudu. We have looked at a number of variables used by different authors who have studied prehistoric weapon technologies, i.e. (a) the maximum width, (b) the penetrating angle, and (c) the cross-sectional area. We have excluded from our sample some trihedral points whose thickness and length make them unlikely as spear tips or projectile points.

(a) The RSP unifacial points have a mean width of 27.2 ± 6.5 mm ($N = 61$). The width of a point is, at least in part, related to the width of the haft; it is interesting to note that Clovis stone points have a similar mean width, 28.7 ± 3.4 ($N = 29$) [98] while a sample of North American stone arrowheads shows a much smaller mean width of 14.5 ± 3.6 ($N = 82$); data from Thompson in Hughes [62]. It is not known if the Clovis points were the tips of hand-held spears or were delivered by spearthrowers; in fact there is no direct evidence of spearthrowers [48,49]. A very large sample of North American triangular arrowpoints ($N = 5827$) which date between 900 and 1700 A.D. have a mean width of 12.6 for notched arrows and 13.5 for unnotched arrows [26]. These values are significantly smaller than the Sibudu sample. A sample of 89 stone-tipped arrows used by Numic groups living in the Great Basin shows that points used on different arrow types (heavy arrows with a short range and light arrows with a longer range, to adapt to hunting of different animals, including humans) also have very narrow widths, varying between 12.7 ± 2.6 and 14.6 ± 2.3. The mean widths of Solutrean shouldered points from French sites is 14 ± 2.36 ($N = 931$) [51]. Compared to the Clovis spears, the Solutrean points and all the North American arrows, the RSP sample has a fairly large standard deviation which suggests lack of standardization or, more likely, the merging of different functional types in the same class. This morphometric variability is evident in Fig. 10.

(b) The penetrating angle (the tip angle seen in plan view, measured in degrees) of the Sibudu points is 68.5 ± 14.4 ($N = 93$), significantly higher (T-test = 25.4; $P < 0.0001$) than that of Solutrean foliate points (54.8 ± 12.5; $N = 92$) which have the widest angle of all other Upper Paleolithic points [90]. We measured the tip angle using the caliper method involving measurement of width at a fixed distance (1 cm) from the tip. The angle is then calculated using a simple trigonometric formula [44].

(c) The tip cross-sectional area (1/2 width $\times$ thickness, expressed in cm^2) is considered by Hughes [62] and Shea [100] the best means to distinguish armatures of different weapon systems, whether arrows, spear-thrower darts, throwing or thrusting spears. Prehistoric (North American) and ethnographic data indicate that the first two weapons have tips with cross-sectional areas of less than 1 cm^2 (0.67 for spearthrower darts and 0.47 for arrowheads). The cross-sectional area of RSP points is 1.3 ± 0.6. This value is very similar to those of Later Levantine Mousterian points from Tor Faraj and Kebara, i.e. 1.13–1.43 [100: Table IX]. These Near Eastern Levallois points are not considered long range projectile points but tips of hand-held or hand-delivered (thrusting or throwing) spears [99] and are dated between 75 and 47 kyr, thus comparable in age to the Sibudu RSP materials. Whether or not projectile technology played a role in the extinction of Neanderthals, it would seem that long-range projectile weaponry (spearthrower darts or arrows) had not yet been adopted by the anatomically modern humans at Sibudu by about 50 kyr.

Layers above RSP have some bifacial points (about one-third of the sample, the majority are unifacial points) including three triangular bifacial points with a concave base, similar to the Streletskian points found in the region of Kostienki (River Don) at Sungir (Central Russia) and in the Urals. The Streletskian points are dated to between 41 and 36 kyr [22,45] comparable in age to the pieces from Sibudu (layer Buff is dated between 35 and 42 kyr; cf. Table 1). The tip cross-sectional area of points from layers above RSP and up to the top of the sequence is 1.1 ± 0.4 ($N = 36$), still in the range of hand-delivered spears.

4.5.8. Other formal tools (Fig. 12)

There are very few end scrapers and they are not particularly well made. Side scrapers and double scrapers occasionally have a thinned base and damage at the distal end, and tend to merge with pointed shapes. There are a few burins ($N = 6$). In the South African MSA burins are sometimes said to be absent or are called technical burins, implying that the analyst is not sure of the diagnosis—but see Sampson [95] and Singer and Wymer [102]. All the RSP burins occur at the distal end of scrapers, on the lateral edge or on the ventral face. One is a dihedral burin (Fig. 12 (7)). It could be argued that the burins are in fact impact fractures due to use of the piece as a point. Burin-like fractures may occur on points thrust into large animals. However one burin has a clear stop notch (= encoche d'arrêt) which precedes the burin blow and was done for the purpose of delimiting the length of the burin spall. This and the dihedral burin are good evidence that the burin blow was deliberate. However the presence of so few specimens suggests that this was not a formalized tool-manufacturing process or that the burin edge was not needed often. Flakes or blades with discontinuous or marginal or irregular retouch, not classifiable as scraper retouch, are classed as pieces with some retouch (Fig. 9).

4.5.9. Pièces esquillées

Pièces esquillées, i.e. scaled pieces (the French term is currently used in Africanist literature [38,83]) are reported as a very common artifact in the South African LSA, even considered one of the criteria used to define and recognize Early LSA assemblages [9]. However, according to Barham [8] and Mitchell [83] the LSA pièces esquillées are just bipolar cores and their high frequencies are seen simply as a reflection of the use of small nodules of locally available but difficult raw materials such as quartz. Some European archeologists hold similar opinions. For instance, in the Gravettian of Portugal, quartz flakes or natural fragments were reduced with the bipolar technique to produce bladelets, as confirmed by experimentation; the method resulted in the production of pièces esquillées [6]. The same authors, however, interpret other "pièces esquillées" as intermediate pieces (i.e. as wedges) and not cores, based on differences in size and raw material.

Synonymous terms such as outils écaillés [80] and core-reduced pieces have been used to describe artifacts that are morphologically similar to pièces esquillées, have bipolar flake removals and again are considered sometimes tools and sometimes cores [8,38]. Outils écaillés, so called and defined by M. Leakey, occur in the Olduvai sequence being especially common in Bed II and Bed IV [64]. There is a rather vast literature on these pieces and we will not attempt to enter the discussion of the use and function of these pieces in all periods and all regions, since a good introduction to the topic is provided by Hayden [56]. We will limit our comments to the morphology and technology of the Sibudu pièces esquillées, without asserting that our interpretation actually applies to other series. True bipolar cores on fine raw materials exist in other post-Howiesons Poort assemblages (Soriano and Villa, unpublished data).

We use the term "pièce esquillée" as defined and illustrated by Demars & Laurent [42], i.e. pieces often of rectangular shape showing thin, chisel-like edges with crushing and splintering at opposite ends ("outil de forme plutôt rectangulaire présentant sur deux extremités ou côtés opposés un esquillement qui affecte les deux faces de la pièce et dont les ondes de choc sont particulièrement bien marquées"). This definition corresponds to the description provided by Hayden [56].

Of the 17 pièces esquillées in layer RSP only one is on dolerite, the other 16 are on hornfels, which is the preferred raw materials for formal tools (Fig. 8 (7)–(9)). Six are made on flakes, one on a blade; for all others the blank could not be determined. Flakes produced from these pieces can be identified because they have a characteristic shattered platform, that is a platform broken at the time of knapping with bulbar scars on the ventral face and splintering on the dorsal face in the impact area and sometimes on the distal end, as confirmed by experimental work [76]. In RSP we have identified 47 flakes >2 cm in length or width, and 1 blade. Pièces esquillées are present, if in low

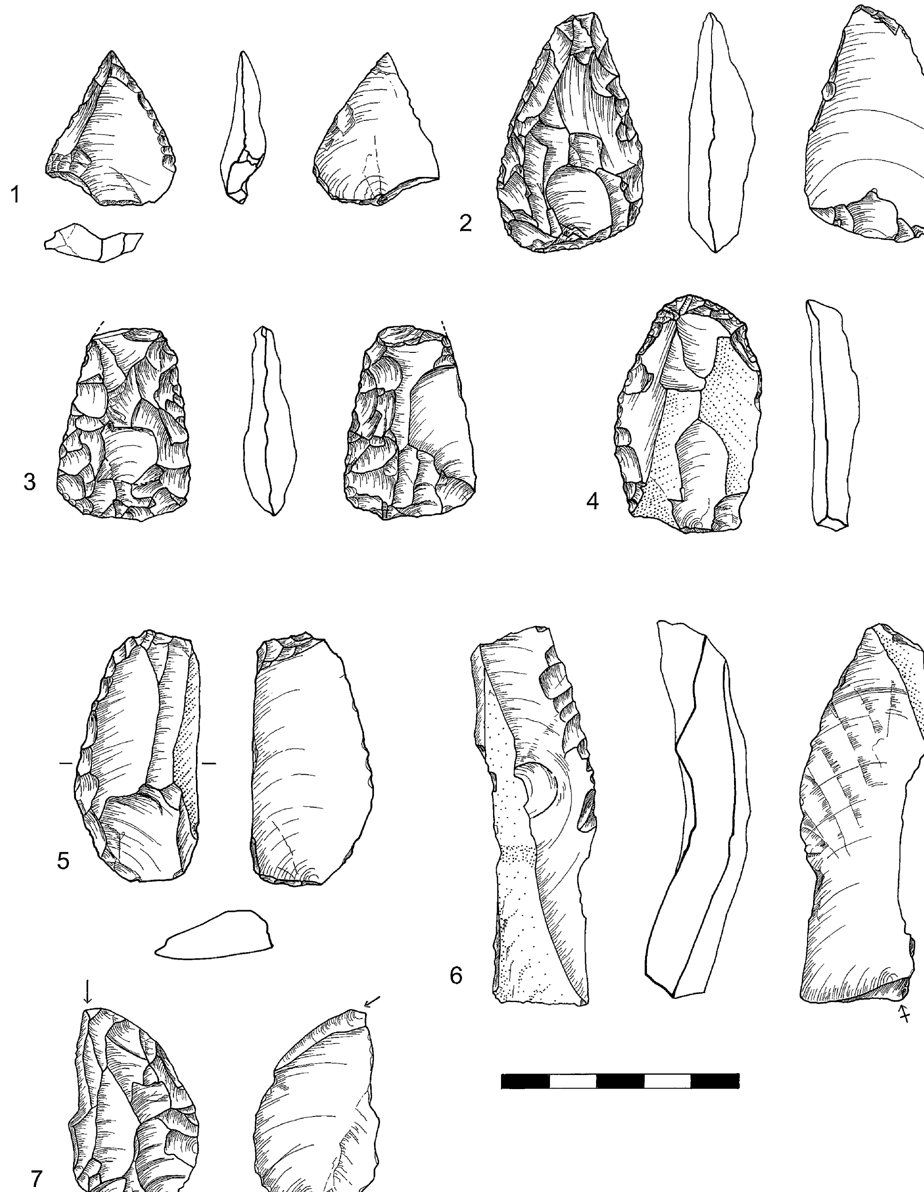

Fig. 12. Formal tools in the RSP layer, all of hornfels. (1) Unifacial point (has traces of ochre in the proximal area), B6d; (2) thick unifacial point passing to convergent scraper, B4d, note the bulbar thinning and the impact scar damage at the tip; (3) bifacial point, broken, E2a; this is the only bifacial point in layer RSP and it may have been recycled, the broken tip is partly retouched; (4) end scraper, E2a; (5) side scraper, E4c; note the thinning of the distale edge; (6) blade struck across the platform of a thick flake and retouched into a side scraper, E4b; (7) dihedral burin, C5d.

proportions, throughout the sequence at Sibudu, starting from the Howiesons Poort levels and up to the top of the sequence.

Whatever the function of these pieces, they were not used for producing blanks for formal tools. We have measured the scar length >2 mm on pièces esquillées with a digital caliper, if the negative bulb of percussion and the scar termination were clearly identifiable. On pièces esquillées the length of scars can sometimes be measured while the width is in most cases incomplete because of scar superposition. The diagram in Fig. 13 shows that flakes produced by pièces esquillées are too small compared to the size of retouched pieces and cannot be considered as desired blanks for formal tools. Pièces esquillées were not bladelet cores either. In RSP only seven bladelets have a platform broken at knapping (which can also result from excessive force in direct percussion). Moreover true bladelet cores flaked by direct percussion are well documented in the assemblage.

Without a direct analysis of LSA "pieces esquillées" or "core-reduced" pieces we cannot say whether the RSP pieces are precursors of the LSA forms. It is interesting that changes in proportions of pièces

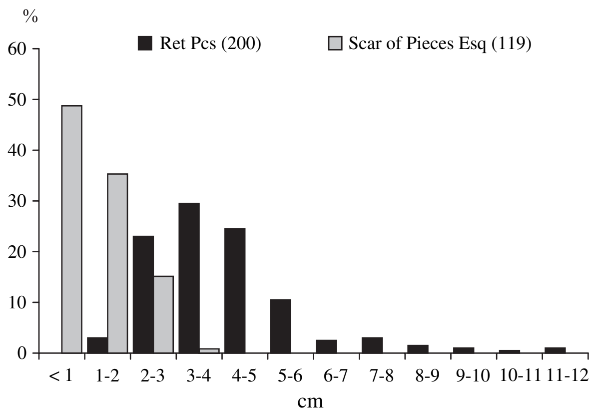

Fig. 13. Length of all formal tools (retouched pieces) and of scars on pièces esquillées from Howiesons Poort and post-Howiesons Poort layers at Sibudu. The mean length of retouched pieces is 40.5±17.5 mm; the mean length of scars is 11.4±6.8 mm.

esquillées in the South African assemblages seem to parallel those observed in Western Europe. Mousterian assemblages occasionally contain pièces esquillées in low frequencies. For instance in the Mousterian levels of Castelcivita (Italy) pièces esquillées are 2.2% of the formal tools; at Chez Pourré-Chez Comte (SW France) their frequency is 1.4% [50,72]. Pièces esquillées are not in the list of tool types used for the Middle Paleolithic, as Bordes considered them pieces shaped by utilization (he called them a posteriori tools), not formally shaped tools, and this may have led to overlooking their occurrence in Middle Paleolithic assemblages. However Bordes himself was quite aware of the occurrence of these pieces in the Upper Paleolithic, including some of the sites he excavated (e.g. Laugerie Haute).

Be that as it may, we note that in transitional industries such as the Châtelperronian at Arcy or the Uluzzian at Castelcivita their frequency is higher. Pièces esquillées are in the list of Upper Paleolithic types and can be quite common in Aurignacian assemblages. For instance pièces esquillées are 21.3% in layer VII at Arcy (382/1795) up from lower proportions in the Châtelperronian levels at the same site, where they vary from 2.6 to 10.8% of the formal tools [32,89]. With the exception of the Uluzzian pieces (their frequency is very high, 48.8%, i.e. 378/775) some of which may be exhausted bipolar cores (see [14]; and contra [32]). French authors tend to view pieces esquillées as chisels for splitting bone or ivory or wood [42,89] although experimental evidence is as yet inconclusive [25,56].

Residue analysis of the Sibudu pièces esquillées is being carried out by Bonny Williamson of the University of the Witwatersrand [121] and her preliminary results show a variety of organic and mineral residues on their edges. We hope that her work will shed some light on the significance and function of these pieces at Sibudu.

5. RSP and the Sibudu sequence in perspective

Several features of the RSP technology and of the Sibudu sequence attract attention and should be discussed in some detail. It has been said that the Middle Stone Age is essentially different from the Middle Paleolithic [79]. We will not enter a discussion about behavioral innovations that concern symbolism, use of personal ornaments, or bone working, since an up-to-date and well-argued account of the evidence from Africa and Eurasia has been recently published [33]. In the context of our research project, we find it more pertinent to see how the Sibudu data fit into expectations about the South African late MSA. We are especially interested in technological advances that have been seen as having a greater time depth in Africa than in Europe and as defining the essential differences of the MSA and the Middle Paleolithic.

5.1. Comparisons

Our comparisons are drawn mostly, though not always, from Western European assemblages for three reasons. The first is that the published documentation of Western European sites is very large and can provide definite answers to the questions we ask. In some cases we have not been able to find equivalent data even in publications of Levantine Mousterian sites. For instance, analyses by Shea [97,98,101] provide excellent discussions of the function, technology and use of Levallois points, and his data can be complemented by work at the site of Umm el Tlel by Bourguignon [19,20] and Boëda et al. [17]. But with few exceptions [19,52] we found difficult to find information on general assemblage composition by layer or frequencies of specific tools with respect to the total of formal tools. Bordes' indices are of limited value to us in this respect, if it is not clear what is the cut-off point for sorting and what is the total on which percentages and indices are calculated since we have to compare them to our procedures. Lack of precise information is a problem that affects also Western European publications but because of their sheer number it is possible to circumvent the problem. Moreover, knowledge of data outside the area of direct experience of the authors (Western Europe and South Africa) is not easily acquired and we are happy to leave some room for additions and corrections to specialists who are familiar with the Levant or other areas of Eurasia.

Of course, humans did not disperse from South Africa directly into Western Europe so that a comparison with the Middle Paleolithic of the Near East or Eastern Europe might seem more appropriate. However our purpose here is not to trace the possible routes of migration of anatomically modern humans out of Africa. We are comparing lithic technologies of two regions, that have been considered as the beginning and the end of the expansion process of modern humans and of the spread of "modern behavior", at a moment in time which corresponds to the beginning of the Middle to Later Stone Age transition. If current ideas about this process are correct we should expect to find differences in the grade and structure of technologies between broadly contemporaneous assemblages of the two regions. This is the purpose of our comparisons.

The last reason is that Middle Paleolithic assemblages and transitional industries in Western Europe (i.e. the Châtelperronian and Uluzzian) were unequivocally produced by Neanderthals, who are deemed behaviorally and anatomically archaic. It is well known that the MSA and the Middle Paleolithic have in common certain technological traditions, such as variants of the Levallois method and retouched artifacts such as scrapers, denticulates and points. These habits may be considered as part of the generalized technological repertoire of stone craftsmen in Africa and Europe, on which specific innovations or specific options were grafted. Although we can reasonably exclude direct interaction between South Africa and Western Europe, still, if new technological behaviors spread as a consequence of population movement out of Africa we should expect to see—after 50–40 kyr—some evidence of commonalities, i.e. persistent configurations in technologies between the two regions that are at least of a degree stronger than the preceding similarities. In other words, we should expect the MSA less similar to the Middle Paleolithic of Western Europe than the LSA should be to the Upper Paleolithic.

The data we have assembled on the Sibudu sequence allow us to consider questions concerning lithic resource procurement, the proportions of stone points which are a defining characteristic of the MSA, the blade and bladelet technology and the significance of time-restricted patterning.

5.2. Lithic resource procurement and use of fine-grained raw materials

Regular long-distance (>50 or 40 km) transport of high-quality stone raw material is considered one of the innovative behaviors that predate the Upper Paleolithic by Mitchell [83] and by McBrearty and Brooks [79] who provide many examples of long-distance transport of non-local rocks in the East African MSA. This is not the case at Sibudu (cf. Section 4.1) and in fact at many other MSA sites in South Africa, such as Die Kelders where all raw materials occur in the vicinity of the site [107], Blombos (Soressi, personal communication), Rose Cottage, Nelson Bay Cave and Klasies [83]. Fine-grained silcrete in the Howiesons Poort levels has been described as an exotic raw material, in contrast to the use of quartzite cobbles from the nearby beach. According to Deacon and Deacon [37] the source of silcrete at Klasies is about 20 or 30 km which hardly qualifies as long-distance transport [46,94]. Selective use of high-quality raw materials for small tools is documented at many sites since the Lower Paleolithic, from Ubeidiya to Terra Amata [110]. Thus the preferential use of fine-grained hornfels for retouched pieces at Sibudu or other MSA sites is not a surprise.

5.3. Time-restricted and regionally based patterning

The analysis of the Howiesons Poort (HP) assemblage at the base of the Sibudu excavated sequence is to be completed in the next few months. However it is already clear that backed segments do not occur in any meaningful frequency in the post-Howiesons layers: there is only one backed segment in layer RSP. Preliminary analysis of the dolerite and hornfels blades from the HP levels suggests that they were produced by soft hammer (see Wurz [123] for a similar observation at Klasies). This stands in strong contrast to the use of hard hammer technique for the production of blades in the post-Howiesons Poort RSP layer, although the raw materials are the same. There seems to be little evidence of continuity between the Howiesons Poort and the later MSA and our data confirm that the HP is not an antecedent to the LSA and did not play a role in the transition, as also suggested by other authors [3,36,108,112]. Backed geometrics are a common type in the South African LSA but they need not represent the same tool as the Howiesons Poort backed segments. The mean length of the Klasies specimens is 3.6 cm, i.e. they are two to three times larger than the Wilton segments that have a mean length 1.2–1.7 cm [113,122] and they may have been used or hafted differently. In contrast to many of the HP specimens, the Wilton segments can truly be called microliths.

The time-restricted patterning and regional stylistic variation exhibited by the Howiesons Poort industry, centered on 66 ± 5 kyr and with a possible time span of about 10 kyr [82] (but see Grün and Beaumont [53] for a longer time span at Border Cave) have been interpreted as evidence of a modern grade of behavior because they suggest the existence of identity-conscious social groups [36] and contrasted with the apparent lack of deliberately imposed form and the homogeneous and invariant nature of Middle Paleolithic tools [79]. However, innovations that have a limited time span and restricted regional distribution are also known among the non-modern Neanderthals. For instance, the Mousterian of Acheulian Tradition of southwestern France, dated to between 65 and 40 kyr, is characterized by: (a) a restricted geographic distribution; (b) a relatively short time duration; (c) internal temporal variation, as it can be differentiated into two successive chronological facies—MTA type A and type B; (d) specific tool forms such as small bifaces (mean length 5–7 cm) which show continuity in methods of shaping and retouch across space and time but clear differences from contemporaneous industries also rich in bifacial pieces, like the Central European Micoquian [104,105]. The Middle Paleolithic blade production system, a specific phenomenon clearly distinct from Upper Paleolithic systems, was also circumscribed in space and time: most sites are located in the western part of the North European plain and span a relatively short time period, Oxygen Isotope Stage 5 [40,41,91].

5.4. Stone points

Evidence for hafting of stone points at Sibudu is provided by a combination of microwear, macrofracture and residue analyses (cf. Section 4.5.6). This is a very innovative approach which should be extended to other industries. However hafting of Middle Paleolithic stone points is no longer a contentious issue.

Evidence for hafting in Middle Paleolithic assemblages as early as OIS 7 and 6 is provided by:

(a) Microwear studies on Levallois points and convergent scrapers from the sites of Corbiac, Biache and Vaufrey [5,11,12];
(b) Distinctive impact scars on the tips of several Mousterian points from la Cotte de St. Brelade, layer 5, dated to OIS 6 [23].
(c) Instances of basal thinning [81];
(d) Two pieces of birch-bark pitch with imprints of a bifacial tool and a wooden haft from Königsaue in Germany [54] from two layers dated to 43,800 and 48.400 years ago.
(e) Bitumen residues on artifacts and a Levallois point embedded in a wild ass cervical vertebra from the site of Umm el Tlel in Syria, dated to about 60 kyr [16,17].

Residue analysis and microwear studies also provide evidence of hafting of points and other stone tools in the Micoquian levels of Starosele (80–40 kyr) and in the Streletskian level of Buran Kaya III (36–32 kyr). The maker of the Streletskian industry is unknown but the maker of the Micoquian at Starosele was most likely a Neanderthal [55].

The high proportions of unifacial points and other retouched pointed forms in layer RSP and all post-Howiesons Poort levels at Sibudu would seem to represent a marked difference from Mousterian assemblages. McBrearty and Brooks [79] contrast the large numbers of African MSA retouched stone points and their regional diversification (from the Aterian to the Stillbay) with the Western European record, where pointed forms are said to be rare and which seem to be dominated by scrapers. In fact, regional diversification in Europe is well documented by the bifacial points of the Central European Micoquian contemporaneous with French Mousterian assemblages with unifacially flaked points.

The impression of low frequency of points in Mousterian assemblages is at least in part due to different ways of counting artifacts. As indicated above, what is called a unifacial point in South Africa [102,112] corresponds to different types of the Bordes' list, i.e. Mousterian points, convergent scrapers, *déjeté* scrapers, Tayac points, and other pieces with limited retouch that might be classed as borers, retouched Levallois points or partly retouched flakes. Depending on the details provided by the analyst, it is sometimes possible to count Mousterian pointed form in the same way as we do at Sibudu. The totals used in percentage calculations exclude unretouched Levallois flakes, pseudo-Levallois points, naturally backed knives and pieces with abrupt and alternate retouch (i.e. natural damage or limited utilization, numbers 46–49 of Bordes' list) and include tool fragments when listed. Pointed forms include Levallois points, whether retouched or unretouched. Table 6 shows that high frequencies of points also occur in Mousterian assemblages, especially Biache, Vaufrey and Castelcivita.

Table 6
Frequencies of pointed forms in Mousterian assemblages

Site	Pointed forms/total tools	%
Pech de l'Azé 1, layer 4 (MTA type A, SW France)	93/2081	4.5
Champlost (Micoquian, Northern France)	64/529	12.1
Combe Grenal, layer 35 (Ferrassie Mousterian, SW France)	90/713	13.0
Chez Pourré-Chez Comte (Ferrassie Mousterian, SW France)	394/2619	15.0
Riencourt-lès-Bapaume, layer CA (Mousterian with blade production, associated with recurrent centripetal Levallois, Northern France)	17/123	13.8
Biache, level II a (Ferrassie Mousterian, Northern France)	71/314	22.6
Castelcivita (Levallois Mousterian, Southern Italy)	137/445	31.0
Vaufrey, layer VIII (typical Mousterian, SW France	26/86	30.2

Note. Data from Soressi [104], Turq [109], Lhomme [72], Ameloot-Van Der Heijden [4], Dibble [43], Gambassini [50], Rigaud [93]. Dates for these sites, when known, are: Pech de l'Azé 1, layer 4: > 50 kyr based on dates for overlying levels; Champlost: OIS 5; Combe Grenal, layer 35: beginning of OIS 4; Riencourt-lès-Bapaume, layer CA: OIS 5c; Biache end OIS 7 - beginning OIS 6; Vaufrey layer VIII: estimated OIS 7; Castelcivita Mousterian about 40 kyr, based on ^{14}C. Procedures for counting points and other tools with convergent edges, as well as procedures for establishing totals of formal tools, are explained in the text.

5.5. Blades and bladelets

Blades are no longer considered a unique invention of modern humans, since blade technologies have been recognized in late Acheulian and early Middle Paleolithic assemblages in Africa and in the Levant and are as old as 300 kyr [7,79]. In Western Europe blade production is documented at several sites in Northern France, Belgium and Germany dated to OIS 5 [29,40,91]. Although we cannot describe in detail the method of blade production at Sibudu due to the absence of blade cores, we can observe several features that are in common with blade production systems documented in Eurasia. These are: the use of direct percussion with a stone hammer, the fact that the cores were only minimally prepared (at Sibudu this is indicated by the scarcity of crested blades and the fact that crested blades are partial and with very few scars) and the association with a dominant flake production system. On the (unverified) assumption that procedures of counting debitage are similar, the Late Mousterian assemblages from the Levant (with a time span between 70 and 48 kyr) have comparable or somewhat higher frequencies of blade production than RSP at Sibudu, where it is 18.1% of the total debitage [61: figure 4]. Toward the end of the Mousterian period in SW France, the Mousterian of Acheulian Tradition type B shows a production of elongated flakes and blades from unipolar cores flaked with the semi-rotating method. At sites such as La Rochette, layer 7, and Pech de l'Azé 1, layers 6 and 7, blades (i.e. with a ratio of length/width ≥ 2) represent more than 20% of all debitage ≥ 3 cm in maximum dimension [104:226]. Several authors support the idea of a link with the succeeding Châtelperronian based on the occurrence in the MTA type B of knives backed by abrupt or semi-abrupt retouch closely resembling Châtelperronian points [34,88]. Specifically in the MTA type B there are more than 50% of elongated pieces with a convex back which include knives with retouched back, naturally backed knives and éclats débordants. The percentage is also calculated on the total of flakes and blades ≥ 3 cm. This emphasis on elongated pieces with a convex back is found only in the MTA type B and in the Châtelperronian [104,105].

Bladelets, however, are extremely rare in Mousterian assemblages. Very few bladelets ($n = 13$; 10 of quartzite and 3 of finer-grained raw material) have been reported by Conard [30] for the Middle Paleolithic assemblage of Tönchesberg in Germany dated to OIS 5. This small assemblage, made mostly on quartz, included a few larger blades ($n = 9$) and some backed pieces, also on fine-grained raw material. However the production of blades or bladelets was not systematic and the small size of the debitage was a clear reflection of the small size of nodules, some of which were transported from 80 to 100 km.

Bladelets and bladelet cores have been reported in significant quantities (13 bladelet cores, 133 complete bladelets and 54 fragments, plus a larger number of blades and 12 blade cores) from the Mousterian site of Champ Grand in SE France. Based on bimodal distribution of blade and bladelet lengths, bladelets are defined as having lengths between 1 and 4 cm and width of less than 1.5 cm. Cores are described as being unipolar, with a semi-rotating method of production and are made on flakes or angular fragments on flint of rather low quality [103]. A few bladelet cores (but no bladelets) have been reported from the late Mousterian levels (levels 10–14) of Gruta da Oliveira in the Almonda karstic system in Portugal. It should be said that the Champ Grand occurrence is not accepted by everybody because the site formation processes are uninvestigated. The Champ Grand assemblage is undated; the Gruta da Oliveira levels with bladelet cores are dated between 40 and 45 kyr as they underlie level 9 which is dated by AMS to 39 kyr [78,125,126,127].

In sum, bladelets in Western Europe are a minimally, or not at all, represented end-product until the Aurignacian. At Sibudu the proportions of bladelets (cf. note to Table 4 for a definition of bladelets) is rather small: in layer RSP there are 6 cores and 44 bladelets, corresponding to 10.8% of all laminar products (44/406) and 5% of all end-products (44/884) or 2.4% of all debitage (44/1811). Still they were deliberately made and cannot be considered the accidental by-products of shaping the core ridges. This appears to be the only difference with Western European lithic assemblages.

6. Conclusion

Our preliminary assessment of the Howiesons Poort levels, contrasting with post-Howiesons Poort technologies, suggests that reconstructions of unilinear and cumulative technological evolution in the South African MSA should be taken with a grain of salt. Evidence from the Sibudu post-Howiesons Poort levels supports the idea of the episodic and discontinuous nature of some of the South African MSA occurrences. Layer RSP indicates that the lithic technology of the late MSA is very similar to that of Middle Paleolithic assemblages and we see no fundamental difference between the two entities, as far as lithic technology is concerned. By 40–35 kyr layers at Sibudu still contain an MSA industry with a similar kind of technology. Comparable data are provided by the post-Howiesons Poort levels of Rose Cottage Cave ([115] and Soriano and Villa, unpublished data) thus showing that the Sibudu results are not strictly local. This runs contrary to expectations that innovations in lithic technologies played a role in the expansion of modern humans out of Africa, at least as far as South Africa is concerned. It remains to be seen if similarities between the late MSA and the Middle Paleolithic are less strong than similarities between the

LSA and the Upper Paleolithic, as implied by the idea that a fundamental rearrangement of human behavior had its beginning in Africa and spread to Europe after 50,000 BP.

Acknowledgements

This research was made possible by grants from the National Science Foundation (BCS 0314371) and the Leakey Foundation to P.V. The Sibudu project directed by Lyn Wadley is funded by the National Research Foundation. The Department of Archaeology at the University of the Witwatersrand provided space and working facilities. We thank the graduate and undergraduate students at the University of the Witwatersrand that have helped us with sorting, the analysis of the Sibudu lithics and computer recording; special thanks are due to Geske Langejans and Tammy Hodgskiss. Bonny Williamson and Marlize Lombard provided advice and information on residue and microscopic analysis of the Sibudu lithics. We are very grateful to Marlize Lombard for attracting our attention to the work of Fischer et al. on points macrofractures; Gail Peterkin very graciously gave us a copy of her thesis and information on her analytical procedures. Grateful thanks also go to Linda Cordell and Douglas Bamforth for information on Clovis weaponry and bibliographical references. Wendy Voorvelt did the drawings and marked the stone artifacts with special care and competence. The comments of Francesco d'Errico and of three anonymous reviewers were insightful and enhanced the quality of the manuscript.

References

[1] S.H. Ambrose, Chronology of the Later Stone Age and food production in East Africa, Journal of Archaeological Science 25 (1998) 377–392.
[2] S.H. Ambrose, Paleolithic technology and human evolution, Science 291 (2001) 1748–1753.
[3] S.H. Ambrose, Small things remembered: origins of early microlithic industries in Sub-Saharan Africa, in: R.G. Elston, S.L. Kuhn (Eds.), Thinking Small: Global Perspectives on Microlithization, Archeological Papers of the American Anthropological Association no. 12, American Anthropological Association, 2002, pp. 9–20.
[4] N. Ameloot-Van Der Heijden, L'industrie laminaire du niveau CA, in: A. Tuffreau (Ed.), Riencourt-lès-Bapaume (Pas-de-Calais), Un Gisement du Paléolithique Moyen, Editions de la Maison des Sciences de l'Homme, Paris, 1993, pp. 26–52.
[5] P. Anderson-Gerfaud, Aspects of behavior in the Middle Paleolithic: functional analysis of stone tools from southwest France, in: P. Mellars (Ed.), The Emergence of Modern Humans: An Archaeological Perspective, Edinburgh University Press, Edinburgh, 1990, pp. 389–418.
[6] Th. Aubry, J. Zilhão, F. Almeida, M. Fontugne, Production d'armatures microlithiques pendant le Paléolithique supérieur et le Mesolithique au Portugal, in: R. de Balbín, P. Bueno (Eds.), Paleolitico y Epipaleolitico, Actas del II Congreso de Arqueologia Peninsular, Tomo I, Fundación Rei Alfonso Henriques, Zamora, 1997, pp. 259–272.
[7] O. Bar-Yosef, S.L. Kuhn, The big deal about blades: laminar technologies and human evolution, American Anthropologist 101 (1999) 322–338.
[8] L. Barham, The bipolar technique in Southern Africa: a replication experiment, South African Archaeological Bulletin 42 (1987) 45–50.
[9] P.B. Beaumont, J.C. Vogel, On a new radiocarbon chronology for Africa south of the equator, African Studies 31 (1972) 65–89, 155–182.
[10] C.A. Bergmann, M. Newcomer, Flint arrowhead breakage: examples from Ksar Akil, Lebanon, Journal of Field Archaeology 10 (1983) 239–243.
[11] S. Beyries, Etude tracéologique des racloirs du niveau IIA, in: A. Tuffreau, J. Sommé (Eds.), Le Gisement Paléolithique Moyen de Biache-Saint-Vaast (Pas-de-Calais), vol. 1, Mém. Soc. Préhist. Française 21, Paris, 1988, pp. 215–230.
[12] S. Beyries, Analyse tracéologique du matériel lithique de la couche VII de la Grotte Vaufrey, in: J.P. Rigaud (Ed.), La Grotte Vaufrey, Mém. Soc. Préhist. Française 19, Paris, 1988, pp. 519–528.
[13] S. Beyries, E. Boëda, Etude technologique et traces d'utilisation des «éclats débordants» de Corbehem (Pas-de-Calais), Bulletin de la Société Préhistorique Française 80 (1983) 275–279.
[14] A. Bietti, A very important Upper Pleistocene site in southern Italy: Grotta di Castelcivita (Salerno, Campania), Review of Archaeology 19 (1998) 11–15.
[15] E. Boëda, Levallois: a volumetric construction, methods, a technique, in: H.L. Dibble, O. Bar-Yosef (Eds.), The Definition and Interpretation of Levallois Technology, Prehistory Press, Madison, 1995, pp. 41–68.
[16] E. Boëda, J. Connan, D. Dessort, S. Muhesen, N. Mercier, H. Valladas, N. Tisnerat, Bitumen as hafting material on Middle Paleolithic artifacts, Nature 380 (1996) 336–338.
[17] E. Boëda, J.M. Geneste, C. Griggo, A Levallois point embedded in the vertebra of a wild ass (*Equus africanus*): hafting, projectiles and Mousterian hunting weapons, Antiquity 73 (1999) 394–402.
[18] F. Bordes, Typologie du Paléolithique Ancien et Moyen, Delmas, Bordeaux, 1961.
[19] L. Bourguignon, Un Mousterien tardif sur le site d'Umm el Tlel (Bassin d'el Kwom, Syrie)? in: E. Carbonell, M. Vaquero (Eds.), The Last Neandertals, The First Anatomically Modern Humans, Grafiques Lluc, Barcelona, 1996, pp. 315–336.
[20] L. Bourguignon, Les industries du Paléolithique intermédiaire d'Umm el Tlel: nouveaux éléments pour le passage entre Paléolithique moyen et supérieur, in: M. Otte (Ed.), Préhistoire d'Anatolie: Genèse de Deux Mondes, ERAUL 85, Liège, 1998, pp. 709–730.
[21] B.A. Bradley, G.C. Frison, Projectile ponts and specialized bifaces from the Horner Site, in: G.C. Frison (Ed.), The Horner Site: The Type Site of the Cody Cultural Complex, Academic Press, New York, 1987, pp. 199–231.
[22] B.A. Bradley, M. Anikovitc, E. Giria, Early Upper Paleolithic in the Russian Plain: Streletskayan flaked stone artefacts and technology, Antiquity 69 (1995) 989–998.
[23] P. Callow, The flint tools, in: P. Callow, J. Cornford (Eds.), La Cotte de St. Brelade, Geo Books, Norwich, UK, 1986, pp. 251–314.
[24] J.P. Chadelle, Le gisement de Champ-Parel à Bergerac (Dordogne, France), observations taphonomiques sur un atelier de taille aurignacien en plein-air, Paléo 1 (2000) 409–421.
[25] M. Christensen, In: Technologie de l'ivoire au Paléolithique supérieur, International Series 751, British Archaeological Reports, Oxford, 1999.

[26] A.L. Christenson, Side-notched and unnotched arrowpoints. Assessing functional differences, in: H. Knecht (Ed.), Projectile Technology, Plenum Press, New York, 1997, pp. 131–142.

[27] A.M.B. Clark, Late Pleistocene technology at Rose Cottage Cave: a search for modern behavior in a Middle Stone Age context, African Archaeological Review 16 (1999) 93–119.

[28] A.M.B. Clark, A technological and behavioral interpretation of the change from the Middle Stone Age to the Later Stone Age in South Africa, Ph.D. dissertation, University of the Witwatersrand, 1999.

[29] N.J. Conard, Laminar lithic assemblages from the Last Interglacial complex in Northwestern Europe, Journal of Anthropological Research 46 (1990) 243–262.

[30] N.J. Conard, Tönchesberg and its position in the Paleolithic prehistory of Northern Europe, Monograph of the Römisch-Germanisches Zentralmuseum, Habelt, Bonn, 1992.

[31] N.J. Conard, M. Soressi, J.E. Parkington, S. Wurz, R. Yates, A unified lithic taxonomy based on patterns of core reduction, South African Archaeological Bulletin 50 (2004) 12–16.

[32] N. Connet, Le Châtelperronien: reflexions sur l'unité et l'identité techno-économique de l'industrie lithique, Ph.D. dissertation, University of Lille 1, France, 2002.

[33] F. d'Errico, The invisible frontier. A multiple species model for the origin of behavioral modernity, Evolutionary Anthropology 12 (2003) 188–202.

[34] F. d'Errico, J. Zilhão, M. Julien, D. Baffier, J. Pelegrin, Neanderthal acculturation in Western Europe? Current Anthropology 39 (Suppl.) (1998) S1–S44.

[35] H.J. Deacon, Two Late Pleistocene-Holocene archaeological depositories from the southern Cape, South Africa, South African Archaeological Bulletin 50 (1995) 121–131.

[36] H.J. Deacon, Modern human emergence: an African archaeological perspective, in: P.V. Tobias, M.A. Raath, J. Moggi-Cecchi, G.A. Doyle (Eds.), Humanity from African Naissance to Coming Millennia, Colloquia in Human Biology and Paleoanthropology, Florence University Press, Florence, 2001, pp. 217–226.

[37] H.J. Deacon, J. Deacon, Human Beginnings in South Africa, David Philip, Cape Town, 1999.

[38] J. Deacon, The Later Stone Age in the southern Cape, South Africa, Ph.D. thesis, University of Cape Town, 1982.

[39] A. Debénath, H.L. Dibble, Lower and Middle Paleolithic of Europe, Handbook of Paleolithic Typology, vol. 1, University of Pennsylvania Museum, Philadelphia, 1994.

[40] A. Delagnes, Blade production during the Middle Paleolithic in Northwestern Europe, in: W. Dong (Ed.), Proceedings of the 1999 Beijing International Symposium on Paleoanthropology, Acta Anthropologica Sinica 10 (Suppl.) (2000) 181–188.

[41] A. Delagnes, L. Meignen, Diversity of lithic production systems during the Middle Paleolithic in France: are there chronological trends? in: E. Hovers, S. Kuhn (Eds.), Transitions Before the Transitions, Plenum/Kluwer Press, New York, in press.

[42] P.Y. Demars, P. Laurent, Types d'Outils Lithiques du Paléolithique Supérieur en Europe, Editions du CNRS, Paris, 1989.

[43] H.L. Dibble, Biache-Saint-Vaast, Level IIa: a comparison of approaches, in: H.L. Dibble, O. Bar-Yosef (Eds.), The Definition and Interpretation of Levallois Technology, Prehistory Press, Madison, 1995, pp. 93–116.

[44] H.L. Dibble, M.C. Bernard, A comparative study of basic edge angle measurement techniques, American Antiquity 45 (1980) 857–865.

[45] P. Dolukhanov, D. Sokoloff, A. Shukurov, Radiocarbon chronology of Upper Palaeolithic sites in Eastern Europe at improved resolution, Journal of Archaeological Science 28 (2001) 699–712.

[46] J. Féblot-Augustin, Raw material transport patterns and settlement systems in the European Lower and Middle Palaeolithic: continuity, change and variability, in: W. Roebroeks, C. Gamble (Eds.), The Middle Palaeolithic Occupation of Europe, University of Leiden, Leiden, 1999, pp. 193–214.

[47] A. Fischer, P. Vemming Hansen, P. Rasmussen, Macro and micro wear traces on lithic projectile points. Experimental results and prehistoric examples, Journal of Danish Archaeology 3 (1984) 19–46.

[48] G.C. Frison, Experimental use of Clovis weaponry and tools on African elephants, American Antiquity 54 (1989) 766–784.

[49] G.C. Frison, North American high plains Paleo-Indian hunting strategies and weaponry assemblages, in: O. Soffer, N.D. Praslov (Eds.), Kostenki to Clovis: Upper Paleolithic-Paleo-Indian Adaptations, Plenum Press, New York, 1993, pp. 237–249.

[50] P. Gambassini, Il Paleolitico di Castelcivita, Culture e Ambiente, Electa Napoli, Naples, 1997.

[51] J.M. Geneste, H. Plisson, Technologie fonctionnelle des pointes à cran solutréennes: l'apport des nouvelles données de la Grotte de Combe Saunière (Dordogne), in: K. Kozlowski (Ed.), Feuilles de Pierre. Les Industries à Pointes Foliacées du Paléolithique Supérieur Européen, ERAUL 42, Université de Liège, Liège, 1989, pp. 293–320.

[52] N. Goren-Inbar, Quneitra: a Mousterian Site on the Golan Heights, Institute of Archaeology, Hebrew University, Jerusalem, 1990.

[53] R. Grün, P. Beaumont, Border cave revisited: a revised ESR chronology, Journal of Human Evolution 40 (2001) 467–482.

[54] J.M. Grünberg, Middle Paleolithic birch-bark pitch, Antiquity 76 (2002) 15–16.

[55] B.L. Hardy, M. Kaye, A.E. Marks, K. Monigal, Stone tool function at the paleolithic sites of Starosele and Buran Kaya III, Crimea: behavioral implications, Proceedings of the National Academy of Sciences USA 98 (2001) 10972–10977.

[56] B. Hayden, Confusion in the bipolar world: bashed pebbles and splintered pieces, Lithic Technology 9 (1980) 2–7.

[57] C.S. Henshilwood, F. d'Errico, C.W. Marean, R.G. Milo, R. Yates, An early bone tool industry from the Middle Stone Age at Blombos Cave, South Africa: implications for the origins of modern human behavior, symbolism and language, Journal of Human Evolution 41 (2002) 631–678.

[58] C.S. Henshilwood, F. d'Errico, R. Yates, Z. Jacobs, C. Tribolo, G.A.T. Duller, N. Mercier, J.C. Sealy, H. Valladas, I. Watts, A.G. Wintle, Emergence of modern human behavior: Middle Stone Age engravings from South Africa, Science 295 (2002) 1278–1289.

[59] C.S. Henshilwood, C.W. Marean, The origin of modern human behavior, Current Anthropology 22 (2003) 627–651.

[60] C.S. Henshilwood, F. d'Errico, M. Vanhaeren, K. van Niekerk, Z. Jacobs, Middle Stone Age shell beads from South Africa, Science 304 (2004) 404.

[61] E. Hovers, The lithic assemblages of Amud Cave, in: T. Akyrzawa, K. Aochi, O. Bar-Yosef (Eds.), Neandertals and Modern Humans in Western Asia, Plenum Press, New York and London, 1998, pp. 143–162.

[62] S.S. Hughes, Getting to the point: evolutionary change in prehistoric weaponry, Journal of Archaeological Method and Theory 5 (1998) 345–408.

[63] J.K. Johnson, Archaic biface manufacture: production failures, a chronicle of the misbegotten, Lithic Technology 8 (1979) 25–35.

[64] P.R. Jones, Results of experimental work in relation to stone industries of Olduvai Gorge, in: M.D. Leakey, D. Roe (Eds.), Excavations in Beds III, IV and the Masek Beds, 1968–1971, Olduvai Gorge, vol. 5, Cambridge University Press, Cambridge, 1994, pp. 254–298.

[65] R.G. Klein, Southern Africa before the Iron Age, in: R.S. Corruccini, R.L. Ciochon (Eds.), Integrative Paths to the

Past: Palaeoanthropological Advances in Honor of F. Clark Howell, Prentice Hall, Englewood Cliffs, NJ, 1994, pp. 471–519.
[66] R.G. Klein, Anatomy, behavior and modern human origins, Journal of World Prehistory 9 (1995) 167–198.
[67] R.G. Klein, Why anatomically modern people did not disperse from Africa 100 000 years ago, in: T. Akazawa, K. Aoki, O. Bar-Yosef, (Eds.), Neandertals and Modern Humans in Western Asia, Plenum Press, New York, 1998, pp. 509–521.
[68] R.G. Klein, Archaeology and the evolution of human behavior, Evolutionary Anthropology 9 (2000) 17–36.
[69] R.G. Klein, Fully modern humans, in: G.M. Feinmann, T.D. Price (Eds.), Archaeology at the Millennium, Plenum Press, New York, 2001, pp. 109–134.
[70] R.G. Klein, Southern Africa and modern human origins, Journal of Anthropological Research 57 (2001) 1–16.
[71] S.L. Kuhn, Mousterian Lithic Technology: An Ecological Perspective, Princeton University Press, Princeton, NJ, 1995.
[72] V. Lhomme, Industries lithiques du Paléolithique moyen à nombreuses fractures. Les exemples du secteur sud de Champlost (Yonne) et de la couche inférieure de «Chez Pourré-Chez Comte» (Corrèze), Ph.D. dissertation, University of Lille 1, France, 2000.
[73] M. Lombard, Closer to the point: macro-fracture, micro-wear and residues analyses of Middle Stone Age lithic points from Sibudu Cave, KwaZulu-Natal, South Africa, M.Sc. dissertation, University of the Witwatersrand, 2003.
[74] M. Lombard, Evidence of hunting and hafting during the Middle Stone Age at Sibudu Cave, KwaZulu-Natal: a multi-analytical approach, Journal of Human Evolution, in press.
[75] G. Lucas, Les lamelles Dufour du Flageolet 1 (Bézenac, Dordogne) dans le contexte aurignacien, Paléo 9 (1997) 191–220.
[76] G. Lucas, Les industries lithiques du Flageolet 1 (Dordogne): approche économique, technologique, fonctionnelle et analyse spatiale, Ph.D. dissertation, University of Bordeaux 1, 2000.
[77] H. de Lumley, Une cabane acheuléenne dans la grotte du Lazaret, Mém. Soc. Préhist. Française 7, Paris, 1969.
[78] A. Marks, K. Monigal, J. Zilhão, The lithic assemblages of the Late Mousterian at Gruta da Oliveira, Almonda, Portugal, in: J. Zilhão, Th. Aubry, A.F. Carvalho (Eds.), Les Premiers Hommes Modernes de la Penninsule Iberique, Actes du Colloque de la Commission VIII de l'UISPP, Trabalhos de Arqueologia 17, Instituto Portugués de Arquelogia, Lisboa, 2001, pp. 145–154.
[79] S. McBrearty, A. Brooks, The revolution that wasn't: a new interpretation of the origin of modern human behavior, Journal of Human Evolution 39 (2000) 453–563.
[80] R.J. Mason, Prehistory of the Transvaal, Witwatersrand University Press, Johannesburg, 1962.
[81] P. Mellars, The Neanderthal Legacy, Princeton University Press, Princeton, NJ, 1996.
[82] G.H. Miller, P.B. Beaumont, H.J. Deacon, A. Brooks, P.E. Hare, A.J.T. Jull, Earliest modern humans in southern Africa dated by isoleucine epimerization in ostrich eggshell, Quaternary Science Reviews 18 (1999) 1537–1548.
[83] P.J. Mitchell, The Archaeology of Southern Africa, Cambridge University Press, Cambridge, 2003.
[84] G.H. Odell, F. Cowan, Experiments with spears and arrows on animal targets, Journal of Field Archaeology 13 (1986) 195–212.
[85] H. Opperman, Strathalan Cave B, North-Eastern Cape Province, South Africa: evidence for human behaviour 29,000–26,000 years ago, Quaternary International 33 (1996) 45–53.
[86] H. Opperman, B. Heydenrych, A 22,000 year-old Middle Stone Age camp site with plant food remains from the North-Eastern Cape, South African Archaeological Bulletin 45 (1990) 93–99.
[87] M. Otte, L.G. Straus, Le Trou Magritte: fouilles 1991–1992, Eraul 69, Liège, 1995.
[88] J. Pelegrin, Technologie lithique: le Châtelperronien de Roc-de-Combe (Lot) et de La Côte (Dordogne), Cahiers du Quaternaire 20, Editions CNRS, Paris, 1995.
[89] M. Perpère, B. Schmider, L'industrie lithique taillée, in: B. Schmider (Ed.), L'Aurignacien de la Grotte du Renne. Les Fouilles de Leroi-Gourhan à Arcy-sur-Cure, Editions du CNRS, Paris, 2002, pp. 107–196.
[90] G.L. Peterkin, Upper Palaeolithic hunting technology and prey selection in Southwest France, Ph.D. dissertation, Tulane University, 1997, UMI Microform 9732439.
[91] S. Révillion, Les industries laminaires du Paléolithique moyen en Europe septentrionale, L'exemple des gisements de Saint-Germain-de-Vaux/Port Racine (Manche), de Seclin (Nord) et de Riencourt-lès-Bapaumes (Pas-de-Calais), Publications du Centre d'Etudes et de Recherches Préhistoriques, Université des Sciences et Technologie de Lille, no. 5, Lille, 1994.
[92] J. Riel-Salvatore, C.M. Barton, Late Pleistocene technology, economic behavior and land-use dynamics in Southern Italy, American Antiquity 69 (2004) 257–274.
[93] J.P. Rigaud (Ed.), La Grotte Vaufrey, Mém. Soc. Préhist. Française 19, Paris, 1988.
[94] W. Roebroeks, J. Kolen, E. Rensink, Planning depth, anticipation and the organization of Middle Palaeolithic Technology: the "Archaic Natives" meet Eve's descendants, Helinium 28 (1988) 17–34.
[95] C.G. Sampson, The Stone Age Archaeology of Southern Africa, Academic Press, New York and London, 1974.
[96] D. Schmitt, S.E. Churchill, W.L. Hylander, Experimental evidence concerning spear use in Neandertals and early modern humans, Journal of Archaeological Science 30 (2003) 103–114.
[97] J.J. Shea, Lithic use-wear evidence for hunting by Neandertals and early modern humans from the Levantine Mousterian, in: G.L. Peterkin, H.M. Bricker, P. Mellars (Eds.), Hunting and Animal Exploitation in the Later Palaeolithic and Mesolithic of Eurasia, Archaeological Papers of the American Anthropological Association 4, American Anthropological Association, 1993, pp. 189–198.
[98] J.J. Shea, Middle Palaeolithic spear point technology, in: H. Knecht (Ed.), Projectile Technology, Plenum Press, New York, 1997, pp. 79–106.
[99] J.J. Shea, Neandertal and early modern human behavioral variability, Current Anthropology 39 (Suppl.) (1998) S45–S78.
[100] J.J. Shea, The Middle Paleolithic of the East Mediterranean Levant, Journal of World Prehistory 17 (2003) 313–394.
[101] J.J. Shea, K.S. Brown, Z.J. Davis, Controlled experiments with Middle Paleolithic spear points: Levallois points, in: J.R. Mathieu (Ed.), Experimental Archaeology: Replicating Past Objects, Behaviors and Processes, BAR International Series 1035, Archeopress, Oxford, 2002, pp. 55–72.
[102] R. Singer, J. Wymer, The Middle Stone Age at Klasies River Mouth in South Africa, University of Chicago Press, Chicago and London, 1982.
[103] L. Slimak, Mise en évidence d'une composante laminaire et lamellaire dans un complexe moustérien du Sud de la France, Paléo 11 (1999) 89–110.
[104] M. Soressi, Le Moustérien de tradition acheulénne du sud-ouest de la France, Ph. D. dissertation, University of Bordeaux 1, 2002.
[105] M. Soressi, Late Mousterian lithic technology. Its implications for the pace of emergence of behavioural modernity and the relationship between behavioural modernity and biological modernity, in: F. d'Errico, L. Backwell (Eds.), From Tools to Symbols, University of the Witwatersrand Press, Johannesburg, in press.
[106] A. Thackeray, The Middle Stone Age south of the Limpopo River, Journal of World Prehistory 6 (1992) 385–440.
[107] A. Thackeray, Middle Stone Age artefacts from the 1993 and 1995 excavations of Die Kelders Cave 1, South Africa, Journal of Human Evolution 38 (2000) 147–168.

[108] C. Tryon, S. McBrearty, Tephrostratigraphy and the Acheulian to Middle Stone Age transition in the Kapthurin Formation, Kenya, Journal of Human Evolution 42 (2002) 211–235.
[109] A. Turq, Paléolithique inférieur et moyen entre Dordogne et Lot. Paléo, supplément n.2, Editions S.A.M.R.A., 2000.
[110] P. Villa, Terra Amata and the Middle Pleistocene Archaeological Record of Southern France, University of California Press, Berkeley and Los Angeles, 1983.
[111] J.C. Vogel, Radiometric dates for the Middle Stone Age in South Africa, in: P.V. Tobias, M.A. Raath, J. Moggi-Cecchi, G.A. Doyle (Eds.), Humanity from African Naissance to Coming Millennia – Colloquia in Human Biology and Palaeoanthropology, Florence University Press, Florence, 2001, pp. 261–268.
[112] T. Volman, The Middle Stone Age in the Southern Cape, Ph.D. dissertation, University of Chicago, 1981.
[113] T. Volman, Early prehistory of Southern Africa, in: R.G. Klein (Ed.), Southern African Prehistory and Paleoenvironmnents, Balkema, Rotterdam, 1984, pp. 169–220.
[114] L. Wadley, The Pleistocene Later Stone Age south of the Limpopo River, Journal of World Prehistory 7 (1993) 243–296.
[115] L. Wadley, Rose Cottage Cave: Archaeological work 1987 to 1997, South African Journal of Science 93 (1997) 439–444.
[116] L. Wadley, What is cultural modernity? A general view and a South African perspective from Rose Cottage Cave, Cambridge Archaeological Journal 11 (2001) 201–221.
[117] L. Wadley, Preliminary report on excavations at Sibudu Cave, KwaZulu-Natal, Natal Museum Journal of Humanities 13 (2001) 1–17.
[118] L. Wadley, How some archaeologists recognize culturally modern behaviour, South African Journal of Science 99 (2003) 247–250.
[119] L. Wadley, Z. Jacobs, Sibudu Cave, KwaZulu-Natal: background to the excavations of Middle Stone Age and Iron Age occupations, South African Journal of Science 100 (2004) 145–151.
[120] L. Wadley, B.S. Williamson, M. Lombard, Ochre in hafting in Middle Stone Age southern Africa: a practical role, Antiquity 78 (2004) 661–675.
[121] B.S. Williamson, P. Villa, L. Wadley, Residue and technological analysis of MSA scaled pieces: bipolar cores or woodworking tools? Paper presented to the 69th Annual Meeting of the Society for American Archaeology, Abstracts, (2004) 371.
[122] S. Wurz, The Howiesons Poort at Klasies River: from artefacts to cognition. M.A. thesis, University of Stellenbosch, 1997.
[123] S. Wurz, Variability in the MSA lithic sequence 115,000–60,000 years ago at Klasies River, South Africa, Journal of Archaeological Science 29 (2002) 1001–1015.
[124] Y. Zaidner, A. Ronen, J.M. Burdukievicz, L'industrie microlithique du Paléolithique inférieur de Bizat Ruhama, Israël, L'Anthropologie 107 (2003) 203–222.
[125] J. Zilhão, The Ebro frontier: a model for the late extinction of Iberian Neanderthals, in: C. Stringer, R.N.E. Barton, C. Finlayson, (Eds.), Neanderthals on the Edge: 150th Anniversary Conference of the Forbes' Quarry Discovery, Gibraltar, Oxbow Books, Oxford, 2000, pp. 111–121.
[126] J. Zilhão, The Lagar Velho child and the Middle to Upper Paleolithic transition in Iberia, paper presented at the Gibraltar Conference, in press.
[127] The chronology of the Aurignacian and of the transitional technocomplexes. Where do we stand? in: J. Zilhão, F. D'Errico (Eds.), The Chronology of the Aurignacian and of the Transitional Technocomplexes. Dating, Stratgraphies, Cultural Implications, Instituto Portugués de Arqueología, Lisbon, 2003, pp. 313–350.