Field and Technical Report

HOWIESONS POORT SEGMENTS AS HUNTING WEAPONS: EXPERIMENTS WITH REPLICATED PROJECTILES

JUSTIN PARGETER

School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, WITS, 2050, South Africa
E-mail: pargi1@yahoo.com

(Received December 2006. Revised February 2007)

INTRODUCTION

Ideas about the possible uses of Howiesons Poort backed artefacts, which appeared about 70 000 years ago, have been based on Later Stone Age and ethnographic examples. This paper describes an experimental test of the effectiveness of Howiesons Poort-type segments as projectile points, as well as the results of Tip Cross Sectional Area (TCSA) calculations (see Shea 2006). My aim is to show the usefulness of a range of possible hafting positions for Howiesons Poort segments as projectile tips through the use of controlled experiments and replication work. The results of these experiments may shed light on the hunting technologies of people living during the Middle Stone Age (MSA) of South Africa. Shea's (2006) Tip Cross Sectional Area (TCSA) calculations were used to compare hafted segments with other types of pre-historic projectile points. The TCSA values, in conjunction with other quantitative or morphometric studies, can help determine how these tools were used.

Archaeologists have often suggested that MSA segments, like their Later Stone Age (LSA) counterparts, may have been parts of projectiles, possibly arrowheads or barbs (e.g. Lombard 2005a). The category 'projectile weaponry' includes such implements as spears used with spear throwers, arrows and darts and work has been done towards quantitatively dividing and classifying various projectile weapons into these categories (e.g. Shea 2006). Spears can be used and manufactured in two different manners. First, short stabbing spears can be used at short distances to inflict high impact damage. Second, longer throwing spears can be launched at a target from some distance with the arm or by some other device such as a spear thrower, but such weapons do not impact with the same high velocities as do the short stabbing spears. Experiments have been conducted to test the effectiveness of both of these types of spear use (e.g. Lombard *et al.* 2004). However, shaft diameter and length alone are not enough to create a distinction between thrusting and throwing spears and it is possible that one type of spear may have served both functions (Villa & Lenoir 2006). Segments appeared in the South African MSA sequence approximately 70 000 years ago and they are characteristic of the Howiesons Poort Industry found mainly south of the Limpopo River (Lombard 2005b).

Most assumptions about the uses of Howiesons Poort backed artefacts have been based almost solely on the use of LSA, Upper Paleolithic, Mesolithic and ethnographic examples. The focus has been on the use of backed artefacts and other microliths as components in hunting weaponry (e.g. Clark 1954; Clark & Walton 1962; Chard 1969; Parkington & Poggenpoel 1971; Noe-Nygaard 1974; Clark *et al.* 1974; Cooke 1975; Clark 1976; H.J. Deacon, 1976, 1989, 1992; Clark 1977; Jacobi 1978; Wadley 1979; Parkington 1980; Fischer *et al.* 1984; Rozoy 1985: 13; Oshibkina 1989; Nuzhnyj 2000; Crombé *et al.* 2001; Mitchell 2002). Clark (1970) has proposed several other uses for segments such as the cutting edges of knives or sickles and saw blades. Evidence of the hafting and use of backed artefacts as cutting components to process or harvest plant material has also been recorded (Oakley 1958; Finlayson 1989; Deacon 1995; Wadley & Binneman 1995; Finlayson & Mithen 1997).

A few researchers have suggested possible hafting positions for backed tools, such as segments hafted in pairs or singly in a horizontal position (Clark 1959, Clark *et al.* 1974). Nuzhnyj (2000: 97) reconstructed horizontally, paired, diagonally and vertically hafted positions for backed pieces from the Mesolithic of Eastern and Western Europe. Previous experiments with backed microliths, such as segments (e.g. Barton & Bergman 1982; Crombé *et al.* 2001: 258) have shown them to be useful when used to tip projectile weaponry. However, Binneman and Hall also conducted a series of experiments with replicas of San bows and arrows fitted with segments (the size of LSA segments) in horizontal and end hafted positions and found them ineffective for penetrating a calf carcass (Binneman 1994). It is also possible that instead of being projectile weapons, Howiesons Poort segments could have been used without any form of hafting as cutting implements.

Micro-residue analyses conducted on segments from the Howiesons Poort levels of Rose Cottage Cave (Gibson *et al.* 2004) and Sibudu Cave (Delagnes *et al.* 2006; Lombard 2006) have yielded direct evidence for the hafting of Howiesons Poort segments and also preliminary suggestions for their possible hafting positions. Of the 48 backed pieces analysed by Gibson *et al.* (2004), all had evidence of a high occurrence of ochre or plant residues on their backed edges. These results support hypotheses put forward by researchers such as Clark (1970) and Phillipson (1976) about the hafting function of backing on artefacts such as segments. Lombard's (in press) analysis of 53 segments from Sibudu Cave also shows a clear concentration of ochre and resin residues on their backed portions. Lombard (2005a, 2006) has undertaken macro-fracture analyses on tools from three Howiesons Poort sites. Diagnostic impact fractures (e.g. step-terminating bending fractures, bifacial spin-off fractures, impact burinations and spin-off fractures >6 mm) were noted on 22% of the Sibudu pieces, 24% of the Umhlatuzana sample and 21% of the Klasies River Cave 2 sample (Lombard 2005a, 2006). These percentages add to the ever-growing body of evidence supporting the idea that Howiesons Poort segments were hafted and used as impact tools (Lombard 2005a, 2006).

THE EXPERIMENTS: DESIGN AND REPLICATION

Direct evidence for the hunting function of Howiesons Poort segments currently exists in use-trace analyses (Gibson *et al.* 2004; Lombard 2005a, 2006, in press). However, support for the idea that segments tip hunting weaponry comes from ethnography and Holocene archaeological contexts (Clark

1954; Clark *et al.* 1974; H.J. Deacon 1976, 1989, 1992; Rozoy 1985:13; Oshibkina 1989) and is thus considerably younger than the Howiesons Poort Industry. In order to expand on the interpretations from both direct and indirect sources, a series of controlled experiments were carried out with replicated tools. These involved attaching 33 replicas of Howiesons Poort type segments, made from European flint, to 27 wooden shafts. These weapons were then thrown at an impala (*Aepyceros melampus)* carcass using a machine built especially for this purpose.

The 33 segments (Fig. 1a and b) were made by a master flint knapper, Sylvain Soriano, using a direct antler percussion knapping technique (S. Soriano, pers. comm. 2006). Flint does not occur in South Africa. However, the primary aim of the experiments was to explore suitable hafting positions for the use of segments; therefore the rock types used were not important in this study. Also, it has been demonstrated that macro-fracture patterns on a variety of local raw materials are similar to those on flint when used for hunting purposes (Lombard *et al.* 2004). The specific morphological characteristics of the replicated segments (mean length = 33.3 mm; mean breadth = 13.1 mm; mean thickness = 3.1 mm) are comparable to Howiesons Poort segments from some South African sites. Howiesons Poort segments from Klasies River Mouth have an average length range of 25–60 mm (Thackeray 1989; Lombard 2005b: 37; Villa *et al.* 2005: 400). Segments from the Howiesons Poort at Umhlatuzana and Sibudu Cave have mean lengths of 30 mm and 29 mm, respectively (M. Mohapi, pers. comm. 2007).

It was important to standardize materials as far as possible, and to make hafting position the most significant variable in the experiments. Therefore, the tools were hafted onto commercial pinewood dowel sticks (length = 920 mm; diameter = 19 mm) using commercially available superglue [Adlock® Instant Adhesive (cyanoacrylate)]. Because pine is a very light wood, some form of weighting was required to give the projectiles the best possible flight trajectories. Two means of weighting the dowels were chosen. The first was inserting a stainless steel rod 1328 mm long, 10 mm wide and weighing 73 g into a 135 mm groove channelled into the dowel stick approximately 40 mm below the head of the spear. In order to maintain constant weight, the same stainless steel rod was used for all of the weapons and was transferred from one weapon to another. The second weighting strategy comprised attaching four steel welding rods (1.6 mm in diameter and 920 mm in length) around the dowel sticks for a more even weight distribution. The combined weight of each weapon after hafting and weighting was 292 g. Freehand throwing would have introduced into the experiment considerable variation in speed, load and angle of incidence. Therefore, a calibrated projectile machine was used to launch the hunting weapons (Fig. 2).

Rather than a split or L-shaped haft, a slotted haft was used because it has superior strength (M. Lombard, pers. comm. 2006). However, in order to secure a tight fit, each slot was made to fit the morphology of its corresponding segment(s). Four different hafting positions were chosen:

1. Vertical hafting (Fig. 3).

A segment was placed vertically with its backed edge inserted into the haft and its sharp cutting edge exposed.

2. Horizontal hafting (Fig. 4).

A segment was placed horizontally into the haft. The backed edges of these segments lay approximately 5 mm deep in the slots.

3. Diagonal hafting (Fig. 5).

Single segments were placed at a 60° angle in the slotted haft. Marlize Lombard (pers. comm. 2006) suggested this arrangement because it makes maximal use of a penetrative point, a diagonal cutting edge and a barb.

4. Back-to-back hafting (Fig. 6).

Two segments were placed back-to-back in the haft so that a convergent point with a long cutting length was created out of the two pieces.

THE EXPERIMENTS: PROTOCOL AND EXECUTION

An impala carcass weighing approximately 50 kg was used as a target in the hunting experiments. The animal had its hide and limbs intact but its internal organs had been removed prior to its arrival at the meat factory. It must be noted that this animal was not killed for the experiment, and that I obtained the carcass from a batch of animals killed as part of standard culling procedures and subsequently sold to a meat factory. Owing to the availability of suitable cold storage facilities and for hygiene purposes, the experiments were carried out inside a meat factory. The interior surfaces of this factory are made of various metals, woods and other hard surfaces with which the tools did come into contact during the experiments. However, deflection onto hard surfaces such as trees and rocks would have occurred during prehistoric hunts as well. The impala carcass was suspended in a natural standing position using rope. This positioning of the animal simulated the approximate resistance properties of a living animal and thus allowed for realistic penetrations of the hunting weapons. The projectile machine was located approximately 4 m away from the carcass. Following the hunting experiments done by Lombard *et al.* (2004) it was decided that each weapon would be fired at the carcass for a maximum of ten shots. After each shot the exact position of the weapon's impact was recorded as well as any additional information such as depth of penetration, tool breakage and contact materials. Once we had finished with each tool, its tip was sealed in a plastic bag and kept for later analysis.

RESULTS

In total, the 27 weapons were projected into the carcass 167 times. About 85% of the weapons were considered successful because they managed to penetrate the target's hide and flesh. Of these successful weapons, 33% penetrated deep (≥30 mm) into the target's flesh and a further 33% of these penetrations could have come into contact with vital organs had there been any in the animal. The remaining 52% of the successful weapons caused minor penetrations or lacerations of the animal's hide or flesh. Only 14% of the total sample was unable to penetrate either the hide or flesh of the target. The high percentage of penetration demonstrates the utility of these projectiles as hunting weapons. A total of 37% of the weapons survived all ten shots at the target. Manufacturing flaws such as haft breakage or weakness in the glue, affected 41% of the weapons and 22% of the segments broke before ten shots could be made.

The various hafting configurations showed slight differences in success rates.

VERTICAL HAFTING

Of the seven weapons in this hafting category, each tipped with one segment, six managed to penetrate the animal's hide and flesh and were therefore considered successful. All of the penetrations were deep enough to have produced a blood trail to track the animal. One of these penetrated deep enough into the hind-quarter of the animal to remain embedded.

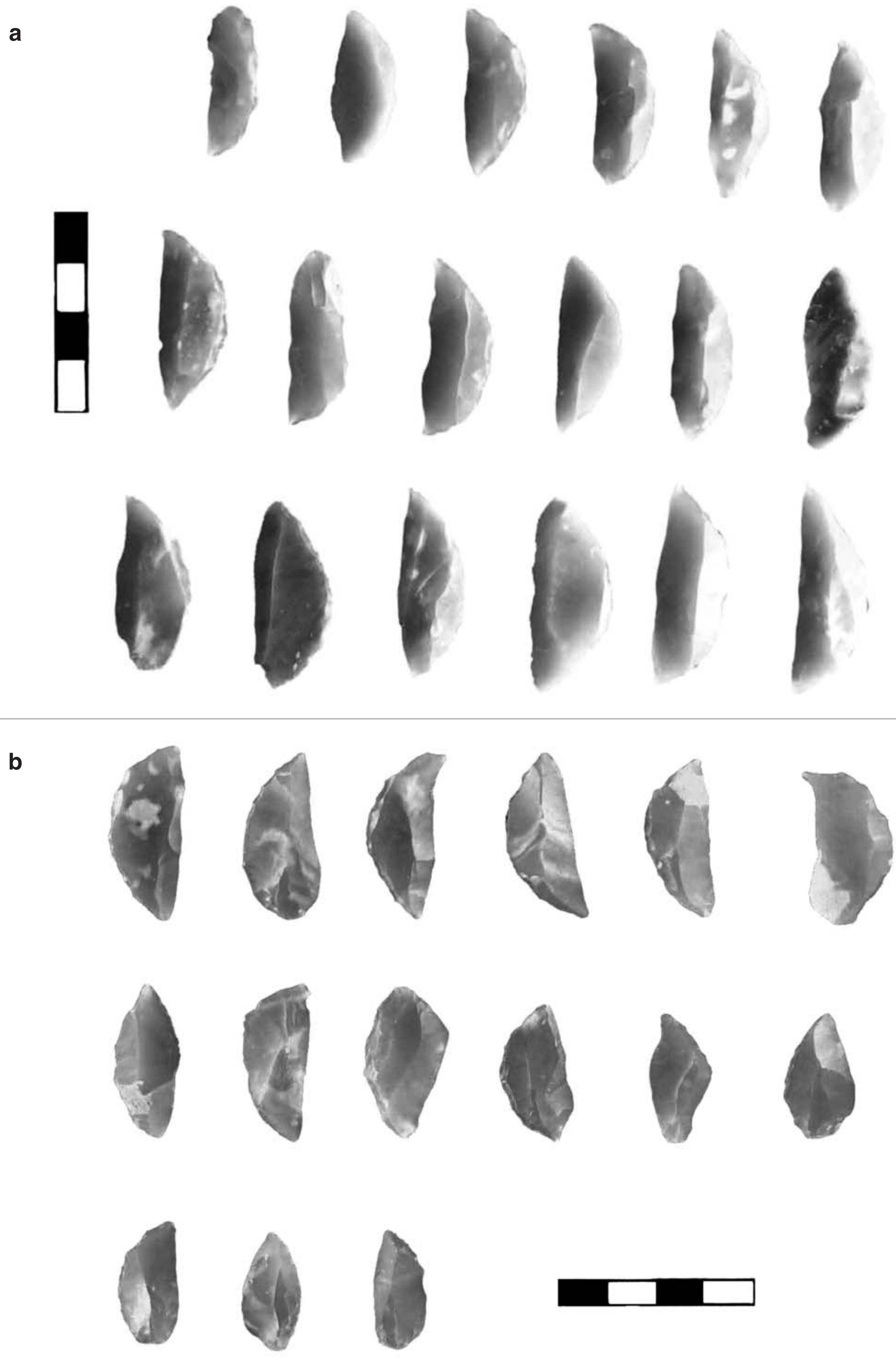

FIG. 1 a and b. *Replicated segments used in the experiment. Scale in cm*

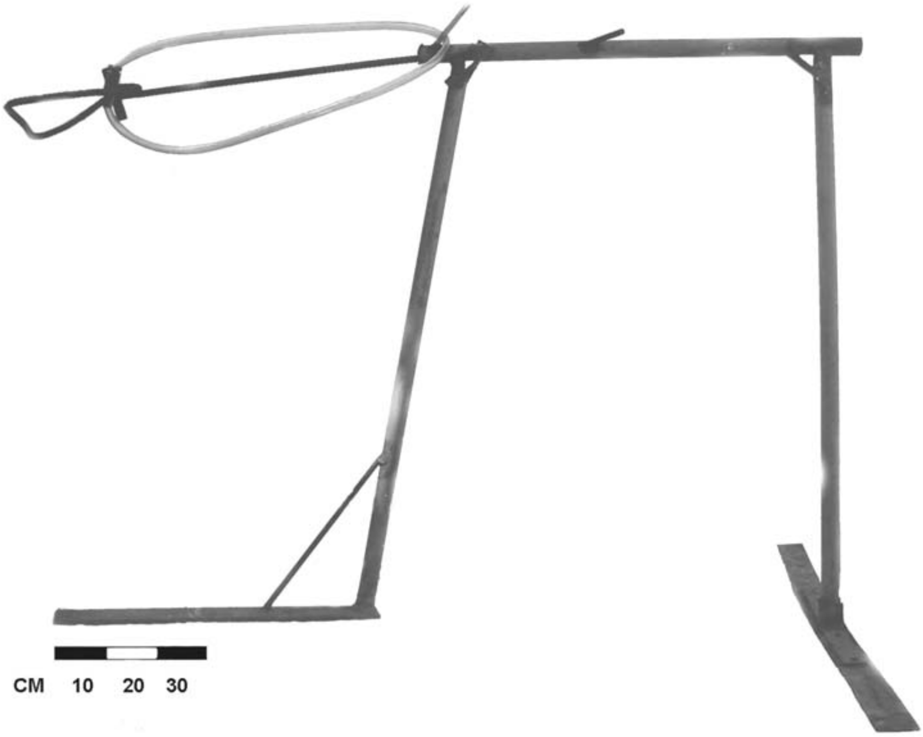

FIG. 2.. *The projectile machine*

HORIZONTAL HAFTING

The seven horizontally hafted weapons lacerated, rather than deeply penetrated the animal's hide and flesh. Three penetrated somewhat, but the other four deflected off the animal and merely cut hide and flesh. Although such wounds would not be deep enough to cripple an animal, they would be sufficient to create a blood spoor to track an animal.

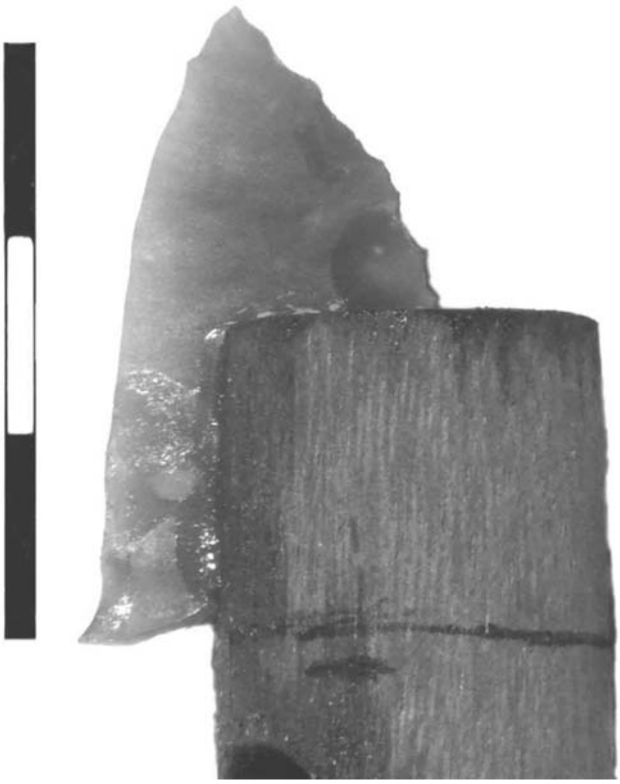

FIG. 3. *Vertically hafted segment. Scale in cm*

BACK-TO-BACK HAFTING

Out of these six weapons, each tipped with two segments, five penetrate the carcass's hide and flesh. Of these five weapons, two inflicted deep wounds (≥40 mm). One penetrated the carcass to a depth of ±40 mm and its barbs made extraction difficult (Fig. 7). The slicing action caused by the two convergent cutting edges of the segments proved to be very effective in creating large gaping wounds in the animal.

DIAGONAL HAFTING

This hafting category was expected to perform well. Out of the seven weapons each tipped with one segment, five were successful and managed to penetrate the animal's hide and flesh. Out of this successful category, two of the weapons caused severe damage to the animal. One inflicted a wound ≥40 mm deep in the forequarter of the animal. The slicing

FIG. 4. *Horizontally hafted segment. Scale in cm*

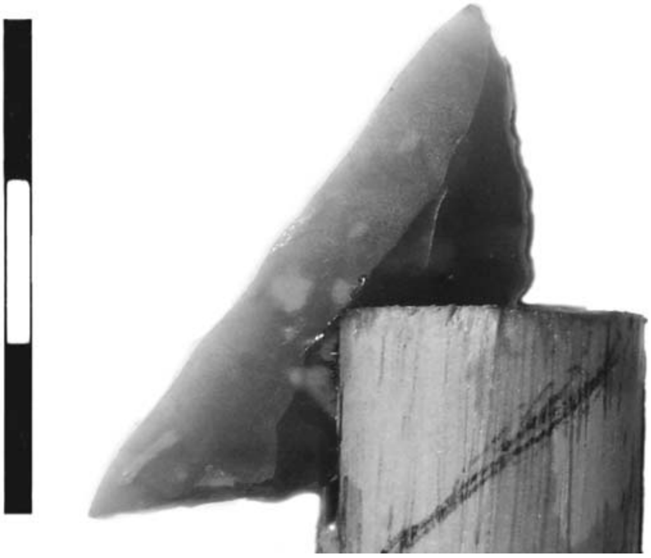

FIG. 5. *Diagonally hafted segment. Scale in cm*

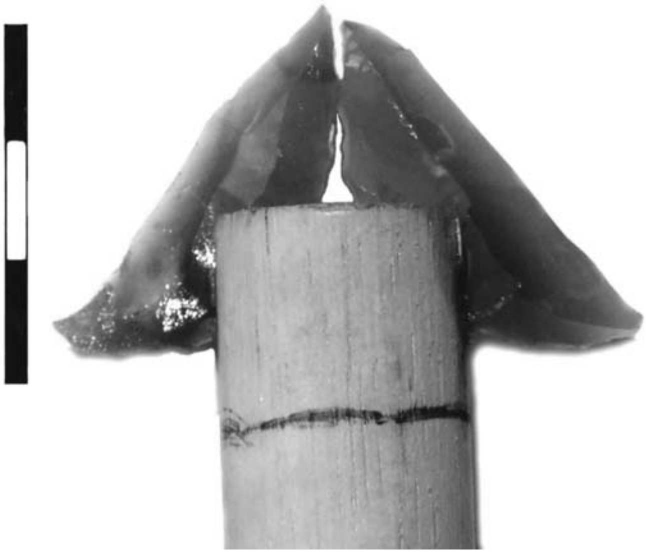

FIG. 6. *Segments hafted back-to-back. Scale in cm*

action of the diagonal cutting edge enabled deep and relatively wide penetrations. The barb and the depth of penetration lodged these weapons firmly in the carcass.

DISCUSSION

Hunters kill their prey either by causing severe blood loss or by penetrating vital organs (Frison 1978). The weapons used in this experiment would have managed to do both. It is possible that in a genuine hunting situation, where an animal's skin is taut and supple, these weapons would have inflicted more severe wounds. A large portion of the fauna coming from the Howiesons Poort levels at Sibudu cave consists of blue duiker (*Cephalophus monticola*). These are very small bovids, smaller than the impala carcass we experimented on, and almost any shot hitting the chest area of this animal could have caused death.

The success of the horizontally hafted pieces was surprising. In most instances they created large enough wounds to allow blood to flow. A bleeding wound allows hunters to track their prey, as is often the case with the poison tipped arrows used by the /Xam bushmen (Deacon, J. 1992). In a few rare instances these weapons penetrated the animal. However, most of them merely lacerated the animal. Segments have sometimes been described as parts of composite weapons, containing several inserts in a haft. The effectiveness of such a composite tool has been experimentally demonstrated by the segments of Howiesons Poort dimensions hafted back-to-back. However, the results of the experiment also show that segments can be hafted singly and that they function well hafted either vertically, diagonally or horizontally.

Much work has gone into creating methods to quantify the difference between stone tools used to tip spears, arrows and darts. The most compelling of these is Shea's (2006) use of the Tip Cross Sectional Area (TCSA) calculation (0.5 × maximum width × maximum thickness) to determine projectile point function. The mean TCSA value for arrowheads is said to be approximately 33 mm^2 (±20); for dart tips it is said to be 56 mm^2 (±18) and for spear points TCSA values are said to centre around 168 mm^2 (±89) (Shea 2006). I calculated the TCSA values for my experimental sample, first, because South African segments were only once before tested as tips in projectile weaponry (Binneman 1994), secondly, because morphologically they are not standard projectile tips and, thirdly, to see where they would fit in the scheme described by Shea. I calculated TCSA values for the individually hafted segments, as well as for the segments hafted back-to-back because these double inserts resemble traditional triangular shaped points commonly associated with the tips of spears. Once these back-to-back segments had been hafted, I took maximum width measurements from the tips of the two barbs of these pieces and calculated the TCSA values (Tables 1 and 2). All the individual segments' TCSA values place them within the category of

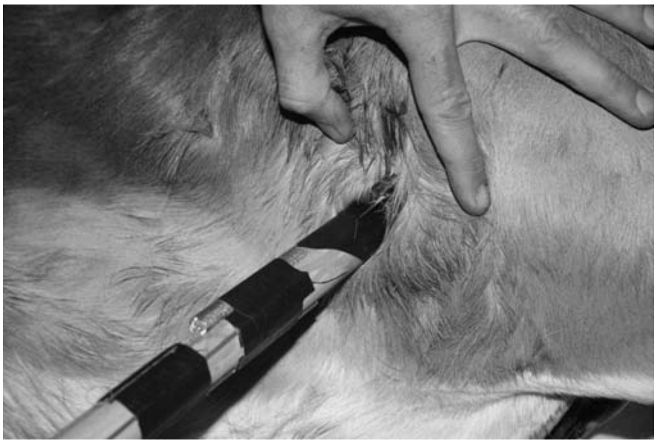

FIG. 7. *Spear with back-to-back segments embedded in carcass. Note head insert and welding rods used to add weight to haft.*

TABLE 1. *Tip Cross Sectional Area (TCSA) measurements on back-to-back hafting category (*n = *6).*

Weapon no.	Mean width (mm)	Mean thickness (mm)	Mean TCSA (mm^2)
8	47	3	94
9	40	3	100
10	44	3	88
11	34	3	51
12	27	2	27
13	34	4	68
Average			71.3

TABLE 2. *Tip Cross Sectional Area (TCSA) values for individual segments.*

	Mean width (mm)	Mean thickness (mm)	Mean TCSA (mm²)
Diagonal			
1	15	4	30
2	16	4	32
3	17	4	34
4	14	4	28
6	16	4	32
13	14	3	21
14	13	3	19.5
Average			28
Vertical			
7	15	4	30
8	13	3	19.5
9	13	3	19.5
10	14	3	21
11	12	4	24
12	14	5	35
30	12	2	12
Average			23
Horizontal			
5	16	3	24
15	13	3	19.5
19	13	3	19.5
23	11	3	16.5
26	11	3	16.5
27	19	4	38
29	11	2	11
Average			20.7
Back-to-back			
16	12	4	24
17	14	3	21
18	10	3	15
20	13	3	19.5
21	12	3	18
22	11	4	22
24	16	4	32
25	11	2	11
28	11	3	16.5
31	11	2	11
32	10	2	10
33	9	2	9
Average	17.4		

arrowheads. Arrowheads and darts are projectiles launched with an intermediary device, rather than directly by the human arm. Effectively, our small-tipped projectiles, which were launched by a machine, could be seen as such weapons. However, three of the weapons that had segments hafted back-to-back (weapons 8, 9 and 10) have TCSA values similar to those of the spear points mentioned by Shea (2006). Another two (weapons 11 and 13) have TCSA values near the values of dart tips (Shea 2006). Lastly, one of the weapons (weapon 12) had a TCSA value very close to those of arrowheads. The mean TCSA for this group of experimental weapons places them somewhere between the category of dart and spear tips, but the back-to-back hafted sample is very small and the results are therefore inconclusive.

CONCLUSIONS

With this study I demonstrated that replicated segments, similar to those from the Howiesons Poort, function very well when used to tip projectiles. They could have functioned as darts or arrowheads. Further experimental work should aim to assess their effectiveness as hand-delivered weapons such as stabbing spears. The segments are effective when hafted in pairs, and also work well when hafted singly. However, not all the hafting positions are equally effective in penetrating hide and flesh. Future experiments should thus aim to test the projectile *versus* hand-delivered hypothesis, various hafting mediums and materials such as heavier woods, mastic recipes (e.g. Gibson *et al*. 2004; Hodgskiss 2006; Lombard 2006; Wadley 2005a,b, 2006) and alternative haft types such as L-shaped or split hafts could be used in conjunction with some form of binding.

ACKNOWLEDGEMENTS

Many thanks to Sylvain Soriano for knapping the segments used in the experiments and to Rodger Govender for providing the carcass. I would like to thank Prof. Lyn Wadley and Marlize Lombard for all their help and guidance with the project and comments on the paper. Finally, to all the friends and family who helped with the designing and experimenting process.

REFERENCES

Barton, R.N.E. & Bergman. C.A. 1982. Hunters at Hengistbury: some evidence from experimental archaeology. *World Archaeology* 14: 237–248.

Binneman, J. 1994. A unique stone tipped arrowhead from Adam's Kranz Cave, eastern Cape. *Southern African Field Archaeology* 3: 60–62.

Chard, C.S. 1969. *Man in Prehistory.* New York: McGraw-Hill.

Clark, J.D. 1959. *The Prehistory of Southern Africa.* Harmondsworth: Penguin Press.

Clark, J.D. 1970. *The Prehistory of Africa.* Southampton: Thames & Hudson.

Clark, J.D. 1977. Interpretations of prehistoric technology from ancient Egyptian ethnology and other sources. Part II: Prehistoric arrow forms in Africa as shown by surviving examples of the traditional arrows of the San Bushmen. *Paleorient* 3: 127–150.

Clark, J.D., Phillips, J.L. & Staley, P.S. 1974. Interpretations of prehistoric ethnology from ancient Egyptian and other sources. Part I: ancient Egyptian arrows and their relevance for African prehistory. *Paleorient* 2: 323–388.

Clark, J.D. & Walton, J. 1962. A Later Stone Age site in the Erongo Mountains, South West Africa. *Proceedings of the Prehistoric Society* 28: 1–16.

Clark, J.G.D. 1954. *Excavations at Starr Carr.* London: Cambridge University Press.

Clark, J.G.D. 1976. Mesolithic Europe: The economic basis. In: Sieveking, G. de. G., Longworth, I.H. & Wilson, K.E. (eds) *Problems in Economic and Social Archaeology:* 449–481. London: Duckworth.

Cooke, C.K. 1975. Two parts of arrowshafts: Pomongwe Cave excavations 1960–61. *South African Archaeological Bulletin* 30: 140.

Crombé, P., Perdaen, Y., Sergant, J. & Caspar, J.P. 2001. Wear analysis on early Mesolithic microliths from the Verrebroek site, east Flanders Belgium. *Journal of Field Archaeology* 28: 253–269.

Deacon, H.J. 1976. *Where Hunters Gathered: A Study of Holocene Stone Age People in the Eastern Cape.* Cape Town: South African Archaeological Society.

Deacon, H.J. 1989. Late Pleistocene palaeoecology and archaeology in the southern Cape, South Africa. In: Mellars, P. & Stringer, C.B. (eds) *The Human Revolution: Behavioural and Biological Perspectives of the Origins of Modern Humans*: 547–564. Edinburgh: Edinburgh University Press.

Deacon, H.J. 1992. Southern Africa and modern human origins. *Philosophical Transactions of the Royal Society* B 337: 177–183.

Deacon, J. 1992. *Arrows as Agents of Belief Amongst the /Xam Bushmen.* Margaret Shaw Lecture 3. Cape Town: South African Museum.

Deacon, J. 1995. An unsolved mystery at the Howieson's Poort name site. *South African Archaeological Bulletin* 50: 110–120.

Delagnes, A., Wadley, L., Villa, P. & Lombard, M. 2006. Crystal quartz tools from the Howiesons Poort at Sibudu Cave. *Southern African Humanities* 18(1): 43–56.

Finlayson, B. 1989. A pragmatic approach to the functional analysis of chipped stone tools. Unpublished PhD dissertation, University of Edinburgh.

Finlayson, B. & Mithen, S. 1997. The microwear and morphology of microliths from Gleann Mor. In: Knecht, H. (ed.) *Projectile Technology*: 107–130. New York: Plenum Press.

Fischer, A., Vemming Hansen, P. & Rasmussen, P. 1984. Macro and micro wear traces on lithic projectile points: experimental results and prehistoric examples. *Journal of Danish Archaeology* 3: 19–46.

Frison, G.C. 1978. *Prehistoric Hunters of the High Plains.* New York: Academic Press.

Gibson, N.E., Wadley, L. & Williamson, B.S. 2004. Microscopic residues as evidence of hafting on backed tools from the 60 000 to 68 000 year-old Howiesons Poort layers of Rose Cottage Cave, South Africa. *Southern African Humanities* 16: 1–11.

Hodgskiss, T. 2006. In the mix: replication studies to test the effectiveness of ochre in adhesives for tool hafting. Unpublished MA dissertation, University of the Witwatersrand, Johannesburg.

Jacobi, R.M. 1978. Northern England in the eight millennium BC: an essay. In: Mellars, P. (ed.) *The Early Post-Glacial Settlement of Northern Europe*: 295–332 London: Duckworth.

Lombard, M., Parsons, I. & van der Ryst, M.M. 2004. Middle Stone Age lithic point experimentation for macro-fracture and residue analysis: the process and preliminary results with reference to Sibudu Cave points. *South African Journal of Science* 100: 159–166.

Lombard, M. 2005a. A method for identifying Stone Age hunting tools. *South African Archaeological Bulletin* 60: 115–120.

Lombard, M. 2005b. The Howiesons Poort of South Africa: what we know, what we think we know, what we need to know. *Southern African Humanities* 17: 33–55.

Lombard, M. 2006. Direct evidence for the use of ochre in the hafting technology of MSA tools. *Southern African Humanities* 18: 57–67.

Lombard, M. in press. Finding resolution for the Howiesons Poort through the microscope: Micro-residue analysis of segments from Sibudu Cave, South Africa. *Journal of Archaeological Science.*

Mitchell, P.J. 2002. *The Archaeology of Southern Africa.* Cambridge: Cambridge University Press.

Noe-Nygaard, N. 1974. Mesolithic hunting in Denmark illustrated by bone injuries caused by human weapons. *Journal of Archaeological Science* 1: 217–48.

Nuzhnyj, D. 2000. Development of microlithic projectile weapons in the Stone Age. *Anthropologie et Prehistoire* 111: 95–101.

Oakley, K.P. 1958. *Man the Toolmaker,* 4th edn. London: Trustees of the British Museum.

Oshibkina, S.V. 1989. The material culture of the Veretye-type sites in the region to the East of Lake Onega. In: Bonsall, C. (ed.) *The Mesolithic in Europe: Papers presented at the Third International Symposium, Edinburgh 1985:* 402–413. Edinburgh: John Donald Publishers.

Parkington, J.E. 1980. Time and Place: some observations on spatial and temporal patterning in the Later Stone Age sequence in southern Africa. *South African Archaeological Bulletin* 35: 73–83.

Parkington, J.E. & Poggenpoel, C. 1971. Excavations at De Hangen 1968. *South African Archaeological Bulletin* 26: 3–36.

Phillipson, D.W. 1976. *The Prehistory of Eastern Zambia.* Nairobi: British Institute in Eastern Africa.

Rozoy, J-G. 1985. The revolution of bowmen in Europe. In: Bonsall, C. (ed.) *The Mesolithic in Europe: Papers Presented at the Third International Symposium Edinburgh 1985*: 13–28. Edinburgh: John Donald Publishers.

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

Thackeray, A.I. 1989. Changing fashions in the Middle Stone Age: the stone artefact sequence from Klasies River Mouth main site, South Africa. *African Archaeological Review* 7: 33–57.

Villa, P., Delagnes, A. & Wadley, L. 2005. A late Middle Stone Age artefact assemblage from Sibudu (KwaZulu-Natal): comparisons with the European Middle Palaeolithic. *Journal of Archaeological Science* 32: 399–422.

Villa, P. & Lenoir, M. 2006. Hunting weapons of the Middle Stone Age and the Middle Palaeolithic: spear points from Sibudu, Rose Cottage and Bouheben. *Southern African Humanities* 18(1): 89–122.

Wadley, L. 1979. Big Elephant Shelter and its role in the Holocene prehistory of central South West Africa. *Cimbebasia* 3: 1–75.

Wadley, L. 2005a. Putting ochre to the test: replication studies of adhesives that may have been used for hafting tools in the Middle Stone Age. *Journal of Human Evolution* 49: 587–601.

Wadley, L. 2005b. A typological study of the final Middle Stone Age stone tools from Sibudu Cave, KwaZulu-Natal. *South African Archaeological Bulletin* 60: 1–13.

Wadley, L. 2006 Partners in grime: results of multi-disciplinary archaeology at Sibudu Cave. *Southern African Humanities* 18(1): 315–341.

Wadley, L. & Binnemen, J.N.F. 1995. Arrowheads or penknives? A microwear analysis of mid-Holocene stone segments from Jubilee Shelter, Transvaal. *South African Journal of Science* 91: 153–155.