Middle Stone Age lithic point experimentation for macro-fracture and residue analyses: the process and preliminary results with reference to Sibudu Cave points

M. Lombard⁎, I. Parsons* and M.M. van der Ryst†

We describe the protocol in the first in a series of experiments to replicate macro-fractures, use-wear and residue distribution patterns on stone tools of the kind used in the Middle Stone Age (MSA) of southern Africa. To our knowledge, no similar experiments have previously been conducted in the region. Unretouched convergent flakes were produced from a selection of raw materials, especially quartzite and hornfels, hafted and used as hunting spears and butchery knives on parts of a Connochaetes taurinus (blue wildebeest) carcass. The hunting experiments were compared with results obtained in Europe on flint tools, and tested whether the concept of diagnostic impact fracture types can be applied to local raw materials and southern African MSA points. The differences in residue distribution patterns between hafted tools used for hunting as opposed to those employed for butchering were also replicated and documented. The preliminary results of these experiments are briefly compared with an archaeological sample from Sibudu Cave, KwaZulu-Natal. We demonstrate for local raw materials and MSA points the applicability of the diagnostic impact fracture types as described by Fisher et al.†

Introduction

The experiments presented here represent a pilot study with the object of creating empirical evidence for hunting and hafting practices during the southern African Middle Stone Age (MSA). Such evidence has the potential to contribute to the debate over archaic and modern human behaviour, but that is not our immediate aim. Raw materials used in southern Africa for MSA stone point manufacture are of a wide variety, often of different grain sizes, that have not been previously examined for their ability to develop diagnostic impact fractures. Testing whether results obtained elsewhere can be applied to raw materials and tools in the southern African MSA context may therefore be of particular value.

The evidence of mechanical impact on stone tools (lithics) is indicative of hunting. Hunting signals a capacity for forward planning, strategic problem solving and communication, provides greater security to the group and ensures more efficient use of the natural environment.2,3 The recognition of impact damage in a lithic assemblage, together with other strands of evidence such as micro-wear and residue distribution patterns that reflect hunting, has the potential to add to the range of information about human behaviour that can be recovered. Such information may then be incorporated in the reconstruction of subsistence strategies at archaeological sites to broaden the understanding of site function and activities.4,5 Stone tools are the most abundant, and sometimes only, cultural remains at MSA sites, which may date back as much as 250 000 years in southern Africa. Lithic points represent some of the most typical artefacts from the MSA. Despite this, little work has focused on their function. This may result from an inaccurate perception that points mostly served as hafted spearheads, based on subjective contemporary impressions of their suitability, possible effectiveness, or similarity to ethnographically recorded hunting weapons.6,7

A debate about spear points from the Middle Palaeolithic (the prehistoric period in Europe, Asia and Africa north of the Sahara between roughly 250 000 and 40 000 years ago) developed soon after the first systematic descriptions of lithic points. Bourlon8 in 1906 suggested that such tools could have been hafted and used as hunting weapons. Initial efforts to identify diagnostic criteria for recognizing hunting tools focused on the Upper Palaeolithic and Mesolithic in Europe. Patterns of lateral snapping and certain fracture types were found to be common results of experimental impact-use.1,7–9 These findings were used to interpret archaeological specimens of the Upper Palaeolithic and Mesolithic from approximately 47 000 years ago. Shea’s10,11 identification of impact-wear on Levallois points and other tool forms from Levantine Mousterian sites dating back to about 60 000 years ago was controversial for a number of reasons. First, the wear was on tools from a period when hunting by Neanderthals and other archaic humans in Europe and the Levant was strongly challenged by zooarchaeological evidence. Second, it suggested a function for these tools in the Levant that has not been demonstrated for points of similar age from Europe. Third, impact-wear was observed on a variety of tools that also displayed evidence of other functions. Lastly, Shea’s hypothesis that differences in the frequencies of impact-wear and Levallois points reflected strategic differences in the way of life of Neanderthals and early modern humans addressed one of the most controversial issues in current palaeoanthropological research.8

Eurasian lithic studies revealed that the functions of points varied and cannot be assumed. Use-wear and residue studies on points from the European Middle Palaeolithic showed no impact damage or use as projectiles.12,13 Use-wear and macro-fracture studies on Middle Palaeolithic Levantine points indicated that they were employed as scrapers or as tools with multiple functions at some sites.14,15 At other sites points are described as impact tools and multiple-use implements.16,17 At the Levantine site of Kebara, where Shea18 argued for impact-use, other researchers19 obtained results indicating that the points were used rather for butchery and the cutting of plant material. The clearest evidence for the use of a Levantine Levallois point

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Table 1. Details of the lithics hafted as spears, and field notes on the thrusting experiment.

<table>
<thead>
<tr>
<th>Point no.</th>
<th>Raw material</th>
<th>Haft material</th>
<th>Binding material</th>
<th>Length × width × Contact materials</th>
<th>Duration (× thrusts)</th>
<th>Field notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>Fine-grained quartzite</td>
<td>Combretum erythrophyllum</td>
<td>Leather thong</td>
<td>75 × 55 × 28 Muscle tissue, bone</td>
<td>10</td>
<td>Tip damage on contact with bone</td>
</tr>
<tr>
<td>102</td>
<td>Fine-grained quartzite</td>
<td>Xapiphyllum parvifolium</td>
<td>Bark (rehafted with fibrous plant twine)</td>
<td>75 × 38 × 16 Muscle tissue</td>
<td>4</td>
<td>Tip damage on contact with bone, bark binding loosened on last impact</td>
</tr>
<tr>
<td>103</td>
<td>Fine-grained hornfels</td>
<td>Canthium imberbe</td>
<td>Sinew</td>
<td>76 × 35 × 13 Muscle, bone</td>
<td>1</td>
<td>Penetrated scapula and fractured in bone</td>
</tr>
<tr>
<td>104</td>
<td>Coarse-grained quartzite</td>
<td>Xapiphyllum parvifolium</td>
<td>Sinew</td>
<td>55 × 41 × 11 Hide</td>
<td>4</td>
<td>Fractured on deflection from hide</td>
</tr>
<tr>
<td>105</td>
<td>Fine-grained quartzite</td>
<td>Commercial dowel</td>
<td>Sinew, fibrous plant twine</td>
<td>60 × 43 × 13 Muscle, bone</td>
<td>2</td>
<td>Penetrated between ribs, tip damage on contact with bone</td>
</tr>
<tr>
<td>106</td>
<td>Coarse-grained quartzite</td>
<td>Commercial dowel</td>
<td>Sinew, fibrous plant twine</td>
<td>62 × 39 × 6 No contact</td>
<td>Not used</td>
<td>Accidental breakage during transport</td>
</tr>
<tr>
<td>107</td>
<td>Fine-grained quartzite</td>
<td>Commercial dowel</td>
<td>Sinew, leather thong</td>
<td>54 × 19 × 11 Muscle, bone</td>
<td>1</td>
<td>Penetrated scapula, minimal damage to point</td>
</tr>
<tr>
<td>108</td>
<td>Medium-grained quartzite</td>
<td>Commercial dowel</td>
<td>Sinew</td>
<td>48 × 31 × 9 Muscle, bone</td>
<td>1</td>
<td>Fractured on contact with bone, binding detached from stone on impact</td>
</tr>
<tr>
<td>109</td>
<td>Medium-grained mudstone</td>
<td>Combretum erythrophyllum</td>
<td>Sinew, leather thong</td>
<td>45 × 39 × 7 Muscle, bone</td>
<td>9</td>
<td>Fractured on contact with bone</td>
</tr>
<tr>
<td>110</td>
<td>Medium-grained mudstone</td>
<td>Commercial dowel</td>
<td>Sinew, fibrous plant twine</td>
<td>44 × 35 × 9 Hide</td>
<td>2</td>
<td>Fractured on deflection from hide</td>
</tr>
<tr>
<td>111</td>
<td>Fine-grained hornfels</td>
<td>Eucalyptus sp.</td>
<td>Sinew</td>
<td>65 × 18 × 10 Hide, muscle, bone</td>
<td>1</td>
<td>Penetrated hide, fractured on contact with bone</td>
</tr>
<tr>
<td>112</td>
<td>Medium-grained quartzite</td>
<td>Commercial dowel</td>
<td>Sinew, fibrous plant twine</td>
<td>61 × 14 × 12 Muscle, bone</td>
<td>1</td>
<td>Fractured on impact, penetrated bone</td>
</tr>
<tr>
<td>113</td>
<td>Medium-grained quartzite</td>
<td>Commercial dowel</td>
<td>Fibrous plant twine</td>
<td>43 × 28 × 13 Hide, muscle, bone</td>
<td>2</td>
<td>Penetrated hide, fractured on contact with bone, tip remained in bone</td>
</tr>
<tr>
<td>114</td>
<td>Fine-grained quartzite</td>
<td>Xapiphyllum parvifolium</td>
<td>Leather thong (rehafted with fibrous plant twine)</td>
<td>42 × 30 × 8 Hide</td>
<td>3</td>
<td>Binding detached, rehafted, tip damage on deflection from hide</td>
</tr>
<tr>
<td>115</td>
<td>Fine-grained chert</td>
<td>Commercial dowel</td>
<td>Sinew, twine (rehafted with fibrous plant twine)</td>
<td>52 × 38 × 9 Hide</td>
<td>3</td>
<td>Haft split longitudinally, rehafted, deflected from hide</td>
</tr>
</tbody>
</table>

as a hafted spearhead comes from Umm el Tlel in Syria, where a medial fragment of the object was found embedded in the vertebra of a wild ass (Equus africanus). In South Africa, MSA points have never been found attached to hafts. Only one occurrence indicates the possible use of a point as the tip of a hunting spear. A fragment of what could be interpreted as a stone point was found lodged in the vertebra of an extinct giant buffalo (Pelorovis antiquus) recovered from Cave 1 at Klasies River Mouth in the southeastern Cape of South Africa.

Background to our experiments

A multi-faceted research project was conducted on 50 retouched points and point fragments from the post-Howiesons Poort MSA layers of Sibudu Cave in KwaZulu-Natal. Optically stimulated luminescence dating indicates ages of between 51 800 ± 2100 and 61 500 ± 2200 years ago for the layers from which most of the examined points were excavated. To establish possible impact-use, the results and definitions established by Fisher et al. for recognizing diagnostic impact fractures (fractures that can occur only through longitudinal impact/projectile use) were used to analyse the sample. For the definition of fracture termination types, the reader is referred to the report of the Ho-Ho Committee presented at the Vancouver Use-Wear Conference.

In the experiments of Fisher et al., hafted points were shot with a bow into animal carcasses. Two quite different types of points, with a wide range of edge shapes, were used. The morphology of the points did not seem to affect the fracture types. Diagnostic impact fractures were found on their experimental sample, and also on a large number of prehistoric flint points of different age, size and shape, thereby suggesting that the defined characteristics of impact function are universal for points of flint and related stone — irrespective of tool morphology and hafting methods. Odell and Cowan obtained similar results on chert, whereas Shea identified impact-wear on Levallois blades, triangular flakes and pointed blades, confirming also that morphology does not influence fracture type. The explanation for this uniformity is found in the physical limitations of the initiation and path of fractures in brittle materials.

Diagnostic impact fractures comprise step terminating bending fractures and any bending fractures from which bifacial spin-off fractures or unifacial spin-off fractures larger than 6 mm initiate. We add burin-like spin-off fractures to the last type based on our own findings as well as on those of other researchers. Bergman and Newcomer pointed out that impact burination may be indistinguishable from intentionally made burins. After
scrutinizing tools from Sibudu Cave, as well as our own experimental examples, it was evident that impact burination lacks the small percussion bulbs on spalls or negative percussion bulbs on points that are present with intentional burination (P. Villa, pers. comm.).

For both the Sibudu sample and the preliminary analysis of our experimental material, we considered diagnostic impact fracture types as the only criteria for spear-use, although other fracture types were also recorded during impact experiments. Using only diagnostic impact fracture types provides the minimum number of points in a sample investigated as impact tools. Results showed that 42% of the Sibudu Cave points and point fragments displayed diagnostic impact fractures. Most of the tools were of fine-grained hornfels, so we applied these outcomes to a larger variety of local raw materials and also, by implication, tested and potentially extrapolated the universality of the Fisher et al. results beyond flint and flint-like raw materials. Furthermore, the analysis of the Sibudu sample also indicated distinct patterning of vegetal and faunal residues that could be tested through experimentation.

### The experiments

#### The design and recording methods

For the experiments, 47 convergent stone flakes were prepared from raw materials of various grain sizes similar to those known

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**Table 2. Details of the lithics hafted as spears, and field notes on the throwing experiment.**

<table>
<thead>
<tr>
<th>Point no.</th>
<th>Raw material</th>
<th>Haft material</th>
<th>Binding material</th>
<th>Length × width × thickness (mm)</th>
<th>Contact materials</th>
<th>Duration (× throws)</th>
<th>Field notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>201</td>
<td>Fine-grained quartzite</td>
<td>Canthium inerme</td>
<td>Bark and sinew</td>
<td>35 × 25 × 6</td>
<td>Hide, fat, muscle tissue, bone</td>
<td>2</td>
<td>Tip damage, penetrated hide</td>
</tr>
<tr>
<td>202</td>
<td>Fine-grained quartzite</td>
<td>Canthium inerme</td>
<td>Leather thong</td>
<td>35 × 30 × 10</td>
<td>Hide, fat, muscle tissue</td>
<td>6</td>
<td>Binding loosened after three throws, refashioned, fractured, penetrated hide</td>
</tr>
<tr>
<td>203</td>
<td>Fine-grained quartzite</td>
<td>Commercial dowel</td>
<td>Fibrous plant twine</td>
<td>37 × 34 × 10</td>
<td>Hide, fat, muscle tissue, sinew</td>
<td>2</td>
<td>Tip fracture, penetrated hide</td>
</tr>
<tr>
<td>204</td>
<td>Fine-grained quartzite</td>
<td>Commercial dowel</td>
<td>Sinew</td>
<td>41 × 23 × 9</td>
<td>Hide, fat, muscle tissue, bone</td>
<td>2</td>
<td>Tip damage on contact with bone</td>
</tr>
<tr>
<td>205</td>
<td>Fine-grained quartzite</td>
<td>Tapiphyllum parivilium</td>
<td>Sinew</td>
<td>53 × 21 × 7</td>
<td>Hide, muscle tissue, bone</td>
<td>1</td>
<td>Fractured on contact with wood</td>
</tr>
<tr>
<td>206</td>
<td>Fine-grained hornfels</td>
<td>Commercial dowel</td>
<td>Leather thong</td>
<td>42 × 23 × 8</td>
<td>Hide, muscle tissue</td>
<td>10</td>
<td>Tip damage, penetrated hide, lasted all ten throws</td>
</tr>
<tr>
<td>207</td>
<td>Fine-grained quartzite</td>
<td>Commercial dowel</td>
<td>Fibrous plant twine</td>
<td>34 × 22 × 6</td>
<td>Muscle tissue, bone</td>
<td>2</td>
<td>Tip damage on contact with bone</td>
</tr>
<tr>
<td>208</td>
<td>Fine-grained quartzite</td>
<td>Commercial dowel</td>
<td>Fibrous plant twine</td>
<td>35 × 21 × 5</td>
<td>Hide</td>
<td>3</td>
<td>Tip damage on deflection from hide</td>
</tr>
<tr>
<td>209</td>
<td>Fine-grained quartzite</td>
<td>Commercial dowel</td>
<td>Fibrous plant twine</td>
<td>34 × 25 × 6</td>
<td>Hard wood</td>
<td>1</td>
<td>Fractured on contact with wood (target missed)</td>
</tr>
<tr>
<td>210</td>
<td>Fine-grained quartzite</td>
<td>Commercial dowel</td>
<td>Fibrous plant twine</td>
<td>36 × 21 × 6</td>
<td>Muscle tissue, sinew, bone</td>
<td>3</td>
<td>Fractured on contact with bone, small tip lodged in scapula</td>
</tr>
<tr>
<td>211</td>
<td>Fine-grained quartzite</td>
<td>Commercial dowel</td>
<td>Sinew</td>
<td>32 × 19 × 5</td>
<td>Hide, muscle tissue</td>
<td>2</td>
<td>Fractured on contact with hide, medial portion penetrated hide</td>
</tr>
<tr>
<td>212</td>
<td>Fine-grained quartzite</td>
<td>Canthium inerme</td>
<td>Sinew</td>
<td>43 × 12 × 10</td>
<td>Muscle tissue, cartilage</td>
<td>1</td>
<td>Fractured on contact with cartilage</td>
</tr>
<tr>
<td>213</td>
<td>Medium-grained quartzite</td>
<td>Tapiphyllum parivilium</td>
<td>Sinew</td>
<td>51 × 19 × 7</td>
<td>Muscle tissue, sinew, bone</td>
<td>3</td>
<td>Severe fracturing on contact with bone</td>
</tr>
<tr>
<td>214</td>
<td>Fine-grained chert</td>
<td>Tapiphyllum parivilium</td>
<td>Bark</td>
<td>36 × 21 × 5</td>
<td>Muscle, bone</td>
<td>1</td>
<td>Tip damage on contact with bone</td>
</tr>
<tr>
<td>215</td>
<td>Medium-grained quartzite</td>
<td>Canthium inerme</td>
<td>Sinew</td>
<td>50 × 32 × 7</td>
<td>Hide, muscle tissue, bone</td>
<td>7</td>
<td>Fractured on contact with bone, penetrated hide</td>
</tr>
<tr>
<td>216</td>
<td>Coarse-grained quartzite</td>
<td>Commercial dowel</td>
<td>Leather thong</td>
<td>39 × 19 × 7</td>
<td>Hide, muscle tissue, bone</td>
<td>3</td>
<td>Fractured on contact with bone, penetrated hide</td>
</tr>
<tr>
<td>217</td>
<td>Medium-grained quartzite</td>
<td>Commercial dowel</td>
<td>Fibrous plant twine</td>
<td>37 × 20 × 5</td>
<td>Muscle tissue, sinew, bone</td>
<td>2</td>
<td>Severe fracturing on contact with bone</td>
</tr>
<tr>
<td>218</td>
<td>Fine-grained mudstone</td>
<td>Commercial dowel</td>
<td>Fibrous plant twine</td>
<td>40 × 26 × 8</td>
<td>Hide</td>
<td>1</td>
<td>Tip damage on deflection from hide</td>
</tr>
<tr>
<td>219</td>
<td>Fine-grained hornfels</td>
<td>Commercial dowel</td>
<td>Leather thong</td>
<td>41 × 24 × 5</td>
<td>Muscle tissue, fat, bone</td>
<td>10</td>
<td>Tip damage on contact with bone, lasted all ten throws</td>
</tr>
<tr>
<td>220</td>
<td>Fine-grained chert</td>
<td>Canthium inerme</td>
<td>Bark, leather thong</td>
<td>40 × 32 × 8</td>
<td>Muscle tissue, fat, bone</td>
<td>1</td>
<td>Tip damage on contact with bone</td>
</tr>
</tbody>
</table>
African artefacts. They may be universal for a wide range of points, including southern African artefacts. Experimental research, the manufacture of hafts forms a research topic in itself, which falls outside the scope of our experiments. According to the most recent example of hafting was used, that is, direct fixing of the stone implement with bindings (Fig. 1). Hafting workshops were undertaken under controlled conditions in a laboratory to prevent any unnecessary contamination or damage to the lithics. Commercial dowel sticks and other hafted points were fashioned from woods of different diameters were used (Tables 1–3). Some of the woods were commonly used by recent hunter-gatherers. The 35 spear specimens were attached to the prepared shafts of about 1200 mm length, and the 12 specimens selected for butchery onto short knife handles. The most basic example of hafting was used, that is, direct fixing of the stone implement with bindings (Fig. 1). According to the most recent experimental research, the manufacture of hafts forms a research topic in itself, which falls outside the scope of our experiments. Fibrous plant twine, bark, leather thongs and sinew served as binding materials. Following Shea25 and Rots,24 the hafts were notched to accommodate the butt of the lithic. This procedure overcame the problem of the stone tool moving backwards or splitting the haft during use. It also generated a surface against which the tool could be secured, thereby considerably improving the strength of the hafting arrangement. As with recent hafting experiments,24 the binding materials were moistened before application. Moistened bindings expand and become more pliable, thereby facilitating hafting, and subsequently contract to their original volume upon drying. This shrinkage, and the fact that individual strands on drying tend to adhere to each other, firmly secured the tool onto its haft.

Based on the locations of macro-fractures, micro-wear denoting hafting, and the distribution of residues on the analysed Sibudu sample, the binding materials were accordingly applied to make contact with at least the proximal third of the convergent flakes. The shafts were placed with the wood extending approximately halfway onto the flakes. Although Plisson and Beyries17 argued that bindings on the lithic itself inhibit penetration and may be cut on impact, 52% of the Sibudu Cave sample displayed clusters of bending fractures located on the medial and proximal laterals (the sharp edges along the sides of the middle and butt ends of the tools). This indicated that binding materials were used directly on the lithics from this site during the MSA.26

Experiment 1: thrusting replicated spears into a carcass portion

A target was created by fixing the forequarter of a blue wildebeest (Connochaetes taurinus), with the hide intact, to a heavy log placed horizontally onto a cleared space in the open to simulate an animal trapped in a pit. Plastic sheeting was placed under the target to enable the collection of stone fragments for subsequent analyses. Following Schmitt et al.,27 the spears were thrust using two hands into the target as forcefully as possible with the

Table 3. Details of the lithics hafted as knives and their use in the butchery experiment.

<table>
<thead>
<tr>
<th>Point no.</th>
<th>Raw material</th>
<th>Haft material</th>
<th>Binding material</th>
<th>Length × width × thickness (mm)</th>
<th>Action</th>
<th>Contact materials</th>
<th>Duration (× movements)</th>
</tr>
</thead>
<tbody>
<tr>
<td>301</td>
<td>Fine-grained chert</td>
<td>Combretum erythrophyllum</td>
<td>Leather thong</td>
<td>50 × 32 × 13</td>
<td>Scraping</td>
<td>Bark of Euclia sp.</td>
<td>124</td>
</tr>
<tr>
<td>302</td>
<td>Course-grained quartzite</td>
<td>Eucalyptus sp.</td>
<td>Fibrous plant twine</td>
<td>92 × 12 × 12</td>
<td>Cutting</td>
<td>Connective tissue</td>
<td>12</td>
</tr>
<tr>
<td>303</td>
<td>Fine-grained quartzite</td>
<td>Combretum erythrophyllum</td>
<td>Leather thong</td>
<td>50 × 48 × 10</td>
<td>Scraping</td>
<td>Inside of hide</td>
<td>100</td>
</tr>
<tr>
<td>304</td>
<td>Fine-grained quartzite</td>
<td>Canthium inerme</td>
<td>Sinew</td>
<td>45 × 21 × 5</td>
<td>Cutting</td>
<td>Hide</td>
<td>14</td>
</tr>
<tr>
<td>305</td>
<td>Coarse-grained quartzite</td>
<td>Eucalyptus sp.</td>
<td>Sinew, leather thong</td>
<td>48 × 36 × 10</td>
<td>Cutting, peeling</td>
<td>Starchy plant (raw potato)</td>
<td>12 (peeling) &amp; 23 (cutting)</td>
</tr>
<tr>
<td>306</td>
<td>Fine-grained hornets</td>
<td>Combretum erythrophyllum</td>
<td>Leather thong</td>
<td>48 × 24 × 10</td>
<td>Cutting</td>
<td>Connective tissue, ligament</td>
<td>172</td>
</tr>
<tr>
<td>307</td>
<td>Fine-grained quartzite</td>
<td>Canthium inerme</td>
<td>Sinew</td>
<td>35 × 20 × 8</td>
<td>Cutting</td>
<td>Bone</td>
<td>77</td>
</tr>
<tr>
<td>308</td>
<td>Fine-grained quartzite</td>
<td>Combretum erythrophyllum</td>
<td>Leather thong, fibrous plant twine</td>
<td>58 × 50 × 13</td>
<td>Scraping</td>
<td>Outside of hide, hair</td>
<td>125</td>
</tr>
<tr>
<td>309</td>
<td>Medium-grained quartzite</td>
<td>Combretum erythrophyllum</td>
<td>Leather thong</td>
<td>50 × 35 × 9</td>
<td>Cutting</td>
<td>Muscle tissue</td>
<td>74</td>
</tr>
<tr>
<td>310</td>
<td>Fine-grained quartzite</td>
<td>Eucalyptus sp.</td>
<td>Leather thong</td>
<td>41 × 27 × 7</td>
<td>Sawing</td>
<td>Hide</td>
<td>More than 100 actions</td>
</tr>
<tr>
<td>311</td>
<td>Fine-grained hornets</td>
<td>Canthium inerme</td>
<td>Leather thong</td>
<td>77 × 48 × 10</td>
<td>Scraping</td>
<td>Bone</td>
<td>214</td>
</tr>
<tr>
<td>312</td>
<td>Fine-grained quartzite</td>
<td>Combretum erythrophyllum</td>
<td>Leather thong</td>
<td>81 × 35 × 15</td>
<td>Cutting</td>
<td>Cartilage, bone</td>
<td>92</td>
</tr>
</tbody>
</table>

Fig. 1. Example of a replicated hafted spear. This fine-grained quartzite flake, 52 mm long, was bound with sinew to a shaft of Canthium inerme, which was notched to accommodate the stone tool.
intention of fracturing and/or scarring the tools. Ten thrusting
sessions were allowed for each spear, or the spear discarded as
soon as the projectile point sustained damage. This procedure
allowed for maximum breakage of points or enough impact and
friction to damage the proximal (end of the tool from which the
flake was struck from the core) part of the lithic.

Several thrusts were directed against the intact hide before this
was removed, and further experiments targeted the muscle and
bone, especially the scapular area. At the end of each procedure
the stone point was detached with minimum handling of the
specimen. Hafting elements retained on the projectile points
were left intact for subsequent sampling in the laboratory.
Table 1 provides information on the materials and other details
of the experiment.

Experiment 2: throwing replicated spears into a carcass
For this experiment the same procedure was followed as for
experiment 1. However, instead of thrusting the spears into the
rib cage, they were thrown from a distance of approximately
3–4 m. Table 2 provides information on the replicated artefacts
and the experiment.

Experiment 3: skinning and butchery activities
The third experiment focused on the use of replicated hafted
MSA points for butchering. The butchery experiment compared
the residue distribution patterns with those that resulted from
hunting activities. One forelimb from the carcass was systemati-
cally butcheted with the hafted knives. The various tasks
performed included skinning, removing muscle tissue from the
core, disarticulating the bones, scraping the bones clean, and
scraping both the inside and outside of the skin. Only one action
was performed with each knife in order to establish use-wear
data. As each knife became blunt, it was set aside to dry in air, and
subsequently detached from its handle and placed in an airtight
plastic bag. The experiment was conducted in the open, where
natural contamination from soil and plant material could affect
the process and thus the results of the residue analysis.

Field results and observations during experimentation
During the hunting experiments, the hide occasionally inhib-
ited easy penetration, with a number of thrown spears deflected
directly from the target on contact. This was primarily attributed to the
stiffened carcass, and the flaccid surface of the hide caused by
the sectioning of the carcass. However, deflection may also
have been a feature of prehistoric hunting practices, and so the
consequences for macro-fractures and micro-wear should also
be investigated. Once a point penetrated the hide, the spear-
heads passed through muscle and sinew with relative ease. We
clearly demonstrated that such tools directed into a trapped
animal might produce potentially lethal wounds (Fig. 2).

Approximately halfway through the experiments the hides were
removed from the targets to ensure the spear’s contact with
bone on impact.

The two-handed thrusting technique proved effective for both
male and female experimenters and the points often penetrated
depthily into the target (Table 1). This indicates that during prehis-
toric times women and smaller or younger males could have
contributed to killing trapped animals with spears. The field
results (Tables 1 and 2) also show that fine-grained quartzite
and hornfels were particularly successful in penetrating the hide. It
is noteworthy that the two hornfels samples used in the throwing
experiment survived all 10 throws without sustaining severe
damage.

Two of the hafts used for experiment 1 exhibited extensive
damage after initial impact (see Table 1) and the lithics had to be
rehafted to continue with the experiment. Both these hafts had
been split to accommodate the lithics, as opposed to the recom-
mended notch method. During experiment 1, the binding
material loosened on three of the projectiles following a number of
thrusts, and rebinding was required (Table 1). This problem
was encountered with only one of the spears in experiment 2
and one of the knives used in experiment 3, illustrating that
stronger hafting arrangements are required for stabbing imple-
ments than for throwing or butchering tools. Binding materials
that loosened during experimentation included bark, sinew and
leather thongs. The only binding material that did not loosen
was the cotton twine; although of commercial manufacture, it
emphasizes the likely use of plant fibres as a useful binding
material in prehistory. The detailed residue analysis of the
Sibudu Cave points shows concentrations of plant fibres on the
proximal and medial lateral edges, supporting this assumption.

Only 10 stone points were necessary to perform the various
butchery tasks efficiently. The amount of time required for all the
actions was remarkably short and the efficacy of the stone knives
noteworthy. The remaining two stone points were used in
experiment 3 for scraping and cutting plant materials as a control
measure (Table 3).

Preliminary macro-fracture results
First, we provide a summary of the main outcomes of the
Fisher et al. experiments. Second, a summary of their results, our
preliminary data and experience with the Sibudu Cave archaeo-
logical sample is presented as a table. We then examine our
experimental and archaeological results within this framework.
The position of the fractures on the points is not discussed as
this reflects hafting arrangements and weaknesses in point
morphology or raw materials; further experimentation is
required to draw conclusions about these matters. We use only
diagnostic impact fracture types as criteria irrespective of the
position on the tool. Often impact fractures are not represented
by a single large fracture and multiple scars can occur, some of
which may be diagnostic.

The conclusions of Fisher et al.
Fisher et al. established that macro-fracture analysis could not
be used to identify the kind of material against which points
were directed. All types of fractures — diagnostic impact
fractures and other fracture types — were observed in relation
to shooting animals, fish or wooden objects. Various macro-
Fractures were present on spear points as well as arrowheads, so that the type of delivery could not be identified. All types of diagnostic impact fractures arose on pointed, transverse and intermediate-shaped tools. Projectiles shot into carcasses showed relatively high frequencies of diagnostic impact fractures and several of these occurred on points that did not hit bone. It seemed as though spear-use resulted in higher frequencies of diagnostic impact fractures than arrow-use. Fisher et al. postulated that the identified diagnostic impact fractures also applied to point types other than the ones described in their article. However, they cautioned that tools used for chopping and stabbing are exposed to similar forces, and therefore may show related fractures. Without supporting micro-wear or residue evidence for impact-use, it is advisable to consider the morphology of the objects to be analysed, before hunting is identified.

Fisher et al. analysed 397 excavated flint points of varying age and morphology and showed that the defined macro-fractures characteristic of impact function were present on prehistoric material. This not only applied to the experimental implements, but also to other point types. The frequency of diagnostic impact fractures on prehistoric points was very similar to that in the projectile experiments — between 39% and 42%. Fisher et al. proposed that the chance of the occurrence of diagnostic macro-fractures on points projected into largish animals — like reindeer — is about 40%, irrespective of the species hunted or morphology of the points.1

Experimental and archaeological results of this project

Table 4 summarizes the results obtained by Fisher et al.,1 in our experiments and the Sibudu Cave macro-fracture analysis, using the same diagnostic fractures as analytical criteria. We show the results that Fisher et al.1 obtained for spears separate from those for arrowheads. By comparing their spear results with ours, the close correlation between them is evident. We have not yet tried to differentiate between fracture patterns from our thrusting/stabbing versus throwing experiments. We did, however, confirm that stabbing results in similar diagnostic macro-fracture types to throwing or shooting. Diagnostic impact fractures were evident on all the raw materials included in our experiments (Table 5), and on convergent flakes of various dimensions. This result supports the assumption that the defined characteristics of impact/projectile function are universal for points of flint and related stone — irrespective of morphology and hafting methods. It also demonstrates that medium- and coarse-grained raw materials show similar macro-fracture types to flint and related fine-grained stone. Larger experimental samples of specific raw materials are, however, necessary to draw more precise inferences. We could also confirm that points do not have to hit bone or other hard materials such as wood to display diagnostic impact fractures. Some diagnostic fractures occurred on impact with the hide of the carcass.

Of particular interest is that 42% of the Sibudu Cave sample displayed diagnostic impact fractures. This percentage is very close to the 40% chance of diagnostic macro-fractures developing on points projected into largish animals, as proposed by Fisher et al.1 The preliminary Sibudu Cave faunal analysis conducted by Plug shows that Equus burchelli (zebra) is especially well-represented at the site.28 Other large animal species included in the Sibudu Cave fauna list are: giraffe, grey rhebuck, blue wildebeest, sable/roan, waterbuck and red hartebeest.29 A finer comparison of the fracture patterns of our experiments with that of the Sibudu Cave sample illustrates the similarities and differences between the macro-fracture analyses of the two samples. Figure 3 shows that the patterns are notably similar in terms of diagnostic impact fractures.

Residue distribution patterns

The difference in the distribution of faunal residues on tools used for hunting as opposed to butchering was clearly illustrated.
on our experimental sample. Where convergent flakes were used as spearheads, faunal residues were distributed extensively over the exposed distal parts. The use of similar tools for butchering resulted in concentrations of faunal residues along the working edges. In both instances the hafts and bindings mostly prevented the faunal residues from spreading onto the proximal portions (Figs 4, 5).

Residue analysis of the Sibudu Cave points indicated a distinct distribution pattern of vegetal and faunal residues. Most of the vegetal residues are concentrated on the proximal and medial parts of the points, while faunal residues are concentrated on the surfaces and along the edges of the distal portions. This is consistent with spearhead-use. Figure 6 illustrates some of the residues observed on the experimental sample compared with similar residues on the Sibudu archaeological sample. The experimental residues were photographed nine months after the experiments were conducted, and no additional preservation measures were taken than those described in the experimental method. Some of the residues

Fig. 4. Faunal residues clearly concentrated on the distal portion of a convergent flake, 48 mm long, used in the hunting experiment. A fragment of the shaft can also be seen adhering to the tool. The shaft and bindings protected the proximal portion of the lithic from acquiring faunal residues, but it exhibits minute traces of macerated wood from the haft.

Fig. 5. Faunal residues concentrated on the lateral edge of an 85-mm-long tool that was used to simulate butchering activities. This deposit clearly differs in extent from the distribution of faunal residues on spears used for hunting.

Fig. 6. Comparison of deposits on experimental and archaeological stone implements. The residues on the left were photographed nine months after the end of the experiments, whereas on the right similar residues were photographed on tools dating to about 60,000 years ago from Sibudu Cave. (a1) Macerated wood resulting from friction with a shaft: ×50; (a2) macerated wood on the proximal portion of a Sibudu Cave point photographed in cross-polarized light: ×200; (b1) woody residue in cross-polarized light: ×200; (b2) woody residue in cross-polarized light: ×200; (c1) animal tissue: ×50; (c2) animal tissue: ×200; (d1) collagen residue: ×200; (d2) collagen residue: ×200.
in the archaeological sample are more than 60,000 years old. The analysis of soil samples from Sibudu Cave\(^2\) established that the residues on the tools are not similar to those in the matrix, eliminating possible post-depositional contamination.

### Conclusion

This experiment set out mainly to test some of the findings of Fisher et al.\(^1\) on raw materials and points similar in morphology to MSA assemblages from southern Africa. A second aim was to compare the residue distribution patterns with those found on the Sibudu Cave archaeological sample. In the process more general results were obtained with regard to the effectiveness of the tools, raw materials and hafting arrangements. Hornfels tools performed particularly well during the throwing experiment. This illustrates that experimentation may also be used to explore why certain raw materials were selected during prehistory.

Problems and solutions regarding hafting were also highlighted. Hafting arrangements where the prescribed notched hafts were not used and the hafts were split did not perform well during impact experiments and may inform on prehistoric hafting techniques. Fibrous plant twine proved to be the most durable binding material.

The applicability of the results of Fisher et al.\(^1\) as an analytical tool for MSA point research is clearly illustrated. Many of their findings were confirmed by our own results and by comparing them to the Sibudu Cave archaeological material. The multifaceted approach used for the interpretation of the Sibudu Cave sample provided macro-fracture, use-wear and residue evidence for their use as spearheads.\(^3\) This may, however, not be the case for other sites or for older samples from the same site.

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