THE EVOLUTION OF BONE POINTS AS HUNTING WEAPONS IN SOUTH AFRICA

Justin Sean Bradfield

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DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the Degree of Master of Science to the University of the Witwatersrand, Johannesburg. It has not been previously submitted for any degree or examination at any other university.

Signed: _________________

Justin Bradfield

Date: _________________

ABSTRACT

The use of formally fashioned bone points as possible components in hunting weaponry has been seen as a marker of behavioural modernity. Unfortunately, their interpretation as hunting weapons, up to now, has been based on morphological analogy with recent hunter-gatherer artefacts. Many studies conducted over the last 30 years have focused on identifying criteria that can be used to establish the function of stone points. There have been no similar macro-fracture studies conducted on bone points thought to have been part of complex weapon systems. This study aims to combine the morphological approach to studying bone points, with macro-fracture analysis. Macro-fracture analysis has been successfully used to discern pointed stone tools that were subjected to longitudinal impact, the most likely cause of which is hunting. This approach was adopted to test whether the same technique is applicable to bone points and whether the bone points that are found in the archaeological record, as far back as *c.* 77 ka ago at Blombos Cave, were used as hunting weapons. The study involved the replication of a range of bone points that were used in an experiment designed to cause impact consistent with that of hunting scenarios. The experiment tested hand-thrust and mechanically projected bone points. The results of this experiment showed that macro-fractures develop similarly on bone points as on stone points. The morphological study of bone points from one ethnographic collection and eight archaeological assemblages, spanning Middle Stone Age (MSA) and Later Stone Age (LSA) periods, confirmed an earlier observation made in the Cape – that there may be some degree of patterning in the overall dimensions of bone points across the landscape. Furthermore, the study showed that all the bone points from MSA assemblages, with the exception of Blombos Cave, fall within the size range of ethnographic arrow tips. The results of the macro-fracture analysis on archaeological and ethnographic samples suggest that bone points from the MSA levels at Blombos, Peers and Sibudu Caves may have been subject to longitudinal impact and as such could have used for hunting purposes, but whether they functioned as part of spears or arrows remains uncertain.

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BBC – Blombos Cave
BRS – Bushman Rock Shelter
DIF – Diagnostic impact fracture
EXP – Experimental
HP – Howieson’s Poort industry
ka – *Kilo annum*
LSA – Later Stone Age
MSA – Middle Stone Age
Mya – Million years ago
NBC – Nelson Bay Cave
RCC – Rose Cottage Cave
Rev. - Reversible
Rob. - Robust
SAM – South African Museum
TCSA – Tip Cross Sectional Area

CHAPTER 1

INTRODUCTION

The role of bone tools as defining traits in human cultures is often an understated and understudied aspect in archaeology. Usually no more than a cursory mention is given to them in site reports (e.g. Cable 1984; Opperman 1987; Mazel 1989, 1996, 1997). The reason for this is that, in the past, we have tended to overlook that which is under-represented in excavated assemblages – thereby basing behavioural and technological interpretations on stone tools. Ethnographic and historical studies of southern African hunter-gatherer societies show that a significant portion of their cultural material comprises bone tools (Wiessner 1983; Wanless 2007; Petillon *et al.* 2008; also see Campbell 1815; Stow 1905; Schapera 1965). There is no reason to believe that this should not have been the case in the past.

The role of formally fashioned bone points as markers of behavioural modernity has been a contentious issue (see McBrearty & Brooks 2000; Mitchell 2002; Marean & Assefa 2005 for a discussion). Until recently, it was thought that bone points were only associated with Later Stone Age (LSA) peoples and represented a degree of modern cognition (Klein 2000; Klein & Edgar 2002). However, recent research has shown that formally made bone points are present in Middle Stone Age (MSA) deposits from *c.* 77 ka (Henshilwood *et al.* 2001a, b; d'Errico & Henshilwood 2007; Backwell *et al.* 2008). The practice now is to examine the role specific artefact types played in a society rather than emphasising their mere presence in an archaeological assemblage (H. Deacon 1995; Wadley 2001).

Previous studies of bone points from southern Africa relied on morphometric comparisons with ethnographic samples, on use-wear studies and on the methods of manufacture of the pieces to determine function (e.g. Henshilwood *et al.* 2001b; d'Errico & Henshilwood 2007; Backwell *et al.* 2008). Explicit functional studies of bone points that have tested hunting use have been relatively limited (e.g. Lombard &

Parsons 2008). In addition, no experimental studies have been conducted on bone points that test for hunting impact damage.

1.1. The aims of this study

The primary aim of this study is to find a method that can start to discern pointed bone tools that were used for hunting activities from ones that served other purposes. I decided to adopt a macro-fracture approach, based on the success of this approach in identifying stone tipped hunting weapons (e.g. Fischer *et al.* 1984; Odell & Cowan 1986; Shea 1988, 2006; Dockall 1997; Lombard *et al.* 2004; Lombard 2003, 2005; Villa & Lenoir 2006; Pargeter 2007; Lombard & Pargeter 2008; Sisk & Shea 2009; Villa *et al.* 2010; Yaroshevich *et al.* 2010; but see Chapter 4 for further detail). The reason for this study has, in a sense, been precipitated by the recent discovery of cylindrical pointed bone tools from MSA levels at Blombos Cave (Henshilwood & Sealy 1997; Henshilwood *et al.* 2001a, b; d'Errico & Henshilwood 2007) and Sibudu Cave (Backwell *et al.* 2008), which, based primarily on their morphological similarity with ethnographic Bushman bone points, have been interpreted as tips of hunting weapons.

Based on the results of the macro-fracture analyses on a variety of pointed bone artefacts, I assessed whether bone points from the MSA and LSA could have functioned similarly to bone points of known function from an experimental sample and ethnographic collection. I also assessed whether, and to what extent, diagnostic impact fractures (DIFs) occur on mechanically projected bone points, i.e., projectiles (arrows or darts projected with bows or spear throwers), compared to pointed bone tools that were hand-thrust or thrown, i.e., spears (e.g. Lombard & Phillipson 2010, Sisk & Shea 2009). Finally, by measuring bone points from different ages and from different sites across South Africa, I aimed to see whether there are any morphological changes in bone points over time and place.

1.2. Methods

Macro-fracture analysis, which is a branch of fracture mechanics that deals with the breakage properties of brittle solids like bone and stone, provides one avenue to explore whether bone points could have been used to tip hunting weapons. Macro-fracture analyses have been applied successfully to explore the potential hunting function of stone tools (see Chapter 4), and I follow the methods outlined in these studies, specifically that of Fischer *et al.* (1984).

In order to provide a baseline of fractures likely to accrue on bone points as a result of hunting use, I conducted an experiment to simulate hunting with bone point tipped arrows and spears. The details of this experiment are given in Chapter 4. The results of this experiment are compared with published macro-fracture results on stone point weapons used in similar modes of delivery. The type and frequency of macro-fractures from my experiment, together with those on an ethnographic collection of bone tipped arrows, are then used to assess the type and probable cause of fractures on pointed bone tools from eight archaeological collections, ranging in age from *c.* 77 ka ago to within the last century.

This study may have the potential to expand on our understanding of the origins of projectile hunting technology, which in turn has implications for our understanding of modern cognition (McBrearty 2007; Sisk & Shea 2009; Lombard & Philipson 2010). If it can be shown that specific fracture types or fracture combinations commonly result from one mode of delivery and not another, then the presence of these fractures would support the use of a specific hunting method rather than another. Recently, many studies have focused on methods for identifying archaeological stone tools that may have been used for hunting purposes (see Chapter 4). Here I offer criteria that may be used to help identify bone points that were used as hunting weapons, specifically as parts of multi-component arrows.

1.3. The important role of bone points in projectile technology

Projectile weapon elements 'play a dynamic role in prehistoric material culture...[and] constitute a useful tool for archaeologists in the construction of chronologies and the definition of cultures' (Petillon *et al.* 2008: 1). The first appearance of projectile technologies in southern Africa has been widely debated. Shea (2006) has argued, based on ballistic morphometry, that stone tipped projectiles were not used prior to *c.* 40 ka ago, whilst Brooks and colleagues (2006) have argued that the small size of MSA lithic points implies the existence of complex projectile technology by at least *c.* 75 ka ago in Africa (McBrearty 2007). Recent use-trace studies on stone points supports the early use of arrows at least 64 ka ago in southern Africa (Lombard & Pargeter 2007; Lombard & Parsons 2008; Lombard & Phillipson 2010), and spears from perhaps as early as 100 ka (Lombard 2005; Lombard 2007; Villa & Lenoir 2006; Villa *et al.* 2009; Villa *et al.* 2010).

The specific role of bone points as part of composite weaponry has been an under-developed area of research. During the 1980s and early 1990s, it was generally assumed that formally made bone tools were first associated with LSA technologies (Thackeray 1992; Klein 2000; Klein & Edgar 2002) and that their appearance in MSA sites was anomalous (e.g. Singer & Wymer 1982). Further, their possible role in projectile weaponry was also neglected; it being assumed that early bone points would have functioned as awls (Klein 1999).

The bone points from Blombos Cave, Sibudu Cave and Peers Cave have gone a long way in dispelling these perceptions (see Henshilwood & Sealy 1997; Henshilwood *et al.* 2001b; d'Errico & Henshilwood 2007; Backwell *et al.* 2008). Recent studies have focused on the possible role of bone points in Stone Age hunting equipment, specifically as components of composite projectile weapons (e.g. Lombard & Parsons 2008). Bone has several advantages over stone when it comes to weapons. Bone is more durable and easier to repair (Knecht 1997). It is, however, more time consuming to prepare and requires more investment of energy. I discuss the properties of bone on Chapter 4, page 59.

Ethnographically we know, however, that not all bone points were used purely as hunting weapons. Highly polished bone points and marked link-shafts were sometimes traded between communities as part of the *Hxaro* system (Weissner 1983). I discuss this aspect in greater detail in Chapter 2. In the chapters that follow I present an overview of our knowledge of pointed bone tools in the archaeological record of southern Africa. I then present a brief description of the archaeological sites from which my samples come. Then, I present a discussion of the macro-fracture analysis method which I have used. This is followed by a chapter on the hunting experiment on which the rest of the analysis is based. Finally, I present my morphometric and macro-fracture analyses chapters and the final discussion of my results.

CHAPTER 2

BACKGROUND ON THE TYPES AND USES OF BONE POINTS IN SOUTH AFRICA

2.1. Introduction

In this chapter I review our knowledge of bone points from the archaeological and ethnographic records. I focus specifically on the possible use of bone points in subsistence practices and how these bone points differ from each other and change over time. The earliest evidence in southern Africa for the use of bone tools comes from Swartkrans in the Cradle of Humankind and dates to 1.8 mya (Backwell & d'Errico 2005). However, there is no evidence at this time to suggest that bone tools were deliberately manufactured, although seven specimens do show evidence of resharpening (d'Errico & Backwell 2003). Rather, their pointed shape and faint polish seems to be the result of use-wear from activities like digging for tubers and termites (Backwell & d'Errico 2005).

The first evidence we have of deliberately manufactured pointed bone tools and bone points in the archaeological record of South Africa comes from the Still Bay (*c.* 75 – 77 ka) levels at Blombos Cave in the Western Cape Province (Henshilwood *et al.* 2001a, b; d'Errico & Henshilwood 2007), and from the Howieson's Poort (> 61 ka) levels at Sibudu Cave in KwaZulu-Natal (Wadley 2008; Backwell *et al.* 2008). All the pointed bone tools from these MSA contexts show clear evidence of having been manufactured with the foresight to aid in function.

The precocious nature of bone points at MSA sites, like Blombos Cave and Sibudu Cave, and the high polish on some of these points, compared with associated awls, may indicate that these tools were seen differently in the eyes of their makers and may have functioned as projectile weapons (d'Errico & Henshilwood 2007). The use of projectile hunting technology, such as bows or atlatls, greatly improves efficiency and requires a greater degree of technical skill than spear hunting. Projectile technology is the use of an intermediary object to propel an arrow, dart or spear (see Knecht 1997; Sisk & Shea 2009).

A variety of pointed bone tools have been recovered ethnographically and archaeologically. Pointed bone tools range in shape from long thin cylindrical points to thick irregularly shaped slivers of bone with a pointed tip and from short conically tapering points to flat elliptical points. The different types of pointed bone artefacts have been assigned functional categories based on their morphology and on ethnographic analogy. Some pointed bones are thought to have been awls and needles and used for domestic purposes whilst others are thought to have been used to tip arrows for hunting (e.g. Sampson 1974; H. Deacon 1976; J. Deacon 1984; Wadley 1993; Deacon & Deacon 1999; Mitchell 2002). Bone points are usually made by shaping both ends and working most or the entire surface of a bone splinter to form a tool with a finely tapering, pointed tip at one end and a squared-off or blunted butt at the other (Goodwin and van Riet Lowe 1929). This criterion has been used to differentiate hunting points from domestic points which were usually not worked over their entire surface, and link-shafts which were tapered at both ends.

2.2 Bone tool terminology

The term pointed bone tool, as used in this study, encompasses all manner of bone artefacts that terminate in a point created by deliberate anthropogenic modification. Pointed bone tools include cylindrical points, flat points, broad points, irregular points and double tapering points. However, the literature does not refer to bone artefacts by their shape classes; instead, it seems to be an accepted convention to refer to bone tools by assumed functional names (e.g. Cable 1984; J. Deacon 1984; Opperman 1987; Deacon & Deacon 1999; Mitchell 2002). These functional names include terms such as arrows (or simply bone points), spears, awls, needles, fish gorges and link-shafts. In this study I follow the standard terminology for the sake of comparability. However, I do not necessarily mean that a ‘needle’, for instance, functioned as such. Rather, I am referring to an artefact that is morphologically similar to artefacts that are commonly referred to as ‘needles’ in the literature. Table 1 presents the terms used to describe the various forms of pointed bone tools in the literature and a morphological description of each one. Figure 1 provides an accompanying illustration to the table.

Table 1. A description of the pointed bone artefacts referred to in this study.

Term	Description
Bone point	Refers to a uni-tapering, cylindrical piece of bone, larger than a ‘needle’. Usually worked over its entire surface. Round to elliptical in cross section.
Link-shaft	A double tapering robust piece of bone, usually cylindrical in cross section.
Awl	An irregularly shaped pointed bone artefact. Usually the proximal epiphysis is still attached and manufacture is focused on the tip.
Spear	A broad piece of bone roughly worked to a point at one end. Usually irregular in cross-section.
Fish-gorge	A small diamond shaped double tapering piece of bone. It is usually flat in cross section and has its widest diameter in the centre.
Needle	An extremely thin cylindrical piece of bone. Manufacture is usually focused on the tip but may occur over the entire length.
Matting needle	A narrow flat piece of bone. The tip is usually oblique and not sharp. Some specimens may have a notch at the base to facilitate the attachment of twine etc.

Figure 1. A variety of ‘typical’ pointed bone tools. A: an ‘awl’ from Nelson Bay Cave; B: a link-shaft from the Fourie collection; C: a bone point or ‘arrow’ from the Fourie collection; D: a ‘matting needle’ from Leholamogoa rock shelter on the Makgabeng plateau; E: a ‘spear’ from Nelson Bay Cave. Scale is 10 mm.

Although bone points used historically and ethnographically for hunting activities are relatively standardised, some variation in size and application is evident. By application I mean that some bone points were used with the accompaniment of poison whilst others were not. Others may have been used specifically to hunt small animals or birds (e.g. Leslie-Brooker 1989; Noli 1993).

Bone points are more durable and easier to repair than stone but are extremely time consuming to make and, depending on the strength of the bow, considerably less effective in bringing down large prey unless the point is poisoned (Knecht 1997; Henshilwood & Marean 2003; Lombard & Parsons 2008). To warrant the use of this technology it must provide some functional or symbolic advantage over its lithic counterparts. The rest of this chapter explores the role bone points are thought to have played in Stone Age societies, particularly in hunting and subsistence systems. I draw on morphological information about the bone points and the analogical inferences that these morphologies have produced.

2.3. Ethnographic background

Ethnographic observations provide valuable knowledge on the behaviours surrounding traditional hunting practices that can aid in the interpretation of archaeological finds. Of interest to this study are the hunter-gatherer populations with whom early European colonists had contact and who managed to maintain some of their traditional ways of life until the 1970s (Smith *et al.* 2000).

2.3.1. Bone points and their preservation

In most cases bone points and pointed bone artefacts have been curated in private and museum collections; traditional paraphernalia collected from extant hunter-gatherer groups during the latter half of the twentieth century by ethnographers and private persons. Such an example is the Fourie collection, comprising over five thousand artefacts from various hunter-gatherer groups in the Kalahari and Kaukau Veld, Namibia.

The majority of these pointed bone tools are intact and well preserved as only the intact 'pristine' specimens would have been collected. Often, bone points are accompanied by the rest of the arrow and occasionally the bow itself; items which rarely, if ever, survive in archaeological deposits. This association of bone points and other utensils, as well as ethnographic eye-witness accounts, allows us a unique insight into how the various pointed bone tools were used and the different forms the tools took for different functions.

2.3.2. The different forms of pointed bone artefacts

Many types of pointed bone tools are present in ethnographic collections. They range in shape from the tapering cylindrical points that are well worked over their entire surface (Goodwin & van Riet Lowe 1929; Goodwin 1945; Clark 1977; Wanless 2007) to more irregularly shaped and less well finished awls and matting needles (Goodwin & van Riet Lowe 1929; Deacon & Deacon 1999; Smith *et al.* 2000; Mitchell 2002). The former pointed bone types were used in composite projectile weaponry (Schapera 1927; Goodwin 1945; Vinnicombe 1971; Clark 1977; Noli 1993; Wanless 2007). They are symmetrical, and of round to oval cross section, in contrast to the other types of bone artefacts such as needles, awls or fish gorges which are usually irregular or elliptical in cross section (Inskeep 1987: 164).

Ethnographic hunter-gatherer arrows were often of composite formation, consisting of a main-shaft, link-shaft and an arrow-head (see Figure 18: 106). The main-shaft was usually made from straightened reed or hard wood. The link-shaft, if present, allowed the point to detach from the main-shaft. In doing so, the point was prevented from being pulled out due to the movement of the fleeing animal after being hit. With the point stuck in the animal, there was enough time for the poison on the point, if present, to be absorbed into the blood stream. The tip, depending on the material used for the main-shaft was usually made of bone, stone or fire-hardened wood fastened to the main-shaft or link-shaft with sinew or twine (Schapera 1927; Goodwin 1945; Vinnicombe 1971; Clark 1977; J. Deacon 1992; Hitchcock & Bleed 1997; Nelson 1997; Wanless 2007). The different arrow types may reflect differences in the type of animals hunted (Goodwin 1945), hunting techniques (H. Deacon 1976; Backwell *et al.* 2008), or cross-cultural relationships (Clark 1977).

Two types of bone pointed arrows have been distinguished among the Kalahari hunter-gatherers (Goodwin 1945; Clark 1977; J. Deacon 1992; Bartram 1997; Wanless 2007; Backwell *et al.* 2008). Examples of both types are presented in Figure 18: 106. The first type consists of a long slender bone point, usually coated in poison and attached by a thin thatch-grass collar to a more robust bone link-shaft. The second type comprises a slightly more robust bone point, fixed directly into the main reed shaft.

Bone arrow-heads are known to differ from link-shafts among San groups in that the former is usually thinner than 5 mm in diameter (Smith & Poeggenpoel 1988). Smith and Poeggenpoel (1988: 112) note that southern San bone points are thicker farther north; a trend also manifest in the LSA archaeological record of the south western Cape. Link-shafts have double tapering ends and are less finely made than the points. As a result they have a much fatter appearance. It is sometimes difficult to distinguish between a link-shaft and a robust bone point (cf. Figure 19: 107 and Backwell *et al.* 2008).

The length of Bushmen arrows is not standardised, but the mean length of arrows in the Fourie collection is 68.4 cm, SD = 5.5 (Chapter 6). The main reed shaft is usually not longer than 50 cm, averaging 40 – 45 cm (also see Schapera 1927; Goodwin 1945; Clark 1977 and Noli 1993 for comparable measurements). This is slightly longer than arrows from the Drakensberg which measured 39 – 41 cm (Vinnicombe 1971). The bone points are known to vary from 5 – 20 cm in length, for example in the Fourie collection.

As arrow-heads, bone points are the most commonly and widely used material (Bosc-Zanardo *et al.* 2008; Petillon *et al.* 2008). San hunter-gatherers would tip their arrows with bone or stone, but, whereas stone was eventually replaced by metal in the 1870s (Bosc-Zanardo *et al.* 2008), bone points continued in use until quite recently (Smith *et al*. 2000) because of, among other things, its manuability. However, bone arrow points did undergo some change in the late eighteenth and nineteenth centuries as Sparrman (1786) and Stow (1905) record contemporary bone points being cut flat at the tip in order to facilitate a triangular bit of iron being fixed to the end to act as the tip.

2.3.3. The functions of bone points

Pointed bone tools can be divided into three groups; namely, those used for domestic, hunting and symbolic purposes (see Figure 1 for examples of the different pointed bone tool morphologies). Awls and needles are pointed bone tools that, as their names imply, were used for domestic purposes. Awls were coarsely made points, usually chosen from naturally pointed bones like the ulna, which were used for piercing leather (Schweitzer 1979; J. Deacon 1984; Mitchell 2002) and as a tool to make engravings on soft materials (e.g. d'Errico 1993). The manufacturing focus on awls was on the point, to the near exclusion of the rest of the bone shaft. This focus indicates that the piece was not intended to be aero-dynamic and that it was likely used in domestic activities. Further support is added to this interpretation by the presence of polish on and near the tip which could only have accrued through much use on soft materials like leather (J. Deacon 1984). Needles, which occur in two varieties, namely, thin cylindrical forms and flat elliptical forms, where used in other domestic activities like weaving, sewing and matting (e.g. H. Deacon 1976; J. Deacon 1984).

In San ethnography bone arrowheads were used in a wide variety of hunting strategies, including ambush hunting, bird hunting and stalking with poisoned arrows (see Lee 1979; Bleed 1986; Bartram 1997; Ellis 1997; Hitchcock & Bleed 1997; Smith *et al.* 2000). Arrows are usually intended to kill by piercing an internal organ or by causing severe bleeding (Miller *et al.* 1986), although different types of arrows were used on different types of prey (Hitchcock & Bleed 1997: 348). A bone point is incapable of inflicting a deadly wound on a large animal unless it penetrates a vital organ or carries poison (Cattelain 1997; Hitchcock & Bleed 1997; Wadley 2007) or is used in conjunction with stone inserts that act as cutting mechanisms (Lombard & Parsons 2008; Pettilion *et al.* 2008). Most bone points examined (n = 64) by me in the Fourie collection were both poisoned and long enough to pierce an internal organ.

The robust bone points sans link-shafts were un-poisoned and often much shorter than their composite equivalents (Chapter 6: 114).

Ethnographic studies conducted over the last forty years on groups of hunter-gatherers living in the Kalahari have shown that their hunting methods vary seasonally (e.g. Bartram 1997). In the dry season, mainly from August to October, food and water are scarce, so smaller non-migrating animals were hunted using snares and traps. In the wet season, mainly from December to March, poison arrows were used to hunt large game that was attracted by the water and food resources in the area.

Hunting did not, however, make up the bulk of the hunter-gatherers' diet. Snaring and plant gathering provided 60 – 80 % of the San hunter-gatherer diet (Smith *et al.* 2000). Bow and arrows are usually only used during times of aggregation and dependent on the availability of poison (Wadley 1987a, 1993; Bartram 1997; Hitchcock & Bleed 1997). Aggregation seasons are known to differ between groups in the Kalahari (Lee 1979) so that two separate groups may have different hunting strategies at the same time of year. However, Hitchcock and Bleed (1997: 353) note that bow and arrow hunting among the !Kung also took place during the dispersal phase where smaller animals were targeted.

Noli's (1993) study of contemporary Bushmen bows showed that they are ineffective in bringing down large prey unless the weapon tip is poisoned. A 10 g arrow fired from a bow with a draw weight of 10 kg is unlikely to penetrate beyond 70 mm into the prey. This depth is not enough to immobilise a large animal. Noli (1993) suggests that Bushmen bows and unpoisoned arrows were used primarily for hunting 'small' animals like the duiker (*Cephalophus monticule*) (see Klein 1976 for animal size classes).

Bone points were not only used for utilitarian purposes, i.e. domestic and hunting. In many hunter-gatherer societies bone points formed part of an intricate system of beliefs and rituals. Indeed, in some Bushmen societies, arrows embodied certain symbolic elements which are associated with the 'ritual' of large-game hunting (J. Deacon 1992). Marked arrows were used to identify the maker of an arrow in meat distribution rights (Marshall 1961; Biesele 1975; J. Deacon 1992). In addition, well finished bone points are known to have been traded among groups as part of the exchange system of delayed reciprocity, known as *Hxaro* (Wiessner 1983; Wadley 1987a; Brooks *et al.* 2006; Petillon *et al.* 2008). Some particularly well finished points may have been made specifically for this purpose. These aesthetic functions have important implications in the assignation as hunting weapons of all bone points found archaeologically. Clearly not all points had a purely utilitarian function.

2.4. Later Stone Age background

Later Stone Age sites have been found in deposits dating back *c.* 38 ka ago in southern Africa (Beaumont & Vogel 1978; J. Deacon 1984; Wadley 1993; Deacon & Deacon 1999; Mitchell 2002) and persist until the start of ethnographic times, roughly four hundred years ago. The LSA material cultures first appear in the latter part of the late Pleistocene (*c.* 40 – 12 ka). Populations were relatively unstable during the first half of the LSA, with a population trough visible between 21 – 13 ka ago, corresponding with the Last Glacial Maximum (Wadley 1993). Sites from this time are most abundant in mountainous regions where, although colder, more water would have been available (Mitchell 1990).

The LSA is sub-divided into discreet complexes, each characterised by a change in material culture.

2.4.1. Standard sub-divisions of the LSA

The earliest of the LSA discreet complexes, the Robberg (*c.* 22 – 12 ka), is characterised by an informal bladelet tradition (J. Deacon 1984; Wadley 1993, 2007). This period was cooler and moister than today, although vegetation was similar. Very few bone points have been found in Robberg assemblages; the most notable coming from Nelson Bay Cave (Klein 1972a; Inskeep 1987) and Rose Cottage Cave (Wadley 2000a).

During the terminal Pleistocene and start of the Holocene (*c.* 12 – 8 ka ago) the temperature and precipitation rose, allowing greater plant and animal diversity (Wadley 1993, 2007). This period is characterised by a shift from bladelet manufacturing to a focus on scrapers, adzes and bone points (H. Deacon 1976; J. Deacon 1984; Wadley 1993, 2007). It is at this time that bone points first enter the archaeological record in meaningful numbers. By *c.* 10 ka ago the Robberg had been completely replaced by the Oakhurst complex in the interior and the Albany at the coast.

The Holocene, *c.* 10 ka onwards, had a climate and environment similar to that of today. It included two industries: the Wilton and the Smithfield. The Wilton, which is a micro-lithic backed tool industry, lasted from *c.* 8 – 4 ka ago and was characterised by a high incidence of scrapers (Wadley 2007: 129). There is clear evidence for lithic hafting at this time as well as a wider variety of bone tools and bows and arrows (J. Deacon 1984). After *c.* 4 ka ago formal stone tools, specifically points, but excluding scrapers, decrease and are accompanied by a proliferation of bone points (Leslie-Brooker 1989; Wadley 2007). The timing of these various changes is by no means uniform. Some traits persisted for longer in some places than at others (*cf.* H. Deacon 1976; J. Deacon 1984; Opperman 1987; Leslie-Brooker 1987, 1989; Mazel 1989).

2.4.2. Bone points and their preservation

Pointed bone tools in general and bone points in particular are not uncommon in LSA assemblages. Usually they are fragmented and often only the bone shaft remains (e.g. Plug 1982; J. Deacon 1984; Wadley 1987, 2000a, b). Occasionally, however, a complete specimen, retaining tip and butt, is preserved (e.g. Sampson 1974; J.

Deacon 1984; Wadley 1987a). The preservation of bone tools, as with all organic materials, is highly variable and dependent on the particular taphonomic conditions of individual sites (Chapter 3: 44).

Our knowledge of LSA pointed bone artefacts comes from the excavations in the Western and Eastern Cape Provinces at sites such as Nelson Bay Cave (Klein 1972a; J. Deacon 1984; Inskeep 1987), Melkhoutboom (H. Deacon 1976), Kasteelberg (Smith & Poeggenpoel 1988) and Die Kelders (Schweitzer 1979). Sites yielding pointed bone artefacts on the highveld are fewer and the pointed bone assemblages are more fragmented at sites such as Jubilee Shelter, Rose Cottage Cave and Sehonghong (see Wadley 1987b, 2000a, b; Mitchell 1995).

2.4.3. Manufacturing techniques

Smith and Poeggenpoel (1988) exposed a bone tool fabrication site during an excavation at Kasteelberg on the Vredenberg Peninsula on the West Coast of South Africa. So far this is the best documented evidence for the manufacture of bone tools in the LSA. Several stages have been identified in the manufacturing process of bone points. The metapodials of medium-large bovids were the most commonly used bone at this site. The first stage was to knock off the articular epiphyses using a hammer stone and "punch". Next, several grooves were made along the long axis of the bone shaft. The bone was then rubbed along the groove with a graving stone until the splinter had been detached. Finally, the bone splinter was ground into the desired shape using first an abrasive stone followed by a smooth stone for polishing (Smith & Poeggenpoel 1988: 106 -107). This manufacturing method has been supported by recent comparative work on bone points from MSA and LSA assemblages (d'Errico & Henshilwood 2007).

2.4.4. Different types of bone artefacts

Among the pointed bone artefact types present at Kasteelberg were those resembling bone points, link-shafts, awls and bodkins. The former two were more numerous than awls and bodkins, although dissimilar percentages have been recorded on ethnographic collections (*cf.* Peringuey 1911; Schweitzer 1979; Smith & Poeggenpoel 1988). All the pointed bone tools interpreted as bone points were of the same mean dimensions as ethnographic reversible poisoned bone points.

Awls were generally polished, from use, and retained the original articular end. Some examples had a slight curve making them unsuitable for hunting weapons, and it is thought that they would have, by default, served as awls or bodkins (Smith & Poeggenpoel 1988: 111). Sometimes the skeletal parts chosen for awl manufacture were ulnae, as these bones are naturally small and pointed. Pointed bone artefacts displaying similar features have been labelled as awls at Nelson Bay Cave (Klein 1972a; Inskeep 1987), Die Kelders (Schweitzer 1979), Melkhoutboom (H. Deacon 1976; J. Deacon 1984) and Uniondale Rock Shelter (Leslie-Brooker 1987).

Needles and matting needles are also sometimes present in LSA assemblages. A needle is so termed due to its extremely thin diameter. A matting needle is made from a flat piece of bone, worked to an elliptical point and sometimes may have a notch at the base to facilitate the twine or sinew that it was used to weave (J. Deacon 1984). Both forms could have served as projectile points as both have the same dimensions and aero-dynamic properties as bone points *i.e*. they are straight and regular (see Figure 1). The only difference between these two artefact forms is the cross sections.

Link-shafts have already been described in the ethnographic section. They are of similar dimensions in the LSA. Another pointed bone tool which closely resembles the link-shaft is the fish gorge. The fish gorges are similarly shaped to the link-shafts except that they taper over more than 90 % of their surface and are smaller and more elliptical in cross section (see J. Deacon 1984; Inskeep 1987; Wadley 1993 and Figure 31).

Among bone points some variety of form is noticeable, although the overall dimensions remain the same. Cylindrically tapering points gradually terminate in a point and are cylindrical to oval in plan view; whereas conically tapering points have a much more abrupt or steeper termination and appear triangular in plan view (Fig. 2). There are also short points with fluted butts akin to those from Uniondale Rock Shelter (Leslie-Brooker 1987, 1989). These points, which have also been found in the Magaliesberg and the Makgabeng, are usually less than 6 cm long and are thought to have been used exclusively for bird hunting (Leslie-Brooker 1987, 1989).

The final distinct type of pointed bone tool can best be described as a spear (Fig. 1E). These bone points are elliptical in cross section and wider than 3 cm at their base. They are relatively rare in LSA assemblages. They are associated with bushpig, buffalo and hippopotamus remains in Oakhurst layers at Umgazana Cave, Pondoland (Sampson 1974), and have also been recovered from Wilton levels at sites like NBC (Inskeep 1987).

Figure 2. A diversity of pointed bone tools taken from an excavation on the Makgabeng Plateau ranging in shape from what could be called a: A) 'needle'; B, C, D) bone points 'arrows', to E) a 'matting needle'. Scale is 5 mm.

2.4.5. The functions of pointed bone tools

The probable uses to which the various pointed bone artefacts in the LSA were put, is based largely on morphometric analogy with ethnographic tools of similar dimensions, as well as inferences drawn from the association of bone points with other items of material culture. The rest of this section deals with our current knowledge of the uses of the various pointed bone artefacts in the LSA of southern Africa.

The use of bone points in hunting weapons was previously thought to have been introduced after 12 ka ago (H. Deacon 1976, 1995; J. Deacon 1984; Klein 1987, 1999, 2000; Inskeep 1987; Mitchell 1988; Mazel 1989; Opperman 1989; Noli 1993).

Inskeep (1987) believes that powerful bows replaced multibarbed spears at this time and that only after 8 ka ago did poison accompany bone points used with much lighter, less powerful bows (also see Noli 1993). Rock art supports the theory that archery systems other than the ones historically/ethnographically employed by Bushmen may have been used in the past (Inskeep 1987; Wilson *et al.* 1990; Humphreys *et al.* 1991). Unfortunately, much of this art is undated and Noli (1993) believes that it may represent the advent of Bantu farmer bows. If, however, more powerful bows were used by the Bushmen during the LSA then one would expect more powerful and robust arrows.

Bone points *c.* 8 ka ago seem to have been used primarily to hunt large antelope, presumably with the aid of poison, while composite segment weaponry and snares were used to catch smaller game (H. Deacon 1976; Cable 1984; Opperman 1987; Mitchell 2002 but also see Noli 1993). Unfortunately no complete bow and arrow survives from this period, but elements, akin to arrow parts of ethnographic times, have survived, especially from Wilton and Smithfield complexes (J. Deacon 1984).

Needles, matting needles and link-shafts are thought to have had comparable functions in the LSA as they did in ethnographic times (H. Deacon 1976; J. Deacon 1984). Due to the highly fragmented state of many LSA bone tools, it is difficult to differentiate between a cylindrical needle shaft and the shaft of a bone point.

Bone spears are not widely known from the LSA, although some examples are present (e.g. Sampson 1974). Historically, spears are known to have formed part of the hunters' equipment (Sparrman 1786; Hitchcock & Bleed 1997). They were used as the final method to dispatch large game after it had been weakened by poisoned arrow. They were also used as the primary hunting weapon more frequently than bows and arrows, as spears could be used all year round and were not dependent on the availability of poisons (Hitchcock & Bleed 1997). However, as primary weapons, spears require a very different hunting strategy than bows and arrows.

Bone points are believed to have been traded as *Hxaro* items during most of the LSA (Wadley 1987a, 1989; Mitchell 2002) just as they were in historic times. The reason for this is that bone bones are predominantly found in aggregation phase assemblages that characteristically contain evidence for gift manufacture and formal behaviour (Wadley 1989). During the Robberg bone points are thought to have been exclusively used as *Hxaro* items and only formed part of projectile hunting equipment during the Holocene; and this with the accompaniment of poison (Wadley 1993).

2.5. Middle Stone Age Background

The Middle Stone Age of southern Africa covers the period from roughly 280 – 30 ka ago (see Mitchell 2002). Most MSA sites have a similar distribution in the landscape as sites from the LSA, although the majority of MSA sites are found along the coast (Clark 1993; H. Deacon 1995; Mitchell 2002; Marean & Assefa 2005; McBrearty 2007). The latter part of the MSA falls within the late Pleistocene and overlaps in time with the earliest LSA sites, e.g. Border Cave (Beaumont & Vogel 1978). The climate during this period was characterised by oscillating cool and warm conditions (see Henshilwood 2008a, b).

2.5.1. Standard sub-divisions of the MSA

The MSA of southern Africa is sub-divided into phases based on stone tool typology. Different researchers have based their ‘typology’ of phases on different sites and, as such, these differ somewhat from each other (*cf.* Volman 1984; Singer & Wymer 1982; Thackeray 1992; Wurz 2000, 2002; Henshilwood *et al.* 2001a; Wadley 2006). I follow the sub-divisions of Wurz (2002).

The Klasies River sub-stage, previously the MSA 2a or MSA I, is characterised by blade production from local raw materials (Wurz 2002: 1004). Retouch is limited, although where it does occur, it is usually to forms points. No bone points have been recovered from this period. The Klasies River stage has been dated by various researchers to fall between *c.* 115 – 90 ka ago (see Wurz 2002: 1003 for details).

The Mossel Bay stage, previously the MSA 2b or MSA II, is characterised by higher proportions of pointed flakes (Thackeray 1992; but see Thompson & Marean 2008) made predominately on quartzite (Wurz 2002). A general reduction in size of lithic blades is noticeable throughout this sub-stage (Wurz 2002; Wadley 2006). Again, dates at the different sites vary, but his stage spans roughly the period from 101 – 60 ka ago (Wurz 2002: 1003).

The next sub-stage is known as the Still Bay and it corresponds to the latter part of the MSA 2b or MSA II (Henshilwood *et al.* 2001a: 639). The Still Bay phase has been dated to *c.* 71.9 - 71 ka ago (Jacobs *et al.* 2008; Jacobs & Roberts 2008). It is characterised by bifacial foliate points (e.g. Henshilwood & Seally 1997; Wurz 2000, 2002; Henshilwood *et al.* 2001a; d'Errico & Henshilwood 2007). These foliate points are thought to have been used to tip hunting spears (Marean & Assefa 2005; Lombard 2007; Lombard & Parsons 2008; Villa *et al.* 2009). Twenty eight bone tools, including five supposed bone points, have been found in this sub-stage at Blombos Cave (Henshilwood & Sealy 1997; Henshilwood *et al.* 2001a, b; d'Errico & Henshilwood 2007).

Overlying Still Bay layers at certain sites, like Sibudu Cave, is a period commonly referred to as the Howieson's Poort. The Howieson's Poort is characterised by highly retouched, mainly backed, pieces made on non-local raw material (e.g. Thackeray 1992; Wurz 2000, 2002; Wadley 2006, 2008). It has been dated to *c.* 64.8 – 59.5 ka ago (Jacobs *et al.* 2008; Jacobs & Roberts 2008). There are numerous small segments, similar to those of the later Wilton complex, which have long been thought to have been used as inserts to complex spears and arrows (e.g. Clark 1967; Lombard & Parsons 2008). There is much evidence to suggest that projectile hunting with hafted stone armatures took place during the Howieson's Poort (Thackeray 1992; Milo 1998; Brooks *et al.* 2006; McBrearty 2007; Pargeter 2007; Lombard 2008; Wadley 2008). To date, only one bone point has been definitively dated to the Howieson's Poort and that is at Sibudu Cave (Backwell *et al.* 2008). Based on C/N ratio and morphological similarity with the Blombos Cave points, the bone point from Peers Cave may also date from the Howieson's Poort or older (d'Errico & Henshilwood 2007).

The final sub-stage known as the Post-Howieson's Poort, previously the MSA III or 3, sees an increase in size of stone tools compared to the Howieson's Poort and slight decline in non-local raw materials at sites like Klasies (Wurz 2002). Dates differ, but fall roughly between 50 – 45 ka ago (Wurz 2002). The formal tool component seems more focused on knives than points (Wurz 2002: 1011). No bone points have so far been recovered from any sites dating to this time.

2.5.2. Bone points and their preservation

Because of their advanced age, organic materials rarely survive from these sites (see Chapter 4: 59). As a result, this absence of evidence was taken as evidence for absence and it was assumed that people living in the MSA did not make bone points and had no projectile technological capabilities (Klein 1987, 1995, 1999, 2000; Klein & Edgar 2002). The occasional bone tools that were recovered from MSA deposits were seen as anomalous (e.g. Singer & Wymer 1982; Plug 1982). Recently, however, the small cache of bone tools, including five bone points, from securely dated Still Bay layers at Blombos Cave (Henshilwood & Sealy 1997; Henshilwood et al. 2001a, b) and several pieces of worked bone, including a bone point, from Howieson's Poort layers at Sibudu Cave (Wadley 2001, 2008; Backwell *et al.* 2008) have lead to studies on pointed bone artefacts from other sites of possible MSA association (d'Errico & Henshilwood 2007). The rest of this section deals with our current knowledge of pointed bone tools from the MSA.

Table 2. The number of bone artefacts interpreted as bone points from Middle Stone Age sites. Information derived from d'Errico & Henshilwood 2007 and Backwell *et al.* 2008. Note: the Klasies piece is not listed here as it has been reassigned to the LSA by d'Errico & Henshilwood 2007.

	Secure MSA Association	Possible MSA association
Blombos Cave	4	1
Sibudu Cave	1	
Peers Cave	1	
Bushman Rock Shelter		3

2.5.3. The different types of pointed bone artefacts in the MSA

Compared to LSA bone points the MSA points at Blombos are generally wider with a thicker cortex. This appears to be similar with all the MSA bone points that have been examined from Still Bay industries (d'Errico & Henshilwood 2007). The bone point from the Howieson's Poort at Sibudu Cave is morphologically closer to LSA bone point dimensions than the Blombos Still Bay points (Backwell *et al.* 2008).

At some MSA sites that preserve bone, most notably at Blombos, three types of 'pointed' bone artefacts can be distinguished, *viz.* 'awls', 'spears' and 'points' (Henshilwood *et al.* 2001b; d'Errico & Henshilwood 2007). The bone points from Peers Cave, Blombos Cave, Blombosch sands and Klasies have been interpreted based on morphometric comparisons with LSA bone tools. Awls are differentiated from points in that awls are worked to a pointed tip. The rest of the piece of bone is very lightly shaped, if at all; and the piece may or may not have a curved profile. On points, care is taken to make the point as straight as possible thereby working the entire surface of the bone sliver. Points are usually cylindrical in cross section and slightly more robust than composite bone points from the LSA. Spears are more irregular in profile and cross section. The tip and the base are usually the only parts that have been significantly worked. The tip is scraped to a point while the base is sometimes tanged, presumably to facilitate hafting (d'Errico & Henshilwood 2007).

2.5.4. Manufacturing techniques

Examination of the bone tools from several MSA sites has shown that the tools have been fashioned from the long bones, scapulae and mandibles of animals in the Bov II/III size range (Henshilwood *et al*. 2001a, b; d'Errico & Henshilwood 2007) although the bones of birds and felids were also used (d'Errico & Henshilwood 2007). The bone tools from Blombos have been made on dry and fresh bones of adult and sub-adult animals (Henshilwood *et al.* 2001b). In some instances the bones show signs of having been heated prior to shaping (d'Errico & Henshilwood 2007). Polishing and hafting traces are present on some of the Blombos pieces (Henshilwood & Sealy 1997; d'Errico & Henshilwood 2007).

A difference in manufacturing techniques is apparent between MSA and LSA bone points. Henshilwood *et al.* (2001b) observe that the majority of Still Bay bone points from Blombos have been shaped by scraping with a lithic edge, whereas most of the LSA points have been abraded against a fixed surface (also see d'Errico & Henshilwood 2007). Although the shaping methods differ between the MSA and LSA, the planning and execution of bone tool manufacture are similar (d'Errico *et al.* 2003).

2.5.5. Functions of bone tools in the MSA

The function of the bone tools in general and the bone points in particular from MSA sites has been interpreted based on morphological analogy with pointed bone tools from LSA and ethnographic collections (e.g. d'Errico & Henshilwood 2007; Backwell *et al.* 2008). Awls are by far the most common pointed bone tool (n = 23) at Blombos Cave (Henshilwood *et al.* 2001b). Awls were probably used to pierce leather in the MSA just as they were in later times. Use-wear traces such as polishing and striations at the tip support this interpretation. Awls were made from a wider variety of skeletal elements than during the LSA.

Studies of MSA hunting paraphernalia suggest that bone points may have formed the fore-shafts of composite weapons (Lombard 2008; Lombard & Parsons 2008). Howieson's Poort segments may have been set around these points serving as barbs to anchor the arrow and do more damage to the prey (Pokins & Krupa 1997; Lombard & Parsons 2008). Although the Sibudu Cave data suggests people at this time hunted a wide variety of animals, bone points are more prevalent in the assemblages dominated by small to medium sized game (Wadley 2006, 2008; Backwell *et al.* 2008). The bone point from the Howieson's Poort at Sibudu Cave has been interpreted at being part of a hunting adaptation to small prey in a closed, forested environment (Backwell *et al.* 2008).

Projectile hunting techniques were not unknown to people in the MSA as there is much evidence to suggest that projectile hunting with hafted stone armatures also took place (Thackeray 1992; Milo 1998; Mohapi 2005; Shea 2006; Brooks *et al.* 2006; McBrearty 2007; Pargeter 2007; Lombard 2008; Lombard & Pargeter 2008; Wadley 2008). The excavators at Blombos have found evidence for hafted bone in association with large fish remains (Henshilwood & Sealy 1997).

The excavators at Blombos have found non-utilitarian polish on one of the points (Henshilwood & Sealy 1997). No polish has been found on pointed bone tools thought to be awls. The polish, which is believed to be deliberate and not the result of use-wear, may reflect the added social and symbolic value of hunting weapons as opposed to domestic tools like awls (Henshilwood *et al.* 2001b; d'Errico *et al.* 2003; d'Errico & Henshilwood 2007; Henshilwood 2008a), although it should be kept in mind that a certain amount of polishing is expected on domestic tools that have been extensively used.

At Blombos Cave, bone tools decrease in the terminal Still Bay industry possibly pointing to a change in hunting strategies (Henshilwood 2008a, b). After the

Howieson's Poort at Sibudu Cave, bone points disappear from the archaeological record only to reappear again in the LSA.

2.6. Summary

It is clear from the evidence presented above that deliberately manufactured bone points are present from as early as the MSA of southern Africa. There are several types of pointed bone artefacts, which include awls, needles, points and spears, indicating that pointed bone tools may have played a role in both domestic and hunting activities. The functional interpretation of the earlier tools is, however, primarily based on morphometric analogy, and no macro-fracture studies have yet been conducted that explicitly test their use as parts of possible hunting weapons.

Of interest to this study is the pointed bone tools used as hunting weapons, specifically bone points. In theory, all pointed bone artefacts are capable of inflicting a wound. However, only those straight enough can be used as projectile elements. Bone arrow points have played a role in large game hunting (H. Deacon 1976), usually with the accompaniment of poison; and in small game hunting in closed forested environments (Backwell *et al.* 2008). Some interpretations suggest that a short point with fluted butts were used exclusively to hunt birds (Leslie-Brooker 1987, 1989) – although this is speculative and is yet to be proved.

Bone points do not represent a continuing presence in the archaeological record. They occur in small numbers in the Still Bay and Howieson's Poort industries and then seem to disappear from the record until the Robberg of the LSA; and then only in small numbers. It is not until the Oakhurst that bone points are found in great numbers. From this time onwards, bone points make up an integral part of hunter-gatherer projectile hunting equipment.

It is uncertain why bone points seem to disappear after the Howieson's Poort. Some cite the inclement climatic conditions of Marine Isotope Stage 3 as signalling a shift in subsistence strategies and a move away from the use of bone points (Mellars 2006; Backwell *et al.* 2008; Cochrane 2008; Wadley 2008). Another possibility to account for this apparent hiatus is ascribed to population extinctions at the end of the Howieson's Poort, which Cochrane (2008: 161) thinks may have disrupted regional ideological networks resulting in a shift in decision making. Others (e.g. Mitchell 2002, 2008; Henshilwood & Marean 2003) reject these explanations and believe that bad preservation or inadequate recording techniques for the few sites that date to this period may better explain the apparent lacuna of bone points. The preservation of bone is a complex scenario with many contributing factors. The density of the bone, rapidity of burial, pH content of the soil and duration of burial all contribute to the life expectance of the fossil (Brain 1981; Shipman 1981).

CHAPTER 3

BACKGROUND AND SUMMARY OF THE SITES INCLUDED IN THIS STUDY

3.1. Introduction

Due to their bio-degradable nature bone tools generally do not survive well in the archaeological record and are usually under-represented. As a result they have not been given as much consideration as their stone counterparts in the interpretation of activities carried out at particular sites. The following sites have been chosen for a number of different reasons, not least of which is their high survival rate and good preservation of organic remains, including pointed bone artefacts. Blombos Cave, Peers Cave and Sibudu Cave have all been chosen because they represent the best documented accounts of bone points in the MSA of southern Africa. Bone implements of this antiquity are extremely rare which makes a study of them all the more interesting and rewarding.

Rose Cottage Cave, Jubilee Shelter and Nelson Bay Cave have been chosen because of the large quantities of bone points and the depth of research undertaken at these sites. The bone points from these sites all date to various periods within the LSA and serve as the “classic” marker on bone points in the archaeological record. The site of Bushman Rock Shelter, also dating to the LSA, has been chosen for slightly different reasons. The bone points from this site exhibit a variation in manufacturing techniques and form from bone points usually described in the literature (see for example Goodwin 1945; Vinnicombe 1971; Schweitzer 1979). A combined study of morphology and macro-fractures may shed insights into the nature of this variation.

The Fourie collection of ethnographic bone points from Namibia was chosen because it is one of the largest comparative collections of its kind. It consists of over one hundred bone tipped arrows of two varieties collected from traditional Bushmen/

hunter-gatherer groups living in northern Namibia from 1916 – 1922 by Dr Louis Fourie. The bone points from this collection are of known function and might help with the interpretation of fracture patterns and frequencies on archaeological bone points used for hunting activities, specifically as arrows.

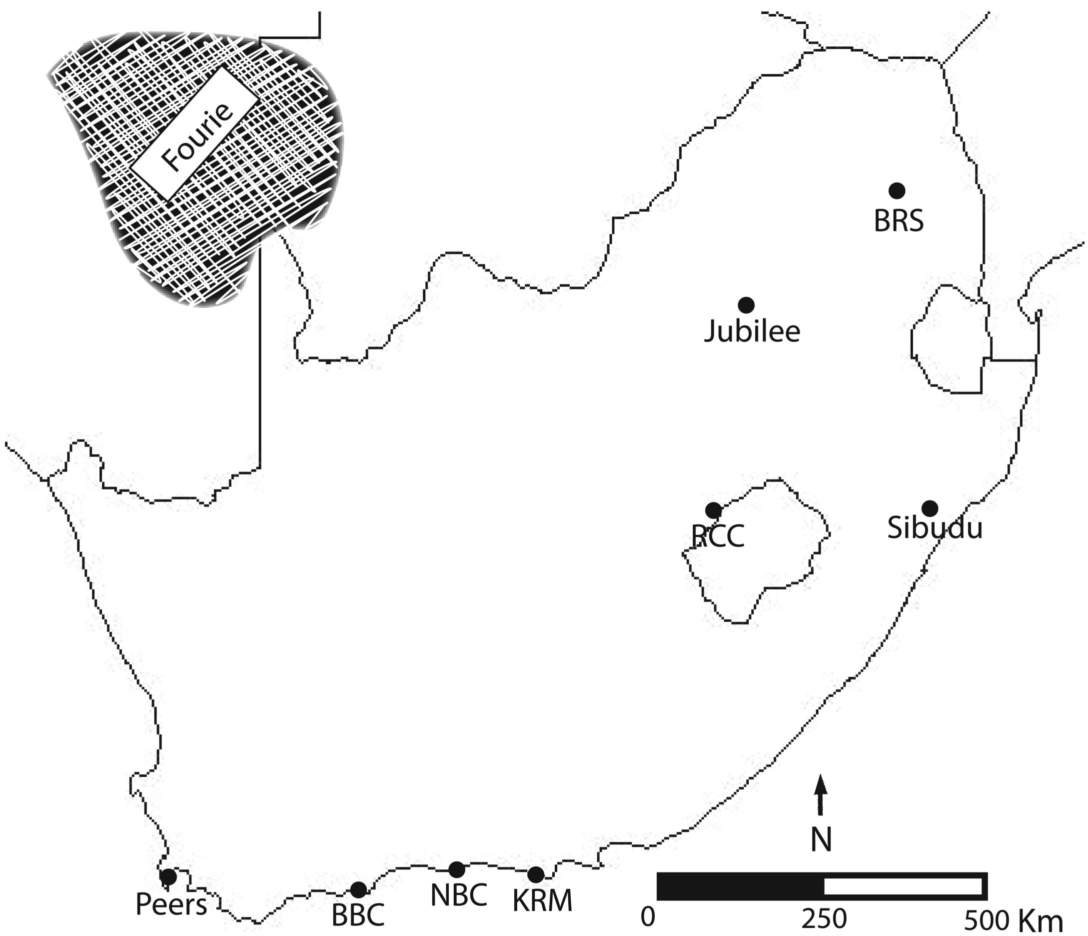

Figure 3. Map of South Africa showing the locations of the various sites whose bone points have been included in this study. BBC = Blombos Cave; NBC = Nelson Bay Cave; KRM = Klasies River Mouth; RCC = Rose Cottage Cave; BRS = Bushman Rock Shelter; Fourie = Kaukau Veld area from where the ethnographic collection was obtained.

3.2. Blombos Cave

Blombos Cave (BBC) is located on the southern Cape coast near the town of Still Bay (24º 25´S, 21º 13´E). It is currently about 100m from the shore and 35 m above sea level (Henshilwood 2008a). It contains both LSA and MSA deposits, with a sterile sand hiatus layer separating the two ages (Henshilwood 2008a). The MSA deposits have yielded several pieces of engraved ochre (Henshilwood *et al*. 2002) as well as about thirty bone tools – the oldest of their kind anywhere in the world *c.* 78 ka ago (Henshilwood *et al.* 2001a, b). This is due in part to the alkaline pH of the soil and the calcium rich ground water which preserve organics well (d'Errico & Henshilwood 2007; Henshilwood 2008a).

The MSA levels are divided into three discreet phases, numbered respectively and ranging in age from *c.* 75 - 125 ka ago (d'Errico & Henshilwood 2007). The youngest of these phases, M1, contains engraved bone and bifacial foliate points typical of the Still Bay industry (d'Errico & Henshilwood 2007). It dates to *c.* 75 ka ago (Henshilwood 2005; Lombard 2007). The retouched lithic component decreases in the upper M2 phase, at 76 ka -, relative to the amount of bone points; and disappear by the lower M2 phase (*c.* 84 ka) and the M3 phase (*c.* 98 ka ago), which is dominated by shellfish remains (Henshilwood 2005; d'Errico & Henshilwood 2007; Lombard 2007).

A total of five bone points (SAM-AA 8947, 8954, 8964, 8955?, 8980) have been found in the BBC deposits – four from the MSA and one from the LSA (Henshilwood & Sealy 1997; Henshilwood *et al.* 2001b; d'Errico & Henshilwood 2007). The MSA bone tools were primarily shaped by scraping with a sharp lithic edge while those from the LSA were shaped via scraping and abrasion (Henshilwood *et al.* 2001b: 654). Henshilwood *et al.* (2001b) note that MSA bone tools were made from a wider variety of bones, and that only bone points exhibited signs of polish. Thus, points were possibly associated with a higher symbolic value than awls (Henshilwood & Sealy 1997; Henshilwood *et al.* 2001b; Henshilwood 2008a).

Further evidence for this is seen in the life expectancy of bone tools in the MSA and LSA. The life of LSA tools was minimal, while MSA tools showed signs of extensive use wear (Henshilwood *et al.* 2001b). The tips of some these tools were also fire-hardened thereby increasing their life-expectancy (Henshilwood *et al.* 2001b).

Fairly extensive studies have been conducted on the bone tools from Blombos (see Henshilwod & Sealy 1997; Henshilwood *et al.* 2001b; d'Errico & Henshilwood 2007). These studies focused on a comparative morphometric analysis with LSA bone tools and manufacturing techniques. Based on these comparisons the authors concluded that the bone points found in the Still Bay layers were likely used to tip hunting weapons (d'Errico & Henshilwood 2007). A macro-fracture analysis of these bone points has the potential to further improve our understanding of the possible functions of these tools by testing the inferences based on morphometry.

The presence of bone points from the overlying LSA layers is also promising. A comparative macro-fracture analysis of the bone points from the LSA and MSA could tell us whether bone points were used for the same purposes through time, and if so, may shed light as to the nature of subsistence change at the site.

3.3. Peers Cave

Peers Cave, previously known as Skildergat Cave, is situated on the Cape Peninsula near the town of Fish Hoek in the Western Cape. Peers Cave was one of the first caves in South Africa to be recognised to contain both Still Bay and Howieson's Poort industries. Unfortunately, the original excavations as well as a later ones conducted by Jolly (1948) and Anthony (1967) were neither well controlled nor well reported (d'Errico & Henshilwood 2007: 8). As a result, there was much confusion over the provenience of artefacts (d'Errico & Henshilwood 2007: 8).

The original excavations revealed a substantial shell midden about 1.5 m thick in the upper layers. The remains of 6 people were found buried in this layer near the wall of the cave (J. Deacon & Wilson 1992). Many ostrich egg shell beads, marine shell pendants, bone awls and arrow points were found associated with these burials. Three more skeletal remains have been found from the underlying MSA levels (J. Deacon & Wilson 1992).

Among some of the artefacts excavated are bone points and awls associated with an LSA burial (J. Deacon & Wilson 1992). A bone point was also recovered from the talus slope by Jolly (1948). It has been securely assigned to the MSA using carbon/nitrogen dating analysis – although, it is still unclear whether it derives from Still Bay or Howieson's Poort layers (d'Errico & Henshilwood 2007). Although mostly covered in a layer of manganese, it was ascertained that the piece had been manufactured by scraping with a lithic edge and had been polished (d'Errico & Henshilwood 2007).

Peers Cave, like Blombos has bone points from both the MSA and LSA levels. A comparative macro-fracture analysis of these points has the potential to shed light on hunting practices practiced by the inhabitants of the cave over time.

3.4. Sibudu Cave

Sibudu Cave, in the Natal woodlands, is situated about 15 km from the coast on a cliff overlooking the Tongati River. It is 100m above sea level and has good organic preservation (Lombard 2005; Wadley 2006). The deposit contains both Still Bay and Howieson's Poort industries occurring at *c*. 70 and *c*. 60 ka ago respectively (Wadley 2006). There is no LSA deposit at Sibudu Cave, so all artefacts have unequivocal MSA associations (Wadley 2006; Backwell *et al.* 2008).

Macro-fracture studies have shown, that in the Still Bay industry, stone points were hafted and used for hunting (Lombard 2005; Wadley 2006). Points were absent during the Howieson's Poort, where segments and backed tools dominate the assemblage (Wadley 2006). One reason proposed for this change in technology, is that it was an adaptation to the environment becoming more wooded (Wadley 2006: 334). This in turn would have necessitated a shift from small to medium size grazers (Wadley 2006; Cochrane 2008).

Wadley interprets this change in faunal exploitation and technology as representative of a change in hunting strategies, in this case the use of bow and arrow, which she says are akin to those of the LSA. The hunting competence by *c.* 60 ka ago was no different from that of the LSA; the inhabitants being skilled encounter hunters, able to kill all size animals in a mosaic of habitats (Wadley 2006; Wadley 2008). During the Howieson's Poort the focus seems to have been on small antelope, like the duiker (*Cephalophus monticula*), best suited to closed forest habitats. In contrast, the Post-Howieson's Poort fauna includes mostly large grazers which would have preferred open grassland (Backwell *et al.* 2008).

Two pointed bone tools were recovered from the Sibudu Cave excavations, attributed to the Howieson's Poort levels (Backwell *et al.* 2008; Wadley 2008). Interestingly, unlike at Blombos Cave, the Still Bay at Sibudu Cave has so far yielded no worked bone. Both of the Sibudu Cave bone points were made from the limb bones of small size mammals and show evidence of having been heated (Backwell *et al*. 2008). Both pieces were shaped by scraping with a lithic edge (Backwell *et al*. 2008).

3.5. Klasies River Mouth

Klasies River Mouth (KRM) is situated on the Tsitsikama coast (33º06´S, 23º24´E) and was one of the largest MSA sites to be excavated in South Africa and also the first to produce bone tools (Singer & Wymer 1982). The late Pleistocene sequence is divided into four discreet phases viz. the MSA I, MSA II, Howieson's Poort and MSA III or Post-Howieson's Poort, all based on their lithic variants (*cf.* Volman 1984; Thackeray 1992; Wurz 2002). Unfortunately, the original excavations were poorly conducted leading to renewed excavations employing better techniques (H. Deacon 1995). KRM has been instrumental in determining MSA cultural markers (*cf.* Singer & Wymer 1982; Volman 1984; Marean & Assefa 2005; Wurz 2000, 2002, 2008).

During the MSA I, *c.* 90 – 115 ka ago, the retouched component is limited and there is little selection of non-local raw materials (Wurz 2002). In the MSA II, *c*. 60 – 100 ka ago, the raw material is mainly quartzite and there is a trend towards smaller size points (Wurz 2002: 1008). The Howieson's Poort shows a preference for non-local raw material (Wurz 2002). It has small blades similar to those of MSA I and the only retouched component at the site (Wurz 2002, 2008). These segments, Deacon (1995) believes were used to tip spears. The Howieson's Poort has recently been dated to *c.* 50 – 62 ka ago (Jacobs & Roberts 2008). The MSA III, *c.* 45 – 50 ka ago, is constrained by its small sample size, but it is evident that non-local raw materials were used – second only to the Howieson's Poort (Wurz 2002). Again, the focus seems to have been on blade production, with "knives" making up the largest percentage of the retouched component (Wurz 2002).

The faunal remains during MSA I show a preference for marine mammals and large bovids, particularly adult eland and juvenile buffalo (Singer & Wymer 1982; H. Deacon 1995). There is also evidence that plant foods were an important dietary component of the inhabitant's diet (H. Deacon 1995). In MSA II, the same trend is seen, except seals become the preferred source of meat. During the Howieson's Poort and MSA III phase the habitat was more open and the climate colder. The hunting methods of the Howieson's Poort have been seen as a technological adaptation focusing on smaller animals in a more open habitat (Singer & Wymer 1982).

A single bone point (SAM-AA 42160) was recovered from Klasies Cave 1 during the Singer and Wymer (1982) excavations. It reputedly came from the base of the Howieson's Poort. The piece is ground symmetrically and associated with trapezes (Singer & Wymer 1982). The Klasies River bone point was made on the shaft fragment of a class II bovid and has been shaped by scraping with a lithic edge (d'Errico & Henshilwood 2007: 13). However, the morphological similarity of this point with LSA and ethnographic examples suggests that it is possible that this point derived from overlying LSA levels, and that its inclusion within the Howieson's Poort may be an erroneous interpretation (d'Errico & Henshilwood 2007: 19).

The bone point from Klasies has been chosen for a macro-fracture analysis for two reasons. First, it is the earliest documented account of a bone point from possible MSA association, and as such is quite an iconic piece. Secondly, the results of the analysis might yield information as to the bone point's function, which in turn could affirm or reject its recent assignation to the LSA.

3.6 Rose Cottage Cave

Rose Cottage Cave (RCC) in the eastern Free State (29º13´S, 27º28´E) has both MSA and LSA deposits spanning the last 100 ka ago (Wadley 1987b; 2001). Much work has been done on the LSA component of this site (*see* Wadley 1987b, 2000a, b, 2001), and it is here that bone points occur.

The MSA lithics are dominated by stone points, knives and scrapers, except in the Howieson's Poort, where backed tools predominate (Wadley 1987b but see Clark 1999 and Mohapi 2005 for a more detailed study). By *c.* 21 ka ago the MSA ends and is replaced by the first LSA industry, the Robberg *c.* 9560 BP (Wadley 1987b). The Robberg is replaced, quite late in time, by the Oakhurst industry which in turn gives way to the Wilton (Wadley 2000a, b). The Oakhurst (9250 – 8160 BP) contains many scrapers but few other formal tools (Wadley 2000a). Scrapers continue to dominate in the Wilton (7630 – 2240 BP), but segments also occur in large numbers (Wadley 2000b).

During the late Pleistocene, vegetation would have been insufficient to support small browsing animals and this is reflected in the faunal record showing a prevalence of large to medium sized bovids which would have preferred open grassland habitats (Wadley 1987b). The focus seems to be on smaller game in the Holocene compared to the Late Pleistocene. During the Oakhurst, warmer conditions prevailed at the site creating a 'mesic' environment. Wadley (2000b) notes that the subsistence change over the last few thousand years was accompanied by bone points, hooks, tanged arrow heads and bifacial bladelets.

The earliest bone point comes from the Robberg industry and is associated with single-sided bladelets; although bone points are most common in the Wilton industry after 2 ka ago, making up a total of 14 pieces, 7 of which are broken. At this time bone awls, fish gorges and engraved bone handles are also common. A single bone point was found in association with small scrapers in the Oakhurst (Wadley 2000a). Blood residues on one of the bone points from the Wilton layers support the interpretation that they were used for hunting (Wadley 2000b). Among other finds from the Wilton layers are blood stained bone hooks (Wadley 2000b).

Much research has been carried out at RCC regarding the role of stone points in hunting activities (see Mohapi 2005; Wadley & Mohapi 2008). My study will be the first functional analysis conducted on the bone points from this site. It is highly probable that the bone points at this sit were indeed used for hunting and a macro-fracture analysis has the ability to further support this interpretation, which at present is based solely on the presence of blood residue on one point and analogy with the stone points.

3.7 Jubilee Shelter

Jubilee Shelter, in the Magaliesberg range, has been extensively excavated and well recorded (e.g. Wadley 1987a, 1989). It has a long occupational sequence. Bone points make their first appearance in the Oakhurst and continue to increase in number until the abandonment of the site a few hundred years ago (Wadley 1987a). The site has played a key role in the understanding of seasonal transhumanence patterns in the LSA of southern Africa. Both the lithic and non-lithic evidence suggests that the shelter was used as an aggregation phase camp in the summer months (Wadley 1987a, 1989).

The Oakhurst, which begins *c.* 12 ka ago and coincides with the climatic amelioration at the end of the last glacial, is characterised by a macro-lithic industry widely distributed across the landscape – suggesting a greater ability to exploit all environments (Wadley 1987a). In the Post-Wilton, small convex scrapers are found in association with bone points. The faunal remains at Jubilee Shelter are well preserved, especially in the Holocene, and represent a wide variety of animals; from fresh water mussel to antelope (Wadley 1987b). The faunal remains support the interpretation of a bushveld environ during the Holocene (Wadley 1987b: 28).

A total of sixteen bone points were recovered intact from Jubilee. Many more bone shafts were recovered whose tips were missing (Wadley 1987b). Interestingly, bone points and other similar items occur only in the Oakhurst and early Post-Wilton layers, associated with demographic expansion; whereas they are absent in the Wilton which is associated with demographic contraction and possibly harsher environmental conditions (Wadley 1987b).

Macro-fracture analysis allows for the study and interpretation of points whose tips are missing or broken. A macro-fracture analysis of the bone points from Jubilee Shelter could contribute to our understanding of hunting practices at this site over time. Why is there an absence of bone points between the Oakhurst and early Post-Wilton and what does this mean for subsistence activities at the site.

3.8. Bushman Rock Shelter

Bushman Rock Shelter (BRS) in the Mpumalanga province (24º35´S, 30º38´E) is yet another site with both MSA and LSA deposits (Louw 1969; Plug 1978, 1981, 1982). The top 18 levels of the shelter date from the late Pleistocene to the early Holocene, and range in age between *c.* 13 – 9 ka ago (Plug 1981). The shelter is predominantly a LSA site containing an Oakhurst techno-complex, although the last three levels have been assigned to the MSA - indicating an abrupt change from one industry to the other (Plug 1981). There is excellent preservation of bone in all levels. Four bone points have been recovered from the LSA layers of the site (Plug 1982), although in an earlier paper (1981) three bone points are alluded to in the MSA layers.

Scrapers are the dominant formal tool throughout the sequence, although they occur in higher percentages in the MSA (Plug 1981). Lithics are much larger than in the LSA, evincing both bifacial and unifacial retouch (Plug 1981). Stone points are present. The first eight levels of the LSA contain few formal tools and no backed pieces. The impression is one of informality and expediency (Plug 1981). In the top five layers the backed tool component increases, especially segments, seemingly at the expense of bone tools (Plug 1981). Large animals dominate the faunal material throughout the sequence but small trappable animals are present in the upper twelve layers (Plug 1981) suggesting a change in hunting techniques. The species hunted remain the same throughout the sequence and are the same species found in the area today, suggesting limited change of climate at the site (Plug 1981: 18).

Bone tools are particularly important in levels 6 – 14 where they compensate for the small number of formal stone tools (Plug 1978, 1982). The nineteen bone points, only four of which are intact, were all made from the shafts of long bones, and were polished over their entire surface (Plug 1982). Bone link-shafts and ornaments are also present (Plug 1982). Three broken points were found in the lower three levels thought to be of MSA provenience (Plug 1981, 1982). The wide variety of bone tools at the site has been taken to reflect their use for a wide variety of purposes. Many of these tools were modified through percussion flaking and bear great resemblance to the stone artefacts such as scrapers, burins and drills. Bone from this site is interpreted as having its own technology akin to that of its lithic counterpart (Plug 1982).

3.9. Nelson Bay Cave

Nelson Bay Cave (NBC) on the Robberg peninsula (34º06´S, 23º24´E) on the southern Cape coast has been studied extensively (*see* Klein 1972a; Inskeep 1987; J. Deacon 1984). It contains both MSA and LSA deposits, but bone points have only been recovered from the LSA levels. The LSA starts at *c.* 18 ka ago where the most common bone tool type is the fish-gorge (J. Deacon 1984). There is a shift in faunal exploitation 12 ka ago at the junction of the Robberg and Albany industries which it is suggested reflects a shift from lithic based multi-barbed spears to bone point based bow and arrow hunting technology (J. Deacon 1984; Mitchell 1988; Inskeep 1987).

Local quartzite is the dominant raw material at Nelson Bay, both in the MSA and LSA, although formal tools were mainly on vein quartz (Inskeep 1987; J. Deacon 1984).The flake based industry at NBC has negligible amounts of formal tools, of which scrapers are the most common (J. Deacon 1984). By the Holocene there is clear evidence for lithic hafting. A change in flaking technique, raw material preferences, and increase in size of untrimmed flakes and scrapers, are also noted after *c.* 12 ka ago (J. Deacon 1984). This disruption in the developmental sequence corresponds to a change in hunting pattern (J. Deacon 1984: 302).

Hunting was geared towards large migratory game in the late Pleistocene with a shift towards smaller animals occurring at *c.* 12 ka ago, that is, the start of the terminal Pleistocene. Deacon (1984) attributes this change to a shift in environmental conditions 2 – 4 ka earlier, which resulted in the disappearance of grassland, a rise in sea level and subsequently the extinction of certain mega-faunal species (also see Klein 1972b). Marine creatures including molluscs, fish and marine birds also make an appearance in these Pre-Wilton levels (Klein 1972b). This period is also characterized by bone tools and scrapers.

Of the 25 bone points that were recovered, 10 were found complete (Inskeep 1987). Four hollow bone points were also recovered which Inskeep suggests functioned either as arrowheads or awls. Bone points and link-shafts on the other hand, he says represent unambiguous evidence, based on ethnographic analogy with the Kalahari San, for the use of bow and arrow hunting. Bone points were finely made and well finished (Inskeep 1987). The number and variety of bone tools continues to increase into the Holocene accompanied by clear evidence for lithic hafting (J. Deacon 1984).

A macro-fracture study of bone points at Nelson Bay Cave has the potential to contribute to our understanding of hunting technology and the reason for the shift in subsistence activities 12 ka ago. The shift towards smaller animals and the disappearance of grassland at this time may have implications for the role of the bow and arrow in LSA communities. Macro-fracture analysis might help resolve the issue of the function of the hollow bone points.

3.10. Fourie Collection

The Fourie collection is an ethnographic collection comprising over 4000 individual artefacts, 1186 of which are arrows. The collection comprises artefacts from thirteen hunter-gatherer groups including the ‡Ao-//Ein, !Kung and the Naron (see Wanless 2007).

Over one hundred arrows are bone tipped and comprise two types. The first of these, which corresponds to Goodwin's (1945) 'Type 3', are slender bone points attached to a more robust bone link-shaft. The bone points are usually poisoned and reversible, remaining inverted into the main-shaft until they were needed (Schapera 1927; Goodwin 1945; J. Deacon 1992; Backwell *et al.* 2008). The second arrow type, which corresponds to Goodwin's (1945) 'Type 4', consists of a robust bone point fixed directly into the main-shaft. This robust bone point can easily be mistaken for the link-shaft of a Type 3 arrow in inverted position.

These two different types of arrows are common among all Bushmen groups of the Kalahari (Wanless 2007) and likely represent different hunting techniques (see Clark 1977; Backwell *et al.* 2008). The different hunting techniques and the role of the bow and arrows have been discussed in Chapter 2.

A macro-fracture analysis of a bone point collection of known use is invaluable in the interpretation of macro-fractures on archaeological bone points. Together with the experimental sample of bone points this collection represents the base line on which fractures on bone will be judged.

3.11. Conclusion

The above mentioned sites constitute some of the best documented sites containing bone points and other pointed bone tools. I have tried to include sites from all across South Africa. There are, of course, many other sites that that could have been included, but which the confines of this project prevented. The scarcity of MSA bone tools has allowed me to include all the pieces known to us. With the exception of Bushman Rock Shelter, which has purported MSA levels, all the MSA bone points came from coastal, or near coastal sites, as in the case of Sibudu Cave. I will now present the results of the morphometric analysis on the pointed bone tools from these sites.

CHAPTER 4

METHODOLOGY

4.1. Introduction

This chapter discusses the three methods which I have used in order to examine the possible use of bone points in the archaeological record over time. The first method that I used was a morphometric analysis of archaeological bone points. This allowed me to replicate my own bone points that fit the mean dimensions of the archaeological samples. I examined the morphometric database for changes in the dimensions of bone points from the various localities and time periods.

My primary technique of analysis to investigate the possible use of bone points in the archaeological record is macro-fracture analysis. It has been established that certain types of fractures occur as the result of certain activities. The set of fractures which I will be looking for are those that occur as the result of longitudinal impact. These fracture types have been established by numerous authors working with stone tipped hunting weapons (e.g. Odell & Vereeken 1980; Fischer *et al.* 1984; Odell & Cowan 1986; Shea 1988; Dockall 1997; Crombe *et al.* 2001; Lombard *et al.* 2004; Lombard 2003, 2005; Shea 2006; Villa & Lenoir 2006; Pargeter 2007; Lombard & Pargeter 2008; Sisk & Shea 2009; Villa *et al.* 2010; Yaroshevich *et al.* 2010). I have used their criteria for identification and interpretation of any fractures that occurred on the bone points.

The application of macro-fracture analysis to bone artefacts represents a promising avenue of research. It has been shown to work well on stone tipped spear and arrow points (e.g. Fischer *et al.* 1984; Odell & Cowan 1986; Lombard *et al.* 2004; Lombard 2003, 2005; Villa & Lenoir 2006; Pargeter 2007; Lombard & Pargeter 2008; Sisk & Shea 2009; Yaroshevich *et al.* 2010). These studies have demonstrated that the identification of fracture types can be used to establish the possible hunting function of hafted tools (Lombard 2005). However, no macro-fracture analyses have been conducted on bone points from southern Africa thought to be hunting weapons. Recent studies have focused on the projectile impact traces of bone points on faunal remains (Letourneux & Petillon 2008) but have not examined the bone points themselves. If diagnostic fractures are left on the bones of the prey then it would be expected that diagnostic fractures should occur on the bone weapons as well.

Once the replica points had been made, using traditional manufacturing techniques, they were hafted onto commercial arrows and propelled into the carcass of a small antelope using a commercial bow. This experiment was designed to produce macro-fractures that would normally occur as a result of hunting, specifically using a bow and arrow. The protocol for this type of replication experiment has been established by other researchers, discussed below, and I largely followed their methods. Once all my replica points had been fired into the carcass, they were examined for macro-fractures. Finally, I re-examined the bone points from various archaeological contexts to see whether similar fractures occur on these points. A positive result would strongly support the hypothesis that projectile technology is not a recent phenomenon, and may well have formed part of the hunting repertoire of people as far back as *c.* 75 ka.

When studying the presence and absence of organic materials, like bone, it is necessary to consider the conditions of survivability of these materials at particular sites. One needs to take cognisance of the intrinsic properties of these materials and of the taphonomic processes under which they were subjected. Most bones break in a predictable fashion (Hesse & Wapnish 1985), which makes certain bones, most notably long-bones, more suitable for point manufacture. This is supported by the many Stone Age bone tools made on limb bones (see Smith & Poegenpoel 1988; Shipman 1989; d’Errico & Henshilwood 2007). The degree, kind and distribution of modification are what determine whether a bone was used as a tool or not (Lyman 1996: 339). Manufactured bone is visible by chipped or ground fracture edges, while use-wear modification is restricted to attritional loss of bone tissue, polish, rounded edges and micro-flaking of fracture surfaces (Lyman 1996). Important to note is that both use-wear and manufacturing traces can result from post-depositional forces, which are discussed below, and need not be the result of intentional modification.

4.1.1. Properties of bone

Bone has several unique properties that set it apart from other raw materials like stone. An understanding of these properties is a prerequisite for working with this material. Most bones are covered by a connective tissue membrane, called the periosteum, onto which muscles and ligaments attach. Over time, the periosteum produces new layers of bone, thus increasing the bone's diameter. The older the animal the thicker the cortical bone will be.

A typical bone, like the long bones, consists of two types of tissue: compact tissue on the outside and spongy tissue inside. The centre of these bones is filled with marrow, a fatty substance which produces erythrocytes. Bones are remodelled continuously throughout life, in response to physical stress, and this is seen in the proportions of cortical and spongy bone (Hesse & Wapnish 1985; Solomon *et al.* 2005). As the muscles develop, the bones to which they are attached thicken and become stronger. As a result of bone growth, tissue is removed from its interior. This, results in a thickening of the compact tissue and a widening of the marrow cavity diameter (Solomon *et al.* 2005).

Bones most commonly selected for point manufacture are long bones, although there is a certain amount of variation in the MSA (Henshilwood *et al.* 2001b). Studies conducted on contemporary faunal samples have shown that certain bones are anisotropic and that they tend to fracture longitudinally (Hesse & Wapnish 1985; Knecht 1997). This is due, in part, to the unidirectional grain of the bone. Bone, compared to its lithic counterpart, is pliable and more durable giving it a longer life expectancy.

The strength of a bone is largely determined by its density. Density is determined by the amount of muscle attachments and stress under which the bone is subjected to during life – it does not increase with age nor does it differ predictably between different bones (Symmons 2002: 92). To produce a piece of suitable proportions to make a point, the bone needs to be broken up. Simply shattering the bone produces flakes, the shape of which cannot be controlled. However, due to the soft nature of bone it is possible to carve grooves down its long axis along which one can control the break (*see* Semenov 1964; Nandris 1971; Newcomer 1974; Smith & Poeggenpoel 1981).

Bone, like other organic materials has a low survivability rate in archaeological deposits. Taphonomy, which in its broadest sense is the study of the laws of burial, can tell us about the likelihood of survivability as well as past environmental conditions (Martin 1999). Bones have different preservation potential based on their size and density (Shipman 1981; Symmons 2002). Generally speaking, rapidly buried bones, especially by fine-grain sediment, are exposed to fewer destructive forces like weathering and are more likely to be preserved (Martin 1999). Some bones may undergo a degree of mineralization after deposition which aids in preservation (Shipman 1981). Polish, although usually indicative of use-wear, may also result from post-depositional abrasion (Brain 1981; Lyman 1996) or organic chemicals in the soil.

Certain fractures are known to occur on bones after deposition. Blasco *et al.* (2008) have shown that the principal cause of oblique notches on bone edges is the result of post-depositional trampling. This is of particular significance to this study which aims to examine macro-fractures produced as a result of hunting. It is therefore essential that the taphonomic processes of a site are assessed before any conclusions are drawn from the faunal remains.

I now turn to a discussion of each of the methodological aspects that I employ in this study. The first section deals with the background to the methodological approaches. In the second section I discuss the specific methods used in this thesis and the protocol used in applying each of the methods discussed above.

4.2. Background to Methods

4.2.1. Morphometric analyses

The study of artefact morphometry has, for much of the past, been the main criterion for the classification of archaeological artefacts into cultural and functional units. Stone tools, being the most commonly recovered artefacts from most sites, have received much attention from archaeologists seeking to study tool function and cultural identity. The grouping of certain morphometric attributes into typologies has formed a major part of these studies (e.g. Bordes 1969; J. Deacon 1984). These typologies are based on assumed function and often rely on ethnographic analogy. Although the intended function of a tool does set constraints on its form, the morphology of points of known function may allow insights into the dimensional variability of points with specific functions. Because this study deals with bone points I shall concentrate on the limited typologies and morphometric studies of bone artefacts. A detailed comparative study of bone point morphology can also be used to differentiate the probable function of the point e.g. spear point versus arrow point versus awls and link-shafts (Henshilwood *et al.* 2001a, b; d'Errico & Henshilwood 2007; Backwell *et al.* 2008).

A variety of different shaped and sized bone points are available in the archaeological record (see d'Errico & Henshilwood 2007; Backwell *et al*. 2008; Bosc-Zanardo *et al.* 2008). Not all bone points were intended for or would have functioned as hunting weapons. Pointed bone artefacts are known to have a variety of domestic functions from awls to matting needles. These functions have been given based largely on the different shapes of the tools and on ethnographic observation. There are four broad types of bone point shapes evident in the southern African archaeological record from the MSA onwards. These can be sub-divided into points used for hunting and into points used for domestic activities. The list below presents the pointed bone forms that have been described in ethnographic and LSA assemblages and which have been largely used to classify pointed bone tools from older deposits.

Points used for hunting include:
(1) Tapering cylindrical points - usually less than 120 mm in length and 10 mm in maximum width. These formal points are almost cylindrical in cross section with marginal widening at the base. They can be further sub-divided into gracile points - with poison and robust points - without poison (Schapera 1927; Goodwin 1945; Wanless 2007; Backwell et al. 2008).

(2) 'Torpedo' shaped link-shafts – usually shorter and thicker than the tapering cylindrical points. Link-shafts are not always cylindrical and may vary. Link-shafts can be distinguished from formal points by their double tapered extremities and relative robusticity (Schapera 1927; Goodwin 1945; Van Riet Louw 1954; Clark 1977; Bosc-Zanardo *et al.* 2008; Backwell *et al.* 2008).

(3) The form of this type is not as narrowly delineated as the form of previous types. These points are larger than those of the other types but of irregular shape. They are thought to have functioned as spear tips during the MSA (see d'Errico & Henshilwood 2007).

Points used for domestic activities include:
(1) Thin flat matting-needle points, usually of similar measurements to the tapering cylindrical points, but flat (Fig. 1D and see Sampson 1974; H. Deacon 1976; J. Deacon 1984; Wadley 1987a).

(2) Extremely thin bone needles, usually of a similar length but <3mm in maximum width (see Sampson 1974; H. Deacon 1976; J. Deacon 1984; Bosc-Zanardo *et al.* 2008).

(3) Irregularly shaped awls, usually only worked to a point near the tip of the piece of bone. Awls are distinguished from points as being broad and flat at the base (Fig. 1A and see Sampson 1974; H. Deacon 1976; J. Deacon 1984; Wadley 1987a; Henshilwood *et al.* 2001b; Backwell *et al.* 2008; Bosc-Zanardo *et al.* 2008).

Bone points, which constitute one element in hunting weapons, '...play a dynamic role in prehistoric material culture. Their technology and technical characteristics vary significantly through space and time, thus constituting a tool for the archaeologist in the construction of chronologies and the definitions of cultures' (Petillon *et al.* 2008: 1). Although typologies should take cognisance of the entire arrow, the head alone has been found to be a discriminating component of the arrow as a whole (Bosc-Zanardo *et al.* 2008). The elements used as the criteria in these definitions include the head, distal extremity, body, edges, ailerons – these are the wings of tanged arrowheads, and the stalk. Study of the hierarchy of these criteria makes it possible to recognise families, groups, types and sub-types (Bosc-Zanardo *et al.* 2008).

A study which examined arrow morphotypes made a distinction between cutting and piercing ability (Bosc-Zanardo *et al.* 2008). Arrows tipped with bone are thought to have been used primarily for piercing activities. In hunting this would be employed when the hunter wants to penetrate the internal organs of the prey. Stone points would be used where the hunter intends to cause loss of blood in the prey. Diamond shaped metal points are optimal as they combine both properties into a single weapon (Bosc-Zanardo *et al.* 2008). These are not common in South Africa prior to the nineteenth century and are probably the result of contact with farmer communities and inter-personal conflict (Petillon *et al.* 2008). Leakey (1926) distinguished two main types of arrows: fletched and unfletched. The fletched or feathered arrows usually employ a single tangential feather among the Bushmen, although this takes different forms during contact situations. Where the arrow is not feathered the tip needs to be much heavier than the main shaft to stabilise the arrow during flight.

Typologies based on style run an inherent risk because style will change as social circumstances, whim and availability of material change (Leakey 1926; J. Deacon 1992). It was for these reasons that Louis Leakey's original attempt to classify African bows and arrows was based on technique of manufacture rather than the non-functional aspects. Deacon adds a further point that, because of the close link between arrows and social networks, no satisfactory explanation of variability can be proposed without reference to ethnography (J. Deacon 1992: 11).

Studies such as those performed by Petillon, Bosc-Zanardo and colleagues have recognised stylistic differences mainly among stone and metal arrow heads but not on the bone equivalents. This might be because little variety can be achieved in bone points if their effectiveness is to be retained (J. Deacon 1992). This in due in part to the inherent properties of bone which limit its cutting ability in favour of piercing ability (Bosc-Zanardo *et al.* 2008). This fact may indeed make morphology a much more powerful tool for interpreting function when applied to bone points as opposed to stone points. The present study seeks to expand this database and test the appropriateness of these morphometric categories through experimental replication and study of hunting macro-fractures.

4.2.2. Experimentation

The aim of experimental archaeology is to reproduce former conditions and circumstances (Ascher 1961; Coles 1979), in order to test hypotheses about past cultural behaviour. As part of the hypothetico-deductive process (Popper 1959; Huffman 2004, 2007; Outram 2008) experimentation allows for the possibility of deductive reasoning rather than relying on probabilistic and inductive extrapolations from ethnographic analogues (Outram 2008: 1). Ethnographic analogues are in essence incomplete since they represent only a limited and selected set of variables and can only control for a certain number of these (e.g. Dominguez-Rodrigo 2008). The benefits of an experimental approach are that the research is performed in a scientific manner, is repeatable and can provide both qualitative and quantitative data (Seetah 2008). This is discussed more fully in the theory chapter.

Experimentation is an indispensable tool for addressing questions of human behaviour and cognition (Isaac 1981; Bell 1994), taphonomy (Fisher 1995; Costamagno *et al.* 2005), Hunting activities (Frison 1989; Pargeter 2007; Lombard & Pargeter 2008; Petillon *et al.* 2008) and subsistence activities (Outram 2002). One way that experiments control their results is to eliminate, as far as possible, other factors which might produce a positive result. For example, my experiment was designed to replicate macro-fractures without interference from taphonomic processes that may influence the fractures on bone points in the archaeological record.

4.2.2.1. How has experimental archaeology previously been used?

In terms of hunting experiments, which is the type that I shall be conducting, a wide variety of studies have been done. Recent experimental research has sought to replicate past hunting behaviours and technologies in an attempt to be able to identify tools used for this purpose in the archaeological record (Fischer *et al.* 1984; Lombard *et al.* 2004; Pargeter 2007; Lombard & Pargeter 2008; Sisk & Shea 2009; Villa *et al.* 2009; Villa *et al.* 2010).

One method used to identify tools used for specific purposes is known as macro-fracture analysis. Macro-fracture studies look for use-wear and diagnostic fracture patterns that can be used to tell us something about the activity that created them. I aim to apply and test the principles of macro-fracture analysis, as established for stone tools, on bone points. I discuss this technique below.

4.2.3. Use-trace analysis

The possible role of stone points as Stone Age hunting weapons has been a topic of research for many years. Much of this research in the last century has focused on the classification of stone tools based on assumed function (e.g. Bordes 1969; J. Deacon 1984) which in turn was based on ethnographic analogy and tool morphology (Hayden 1979; Odell 1988). It was assumed that particular tool shapes must have been used for certain activities, based on ethnographic observation and a likely function for that particular shape tool. However, these morphological terms, e.g. scraper, segment, point etc. have little functional integrity as many tools were in fact used for a variety of tasks and can fall into different categories depending on the life-history of the tool (Hayden 1979; Odell 1988; Casper & De Bie 1996). Morphology was shown to be inadequate as a stand-alone method for ascribing function to tools. Additional information was needed.

As early as the 1800s use-wear patterns were observed on stone tool artefacts (Spurrell 1892 in Hayden 1979). These use-wear patterns consisted of striations, polish, edge crushing and other unintentional modifications to the surface of the tool acquired through use in a particular activity. However, it was not until the work of the Russian researcher Sergi Semenov (1964) that replication experiments were used to draw inferences on the possible causes of the various use-wear traces. Unfortunately advances in this field of research were not forthcoming until a decade later when the

Ho Ho[1] conference was convened which integrated overall tool morphology and use-wear analysis into a general core of behavioural archaeology (Hayden 1979: 5).

Coupled with the examination of use-wear came the study of impact damage on artefacts. These impacts occur as the result of a forceful collision of the artefact with other objects and were thought to be able to provide data on possible site function, patterns of weapon use and discard, and other aspects of subsistence behaviour (Donahue 1988; Dockall 1997). Dockall makes the distinction between these two types of wear. Abrasive wear results in surface deformation in the form of polishes, striations and edge dulling. This type of wear may represent extended use. Abrasive wear does not result in mechanical failure but may hinder use efficiency. The second type of wear is fatigue wear which includes all forms of macro-fractures. The type of fatigue wear evinced differs per contact material but usually results in mechanical failure of the tool. Use-wear and macro-fracture analysis can provide complimentary data sets about the task to which an artefact was put (Hayden 1979; Lawn & Marshal 1979).

4.2.3.1. The Mechanics of macro-fracture

Macro-fractures form along existing fissures which arise from inherent flaws or weaknesses in the material (Lawn & Marshal 1979). The force from an impact causes the fissure to travel along the main axis of the piece until the force has dissipated. At this point a break forms perpendicular to the main axis thereby detaching a sliver of material. This last process can take a variety of forms depending on the amount of force, angle of impact and raw material. Fracture types are also influenced by the raw material, angle of the edge and convexity/concavity of facets near the edge (Hayden 1979; Fischer *et al.* 1984). The identification of fracture types can be used to establish a number of variables e.g. the amount of force exerted at time of impact, vertical direction of the force, nature of contact area, and whether the point was hafted

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[1] The Ho Ho committee was formed in 1977 with the aim of producing a standard use-fracture classification that would be suitable for use-wear studies.

(Hayden 1979: 6; Lombard 2003: 28). Macro-fracture analysis draws upon the underlying principles of fracture mechanics for brittle solids. These principles can be used in conjunction with the physical properties of the material such as loading vectors to make predictive statements about wear characteristics (Hayden 1979).

The Ho Ho classification and nomenclature committee report (see Hayden 1979: 133 – 135) distinguished between two fundamentally different types of fractures: the Hertzian (cone or point initiations) and bending (break and break derivative) fractures. The former type result from force applied over a relatively small area and where the fracture occurs close to the point of initiation. The latter type result from force applied over a large area and where the fracture does not necessarily initiate close to the impact area (Lombard 2003: 28). The various sub-types of fractures have been defined and expanded on elsewhere (e.g. Crabtree 1972; Hayden 1979; Fischer *et al.* 1984; Lombard 2003; Yaroshevich *et al.* 2010).

1. A Feather termination fracture: is a form of bending fracture which terminates in an edge with a minimal margin. The force is applied parallel to the flake surface.
2. A Step termination fracture: is a bending fracture, which before meeting the opposite surface terminates abruptly in a right angle.
3. A Hinge termination fracture: is a bending fracture which, after running parallel to the opposite surface, meets this surface in an obtuse curve.
4. A Snap fracture: is a bending fracture which meets the opposite surface immediately perpendicular to the point of initiation.
5. An Embryonic bending fracture: is one where the fracture path terminates before reaching the opposite surface of the specimen.
6. A Spin-Off fracture: is a cone fracture which initiates from a bending fracture and removes part of the original surface of the specimen.

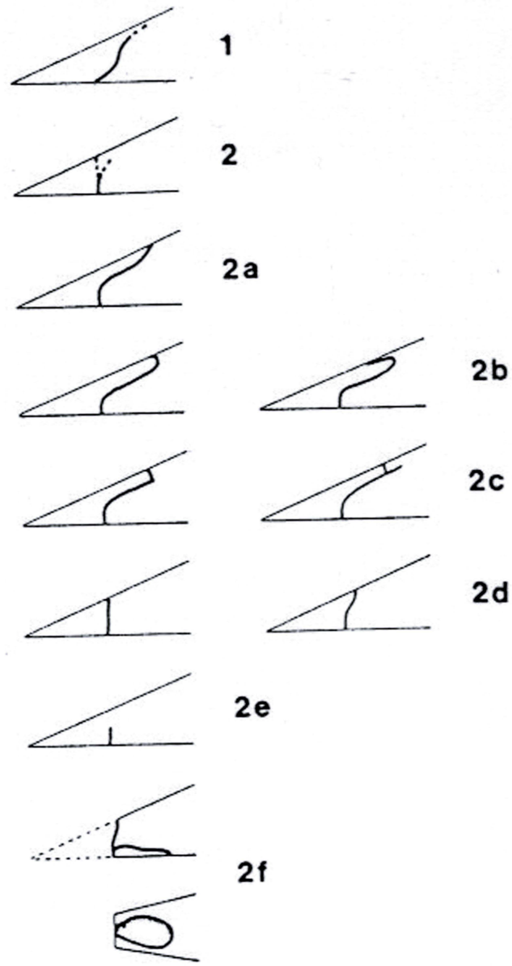

Figure 4. Plan diagram of the various types of impact fractures on projectile points as given by Fischer *et al.* 1984. 1 = a cone initiating fracture; 2 = a bending fracture; 2a = a feather terminating fracture; 2b = a hinge terminating fracture; 2c = a step termination fracture; 2d = a snap fracture; 2e = an embryonic bending fracture; 2f = a spin-off fracture.

Although the mechanics of formation of the fracture are similar regardless of the mode of use, some fractures can be considered diagnostic of longitudinal impact (Fischer *et al.* 1984; Dockall 1997; also see Lombard *et al.* 2004; Lombard 2005; Yaroshevich *et al.* 2010). Macro-fracture studies have shown that spin-off fractures are the most characteristic diagnostic fracture of longitudinal impact use (Fischer *et al.* 1984: 19 - 46; Lombard 2003: 29). Spin-off fractures can occur in two varieties i.e. unifacial and bifacial spin-offs. Although spin-off fractures smaller than 6mm can be diagnostic (Fischer *et al.* 1984) it is common practice to only count spin-off fractures larger than 6mm to ward against other possible causes like trampling (see McBrearty *et al.* 1998; Lombard 2005). Fractures along the lateral edge of stone points, regardless of their terminations, have also been noted on experimental stone points (Lombard *et al.* 2004; Lombard 2005). They are referred to as impact burination fractures. Step-terminating bending fractures are also considered diagnostic of projectile activity (Fischer *et al.* 1984; Lombard 2005). Snap and feather fractures, although present on experimental projectile stone points, are not considered diagnostic (Lombard 2003).

4.2.3.2. Hunting weapon impact fractures

For points used as weapon tips a fracture may occur when the point hits a hard surface perpendicular to the point's main axis. The impact can cause chips to detach from the dorsal and ventral surfaces near the tip. Next, one or more transverse bending fissures may travel down the lateral edge of the point's length as the force of the impact is transferred down the point (Bergman & Newcomer 1983). Various factors influence the type of fractures that will occur. Most of these factors have to do with the morphology of the point, particularly the relative length and cross section shape of the point (Bergman & Newcomer 1983). The most common type of damage to points used for hunting occurs at the tip (Frison 1989). Depending on the type of fractures, the position of the fractures and the particular grouping of various fracture types, inferences can be drawn as to the probable activity responsible (see Bergman & Newcomer 1983; Fischer *et al.* 1984; Lombard 2003; Yaroshevich *et al.* 2010).

These types of fractures are commonly referred to as diagnostic impact fractures or DIFs. However, this line of evidence alone is not enough to tell exactly what activity the tool was put to. For example, all tools subjected to longitudinal impact, from a burin to a thrust spear or projectile point will develop similar fractures (Bergman & Newcomer 1983; Odell 1988; Lombard 2003; Lombard *et al.* 2004). Macro-fractures alone cannot tell us about other possible functions of the tool or the materials on which they were used (Odell 1975; Lombard 2003).

Macro-fracture analysis thus provides only one line of evidence as to the probable function of a tool and must be supplemented by additional information, such as morphological studies, evidence for hafting and detailed faunal analysis of the relevant sample. Certain abrasive-wear traces such as linear polishes and striations are also another line of evidence that suggests use as a projectile implement (Fischer *et al.* 1984; Crombe *et al.* 2001). Importantly, the lack of fractures doesn't mean that a tool was not used, as recent experimental work has shown that not all tools develop fractures (see Odell 1975; Fischer *et al.* 1984; Odell & Cowan 1986; Lombard 2003, 2005; Villa *et al.* 2009).

4.2.3.3. Limitations to macro-fracture analysis

The Ho Ho commission originally identified four main weaknesses of this approach to studying use-wear. The problem areas it identified were: first, the lack of experiments on specific modes of tool use to determine variance in wear patterning. Secondly, how can other causes of fractures like trampling be identified and distinguished from one another. For example, edge crushing and snap fractures and oblique notches have been found in trampling experiments (McBrearty *et al.* 1998; Blasco *et al.* 2008). Thirdly, how does the morphology of the piece influence fracture type. Finally, there is a lack of understanding of the effects of soil deposition on tool surface modification. One possible answer to some of these issues has been to look at the shape and position of the use-wear as an additional indicator of function (see Odell 1975: 230). Another problem perpetuated by some researchers is the lack of a standardized terminology. Unfortunately, the nomenclature of the Ho Ho conference is either unknown or disregarded by some researchers (Dockal 1997; Petillon *et al.* 2008).

The most important assumption of macro-fracture analysis is that particular types of fractures can be produced only through particular types of activities (Odell & Cowan 1986; Lombard 2005, 2007; Letourneux & Petillon 2008). If it can be shown through experimental studies that a particular activity or type of activity produces specific fractures or fracture patterns then it is probable that the same type of fracture on an archaeological sample would have been caused by a similar activity. This is possible because the same processes that cause brittle solids to break in particular ways still operate today.

A suite of experimental studies have sought to examine, through use-wear analysis, the functional aspects of stone points, particularly whether certain stone points were used as hafted projectile weapons (e.g. Fisher *et al.* 1984; Odell & Cowan 1986; Odell 1981, 1988; Shea 1988; Casper & De Bie 1996; Crombe *et al.* 2001; Lombard *et al.* 2004; Lombard 2005; Villa & Lenoir 2006; Lombard & Parsons 2008; Lombard & Pargeter 2008; Sisk & Shea 2009; Villa *et al.* 2009a, b; Villa *et al.* 2010; Yaroshevich *et al.* 2010). As few comparable studies have as yet been carried out on bone points thought to be hunting weapons it is important for me to draw on the studies done on the lithic equivalents. Macro-fracture is assumed to work similarly on all brittle solids (Hayden 1979) which includes bone and stone. If this is indeed the case, lithic macro-fracture studies may shed invaluable light on the application of this technique to bone points. As most of these studies followed similar experimental protocols and achieved comparable results I will deal with these as a unit.

4.2.3.4. Previous experimental and use-wear studies on bone

All of the above studies have focused on lithic raw materials. Bone, like other anisotropic solids has a tendency to fracture longitudinally, due in part to its unidirectional grain (Lawn & Marshal 1979; Hesse & Wapnish 1985; Knecht 1997). Most mammalian bone responds in a predictable way when stressed. Due to its greater energy absorbing capacity it tends to exhibit spiral fractures when broken artificially (Lawn & Marshal 1979; Shipman 1981; Johnson 1989). Unfortunately, only the most recent and/or most destructive activities are recorded on the bone surface (Griffitts 1997: 238). When working with bone it is important to note that other agencies than anthropogenic can produce abrasive use-wear traces on the bone surface (Johnson 1989). These are discussed in detail in the taphonomy chapter.

In his *Replication and Analysis of Bone Tools* Griffitts (1997) examined the use-wear of archaeological bone tools and his own experimental samples. He manufactured his own bone tools and used these in various activities. The use-wear resulting from the manufacturing process and the different activities was examined using high and low power microscopy. The two main activities he studied were hide and plant processing. Bone tools used for hide processing were found to have rounded surfaces and working edges though these tended to follow the topography of the bone. A bright polish was also produced on some of these tools. Bone tools used for plant processing were also found to develop rounded edges while the face became flattened or sheared off. Wear was concentrated on the highest point of the bone surface. Griffitts concluded that all bone tools, irrespective of the activity they are used for, pass through the same initial stages of indiscreet weak polish but eventually wear differently depending on function (Griffitts 1997: 236 – 238; also see Backwell & d'Errico 2005).

A study which focused on the identification of hunting macro-fractures on bone was conducted by Letourneux and Petillon (2008). This study focused on the impacted rather than the impacting material. The identification of hunting and specifically projectile impact traces on archaeological faunal remains is an important issue for understanding prehistoric hunting behaviour, method of capture and origin of bone accumulation. Their study found that bone points are more resilient than their stone counterparts but have less cutting abilities. Their primary performance advantage would have been in their power of penetration. The type and extent of damage by bone points varies according to the morphology and thickness of the impacted bone. However, three main traces left by bone points were identified namely: perforations, punctures and notches which are the most frequent (Letourneux & Petillon 2008). These traces all have rounded to oval edges (Letourneux & Petillon 2008).

Another study recently conducted used a macro-fracture analysis on bone points from Borneo to determine whether they may have been used as hafted hunting weapons (Barton *et al.* 2009). Drawing on the work of previous researchers (Guthrie 1983; Pasveer 2005), which showed that hafted bone points used as projectiles are most likely to break at the tip due to impact or at the weak point immediately outside of the haft, they were able to establish that their bone points were indeed used as hafted hunting weapons. Unfortunately, none of these studies detailed the specific types of fractures that accrue as a result of hunting.

The recent experimental replication study by Blasco *et al.* (2008) examined a crucial issue in the understanding of fracture patterns on bone tools. Their study addressed the question of the identification of fractures that result from intentional breakage, either for marrow procurement or tool manufacture, and fractures that result accidentally after deposition. In a replication experiment the authors superficially buried pieces of flaked bone under a gravel matrix and trampled over them for a period of 15 minutes. On examination they found that oblique notches had occurred on the fractured edges of the bone (Blasco *et al.* 2008). Notches are not usually present on intentionally modified bone but there are exceptions (see Plug 1982; Leslie-Brooker 1987, 1989). However, this experiment did not replicate cylindrical bone points, only irregularly shaped flakes. Because cylindrical bone points have no edges on which notches could occur it remains unclear what effect trampling might have on these points.

4.2.4. Summary

Macro-fracture analysis is a potentially useful tool to study how/for what activities bone artefacts were used. However, it cannot be considered a stand alone method for identifying specific functions and must be used in conjunction with other analyses. Most of this research on macro-fractures has focused almost exclusively on stone tools. An under-explored avenue for future research is how bone fractures as a result of use, specifically as projectiles. It is this information that the present study seeks to ascertain.

4.3. Applied Methods

The application of my research comprised four parts:
(1) A morphometric study of bone points from different archaeological contexts spanning from the MSA to the ethnographic past.

(2) Experiments designed to approximate hunting macro-fractures were conducted. Using the morphometric study as a guide, I replicated a range of bone points that kept within the mean range of those in the morphometric study and shot them into an antelope carcass.

(3) Once each bone point had been used they were examined for diagnostic macro-fractures and other traces of use-wear.

(4) The results obtained from the macro-fracture examination were used to asses the possible function of archaeological bone points thought to have been used as hunting weapons.

4.3.1. Morphometric analysis

A morphometric database of bone points from selected sites (see Table 3) was used to replicate my own experimental bone points that fit the mean ranges of the archaeological samples. Because certain weapon types impose constraints on point design, a morphological similarity between archaeological bone points and ethnographic ones might suggest a similar function. For this reason, the database took into account a morphometric comparison of bone points of known function from a large ethnographic collection i.e. the Fourie collection. Where the morphometric measurements are not already published a digital callipers were used. Measurements were taken of the length of the piece, the diameter in the centre of the piece as well as the diameter 1cm and 3cm from the tip. Where the piece is broken, only the tip measurement was taken. The results of this study are given in the Chapter 6.

I chose to do a comparative morphometric study of Later and Middle Stone Age bone points with ethnographic bone points of known function due to the striking similarity in shape between these bone points. Establishing a comparative morphology may also allow me to infer functional constraints and examine the range of variation among bone points used for particular activities. I will be building on some of the work already done by Henshilwood and d'Errico (2007) and Backwell *et al.* (2008) by looking at a sample of points from a wider variety of sites. By conducting a comparative morphometric study of bone points I hope to be able to document any change in their possible use as hunting weapons, from their earliest occurrence in the MSA until their recent association in the historic past.

Table 3. Individual sites from which bone points were examined

SITES	REFERENCES
MIDDLE STONE AGE	
Blombos Cave	Henshilwood & Sealy 1997; Henshilwood *et al.* 2001a, b; d'Errico & Henshilwood 2007; Villa *et al.* 2009a
Sibudu Cave	Wadley 2006; Wadley & Jacobs 2006; Villa & Lenoir 2006; Backwell *et al.* 2008; Wadley 2007, 2008
Peers Cave	Jolly 1948; Deacon & Wilson 1992; Henshilwood *et al.* 2001b; d'Errico & Henshilwood 2007
LATER STONE AGE	
Klasies River	Singer & Wymer 1982; Henshilwood *et al*. 2001b; Wurz 2002; d'Errico & Henshilwood 2007
Nelson Bay Cave	Klein 1972a, b; J. Deacon 1984; Inskeep 1987
Bushman Rock Shelter	Louw 1969; Plug 1981, 1982
Rose Cottage Cave	Wadley 1987b, 2000a, b, 2001; Clark 1999; also Mohapi 2005
Jubilee Shelter	Wadley 1987a, 1989
ETHNOGRAPHIC	
Fourie collection	Wanless 2007; Backwell *et al.* 2008

The above sites have been chosen because they represent the best documented occurrences of bone points and cover all South African industries in which bone points are known to occur (see Table 4). My database will take into account various aspects of the pieces concerned (see Table 5). Where this information is published I will use that data. For the Middle Stone Age for example, the information has been compiled by Henshilwood *et al.* (2001b) and d'Errico & Henshilwood (2007).

Table 4. Number of bone points from the various industries that I shall look at.

Middle Stone Age			Later Stone Age					Ethnographic
Still Bay	Howieson's Poort	Possible Association	Robberg	Oakhurst Complete	Oakhurst Broken	Wilton Complete	Wilton Broken	Fourie Collection
6	2	3	1	23	15	37	19	117

4.3.2 Replication of bone points

For the replication I have followed the techniques used for the Middle Stone Age bone points, such as those from Blombos, as determined by d'Errico & Henshilwood (2007) and for the Later Stone Age points, such as those from Kasteelberg, as described by Semenov (1964) and Smith & Poeggenpoel (1988). Two main types of manufacturing processes have been identified (d'Errico & Henshilwood 2007), namely scraping with a sharp lithic edge and grinding against an abrasive surface. The replica points for this study have been fashioned on pieces of granite and rough sandstone, and by scraping with a sharp piece of basalt. A total of 28 pieces of bone were fashioned into points. Seventeen of these were fashioned by grinding against a piece of flat sandstone which was picked up in the vicinity of Blombos Cave (Fig. 5). On average, points fashioned by grinding took just over an hour to complete.

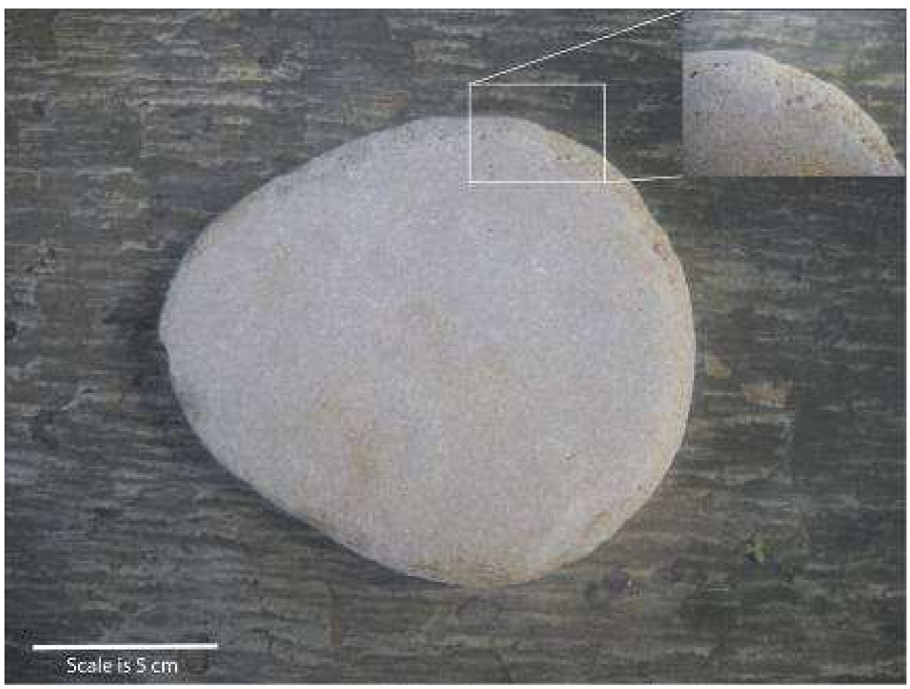

Figure 5. A flat sandstone rock used to grind the bone points. This piece was picked up in the vicinity of Blombos Cave.

The bone points were fashioned from the meta-tarsals, femurs, humori, radii and scapulae of medium to large sized animals including eland (*Taurotragus oryx*), kudu

(*Tragelaphus strepsiceros*), blue-hartebeest (*Alcelaphus buselaphus*) and wildebeest (*Connochaetes gnou*). Some bones were dried in the sun for 1 month to allow natural defleshing; others were defleshed immediately using a surgical scalpel. Care was taken not to damage the bone during the defleshing process. Once all the flesh was off, the bones' epiphyses were knocked off and the shaft fractured using a hammer and anvil technique. Suitably shaped pieces were chosen to be worked further by scraping or grinding.

After about half an hour of manufacturing it was decided what shape the piece should take. Three main shapes were chosen based on the most commonly occurring shapes in the LSA and ethnographic records (see for example Sampson 1974; Inskeep 1987; J. Deacon 1984; Wanless 2007; Bosc Zanardo *et al.* 2008) as well as those from MSA deposits at Blombos Cave (Henshilwod *et al.* 2001b; d'Errico & Henshilwood 2007). The three shapes were long cylindrical points and flat points (see Fig. 1). In addition, robust irregularly shaped pieces similar to those identified as spear points were also manufactured. These generally required less manufacturing time as they were not worked over the entire surface of the piece.

Table 5. Table showing manufacturing particulars of bone point replicas

Catalogue number	Animal	Type of bone	Fresh/Dry bone	Method of shaping	Manufacturing Time in h
EXP 00	Cow	Radius	F	Ground	2
EXP 01	Eland	Humerus	F	Ground	1.5
EXP 02	Cow	Radius	F	Ground	1.5
EXP 03	Cow	Radius	F	Ground	1
EXP 04	Cow	Radius	F	Scraped	1
EXP 05	Cow	Radius	F	Scraped	1
EXP 06	Cow	Radius	F	Ground	1.5
EXP 07	Cow	Radius	F	Ground	1
EXP 08	Eland	Humerus	F	Ground	1
EXP 09	Cow	Radius	F	Scraped	2
EXP 10	Hartebeest	Humerus	F	Ground	2
EXP 11	Hartebeest	Humerus	F	Ground	2
EXP 12	Eland	Scapular	F	Ground	1
EXP 13	Wildebeest	Humerus	F	Ground	1
EXP 14	Bov I	Femur	D	Ground	0.5
EXP 15	Wildebeest	Humerus	F	Mechanical	-
EXP 16	Hartebeest	Femur	F	Ground	2
EXP 17	Hartebeest	Femur	F	Scraped	1
EXP 18	Wildebeest	Humerus	F	Mechanical	-
EXP 19	Wildebeest	Humerus	F	Ground	1.5
EXP 20	Bov III	Radius	D	Ground	1.5
EXP 21	Bov III	Radius	D	Scraped	1
EXP 22	Bov III	Radius	D	Ground	1
EXP 23	Bov III	Radius	D	Scraped	0.5
EXP 24	Wildebeest	Humerus	F	Ground	1
EXP 25	Wildebeest	Humerus	F	Mechanical	-
EXP 26	Wildebeest	Humerus	F	Mechanical	-
EXP 27	Wildebeest	Humerus	F	Mechanical	-

Table 6. Table showing morphometric particulars of bone point replicas. All measurements are in millimetres unless otherwise specified.

Catalogue number	Shape	Length	Diameter (1cm from tip)	Diameter (3cm from tip)	Diameter Centre piece	Max. Thickness (mm)	Mass (g)	TCSA
EXP 00	Cylindrical	70.1	4.5	5.7	6.6	6.6	4.89	21.78
EXP 01	Cylindrical	71	4.3	5.3	7.4	7.4	5.07	27.38
EXP 02	Cylindrical	53.7	4.5	5.7	6.8	7.0	4.11	23.12
EXP 03	Flat	54.3	8.3	8.6	8.7	3.8	3.72	16.53
EXP 04	Irregular	88.6	7.8	14.8	17.9	5.8	17.51	51.91
EXP 05	Irregular	100	6.1	11.9	18.7	6.5	15.42	60.77
EXP 06	Flat	78.4	6.1	9.9	10.3	4.1	5.66	21.11
EXP 07	Irregular	97.6	8.1	16.9	20	7.9	19.12	79
EXP 08	Cylindrical	83.4	5.9	9.2	7.9	8.1	10.61	31.52
EXP 09	Cylindrical	64.2	4.9	7.6	5.8	6.0	4.9	22.62
EXP 10	Cylindrical	86.8	4.7	7.5	7	7.3	10.46	24.5
EXP 11	Cylindrical	79.8	6	7.5	5	5.2	5.52	12.5
EXP 12	Flat	82.2	4.4	7.6	8.6	2.9	3.82	12.47
EXP 13	Cylindrical	49.5	3.5	6.5	6.4	6.7	3.21	20.48
EXP 14	Cylindrical	36.1	3.4	6.2	5.6	5.8	0.75	15.68
EXP 15	Cylindrical	62.5	5.1	6.6	6.4	6.6	2.26	20.48
EXP 16	Cylindrical	57.8	4.6	6.2	6.4	6.6	3.19	20.48
EXP 17	Irregular	78.7	8.1	14.3	19.7	7.4	14.36	72.89
EXP 18	Cylindrical	85.3	4.7	6.3	6.1	6.7	3.79	18.6
EXP 19	Cylindrical	54.1	4	6.5	6.5	6.8	4.56	21.12
EXP 20	Flat	84.6	4.9	6.9	11.2	11.3	5	62.72
EXP 21	Flat	90.4	7.7	11.3	12.3	3	7.33	18.45
EXP 22	Cylindrical	51.9	5.1	7.8	8.8	9.0	3.24	38.72
EXP 23	Irregular	120	6.2	10.7	16.7	11.2	27.12	93.52
EXP 24	Cylindrical	38.9	5.3	7.1	7.1	7.3	3.21	24.85
EXP 25	Cylindrical	81.7	3.6	6.2	6.3	6.6	2.47	19.84
EXP 26	Cylindrical	74.3	5.3	7.4	9.4	9.5	4.73	44.18
EXP 27	Cylindrical	67	5.5	6.4	7.6	7.9	3.36	28.88

All the above points conform to the mean measurements of bone points from several archaeological samples (see Chapter 6). The average measurements for the cylindrical bone point replicas are given in Table 7. Tip Cross Sectional Area measurements are given for comparative purposes with stone tool studies. One will notice however, that except for the cylindrical sample, the mean measurements fall outside the parametres of the function to which they were put. Interestingly, the cylindrical bone points conform almost exactly to TCSA measurements of North American stone points used as arrows (*cf.* Shea 2006).

Table 7. Average measurements of replica bone points. All measurements are in mm unless otherwise specified.

	Length	Diameter 1 cm from tip	Diameter 3 cm from tip	Diameter at centre	Max. thickness	Mass (g)	TCSA
Cylindrical	64.9	4.7	6.7	6.8	7.0	4.46	33.53
Irregular	96.9	7.2	13.7	18.6	7.7	18.72	71.62
Flat	77.9	6.3	8.8	10.2	5.0	5.1	26.25

Figures 6 to 9 below represent a selection of bone points at different stages of the manufacturing process. A and B in each figure, with the exception of Figure 9, represents the dorsal and ventral surface of the bone pieces after one hour of grinding against a sandstone cobble. C represents the finished product after two hours of grinding, or scraping as in the case of EXP 09 (Fig. 7). Figure 9 illustrates three points that were ground mechanically. The reason for this was to increase the sample size in a short time.

Figure 6. EXP 00: A piece of *Bos Taurus* radius which was ground for two hours on coarse sandstone. Scale is 20 mm

Figure 7. EXP 09. A piece of a *Bos Taurus* radius which was scraped with an obsidian flake for two hours. Scale is 20 mm.

Figure 8. EXP 11. A piece of *Alcelaphus buselaphus* (Hartebeest) humerus which was ground for two hours on coarse sandstone. Scale is 20 mm.

Figure 9. EXP 18, 25 and 27. Mechanically ground for 20 minutes. Scale is 20 mm.

4.3.3. Experimentation

The experiment was designed to replicate impact related macro-fractures on pointed bone tools. A total of 28 bone points were propelled into a suspended carcass using an 18 kg (40 Lb) commercial long-bow and by hand (Fig. 10). Three types of bone points were tested: a) robust cylindrical points, akin to archaeological bone points classified by Goodwin (1945) as 'Type 4'; b) thin flat points, similar archaeological artefacts interpreted as matting needles (e.g. Sampson 1974); and c) irregularly shaped bone points, morphometrically similar to proposed Middle Stone Age spear points (d'Errico & Henshilwood 2007).

Figure 10. 70 cm arrow at full draw with a 40 lb commercial bow. Note the white mark on the arrow indicating the 40 cm draw length.

Twenty two bone point replicas, consisting of 4 flat points and 18 cylindrical points (Table 6; also see Chapter 4) were hafted to 70 cm long commercial arrows using a reed collar and insulation tape. In each case the bone point was pushed into one end of the reed collar, and the arrow-shaft, which had the commercial tip removed, was pushed into the other end of the collar. The collar was then bound with insulation tape to secure the point and arrow-shaft and to prevent against splitting on impact (Fig. 11). The rest of the replicated bone points (n = 6) were attached to a 1.6 m long stave whittled from a branch of an *Acacia xanthophloea* tree. A 5 cm deep notch was carved into the narrower end of the stave. This end was then whittled down to form a tapering point. The bone points were wedged into the notch which was then bound with insulation tape (Fig. 12).

Figure 11. Method of hafting bone point to arrow-shaft.

Figure 12. Tip of spear showing inset and method of hafting.

On historic and ethnographic arrows the bone points are secured to the link-shaft and main-shaft by sinew (e.g. Goodwin 1945; Vinnicombe 1971; Wanless 2007). During the MSA, there is evidence that this may have been done using compound adhesives (e.g. Wadley *et al.* 2009; Wadley 2010). I decided to use insulation tape for my hafting as this seemed most like the sinew binding used in ethnographic times and it is comparable to similar replication experiments (e.g. Sisk & Shea 2009).

It was decided to use a carcass instead of ballistics gel as the skeleton of the animal represents a more realistic scenario in that the projectile is likely to meet angular force as opposed to the blunt trauma of ballistics gel. Following the protocols of other similar studies (e.g. Barton & Bergman 1982; Odell & Cowan 1986; Casper & Bie 1996; Dockall 1997; Lombard *et al.* 2004; Sisk & Shea 2009) the carcass was suspended in an upright position and shot with the bow and arrow from several metres distance.

To insure against loss of and damage to points on surfaces other than the carcass, plastic sheeting was spread on the ground under the suspended carcass. A dense 1 m × 1.5 m polystyrene and cardboard frame was set up behind the carcass. The frame was 10 cm thick and capable of stopping an arrow without damaging it. The projectile experiments were conducted at a distance of 7 m from the target as my accuracy deteriorated the farther away I stood. This is, however, only 3 m closer than the minimum distance used by Bushmen groups in the Kalahari when hunting (Cattelain 1997; Hitchcock & Bleed 1997; Wanless 2007).

The bone point replicas were used in simulated hunting experiments. I tested only one variable with the experiments i.e., the nature of impact damage that accrues on bone points as the result of projectile hunting. I conducted experiments with both projectile and hand delivered points in order to test whether there are any morphological differences in the damage between impacts produced by these two methods.

4.3.4. Use-trace analysis

4.3.4.1. Discerning macro-fracture based on stone tool studies

Because specific diagnostic macro-fractures are known to occur on stone tipped projectiles (e.g. Lombard 2005) I will use this technique to see if similar diagnostic fractures occur on bone tipped projectiles. I shall use the fracture categories laid down for lithic studies by (e.g. Fisher *et al.* 1984; Odell & Cowan 1986; Odell 1988; Shea 1988; Casper & De Bie 1996; McBrearty *et al.* 1998; Crombe *et al.* 2001; Lombard *et al.* 2004; Lombard 2005; Brooks *et al.* 2006; Villa & Lenoir 2006; Lombard & Parsons 2008; Lombard & Pargeter 2008; Sisk & Shea 2009; Villa *et al.* 2009a, b; Villa *et al.* 2010; Yaroshevich *et al.* 2010).

The macro-fracture analyses were carried out using a hand lens. Where fractures were discerned, the points were examined in more detail using an *Olympus SZ61 zoom stereo microscope.* Micrographs were taken using an *Olympus DP12 microscope digital camera system.*

By examining the impact fractures found on Middle Stone Age and Later Stone Age bone points that result from hunting I will be able to assess how many of the bone points in an archaeological assemblage may have been damaged in this way during hunting and also the expected frequency of characteristic hunting macro-fractures in an assemblage of bone points. I will also compare the macro-fracture results from the experiments and archaeological samples with ethnographic bone points of known function i.e. bone points from arrows that are known to have been used to hunt game. Because not all points will develop fractures I will replicate about 15 specimens of either category and continue the experiments up to a total of 20 shots per point, or until fractures are produced. To ensure reliability of my results I will follow the guidelines for experimental archaeology as laid down by several authors (e.g. Coles 1973; Outram 2008; Seetah 2008).

4.4. Conclusion

In order to examine the evolution of bone points as hunting weapons in South Africa I have adopted a three tiered approach. First, I conducted a comparative morphometric study of bone points from several archaeological contexts and locals, expanding on the work already done by others (e.g. d'Errico & Henshilwood 2007;

Backwell *et al.* 2008). This allowed me to manufacture my own experimental bone points that fit the mean dimensions of the archaeological counterparts. The methods of manufacture were the same as those observed on the archaeological specimens (see Semenov 1964; Smith & Poeggenpoel 1988; d'Errico & Henshilwood 2007). Secondly, I affixed these replica bone points to commercial arrows and fired them at an antelope carcass using a commercial archery bow in an experimentally replicated hunting scenario. Finally, I conducted a macro-fracture analysis of the bone points broken during the experiment. For this analysis I drew upon the work previously conducted on the lithic equivalents (e.g. Fischer *et al.* 1984; Odell & Cowan 1986; Lombard *et al.* 2004; Lombard 2003, 2005; Villa & Lenoir 2006; Pargeter 2007; Lombard & Pargeter 2008; Sisk & Shea 2009; Yaroshevich *et al.* 2010).

The results obtained from this study were used to assess the possible hunting use to which bone points in the archaeological record were put. I re-analysed the bone points from several archaeological collections to see whether similar fractures are evident on these bone points as on my experimental points, and what this can tell us about their possible use as hunting weapons.

CHAPTER 5

A REPLICATION EXPERIMENT TO TEST FOR THE FORMATION OF MACRO-FRACTURES ON BONE TIPPED WEAPONS

5.1. Data collection

As discussed previously in Chapter 4, my primary technique of analysis for identifying hunting fractures on bone points is macro-fracture analysis. Previous studies on stone tipped weapons have identified three fracture types that can be considered diagnostic of hunting impact. These three fractures are step termination bending fractures, spin-off fractures (Fischer *et al.* 1984; Lombard 2005), and impact burination fractures (Lombard 2005; Lombard & Pargeter 2008). These three fractures are considered diagnostic regardless of the mode of delivery, whether it be thrust, thrown or mechanically projected (e.g. Fischer *et al.* 1984; Odell & Cowan 1986; Lombard *et al.* 2004; Lombard 2003, 2005; Villa & Lenoir 2006; Pargeter 2007; Lombard & Pargeter 2008; Sisk & Shea 2009; Yaroshevich *et al.* 2010).

For this study I have used the criteria laid out in stone point studies (e.g. Fischer *et al.* 1984; Odell & Cowan 1986; Lombard *et al.* 2004; Lombard 2003, 2005; Lombard & Pargeter 2008) for the identification of these macro-fractures on the bone points. The reader is referred to Chapter 4, page 66 for a discussion on the characteristic features of the various fracture types.

5.2. Results of the experiment

5.2.1 Replicated hunting activities, problems incurred and penetration statistics

Initially, the bow was drawn only 40 cm in order to keep to the velocity of a traditional bushman bow (e.g. Vinnicombe 1971; Cattelain 1997; Wanless 2007), which is roughly 33 metres/second. However, after the first five shots all points failed to penetrate the skin. Thereafter, the bow was drawn to its full length of 70 cm, giving the arrow a velocity of 55-58 metres/second (see Collier's Encyclopaedia 1967 for details on the velocity of commercial bows). This velocity would be comparable with the larger, more powerful bows sometimes depicted in rock art (see Humphreys *et al.* 1991; Noli 1993). After this adjustment the majority of shots still did not penetrate the carcass. All arrow points were shot at both the 70 cm and 40 cm velocities.

At full draw, only five projectile points were able to penetrate the skin. Two points were able to penetrate up to 5 cm while the remaining three only managed to penetrate 3 cm. The bone points which were shot from the bow and which made contact with the hide proved extremely difficult to extricate, even those with only a 3 cm depth, and often a pair of pliers was needed to remove them. Previous studies (Letourneux & Petillion 2008) have shown that bone tipped arrows are capable of penetrating the bone of unskinned, non-eviscerated prey. These arrows, however, were projected from a 28 kg bow and therefore at a much higher velocity than in my experiment.

As none of the bone points in my experiment penetrated deep enough to incur damage against a bone, a flap of skin was lifted to expose the rib-cage. It was decided that the most effective and expedient way for the bone points to develop fractures was to impact with the harder skeletal material. Arrows were then shot at the skinless portion of the carcass as well as at the hind and fore-quarters that were still covered with skin. In this way each arrow had an equal opportunity to impact skeletal material and an area that was protected by skin. Each point was fired a maximum of ten times or until the point broke. At the end of the projectile experiments, the points that had not sustained damage were fired another 10 rounds. Points that did not sustain damage after the twentieth round were retired. The tips of three points (EXP 09, 11 and 18) were lost during the experiment.

With the sole exception of EXP 19 no points sustained damage merely by impacting the skin or flesh. All damage to the bone points occurred as a result of contact with skeletal material. However, similar experiments involving stone points found a small amount of fractures developing as a result of impact with flesh (Fischer *et al.* 1984). Where an arrow impacted the skin, but did not penetrate, it ricocheted resulting in fracturing of the arrow shaft. It is doubtful whether a traditional arrow made from thatch would have been able to withstand an impact of this nature. Only two of the shots that penetrated the skin did so deeply enough to reach bone. All of these were shot from the bow at full draw of 70 cm.

Of the six points used as hand delivered spears (EXP 04, 05, 07, 17, 21, 23), none managed to penetrate the hide. Although undesirable, this was not wholly unexpected as other experiments have recorded similar results (Odell & Cowan 1986: 202). Three points sustained damage from use in this method.

The results of the experiment should be considered only an approximation of that which would develop on archaeological bone-tipped hunting weapons, due to the many uncontrolled variables in this experiment. Notwithstanding, impact fractures are not governed by penetration of the artefact as Fischer *et al.* (1984) have shown. Nor are they governed by method of hafting (Lombard *et al.* 2004; Lombard & Pargeter 2008), although this may influence the frequency of fractures.

5.2.2. Results of the macro-fracture analysis

By the end of the experiment 53.5 % (n = 15) of the points had sustained enough damage to render them ineffective in penetration. Broken down into their constituent shapes this represents 40 % (n = 2) of irregularly shaped points, 60 % (n = 3) of flat points and 55.5 % (n = 10) of cylindrical points. Although the samples of irregular and flat points are considerably less than that of cylindrical points, these relative percentages were expected. Irregular points, due to their robusticity, are presumably less likely to accrue macro-fractures; whereas flat points, judging from this experiment, are more likely to do so, probably due to their thin cross sections. Cylindrical points appear intermediate; not as robust as irregular points, but, due to their tapering cylindrical shape, they would have more energy absorbing capacity than flat points.

Of the two main types of fractures known to occur in brittle solids, namely point initiating cone fractures and bending fractures (Hayden 1979; HoHo committee report 1979; Fischer *et al.* 1984; Odell & Cowan 1986; Lombard 2005), the majority of fractured points in this experiment amounting to 73 % (n = 11) exhibited bending fractures. Statistically, 66.6 % (n = 14) of all bending fractures occurred on cylindrical points. Two of the three flat points that sustained breakage have bending fractures while the third flat point as well as the more robust and irregularly shaped spear points all had point initiation fractures. Three cylindrical points developed point initiation fractures (Figs 13F & 16A, B). All of these, with the exception of one, had feather terminations. The exception exhibited a hinge termination. A fourth point that had point initiation fractures was an irregularly shaped thrust point. The tip of this piece showed signs of heavy crushing with three step termination fractures on the ventral face (Fig. 12A). The majority of points (n = 10) fractured less than 10 mm from the tip. The tips of these pieces were not recovered because either they were too small or the force caused them to disintegrate on contact with skeletal material. Of the five pieces which broke more than 10 mm from the tip, both parts were recovered. These five points make for interesting study as it allows one to examine both sides of a fracture.

Tables 8 and 9 show the distribution of the 32 macro-fractures on the 15 bone points. In Table 8 the distribution is per morphometric category. Step terminations are the most common fracture type on flat and irregular shaped points, while hinge terminations dominated the cylindrical sample. The same types of fractures occur on bone points used in the different hunting activities (Table 9). Noteworthy, is the presence of spin-off fractures in the arrow category and not in the thrust spear category. Spin-off fractures are thought to be diagnostic of hunting use (Fischer *et al.* 1984; Lombard 2005) and their presence here supports this classification. No bifacial spin-off fractures were present on the experimental sample and the unifacial spin-off category includes all size fractures (*cf.* Lombard 2005).

Table 8. Number of impact fractures per morphometric category of bone points.

	Cylindrical n = 10	Flat n = 3	Irregular n = 2
Snap terminations	1	-	-
Uni-facial spin-off	2	-	-
Step terminations	4	2	5
Hinge terminations	10	1	-
Feather terminations	5	-	1
Impact burinations	-	-	1

Table 9. Number of impact fractures per activity.

	Arrow points	Thrust points	Total Fractures
Snap terminations	1	-	1
Uni-facial spin-off	2	-	2
Step terminations	6	5	11
Hinge terminations	11	-	11
Feather terminations	5	1	6
Impact burinations	-	1	1

Hinge termination fractures appear to be the most common fracture type, occurring 11 times on 53.3 % (n = 8) of the points. They occur most frequently on cylindrical arrow points but are not considered diagnostic impact fractures when it comes to stone-tipped hunting weapons (see Fischer *et al.* 1984).

Step termination fractures are the next most commonly occurring fracture type on the experimental sample, occurring 11 times on 33.3 % (n = 5) of the bone points. Unlike hinge terminations, step fractures are considered to be diagnostic of longitudinal impact (see Fischer *et al.* 1984). They occur in almost the same frequency in both arrows and thrust spear points of my experiment (Table 9), but have their highest percentage in irregularly shaped points (Table 8). These irregular points are dominated by step termination fractures.

Small step and hinge fractures can be difficult to distinguish from one another. Under a microscope however, one sees that with a hinge termination fracture, the force turns back upon itself abruptly towards the surface, whereas a step termination results from incomplete propagation of the fracture causing it to terminate abruptly at a right angle (Hayden 1979; Fischer *et al.* 1984).

A hinge fracture, and to a lesser extent a step fracture are the outcomes of force which has dissipated before running its course. Further force in either of these situations would result in a gradual termination or feather termination. This is evident in Figure 14F where a weakness is seen at the base of the hinge. More pressure, or a continuance of the pressure, would result in the hinge being removed and a feather terminating fracture forming. The difference then between these fractures appears to be in the amount and consistency of force. This is important as step terminations are considered diagnostic of hunting/impact use whereas feather terminations are not. The mechanical processes involved in the formation of feather termination fractures are different from those involved in the formation of step and hinge terminations and are more highly influenced by the thinness of the edge on which they form (Lawrence 1979), meaning that feather terminations are likely to form as a result of other non-hunting activities.

Crushing is evident on four tips, namely EXP 00, 05, 06 and 26 (Fig. 13). Crushing is identified by multiple small uneven overlapping step fractures, visible as tiny chips and removals along the point or edge on which impact was made (see Lawrence 1979: 117). No other visible signs of use-wear were distinguished on any of the pieces.

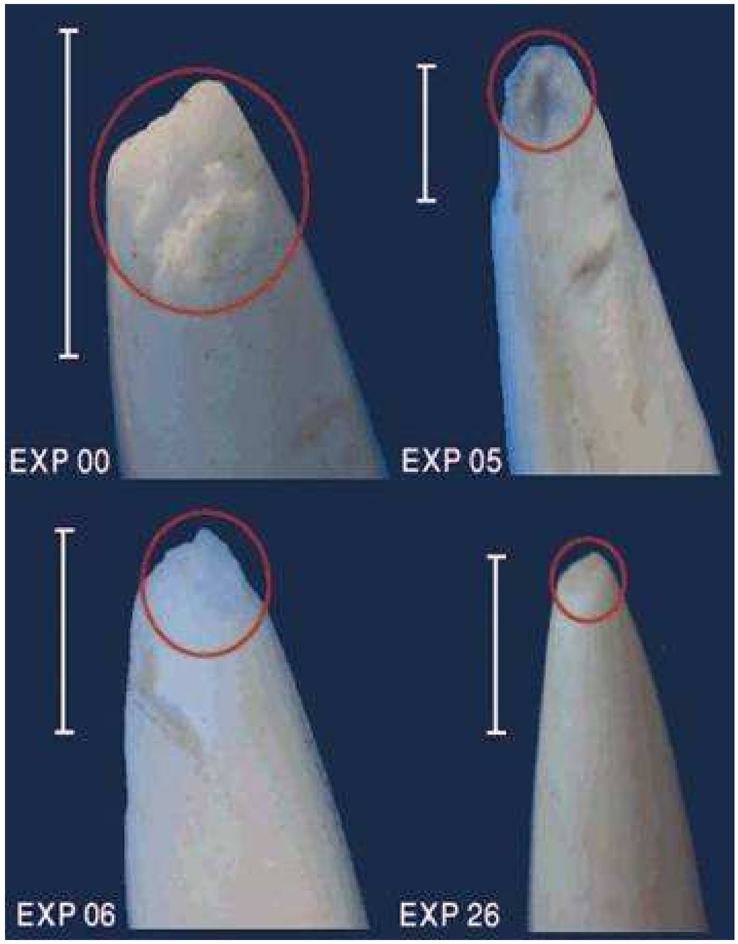

Figure 13. Forms of tip crushing on differently shaped bone points. Scale is in 5mm.

Three pieces (EXP 13, 17, 26) developed a variety of complex fracture patterns and eight others developed multiple fractures of the same kind (see Table 11). The formation of compound fractures does not appear to be influenced by artefact shape. However, when viewed against the activity to which the points were put a pattern starts to emerge (see Table 12). Seventy three percent (n = 8) of the compound fractures have developed on points used as arrows, while only 27 % (n = 4) occurred on thrust points. The only multiple fracture type which developed on the thrust points was multiple step terminations.

Table 10. Description of fracture types occurring on experimental bone points.

Catalogue #	Mode of delivery	# of times projected/thrust	Description of fracture
EXP 00	Arrow	20	Step-like crushing down one edge
EXP 05	Thrust	4	Crushed tip with three step fractures down lateral edge
EXP 06	Arrow	1	Crushed tip with diagonal hinge fracture down broad edge
EXP 09	Arrow	10	45º distal snap fracture
EXP 10	Arrow	10	Feather termination fracture on distal end
EXP 11	Arrow	5	Hinge termination fracture
EXP 13	Arrow	9	Feather termination fractures on distal and proximal ends; a hinge termination separated the pieces leaving a step termination on the proximal side
EXP 14	Arrow	5	Double hinge termination on the medial-distal end resulting in a spin-off fracture
EXP 17	Thrust	7	Distal end has a feather termination on the broad face and an impact burination terminating in two step fractures
EXP 18	Arrow	3	Hinge termination
EXP 19	Arrow	10	Hinge termination at distal end
EXP 20	Arrow	1	Some crushing alone the tip. The pieces is separated by a hinge termination 13.4 mm from the tip
EXP 21	Thrust	2	Step termination 12.6 mm from the tip
EXP 26	Arrow	1	Diagonal hinge termination resulting in a spin-off fracture 40.9 mm from the tip
EXP 27	Arrow	6	Two parallel step terminations at distal end; step and feather termination at proximal end

Only one impact burination accrued on the experimental bone points. This point was EXP 17 and was an irregularly shaped piece used as a thrusting spear. The burination terminated in two parallel step fractures (Fig.14D). The reason for the absence of these fractures on the other bone points is discussed later.

Table 11. Number of compound fractures occurring on the variously shaped points.

Compound fractures	Cylindrical	Flat	Irregular
Step/hinge/feather	2		
Feather/step			1
Multiple feathers		1	
Multiple steps	1	1	2
Multiple hinges	2	1	

Table 12. Number of compound fractures occurring as a result of different activities.

Compound fractures	Arrow	Thrust
Step/hinge/feather	2	
Feather/step	1	1
Multiple feathers	1	
Multiple steps	1	3
Multiple hinges	3	

Usually a point initiation fracture retains part of the original point. In Figure 19 below, one can see how a point initiation feather fracture (middle) differs from a crushed tip (left) and a snap fracture (right) in which the original points have been removed. Also noteworthy is the distinguishing features between a crushed and snapped tip. Crushing occurs much closer to the tip and shows signs of weaknesses along the edge. These weaknesses manifest as micro-fissures similar to the one observed in Figure 16F but on a smaller scale.

The solitary snap fracture (EXP 09) is worth a note. It differs from regular snap fractures as defined on stone points (Hayden 1979; Fischer *et al.* 1984) in that it is diagonal in profile and has an uneven and pitted surface. Diagonally slanting fractures are seen on several other specimens (e.g. EXP 06, 17, 20, 26). The pitted fracture surface is probably due to the nature of bone, although this aspect was discussed in more depth regarding archaeological specimens in Chapter 4.

Equally important are what fractures did not occur or were not visible. Impact burinations have been cited in recent papers (e.g. Lombard 2005; Lombard & Pargeter 2008) as diagnostic of longitudinal impact. An impact burination initiates in the same way as do other bending fractures and may terminate similarly. The difference is in the location of the fracture. Impact burinations are traditionally found along the lateral edge of stone points (see Lombard 2005; Villa *et al.* 2009a, 2010). The absence of impact burinations in the experimental sample of cylindrical bone points is probably due to the shape of the point i.e. there is no lateral side on a cylinder.

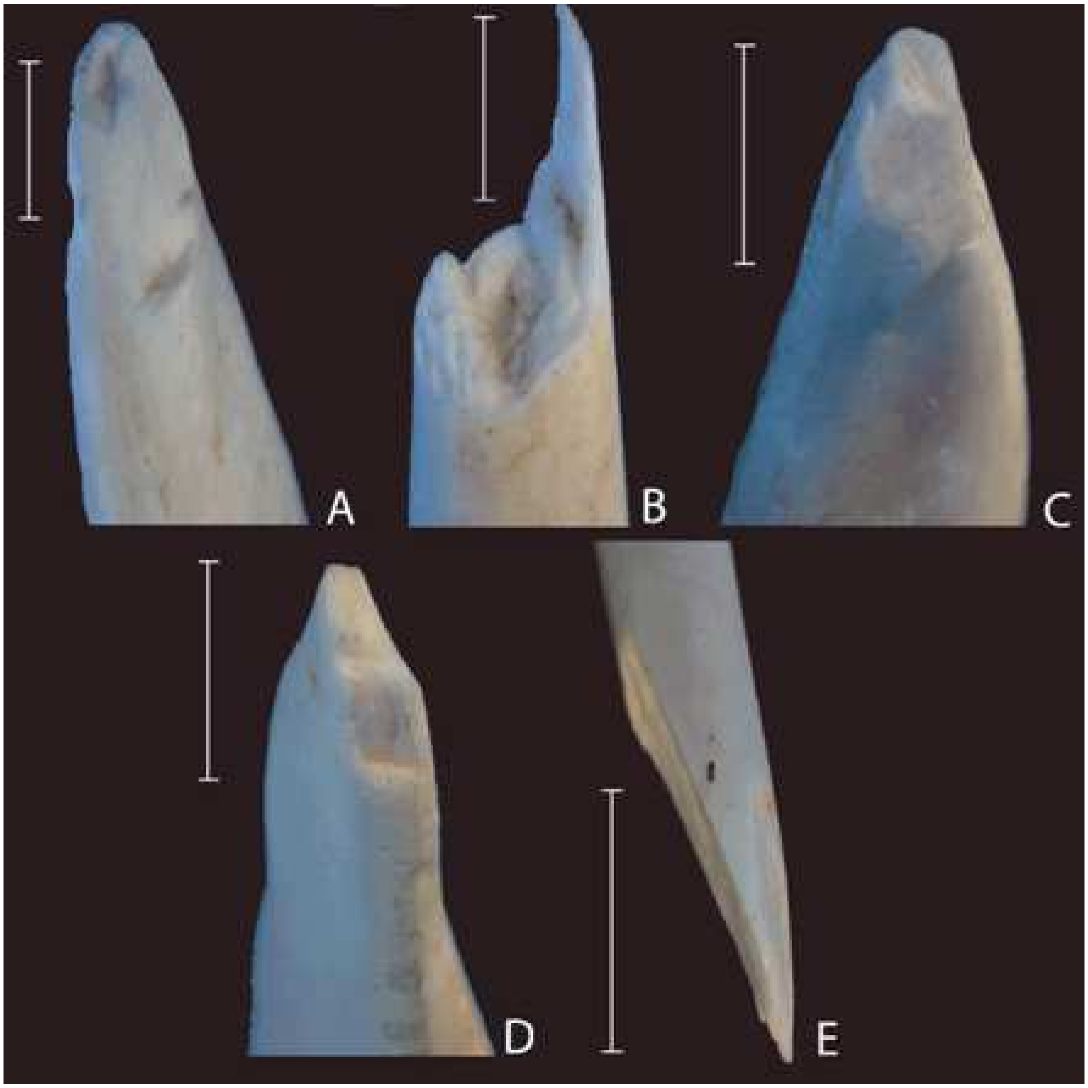

Figure 14. Step termination fractures: A (EXP 05) note double step fractures; B (EXP 13) note the step fracture in the centre of the piece; C (EXP 27) note the step fracture of the left of this double fracture, proximal end; D (EXP 17) double step fracture down lateral side of an irregular shaped piece; E (EXP 27) double step fracture on distal end. Scale bar is 5mm.

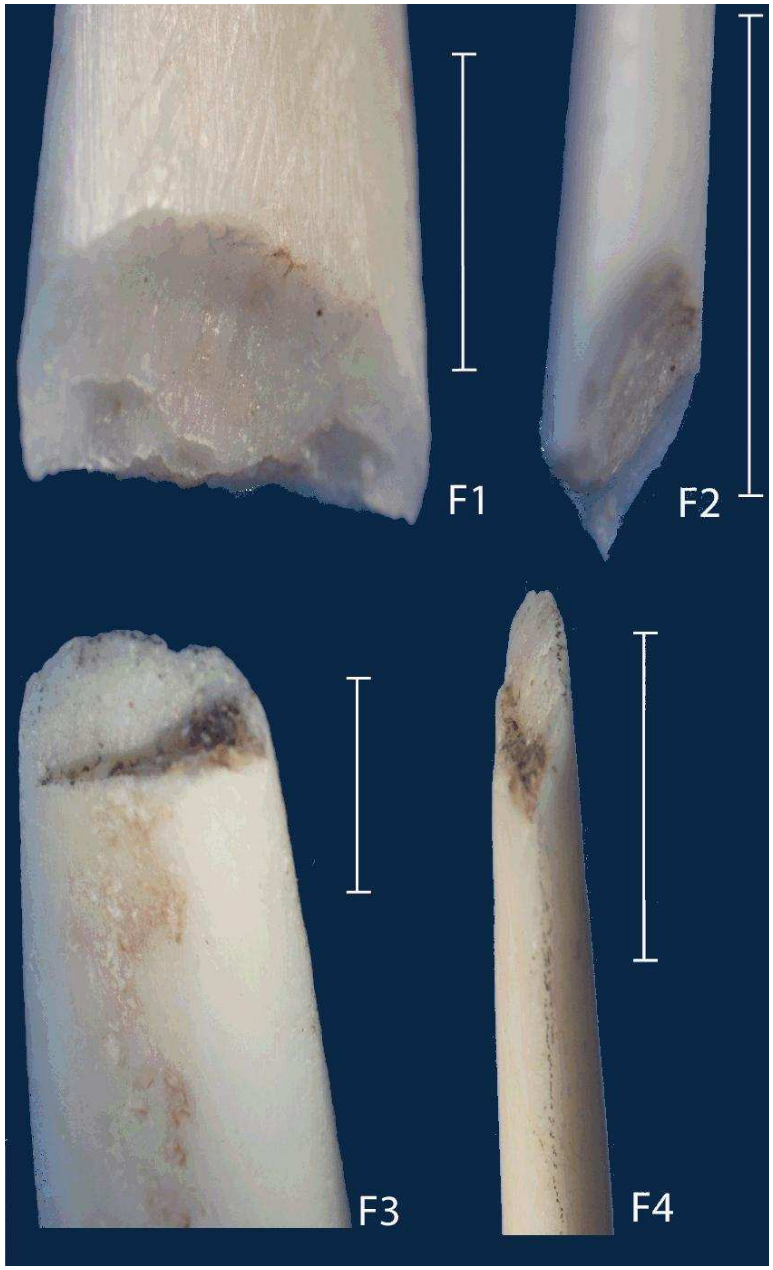

Figure 15. Step termination fractures: F1 (EXP 21) frontal view of the distal part of a step fracture on a flat point resulting from thrusting activities; F2 Lateral view of the same piece; F3 frontal view of the step fracture on the proximal piece; F3 Lateral view of the same fracture. Scale bar is 5mm.

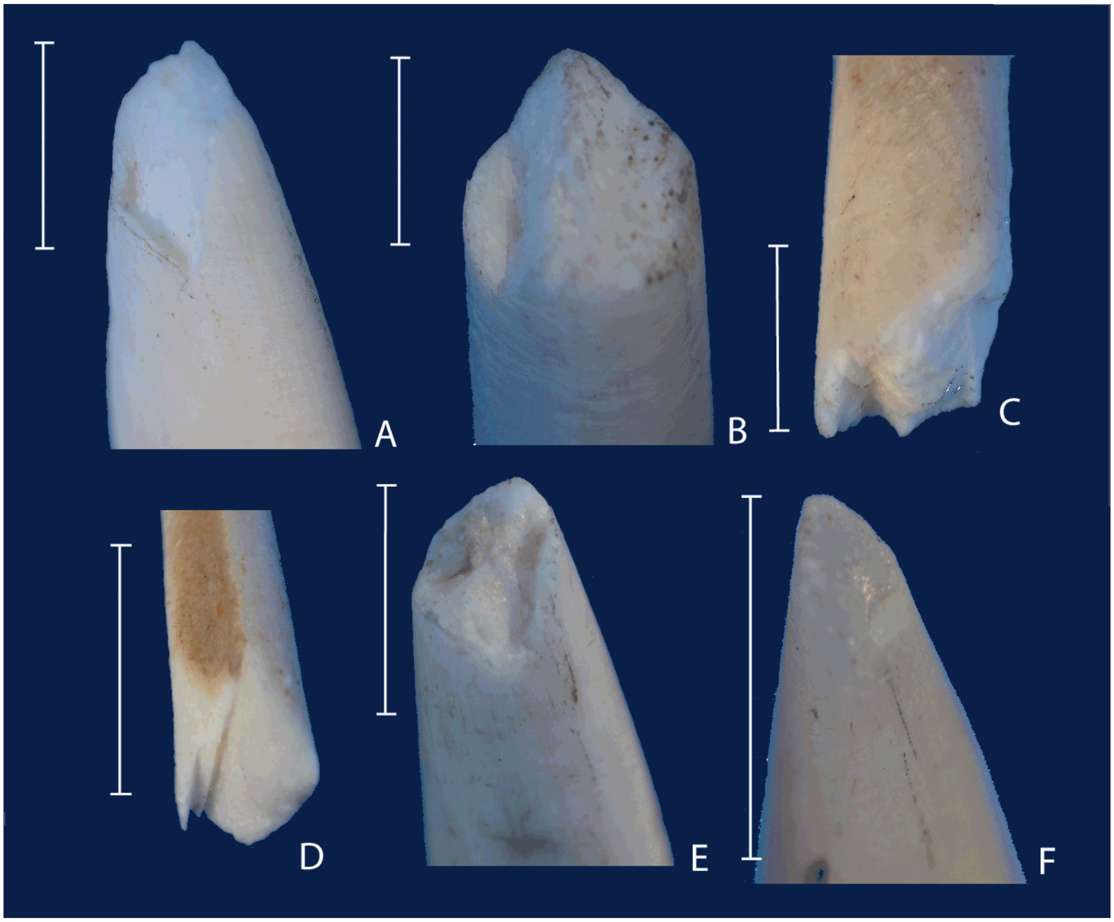

Figure 16. Hinge fractures: A (EXP 06) hinge fracture down broad face of flat point, note the crushing at the tip; B (EXP 11) note the hinge on the left of the piece; C (EXP 13) reverse hinge fracture on the distal part of the piece, note what the fracture looks like on the proximal part in the next figure; D (EXP 14) parallel reverse hinge fracture on distal part of piece; E (EXP 18) note the hinge on the right; F (EXP 19) note the weakness of the hinge that would have resulted in a feather termination if the force continued. Scale bar is 5mm.

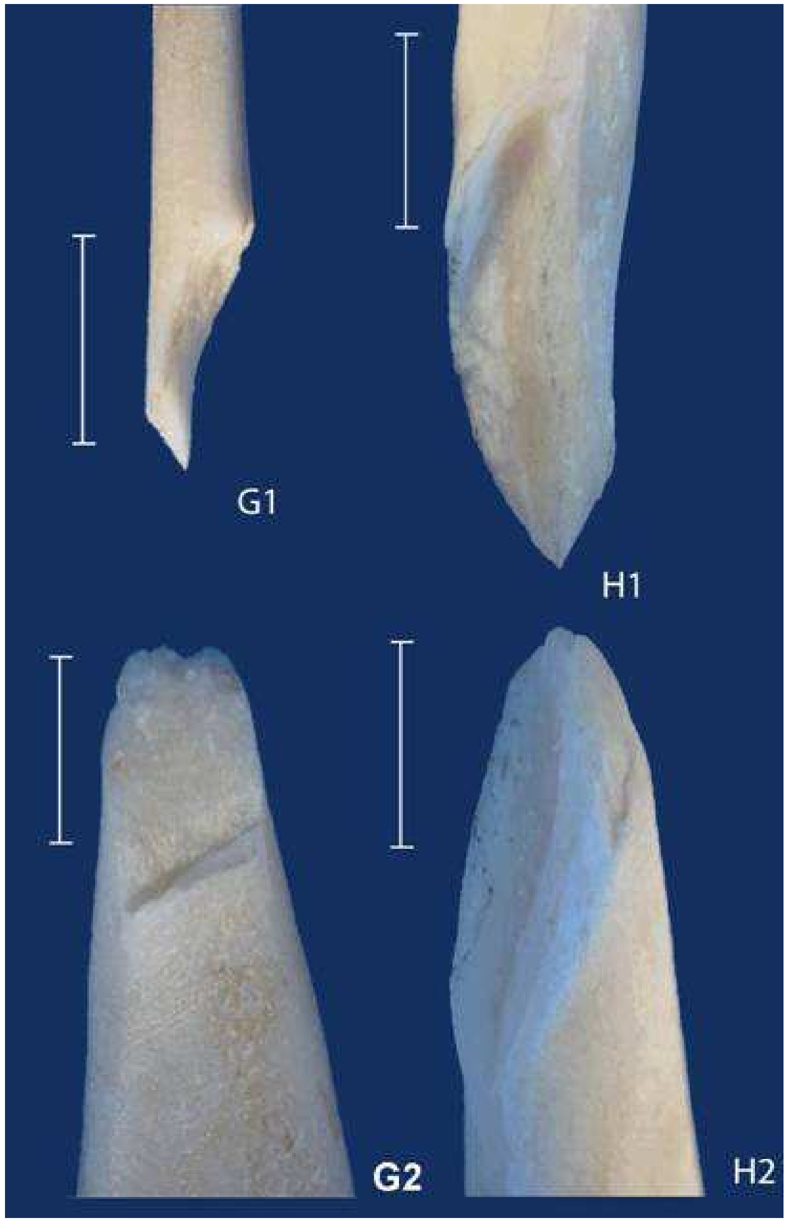

Figure 17. Hinge fractures: G1 (EXP 20) distal part of a hinge fracture, note how this part resembles a feather fracture; G2 Proximal portion of the same piece; H1 (EXP 26) distal portion, note the ridge in the centre and typical hinge in the top left of the piece; H2 proximal portion of the same piece, note the hinge-like fracture in the centre, this formation is probably due to a weakness in the bone. Scale bar is 5mm.

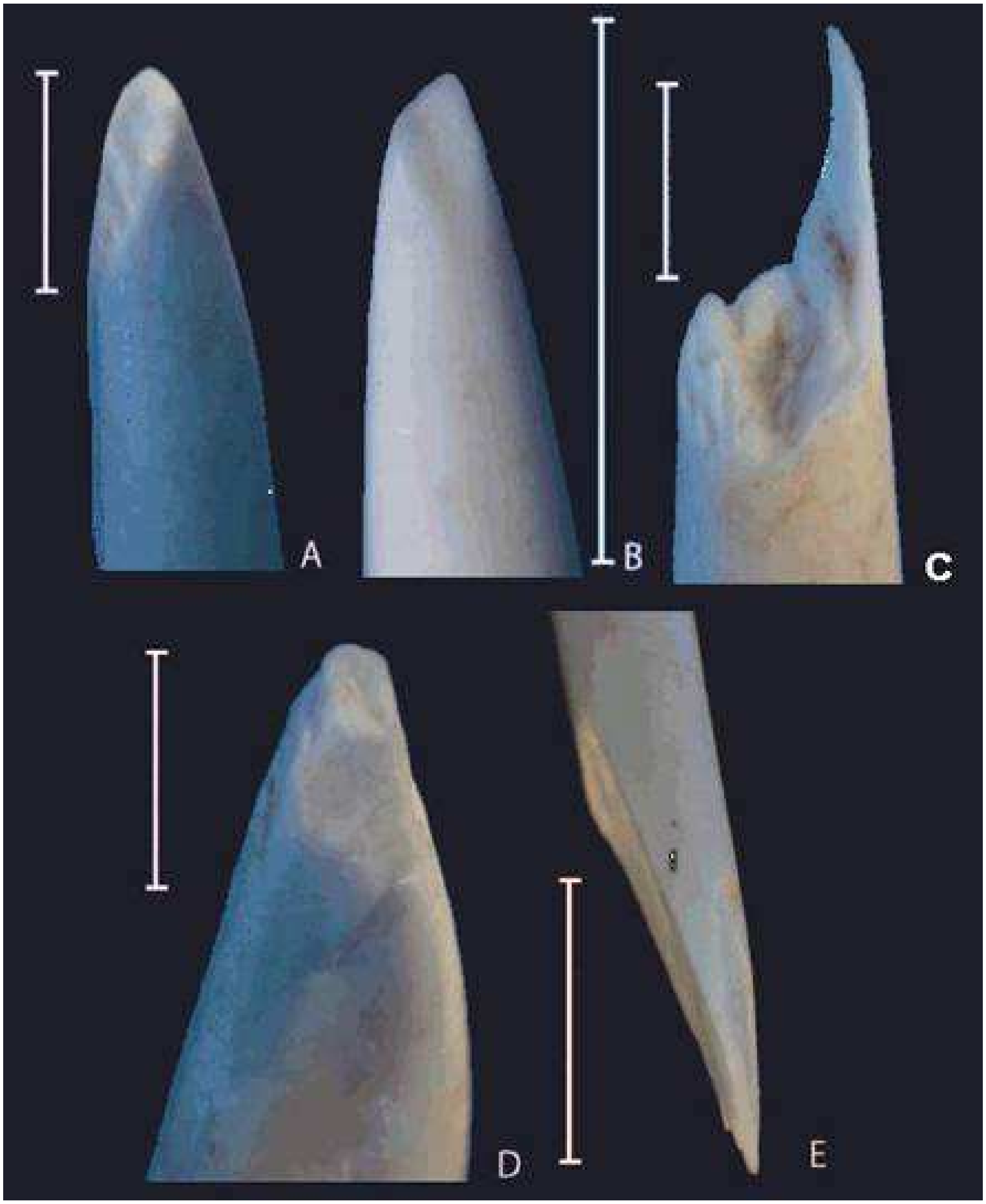

Figure 18. Feather termination fractures: A (EXP 10) note the ripple feature on the face of the feather; B (EXP 13) feather fracture on distal tip of piece; C note the long feather on the right of the same piece; D (EXP 17) small feather termination on distal tip of irregularly shaped point; E (EXP 27) proximal end, note the feather fracture on the right side. Scale bar is 5mm.

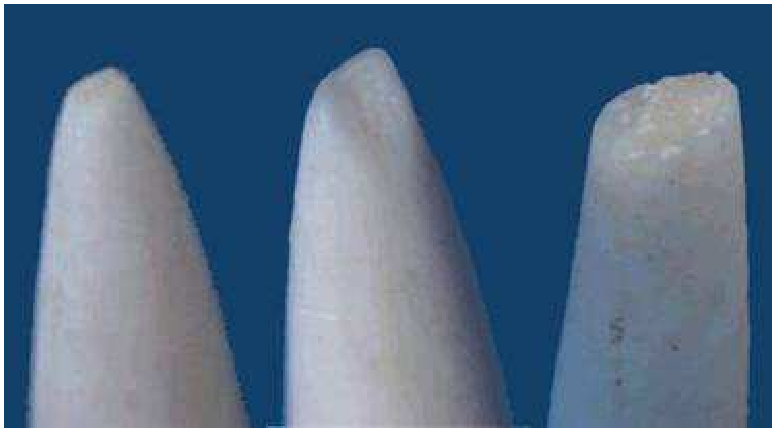

Figure 19. Comparison of three points. From left to right is a simple crushed tip, feather or spin-off fracture, snap fracture.

Slightly trickier are spin-off fractures. These are fractures that initiate from a bending fracture, removing part of the original surface (Yaroshevich *et al.* 2010: 272), and are considered the most diagnostic fracture type indicative of hunting use (Fischer *et al.* 1984; Lombard 2005; Villa *et al.* 2009; Yaroshevich *et al.* 2010). Only two spin-off fractures occurred on the experimental bone points, and these were on cylindrical points employed as arrows.

Figure 20. Spin-off fractures: A (EXP 14) and B (EXP 26), note the presence of spin-off fractures on these points once their two constituent pieces are put together. Scale bar is 5mm.

Tables 13 to 15 show the relative percentages of impact fractures accrued on experimental stone points as a result of hunting activities. In Table 13 the percentages of the various macro-fractures, which resulted from use as projectiles, on stone segments (Pargeter 2007; Lombard & Pargeter 2008) and bone points (this study) are compared. The most obvious difference between these two studies is the absence of impact burinations in the bone point sample and the high frequencies of hinge and feather termination fractures. Hinge and feather terminations are the lowest categories in the stone segment sample but the highest categories in the bone point sample. Step terminations appear more common on bone points compared to stone artefacts accounting for the majority of DIFs in this category.

Table 13. Comparison of impact fracture results obtained from experimental hunting with stone and bone arrow points.

	Pargeter's 2007 experimental results n = 30		Present study's results n = 12	
Step terminations	1	3 %	6	50 %
Spin-off fractures	3	10 %	2	17 %
Impact burinations	8	26 %	0	0 %
Snap fractures	6	20 %	1	8 %
Hinge/Feather term.	3	10 %	15	125 %
DIFs	**12**	**40 %**	**8**	**67 %**

An experimental study carried out by Odell & Cowan (1986) tested 51 stone tipped spears and 80 stone tipped arrows. Table 14 shows the macro-fracture results of the combined spear and arrow sample. Step terminations are the most frequent fracture, followed by step/hinge combinations. Crushing appeared on 12 % of tips. Approximately 34.7 % of the fractures were DIFs. This is a similar percentage to that obtained by Pargeter (2007). Similarly, feather terminations account for the lowest group of fractures. Upon retirement, every piece exhibited fracturing at the tip (Odell & Cowan 1986). Unfortunately, the authors did not distinguish between the relative frequencies of macro-fractures occurring on arrows and those occurring on spears.

Table 14. Impact fracture results obtained from early experiments with stone points. Table is modified.

Odell & Cowan's 1986 experimental results	
Step Terminations	30.6 %
Impact burinations	4.1 %
Snap fractures	10.2 %
Step/hinge terminations	28.6 %
Feather terminations	2 %

Table 15 shows the results of hunting experiments from three independent studies. All studies represented here used stone points. The presentation of results in the three studies was not entirely comparable and so only the DIF category from these studies is represented below. The percentages of DIFs on arrow points in these studies are similar to the percentages obtained on the bone points in the present study (28 % see Table 15). However, the DIF percentage on thrust spear points is much higher (71 %) in the bone point study than in the experimental studies below. Table 15 represents the number and percentage of tools out of the entire sample that developed DIFs.

Table 15. Comparison of results obtained from various experimental studies using stone points as hunting weapons.

	Fischer *et al.* 1984				Lombard *et al.* 2004		Yaroshevich *et al.* 2010		This study			
	Spears		Arrows		Spears		Arrows		Spears		Arrows	
	n	%	n	%	n	%	n	%	n	%	n	%
DIFs	6	54	54	39	20	57	29	28	2	33	5	28

5.3. Conclusions

The aim of this preliminary experiment was to test whether similar macro-fractures develop on bone points used for hunting as have been shown to develop on stone points used for hunting. The macro-fracture results from this experiment, however, should be considered only an approximation of the fractures that could develop on bone tipped weapons as a result of hunting impact as not all variables were controlled. For example, in order to maintain accuracy, the distance from which the arrows were shot was 3 m closer than the minimum hunting distance for Kalahari Bushmen. Similarly, the carcass was two days old, had been eviscerated prior to purchase and was suspended from wire, albeit in an upright position. Likewise, the bow from which the arrows were propelled was modern, as were the arrow shafts. It is not known to what extent, if any, these factors played on the formation of the macro-fractures.

The experiment tested three shapes of bone points in two different hunting situations *viz.* arrow and spear hunting. Due to the unlikelihood of the robust irregularly shaped points being used efficiently as arrow tips, they were only used to tip the spears. Likewise, cylindrical points were only used for arrow tips, whilst flat points were used for both activities. Over half the sample of bone points tested developed impact fractures, although not all fractures could be considered diagnostic of impact function. It is clear from the analysis that the same types of macro-fractures accrue on bone points used for hunting purposes as on stone points. Furthermore, most of these fractures occur in similar percentages as are found on their replicated stone counterparts. In this study, flat points showed the highest percentage of fractures whilst irregular points exhibited the lowest.

Based on the results of these experiments, step fractures seem least common on tapering cylindrical points, whereas they occur on both flat and spear-like points irrespective of the mode of delivery. Hinge and feather fractures seem to be most common on tapering cylindrical points, although these are not considered diagnostic of hunting use for stone implements. No snap fractures were observed on flat or spear-like points, nor were any impact burinations found on cylindrical points. It would seem that a specific shape or raw material does promote the occurrence of certain fracture types over others.

Diagnostic impact fractures are present on 40% (n = 6) of the experimental bone points. This translates to 43.7 % of all fractures. DIFs occur in their highest percentage (86 %) on spear points which were thrust. Only 32 % of the fractures that developed on the arrows were DIFs. As far as the shape of the points go the highest percentage of DIFs were found on irregularly shaped points, then flat points and finally cylindrical points had the lowest percentage of DIFs.

The most commonly occurring DIF in all categories was the step termination. Also present, but in much fewer numbers were spin-offs and impact burinations. Spin-off fractures were all unifacial and only recorded on arrow points. The solitary impact burination occurred on an irregularly shaped point used as a spear. The reason why no impact burinations occurred on the cylindrical points is most probably due to their shape. An impact burination can only develop on a lateral side, of which there are none on a cylinder. Spin-off fractures, although few in number in this sample, may have greater potential for distinguishing archaeological bone points that were used as projectiles rather that thrusting weapons, but further experimentation is needed to test this prediction.

These results have interesting correlations with similar experimental studies done on stone hunting points. For instance, there is a much higher percentage of non-diagnostic fractures that developed on the bone arrow points as opposed to the stone arrow points (Table 13). The percentage of DIFs on thrust points is also remarkably higher than in either of the two thrusting experiments involving stone (see Table 15). At this stage the reasons for these differences are unclear. It may be due to the relatively low numbers of spears used in this experiment which could obscure the results; or perhaps to the specific way in which bone fractures. More experiments are needed to answer this question.

In an archaeological sample of bone points it is very rare to have both parts of an individual point preserved. However, during a controlled experiment it is possible to retain both parts of a break thereby providing a unique insight into the nature of bone point breakage. It is evident that for whatever break one finds on the anterior portion the opposite break will be present on the proximal portion.

Another interesting find during this experiment is the inversion of fracture types. According to the literature (see Chapter 4: 63), the terminations that one looks for are located on the proximal part of the piece, having initiated on the distal portion. However, on four pieces (EXP 13, 14, 26, 27) the fracture occurs on the distal portion of the point. Cognisance of this mechanical fact is important for the accurate identification of hunting fractures on archaeological points. Fortunately, none of these fractures were DIFs and so did not obscure this category.

During the experiment one of the projectile points (EXP 27) sustained damage at its base. This is likely the outcome of backward pressure applied to the point as it made contact with the carcass. The impact would have knocked the base of the point against the arrow shaft thereby creating a set of fractures that one would expect to find at the tip of a projectile point. Fractured bases are not uncommon in the stone point studies (e.g. Odell & Cowan 1986) and are probably governed by the method hafting. On the experimental stone points examined by Odell & Cowan, 12.2 % of point bases developed snap, step and hinge fractures or combinations of the three. Only 2 % of bases developed feather fractures. The present bone point study accrued a feather and a step fracture at the base of EXP 27 (see Figure 18E). The continued pressure of the main shaft on the points may explain the reverse fracture terminations evident on some of the pieces.

Over half of the bone points developed multiple fractures and multiple fracture types (Tables 11 & 12). Arrows developed the highest frequency of compound fractures and compound fracture types, although the former is probably due to the high sample size of arrows compared to spears. None of the flat points developed compound fracture types, although they did develop multiples of the same fracture types. The highest percentage of multiple step fractures occurred on the spear sample at the virtual exclusion of all other compound fractures, save that of one feather/step combination.

Future experimentation on bone points will aim to test whether similar fracture types occur as a result of non-hunting activities. Experiments will aim to replicate macro-fractures from awl use and other domestic activities, as well as fractures resulting from trampling and dropping.

CHAPTER 6

MORPHOMETRIC RESULTS AND OTHER OBSERVATIONS REGARDING HISTORICAL, ETHNOGRAPHIC AND ARCHAEOLOGICAL POINTED BONE ARTEFACTS

6.1. Introduction

In this chapter I present the morphometric analyses of pointed bone tools and bone points from various archaeological sites from the MSA and LSA, as well as the ethnographic Fourie collection. I present each site separately and compare the morphologies of the various pointed bone artefacts in that assemblage. Finally, I compare the bone point morphologies from the different sites and contexts.

6.2. The Fourie collection: historical and ethnographic pointed bone artefacts

6.2.1. Some general observations

As mentioned in Chapter 3 the Fourie collection comprises over 4000 cultural artefacts collected from at least five Bushmen groups living in the Kalahari and Kaukau Veld. Sixty three percent of the arrows that were examined in the Fourie collection are complete, i.e., they consist of the bone point, connecting collar, link-shaft and main shaft. Altogether, I examined 104 bone points from the collection. There are two varieties of bone points, namely, thin reversible poisoned points with link-shafts and robust non-reversible, non-poisoned points without link-shafts.

Figure 21. Examples of bone tipped arrows from the Fourie collection. The four on the left are examples of reversible points with the bone point extended. The four on the right are examples of robust non-reversible bone points. Scale is 10 mm. From Backwell *et al.* 2008: Fig 3.

Bone points and link-shafts were examined, as both have pointed tips and could have functioned similarly. Indeed, the robust bone points are morphologically similar to link-shafts and the two could easily be mistaken for one another. In some cases the link-shafts are poorly made, but in most cases they are well polished; more so than any of the bone points I examined. Link-shafts range from cylindrical to elliptical in cross-section and are usually only worked far enough to make them level with the main shaft (Fig. 21).

Figure 22. Example of a Naron link-shaft (MM/40/69/30). Scale is 10 mm.

Apart from bone point tipped arrows, there are metal tipped arrows. The metal tipped arrows follow the same design as the bone pointed ones. However, instead of the bone point terminating in a point, they are sawed flat just below the tip (Fig. 23). This is to facilitate the attachment of a triangular piece of metal, which served as a cutting and piercing tip. These arrows, even with the accompaniment of poison, are never reversible.

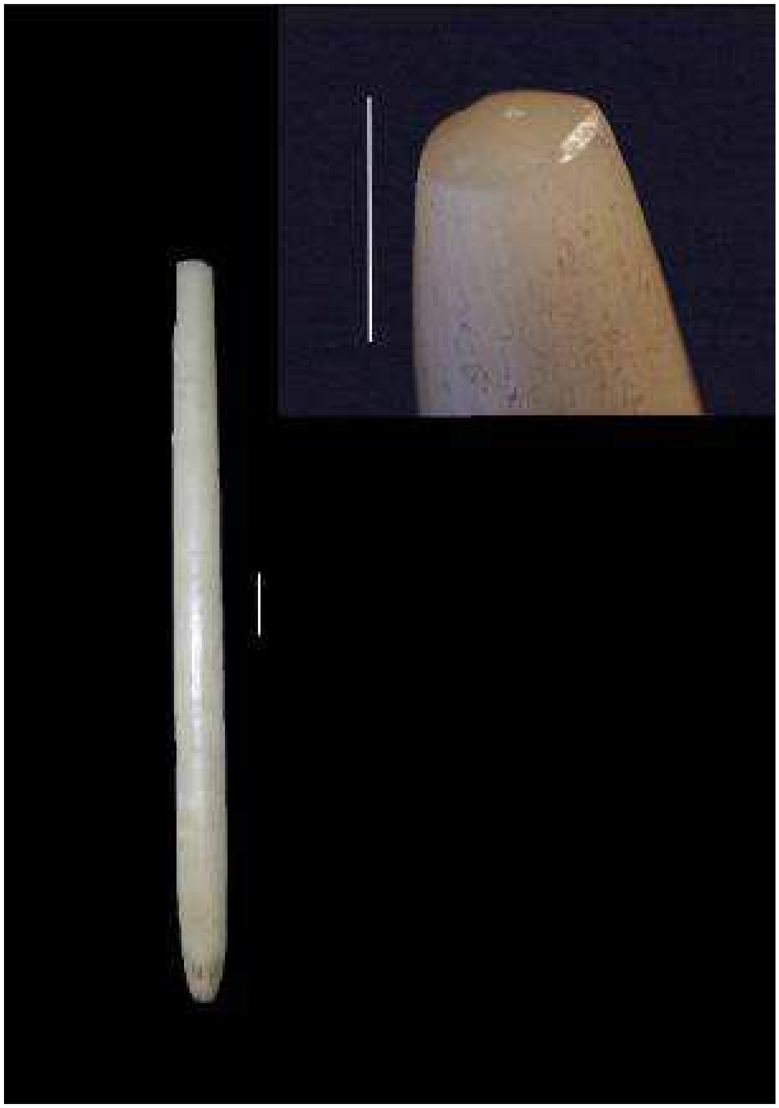

Figure 23. Bone point with tip cut off (MM/40/69/2258). Note the smooth facets in the inset. Scale bar is 5 mm.

6.2.2. Bone point dimensions

I have decided to represent the bone point morphometric data of this collection according to cultural group. I have done this in order to see whether there are any differences in bone point dimensions between different groups living across the landscape. Although there are not an equal number of bone points represented in each of the cultural groups, the mean values can be taken as representative of the whole. The results of these measurements are presented in Tables 1 – 6 of Appendix A, and are summarized here in Table 16. Where values are missing it means that the bone point was either too fragmentary to be measured or it was inseparable from its link-shaft and could not be weighed separately.

Table 16. Comparative dimensions of 98 reversible bone points from the various hunter-gatherer groups in the Fourie collection. All measurements are in mm unless specified. The (~) sign indicates an approximate value.

	Diameter 1 cm from tip	Diameter 3 cm from tip	Centre	Length	TCSA (mm²)	Weight (g)
Naron (n = 14)	2.5	3.8	4.7	99.5	11.38	3.6
‡Ao-//Ein (n = 38)	2.8	4.1	4.8	116.1	12.59	4.7
Hei-//om (n = 8)	3.1	4.5	5.4	148.7	13.21	3.3
!Kung (n = 32)	2.5	3.7	4.5	99.4	9.7	2.1
Hu//Ein (n = 4)	2.9	4.4	4.9	105.5	12.3	-
Bushman (n = 2)	-	-	2.8	~101	18.6	3.9
Mean	**2.7**	**4.1**	**4.5**	**111.7**	**12.96**	**3.5**
SD	**0.6**	**0.9**	**0.8**	**31.1**	**4.8**	**2.1**
Min.	**1.6**	**2.5**	**2.4**	**58.4**	**2.88**	**1.6**
Max.	**4.9**	**6.7**	**7.4**	**194.2**	**27.38**	**10.8**

These data show little variation in the overall dimensions of bone points between the different hunter-gatherer groups. The general shape of bone points in the collection is cylindrical, although six elliptical points were recorded. The Hei-//om bone points are longer and wider than the other groups. The robusticity of these points should not be confused with the category of *robust* points which have their highest number in the ‡Ao-//Ein group (Table 8). !Kung points are the smallest among the six groups.

All the points examined have a similar tip ratio (i.e. the diametrical difference from 1 cm to 3 cm from the tip), ranging from 1.2 – 1.5 mm, with a mean difference of 1.4 mm. TCSA values from all cultural groups fall within the range of hypothetical stone arrow tips as defined by Shea (2006). The ‡Ao-//Ein bone points exhibit the widest range of TCSA values (2.88 mm² - 27.38 mm²) and are also the heaviest of the bone points.

Table 17. Morphometric attributes of robust bone points in the Fourie collection. TCSA values are in mm² and weight values are in g. All other measurements are in mm. The (~) sign indicates an approximate value.

Sample	Provenience	Cultural Group	Diameter From Tip 1 cm	Diameter From Tip 3 cm	Diameter in centre	Length	TCSA	Weight	Shape
FC 16	MM/40/69/2256	‡Ao-//Ein	3.7	5.8	6.9	110.5	23.8	4.9	Ellip.
FC 17	MM/40/69/2257	‡Ao-//Ein	4.9	6.7	7.4	155.9	27.38	10.8	Cyl.
FC 19	MM/40/69/2259	‡Ao-//Ein	3.9	6.2	6.2	88.8	19.22	3.5	Cyl.
FC 20	MM/40/69/2262	‡Ao-//Ein	3.7	5.2	6.9	159	23.8	9.8	Cyl.
FC 43	MM/40/69/415	Naron	-	-	6.4	~85.4	20.48	3.2	Ellip.
FC 73	MM/40/69/777J	!Kung	3.9	6	6.3	75.6	19.84	-	Cyl.
		Mean	**4**	**6**	**6.7**	**112.5**	**22.4**	**6.4**	
		SD	**0.5**	**0.5**	**0.5**	**38.2**	**3.13**	**3.6**	
		Min.	**3.7**	**5.2**	**6.2**	**75.6**	**19.22**	**3.2**	
		Max.	**4.9**	**6.7**	**7.4**	**159**	**27.38**	**10.8**	

Six robust bone points were recorded in the Fourie collection; dimensions are presented in Table 17. The majority (66.6 %) of robust points come from the ‡Ao-//Ein cultural group. On average there is a 2.2 mm difference in thickness between the robust points and the reversible points. The mean weight of the robust points is almost double that of the reversible points. This fact is accentuated as the reversible points were weighed with their link-shafts whereas the robust points, which lack link-shafts, were weighed by themselves. The mean length of the robust points is only slightly (1.2 mm) longer than the reversible points. This is interesting as none of the robust points are poisoned and it is assumed that they would have been intended to pierce internal organs rather than as a vector for poison (Backwell *et al.* 2008).

6.2.3. Dimensions of whole arrows

Complete arrows were represented in four of the Bushmen groups. The largest sample of complete arrows available for study came from the !Kung cultural group (n = 34; 50.7 %). Tables 7 to 11 in Appendix A present the weights and lengths of the arrows that were measured. Table 18 presents a summary of the mean weights and lengths of arrows from the different groups. All arrows represented in this section are inclusive of their bone points and link-shafts.

Table 18. Mean arrow dimensions from five hunter-gatherer groups in the Fourie collection.

	weight (g)	Length (cm)
Naron	11.6	64.4
‡Ao-//Ein	12.6	72.1
Hei-//om	13.1	67.4
!Kung	10.4	67.4
Hu//Ein	13.8	70.9
Mean	**12.3**	**68.4**
SD	**2.0**	**5.5**
Min.	**7.3**	**52.3**
Max.	**16.1**	**77.6**

The mean weight of arrows in the Fourie collection is 12.3g with a range of 7.3 – 16.1 g coming from the Hei-//om and !Kung groups respectively. The mean recorded weight of other ethnographic Bushmen arrows ranges from 7.2 g in the Drakensberg (Vinnicombe 1971) to 10 g in the Cape and Kalahari (Noli 1993). The average weights from each of the cultural groups in the Fourie collection are slightly higher but not significantly so. The heaviest arrows in the Fourie collection come from the Hu//Ein group.

The mean length of arrows in the collection is 68.4 cm with a range of 52.3 – 77.6 cm from the Naron and Hu//Ein groups respectively. This is slightly longer than Arrows from the Drakensberg which measured 50 – 66 cm (Vinnicombe 1971). The longest arrows in the Fourie collection come from the ‡Ao-//Ein group.

6.3. Jubilee Shelter: Later Stone Age pointed bone artefacts

6.3.1. Some general observations

A total of 53 bone points and shaft fragments from Jubilee Shelter were examined. The assemblage is highly fragmented with few intact bone points. Just under half (41.5 %; n = 22) the specimens examined are shaft fragments. Altogether 118 shaft fragments were noted in the assemblage but were not examined because they were too highly fragmented. These shaft fragments represented various stages of the manufacturing process. Most have snap fractures (see Chapter 7: 174).

Due to the highly fragmented state of the assemblage, I was, in most cases, unable to take measurements 1 cm and 3 cm from the tip. The length measurements in Table 19 should therefore be taken as approximate values. The average length of bone points retaining the tip was only 24.3 mm. Shaft fragments were not weighed. Samples JS 1 – JS 31 indicate the bone points that retained either the tip or butt of the piece, or both. Samples JS 32 – JS 53 are larger shaft fragments with neither tip nor butt.

The majority (75.5 %; n = 40) of bone points and shaft fragments are cylindrical. Eight (15.1 %) are elliptical; four flat (7.5 %) and one pyramidal shaped (1.9 %) points are present. The average weight of the bone points is 0.4 g, indicative of the highly fragmentary nature of the collection. The average diameter of bone points and shaft fragments is 4.1 mm with a range of 1.9 – 7.7 mm. This is slightly smaller than bone points from the Fourie collection, although the range spans most of the Fourie bone point measurements.

The mean TCSA value is 7.48 mm². This is smaller than the Fourie collection mean value but is close in size to the !Kung bone points. The largest TCSA at Jubilee occurs on an elliptical point and measured 22.8 mm².

6.3.2. Bone point dimensions

Table 19. Morphometric values for bone points and shafts from Jubilee Shelter. TCSA values are in mm² and weight values are in g. All other measurements are in mm.

Sample	Provenience	Diameter in centre	Length	TCSA	Weight	Shape
JS 1	Gavin/hearth mixed A4	3.6	32.2	6.48	0.6	Cyl.
JS 2	Basal Bradley B2	4.6	13	10.58	0.2	Cyl.
JS 3	Basal Bradley	7	14.8	10.5	0.3	Flat
JS 4	Basal Bradley	1.9	9	1.8	0.0	Cyl.
JS 5	J5A4	5.5	39.5	11	0.6	Flat
JS 6	B4PT	7.7	18.1	19.25	0.4	Flat
JS 7	Colin B3	5.2	47	13.5	1.6	Cyl.
JS 8	Colin B3	3.8	36.3	7.22	0.8	Cyl.
JS 9	Colin B3	5	12.8	12.5	0.2	Ellip.
JS 10	Colin B3	3.5	10.6	6.12	0.1	Cyl.
JS 11	Colin B3	3.1	23.1	4.8	0.4	Cyl.
JS 12	C2 D2	5	36	12.5	0.6	Cyl.
JS 13	C2 D2	3.3	26	5.44	0.2	Cyl.
JS 14	Gavin B4	5	10	12.5	0.2	Cyl.
JS 15	Gavin B4	4.6	10.9	10.58	0.2	Flat
JS 16	Hearth two	4.1	41.4	8.4	0.7	Ellip.
JS 17	Hearth two	3	26	4.5	0.2	Cyl.
JS 18	Hearth two	3.9	19	7.6	0.4	Cyl.
JS 19	Bradley hearth one	3.8	48.4	7.22	1.0	Cyl.
JS 20	Bradley hearth one	3.7	6	6.84	0.0	Ellip.
JS 21	Sue	4.8	24.9	11.52	0.5	Cyl.
JS 22	Sue	4.4	27.3	9.68	0.5	Cyl.
JS 23	Sue	3.1	40	4.8	0.5	Cyl.
JS 24	Sue	3.7	24.1	6.84	0.4	Cyl.
JS 25	Sue	5.1	24.1	13	0.5	Cyl.
JS 26	B4 BH2	3.4	13.7	5.78	0.2	Cyl.
JS 27	C3 Lyn III	4	19.5	8	0.1	prism
JS 28	Pink Suzanne C3-C4	7.6	59.1	22.8	1.9	Ellip.
JS 29	Lyn I C2/D2	5.8	12.8	16.82	0.2	Ellip.
JS 30	Mark/Suzanne intersection B4	2.7	12.2	2.7	0.1	Ellip.
JS 31	Mark/Suzanne intersection B4	5	17	12.5	0.4	Ellip.
JS 32	Red Lyn	5.4	18.5	14.58	-	Cyl.
JS 33	Bradley C1 D1	3	20.5	4.5	-	Cyl.
JS 34	cash B2/B3	3.5	16.5	6.12	-	Cyl.
JS 35	BB C1/D1	4.3	17	9.24	-	Cyl.
JS 36	B3 Red Lyn	3.5	17	6.12	-	Cyl.
JS 37	Colin B3	2.9	14	4.2	-	Cyl.

JS 38	Colin B3	2.5	20.5	3.12	-	Cyl.
JS 39	Colin B3	3	28.2	4.5	-	Cyl.
JS 40	B3 PB	4	20.5	8	-	Cyl.
JS 41	B3 PB	4.5	25.9	10.12	-	Cyl.
JS 42	Suzanne	4.1	23.9	8.4	-	Cyl.
JS 43	Hearth 3 A4	2.8	29	3.92	-	Ellip.
JS 44	Hearth 3 A4	4.6	19.5	10.58	-	Cyl.
JS 45	Hearth 3 A4	3.5	16.4	6.12	-	Cyl.
JS 46	Hearth 3 A4	4.5	20.1	10.12	-	Cyl.
JS 47	C1 Red Brown under Bradley	4	15.6	8	-	Cyl.
JS 48	C1 Red Brown under Bradley	2.1	11.5	2.2	-	Cyl.
JS 49	B3 Lyn 2	3.5	22	6.12	-	Cyl.
JS 50	Hearth 3 B4	3.5	17	6.12	-	Cyl.
JS 51	Hearth 3 B4	3.3	12	5.44	-	Cyl.
JS 52	Lyn 3 C2 D2	3	12	4.5	-	Cyl.
JS 53	Mark B4	4	18.4	8	-	Cyl.
	Mean	**4.1**	**24.3**	**7.48**	**0.4**	
	SD	**1.2**	**11.0**	**3.1**	**0.4**	
	Min.	**1.9**	**6.0**	**1.8**	**0.0**	
	Max.	**7.7**	**59.1**	**22.8**	**1.9**	

6.3.3. Some other finds

All the bone points and shaft fragments that were examined from Jubilee Shelter show signs of having been ground on an abrasive surface. On all but two pieces, the angle of striations ran diagonally from top left to bottom right, if the tip is orientated up. The striations on the two exceptions run from top right to bottom left at the same orientation. The former pattern is indicative of grinding in an anti-clockwise motion whilst the latter would commonly occur if the piece were moved in a clockwise motion.

Among the bone points and fragments from Jubilee are six noteworthy pieces. Three points have stemmed butts (Fig. 24), similar to those previously described from Uniondale rock shelter (Leslie-Brooker 1987, 1989). Unfortunately, the tips of these points are not present, but judging from their taper angle they were probably never very long. During my analysis I counted 14 shaft fragments exhibiting signs of having been heated. Some were heated to the extent that they were too brittle to handle. Without further tests it is uncertain whether this heating occurred pre- or post-depositionally and whether it was deliberate or accidental.

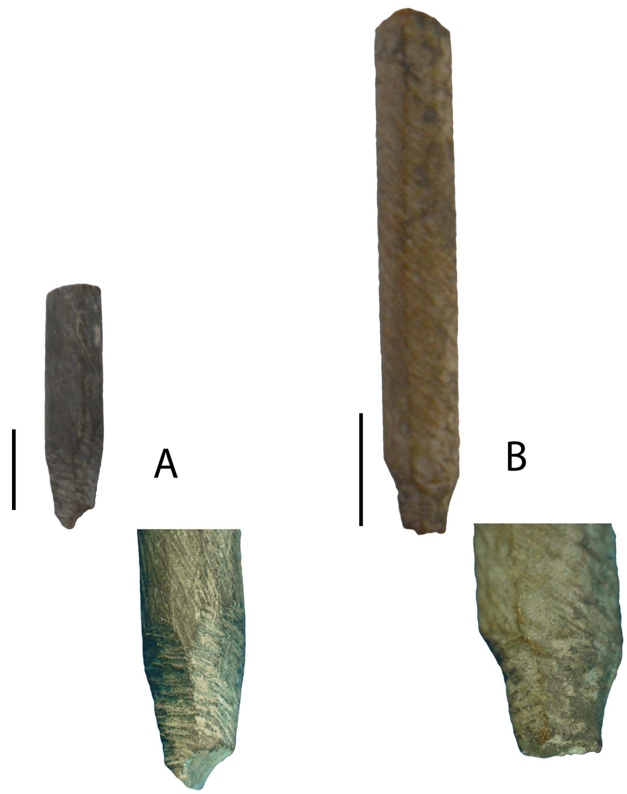

Figure 24. Two examples of stemmed bone points from Jubilee Shelter (A: B4 BH2; B: SUE [4]). Scale is 5 mm.

Two bone points were found with the tip snapped off, reminiscent of similar bone points found in the Fourie collection (Fig. 23: 117 and Chapter 7: 174). In both cases, there is evidence of grinding and shaping post breakage. On one of the pieces there seems to be scratch marks just below the snap (Fig. 25). It is possible that these points were snapped deliberately to facilitate the attachment of a metal tip, and that the scratch marks indicate the place where the metal wire was twined round the bone point (*cf.* Sparrman 1786). There are several examples of metal tipped arrows with this type of hafting in the Fourie collection. The fact that all these snapped points at

Jubilee came from levels that contained pottery (Wadley 1987a) supports the hypothesis that metal was being used at this time.

Figure 25. Two bone points from Jubilee Shelter with the tip deliberately snapped off (A: Hearth 2; B: Colin B3). Note the grind marks on the break facet. Note the scratch marks below the break on the shaft of A.

One shaft fragment has signs of deliberate markings towards its tip (Fig. 26). Unfortunately, the piece was too fragmented to be able to tell whether it was originally intended as a bone point, a link-shaft or an ornament. Ethnographically, link-shafts are known to carry similar deliberate markings as a means of identification (e.g. Weissner 1983). It is possible that these markings, which appear too regular to be the result of hafting with a metal tip, were meant to function similarly to ethnographic marked link-shafts.

Figure 26. Pointed bone fragment (Lyn 1 C2/D2) from jubilee Shelter with parallel, horizontal engraved lines. Scale is 5 mm.

Finally, a single perforated pointed bone artefact was found (Fig. 27). The perforation is not natural and its symmetry is suggestive of drilling – a practice not uncommon in the LSA. This piece is elliptical, to flat in cross section and was possibly intended as a matting needle. Its overall morphology however, is quite conducive to projectile functioning. The piece is broken in half and included in the macro-fracture analysis (see Chapter 7: 174).

Figure 27. Perforated pointed bone tool (J5/A4) form Jubilee Shelter, possibly a matting needle. It has an elliptical cross section. Scale is 10 mm.

6.4. Rose Cottage Cave: Later Stone Age pointed bone artefacts

The bone point assemblage from RCC is also highly fragmented. Altogether nine cylindrical shaft fragments and three elliptical shaft fragments were too fragmented to examine. Apart from these 12 pieces a total of six bone points and six shaft fragments were examined (Table 20). None of the points examined can be considered complete as all have breaks on their proximal or distal extremities. Only one piece (RCC 4) is longer than 30 mm. Three pieces (RCC 1, 2 & 6) retain their tips intact. For the remaining sample, the tips are missing and so no measurements could be taken from there.

Table 20. Morphometric values for bone points and shaft fragments from Rose Cottage Cave. TCSA values are in mm² and weight values are in g. All other measurements are in mm.

Sample	**Provenience**	**Diameter From Tip**		**Diameter in centre**	**Length**	**TCSA**	**Weight**
		1 cm	**3 cm**				
RCC 1	N5 Brown Peter	1.8	-	2	21	2	0.2
RCC 2	Q5 LB	3.5	-	4.6	28.1	10.58	0.4
RCC 3	J4 Janice [1]	-	-	-	7.5	-	0.1
RCC 4	K3 Janice	-	-	4	47.9	8	0.6
RCC 5	Q4 CM	-	-	-	9.4	-	0.2
RCC 6	Q4 Janice	5.5	-	7.5	25.5	28.12	0.7
RCC 7	J4 Janice [2]	-	-	4.9	18.9	12	0.3
RCC 8	N4 CM	-	-	4.6	17.3	10.58	0.5
RCC 9	P3 Peter	-	-	4.1	21.5	8.4	0.3
RCC 10	M5 Philip	-	-	8.5	13.9	36.12	0.3
RCC 11	J4 Philip	-	-	3.3	13	5.4	0.1
RCC 12	N3 CM	-	-	3.8	19.1	7.22	0.3
		Mean		**4.7**	**20.2**	**12.84**	**0.3**
		SD		**1.9**	**10.6**	**10.7**	**0.2**
		Min.		**2.0**	**7.5**	**2.0**	**0.1**
		Max.		**8.5**	**47.9**	**36.12**	**0.7**

Due to the highly fractured nature of the assemblage the mean weights and lengths do not reveal much about the bone points. Of more interest are the TCSA values. The mean TCSA of RCC bone points is 12.84 mm². This is much larger than the values obtained for the Jubilee bone points and more similar to those of the Fourie collection, specifically the ‡Ao-//Ein cultural group.

The mean diameter of RCC bone points falls between that of the Jubilee collection and Fourie collection; lying closer to the Jubilee mean average of 4.1 mm. Eight (58.3 %) RCC bone points and fragments had a cylindrical cross-section. Despite the fewer number of points, this is much lower than the Jubilee sample (75.5 %). Twenty-five percent of bone points are elliptical in cross-section compared to 15.1 %

of Jubilee points. Flat and pyramidal points are in the minority, as with the Jubilee points, accounting for one specimen each. Only one polished piece and two heated pieces were found in the RCC collection of pointed bone tools.

Figure 28 presents the base of a bone point the Oakhurst levels at RCC. The base of this piece seems to have been filed down to form some sort of ‘stem’; perhaps intended for the same purpose as other ‘stemmed’ bone points. The tip of this piece was unfortunately missing.

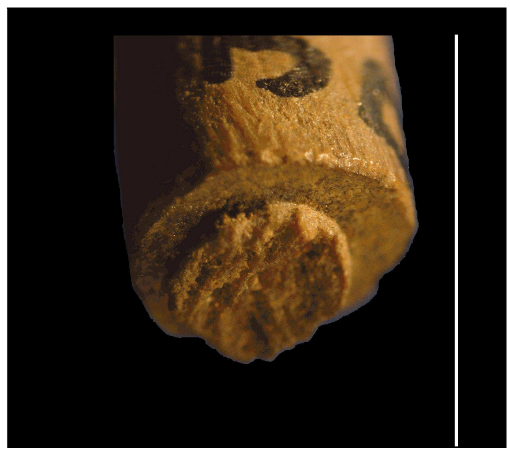

Figure 28. RCC 3 proximal break. Scale is 5 mm.

6.5. Nelson Bay Cave: Later Stone Age pointed bone artefacts

6.5.1. Some general observations

A total of 90 pointed bone artefacts were examined from NBC. They include bone points (n = 42), hollow bone points (n = 5), awls (n = 12), spears (n = 7) and fish gorges (n = 8). The names of these categories are derived from the accession register and have been based on overall morphology by the excavators. Because no functional studies have been conducted on these tools yet, it may be misleading to refer to them by functional names. Essentially, ‘awls’ are irregular points, ‘spears’ are broad points and ‘fish gorges’ are diamond shaped points. Nevertheless, it has become standard practice to assign these functional terms to differently shaped artefacts (e.g. Cable

1984; J. Deacon 1984; Opperman 1989). I retain this functional terminology for the sake of convenience and comparability. The reader is, however, advised that when I refer to awls, spears and fish gorges, I am referring to morphological types and not functional categories.

Due to the high number of points in the assemblage shaft fragments are not included in the study. Fish gorges are also largely excluded from this study, but eight fractured gorges were examined for comparative purposes (see Chapter 7) and their morphologies are therefore included in this section. The general condition of bone points is much better than at Jubilee Shelter and Rose Cottage Cave.

6.5.2. The bone point dimensions from the different time periods at Nelson Bay Cave

Tables 12 – 14 in Appendix B present the specifics of bone points from the various LSA industries present at NBC. Table 21 below presents the summarized data from Appendix B. Pointed bone artefacts and bone points in particular are present in all cultural complexes at NBC. This makes NBC fairly unique among the sites looked at so far, because the sample is large enough to be able to separate out cultural levels. Bone points are present in different phases within the LSA at other sites, but not in meaningful numbers. I do, however, deal with these separations in the final section of this chapter (page 156). The majority (61.9 %) of bone points at NBC are broken to varying degrees. Although all the bone points are morphologically similar a number of distinctions can be made between the different industries.

Table 21. Summary of morphometric averages of bone points from Nelson Bay Cave (n = 42). TCSA values are in mm² and weight values are in g. All other measurements are in mm.

Industry	Diameter From Tip 1 cm	Diameter From Tip 3 cm	Diameter in centre	Max. diameter	Length	TCSA	Weight
Wilton	3.2	4.5	4.8	5.2	56.3	17.49	1.3
Albany	3.2	4.4	4.8	5.4	43.5	11.66	1.1
Robberg	3.9	5.1	4.3	4.6	50.6	9.75	0.8
Mean	**3.4**	**4.7**	**4.6**	**5.1**	**50.1**	**12.96**	**1.1**
SD	**1.1**	**1.5**	**0.7**	**1.6**	**5.2**	**5.9**	**0.7**
Min.	**2.1**	**2.2**	**2.9**	**2.9**	**3.6**	**4.5**	**0.0**
Max.	**5.9**	**8.5**	**8.2**	**10.8**	**199.2**	**125.00**	**3.8**

What is immediately apparent from the data, is that the general size and robusticty of the NBC bone points tends to increase through time. The tip ratio remains relatively constant throughout, but the thickness, weight and TCSA values increase towards the upper levels. The tip proportions are slightly thicker during the Robberg than the Albany and Wilton. Bone points are longest during the Wilton, followed by the Robberg and finally the Albany.

Although much shorter in length, the mean values of bone points from NBC are more akin to the reversible bone points than the robust bone points in the Fourie collection. Indeed, the mean TCSA values are identical. One quite noticeable difference, however, between the two assemblages, is that bone points in the Fourie collection, whether they be robust or reversible, tend not to increase in width from their mid-point to their butt whereas the majority of NBC bone points do just that – they increase progressively from their tips to their butts. The angle of manufacturing striations on bone points from NBC run either diagonally from top left to bottom right or longitudinally from tip to butt.

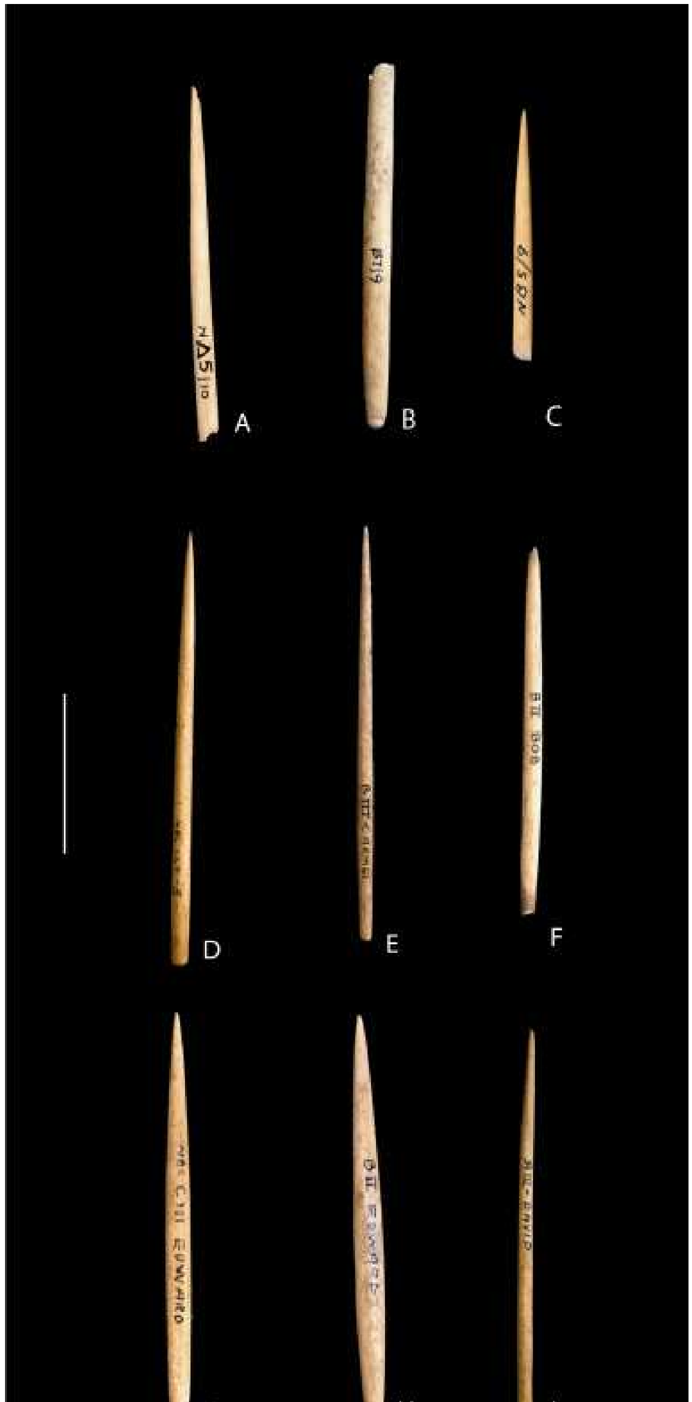

Figure 29. A selection of bone points from Nelson Bay Cave. The selection corresponds to the catalogue numbers in Tables 12 – 14 of Appendix B: A) 15, B) 20, C) 21, D) 33, E) 36, F) 37, G) 40, H) 42 and I) 43. Note the widths of some of these

pieces are akin to the robust bone point variety in the Fourie collection. Scale is 30 mm.

6.5.3. The morphologies of the different pointed bone tools at Nelson Bay Cave

I now turn to the morphological attributes of the additional pointed bone tools and compare them to those obtained for the bone points. Here I demonstrate that the characteristics of some pointed tools, that have previously been classed as 'awls', are also consistent with those obtained for arrowheads. Table 22 presents the summarised results of the morphometric analysis on all the pointed bone tools from NBC. A breakdown of the morphometrics for each pointed bone tool category is supplied in Tables 15 – 19 of Appendix B.

Table 22. Summary of the mean morphometric values of the various pointed bone artefacts at Nelson Bay Cave (n = 90). TCSA values are in mm² and weight values are in g. All other measurements are in mm.

Pointed bone type	**Diameter From Tip**		**Diameter in centre**	**Max. diameter**	**Length**	**TCSA**	**Weight**
	1 cm	**3 cm**					
Bone points	3.4	4.7	4.6	5.1	50.1	12.96	1.1
Hollow points	2.8	4.2	4.4	4.7	56	9.69	0.8
Ambiguous points	2.9	5.4	5	5.9	50.4	10.2	0.9
Awls	2.2	4.9	4.2	9.4	48	10.02	1
Spears	6.8	9.7	9.3	11.8	71.7	49.22	4.8
Gorges	3	-	4.8	4.8	34	12.25	0.4
Mean	**3.6**	**5.5**	**5.0**	**6.2**	**50**	**15.27**	**1.2**
SD	**1.1**	**1.5**	**0.7**	**1.6**	**5.2**	**5.87**	**0.7**
Min.	**1.6**	**4.0**	**2.0**	**3.0**	**25.5**	**2.0**	**0.0**
Max.	**13.2**	**10.0**	**17.1**	**99.6**	**121.8**	**145.35**	**12.4**

Hollow bone points differ from regular bone points in that they are hollow in the centre (Fig. 30). They are made from specific skeletal parts and are often derived from birds. Four of the five pieces come from Wilton levels; the exception coming from the Robberg. Over 80 % of hollow bone points are broken. Their overall cross-section is elliptical.

The tip ratio is similar to the bone points, as is their diameter and length. Lengths range from 25.5 – 99.6 mm with a mean of 56 mm (SD = 31.9 mm). The TCSA values range from 5.44 – 11.92 mm² with a mean of 9.69 mm² (SD = 2.92 mm²). In both cases these ranges fall just inside the lower range of historical and ethnographic Bushmen arrows in the Fourie collection.

Figure 30 Examples of hollow bone points from Nelson Bay Cave (L: RA II Bert; R: Talus above David). Scale is 10 mm.

Table 16 of Appendix B refers to a class of pointed bone tools which I have termed ambiguous points (Fig. 31). These tools are labelled as 'awls' on the NBC collection register but they differ from the other 'awls' in some respects. Their overall morphology is more akin to bone points than 'awls' (Table 17 of Appendix B).

Ambiguous points' lengths range from 19.9 – 77 mm (SD = 16 mm) and their TCSA values from 3.8 – 18 mm² (SD = 5.45 mm²). The mean lengths are closer to those of the bone points but the mean TSCAs resemble 'awls'. The main difference between bone points and ambiguous points is the tip ratio which, in the latter case, is closer to 'awls'. However, unlike awls, the medial/proximal ratio of ambiguous points is more similar to bone points. This relatively narrow butt could have facilitated hafting in an arrow or stave.

Figure 31. Examples of ambiguous bone points from Nelson Bay Cave: 'awls' which could have functioned as projectiles. Scale is 10 mm.

'Awls' are present in all industrial levels but have their highest representation in the Albany (Table 17 of Appendix B). They are similar in length to bone points but have a higher tip ratio and continue to increase in width towards the butt. In most cases the 'awls' retain the proximal epiphysis of the bone from which they are made (Fig. 32). Often 'awls' are also made from bones with a thin cortex and are therefore hollow.

Figure 32. Two examples of ‘awls’ from Nelson Bay Cave. Scale is 10 mm.

Seven broad bone points ‘spears’ were found in Albany and Wilton levels (Table 18 of Appendix B). Their average cross-section is elliptical (Fig. 33). ‘Spears’ are by far the largest of all pointed bone categories in the assemblage (Table 22). Although the mean TCSA values of bone ‘spears’ falls intermediate between the mean values of Shea’s (2006) hypothetical arrow and dart categories, their range (32.00 – 145.38 mm²) covers all three of Shea’s categories, including arrows, darts and spears.

On one example parallel notches are evident on both laterals. It is uncertain what this represents. It could be to facilitate hafting or perhaps to aid in identification, similar to marked link-shafts in ethnographic collections. Alternatively, they could merely represent idle dawdlings.

Figure 33. Examples of ‘spears’ from Nelson Bay Cave. Note the notches on the right hand piece and the hollow nature of the one second from right. Scale is 10 mm.

The fractured fish gorges (n = 8) are elliptical in cross-section, and appear predominately in the Robberg and Wilton levels (Table 19 of Appendix B). Their diametres and TCSA values are very similar to those of the bone points (Table 22). The main difference between gorges and bone points is the length and shape. Fish gorges are usually less than half the length of points and weigh less than half of the latter.

Figure 34. Two examples of fish gorges from Nelson Bay Cave. Scale is 10 mm.

6.6. Bushman Rock Shelter: Later Stone Age and putative Middle Stone Age pointed bone artefacts

6.6.1. Some general observations

A total of 20 pointed bone artefacts were examined from BRS. Of these, 15 are bone points and five are other pointed bone tools like ‘spears’ and ‘needles’. Three of the bone points (BRS 13 – 15) are from the lower three levels of the site and may be of possible MSA association. The majority (n = 16) of pointed bone artefacts are broken. One noticeable difference at BRS compared to other sites is the high percentage of elliptical shaped bone points (n = 6; 40 %). This is the same percentage as cylindrical bone points. Flat points were in the minority (n = 3) with one point flat at the base and cylindrical towards the tip (BRS 06). Tables 23 – 25 present the results of the morphometric analysis of BRS bone points and other pointed bone tools respectively.

6.6.2. *Bone point dimensions*

Table 23. Morphometric values of bone points from Bushman Rock Shelter. TCSA values are in mm² and weight values are in g. All other measurements are in mm.

Sample	**Provenience**	**Context**	**Diameter From Tip**		**Diameter in centre**	**Max. diameter**	**Length**	**TCSA**	**Weight**	**Shape**
			1 cm	**3 cm**						
BRS 01	unprovenanced	LSA	-	-	4	4	-	8	0.4	Cyl.
BRS 02	unprovenanced	LSA	-	-	4	4	-	8	0.6	Cyl.
BRS 03	unprovenanced	LSA	4.7	5.5	5	5.7	43	16.24	1.1	Cyl.
BRS 04	unprovenanced	LSA	-	-	4.3	4.3	52.4	9.24	1.1	Cyl.
BRS 05	C6/3	LSA	3.8	5.3	5.3	6.1	61	9.45	1.2	Flat
BRS 06	A6/5(b) [a]	LSA	2.7	3.6	3.4	7	70	10.85	1.4	F - C
BRS 07	A6/5(b) [b]	LSA	-	-	2.9	2.9	26.4	4.2	0.3	Cyl.
BRS 08	C6/6	LSA	2	2.5	2.8	2.8	69.4	3.92	0.5	Ellip.
BRS 09	AB6/13a	LSA	3	3.9	3.8	3.9	41.6	7.6	0.6	Ellip.
BRS 10	A6/5(b) [c]	LSA	3.8	-	-	5.6	24.8	8.12	0.3	Flat
BRS 11	C6/5	LSA	2.6	-	4	4.9	32.5	6.61	0.4	Ellip.
BRS 12	C6/14(a)	LSA	3	-	3.4	3.4	23.2	5.78	0.1	Ellip.
BRS 13	C8/15	MSA?	-	-	3	3.5	-	6.12	0.3	Cyl.
BRS 14	C6/18(a)	MSA?	5	-	6.5	6.5	20.6	12.67	0.3	Ellip.
BRS 15	AB6/18	MSA?	3.5	-	4	5	30	12.5	0.3	Ellip.
	Mean		**3.4**	**4.2**	**4**	**4.6**	**41.2**	**8.62**	**0.6**	
	SD		**0.9**	**1.2**	**1**	**1.3**	**18**	**3.4**	**0.4**	
	Min.		**2**	**2.5**	**2.8**	**2.8**	**20.6**	**4.2**	**0.1**	
	Max.		**5**	**5.5**	**6.5**	**6.5**	**69.4**	**16.24**	**1.4**	

Table 24. Average measurements of bone points per age level at Bushman Rock Shelter. TCSA values are in mm² and weight values are in g. All other measurements are in mm.

Context	Diameter From Tip		Diameter in centre	Max. diameter	Length	TCSA	Weight
	1 cm	3 cm					
LSA Mean	3.2	4.2	3.9	4.5	44.4	8.17	0.7
LSA SD	0.9	0.9	0.8	1.3	18.0	3.26	0.4
MSA Mean	2.8	-	4.5	5	25.3	10.43	0.3
MSA SD	1.1	-	1.8	1.5	6.6	3.73	0

The relatively low average weights reflect the fractured nature of the assemblage. The mean TCSA value of bone points is 8.62 mm² with a range of 3.92 mm² – 16.24 mm². The average length is 41.2 mm with an average centre diameter of 4 mm. There is an increase of 0.4 mm on average between the diameter of the mid-point and the maximum diameter. This is in keeping with the results obtained from other LSA and MSA sites (see Table 30). There is a 0.8 mm difference between the tip measurements taken 1 cm and 3 cm from the tip, which is less than at any other site examined in this paper.

Separating the BRS bone points into LSA and possible MSA association, the overall robusticity of MSA points from the medial point onwards is greater than that of LSA points. Putative MSA bone points therefore have a greater TCSA mean value. Interestingly, the measurement 1 cm from the tip is, on average, less on MSA bone points than on LSA. This makes the degree of increase from the tip to the mid-point all the more pronounced. This should, however, be viewed with caution given the small number of MSA bone points in the sample.

Table 25. Morphometric values of pointed bone tools excluding bone points at Bushman Rock Shelter. TCSA values are in mm^2 and weight values are in g. All other measurements are in mm.

Sample	**Provenience**	**Context**	**Diameter From Tip 1 cm**	**Diameter From Tip 3 cm**	**Diameter in centre**	**Max. diameter**	**Length**	**TCSA**	**Weight**	**Shape**
BRS 16	A6/5(b) [d]	LSA	6.9	10	11	12	80.5	72	4.2	Flat
BRS 17	A6/5(b) [e]	LSA	4	7.9	10.5	12.6	92.1	79.38	4.5	Flat
BRS 18	C6/10	LSA	7	9.9	9.5	12	68.4	72	5.5	Ellip
BRS 19	A6/5(a)	LSA	-	-	4.6	9	~100	40.5	2.4	Ellip
BRS 20	A6/11	LSA	-	-	9.5	20	~117	200	20.6	Irreg
	Mean		**5.9**	**9.3**	**9**	**13.1**	**91.6**	**92.77**	**7.4**	
	SD		**1.7**	**1.2**	**2.5**	**4.1**	**18.5**	**61.71**	**7.4**	

Table 25 presents measurements of the other pointed bone tools present in the collection. These include two 'matting needles' (BRS 16 & 17), one possible spear point (BRS 18) and two 'awls' (BRS 19 & 20). The overall dimensions of these tools are larger than those of the bone points presented in Table 23. All these pointed bone tools were excavated from LSA levels. Unfortunately, the two 'awls' are broken so no measurement could be taken of the tip ratio. Interestingly, although only one possible spear point is present, the TCSA values fall between Shea's (2006) hypothetical dart tip and thrusting spear categories.

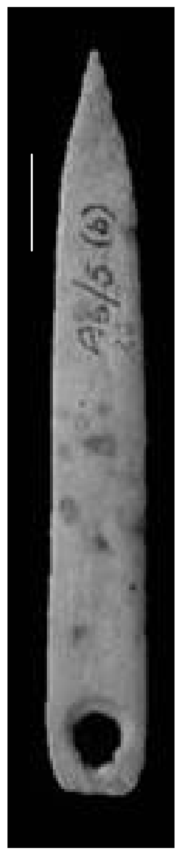

Figure 35. Perforated pointed bone tool, possibly a matting needle (A6/5) from LSA levels at Bushman Rock Shelter. Scale is 10 mm.

Figure 36. Curved pointed bone artefact from Bushman Rock Shelter (A6/5b). This piece may have functioned as a matting needle as its curved profile would inhibit it functioning well as a projectile. Scale is 10 mm.

Figure 37. The three bone points from possible MSA layers at Bushman Rock Shelter. A (C8/15); B (C6/18a); C (AB6/18). Scales are 5 mm.

6.6.3. Some other interesting finds

Among the pointed bone artefacts at BRS are three incised pieces, two of which are represented in Figures 38 and 39 and come from the LSA levels. Figure 38 represents a bone point with a missing tip and shallow horizontal incisions. The tip does not look deliberately snapped and there is evidence that the incisions continued towards the tip. These markings may represent identification markings used by the hunter to identify his arrow (see Weissner 1983).

Figure 38. Broken bone point with snapped tip (A6/5) from Bushman Rock Shelter. Note the incisions toward the distal extremity. Scale is 5 mm.

Figure 39 represents a well polished hollow piece of bone with deep parallel incisions. There is not enough evidence on the piece to say whether it originally formed part of a bone point. It may represent an ornament meant to be strung like a bead from a string, or perhaps even a blank for making bone beads.

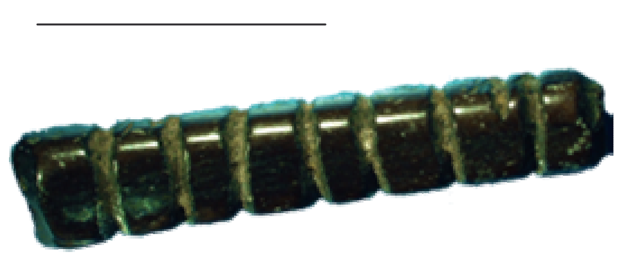

Figure 39. Hollow bone artefact from LSA levels at Bushman Rock Shelter. Note the deep parallel incisions. Scale is 5 mm.

6.7. Blombos Cave: Later and Middle Stone Age pointed bone artefacts

6.7.1. Some general observations

The Blombos collection consists of 23 pointed bone artefacts. Previous studies divided these tools into points and 'awls' (Henshilwood *et al.* 2001a; d'Errico & Henshilwood 2007). The point category was further divided into possible spears and possible projectile points, based on morphological similarity to ethnographic tools of the same function. Six 'awls' and one bone point from the LSA levels at Blombos were included in these previous studies for comparative purposes, and I also include some of them in this current study. However, the mean values for each table only include the MSA pieces as not all the LSA pointed bone artefacts from BBC were examined for this study. For full details on manufacturing techniques and point symmetry of individual pointed bone tools from BBC the reader is referred to Henshilwood *et al.* (2001a, b) and d'Errico & Henshilwood (2007).

6.7.2. Dimensions of pointed bone artefacts

Tables 26 to 28 present the results of my morphometric analysis of the Blombos pointed bone tools. Fifty-six percent (n = 13) of the tools are broken. The pointed bone tools are commonly elliptical (n = 10) in cross-section, followed by cylindrical (n = 6), flat (n = 5) and irregular (n = 2) shapes. In Table 26, sample BBC 7 is a shaft fragment with similar polishing and manufacturing technique to BBC 3. It is thought that they may have belonged to the same piece (d'Errico & Henshilwood 2007).

The TCSA values of the proposed Still Bay projectile points range from 14.04 mm² to 43.24 mm² with a mean of 28.50 mm². This mean lies midway between the mean values of the bone 'spears' (49.20 mm²) from NBC and bone points (12.96 mm²) from NBC and the Fourie collection. The range overlaps with both categories. The BBC TCSA values are much closer to the robust points (22.40 mm²) from the Fourie collection.

Indeed, the other measurements of the BBC bone points are similar to the robust points from the Fourie collection, only differing by an average of 0.7 mm in thickness. The average length of BBC points is similar to those from NBC, with one point (BBC 5) obscuring the mean results. However, if the bone fragment BBC 7 is part of BBC 3 then it is likely that the complete length would be nearer that of BBC 5 and therefore longer than the Fourie bone points. The one LSA bone point from BBC is morphologically similar to bone points from NBC and the Fourie collection. In summary it would appear that the MSA bone points from BBC are morphologically more akin to the Fourie collection of robust bone points than to either the reversible bone points or bone 'spears' from NBC.

The two proposed bone spears from the Still Bay levels at BBC do not seem to fit the mean dimensions of proposed bone spears from NBC. In fact, the BBC proposed spears appear morphologically more similar to the Fourie collection robust bone points than the BBC proposed projectile points.

The proposed bone awls from BBC are also interesting. In all morphometric categories the BBC Still Bay 'awls' resemble Fourie robust points to a greater degree than they do NBC 'awls'. There is greater similarity among 'awls' and 'spears' at BBC than between 'awls' from NBC and BBC. Unfortunately, apart from general morphology, I am not aware of any published measurements in either the ethnographic or archaeological reports that establish what constitutes an awl.

Table 26. Morphometric values of possible projectile bone points from Blombos Cave. TCSA values are in mm^2 and weight values are in g. All other measurements are in mm.

No.	Provenience	Context	Diameter From Tip		Diameter in centre	Max. diameter	Length	TCSA	Weight	Shape
			1 cm	3 cm						
BBC 3	8947	Still Bay	4.3	6.9	6.8	7	54	23.12	2.7	Ellip.
BBC 5	8964	Still Bay	5.1	8	9.3	12	148.2	43.24	9.8	Irreg.
BBC 6	8954	Still Bay	4.6	5.5	5.3	6.2	62	14.04	1.3	Ellip.
BBC 7	8955	Still Bay	-	-	8.7	8.2	-	33.62	0.7	Ellip.
BBC 4	8980	LSA	3	4.2	4.2	4.4	53.3	8.82	1.1	Cyl.
	Mean		**4.7**	**6.8**	**7.5**	**8.3**	**88.1**	**28.5**	**3.6**	
	SD		**0.9**	**1.7**	**2.2**	**2.8**	**46**	**14.1**	**3.8**	
	Min.		**4.3**	**5.5**	**5.3**	**6.2**	**54**	**14.04**	**0.7**	
	Max.		**5.1**	**8**	**9.3**	**12**	**148.2**	**43.24**	**9.8**	

Table 27. Morphometric values of possible spear points from Blombos Cave. TCSA values are in mm^2 and weight values are in g. All other measurements are in mm.

No.	Provenience	Context	Diameter From Tip 1 cm	Diameter From Tip 3 cm	Diameter in centre	Max. diameter	Length	TCSA	Weight	Shape
BBC 11	8949	Still Bay	3.2	6.5	-	7.6	89.5	24.5	1.7	Flat
BBC 17	8940	Still Bay	3.6	5.2	5.6	5.2	48	14.56	0.7	Flat
	Mean		**3.4**	**5.8**	**5.6**	**6.4**	**68.7**	**19.53**	**1.2**	
	SD		**0.3**	**0.9**	**0**	**1.7**	**29.3**	**7.02**	**0.7**	

Table 28. Morphometric values of possible awls from Blombos Cave. TCSA values are in mm^2 and weight values are in g. All other measurements are in mm.

No.	Provenience	Context	Diameter 1 cm	From Tip 3 cm	Diameter in centre	Max. diameter	Length	TCSA	Weight	Shape
BBC 1	BBC cc H5d	Still Bay	-	-	5.1	8.1	79.2	28.88	2.8	Cyl.
BBC 2	8981	Still Bay	3.5	7.5	7.6	8	67.1	6	2.2	Ellip.
BBC 9	8961	Still Bay	2.5	3.2	3.5	4.5	36.5	6.12	0.4	Cyl.
BBC 10	8943	Still Bay	4	-	5.6	5.6	20.7	15.68	0.2	Flat
BBC 12	8969	Still Bay	2.5	3.5	3.5	3.5	51.4	6.12	0.6	Ellip.
BBC 13	8956	Still Bay	4.1	5	5.1	5.1	52	12.75	0.6	Flat
BBC 14	8949	Still Bay	-	-	3.9	4	74.2	7.6	0.9	Cyl.
BBC 16	8948	Still Bay	5	7.8	7.5	8.4	48	28.12	1.2	Ellip.
BBC 18	8952	Still Bay	3.9	5	5	6.6	53.4	12.5	1	Ellip.
BBC 19	CC I6a	Still Bay	6.1	10.6	11.6	13.7	75.2	61.48	5.4	Irreg.
BBC 20	CFC G5b	Still Bay	-	-	-	2.1	12.1	2.2	0	Cyl.
BBC 21	8953	Still Bay	4.5	7.3	7.2	8.8	73.9	26.28	1.9	Flat
BBC 22	8965	Still Bay	2.6	5	6.9	10.1	90	17.25	2.6	Ellip.
BBC 23	F9c	Still Bay	-	-	5	5	39.1	12.5	1.1	Cyl.
BBC 8	8977	LSA	2	3.9	3.9	5.8	57.9	7.6	0.7	Ellip.
BBC 15	8978	LSA	4	11.5	10.5	14.5	53.1	60.37	2.6	Ellip.
		Mean	**3**	**7.7**	**7.2**	**10.1**	**55.5**	**33.98**	**1.5**	
		SB Mean	**3.9**	**6.1**	**5.9**	**6.7**	**55.2**	**17.39**	**1.5**	
		SD	**1.2**	**1.2**	**2.2**	**3.1**	**22.8**	**15.32**	**1.4**	
		Min.	**2.5**	**3.2**	**3.5**	**2.1**	**12.1**	**2.2**	**0**	
		Max.	**6.1**	**10.6**	**11.6**	**13.7**	**90**	**61.48**	**2.8**	

The difference between proposed spears and awls and robust projectile points in the Fourie collection seems to be at the butt. The butts of the robust points are all similar in width to their mid-points in order to facilitate hafting and aerodynamics. All the ‘awls’ at BBC and NBC have butts that are too wide or irregular to be hafted to a cylindrical shaft. This seems to be the common criteria for differentiating ‘awls’ in the literature. The main difference between BBC ‘spears’ and ‘awls’ appears to be that ‘spears’ have a more gradual taper from the mid-point to the tip whereas on ‘awls’ the focus of manufacture seems to have been only on the tip while the base of the piece was left unworked.

Figure 40. Highly polished bone point from Still Bay layers at Blombos Cave (SAM-AA-8947). Scale is 10 mm.

Figure 41. Suggested tanged bone spear point from Blombos Cave Still Bay levels (CC I6a). Scale is 10 mm.

Figure 42. Two possible awls from Blombos Cave (SAM-AA-8965 and 8978). Scale is 10 mm.

6.8. Sibudu, Klasies and Peers Caves: Middle Stone Age pointed bone artefacts

Few pointed bone tools from MSA contexts have been found at Sibudu, Klasies and Peers Caves. For this reason I have chosen to deal with these sites in a single unit. Unfortunately, the bone point found in the Talus slope at Peers Cave and published by d'Errico & Henshilwood (2007) was not available for study. The morphometric values from this piece have therefore been taken from the illustrations in d'Errico & Henshilwood (2007, Fig. 11). The age of this piece is not precisely known, but d'Errico & Henshilwood have assigned it to the MSA based on morphological comparisons with the Blombos bone points. It probably comes from either Howieson's Poort or Still Bay levels. An additional pointed bone tool from Peers Cave (open site 114) was provided for analysis by Iziko museum. This piece is flat, highly root etched and of an unknown age, but I have included it for comparative purposes.

The published bone point from Klasies has been included in this section on MSA pointed bone tools even though it has recently been reassigned to the LSA levels of Klasies (d'Errico & Henshilwood 2007). I have done this mainly because of its historical association with the MSA, but also because, similar to Sibudu and Peers Caves, pointed bone tools are rare at Klasies. The bone point from Sibudu Cave, which was classified as a projectile point by Backwell and colleagues (2008) has also been included in this section. Apart from a bone needle it is the only pointed bone tool that has been published from this site. It is also the only bone point that has been securely dated to Howieson's Poort levels. This makes a good comparative piece with the Blombos bone points that date to the Still Bay.

Table 29. Morphometric comparison of bone points from Sibudu, Klasies and Peers Caves. TCSA values are in mm² and weight values are in g. All other measurements are in mm.

	Context	Diameter From Tip 1 cm	Diameter From Tip 3 cm	Diameter in centre	Max. diameter	Length	TCSA	Weight	Shape
Sibudu	HP	3.3	5.1	5.5	5.5	49.34	15.12	1.9	Cyl.
Klasies	MSA/LSA	3	4.4	4	5	77.1	8.00	2.1	Cyl.
Peers	Talus	3.9	5.9	5.9	6.8	70	23.12	-	Cyl.
Peers	unknown	3.5	6	5.7	6.1	41	17.10	0.7	Flat

Most of the bone points from these three sites have a cylindrical shape (Table 29). The morphometric values of the Sibudu Cave bone point are generally more akin to Wilton bone points from NBC. There is a 1.8 mm difference between the measurements 1 cm and 3 cm from the tip on the Sibudu Cave bone point. Thereafter the piece is fairly uniform, only increasing by 0.4 mm until the proximal break. The length is closer to the NBC bone point mean lengths, particularly from the Robberg assemblage, than at any other site.

The Klasies bone point most closely resembles the mean Albany bone point values from NBC and the mean values from RCC. It is slighter in form than the bone point from Sibudu Cave but it weighs more. The TCSA value is small and closely associated with the mean values from Jubilee Shelter and the Robberg at NBC. The tip ratio is similar to that of the Sibudu Cave bone point, being 0.4 mm slighter. The bone point from Klasies has a slight curvature (Fig. 45), similar to that observed on a matting needle at BRS (Fig. 36), which would hamper its proposed function as a projectile.

The Peers Cave bone point has a similar dimension and tip ratio to the mean Fourie robust point values. The maximum diameter and TCSA value is also closely akin to the Fourie robust points. The morphometric values of the flat point from Peers Cave are similar to the cylindrical point. Its TCSA values are however, more closely associated with the mean Wilton values at NBC.

Figure 43. The Sibudu Cave bone point taken at four angles. Scale is 10 mm. Previously published in Backwell *et al.* (2008, Fig 4).

Figure 44. The Peers Cave point taken at three angles. Scale is 10 mm. Previously published in d’Errico & Henshilwood (2007: Fig 11a).

Figure 45. The bone point from Klasies. Note the slight curvature of the piece. Scale is 10 mm.

6.9. Discussion

Table 30 presents the mean summarised results of bone points for each of the above mentioned sites. For the sake of convenience I have included the means for each of the three time periods. The main problem with working with means is the possibility of a precocious measurement obscuring the result. Coupled with this is the small sample size at some of the sites that can accentuate the problem. An un-intact or fractured assemblage can also give a false result. For these reasons I have included measurement ranges to counter precocious measurements and, where an assemblage is highly fragmented, I have only included those pieces that were the most complete and which retained an original proximal or distal end.

As can be seen from Table 30 and Figure 46 the tip ratio of bone points seems to increase the further back in time one goes. Not only do the individual measurements increase but the difference between the measurements taken 1 cm and 3 cm from the tip also increase further back in time. However, the robust bone point category in the ethnographic collection is identical to the MSA mean and far larger than reversible bone points. As a result, the inclusion of the robust bone points in the ethnographic category would cause that mean to be increased. For this reason, I have excluded the historical/ethnographic robust points from the figure below.

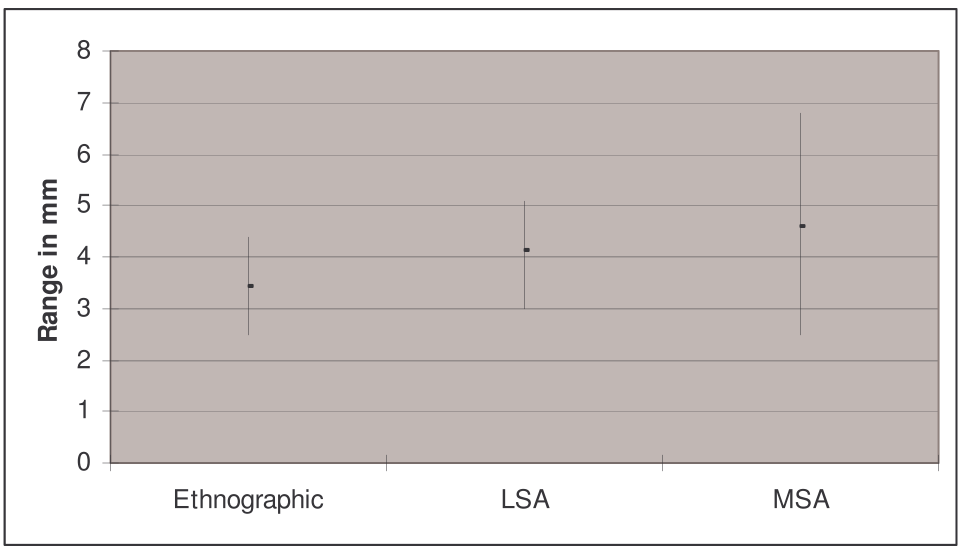

Figure 46. Tip ratio of bone points (excluding robust points) through time. The values indicate the difference between 1 cm from the tip and 3 cm from the tip.

Leaving robust points out of the equation for now, I discuss the medial measurements (Fig. 47). The mid point ranges of ethnographic reversible bone points, LSA and MSA bone points are 2.8 mm – 5.4 mm; 3.9 mm – 4.8 mm and 4.5 mm – 7.5 mm respectively. The range of the LSA bone points falls within that of the ethnographic sample, whereas the range of MSA bone points starts just outside of the ethnographic sample. Similar results are evident in the maximum diameter category. The maximum diameter ranges for ethnographic to MSA bone points is 2.8 mm – 5.4 mm; 4.1 mm – 5.5 mm and 5.0 mm – 8.3 mm respectively. Here again, the ethnographic range encompasses most of the LSA sample, and that of the MSA sample falls largely outside of the LSA maximum range. The ratio between the mid point and the maximum diameter is 1:1 in the ethnographic sample. In the LSA sample there is a difference of 0.5 mm and of 0.6 mm in the MSA sample. It is clear, even within age classes, that bone points exhibit a temporal decrease in size (*cf.* Backwell *et al*. 2008).

Taking ethnographic robust points into consideration one sees that, not only is their mean tip ratio identical to that of the MSA sample, but their mid point and maximum diameter falls within the MSA range (Fig. 48). The only difference is that MSA bone points tend to increase from the mid point to the butt – similar to but not as drastically as 'awls' – whereas robust points do not. The one possible exception to this are the bone points from possible MSA levels at BRS. As none of these three pieces retained their proximal extremity we do not know how thick they would have been at their maximum point.

Apart from temporal differences there appears to be an increase in overall dimensions moving from the interior towards the Cape and the coast in the LSA samples. Bone point dimensions at BRS are slighter than at Jubilee whose bone points are in turn slighter than at RCC. The bone point from Klasies is slightly larger than those from RCC. The NBC bone points are the largest of the LSA assemblages. Unfortunately, the same pattern is not repeated in the small MSA collection, nor in the Fourie collection, as some cultural groups' territories would overlap during their seasonal transhumanence. Further studies are needed from a wider variety of sites to see whether this trend is real or merely reflective of the specific samples chosen for this study.

Table 30. Summary of morphometric values of the 234 bone points from the different sites and industries. TCSA values are in mm² and weight values are in g. All other measurements are in mm. SD is standard deviation.

	Site	Diameter From Tip 1 cm	Diameter From Tip 3 cm	Diameter in centre	Max. diameter	Length	TCSA	Weight
Ethnographic	**Naron**	2.5	3.8	4.7	4.7	99.5	11.38	3.6
	‡Ao-//Ein	2.8	4.1	4.8	4.8	116.1	12.59	4.7
	Hei-//om	3.1	4.5	5.4	5.4	148.7	13.21	3.3
	!Kung	2.5	3.7	4.5	4.5	99.4	9.7	2.1
	Hu//Ein	2.9	4.4	4.9	4.9	105.5	12.3	-
	Bushman	-	-	2.8	2.8	101	18.6	3.9
	Mean reversible	**2.7**	**4.1**	**4.5**	**4.5**	**111.7**	**12.96**	**3.5**
	Robust points	**4**	**6**	**6.7**	**6.7**	**112.5**	**22.4**	**6.4**
	Mean (n = 104)	**3.3**	**5.1**	**5.6**	**5.6**	**112.1**	**17.68**	**4.9**
	SD	**0.6**	**0.9**	**0.8**	**0.8**	**31.1**	**4.8**	**2.1**
	Min.	**1.6**	**2.5**	**2.4**	**2.4**	**58.4**	**2.88**	**1.6**
	Max.	**4.9**	**6.7**	**7.4**	**7.4**	**194.2**	**27.38**	**10.8**
LSA	**Jubilee bone points**	-	-	4.1	4.1	24.3	7.48	0.4
	RCC bone points	-	-	4.7	4.7	20.2	12.84	0.3
	NBC Robberg	3.9	5.1	4.3	4.6	50.56	9.75	0.8
	NBC Albany	3.2	4.4	4.8	5.4	43.5	11.66	1.1
	NBC Wilton	3.2	4.5	4.8	5.2	56.3	17.49	1.3
	NBC Average	3.1	5.1	4.8	5.5	50.2	11.58	1
	LSA BRS	3.2	4.2	3.9	4.5	44.4	8.17	0.7
	Klasies	3	4.4	4	5	77.1	8	2.1
	Mean (n = 119)	**3.3**	**4.6**	**4.4**	**4.9**	**45.8**	**10.86**	**0.9**
	SD	**0.1**	**0.5**	**0.4**	**0.5**	**22.8**	**2.4**	**0.7**
	Min.	**0.9**	**0.9**	**0.8**	**1.9**	**3.6**	**1.80**	**0.0**
	Max.	**1.2**	**8.5**	**8.5**	**10.8**	**199.2**	**145.35**	**3.8**
MSA	**MSA BRS**	2.5	-	4.5	5.0	25.3	10.43	0.3
	Sibudu Cave	3.3	5.1	5.5	5.5	49.3	15.12	1.9
	Peers talus	3.9	5.9	5.9	6.8	70	23.12	-
	BBC points	4.7	6.8	7.5	8.3	88.1	28.5	3.6
	Mean (n = 11)	**3.7**	**5.9**	**5.8**	**6.4**	**58.2**	**19.29**	**1.9**
	SD	**0.9**	**0**	**1.2**	**1.5**	**27.0**	**8.1**	**1.7**
	Min.	**1.1**	**4.4**	**1.8**	**1.5**	**6.6**	**3.73**	**0**
	Max.	**5.1**	**8.0**	**9.3**	**12.0**	**148.2**	**43.24**	**9.8**

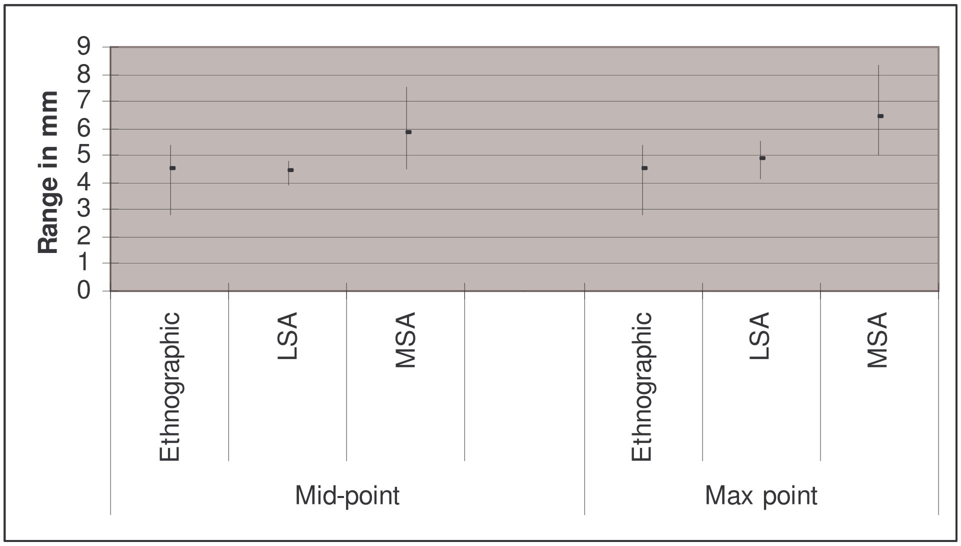

Figure 47. Mid-point and maximum diameter ranges and mean values of bone points from Ethnographic, LSA and MSA mean samples. Refer to Table 30.

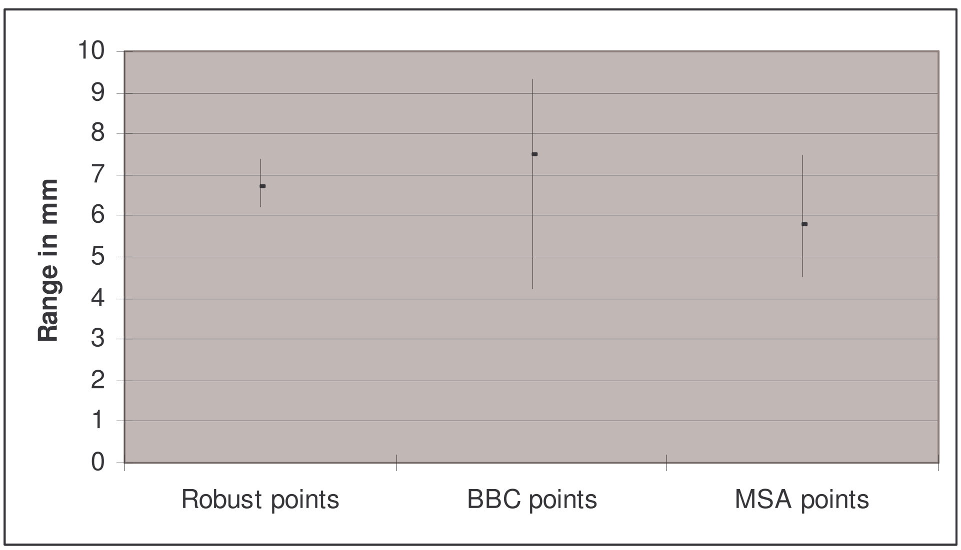

Figure 48. Diameter ranges and mean values of robust bone points, BBC bone points and the average of all other MSA bone points.

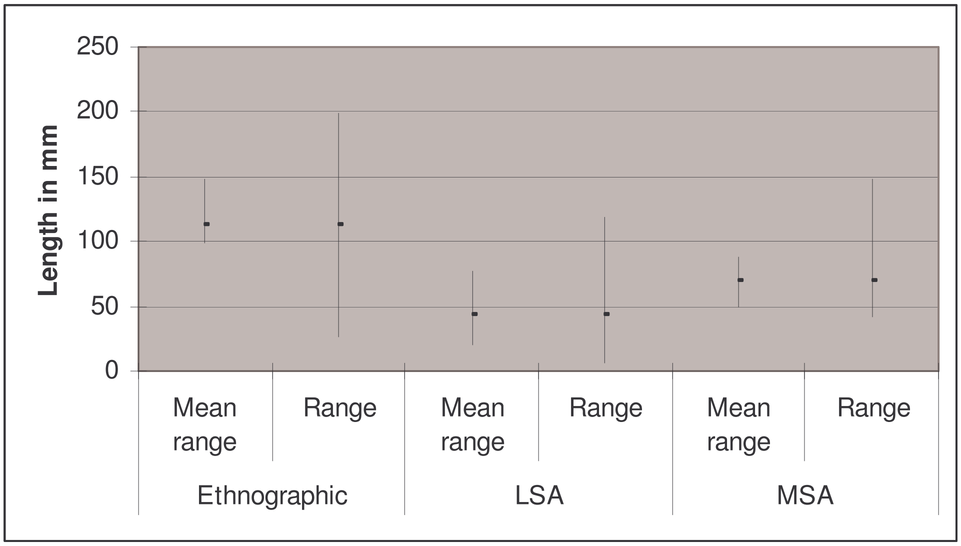

Figure 49. Length ranges of bone points from the ethnographic, LSA and MSA samples.

Figure 49 illustrates the length ranges and mean values of bone points through time. The Fourie ethnographic collection has the greatest range, spanning 173 mm. This is followed by bone points from the LSA (113.2 mm) and MSA (107.2 mm). The mean range of LSA bone points spans 56.9 mm, followed by ethnographic (49.3 mm) and MSA (38.8 mm) bone points. The LSA and MSA mean ranges overlap, whereas the mean range of ethnographic bone points falls outside the maximum range of the previous two. However, the ranges of all three periods overlap considerably.

The ethnographic robust points range from 75.6 mm to 155.9 mm with a mean of 112.5 mm. This is well within the range of reversible points and overlaps with LSA and MSA ranges. The mean length of robust points is similar to that of reversible points, yet robust points were unpoisoned. Most reversible bone points are capable of penetrating internal organs of small antelope as are their robust counterparts. It appears that the length of the point may not be the primary indicator of whether the point was poisoned or accompanied by a link-shaft (*contra* Backwell *et al.* 2008). Rather their width seems to be the differentiating factor.

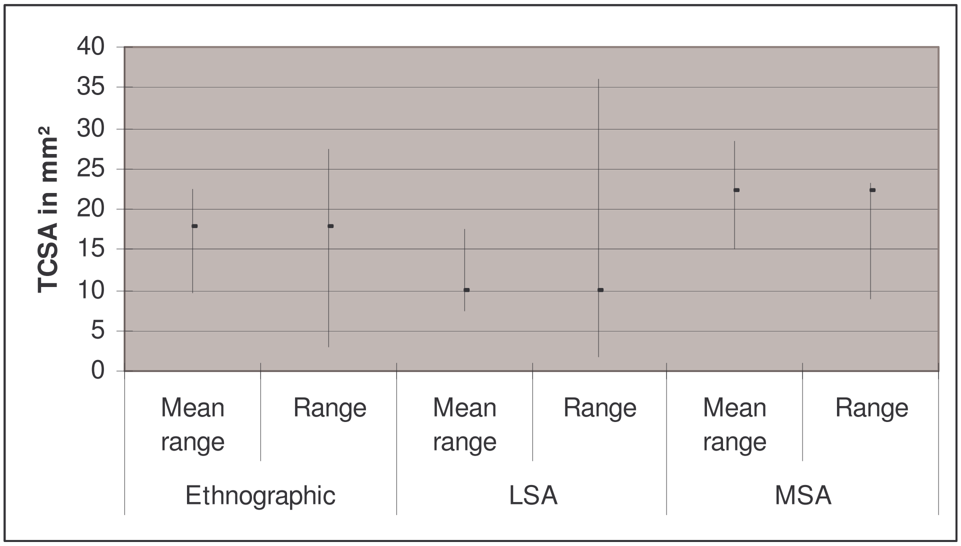

Figure 50. TCSA ranges of bone points from the ethnographic, LSA and MSA samples.

Figure 50 illustrates the Tip Cross Sectional Area (TCSA) ranges of bone points through time. The average TCSA of all bone points included in this study is 16.63 mm^2. With the exception of a small portion of the LSA sample, all bone point ranges fall below the average TCSA attributed to hypothetical stone arrowheads (see Shea 2006). The ranges of bone points overlap with each other through time. The mean values are highest in the MSA sample followed by the ethnographic collection and then the LSA sample.

Among the bone points studied in the various assemblages, a number of interesting pieces stand out. The first type of bone point worth highlighting is the deliberately snapped type as seen in the Fourie collection (Fig. 20) and in the Post-Wilton levels at Jubilee Shelter (Fig. 25). In both cases there are signs of shaping on the fracture surface indicating that they were snapped intentionally during manufacture. The bone point from Jubilee has additional circular scratch marks just below the break. I believe that such intentional breaks may indicate the facilitation of attachment of a metal arrow tip, such as is known to have been the case in ethnographic times

(Wanless 2007; Bosc-Zanardo *et al.* 2008). If this is the case, it provides a convenient proxy with which to establish a relative date.

The second interesting fact is the presence of polish on some bone points. As discussed in Chapter 4, polish can develop on bone in a variety of ways and through a number of activities. In the Fourie collection most of the polishing occurred on link-shafts. At Blombos Cave, polish was one of the diagnostic criteria for bone points, and used to differentiate them from ‘awls’. In the case of link-shafts in the Fourie collection, one possibility to account for their polish is that they were the part of the arrow that was most handled. The bone point, which was covered in poison, was seldom touched by the hunters for fear of contacting the poison (Wanless 2007). The hunters would, therefore, only have handled the link-shaft. The link-shaft was never inverted like the bone point was, but was kept exposed at all times. It is also unlikely that a bone point intended to hold poison would be polished, as the more highly polished bone is the less likely poison is to adhere to its surface.

In the case of the polished bone points from Blombos Cave, d’Errico and Henshilwood (2007: 143) argue that ‘the high polish on these points has no apparent functional cause; rather, it seems to have been produced to give a distinctive appearance – an “added value” – to these artefacts’. The polish on these points, as well as on some specimens from Bushman Rock Shelter, does indeed seem deliberate as it looks different from the use-wear polish that develops on ‘awls’ and ‘needles’. However, further use-wear studies need to be conducted on these pieces to establish whether the polish on the ‘awls’ and ‘needles’ is the result of use, and whether the polish on ethnographic link-shafts is the result of handling. Thus, I tentatively suggest that, if the three polished bone points from Blombos Cave were used as hunting weapons, they may have been intended to be used without the accompaniment of poison.

A further observation that was made during the course of the analysis was the apparent absence of mastic traces along the length of the bone points. The hypothesis put forward by Clark (1967) and Lombard and Parsons (2008) – that stone segments may have been used as inserts along the length of bone tipped arrows – cannot yet, on the basis of this study, be sustained. Further studies that take into account a larger sample of bone points may, however, still yield positive results for mastic traces. It should be mentioned, though, that one would not necessarily expect to find mastic traces on the bone points, given the tendency in ethnographic examples to use twine or sinew instead.

Finally, in order for a bone point to function well as an arrow, or even as a thrown spear, it must be as straight as possible (Collier's Encyclopaedia 1967; also see Miller *et al.* 1986; Noli 1993). Any curvature of the arrow-shaft or bone point would result in deflection of the arrow upon release from the bow. The curvature of the bone point from Klasies (Fig. 44) is therefore surprising and may indicate that it was not used as an arrowhead.

6.10. Concluding summary

Based on the morphometric analysis of 234 bone points from nine sites across South Africa I would like to single out three main findings:

- There appears to be a reduction in overall metric values of bone points across the landscape. Bone points at the coast are generally larger than bone points in the interior. This pattern is mainly visible in the LSA sample, but also in the MSA sample, with the exception of Peers Cave which does not conform to this pattern. Caution is, however, advised as the MSA sample is still small with few sites represented.
- There appears to be a decrease in the width (circumference) of bone points over time as metric values are higher in the older samples and lower in the

younger ones as previously noticed by Backwell *et al.* (2008). This is only noticeable at the level of ages, i.e. from ethnographic sample to LSA samples to MSA samples, and is not noticeable within the MSA, LSA or ethnographic samples.

- Although I included TCSA values in this study based on Shea's (2006) application to stone points, such values have subsequently been shown to be unconvincing functional indicators (e.g. Lombard & Phillipson 2010; Sisk & Shea 2009). Here I use them mainly as a morphometric attribute, following Lombard and colleagues (2010). However, my study shows that they fail to take into account the cylindrical nature of the bone points, and that larger bone points are naturally going to have higher TCSA values. Therefore, except for relating to size and shape, I caution against functional interpretations based on such values obtained for pointed bone artefacts unless substantiated by explicit functional studies (see Lombard & Phillipson 2010; Sisk & Shea 2009).

CHAPTER 7

MACRO-FRACTURE RESULTS OF BONE POINTS AND OTHER POINTED BONE TOOLS FROM ETHNOGRAPHIC AND ARCHAEOLOGICAL SAMPLES

7.1. Introduction

In this chapter I present and discuss the results of the macro-fracture analysis of bone points from the Fourie ethnographic collection and the archaeological sites from MSA and LSA contexts which have been introduced in Chapter 3. The macro-fracture types and frequencies on bone points are compared with macro-fractures on awls, link-shafts, spears and needles. I then compare the results of the macro-fracture analyses from the different sites and contexts.

Each section is organised as follows: first, I discuss the occurrence of fracture types – what fractures occur and how frequently; secondly, the provenance of fractures on the bone points, looking at the proportion of proximal and distal fracture occurrences; next, the presence of inverse fractures in the assemblages, if applicable; and finally, the occurrence of fracture combinations is discussed; which fracture types occur in combination with other fracture types, and their frequency.

7.2. The Fourie ethnographic collection

7.2.1. Results of the macro-fracture analysis

Table 1 presents the results of the macro-fracture analysis on the bone points and link-shafts in the Fourie collection. A total of 16 (15.4 %) of the 104 bone points exhibit macro-fractures. All but one of the six robust bone points (83.3 %) developed fractures. Only eleven (11.1 %) reversible points developed fractures. Altogether 40 fractures were recorded on the pointed bone tools (Table 31). Fourteen (35 %) of these fractures are DIFs (comprising spin-off fractures and step terminations as defined in Chapter 4). Relative to the number of tools in each category, robust bone points developed the highest frequency of DIFs. They were followed by reversible points and link-shafts.

During the analysis I found that in 60 % (n = 59) of cases where the bone point and link-shaft were present the link-shaft exhibited fractures whereas the bone point did not. Eleven link-shafts which showed signs of fractures, and whose associated bone points also had fractures, were included in this analysis. Their inclusion was justified as their morphology is similar to bone points, which suggests they could have functioned similarly. I did not include all the fractured link-shafts from the assemblage because I could not be sure that their fractures had developed as a result of use rather than post-collection handling – the white colour of the pieces made it difficult to distinguish fresh breaks from older ones.

Table 31. Results of macro-fracture analysis on bone points and link-shafts from the Fourie collection. Percentages are of the total number of fractures per category.

	Robust points n = 5		**Reversible points n = 11**		**Link-shafts n = 11**	
	n	**%**	**n**	**%**	**n**	**%**
Snap fractures	1	9	3	21	1	7
Spin-off fractures	1	9	-	-	-	-
Step terminations	4	36	6	43	3	20
Hinge terminations	-	-	4	29	2	13
Feather terminations	2	18	-	-	3	20
Crushing	3	27	1	7	5	33
Notches	-	-	-	-	1	7
Total DIFs	**5**	**45**	**6**	**43**	**3**	**20**

Step termination fractures (33 %; n = 13) are the most common fracture type in this collection, followed by tip crushing (23 %; n = 9) and hinge terminations (15 %; n = 6). Only one (3 %) spin-off fracture was found on the sample and it was on a robust point. Link-shafts exhibit the highest number of fractures (38 %; n = 15) and fracture types. This is followed by reversible points (35 %; n = 14) and robust points (28 %; n = 11). However, robust points show the highest percentage of fractures relative to the number of points on which fractures are present, and it is expected that the robust point category would have dominated the fracture frequency category if the sample was the same as the other two. Robust points, despite their morphological similarity with link-shafts, exhibit DIFs of comparable frequencies to bone points used in my replication experiment (Chapter 5). The same is true of the reversible bone points.

Diagnostic impact fractures occur in their highest percentages on robust bone points (45 %; n = 5) followed by reversible bone points (43 %; n = 6) and link-shafts (20 %; n = 3). The only DIFs that are present on link-shafts are step terminations. They occur on three separate specimens. The question is how a fracture, considered diagnostic of impact use, can occur on a link-shaft. On impact, link-shafts are subject to the same forces as bone points when projected from a bow. When the point makes impact with a target it is forced back into the reed collar thereby making contact with the link-shaft. At the same time the force in the main shaft continues to act on the link-shaft forcing it forwards. It can therefore be expected, that after repeated use, the link-shaft would exhibit similar impact fractures to the bone points themselves. This interpretation is based on observations made on the Fourie link-shaft collection.

Table 32. The provenience of fractures on points and link-shafts from the Fourie collection.

	Distal		**Medial**		**Proximal**	
	n	**%**	**n**	**%**	**n**	**%**
Points	20	69	2	7	7	24
Link-shafts	4	33	-	-	8	67

Table 32 shows that, on average, 58 % (n = 24) of fractures occur on the distal part of the piece, whereas only 36 % (n = 15) occur on the proximal part. The data show that distal edge damage is more common on points whereas proximal edge damage is more common on link-shafts. All damage on the distal edge of the link-shafts consists of crushing. Hinge, step and feather termination fractures only occur on the proximal portion of link-shafts.

Three points and three link-shafts developed compound fractures (Table 33). Two of the points that had compound fractures were robust points. Interestingly, the combination of fractures is not the same on points as on link-shafts. In all cases but one, the combinations consist of one or more step termination fractures.

Table 33. Fracture combinations on bone points and link-shafts. Percentages are of total fracture combinations.

	Points		**Link-shafts**	
	n	**%**	**n**	**%**
Step + Spin-off	1	17		
Step + Snap	1	17		
Step + Hinge + Snap	1	17		
Step + Notch			1	17
Step + Hinge			1	17
Hinge + Feather			1	17

7.2.2. General observations

An interesting observation, made during analysis, was the identification of re-used bone points. Four points exhibit signs of post-fracture smoothing, indicating that they were probably re-used after the fracture had occurred. Examples are presented in Figures 53C; 54C and 55A.

Although only eleven link-shafts are included in this study, the link-shafts in the Fourie collection are the most fractured of all the pointed bone artefacts. Fractures are present on at least 75 % of link-shafts. I decided to only present the results of the eleven link-shafts that accompany the fractured bone points in order that the two might provide complementary information.

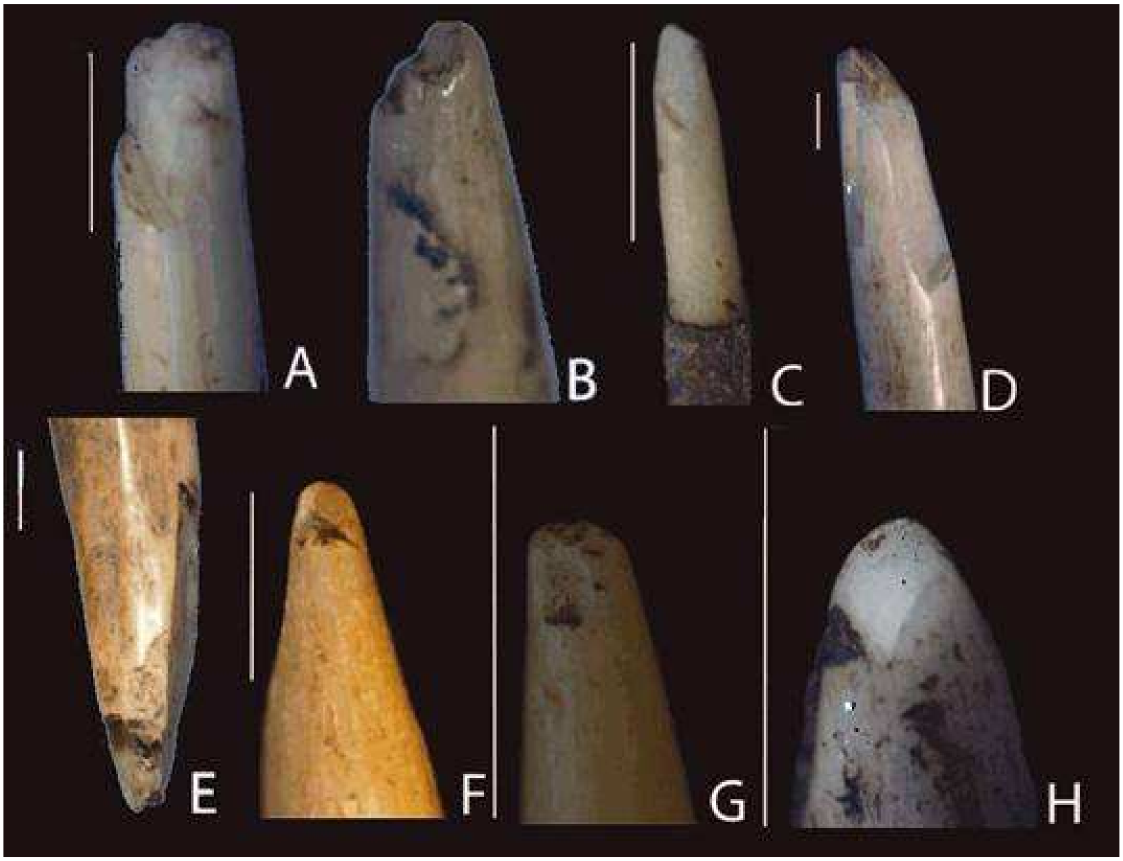

Figure 51. Examples of step termination fractures on bone points and link-shafts from the Fourie collection. A: (MA/40/69/91), the distal tip of a link-shaft, note the crushing at the tip; B: (MA/40/69/358), the distal tip of a bone point, note the parallel step terminations; C: (MA/40/69/402), the distal tip of a bone point with remnants of poison coating below the tip; D: (MA/40/69/777R), distal tip of a link-shaft with slight polish present; E: (MA/40/69/1072), proximal end of link-shaft with a long step termination and short hinge termination fractures present; F: (MA/40/69/2255), distal tip of steeply tapering link-shaft; G: (MA/40/69/2256), distal tip of robust bone point showing a step terminating spin-off fracture; H: (MA/40/69/2257),distal tip of a robust bone point, note the obtuse fracture angle. Scale is 5 mm.

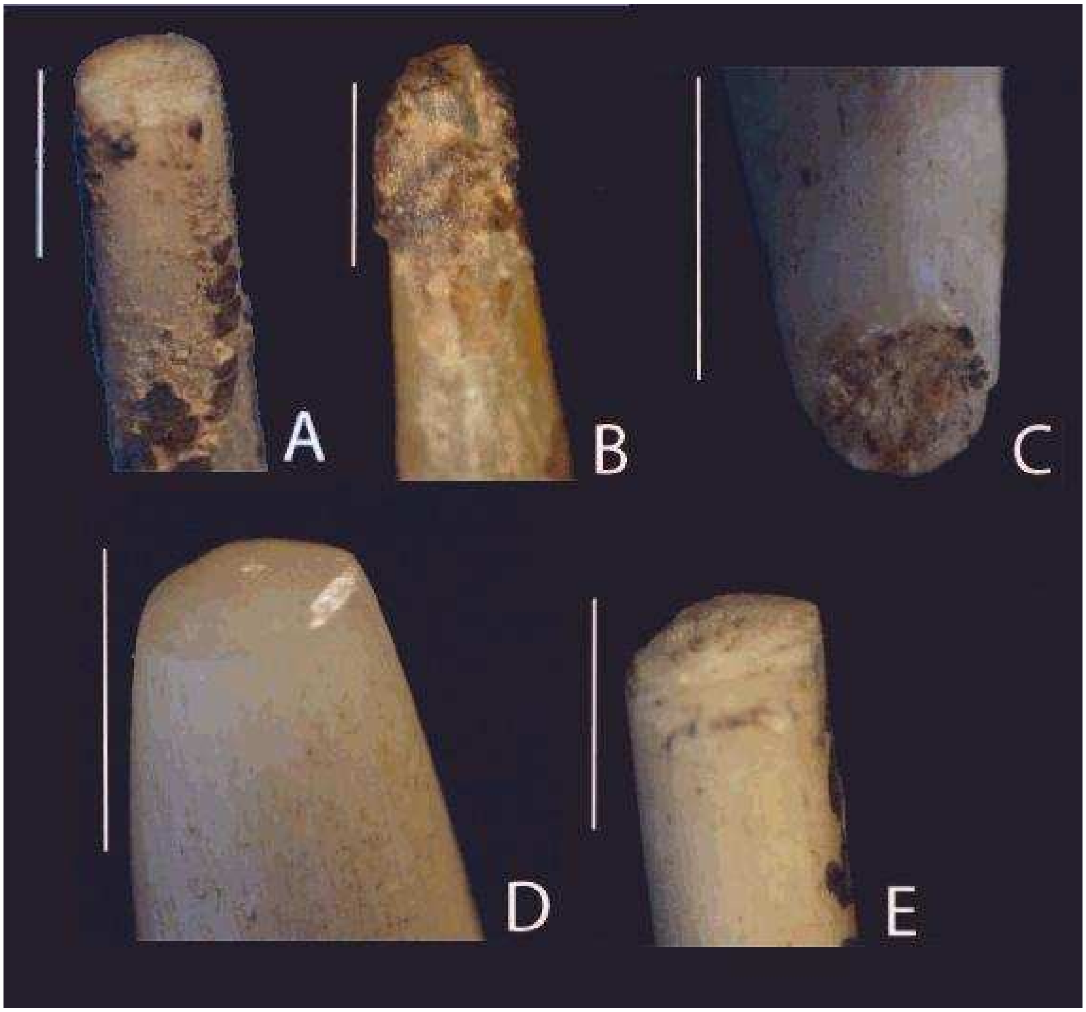

Figure 52. Examples of snap fractures on bone points and link-shafts from the Fourie collection. A: (MA/40/69/471), distal portion of bone point with remnants of poison; B: (MA/40/69/1072), distal portion of bone point surrounded by a coating of poison; C: (MA/40/69/2257), pitted base at proximal end of robust point; D: (MA/40/69/2258), deliberate snap at distal end of bone point, note the smooth facets around the snap; E: (MM/1/67/6004), distal end of bone point. Scale is 5 mm.

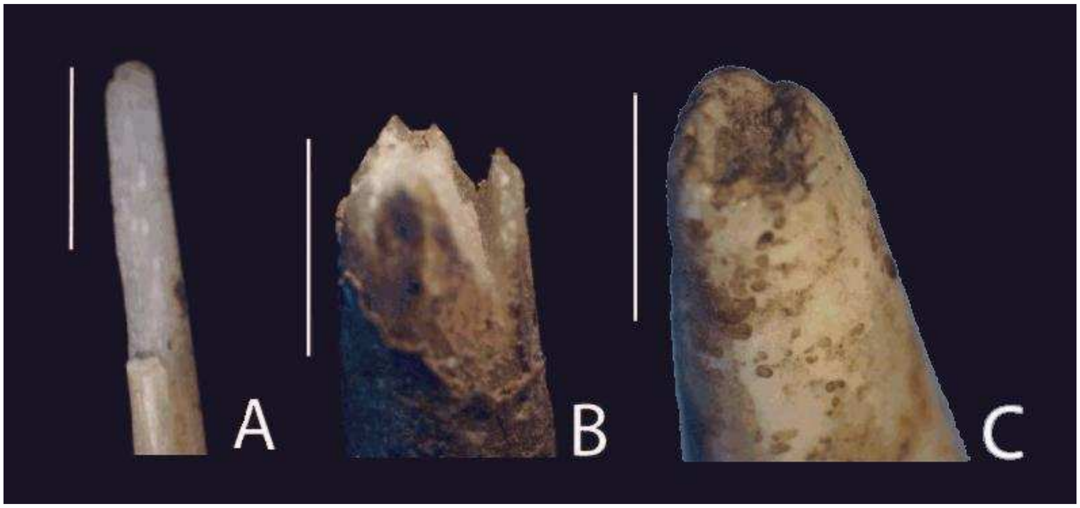

Figure 53. Examples of hinge termination fractures on the distal tips of bone points from the Fourie collection. A: (MA/40/69/627), the force of this fracture travelled almost 10 mm before terminating; B: (MA/40/69/671Y), a very complex angular fracture; C: (MM/1/67/6004), the dirt in this hinge termination causes it to resemble crushing. Scale is 5 mm.

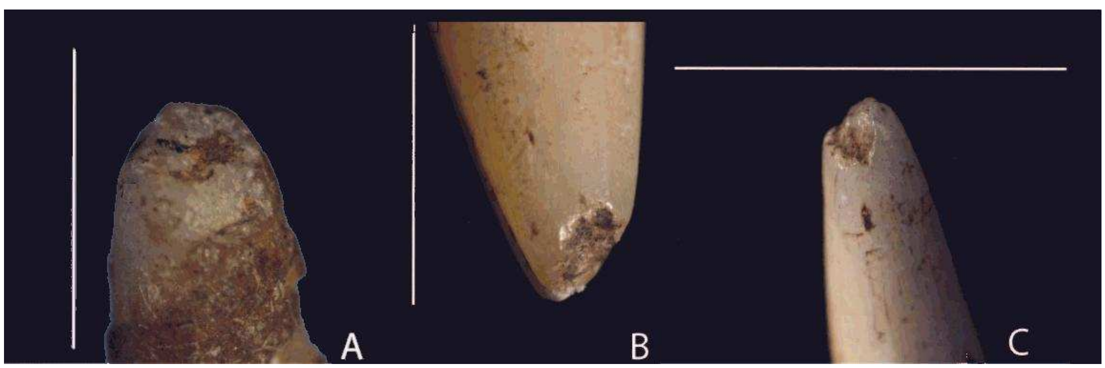

Figure 54. Examples of crushing on bone points and link-shafts from the Fourie collection. A: (MA/40/69/91), distal tip of bone point, note the poison coating; B: (MA/40/69/2258), crushed base of a link-shaft; C: (MA/40/69/2289), crushed distal tip of a robust point. Note it’s similarity with Figure 49C. Scale is 5 mm.

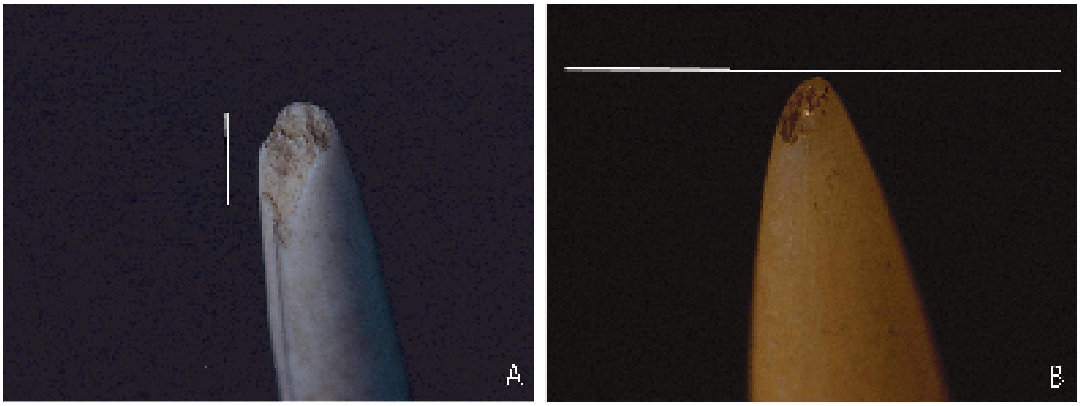

Figure 55. Two examples of feather termination fractures on the distal tips of bone points from the Fourie collection. A: (MA/40/69/415), note the tip crushing above the feather termination; B: (MA/40/69/2262), a ‘micro’ feather on the tip of this robust point. Scale is 5 mm.

7.3. Jubilee Shelter

As mentioned in Chapter 6, the Jubilee Shelter bone point assemblage is highly fragmented. For this reason macro-fractures are present on most of the pieces. There was no contextual information about whether these fractures occurred pre- or post-depositionally. Only pieces that retain the tip and/or the butt are included in the macro-fracture analysis. Shaft fragments are excluded because it is often difficult to tell in which direction the tip would have been, and because shaft fragments cannot unequivocally be assigned to bone points. They could have formed part of awls or needles.

Table 34. Number of fractures occurring on 31 bone points from Jubilee Shelter. Percentages are of total fractures.

	Bone points n = 31	
	n	**%**
Snap fractures	23	28
Spin-off fractures	17	21
Step terminations	15	13
Hinge terminations	10	19
Feather terminations	14	17
Crushing	2	3
Total DIFs	**32**	**40**

Table 34 shows the results for 31 bone points that were examined for macro-fractures. Eighty one fractures were recorded, of which 40 % (n = 32) can be considered diagnostic of longitudinal impact. Diagnostic impact fractures occur on 15 of the 31 bone points i.e. 48.4 %. This is higher than the 32 % obtained on the experimental sample of bone point arrows (Chapter 5). The two DIFs, step terminations and spin-off fractures, occur more often than any other fracture category save snap fractures. The most common termination associated with spin-off fractures are feather terminations (56 %; n = 9), followed by step terminations (31 %; n = 5) and hinge terminations (6 %; n = 1).

The majority (39.5 %; n = 32) of fractures occur on the distal extremity with only 24.7 % (n = 20) occurring on the proximal extremity (Table 35). The most commonly occurring fractures on the distal extremity are snap fractures and spin-off fractures followed by step terminations. This is noteworthy as step terminations and spin-off fractures are considered diagnostic of longitudinal impact on experimental stone hunting weapons (see Chapter 4) and would be expected on the distal portion of the point. Four spin-off fractures and one step termination are present, however, on the proximal extremity of two bone points.

Table 35. The provenience of fractures on bone points from Jubilee Shelter.

	Distal		Medial		Proximal	
	n	%	n	%	n	%
Jubilee bone points	32	39	30	37	20	24

Nine inverse fractures were identified on the Jubilee Shelter bone points just as were noticed on the experimental bone points. Inverse hinge and feather terminations both occur three times followed by spin-off fractures and step terminations. The significance of these inverse fractures will be discussed in the final section of this chapter.

Table 36. Various fracture combinations and their frequency on Jubilee Shelter bone points.

Types of fracture Combinations	Number and percentage of Fracture combinations	
	n	%
Multiple step terminations	2	9
Multiple spin-off fractures	4	18
Multiple feather terminations	2	9
Multiple hinge terminations	1	5
Hinge + Feather	1	5
Step + spin-off	3	14
Spin-off + feather	4	18
Snap + spin-off	2	9
Snap + spin-off + hinge	1	5
Snap + spin-off + feather	1	5
Step + spin-off + feather	1	5

A large number and wide variety of fracture combinations was noted on the Jubilee Shelter bone points (Table 36). Spin-off fractures are the most common fracture (73 %; n = 16) occurring in conjunction with another fracture type. This is not surprising as spin-off fractures occur as secondary fractures, whereas other fracture terminations can occur in the absence of spin-off fractures. The next most commonly occurring fractures, in conjunction with others, are the feather terminations (41 %; n = 9) followed by step terminations (27 %; n = 6), snap fractures (23 %; n = 5) and hinge terminations (14 %; n = 3). In all cases (18 %; n = 4) involving snap fractures, spin-off fractures seem to result. It would appear that the one gives rise to the other. This is worth further investigation as snap fractures are not considered diagnostic of longitudinal impact whereas spin-off fractures are.

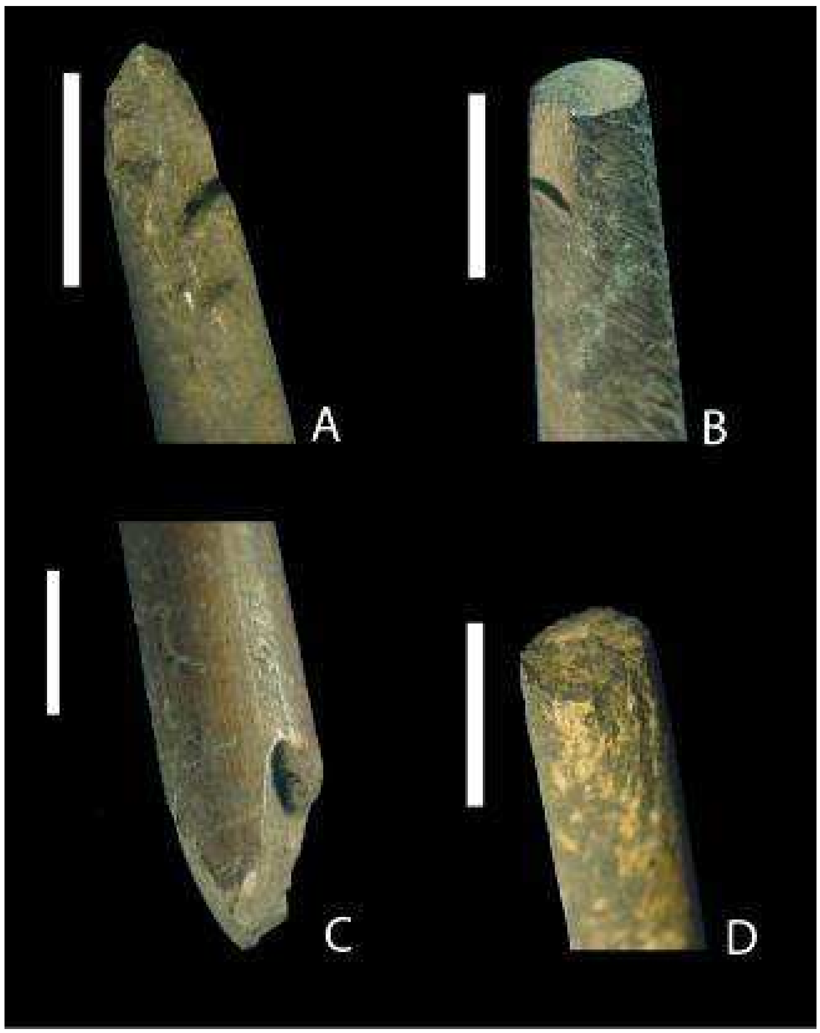

Figure 56. A selection of fracture terminations resulting from spin-off fractures from Jubilee Shelter. A: (Sue [2]), double step fracture on distal tip; B: (Colin B3 [2]), hinge termination spin-off fracture originating from a snap fracture on the distal portion; C: (Colin B3 [1]), proximal spin-off fracture resulting in a feather termination on left and hinge termination on right; D: (C2 D2 [2]), feather termination spin-off fracture resulting from a distal snap fracture. Scale is 5 mm.

7.4. Rose Cottage Cave

A total of 12 bone points and shaft fragments were analysed for macro-fractures. Altogether 27 macro-fractures were recorded, of which 12 (44 %) are DIFs. Although shaft fragments accrue the highest number of fractures (52 %; n = 14), they only dominate in two categories: that of snap fractures and fractures with step terminations. These two fracture types dominate in the assemblage overall.

Table 37. Results of the macro-fracture analysis on 12 bone points and shaft fragments from rose Cottage Cave. Percentages are of total fractures per category.

	Bone points (n = 6)		Shaft fragments (n = 6)	
	n	%	n	%
Snap fractures	3	27	5	36
Spin-off fractures	2	18	1	7
Step terminations	3	27	6	43
Hinge terminations	3	27	1	7
Feather terminations			1	7
Total DIFs	**5**	**45**	**7**	**50**

Table 38. Location of fractures on Rose Cottage Cave bone points and shaft fragments.

	Distal		Medial		Proximal	
	n	%	n	%	n	%
RCC bone points + fragments	11	38	10	35	8	28

The occurrence of fractures is fairly evenly distributed over the pieces (Table 38). The highest number of fractures (38 %; n = 11) was recorded on the distal extremity, followed by medial breaks (35 %; n = 10) and proximal breaks (28 %; n = 8). Seven (58.3 %) DIFs occur on the distal extremity.

A smaller variety of fracture combinations is evident on the RCC bone point sample than on the Jubilee Shelter sample. Nevertheless they are present. Five fracture combinations were observed (Table 39). They occur eight times, evenly distributed among bone points and shaft fragments. Step terminating spin-off fractures are most common on bone points, whereas snap and step combinations were more prevalent on the shaft fragments. Snap and step combinations are the only fracture combination that occurs on both bone points and shaft fragments. In one case involving a step termination on a shaft fragment, the fracture is recent. Therefore it could not have resulted from hunting.

Table 39. Types and number of fracture combinations at Rose Cottage Cave.

	Bone points (n = 6)		**Shaft fragments (n = 6)**	
	n	**%**	**n**	**%**
Multiple hinges	1	25	-	-
Multiple steps	-	-	1	25
Spin-off + step	2	50	-	-
Spin-off + snap	-	-	1	25
Snap + step	1	25	2	50

7.5. Nelson Bay Cave

A wide variety of pointed bone tools are present in the NBC collection. A total of 140 fractures were observed on 90 pointed bone tools. Table 40 presents the results of the macro-fracture analysis on all pointed bone tool classes. For the purposes of this study, as in the morphology chapter, I have divided the awls into two categories: regular awls and ambiguous points – pieces that were categorized as awls but which could easily have functioned as weapon tips.

Bone points are the most numerous of the pointed bone tools so it is not surprising that they accrued the most fractures (57 %; n = 80). Twenty-five (31 %) DIFs developed on the 42 bone points. Hinge terminations are the most common fracture occurring 38 times (27 %), and on all pointed bone categories. They are the most common fracture in each of the categories except ambiguous points in which step terminations occur most frequently. The only other fractures that developed on all pointed bone categories are snap fractures and step terminations. However, spin-off fractures, the other DIF, only occur on bone points and ambiguous points. Indeed, the DIF frequency is negligible on all classes except bone points and ambiguous points. This fact would seem to justify the separation of the ambiguous points from the awls.

Despite the relatively small samples, the frequency of DIFs, and indeed fractures in general, on hollow bone points and bone spears, seems low. Hollow points only developed five fractures, two of which are hinge terminations. The so-called bone spears developed 10 fractures, with hinge terminations (30 %; n = 3) again dominating. No spin-off fractures occur in either tool category. Only one step termination was identified in each category.

A similar distribution of fractures is found on awls. Hinge terminations are most prevalent; there are no spin-off fractures and only one step termination. The main difference between awls, hollow points and spears is the relatively high frequency of snap fractures on awls. Based on the results of this macro-fracture analysis it would appear that the hollow points, spears and awls from NBC were mostly not used for hunting; and that bone points and ambiguous points probably were regularly incorporated in impact or hunting tools.

Based on the results below, I have combined the ambiguous points with the bone points, as it appears they could both have functioned as components in hunting tools. The result is a total of 58 bone points that could have possibly functioned as projectile tips. On these 58 bone points 28 fractures (24 %) developed on the proximal extremity. The 28 fractures occur on 13 specimens. Of the 58 bone points 69 fractures (59 %) developed on the distal extremity (Table 41). Eighteen bone points had no fractures on the distal extremity. Twenty seven DIFs developed on the distal extremities compared to nine DIFs on the proximal extremities. The percentages and location of these fractures are not unexpected on projectile points (Chapter 4).

Table 40. Results of the macro-fracture analysis on the pointed bone tools from Nelson Bay cave.

	Bone points (n = 42)		Hollow points (n = 5)		Ambiguous points (n = 16)		Awls (n = 12)		Spears (n = 7)		Gorges (n = 8)	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Snap fractures	9	11	1	20	9	33	4	36	2	20	3	43
Spin-off fractures	13	16	0	0	1	4	0	0	0	0	0	0
Step terminations	12	15	1	20	10	37	1	9	1	10	1	14
Hinge terminations	22	28	2	40	4	15	4	36	3	30	3	43
Feather terminations	22	28	0	0	3	11	2	18	1	10	0	0
Crushing	2	3	1	20	0	0	0	0	3	30	0	0
Total DIFs	**25**	**31**	**1**	**20**	**11**	**41**	**1**	**9**	**1**	**10**	**1**	**14**

Table 41 shows that the distal extremity developed the most fractures on all types of pointed bone tools. It appears that the main difference between bone points and other pointed bone tools is the relative percentage of fractures on the proximal extremity. The higher relative percentage of fractures on the proximal extremity of bone points may be due to different hafting methods for spears. Certainly, awls were not hafted. Another possibility that is not explored in this study is that tools classified as spears may have had a completely different function.

Table 41. Provenience of fractures on Nelson Bay Cave bone points, awls and spears.

	Distal		**Medial**		**Proximal**	
	n	**%**	**n**	**%**	**n**	**%**
NBC bone points (n = 58)	69	59	20	17	28	24
NBC Awls (n = 12)	9	69	4	31	0	0
NBC spears (n = 7)	9	56	4	67	3	19

Inverse fractures are present on 35 bone points. Only seven among the other pointed bone tools developed inverse fractures. These other bone points include hollow points and spears. No inverse fractures were identified on awls or fish gorges. As discussed in Chapter 5, inverse fractures are appear more likely to occur on tools that have been hafted. The occurrence of inverse fractures on the NBC pointed bone tools seems to validate this conclusion. Inverse hinge terminations are the most common among bone points, occurring 18 times on 16 points. Next are feather terminating inversions occurring 11 times on seven points, followed by seven step terminating fractures on seven points and six spin-off fractures on five points.

Sixteen different fracture combinations were identified on the bone points – now including the ambiguous points (Table 42). Snap fractures are the most prevalent, occurring on six points. Multiple feather terminations and combinations of spin-off, hinge and feather terminations are each present on five points. The most common termination resulting from a spin-off fracture is the feather termination.

Table 42. Compound fractures occurring on bone points at Nelson Bay Cave.

Type of fracture combination	Points with combinations	
	n	%
Multiple spin-off fractures	3	9
Multiple step terminations	3	9
Multiple hinge terminations	2	6
Multiple feather terminations	5	15
Snap + step	1	3
Snap + hinge	2	6
Snap + feather	1	3
Spin-off + feather	2	6
Snap + spin-off + feather	1	3
Step + hinge	2	6
Hinge + feather	1	3
Step + feather	3	9
Snap + spin-off + step	1	3
Spin-off + hinge + feather	5	15
Step + hinge + feather	1	3
Snap + Spin-off + hinge + feather	1	3

7.6. Bushman Rock Shelter

A total of 16 pointed bone artefacts underwent a macro-fracture analysis. These 16 pointed bone artefacts comprise 13 bone points, 10 from LSA and three from possible MSA levels, one matting needle and two awls (Table 43). Altogether, 49 fractures were present on the pointed bone tools. Thirty-seven fractures accrued on bone points, of which six (16 %) are DIFs. Four fractures occur on the matting needles, two (50 %) of which are DIFs whilst the two awls accrued eight fractures of which four (50 %) are DIFs.

Hinge termination fractures dominate the fracture category and occur in their highest number (32 %; n = 12) in the bone point categories. They do, however, only occur once in the other two categories. The next most common fracture type is the spin-off fracture. Spin-off fractures occur 11 times (30 %) on all pointed bone tool categories and dominate the fractures on awls. Spin-off fractures are followed by feather terminations (27 %; n = 10), snap fractures (24 %; n = 9), notches (11 %; n = 4) and finally step terminations and crushing, each of which occur once (3 %).What is immediately apparent, when looking at Table 43, is the near absence of step termination fractures. There is only one example of a step termination in the whole assemblage and it occurs on an awl. Also surprising is the number of DIFs, relative to the amount of tools, which occur on the matting needle and awls. The significance of this is discussed in the final section of this chapter.

Given the small sample of possible MSA bone points there does not seem to be much difference between them and the LSA bone points. Hinge terminations dominate in both categories. These are followed by snap fractures, feather terminations and spin-off fractures albeit in different orders in the two categories. Notches only occur on the LSA bone points whilst crushing occurs once only on the possible MSA bone points. It is uncertain at this stage what this signifies, if anything.

Table 43. Macro-fracture results of 16 pointed bone tools from Bushman Rock Shelter.

	LSA points (n = 10)		**MSA points (n = 3)**		**Matting needle (n = 1)**		**Awls (n = 2)**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Snap fractures	6	22	2	20	0	0	1	13
Spin-off fractures	5	19	1	10	2	50	3	38
Step terminations	0	0	0	0	0	0	1	13
Hinge terminations	8	30	4	40	0	0	1	13
Feather terminations	4	15	2	20	2	50	2	25
Crushing	0	0	1	10	0	0	0	0
Notches	4	15	0	0	0	0	0	0
DIFs	**5**	**19**	**1**	**10**	**2**	**50**	**4**	**50**

Table 44. Provenience of fractures on Bushman Rock Shelter bone points, needle and awls.

	Distal		Medial		Proximal	
	n	**%**	**n**	**%**	**n**	**%**
Bone points	14	39	14	39	8	22
Matting needle	4	100	0	0	0	0
Awls	7	88	1	13	0	0

Table 44 presents the provenience of fracture on the three pointed bone tool categories. For this purpose I have combined the LSA and MSA bone points. In all cases the majority of fractures occur on the distal portion of the piece. The one possible exception is the bone point category which has an equal number of fractures medially as at the distal extremity. Interestingly, proximal fractures only occur on the bone points.

Six inverse fractures were recorded. They were present only on the LSA bone points and did not occur on possible MSA bone points or on the other pointed bone tools. As with sites that have been discussed previously, hinge terminations dominated the inverse fracture sample. Inverse hinge terminations occur four times followed by spin-off fractures and feather terminations each occurring once.

Eight fracture combination types developed on the pointed bone tools (Table 45). They are most prevalent on bone points, particularly LSA bone points. This, however, may be influenced by the relative sample sizes. Altogether 24 fracture combinations were recorded. The spin-off and feather termination is the most common fracture combination, occurring eight times (33 %) on all pointed bone tool categories. Except for the above mentioned fracture combination, awls developed different fracture combinations to bone points.

Table 45. Compound fractures occurring on pointed bone artefacts from Bushman Rock Shelter.

	LSA bone points		MSA bone points		Matting needle		Awls	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Multiple spin-off fractures	1	8	0	0	1	33	1	20
Multiple hinge terminations	2	17	1	25	0	0	0	0
Multiple feather terminations	1	8	0	0	1	33	0	0
Snap + step	0	0	0	0	0	0	1	20
Spin-off + feather	4	33	1	25	1	33	2	40
Hinge + feather	2	17	1	25	0	0	0	0
Step + feather	0	0	0	0	0	0	1	20
Spin-off + hinge + feather	2	17	1	25	0	0	0	0

7.7. Blombos Cave

In Chapter 6 I discussed the three types of pointed bone tools that have been identified at Blombos Cave, namely bone points, awls and spears. Morphometrically all three types are more akin to the robust points in the Fourie collection than to other similarly classified tools. The results of the macro-fracture analysis of BBC pointed bone tools are presented below in Tables 46 and 47.

A total of 35 fractures were recorded on 23 pointed bone tools. The majority (70 %; n = 16) of these fractures occur on proposed awls, but have their highest frequency, relative to the number of pieces they occur on, on proposed bone points. DIFs occur in their highest numbers on proposed bone points, accounting for four fractures on four points. Snap fractures and hinge terminations are the most frequently occurring fractures, each amounting to nine (26 %) fractures. These are followed by feather terminations (23 %; n = 8). Snap fractures and feather terminations are the only fracture types to occur on all pointed bone tool categories. Crushing and notches occur on two points in the proposed awl category. They are absent in the other two categories.

Table 46. Results of the macro-fracture analysis on pointed bone tools from Blombos Cave.

	Proposed bone points (n = 5)		**Proposed spears (n = 2)**		**Proposed awls (n = 16)**	
	n	**%**	**n**	**%**	**n**	**%**
Snap fractures	2	13	1	50	6	33
Spin-off fractures	2	13	0	0	0	0
Step terminations	2	13	0	0	2	11
Hinge terminations	4	27	0	0	5	28
Feather terminations	5	33	1	50	2	11
Crushing	0	0	0	0	1	56
Notches	0	0	0	0	2	11
Total DIFs	**4**	**27**	**0**	**0**	**2**	**11**

Snap fractures and feather terminations are the only fractures that are present on proposed spear points. The absence of DIFs and other fractures on the proposed spear points may be explained by the fact that there were only two specimens. Spin-off fractures are present on two proposed bone points and are not present in the other bone tool categories. The proposed bone point category is dominated by feather and hinge terminations whilst proposed awls are dominated by snap fractures and hinge terminations.

In terms of fracture location: 15 fractures were recorded on the proximal extremities whilst only 10 fractures were recorded on the distal extremities. This equates to three distal, two medial and nine proximal fractures on proposed bone points (Table 47). Sixty-six percent of inverse fractures occur on proposed bone points. All the fractures recorded on the proposed bone points (with the exception of the two step terminations, one snap fracture and one feather termination) are located on the proximal extremities.

Table 47. Provenience of fractures on proposed bone points from Blombos Cave.

	Distal		Medial		Proximal	
	n	%	n	%	n	%
BBC proposed bone points	3	21	2	14	9	64

Figure 54 shows the macro-fractures that developed at the base of BBC 3 (SAM AA-8947). If, as hypothesised by d'Errico & Henshilwood (2007), the shaft fragment BBC 7 is part of the shaft of BBC 3 then these fractures are not located at the butt but on the distal portion of a medial break. Their orientation indicates that they are inverse fractures. Altogether 18 inverse fractures were recorded on the BBC pointed bone tools. The most prevalent are inverse hinge terminations (33 %; n = 6) and inverse feather terminations (28 %; n = 5).

Table 48. Compound fractures occurring on proposed bone points and awls from Blombos Cave.

	Proposed bone points		Proposed awls	
	n	%	n	%
Multiple hinge terminations	1	20	1	17
Multiple feather terminations			1	17
Multiple notches			1	17
Snap + feather			1	17
Snap + spin-off + feather	1	20		
Spin-off + hinge + feather	1	20		
Hinge + feather	1	20		
Hinge + step			1	17
Step + hinge + feather	1	20	1	17

Figure 57. Base of polished bone point BBC 3 (SAM AA 8947), showing two hinge termination fractures and a feather terminating spin-off fracture. Scale is 10 mm.

A variety of fracture combinations are present on the proposed bone points and awls (Table 48). Except for multiple hinge terminations, proposed points and proposed awls did not develop the same fracture combinations. Multiple hinge terminations are the only fracture to occur more than once. The proposed bone point category seems more prone to developing two or more different fracture combinations whereas proposed awls seem to develop multiples of the same fracture type or, at the most, combinations of two different fractures.

7.8. Sibudu, Klasies and Peers Caves

Considering the small number of bone points from these three sites I have decided to present the macro-fracture results of their bone points in one section. Unfortunately, as with the morphometric details I have had to rely on the illustration of the Peers Cave bone point in d'Errico & Henshilwood (2007) for the macro-fracture analysis of this piece. On this illustration (see Fig. 44: 156) it is possible to discern the proximal break but sufficient detail of the tip is lacking. Table 49 presents the results of the macro-fracture analysis on the bone points from these three sites.

Table 49. Results of the macro-fracture analysis of bone points from Sibudu, Klasies and Peers Caves.

	Sibudu (n = 1)		**Klasies (n = 1)**		**Peers (n = 2)**	
	n	**%**	**n**	**%**	**n**	**%**
Snap fractures	1	20	0	0	0	0
Spin-off fractures	1	20	0	0	1	25
Step terminations	1	20	0	0	1	25
Hinge terminations	1	20	2	100	1	25
Feather terminations	0	0	0	0	1	25
Crushing	1	20	0	0	0	0
Total DIFs	**2**	**40**	**0**	**0**	**2**	**50**

What stands out in the above table is the fractured nature of the Sibudu Cave bone point relative to the three pieces from the other two sites. The Sibudu Cave bone point has essentially developed three fracture locations. The piece has crushing at the tip, but no fracture *per se*. It is broken in half by a hinge terminating fracture, and the butt has a snap fracture, from which a step terminating spin-off fracture developed (Fig. 58). It is uncertain whether the piece extended beyond this proximal portion and if so how far. Three (75 %) of the four fractures on the Sibudu Cave bone point developed on the proximal extremity. The only noticeable damage on the distal extremity is tip crushing. The proximal spin-off fracture may indicate that this piece was hafted.

The solitary bone point from Klasies is relatively intact. The base of this piece terminates in two inverse shallow hinge termination fractures (Fig. 59). There is no other visible damage on this piece.

The two bone points from Peers Cave developed four fractures between them. The only visible damage to the cylindrical bone point is an inverse hinge termination on the proximal extremity (see Chapter 6: Fig. 45). This fracture is very similar to the medial break on the Sibudu Cave bone point and it is probable that the bone point from Peers Cave originally extended in length well beyond its current proximal position.

The other, flat pointed bone tool from Peers Cave, accessioned as Open Site 114 (Fig. 60) developed the most fractures (75 %; n = 3) of the two. The tip developed a step termination spin-off fracture, probably the most diagnostic impact fracture indicating longitudinal impact, and by implication, hunting activity. The other fracture is a small feather termination.

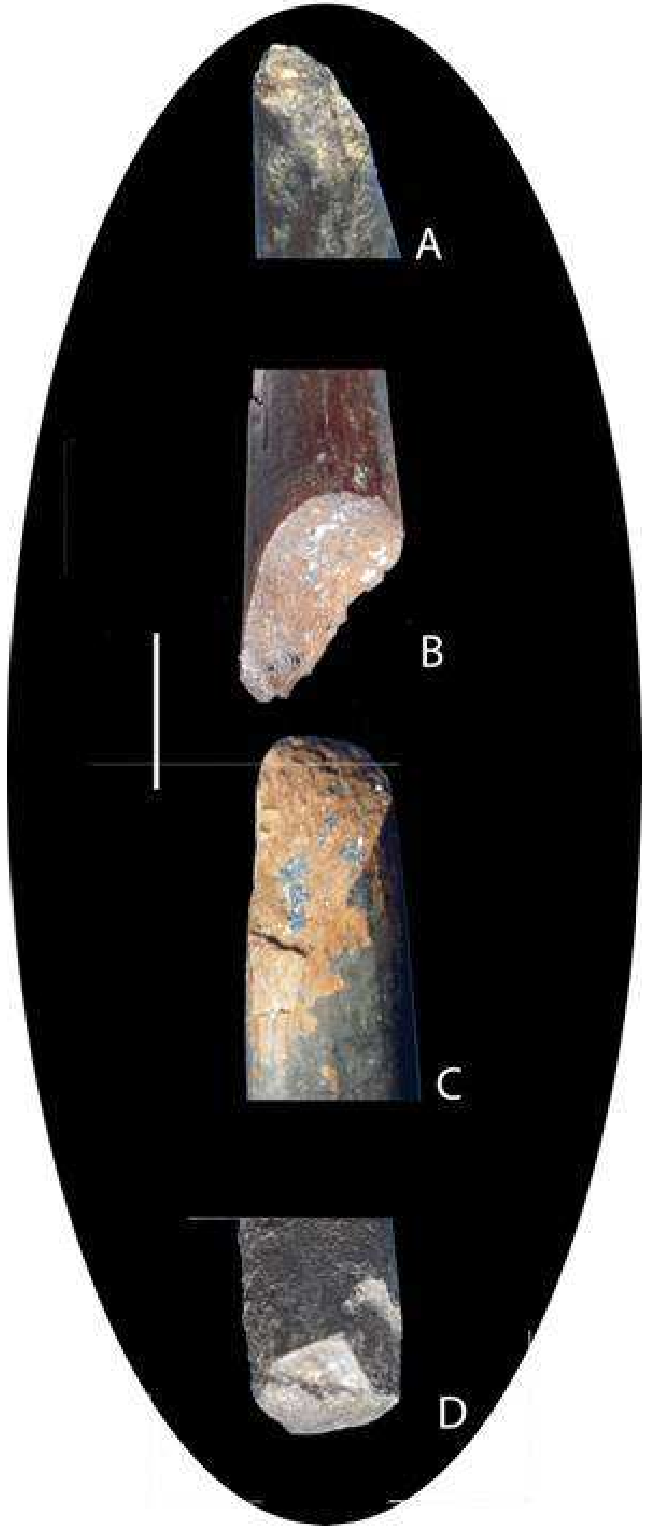

Figure 58. Macro-fractures at various points along the Sibudu Cave bone point. A: crushed tip; B & C: the distal and proximal portions of the hinge termination fracture that divides the piece in two; D: the butt showing the step termination spin-off fracture (circled) which developed from a snap fracture. Scale is 10 mm.

Figure 59. Double hinge terminations on the butt of the bone point from Klasies (SAM AA 42160). Scale is 10 mm.

Figure 60. Dorsal and ventral views of the flat pointed bone artefact from Peers Cave (Open Sites 114). Note the heavy root etching. Scale is 10 mm.

7.9. Discussion

Table 50 presents the collated results of macro-fracture analyses on bone points from the nine sites. Diagnostic impact fractures occur in their highest frequencies, relative to the number of points present, on bone points from Sibudu Cave and Jubilee Shelter. These are followed by Peers Cave and the robust bone points from the Fourie collection. It would appear, judging from the Fourie collection, that robust points are more likely to develop macro-fractures than slenderer points. However, this is not the case, as the Jubilee assemblage was morphometrically more similar to slender reversible points. The older age of the Jubilee assemblage, however, may mean that taphonomic factors have a greater role to play in the accrual of fractures.

The majority of fractures are located at the distal extremity (48 %; n = 153). This is followed by proximal breaks (27 %; n = 87) and medial breaks (23 %; n = 73). An interesting development is the location of fractures, specifically DIFs, over time. Table 51 shows that in the younger assemblages i.e. Fourie, Jubilee, RCC and NBC the majority of DIFs, and fractures in general, occur at the distal extremity. However, in the older assemblages, such as Klasies and the MSA sites, the majority of DIFs, and fractures in general, occur at the proximal extremity. It is poorly understood, at this stage, why this should be the case.

One possibility might be in the method of hafting or attachment to an arrow shaft. It is possible that in later times the bone points were more securely fixed to the main arrow-shaft whereas during the MSA there may have been more slack at the point of contact between the bone points and shafts. This would have caused a rebound effect on impact with a target resulting in the bone point being pushed back into the shaft, and fractures developing as a result. This would also have caused the arrow-shaft to split. Another possibility is that the main shafts were made from different materials. Ethnographically, we know that Bushmen used both hard-wood and thatch grass for their arrow shafts (Schapera 1927; Wanless 2007). The flimsier hollow thatch grass would presumably cause less resistance on impact, resulting in less severe fracturing at the butt of the point.

Table 50. Summary of fracture frequencies on bone points according to site. Rob. = robust bone points; Rev. = reversible bone points.

	Fourie collection				**Jubilee**		**RCC**		**NBC**	
	Rob. n = 5		**Rev. n = 11**		**n = 30**		**n = 6**		**n = 58**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Snap fractures	1	9	3	21	23	28	3	23	18	15
Spin-off fractures	1	9	-	-	17	21	2	15	14	12
Step terminations	4	36	6	43	15	19	3	23	32	27
Hinge terminations	-	-	4	29	10	12	3	23	26	22
Feather terminations	2	18	-	-	14	17	2	15	25	21
Crushing	3	27	1	7	2	2	-	-	2	2
Notches	-	-	-	-	-	-	-	-	-	-
Total DIFs	**5**	**45**	**6**	**43**	**32**	**40**	**5**	**38**	**46**	**39**

	BRS		**Klasies**		**Sibudu**		**Peers**		**BBC**	
	n = 13		**n = 1**		**n = 1**		**n = 2**		**n = 5**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Snap fractures	8	22	-	-	1	20	-	-	2	13
Spin-off fractures	6	16	-	-	1	20	1	25	2	13
Step terminations	-	-	-	-	1	20	1	25	2	13
Hinge terminations	12	32	2	100	1	20	1	25	4	27
Feather terminations	6	16	-	-	-	-	1	25	5	33
Crushing	1	3	-	-	1	20	-	-	-	-
Notches	4	11	-	-	-	-	-	-	-	-
Total DIFs	**6**	**16**	**0**	**0**	**2**	**40**	**2**	**50**	**4**	**27**

Table 51. Summary of fracture locations on bone points.

	Distal		Medial		Proximal	
	n	**%**	**n**	**%**	**n**	**%**
Fourie	20	69	2	7	7	24
Jubilee	32	39	30	37	20	24
RCC	11	38	10	34	8	28
NBC	69	59	20	17	28	24
BRS	14	39	14	39	8	22
Klasies	0	0	0	0	2	100
Sibudu	1	20	1	20	3	60
Peers	3	75	0	0	1	25
BBC	3	21	2	14	9	64

This brings me to the presence and formation of inverse fractures and fracture terminations. We have already seen that fractures can develop on the proximal portion of the bone points and continue towards the distal extremity i.e. in the opposite direction to that normally described for macro-fracture formation (*cf.* Chapters 4 & 5). Altogether 92 inverse fractures were recorded on bone points from all the sites. The majority (41 %; n = 38) come from NBC followed by Jubilee Shelter (35 %; n = 32). Inverse fractures are dominated by hinge terminations (36 %; n = 33) followed by feather (25 %; n = 23) and step (23 %; n = 21) terminations.

The Fourie collection, which is by far the largest bone point sample, only developed three inverse fractures; one hinge termination and two step terminations. Their associated link-shafts however developed seven inverse fractures. These are dominated by feather terminations. One reason to account for these inverse fractures may be the method of hafting. As discussed above, if the point is not securely hafted to the arrow shaft on impact with the target, energy in the arrow shaft will cause it to act as a secondary source of impact. This may explain the higher number of proximal inverse fractures on link-shafts as opposed to bone points in the Fourie collection.

In Tables 52 and 53 I have divided the macro-fractures from all the sites according to cultural complex and age, as far as this can be determined. At certain sites, like BRS, no specific industry is given for the bone points and so Table 53 summarises the number of fractures per age. Wilton assemblages have the highest number of fractures (26 %; n = 59) followed by Oakhurst/Albany (23 %; n = 53) and Post-Wilton (24 %; n = 55). Howieson's Poort assemblages have the least number of fractures (2 %; n = 5). Diagnostic impact fractures are present in their highest numbers in the Oakhurst/Albany (27 %; n = 17) and decrease through time towards the ethnographic present (17 %; n = 11). From the Robberg to the Still Bay the number of DIFs increases, from one in the Robberg to four in the Still Bay, but remains considerably less than in the upper levels. The macro fracture results from this study, however, cannot be used to support the hypothesis that bone points from the Robberg were not used as hunting weapons (Wadley 1987a, 1989, 1993; Mitchell 2002). Larger numbers of bone points from the Robberg industry are needed to make any functional interpretations of these points valid.

Hinge terminations are the most common fracture type, occurring a total of 50 times (23 %). These are followed by feather terminations, step terminations, snap fractures and spin-off fractures respectively. All levels are dominated by hinge terminations with the notable exceptions of the Oakhurst/Albany, which is dominated by feather terminations, and the ethnographic levels in which step terminations dominate.

Twenty-three separate types of fracture combinations were recorded on bone points from the different assemblages (Table 54). The majority (70 %; n = 16) of these fracture combinations occur on bone points from NBC. Most common type of fracture combinations are multiple feather terminations and multiple spin-off fractures, both occurring seven times (30 %). However, these combinations are only present on the Jubilee and NBC samples. Multiple hinge terminations are the most common across sites as they occur at five of the eight sites. The Fourie collection only developed three (13 %) compound fractures which is unexpected, given the number of bone points that are present in this sample.

Table 52. Frequency of bone point macro-fractures from the different age levels. Only bone points from samples of known industrial association are represented here. Percentages are of fracture types.

	Snap fractures		Spin-off fractures		Step terminations	
	n	**%**	**n**	**%**	**n**	**%**
Ethnographic	4	12	1	3	10	29
Post-Wilton	11	32	11	38	1	3
Wilton	7	21	5	17	11	32
Oakhurst/Albany	9	26	9	31	8	24
Robberg	0	0	0	0	1	3
Howieson's Poort	1	3	1	3	1	3
Still Bay	2	6	2	7	2	6

	Hinge terminations		Feather terminations		Crushing		DIFs	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Ethnographic	4	9	2	5	4	8	11	17
Post-Wilton	12	28	8	20	12	24	12	19
Wilton	12	28	12	30	12	24	16	25
Oakhurst/Albany	7	16	13	33	7	14	17	27
Robberg	14	33	0	0	14	28	1	2
Howieson's Poort	1	2	0	0	1	2	2	3
Still Bay	4	9	5	13	0	0	4	6

Table 53. Summary of fracture frequency on bone points according to age.

	Ethnographic n = 104		LSA n = 119		MSA n = 11	
	n	%	n	%	n	%
Snap fractures	4	16	50	21	5	15
Spin-off fractures	1	4	38	16	5	15
Step terminations	10	40	50	21	4	12
Hinge terminations	4	16	49	20	10	29
Feather terminations	2	8	45	19	8	24
Crushing	4	16	4	2	2	6
Notches	0	0	4	2	0	0
Total DIFs	**11**	**44**	**88**	**37**	**9**	**26**

Spin-off fractures and step terminations are the most numerous fracture types occurring in conjunction with other fractures. They each occur 11 times. Snap fractures, hinge terminations and feather terminations each occur only 10 times. Snap fractures result in spin-off fractures 10 times. This combination occurs at five sites namely: Jubilee, NBC, Sibudu Cave, Peers Cave and BBC; but is most prevalent at Jubilee and NBC. The most common way in which a spin-off fracture terminates is in a feather termination (n = 5). This is closely followed by step and hinge terminations, both occurring four times.

An important factor to keep in mind when interpreting the significance of fracture frequencies on bone points, is the possibility that some fractures may have occurred as a result of activities other than hunting. The number of fractures represented on ethnographic bone points and LSA bone points seem very different, even though the number of bone points in each sample is similar. This may be for two reasons.

Table 54. Summary of compound fractures on bone points.

	Fourie	Jubilee	RCC	NBC	BRS	Klasies	Sibudu	Peers	BBC
Multiple spin-off fractures	-	4	-	3	1	-	-	-	-
Multiple step terminations	-	2	-	3	-	-	-	-	-
Multiple feather terminations	-	2	-	5	1	-	-	-	-
Multiple hinge terminations	-	1	1	2	3	1	-	-	1
Snap + spin-off	-	2	-	-	-	-	-	-	-
Snap + step	1	-	1	1	-	-	-	-	-
Snap + feather	-	-	-	1	-	-	-	-	-
Snap + hinge	-	-	-	2	-	-	-	-	-
Spin-off + step	1	3	2	-	-	-	-	-	-
Spin-off + feather	-	4	-	2	4	-	-	-	-
Step + feather	-	-	-	3	-	-	-	-	-
Step + hinge	-	-	-	2	-	-	-	-	-
Step + notch	-	-	-	-	-	-	-	-	-
Hinge + feather	-	1	-	1	2	-	-	-	1
Snap + spin-off + step	-	-	-	1	-	-	-	-	-
Snap + spin-off + feather	-	1	-	1	-	-	-	1	1
Snap + spin-off + hinge	-	1	-	-	-	-	-	-	-
Snap + step + hinge	1	-	-	-	-	-	-	-	-
Spin-off + step + feather	-	1	-	-	-	-	-	-	-
Spin-off + hinge + feather	-	-	-	5	2	-	-	-	1
Step + hinge + feather	-	-	-	1	-	-	-	-	1
Snap + spin-off + step + hinge	-	-	-	-	-	-	1	-	
Snap + spin-off + hinge + feather	-	-	-	1	-	-	-	-	-

First, the nature of an ethnographic collection is essentially biased. Collectors were usually after the most “pristine”, intact specimens. For this reason Dr Louis Fourie may have purposely not collected bone tipped arrows that had been damaged due to hunting. Secondly, the nature of post-depositional fracturing of bone points and of fracturing due to different activities is still poorly understood (see Chapter 4). It is possible that the highly fractured nature of the LSA bone point sample may be the result of factors that have not been tested in this study. An avenue for future research would be to explore how bone points fracture as a result of post-depositional factors such as trampling.

Coupled with this problem is the presence of recently formed DIFs and other macro-fractures on bone points. Rose Cottage Cave is a case in point where a recently formed (post-excavation) step termination was recorded on one of the bone points. This fact would seem to indicate that macro-fractures, and even so-called DIFs, can occur on bone points as a result of forces or activities different from hunting or impact use.

Another aspect which could potentially prove problematic for studies such as this one is the presence of DIFs on pointed bone artefacts other than bone points. In a few cases, most notably at BRS, DIFs occur on awls and matting needles. In most cases these DIFs are step terminations (e.g. BBC and NBC) but at BRS spin-off fractures are evident on the two awls and one matting needle. Further studies are needed to determine why DIFs occur on these tools, but I would suggest here that the reason may lie in the nature of DIF formation. Diagnostic impact fractures are meant to be diagnostic of longitudinal impact (Chapter 4). If an awl or needle were used in such a way that short bursts of force were applied to the tip of the piece down its long axis (for example jabbing at a piece of leather), then spin-off fractures and step terminations would be expected. What is important is the number of times these fractures occur on awls and needles relative to the number of times they occur on bone points. In all samples included in this study, DIFs are most frequently represented on bone points (36 %; n = 108) and occur infrequently on other types of pointed bone tools (16 %; n = 13).

The question of whether macro-fracture analysis is a useful method for identifying bone points used for hunting weapons remains to be addressed. I suggest that it is. Although macro-fractures and DIFs are present on all categories of pointed bone artefacts, they are most highly represented on bone points. With the exception of BRS, spin-off fractures seem to be the most diagnostic fracture type because at all other sites they occur only on bone points.

In the next chapter I compare the results of the macro-fracture analysis of the experimental bone points and the archaeological specimens. I also evaluate the comparability of my results with those obtained during stone tool studies.

CHAPTER 8

DISCUSSION & CONCLUSION

In this chapter I argue that macro-fractures develop similarly on bone tipped hunting weapons as on stone tipped hunting weapons, and that morphological and macro-fracture analyses can, and should, be used in conjunction with one another. Macro-fracture analysis cannot, at this stage, be used to definitively distinguish projectile from thrust weapons. Furthermore, additional experimental studies are needed to rule out the formation of DIFs in activities other than hunting. Finally, it is argued that there may be some degree of patterning in the overall dimensions of bone points across the landscape. The chapter begins by giving a summary of the pertinent results of the experiment and archaeological analyses. It then compares these results to results obtained on experimental stone tipped hunting weapons. Finally, it deals with some conclusions drawn from this study.

8.1. Summary results of the experiment

The hunting experiment (Chapter 5) involved the use of 28 replicated bone points. These bone point replicas were used to tip arrows and spears that were mechanically projected and hand-thrust into an impala carcass in order to simulate the two hunting techniques. Of these replica bone points, 15 developed 32 macro-fractures. The thrust spears developed a lower fracture frequency, relative to the number of specimens used, than arrows.

The macro-fracture results obtained during the hunting experiment can be considered an approximation of the types and frequency of fractures likely to develop on bone tipped weapons in real-life hunting scenarios. Although the several uncontrolled variables in the experiment undoubtedly affected the penetrative efficacy of the experimental weapons adversely, it is not known to what extent they affected the types of fractures that would develop under normal hunting circumstances. My method of hafting the bone point replicas to the arrow-shaft using insulation tape may also have affected penetration, although, Fischer *et al*. (1984) explicitly state that the method of hafting does not affect fracture types. My experiment, therefore, did show that macro-fractures develop similarly on bone points as on stone points that have been subject to longitudinal impact.

Hinge terminations were the most common fracture type occurring on bone points used as arrows, whilst step terminations were the most common fracture type on bone points that were thrust. Multiple step terminations and multiple hinge terminations were the most common compound fractures that developed on the experimental bone points in both delivery modes. Spin-off fractures occurred only twice on the arrow points and were absent on the thrust spear points. Impact burinations, considered diagnostic of longitudinal impact in stone tool studies, were absent on all cylindrical bone points. Similarly, no snap fractures were recorded on flat bone points whereas one was recorded on a cylindrical point. Snap fractures are also common on archaeological cylindrical bone points. These findings seem to indicate that certain shapes promote the occurrence of certain fractures. This is an important point to keep in mind when conducting macro-fracture analyses on unknown samples.

8.2. Summary results of the morphometric and macro-fracture analyses on archaeological pointed bone tools

In Chapters 6 and 7 I presented the results of my examination of 234 bone points from eight archaeological sites, and one ethnographic collection of bone arrowheads and link-shafts from various hunter-gatherer groups in northern Namibia. The sample included four sites with bone points of LSA association, three sites with bone points of MSA association, one ethnographic collection of Bushmen arrows, and one site with bone points from both LSA and putative MSA levels. The bone points were measured and examined for macro-fractures. Of the total bone points examined, 146 (62 %) developed fractures. Altogether 299 fractures were identified on the 146 fractured bone points. In addition, four other types of pointed bone tools, totalling 69 specimens, were examined. Of these additional pointed bone tools – which included awls, spears, needles and link-shafts – 81 fractures were recorded (Table 55). Diagnostic impact fractures occurred on 36 % (n = 108) of the fractured bone points as opposed to 16 % (n = 13) of the other pointed bone tools.

Hinge terminations are the most common fracture type occurring on the archaeological bone points. They dominate in all assemblages except in the Albany (*c.* 12 – 9 ka) at Nelson Bay Cave, in which feather terminations dominate, and in the Fourie ethnographic collection in which step terminations dominate. Fractures are usually concentrated on the distal portion of the points except on the MSA bone points where the fractures are equally distributed over the distal and proximal portions.

There are many combinations of fractures occurring on the bone points. Combination fractures are most common on the highly fragmented assemblages like Jubilee Shelter and Rose Cottage Cave. On the Fourie collection only three compound fractures are discernable. Fracture combinations include up to four fracture types on some pieces. Feather terminating spin-off fractures are the most commonly occurring compound fracture on the archaeological sample, followed by multiple hinge terminations, multiple feather terminations, multiple spin-off fractures and combinations of all three. Spin-off fractures and step terminations are the most common fractures occurring in combination, both with themselves and with other fracture types.

Of the two DIFs that can occur on cylindrical bone points, step terminations were the most common on the experimental and Fourie samples. This is seemingly indicative that step termination fractures are more diagnostic of longitudinal impact than spin-off fractures, when it comes to bone-tipped weapons. However, the presence of a step termination, of recent formation, on a bone point from Rose Cottage Cave (Chapter 7:

178) coupled with the complete absence of recent spin-off fractures, may indicate the contrary.

Table 55 presents the collated results of macro-fractures on the various pointed bone tool categories that have been examined in the previous chapters. The two DIFs, spin-off fractures and step terminations, do not only occur on bone points. Where they do occur on other pointed bone tools, however, they are in negligible frequencies. However, the fact that they are present on other pointed bone tools would seem to indicate that the mere presence of these so-called DIFs is not enough to tell whether a bone tool was used for hunting or as a domestic tool. DIFs result from any longitudinal impact. Hunting is an activity in which longitudinal impact regularly results, but it is not the only such activity. This must be borne in mind when examining pointed bone tools from archaeological assemblages. That said, the five spin-off fractures occurring on awls and needles, came from the Bushman Rock Shelter collection only. At no other site were spin-off fractures present on pointed bone tools other than bone points.

Table 55. Collated table showing the amount of fractures occurring on the different pointed bone tools from all sites.

	Points (n = 146)		**Awls (n = 30)**		**Spears (n = 9)**		**Link-shafts (n =**		**Needles (n = 1)**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Snap fractures	59	20	11	30	3	25	14	50	-	-
Spin-off fractures	44	15	3	8	-	-	-	-	2	50
Step terminations	64	21	4	11	1	8	3	11	-	-
Hinge terminations	63	21	10	27	3	25	2	7	-	-
Feather terminations	55	18	6	16	2	17	3	11	2	50
Crushing	10	3	1	3	3	25	5	18	-	-
Notches	4	1	2	5	-	-	1	4	-	-
DIFs	**108**	**36**	**7**	**19**	**1**	**8**	**3**	**11**	**2**	**50**

In Chapter 6 I showed that during the LSA there appears to be a slight overall size reduction of bone points from the coast to the interior. A similar observation has been made with regard to San and LSA bone points of the south-western Cape which seem to increase in thickness farther North (Smith & Poeggenpoel 1988). Also, bone points from coastal sites are generally more intact than bone points from inland sites. It is unclear, whether this is a real phenomenon or merely a product of selected site sampling. Further studies are needed which take into account a larger selection of sites in order to test the validity of the size differential among bone points across the landscape.

As for the relative intactness of bone points at coastal sites, I suggest that this may be due to the nature of the deposit in which they were buried. At the coast the sand in usually less compact, with larger air spaces between particles, than soil away from the coast. This may provide a cushioning effect on artefacts buried in the sand (see Martin 1999).

The morphometric analysis has shown that the main differentiating factor between bone points and other pointed bone artefacts is at the butt and middle of the piece. The bone points from the Fourie collection had the same, or nearly the same, measurements at the middle as at the butt. The difference in the width, taken 3 cm from the tip and at the point of maximum thickness, is seldom greater than 0.4 mm. This is echoed in the bone points from Nelson Bay Cave, Bushman Rock Shelter, and Sibudu Cave. However, the fact that the difference between these two measurement points on Blombos Cave awls and spears is only 0.6 mm, the same as for the Klasies River bone point, and that the Peers Cave talus point has a difference of 0.9 mm, seems to indicate that these measurements are not appropriate for assigning functional properties to bone tools. I suggest, rather, that the degree of modification be taken as a more telling sign of whether a tool was meant to function as an arrow. Ethnographic bone arrow points have a more uniform degree of modification than awls, spears, link-shafts and needles.

Figure 48 (Chapter 6), however, shows that although the MSA measurements are higher than either the ethnographic or LSA measurements, there is some degree of overlap in the lower end of the MSA ranges with the upper ranges of the ethnographic and LSA samples. Also, on both the MSA and LSA samples the bone points continue to increase after the mid-point, whereas in the ethnographic sample none of the specimens do. Finally, the thickness range in the LSA sample is less than in either the ethnographic or MSA samples. In other words, regardless of the larger geographical area from which the LSA sample was collected and the time periods to which the points belong, they appear more standardised than the bone points from the MSA and ethnographic samples.

TCSA measurements were shown to be unconvincing functional indicators on bone as well as stone (Lombard & Phillipson 2010; Sisk & Shea 2009). TCSA measurements cannot take into account the diverse nature of cylindrical objects. Furthermore, the range of arrow TCSAs, as defined by Shea (2006), encompasses all other weapon categories, namely, dart tips and small spears. This suggests that macro-fractures could be a more reliable indicator of tool use.

Table 56 shows that the mean width dimensions of bone points from all the sites, except BBC, fall within the range of bone arrow points from the Fourie collection. In all cases, the mean dimensions of the BBC bone points are larger than the Fourie means, and fall outside of the Fourie ranges (Chapter 6). However, in light of the similar macro-fracture results of the BBC bone points with bone points used in hunting (i.e. the Fourie and experimental samples), it would seem that the size difference may have more to do with age than function. Another possibility to account for this discrepancy, which I discussed in Chapter 7, page 194, is that the mode of delivery of these bone tools may have been different. This would account for the occurrence of macro-fractures farther from the tip than in most ethnographic and LSA examples that I have examined.

Table 56. Comparison of bone point mean widths from the different samples. This table is a condensed version of Table 29, Chapter 6: 154. Rev. = reversible; Rob. = robust.

	Diameter from tip		Diameter in centre	Max. diameter
	1 cm	3 cm		
Fourie Rev.	2.7	4.1	4.5	4.5
Fourie Rob.	4	6	6.7	6.4
Jubilee	-	-	4.1	4.1
RCC	-	-	4.7	4.7
NBC	3.4	4.7	4.6	5.1
BRS LSA	3.2	4.2	3.9	4.5
BRS MSA	2.8	-	4.5	5
Klasies	3	4.4	4	5
Sibudu	3.3	5.1	5.5	5.5
Peers Talus	3.9	5.9	5.9	6.8
Peers open site	3.5	6	5.7	6.1
BBC MSA	4.7	6.8	7.5	8.3

8.3. Comparison of experimental and archaeological results

Tables 57and 58 present the location of macro-fractures on the bone points from the various assemblages. Assemblages are lumped together per archaeological period. Distal fractures are the most common. These are followed, at least in the experimental and LSA samples, by medial and proximal fractures respectively. In the ethnographic and MSA samples proximal fractures occur more frequently than medial fractures.

On all samples DIFs are most common on the distal portion. The ethnographic and MSA samples have their second highest DIF frequency on the proximal portion, as opposed to the medial portion on the experimental and LSA samples. One reason proposed to account for this discrepancy, at least for the ethnographic sample, is the nature of its collection. It is arguable that an ethnographic collection is by nature biased towards intact specimens and may not accurately represent the uses for which these tools were intended.

The LSA and MSA samples represent the bone points with, spatially, the most evenly distributed fractures. The location of fractures on the experimental and ethnographic samples, however, favours the distal portion. The reason for the more widespread distribution of fractures on the LSA and MSA samples might have to do with post-depositional factors. Future studies should aim to address whether and what types of macro-fractures develop on bone points after deposition.

Table 57. Amount of fractures at different places along the length of the bone points from the different ages and experimental sample.

	EXP (n = 15)		Ethno. (n = 16)		LSA (n = 119)		MSA (n = 11)	
	n	%	n	%	n	%	n	%
Distal	15	56	20	69	112	46	14	42
Medial	7	26	2	7	69	28	5	15
Proximal	5	19	7	24	65	26	14	42

On both the experimental sample and the archaeological samples, hinge terminations are the most frequent fracture type on bone points. Although, no hinge terminations developed on the ethnographic robust bone points even though they were morphologically closer to the experimental bone point replicas. Thrust spears in the experimental sample favoured step terminations, whereas in the archaeological samples the so called spear points favoured snap fractures and hinge terminations. During the experiment, thrust bone points tended to develop fractures quicker than projected bone points, possibly indicating that bone-tipped spears have a shorter life expectancy than arrows.

Table 58. Percentages of various fracture types at cardinal locations on bone points from the different ages and experimental sample.

		EXP (n = 15)	Ethno. (n = 16)	LSA (n = 104)	MSA (n = 11)
Distal	**Snap fractures**	100	42.8	43.4	20
	Spin-off fractures	33.3	100	56.7	40
	Step terminations	62.5	90	52.4	75
	Hinge terminations	37.5	50	25	27.2
	Feather terminations	100	100	49	42.8
	DIFs	**54.5**	**90.9**	**54.4**	**55.5**
Medial	**Snap fractures**	0	28.6	32	40
	Spin-off fractures	66.6	0	16.2	20
	Step terminations	25	0	33.3	0
	Hinge terminations	50	25	54.5	9.1
	Feather terminations	0	0	17.6	14.2
	DIFs	**36.4**	**0**	**25.3**	**11.1**
Proximal	**Snap fractures**	0	38.6	24.5	40
	Spin-off fractures	0	0	27	40
	Step terminations	12.5	10	14..3	25
	Hinge terminations	12.5	25	20.4	63.6
	Feather terminations	0	0	33.3	42.8
	DIFs	**9.1**	**9.1**	**20.3**	**33.3**

8.4. A comparison of results with similar stone tool studies

It remains to be discussed how and to what extent my macro-fracture study compares with similar studies that have been conducted on stone points. The reader is referred back to Tables 13 and 15, Chapter 5, which present a comparison of recent studies conducted on experimental stone tipped hunting weapons. Table 59 presents a comparison of this study's collated archaeological macro-fracture analysis with a study of stone points from two MSA sites. Results obtained for assemblages from Blombos Cave and Sibudu Cave, provide a convenient comparison, as I have also analysed the bone points from these sites.

Table 15 presents the results for arrows and thrust spears. As can be seen from the Fischer *et al.* (1984) experiment, six (54 %) of their spears developed DIFs. In my own study, DIFs developed on two of the six spears (*i.e.* 33 %). In all studies spears accrue higher frequencies of DIFs than arrows. In the present study, however, DIFs developed on a much lower percentage of spears than in the Fischer and colleagues (1984) and Lombard and colleagues (2004) experiments. The smaller sample size of my spear category must, of course, be considered. All the DIFs in my spear category were step terminations; no spin-off fractures developed. It is not known at this stage whether this is a sample size issue, or whether spin-off fractures, on bone, might be more diagnostic of projectile activity. Using the relative percentage of DIF occurrences to differentiate between spears and arrows, however, is problematic. In the present study there is only a 5 % difference between spear and arrow values. Coupled with this is the much higher percentage of DIF occurrences on arrows in the Fischer *et al.* (1984) experiments.

Table 13 presents a comparison with a study of macro-fractures obtained on variously hafted stone segments. Only projectile weapons are considered in this table. The table presents the number of fractures per category and not the number of points exhibiting those fractures, as is the case in Table 15. Regardless of the smaller sample size in my study, a number of differences are noticeable. Hinge and feather terminations were the most commonly occurring fracture types in my study, followed by spin-off fractures and step terminations. In Pargeter's (2007) study, snap fractures were most common, after impact burinations (see Fig. 62 for an example), followed by spin-off fractures and hinge and feather terminations.

Although impact burinations were the most common fracture type in Pargeter's (2007) experiments, these fractures cannot occur on cylindrical objects like bone points. Therefore, my study showed a zero result for impact burinations. The fact that impact burinations cannot develop on bone points means that there is one less DIF type compared to stone tool studies. This may account for the lower overall frequency of DIFs in a bone point assemblage. Interestingly, impact burinations aside, Pargeter's (2007) and my study developed the same number of DIFs irrespective of sample size, suggesting that bone points are more likely to develop step terminations and spin-off fractures than stone tipped hunting weapons (*cf.* Frequencies in Table 13).

Table 59 presents a comparison with a macro-fracture analysis conducted on stone points associated with the Still Bay Industry from Blombos and Sibudu Cave. For the purposes of comparable sample sizes I have grouped the bone points from the various sites in my study into three broad archaeological periods. The table shows the number of fractures present per sample and not necessarily the number of specimens on which the fractures occur.

Apparent from the table is the higher number of fractures, specifically DIFs, on the bone points compared with the Still Bay stone points. The percentage of DIFs decreases on bone points further back in time, remaining consistently above the frequencies on the stone tools. In the stone tool study, DIFs are always below 20 %, even at Umhlatuzana which is included in Lombard's (2007) study. The most common fracture type on the Still Bay points from Blombos and Sibudu is the snap fracture. On bone points from the LSA and MSA the most frequent fracture types are hinge and feather terminations, whilst on the ethnographic bone points step terminations are the most frequent fracture type. The least common fracture type on the Still Bay stone points seems to be step terminations, whereas on bone points from the ethnographic and the LSA collections, spin-off fractures are the least common. On the MSA bone point sample snap fractures develop least often, closely followed by spin-off fractures and step terminations. In the stone tool study, DIFs seem to develop less frequently than other fracture types. This is not the case in the bone point study.

Table 59. Comparison with macro-fracture analysis conducted on archaeological stone points from the Still Bay contexts at Blombos Cave and Sibudu Cave.

	Lombard 2007				This study					
	BBC M1 (n = 115)		Sibudu (n = 22)		Fourie collection (n = 16)		LSA (n = 104)		MSA (n = 11)	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Snap fractures	52	45	9	41	4	16	50	21	5	15
Spin-off fractures	14	12	2	9	1	4	38	16	5	15
Step terminations	8	7	2	9	10	40	50	21	4	12
Hinge + Feather terminations	16	14	8	36	6	24	94	39	18	53
DIFs	**20**	**17**	**4**	**18**	**11**	**44**	**88**	**37**	**9**	**26**

Figures 61 and 62 provide a comparison of commonly occurring fractures on bone and stone tools. The principles of macro-fracture mechanics state that similar sets of fractures will develop on all brittle solids, including bone and stone, which have been subject to longitudinal impact (Hayden 1977; Lawn & Marshal 1977). These figures serve to highlight the similarity of fractures on the two materials, and are a validation of the use of a macro-fracture approach to the study of pointed bone tools.

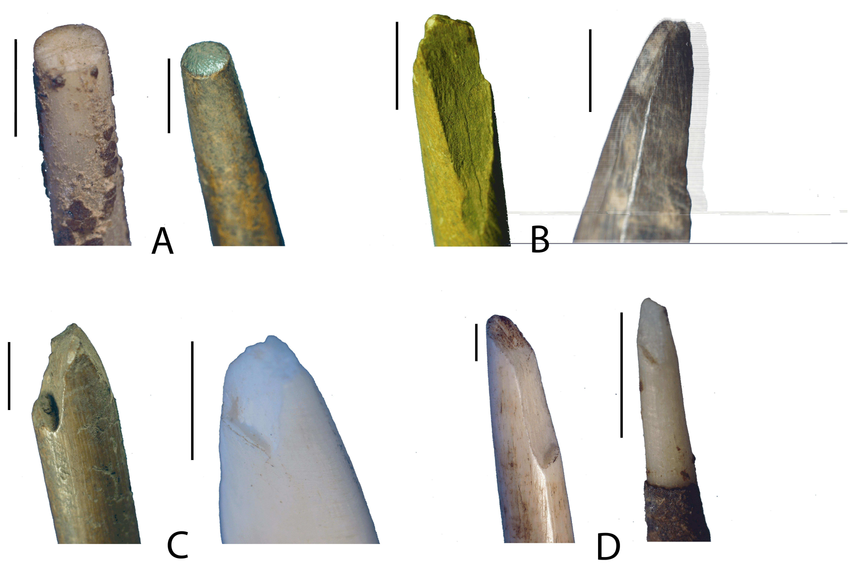

Figure 61 The four most common macro-fractures on bone points. A: snap fractures; B: feather terminations; C: hinge terminations; D: step fractures. Scale is 5 mm.

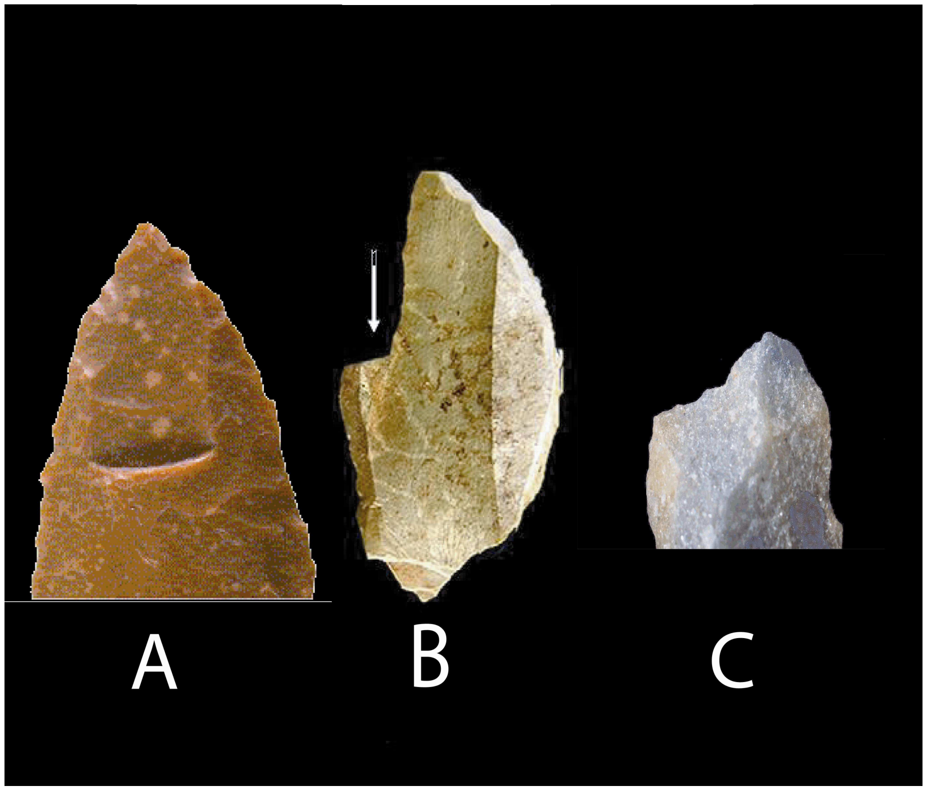

Figure 62. A selection of three fracture types on stone tools. A: Step termination, previously published in Villa *et al.* 2009; B: Impact burination, previously published in Lombard & Pargeter (2008); C: feather termination, provided by Justin Pargeter.

8.5. Conclusion

This study has shown that macro-fractures develop similarly on pointed bone tools as they do on stone tools when used for hunting purposes. Not only do the same types of fractures develop, but they develop in the same way. My experimental study has shown that certain shapes seem to promote the formation of certain fractures over others. For instance, on flat and irregularly shaped bone points, step terminations seem to accrue more easily as they are the dominant fracture type in these categories.

Cylindrical points on the other hand seem more prone to developing hinge terminations and spin-off fractures than flat or irregular bone points.

Although spin-off fractures are rare on flat and irregularly shaped bone tools they are present on a couple of bone points from Nelson Bay Cave and the Open Sites 114 bone point from Peers Cave. Certain fractures, like impact burinations, which occur frequently on stone hunting weapons, cannot occur on bone points due to their cylindrical shape. This means that there is one less DIF category on bone than on stone. It is important, therefore, when conducting a macro-fracture analysis, to bear in mind the overall morphology of the piece under examination.

Overall, spin-off fractures are present in higher frequencies on bone points than stone points. In stone tool studies, DIFs, and macro-fractures in general, occur in higher frequencies on experimental hunting weapons when compared with archaeological analyses (*cf.* Fischer *et al.* 1984; Lombard *et al.* 2004; Lombard 2007; Pargeter 2008; Yaroshevich *et al.* 2010). In the present study on bone points, however, the opposite is true. More macro-fractures are present on the archaeological samples than on the experimental hunting weapons. Without further experimental work it is unfortunately not possible to ascertain why this is the case. It is likely that post-depositional factors have a role to play.

Based only on the macro-fracture results of this study, it is difficult to distinguish bone points that were used as spears from those that were used as arrows. In my experiment, a higher percentage of DIFs developed on thrust spears than on arrows, even though the overall fracture frequency was lower on spears. Spin-off fractures were absent on spear points in both the experimental and archaeological samples. However, spin-off fractures were present on the awls and needle from Bushman Rock Shelter.

It is not known, at this stage, whether awls and needles, in general, develop spin-off fractures, as relatively few of these tools have been analysed in this study. So, until further studies with larger sample sizes can support this result, caution is advised when interpreting different functions based on macro-fractures alone. If, however, it is found that Bushman Rock Shelter represents an exception rather than a norm, then it would appear that spin-off fractures are the diagnostic fracture distinguishing hunting use – possibly even projectile use – from other functions.

This study has shown that bone points appear larger at the coast and decrease in size inland during the LSA. Further studies, however, are needed to test the validity of this pattern. In addition, future studies should examine bone points from coastal ethnographic collections to see whether they differ from those farther inland.

Finally, the results of the macro-fracture analyses from this study confirm the proposition that the bone points from the MSA levels underwent the same or similar activity to LSA and ethnographic bone points. The macro-fracture results match those of the experimental bone point arrows. This tentatively suggests that bone points in the MSA, as far back as *c.* 77 ka ago at Blombos Cave, were used as hunting weapons. Whether as spear or arrow tips remains to be explored.

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APPENDIX A

Table 1. Morphometric values of bone points from the Naron cultural group. TCSA values are in mm² and weight values are in g. All other measurements are in mm. The (~) sign indicates an approximate value.

Sample	Provenience		Diameter From Tip		Diameter in	Length	TCSA	Weight	Shape
			1 cm	3 cm	centre				
FC 1	MM/40/69/26		3	4.6	5.2	114.95	13.52	6.7	Cyl.
FC 2	MM/40/69/30		2.4	3.1	3.5	156.5	6.12	2.9	Cyl.
FC 5	MM/40/69/84		2.1	3.9	3.9	86.9	7.66	-	Cyl.
FC 6	MM/40/69/87		2.4	3.6	3.5	78.9	6.12	1.7	Cyl.
FC 7	MM/40/69/89		2.5	3.8	4.6	77.7	10.58	-	Cyl.
FC 8	MM/40/69/91		3	4.3	4.6	66.2	10.58	-	Cyl.
FC 9	MM/40/69/98		2.4	3.6	4.7	130.7	11.04	-	Cyl.
FC 32	MM/40/69/416		2.4	3.7	4.6	97.8	10.58	-	Cyl.
FC 34	MM/40/69/408		2.9	4.6	6	146	18	-	Cyl.
FC 35	MM/40/69/315		2.9	4.5	5.2	89.3	13.52	-	Cyl.
FC 39	MM/40/69/402		2.8	3.6	4	76.6	8	-	Cyl.
FC 40	MM/40/69/401		2.2	3.2	4.5	105.3	10.12	-	Cyl.
FC 41	MM/40/69/404		1.6	2.5	5.1	166.5	13	-	Cyl.
FC 43	MM/40/69/415		-	-	6.4	~85.4	20.48	3.2	Ellip.
		Mean	**2.5**	**3.8**	**4.7**	**99.5**	**11.38**	**3.6**	
		SD	**1**	**0.6**	**0.8**	**33.1**	**4.1**	**2.1**	
		Min.	**1.6**	**2.5**	**3.5**	**66.2**	**6.12**	**1.7**	
		Max.	**3**	**4.6**	**6.4**	**166.5**	**20.48**	**6.7**	

Table 2. Morphometric values of bone points from the ‡Ao-//Ein cultural group. TCSA values are in mm² and weight values are in g. All other measurements are in mm. The (~) sign indicates an approximate value.

Sample	Provenience	Diameter From Tip		Diameter in centre	Length	TCSA	Weight	Shape
		1 cm	3 cm	of piece				
FC 3	MM/40/69/31A	2.4	3.1	3.9	113.9	7.6	-	Cyl.
FC 4	MM/40/69/32	3	4.1	4.7	90.7	11.04	-	Cyl.
FC 10	MM/40/69/269	2.8	3.9	4.5	104.6	10.12	-	Cyl.
FC 16	MM/40/69/2256	3.7	5.8	6.9	110.5	23.8	4.9	Ellip.
FC 17	MM/40/69/2257	4.9	6.7	7.4	155.9	27.38	10.8	Cyl.
FC 19	MM/40/69/2259	3.9	6.2	6.2	88.8	19.22	3.5	Cyl.
FC 20	MM/40/69/2262	3.7	5.2	6.9	159	23.8	9.8	Cyl.
FC 21	MM/40/69/2263	2.8	4.6	5.5	127.9	15.12	4.6	Cyl.

FC 22	MM/40/69/2264		2.7	4.2	4.6	108.1	10.58	3.1	Cyl.
FC 23	MM/40/69/2266		2.2	4.4	4.8	91.4	11.52	3	Cyl.
FC 24	MM/40/69/2267		3.4	4.9	4.5	92.8	10.12	-	Cyl.
FC 25	MM/40/69/2268		3.1	4.8	6.4	102.6	20.48	4.3	Cyl.
FC 26	MM/40/69/2269		4.5	6.3	4.9/7.0	104.9	24.5	4.9	Ellip.
FC 42	MM/40/69/406		2.8	3.7	3.5	120.8	6.12	-	Cyl.
FC 45	MM/40/69/423		3	3.8	5	144.6	12.5	-	Cyl.
FC 46	MM/40/69/424		2.8	3.5	4.5	127.8	10.12	-	Cyl.
FC 47	MM/40/69/425		2.4	3.9	4.9	140.4	12	-	Cyl.
FC 49	MM/40/69/1072		2.7	3.9	4.9	125.4	12	-	Cyl.
FC 57	MM/40/69/479		2.5	4.2	4.5	85.7	10.12	-	Cyl.
FC 58	MM/40/69/1074		2.4	3.6	4	136.3	8	-	Cyl.
FC 59	MM/40/69/1075		2.1	3.3	4.5	129.1	10.12	-	Cyl.
FC 60	MM/40/69/25B		2.2	3.4	5.1	151	13	3.2	Cyl.
FC 61	MM/40/69/25C		2.6	3.9	4.6	122.2	10.58	-	Cyl.
FC 62	MM/40/69/25D		1.9	3.4	4.3	96.3	9.24	-	Cyl.
FC 63	MM/40/69/25E		2.4	3.7	4.1	79.9	8.4	-	Cyl.
FC 64	MM/40/69/25G		2	3.4	4.1	199.8	8.4	-	Cyl.
FC 66	MM/40/69/25I		2.4	3	4.4	162.8	9.68	-	Cyl.
FC 67	MM/40/69/25J		3.9	4.4	4.4	69.7	9.68	-	Cyl.
FC 69	MM/40/69/25L		2.3	3.5	4.6	142.7	10.58	-	Cyl.
FC 70	MM/40/69/25M		2.3	3.8	4.3	83.1	9.24	-	Cyl.
FC 78	MM/40/69/469		2.3	3.6	2.4	87.2	2.88	1.9	Cyl.
FC 79	MM/40/69/470		2.4	4.1	4.8	98.9	11.52	2.6	Cyl.
FC 80	MM/40/69/471		-	-	4.6	~191.6	10.58	5.1	Cyl.
FC 81	MM/40/69/472		2.5	3.8	4.7	101.2	11.04	-	Cyl.
FC 82	MM/40/69/473		2.4	3.8	4.6	99.7	10.58	-	Cyl.
FC 83	MM/40/69/474		2.5	3.8	4.4	95.9	9.68	-	Cyl.
FC 84	MM/40/69/475		2.6	4	5	92.7	12.5	-	Cyl.
FC 85	MM/40/69/476		2.3	3.7	4.9	151.2	12	-	Cyl.
		Mean	**2.8**	**4.1**	**4.8**	**116.1**	**12.59**	**4.7**	
		SD	**0.7**	**0.9**	**0.9**	**28.7**	**5.3**	**2.7**	
		Min.	**1.9**	**3.0**	**2.4**	**69.7**	**2.88**	**1.9**	
		Max.	**4.9**	**6.7**	**7.4**	**162.2**	**27.38**	**10.8**	

Table 3. Morphometric values of bone points from the Hei-//om cultural group. TCSA values are in mm² and weight values are in g. All other measurements are in mm.

Sample	Provenience		Diameter From Tip		Diameter in centre of piece	Length	TCSA	Weight	Shape
			1 cm	3 cm					
FC 11	MM/40/69/2072		3.1	4.6	5.4	119.6	14.58	4	Cyl.
FC 12	MM/40/69/2073		2.8	3.9	4.4	95.8	9.68	2.2	Cyl.
FC 13	MM/40/69/2075		2.6	3.3	4.2	117.4	8.82	2.8	Cyl.
FC 51	MM/40/69/630		2.5	3.3	4.1	126.9	8.4	-	Cyl.
FC 52	MM/40/69/1073		3.1	5	6	82.9	18	-	Cyl.
FC 54	MM/40/69/627		2.2	3.1	4	194.2	8	-	Cyl.
FC 55	MM/40/69/629		3	4.1	5.1	148	13	-	Cyl.
FC 56	MM/40/69/628		2.5	4.1	4.9	155.9	12	4.4	Cyl.
		Mean	**3.1**	**4.5**	**5.4**	**148.7**	**13.21**	**3.3**	
		SD	**0.3**	**0.7**	**0.7**	**35.4**	**3.5**	**1.0**	
		Min.	**2.2**	**3.1**	**4.0**	**82.9**	**8.00**	**2.2**	
		Max.	**3.1**	**5.0**	**6.0**	**194.2**	**14.58**	**4.4**	

Table 4. Morphometric values of bone points from the !Kung cultural group. TCSA values are in mm² and weight values are in g. All other measurements are in mm.

Sample	Provenience	Diameter From Tip		Diameter in centre of piece	Length	TCSA	Weight	Shape
		1 cm	3 cm					
FC 14	MM/40/69/2154	2.2	3.3	4.1	79.9	8.4	-	Cyl.
FC 31	MM/40/69/295	2.1	3.6	4.1	87.2	8.4	-	Cyl.
FC 33	MM/40/69/298	2	3.4	3.9	81.7	7.6	-	Cyl.
FC 36	MM/40/69/297	2.2	3.4	4.8	156.3	11.52	-	Cyl.
FC 38	MM/40/69/299	2.1	3.2	3.9	107.5	7.6	-	Cyl.
FC 50	MM/40/69/740	2.5	3.5	5.1	26.3	13	-	Cyl.
FC 53	MM/40/69/759	2.1	3.3	4.2	91.6	8.82	-	Cyl.
FC 72	MM/40/69/777C	2.7	3.1	4.3	106.3	9.24	2.2	Cyl.
FC 73	MM/40/69/777J	3.9	6	6.3	75.6	19.84	-	Cyl.
FC 74	MM/40/69/777Q	2.4	3.7	4.1	87.8	8.4	1.6	Cyl.
FC 75	MM/40/69/777R	2	3.4	4.1	108.6	8.4	-	Cyl.
FC 76	MM/40/69/777S	2.3	3.4	4.3	107.9	9.24	-	Cyl.
FC 77	MM/40/69/777T	2.1	3.4	4.1	121.1	8.4	2.5	Cyl.
FC 86	MM/40/69/671AJ	2.7	4	4	63.8	8	-	Cyl.
FC 87	MM/40/69/671H	2.2	3.3	4.3	131	9.24	-	Cyl.
FC 88	MM/40/69/671N	2.3	3.1	3.8	72.3	7.22	-	Cyl.
FC 89	MM/40/69/671V	2.5	3.7	4.8	87.4	11.52	-	Cyl.
FC 90	MM/40/69/671O	2.1	3.3	4.2	155.6	8.82	-	Cyl.
FC 91	MM/40/69/671G	2.1	3.1	4.3	105.5	9.24	-	Cyl.
FC 92	MM/40/69/671P	2.4	3.1	4.1	112.3	8.4	-	Cyl.

FC 93	MM/40/69/671L	2.7	3.9	4.3	84.6	9.24	-	Cyl.
FC 94	MM/40/69/671AL	2.6	3.1	4.5	172.3	10.12	-	Cyl.
FC 96	MM/40/69/671T	2.3	4.3	4.5	58.4	10.12	-	Cyl.
FC 97	MM/40/69/671D	2.7	4.2	4.3	84.4	9.24	-	Cyl.
FC 98	MM/40/69/671Q	3.3	4.2	4.4	75.3	8.8	-	Cyl.
FC 99	MM/40/69/671Y	-	-	4.1	-	8.4	-	Cyl.
FC 100	MM/40/69/671S	2.8	3.9	4.4	88.9	9.68	-	Cyl.
FC 101	MM/40/69/671AI	2	3.2	4.3	104.9	9.24	-	Cyl.
FC 102	MM/40/69/671K	2.8	4.4	4.4	65.8	9.68	-	Cyl.
FC 103	MM/40/69/671R	2.5	3.5	4.3	86	9.24	-	Cyl.
FC 104	MM/40/69/671C	2.8	3.9	4.7	79.6	11.04	-	Cyl.
FC 105	MM/40/69/671J	1.8	2.8	3.4	115.7	5.78	-	Cyl.
	Mean	**2.5**	**3.7**	**4.5**	**99.4**	**9.7**	**2.1**	
	SD	**0.4**	**0.6**	**0.5**	**30.1**	**2.3**	**0.5**	
	Min.	**1.8**	**2.8**	**3.4**	**58.4**	**5.78**	**1.6**	
	Max.	**3.9**	**6.0**	**6.3**	**172.3**	**19.84**	**2.5**	

Table 5. Morphometric values of bone points from the Hu//Ein cultural group. TCSA values are in mm² and weight values are in g. All other measurements are in mm.

Sample	**Provenience**	**Diameter From Tip**		**Centre**	**Length**	**TCSA**	**Weight**	**Shape**
		1 cm	**3 cm**					
FC 27	MM/40/69/358	-	-	-	-	-	-	Cyl.
FC 28	MM/40/69/357	-	-	-	-	-	-	Cyl.
FC 37	MM/40/69/384	2.1	3.7	4.2	130.3	8.82	-	Ellip.
FC 44	MM/40/69/410	3.7	5	5.6	80.7	15.68	-	Cyl.
	Mean	**2.9**	**4.4**	**4.9**	**105.5**	**12.3**	**-**	
	SD	**1.1**	**0.9**	**1.0**	**35.1**	**4.9**	**-**	

Table 6. Morphometric values of bone points from an unnamed Bushman group. TCSA values are in mm² and weight values are in g. All other measurements are in mm. The (~) sign indicates an approximate value.

Sample	**Provenience**	**Diameter From Tip**		**Centre**	**Length**	**TCSA**	**Weight**	**Shape**
		1 cm	**3 cm**					
FC 107	MM/1/67/600	-	-	5.3/7.1	~113.1	25.2	5.1	Ellip.
FC 108	MM/1/67/6004	-	-	4.9	~88.9	12	2.7	Ellip.
	Mean	**-**	**-**	**2.8**	**101**	**18.6**	**3.9**	
	SD	**-**	**-**	**1.5**	**17.1**	**9.3**	**1.7**	

Table 7. Naron arrow weights and lengths.

Sample	Provenience	weight (g)	Length (cm)
FC 32	MM/40/69/416	11.5	70.5
FC 34	MM/40/69/408	14.6	73
FC 35	MM/40/69/315	11.9	63.6
FC 39	MM/40/69/402	9.8	61.4
FC 40	MM/40/69/401	10.1	59.7
FC 41	MM/40/69/404	16.3	70.1
FC 43	MM/40/69/415	7.2	52.3
Mean		11.6	64.4

Table 8. ‡Ao-//Ein arrow weights and lengths

Sample	Provenience	weight (g)	Length (cm)
FC 42	MM/40/69/406	10.8	67.5
FC 45	MM/40/69/423	11.6	69
FC 46	MM/40/69/424	13.8	74.8
FC 47	MM/40/69/425	13.6	70.6
FC 48	MM/40/69/478	11.5	69.3
FC 49	MM/40/69/1072	12.3	63.6
FC 57	MM/40/69/479	8.7	55.9
FC 58	MM/40/69/1074	14.5	71.8
FC 59	MM/40/69/1075	10.6	62.4
FC 60	MM/40/69/25B	13	73.5
FC 61	MM/40/69/25C	13.5	71.5
FC 62	MM/40/69/25D	13.1	70.7
FC 63	MM/40/69/25E	9.8	58.6
FC 64	MM/40/69/25G	11.8	71.5
FC 65	MM/40/69/25H	14.3	71.5
FC 66	MM/40/69/25I	13.8	69
FC 67	MM/40/69/25J	10.9	65.7
FC 68	MM/40/69/25K	9.3	-
FC 69	MM/40/69/25L	12.7	73.6
FC 70	MM/40/69/25M	10.8	66.9
Mean		12.6	72.1

Table 9. Hei-//om arrow weights and lengths.

Sample	Provenience	weight (g)	Length (cm)
FC 51	MM/40/69/630	10.7	64.9
FC 52	MM/40/69/1073	11.3	60.9
FC 54	MM/40/69/627	16.1	77.4
FC 55	MM/40/69/629	14.2	60
FC 56	MM/40/69/628	13.3	73.8
Mean		13.1	67.4

Table 10. !Kung arrow weights and lengths.

Sample	Provenience	weight (g)	Length (cm)
FC 31	MM/40/69/295	9.5	59.3
FC 33	MM/40/69/298	10.9	65.4
FC 36	MM/40/69/297	12.1	63.6
FC 38	MM/40/69/299	9.9	65.1
FC 50	MM/40/69/740	8.9	65.5
FC 53	MM/40/69/759	11.4	65.1
FC 71	MM/40/69/777B	10.4	67.6
FC 72	MM/40/69/777C	10.9	65.7
FC 73	MM/40/69/777J	9.3	52.9
FC 74	MM/40/69/777Q	8.8	61.6
FC 75	MM/40/69/777R	10.4	70.1
FC 76	MM/40/69/777S	12.7	69.2
FC 77	MM/40/69/777T	10.7	74.2
FC 86	MM/40/69/671AJ	11.2	65
FC 87	MM/40/69/671H	10.6	66.1
FC 88	MM/40/69/671N	7.3	59
FC 89	MM/40/69/671V	9.8	-
FC 90	MM/40/69/671O	9.9	71.9
FC 91	MM/40/69/671G	10.4	66.8
FC 92	MM/40/69/671P	10.3	69.4
FC 93	MM/40/69/671L	11.4	68.9
FC 94	MM/40/69/671AL	11.8	60.2
FC 95	MM/40/69/671F	9.1	-
FC 96	MM/40/69/671T	8.9	63.6
FC 97	MM/40/69/671D	10.1	66.8
FC 98	MM/40/69/671Q	8.6	64.9
FC 99	MM/40/69/671Y	9.1	-
FC 100	MM/40/69/671S	10.6	62.4
FC 101	MM/40/69/671AI	10.7	63.6
FC 102	MM/40/69/671K	10.1	61.4

FC 103	MM/40/69/671R	8.2	66.2
FC 104	MM/40/69/671C	10.6	62.6
FC 105	MM/40/69/671J	10.3	70.2
FC 106	MM/40/69/671M	8.2	-
Mean		10.4	67.4

Table 11. Hu//Ein arrow weights and lengths.

Sample	**Provenience**	**weight (g)**	**Length (cm)**
FC 37	MM/40/69/384	16	77.6
FC 44	MM/40/69/410	11.6	64.3
Mean		13.8	70.9

APPENDIX B

Table 12. Morphometric values of bone points from the Robberg levels of NBC (n = 5). TCSA values are in mm² and weight values are in g. All other measurements are in mm.

No.	Provenience	Diameter From Tip		Diameter in centre	Max. diameter	Length	TCSA	Weight	Shape
		1 cm	**3 cm**						
NBC 2	NB 1/9	-	-	4.1	4.1	42.3	8.4	0.5	Cyl.
NBC 3	N/B1/3	3.2	4.3	4.3	4.7	59.9	9.24	0.8	Ellip.
NBC 4	N/B2/8	-	-	3.4	3.6	59	5.78	0.6	Cyl.
NBC 5	N 85/3	4.6	5.9	5.6	5.6	47.9	16.52	1.1	Cyl.
NBC 8	NB8/16	-	-	4.2	5	43.7	8.82	1.1	Cyl.
Mean		**3.9**	**5.1**	**4.3**	**4.6**	**50.56**	**9.75**	**0.8**	

Table 13. Morphometric results of bone points from the Albany levels at NBC (n = 11). TCSA values are in mm² and weight values are in g. All other measurements are in mm.

No.	Provenience	Diameter From Tip		Diameter in centre	Max. diameter	Length	TCSA	Weight	Shape
		1 cm	**3 cm**						
NBC 24	?/10	3	4.2	5.9	8	89.4	12.39	3.1	Ellip.
NBC 25	B3/13	-	-	-	-	53	-	1.7	Cyl.
NBC 26	B2/12	-	-	5.1	5.1	29	13	0.7	Ellip.
NBC 27	8/12צ	-	-	6.1	6.1	21	18.6	0.5	Cyl.
NBC 29	Δ5/10	3.2	4	4	4.5	68.9	8	1.4	Cyl.
NBC 30	B6/11/J	2.1	3.9	3.6	3.9	41.6	7.02	0.1	Flat
NBC 31	B2/13	-	-	4	4	31.9	8	0.7	Cyl.
NBC 32	Δ9/12	4.1	5.6	5.5	6.5	61	15.4	2	irreg.
NBC 33	B2/10	-	-	5.5	6	32.3	15.12	1.3	Cyl.
NBC 34	Δ4/10 [1]	3.9	-	5.4	6.5	30.9	14.58	0.6	irreg.
NBC 35	Δ4/10 [2]	2.8	-	3	3.5	19.4	4.5	0.2	Cyl.
Mean		**3.2**	**4.4**	**4.8**	**5.4**	**43.5**	**11.66**	**1.1**	

Table 14. Morphometric results of bone points from the Wilton levels at NBC (n = 26). TCSA values are in mm² and weight values are in g. All other measurements are in mm.

No.	Provenience	Diameter From Tip		Diameter in centre	Max. diameter	Length	TCSA	Weight	Shape
		1 cm	3 cm						
NBC 36	BT/9	5.6	5.9	5.8	6	67.6	16.82	3	Cyl.
NBC 37	NB5/9	2.5	3.6	3.4	4	47.6	6.12	0.6	Ellip.
NBC 38	Δ7/9	-	-	6.5	7	22	21.12	1.3	Cyl.
NBC 39	NB7/3	4.9	8.5	8.2	10.8	50	33.62	2.2	irreg.
NBC 40	NB5/3	-	-	5.2	6	31	13.52	0.9	Cyl.
NBC 41	B1/6	-	-	3.4	3.4	3.6	5.78	0.1	Cyl.
NBC 42	3/13ע	-	-	3.1	3.1	31.2	4.8	0.3	Cyl.
NBC 43	B8/14	5.9	-	6.2	6.2	19.6	19.22	0.6	Cyl.
NBC 44	Δ5/10	3	-	3.6	4.1	29	6.48	0.3	Ellip.
NBC 45	B8/13	2.6	4.6	3.8	5.2	39.2	7.22	0.6	Cyl.
NBC 54	Δ5/3	2.8	4	3.2	4	25	5.12	0.1	Cyl.
NBC 55	NBC 124-5	2.2	3.2	4.9	5.1	110.5	12	3.8	Cyl.
NBC 56	Burial 1	3	5	4.2	4.6	119.2	8.82	2.1	Cyl.
NBC 57	NBC 98 - 5	2.2	3.2	5.1	5.1	72	13	2	Cyl.
NBC 59	BIII Carmel	-	-	3.9	3.9	94	7.6	1.6	Cyl.
NBC 60	BII Bob	2.8	5	4.4	4.4	80.6	9.68	2.1	Cyl.
NBC 61	AII Clara	2.4	2.2	5.4	5.4	61.9	14.58	1.7	Cyl.
NBC 62	XO Betty	5.1	5.1	2.9	2.9	34.5	31.2	0.3	Cyl.
NBC 63	NBC 124-6	4.4	6.1	5.1	5.2	43.9	13	0.9	Flat
NBC 64	EIII a/1 [1]	2.3	3.8	5.8	6.8	37.5	17.69	1	Ellip.
NBC 65	NBC 61-3	2.5	4	3.9	4.1	51	7.6	0.8	Cyl.
NBC 66	CIII Edward	3	-	5	5	75.7	125	2	Cyl.
NBC 67	NBC 145-8	3.1	5.2	3.1	3.1	12	4.8	0	Cyl.
NBC 68	BII Edward	2.1	3.2	5.5	5.5	67	14.3	1.8	Ellip.
NBC 69	AIII David	3	4.8	3.4	3.9	99.1	5.78	1.8	Cyl.
NBC 70	NBC 125-7	3	-	5.2	6	83.4	12.48	1.3	Ellip.
	Mean	**3.2**	**4.5**	**4.8**	**5.2**	**56.3**	**17.49**	**1.3**	

Table 15. Morphometric values of hollow bone points from NBC (n = 5). TCSA values are in mm² and weight values are in g. All other measurements are in mm.

Sample	Provenience	Context	Diameter From Tip 1 cm	Diameter From Tip 3 cm	Diameter in centre	Max. diameter	Length	TCSA	Weight	Shape
NBC 1	DS/11	Robberg	3.5	4.5	5.1	5.1	99.6	13	1.6	Ellip.
NBC 71	NBC 71-3	Wilton	2.5	-	4.8	5.2	25.5	11.52	0.5	Ellip.
NBC 72	Y1 Brett/Bonnie	Wilton	2.6	4.1	3.3	3.9	26.1	5.44	0	Cyl.
NBC 73	Talus atop David	Wilton	2.5	4	4.5	4.6	74.5	10.12	1.1	Cyl.
NBC 74	AII Bert	Wilton	-	-	4.1	4.5	54.2	8.4	0.7	Ellip.
	Mean		**2.8**	**4.2**	**4.4**	**4.7**	**56**	**9.69**	**0.8**	
	SD		**0.5**	**0.3**	**0.7**	**0.5**	**31.9**	**2.92**	**0.6**	

Table 16. Morphometric values of ambiguous bone points from NBC (n = 16). These pointed bone tools were classified as ‘awls’ in the original excavation but could easily have functioned as bone points. TCSA values are in mm^2 and weight values are in g. All other measurements are in mm.

Sample	**Provenience**	**Context**	**Diameter From Tip**		**Diameter in centre**	**Max. diameter**	**Length**	**TCSA**	**Weight**	**Shape**
			1 cm	**3 cm**						
NBC 79	NBC 128-5	Wilton	-	-	5.6	9.2	77	15.68	3.5	irreg.
NBC 80	Y1 Cedric [1]	Wilton	-	-	6	6	61.2	18	0.9	Flat
NBC 81	AIII Jill	Wilton	-	-	6	6	45	18	0.9	irreg.
NBC 82	AII Bert [1]	Wilton	2.5	4.6	4.3	5	41	4.5	0.1	Flat
NBC 83	OX Betty	Wilton	3.3	4	4	5.5	66.9	4	0.7	Flat
NBC 84	NBC 132-6	Wilton	3	6	5.9	6	73.7	10.32	1.5	irreg.
NBC 85	E iv/1 [1]	Wilton	2	5.5	4	5	52	6	0.5	Ellip.
NBC 86	AII Bert [2]	Wilton	-	-	3.5	4.2	26.6	6.12	0.1	Ellip.
NBC 87	B - I Bob	Wilton	3.4	8	9.8	11.1	63	14.7	1.5	irreg.
NBC 88	D iv/3	Wilton	3.1	6.4	5.1	6	42	9.18	0.7	irreg.
NBC 89	CIII Bert	Wilton	2.9	4.4	4	4.5	39	3.8	0.4	Flat
NBC 90	Y1 Cedric [2]	Wilton	-	-	3.3	3.3	19.8	5.44	0	irreg.
NBC 91	NBC 120-7	Wilton	-	-	3.6	3.6	38	6.48	0.3	Flat
NBC 92	NBC 80-3	Wilton	3	4.5	4	7	54.1	8	1.3	irreg.
NBC 93	NBC 84-1	Wilton	-	-	5.5	5.5	49	15.12	0.4	irreg.
NBC 94	NBC 86-1	Wilton	-	-	6	6	58.1	18	1.5	irreg.
	Mean		**2.9**	**5.4**	**5**	**5.9**	**50.4**	**10.2**	**0.9**	
	SD		**0.5**	**1.3**	**1.6**	**2**	**16**	**5.45**	**0.9**	

Table 17. Morphometric values of bone ‘awls’ from NBC (n = 12). TCSA values are in mm² and weight values are in g. All other measurements are in mm.

Sample	Provenience	Context	Diameter From Tip		Diameter in centre	Max. diameter	Length	TCSA	Weight	Shape
			1 cm	**3 cm**						
NBC 6	N B5/3	Robberg	3.1	6	6	8.9	48.5	18	0.9	Flat
NBC 7	3/9צ	Robberg	1.6	4.1	3.4	7	48.1	5.78	0.6	irreg.
NBC 18	B2/10	Albany	-	-	3.4	5.1	42.1	5.78	0.2	Cyl.
NBC 19	9/12צ	Albany	-	-	5.7	17.1	62.6	16.24	2.6	Ellip.
NBC 20	Δ/12	Albany	-	-	3.5	6.7	49.1	6.12	0.7	Ellip.
NBC 21	Δ4/10	Albany	-	-	6.2	17	44.6	19.22	3	Ellip.
NBC 22	B6/10	Albany	-	-	4.9	9.5	95	12	1.6	Ellip.
NBC 23	ΔA4/10	Albany	-	-	3.9	7.6	45	7.6	0.7	irreg.
NBC 49	5/10צ	Wilton	1.9	4.5	4.2	8.5	55.2	9.45	0.5	irreg.
NBC 50	8/18צ	Wilton	-	-	5.6	15.5	-	15.68	1.4	irreg.
NBC 95	E iv/1 [2]	Wilton	-	-	2	7.6	45	2	0.1	irreg.
NBC 96	E iv/1 [3]	Wilton	-	-	2.2	3	41.5	2.42	0	irreg.
	Mean		**2.2**	**4.9**	**4.2**	**9.4**	**48**	**10.02**	**1**	
	SD		**0.8**	**1.0**	**1.4**	**4.6**	**15.4**	**6.04**	**1.0**	

Table 18. Morphometric values of bone ‘spears’ from NBC (n = 7). TCSA values are in mm² and weight values are in g. All other measurements are in mm.

Sample	Provenience	Context	Diameter From Tip		Diameter in centre	Max. diameter	Length	TCSA	Weight	Shape
			1 cm	**3 cm**						
NBC 14	Δ3/12	Albany	6	-	8	10	34.9	32	1.6	Ellip.
NBC 15	7/14צ	Albany	5.8	10	9.2	11.1	46	46	1.9	Ellip.
NBC 16	B6/13	Albany	9.9	10	10.1	14.8	121.8	50.5	12.4	Ellip.
NBC 17	B5/12	Albany	13.2	17	17.1	18	64	145.35	7.9	irreg.
NBC 46	Δ9/12	Wilton	5.1	7.6	6.3	8	37	19.84	1.3	Ellip.
NBC 47	B7/9	Wilton	5	7.9	8	8.5	101	32	4.3	Cyl.
NBC 48	5/3צ	Wilton	3	6	6.3	12.6	97.5	18.9	4.3	irreg.
	Mean		**6.8**	**9.7**	**9.3**	**11.8**	**71.7**	**49.22**	**4.8**	
	SD		**3.5**	**3.9**	**3.7**	**3.6**	**34.9**	**44.02**	**4.1**	

Table 19. Morphometric values of bone fish gorges from NBC (n = 8). TCSA values are in mm² and weight values are in g. All other measurements are in mm.

Sample	Provenience	Context	Diameter From Tip		Diameter in centre	Max. diameter	Length	TCSA	Weight	Shape
			1 cm	3 cm						
NBC 9	5/9צ	Robberg	-	-	4.5	4.5	28.6	10.12	0.4	Ellip.
NBC 10	N/Δ7/9	Robberg	-	-	6.7	6.7	42	22.44	0.7	Ellip.
NBC 11	Δ1/9	Robberg	-	-	5	5	31	12.5	0.2	Ellip.
NBC 12	B3/15	Robberg	-	-	4	4	48.5	8	0.4	Ellip.
NBC 13	B8/9	Robberg	-	-	5.1	5.1	33	13	0.4	Ellip.
NBC 51	3/10צ	Wilton	-	-	3.9	3.9	25.4	7.6	0.2	Ellip.
NBC 52	3/10צ	Wilton	-	-	3	3	28	4.5	0.1	Ellip.
NBC 53	Δ3/10	Wilton	3	-	6.3	6.3	35.7	19.84	0.5	Ellip.
		Mean	**3**	**-**	**4.8**	**4.8**	**34**	**12.25**	**0.4**	
		SD	**-**	**-**	**1.2**	**1.2**	**7.8**	**6.16**	**0.2**	