MIDDLE STONE AGE ROSE COTTAGE CAVE LITHIC POINTS: DOES TECHNOLOGICAL CHANGE IMPLY CHANGE IN HUNTING TECHNIQUES?

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ABSTRACT

Points are often the most abundant retouched lithics in MSA collections yet very little research has been done on their functions, especially in southern Africa where it has always been assumed that points were spears. This paper reports on the results of a technological analysis of two types of points from Rose Cottage Cave, South Africa. The study aims at examining the possibility that thick, broad points from various post-Howiesons Poort layers dating between 50 000 and 28 000 years ago were used as spearheads that were thrust at prey, while the narrow, thin points from one of the final MSA layers, Dc, (between 31 000 and 29 000 years old), were used as arrowheads that may have transported poison to prey. The results indicate that the former type of points were more likely to have been used as spearheads while the latter type were more likely to have been arrowheads.

DECLARATION

I declare that this research report is my own unaided work. It is submitted for the degree of Masters of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination in any other university.

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CHAPTER ONE

INTRODUCTION

Lithic points represent the single most durable artifact occurring in the archaeological record (Knecht 1997). This is why archaeologists have long used spears and arrow points as a unit study in research on the ancient lifeways of prehistoric hunter-gathering societies (Justice 1987). Although spears and arrows are used for hunting, they form only part of a larger hunting apparatus. The other apparatus was made of perishables, such as wood, which decompose and are therefore very rarely found in archaeological sites (Shott 1997). It is for this reason that the identification of prehistoric hunting weapons usually depends on stone points as these do not easily disintegrate or decay even after thousands of years of burial (Justice 1987). However, "spears, spearthrowers, bows and arrows preserved in specialized contexts (for example, the dry caves of the Great Basin and the American southwest and the water-logged sediments of northern Europe) with their wood handles and mastic and sinew hafts offer us tantalizing evidence of the technologies we are attempting to reconstruct…" (Knecht 1997: 4).

The present study focuses on stone points in an attempt to contribute to the general research on subsistence behaviour of southern African hunter-gatherers. The study is aimed at examining the technological differences between two different types of lithic points in Rose Cottage Cave (RCC), South Africa. It aims to examine the possibility that thick broad points from the various post-Howiesons Poort layers at RCC were used as spearheads which were thrust at animals, while the narrow, thin points from layer Dc, one of the final Middle Stone Age (MSA) layers, were used as arrowheads that may have transported poison to prey. The former type of points are between about 50 000 and 28 000 years old while the latter date between 31 000 and 29 000 years ago. I shall achieve my aims through a technological study of the points and the methodology will be discussed shortly.

The study is new and important because no-one in southern Africa, except for Villa *et al*., (in press) has previously distinguished the use of different kinds of points through a technological study. Similar lithic studies have been conducted in Europe, but they mostly used methods of analysis different from my own. Some of these methods will be discussed in the next chapter. As Justice (1987: 4) points out, “the manufacturing strategies used in prehistory varied widely within each time and period and from culture to culture”, however, “some basic aspects of stone age industries are universal”. It is for this reason that this study will use technological studies from other parts of the world for comparative purposes and making inferences about the Rose Cottage Cave points.

Lastly, if the Dc points appear to be arrowheads, then a new hunting technology may be implied in the final MSA.

CHAPTER TWO

LITERATURE REVIEW

This chapter is a background to the study of points and their functions.

Mousterian and Levallois Points.

According to Debenath and Dibble (1994), points have long been recognized in Paleolithic contexts and the term "points" has been in the literature since the eighteenth century. Since then, there have been several different attempts to define the term and one of these definitions is that by Cheynier (1954 as cited by Debenath & Dibble 1994: 58) who defines a point as "any blade or flake for which an extremity was made pointed by bilateral retouching". There have also been many publications produced on point typologies, however, only two types found in the data set of the present study will discussed here, namely Mousterian points and Elongated Mousterian points.

Mousterian points (called Type 6 by Debenath & Dibble 1994) and Elongated Mousterian points (called Type 7 by Debenath & Dibble 1994) have been defined morphologically as "triangular, sub-triangular, sometimes lozenge-shaped, more or less elongated, with a pointed end produced by significant retouching and made on a flake which is either Levallois or not" (see Fig. 2.1 and 2.2) (Debenath & Dibble 1994: 61). These types of points must be flat and straight though they can also be skewed (*dejetees).* Mousterian points may also be thin, either on the proximal or distal end. The distal extremity of the point in particular must form a sharp angle and the difference between Types 6 and 7 lies in the fact that the latter is longer than the former (*ibid*: 62). Elongated Mousterian points are said to have lengths that are at least twice their widths (Fig. 2.3) (Debenath & Dibble 1994).

For a long time Mousterian points and Elongated Mousterian points have been confused with Levallois points. However, what distinguishes Mousterian points from Levallois points is the significant presence of retouch on the former. On Mousterian points, the point is deliberately formed by retouch, therefore a naturally pointed flake or blade is not classified as a Mousterian point. A Levallois point is described as a triangular flake with a central or medial ridge or converging ridges. It is the medial ridge that guides the removal of the point and also predetermines the triangular form (*ibid*: 50). The point sometimes has a step-flake removed at the base. In the South African context, Mossel Bay points are Levallois products. Mossel Bay points have been described by Goodwin (1929: 136) as “longitudinally trimmed flakes, trimmed by the removal of two, or at the most three, convergent flakes”. Goodwin (1929) further points out that the third flake removed from these points is usually the central one.

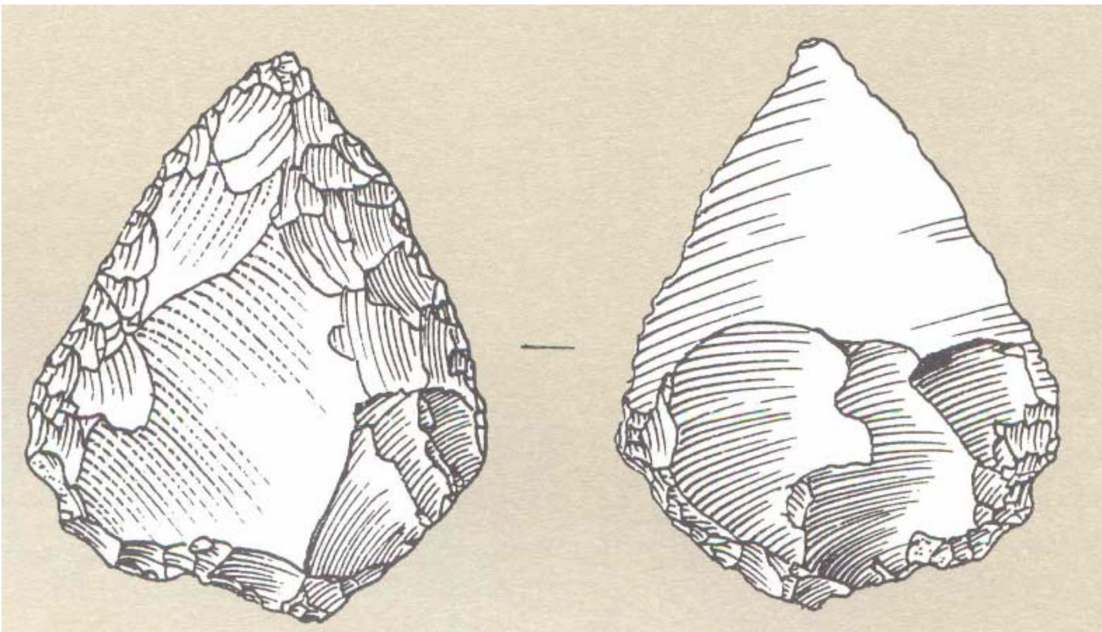

Fig. 2.1 A unifacial Mousterian point with retouch on the base
(From Debenath & Dibble 1994).

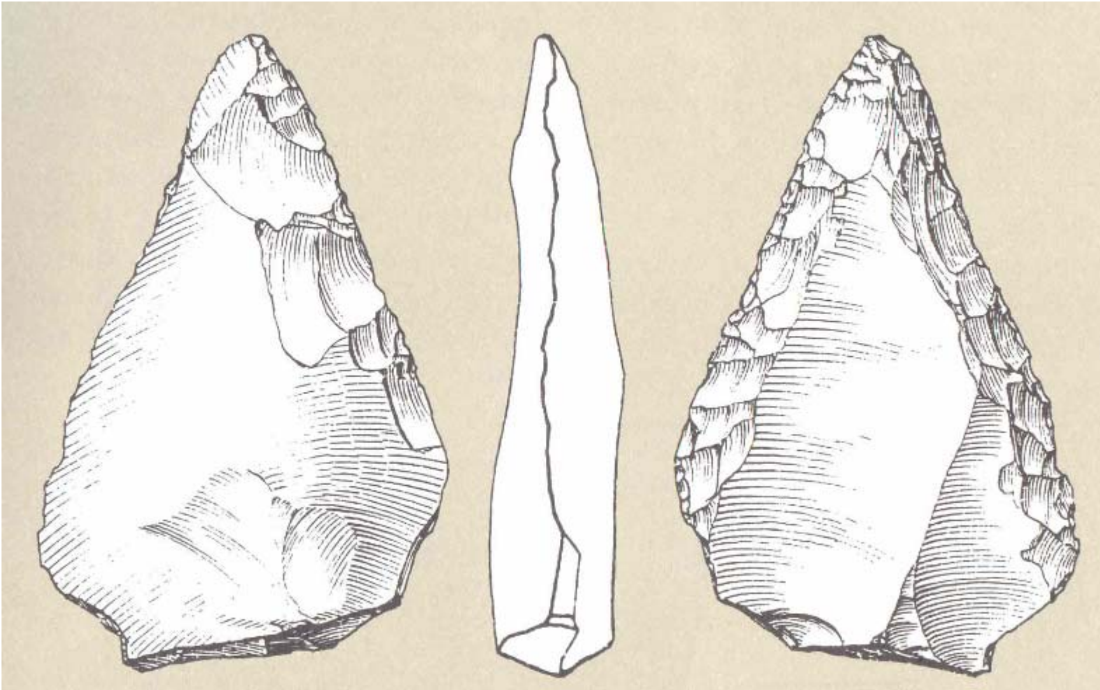

Fig. 2.2 A bifacial Mousterian point (From Debenath & Dibble 1994).

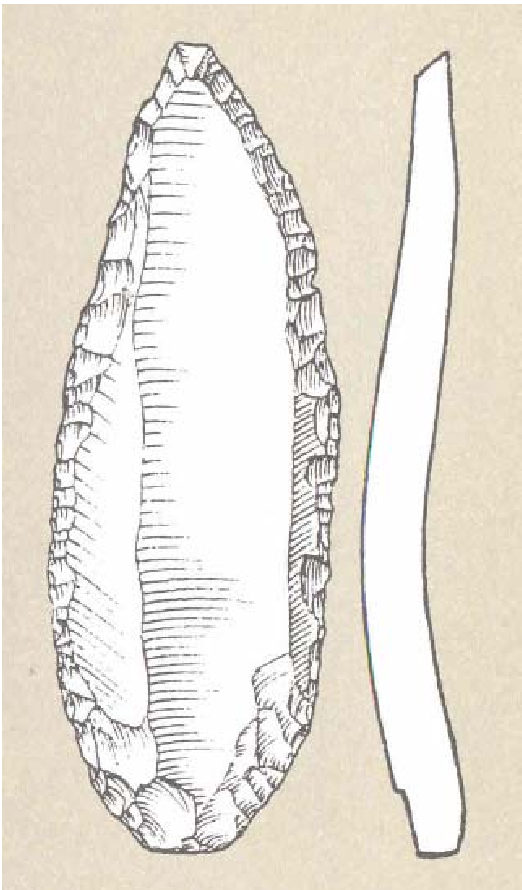

Fig. 2.3 An elongated Mousterian point (From Debenath & Dibble 1994).

Projectiles and hand-held spears.

According to Knecht (1997: 3), “projectile technology refers to launched weapons used in both hunting and warfare”. This definition implies that projectile points are thrown or propelled with force. Knecht (1997) also points out that thrusting spears are actually not projectile points because they never leave the hand of the hunter during use and are often referred to as lances (also see Ellis 1997). A dart, however, refers to a spear propelled with the aid of a spearthrower (Knecht 1997; Ellis 1997). Knecht (1997) uses the term dart when referring to light, slim projectiles and reserves the word ‘spear’ for the description of more massive, longer, robust weapons which are thrown by hand or with a spearthrower. By implication, projectiles also include arrows.

Despite this seemingly clear distinction between projectiles and handheld spears, there is confusion in the literature involving the use of these terms and sometimes this makes it difficult for readers to understand exactly what is being talked about. For instance, Shott (1993, 1997, 2002) uses the words ‘darts’ and ‘spears’ interchangeably at times, though there are times when it seems he distinguishes between the two. Patterson (1985), too, uses spear to refer to both darts and thrusting spears and he uses the term ‘projectile’ to refer to any type of points, whether handheld or thrown. Justice (1987) also uses the term ‘projectile point’ to refer to both spears and arrows.

Moreover, Van Buren (1974: 4) defines a projectile point as “the penetrating tip of a weapon or hunting instrument that is thrust, cast, hurled, or otherwise directed toward a target by human energy, with or without the aid of wooden instruments”. This definition, according to Van Buren (1974), covers stone points that were used as arrows, atlatl darts, spears, lances, and javelins. Van Buren (1974) is aware of the confusion of the use of these terms in the literature. He points out that the lack of agreement on the use of these terms is a result of the lack of knowledge about the end use of different sizes and styles of projectile points (*ibid*: 4).

Lithic points are often the most abundant retouched lithics in Middle Stone Age (MSA) collections yet very little research has been done on their functions, especially in southern Africa where it has always been assumed that points are spears. The invention of hunting spears has been regarded as “a major behavioural advance in human adaptations” because it marks “a uniquely human way of life that revolves around hunting” (Lombard 2003: 3), yet little thought has been given to the way in which the spears were used.

Although research has shown that other material, such as wood, was sometimes used in the manufacture of spear points, the use of stone tipped points has been regarded as a significant improvement. In a stone point there is more investment of labour before use (Shea 1997) and it should be long lived. In addition, stone tipped spears have an advantage over wooden spears in that they not only will pierce through the thickest animal skin, but can also “create a large lashing wound that aids the formation of a blood trail for tracking wounded game” (Lombard 2003: 6). A lithic spear point has an advantage over a wooden spear in that if left inside the animal’s body, the edges of the point cause more internal damage, which can immobilize the animal more quickly (Lombard 2003). Stone points are versatile in that, if damaged during hunting, they can be used as knives for butchering or as scrapers (*ibid*: 5).

Functions of points are explained by residue and microwear analysis as well as by experiments involving the use of points. Functions are also explained by technology because of desirable properties of tools, for instance, the aerodynamic property of projectiles. In addition, evidence of the use of lithic points is found in the bones of animals which were hunted using these points. These are going to be discussed in the sub-sections that will follow.

Residue and Microwear Studies of Points.

In recent years, in an attempt to understand how points functioned, use-wear analysis has been the focus of archaeological studies of points (Odell & Cowan 1986; Odell 1988; Knecht 1997). These studies involve studying the patterns of damage that occur on the edges and surfaces of stone tools due to use (Odell 1988). Use wear analysis was developed in Russia by S. A. Semenov in 1964 and, subsequently, there have been a number of experimental studies which have mostly relied on comparisons of prehistoric damage and experimentally induced damage (*ibid*: 336).

Micro-wear analysis of polish, edge damage and impact striations on experimental Clovis points from Colby have shown consistent use of these tools as hafted spear points and butchering tools (Kay 1996 in Lombard 2003).

Lombard (2003, in press) found residues on points from Sibudu Cave (South Africa) which suggest that the points were hafted spearheads. They had ochre on their thin bases and wear patterns that suggested hafting. In combination with ochre, which could have been used as resin, it has been suggested that plant twine was probably used for binding these points to wooden hafts. In addition, animal remains were most often found on the distal portions of the points (Lombard 2003, in press).

Shea (1988, 1989, 1995) used use-wear analysis on stone artifacts from Middle Paleolithic occupations of Kebara Cave Levels IX-XII in Mount Carmel, Israel. His experimental study involved the use of more than 1000 tool replicas, which were thrown, thrust and bow-shot against dead animal targets (in this case horse, white-tailed deer and goat). These tools were used until they could no longer penetrate targets effectively or until they became unhafted or snapped. Then, using a microscope, use-wear analysis was done on them (Shea 1988).These experimental tools were then compared to the archaeological tools from the named site and it was concluded that the points from Kebara were used as hafted projectile points (Shea 1988).

In addition, Shea (1989,1993, 1994, 1995) did microwear analysis of Levallois points from Tabun Cave I, II, and IX, Hayonim Cave Level E, Qafzeh Cave Levels XV-XXIV, and Tor Faraj Rockshelter Level C. Wear patterns of these points have been consistent with the notion that some Levallois points were used as hafted stone spear points (Shea 1989, 1993, 1994, 1995).

Experimental Studies of Points

Experiments by some archaeologists have tested the hunting capabilities of lithic spear points. Some of these experiments were carried out in Zimbabwe and have served as proof that lithic points were indeed used as spear points and projectiles and that some of these were even hafted on handles. Extensive culling of elephants in Hwange National Park provided an opportunity to test replicas of Clovis tools and weaponry (Frison 1989, 1991). The experiments have left no doubt that Clovis projectile points can inflict lethal wounds on African elephants and also that simple tools can be used to perform the necessary butchering. The most common damage observed on the points was the crushing. This damage could easily be repaired by the reshaping of the distal end of a point with an antler flaking tool while still mounted in the foreshaft (Frison 1989, 1991). African and Asiatic elephants are believed to have been physiologically similar to extinct North American mammoths (Solecki 1992), therefore, these experiments have provided a good basis upon which inferences concerning the hunting of mammoths and issues concerning tool efficiency have been based (Frison 1989, 1991). The association of mammoth remains in the archaeological records in North America with Clovis type projectile points has led to the conclusion that these animals may have been hunted using Clovis points (Frison 1989).

Shea (1995: 285), also points out that “the best way to evaluate the plausibility of Levallois points as spear points” is to use them in feasibility experiments. This observation is based on about ninety experiments with replicas of Levallois points hafted on wooden spears that were thrown and thrust at carcasses of goats, gazelle, deer and horse (*ibid*: 285). From these experiments, Shea (1995) observed that

Levallois points are very effective spear points and that whether thrown like a javelin or thrust like a bayonet, they have little difficulty penetrating the hide, abdominal wall and viscera of an animal carcass. Shea (1995: 286) has, therefore, suggested that “Levallois points would have had considerable ‘stopping power’, an ability to quickly and decisively immobilize large animals” He further points out that the passage of these sharp, broad points through the skin and muscle of animals creates long slashing wounds that heal slowly and leave a blood trail for hunters to follow to the injured animal (*ibid*: 286).

Moreover, experimental studies conducted by Shea and colleagues (2001: 812) in their study of Later Levantine Mousterian assemblages have shown that these points, which dated between 47 000 and 130 000 years ago were more likely to have been used as spear points than knives because they are shorter and broader than would be effective for knives. They point out that “if Levallois points were manufactured with the intention of using them as armatures for thrusting spears, they should be short and broad” (*ibid*: 812).

Odell and Cowan (1986) conducted experiments with 80 spears and arrows on animal targets. They found out, after tabulating the means of length, width, thickness and weight, that the objects used to tip spears were larger in general than those used to tip arrows. They also found out that the wide tip angle for projectiles correlates negatively with penetration in that “the wider the angle, the greater is the tendency for the point to bounce off its mark”. Odell and Cowan (1986) have therefore concluded that wide-angled points would have placed the hunter at a disadvantage if they were used as projectiles rather than stabbing spears. Their experiment also verified that retouched points penetrated deeper than unmodified flake points, though the difference may not be that significant. Moreover, they discovered that bifacially shaped points possess an advantage with regard to the degree of penetration (*ibid*: 203).

In their attempt to determine the functions of the microlithic points from The Powell Mesolithic site in southern England, Barton and Bergman (1982) also performed experiments. Duplicates of the archaeologically recovered microlithic points were made and used as arrowheads in experiments to shoot at dead deer. Then the fractures caused by the impact with the animal were studied. It was discovered that the impact fractures on the experimental points were similar to those on the archaeological points, suggesting that the two kinds of points were used similarly (*ibid*: 242). Such studies have highlighted the importance of technological studies of points, in conjunction with replication and experimentation.

Technological Studies of Points

As has been the case with other formal tool types, research on lithic points focused, during the early years, mostly on the morphological variation and geographic distribution (Odell 1988; Knecht 1997). Initially, points were named after the sites from which they were discovered, but as time went on similarities were recognised in size and form across sites and so regional typologies were introduced. These projectile point types have not only been used as time markers, but also as representatives of particular culture complexes (Knecht 1997).

The traditional morphological analyses of lithic points were supplemented by studies of breakage patterns (Odell 1988). This kind of analysis was used, for example, by Holdaway (1989) in his analysis of lithic points from two Iranian Mousterian sites, Warwasi and Bisitun. He aimed to determine whether the Mousterian points from these sites were, in fact, used as hafted projectile weapons.

Furthermore, studies on projectile points have focused on projectile life history (Knecht 1997). There is one group of archaeologists that claims that variability in the forms of points could be due to morphological changes that a single point can go through during the trajectory of production, use, breakage and repair (Flenniken & Raymond 1986; Flenniken & Wilke 1989). This group claims that " given a full range of possible variation in a single projectile point throughout its use-life, the possibilities for determining the cultural phase of occupation of a site on the basis of projectile point types present are extremely limited" (Knecht 1997: 10). There are, however, other archaeologists who contest that typologies allow for a range of variability in morphology that can be expected to be generated throughout the use-life of a point (Thomas 1986).

The study of points has also shifted to more emphasis on morphometric analysis and the essence of this kind of study is to identify any patterning in metric and geometric variables statistically (*ibid*: 7). Another reason for this shift is that technological analyses of points are believed to be a good basis for the interpretation of archaeological hunting strategies. Experimental work described in the previous section tends to support this hypothesis. Variables related to base shape such as notches, stems and bevels, overall size (width, thickness, length and weight), generalized form (in terms of cross-section shape and edge contours) and edge angle have been part of this type of technological study (Knecht 1997). Projectile width influences sharpness, penetration of the point into the animal's body and the size of the wound (Shea 1997; Nelson 1997). Nelson (1997) further shows that the overall size of the point correlates with the potential for extended use-life through resharpening and is also related to the distance and the speed of the projectile.

Some of the studies, which have used metric analysis to determine the functions of lithic points, have been those conducted by Shott (1993; 1997). In most parts of eastern North America, a shift from notched or stemmed points to triangular bifaces that occurred between 1500 and 1200 years ago was commonly linked to the introduction of the bow and arrow. It has also been suggested by a number of scholars that bow and arrow hunting was more effective than spear hunting (Shott 1993). Shott's studies were prompted by these suggestions as he wanted to test their validity.

One of Shott's studies used data from two Late Woodland sites, Childers and Woods and these sites are situated on the Ohio River in southwestern West Virginia. His data consisted of stemmed, notched and triangular forms from both sites and Thomas' (1978) functions analysis was used in an attempt to distinguish arrow from dart or spear points. It has been used to assign specimens of unknown functions to proper categories (Thomas 1978). The formula is as follows:

Function 1. Darts: C = .188 ML + 1.205 MW + .392 MT - .223NW-17.552 and
Function 2. Arrows: C = .108 ML + .470 MW + .864 MT + .214 NW – 7.922;

where C = the function result expressed numerically, ML = maximum length, MT = maximum thickness, MW= maximum width and NW = neck width (Thomas 1978). When using this analysis, the metric attributes of each one of the points being analysed were inserted into each function and the higher C value indicated the correct classification.

The analysis has identified all small triangular bifaces as arrow points, thus validating the widely held assumption that they are indeed arrow points (Shott 1993). The relatively few Lowe Flared Base bifaces have been identified as dart or spear points. However, most Chesser Notched specimens, which had always been classified as dart or spear points, were reclassified as arrow points (*ibid*: 432). This classification of Chesser Notched points as arrow points has led to Shott (1993) suggesting that the bow- and-arrow introduction occurred earlier than supposed. He further suggests that if that is the case, "the ballistic-performance requirements of arrows initially were met by altering the dimensions and properties of existing projectile-point forms" (*ibid*: 432).

Patterson (1985) also carried out a functional analysis of stemmed projectile points from site 41 HR182 in Harris County, Upper Texas. In his analysis, Patterson (1985) looked at the weights, lengths, widths and neck thicknesses of the points to determine whether they are arrow points or spears (it should be noted that the term 'spear points' is used by Patterson to refer to both thrusting spears and points used on darts with the spear thrower (atlatl)). The study found out that thickness, neck width and weight are the key attributes for use in classification. It was also discovered that on the Upper Texas coast, arrow points generally weigh less than 2 grams while spear points generally weigh over 3 grams (*ibid*: 89).

Lastly, the study carried out by Villa *et al*. (in press) on selected stone points from Sibudu Cave in South Africa also employs metric analysis to determine the functions of points. The study suggests that thick, broad points with wide angles were used as spearheads, which were used for stabbing or thrusting at animals. Villa and colleagues point out that though McBrearty and Brooks (2000) have suggested that there were some MSA stone points which may have been used as arrowheads, this is not the case with Sibudu points. They point out that examination of the maximum width, penetrating angle (the tip angle seen in plan view, measured in degrees) and the cross-sectional area (1/2 width x thickness, expressed in cm^2) of these points has indicated that these points were more likely to have been used as spearheads (Villa *et al*. in press). For instance, these points have an average width of 27.2 mm ± 6.5 and this is quite close to the mean width of Clovis points (28.7 ± 3.4) which are known to have been spearheads. In contrast, the mean width of North American stone arrowheads is much smaller (14.5 ± 3.6).

Evidence in Bones.

The appearance of lithic points in association with bones in archaeological sites has also served as undisputed evidence of the use of points as hunting weapons. For instance, Milo (1998) found a stone point tip embedded in an extinct buffalo cervical vertebra in Klasies River Mouth, South Africa. The stereo-microscopic examination of the vertebra has confirmed that the bone was cut cleanly when still fresh because there is no crushing or any indication that the bone was cut while dry. This has been used as evidence to suggest that at Klasies River Mouth lithic points were used as hafted spear tips for hunting (Milo 1998).

Another example is that of a Mesolithic site called Bloksbjerg in Klampenborg, north of Copenhagen. The tip of a stone point with slightly concave retouched sides was found embedded into a tubular bone. This tip had a width of 8-9 mm at the proximal part (Friis-Hansen 1990). It is suggested that this tip could have been used as an arrowhead because it is well suited for an 8.5 mm diameter arrow-shaft with a long binding. Such arrow types appear to have been used during the Ertebolle phase because one was found hafted with a tranchet transverse arrowhead in a bog near Koldhuse, Vissenbjerg in Denmark (*ibid*: 501).

Moreover, in Kongemose, Denmark, a rhomboidal arrowhead of flint was found deeply embedded in an unhealed lesion in a limb bone of red deer in a western Zealand bog (Friis-Hansen 1990). This settlement has been radiocarbon dated to 5 600-5 350 B.C. while pollen analysis has dated it to the early Atlantic period, pollen zone VI (*ibid*: 501). The arrowhead has six fragments and two have linear striations or small scratches in the surface as well as other well-developed wear traces and these clearly indicate the direction of the arrow at the moment of impact with the bone if the head was effectively fixed to the arrow-shaft (Friis-Hansen 1990).

Lastly, at a site northeast of Hamburg, Stellmoor, two broken proximal ends of tanged arrowheads were discovered in position in foreparts of arrow-shafts. There were also two points of arrowheads which were embedded in reindeer vertebrae (*ibid*: 502). According to Friis-Hansen:

> The frequency of diagnostic macro- and micro-wear traces is relatively high in the abundant assemblage, and it is likely that all the flint points represent used arrowheads… It is generally accepted that the numerous reindeer discovered were by preference shot with arrows mounted with flint points (1990: 502).

Summary

This chapter has reviewed literature concerning lithic points and their functions. It has shown that there are different ways in which functions of points and their effectiveness can be studied, namely: technological, residue and microwear analysis as well as experimental studies. Lastly, the chapter has also shown that evidence of prehistoric use of points can be found in archaeological faunal remains.

CHAPTER THREE

THE BACKGROUND

This chapter provides the history of Rose Cottage Cave and will particularly look at the MSA cultural sequence.

Rose Cottage Cave: Location and Description

Rose Cottage Cave is located on the northern slopes of the Platberg, approximately five kilometers from Ladybrand in the eastern Free State (29°13′S; 27°28′E) (Wadley 1997). The cave lies within the Basutolian Ecozone, which is described by Clark (1997a) as being "an area of highveld in which cryptocrystalline silicas are relatively abundant…" This cave is about 20m long and 10 m wide and is protected by a great boulder that encloses the front of the cave and leaves a skylight and narrow east and west entrances. (Wadley 1997) (see Fig. 3.1 for the location of Rose Cottage).

Excavations

Rose Cottage Cave has been excavated as part of a research programme undertaken by the Department of Archaeology, University of the Witwatersrand (*ibid*: 439). The cave was first recognized as an archaeological site by B.D. Malan who excavated it between 1943 and 1946. P.B. Beaumont was the second to excavate the cave in 1962 with the intention of producing a larger artefact sample, a range of radiocarbon dates and an accurate stratigraphic sequence (Clark 1997a). Unfortunately, neither Malan nor Beaumont published their findings from Rose Cottage Cave, but the MSA tools excavated by Malan were later analysed by Wadley and Harper (1989) while Beaumont's material was analysed by Kohary. Between 1987 and 1997, the cave was excavated by Lyn Wadley (Wadley 1997).

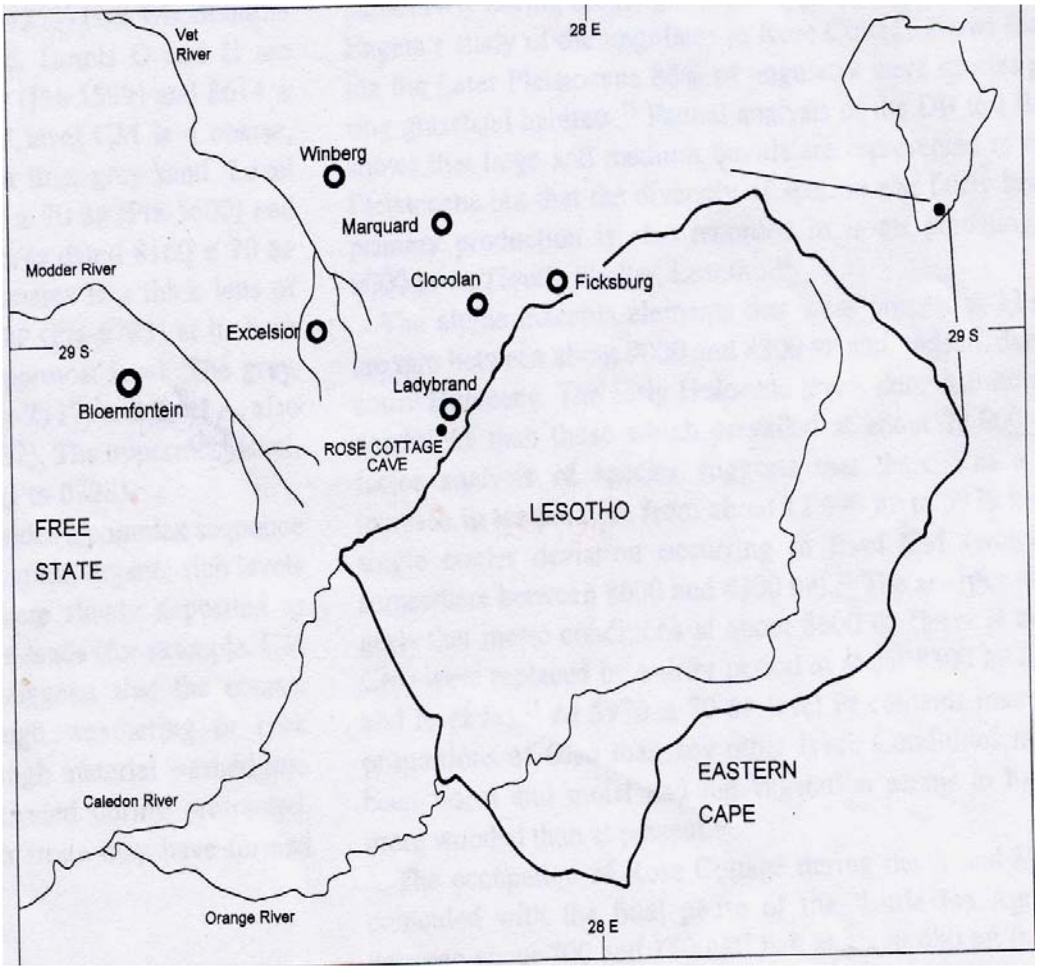

Fig. 3.1. The location of Rose Cottage Cave (From Wadley 1997).

The Cultural Sequence.

Rose Cottage Cave has a long sequence of Stone Age occupations that date from the late Pleistocene to just a few hundred years ago. The deposit is more than 6m deep and the occupation is thought to extend more than 100, 000 years (Wadley 2004). It is one of the few sites in Southern Africa with a full MSA sequence where the Howiesons Poort is sandwiched between pre-Howiesons Poort and post-Howiesons Poort layers (other sites with this sequence are Peers Cave, Klasies River Mouth (both in the Cape), Apollo 11 (in Namibia), Border Cave (in the Swaziland/Kwazulu-Natal boundary) and Umhlatuzana (Kwazulu-Natal). The cave also has a possible MSA/LSA transitional industry and an LSA sequence with

Robberg, Oakhurst, Wilton and post-classic Wilton industries (Wadley 1997). According to Wadley (1997), the cave has the potential for reliable finite dates for the full MSA sequence. In addition, the cave offers a chance to examine the final phases of the MSA and the beginning of the LSA.

Most of the stone tools found in the cave have been produced from opaline whose source could probably have been the Caledon River nearby (Clark 1997b). According to Wadley (1997), the basal levels, LEN and KUA, contain an MSA assemblage that has many points and some scrapers as well as knives (called straight scrapers elsewhere). Moreover, blades in this assemblage are more common than flakes and also present in this assemblage are bladelets (see Fig. 3.2 for the stratigraphy of MSA Rose Cottage Cave layers).

Overlying levels LEN and KUA are 15 levels (EMD to SUZ), which have a Howiesons Poort Industry, and this industry is distinguished by the presence of backed tools such as segments, backed blades and a variety of geometrics (Harper 1997). Rarely found in this industry are 'traditional' MSA tools, that is, points, scrapers and knives. However, with regard to informal tools, the frequencies of blades and bladelets double those from the previous levels and there are few flakes (Harper 1997; Wadley 1997). Wadley (1997) describes tools from the Howiesons Poort as "aesthetically pleasing", "symmetrical and finely worked". She further points out that the Howiesons Poort levels contain a greater volume of artifacts than any other levels in the site (1997: 441).

Above the Howiesons Poort levels are the post-Howiesons Poort levels (BYR to KAR). These levels rarely contain backed tools, however, scrapers, points and knives recur, with convex scrapers becoming the most common retouched tool. Blades and bladelets also decrease while flakes increase tremendously (Harper 1997; Wadley 1997).

According to Wadley (1997), the MSA levels above KAR have very low proportions of retouch. The earliest of these, Dy, dates to 30, 800 ± 200 BP (Wadley 2004). Dy contains 7 659 pieces of worked stone, 74 of which are retouched. The assemblage in this layer comprises: small sidescrapers, medium sidescrapers, large sidescrapers, knives, naturally backed knives, adzes, awls, points, backed bladelets (< 25 mm), obliquely backed bladelets, broken backed blades miscellaneous backed tools, broken retouch and miscellaneous retouch (*ibid*: 26) (Fig. 3.3).

Layer Dc lies above Dy and this layer dates to between 31 000 and 29 000 years ago (Wadley: personal communication). Dc contains 23 531 lithics (including chips) and 273 are retouched. There are 23 classes of retouched tools in this layer, namely: small end and sidescrapers, medium end and sidescrapers, large end and sidescrapers, knives, naturally backed knives, adzes, spokeshaves, awls, borers, denticulates, points, broken retouch, large obliquely backed tools (> 25 mm), large miscellaneously backed tools, backed bladelets, (< 25 mm), obliquely backed bladelets, small miscellaneously backed tools (< 25 mm), flakes with burin blows and miscellaneous retouch (Wadley 2004) (see fig. 3.3).

Level Ru, which is said to be the final MSA level, has three dates, that is, 27 700 ± 480 BP, 27 800 ± 1 700 BP and a basal date of 28 800, ± 450 BP (Wadley 2004). This layer contains an assemblage with 61 193 lithics (including chips) and retouched tools are uncommon (*ibid*: 30). Wadley (2004) points out that the enormous density of lithics in this assemblage suggests that layer Ru represents multiple occupations. The tool classes in this layer include small end and sidescrapers, medium end, side and steep scrapers, and large end, side and end and sidescrapers, knives, naturally backed knives, adzes, awls, spokeshaves, points, broken retouch, large-backed blades (> 25 mm), large broken-backed tools, backed bladelets (< 25 mm), small broken-backed tools and miscellaneous retouch (*ibid*: 32). There are lower frequencies of points, scrapers and backed tools in this layer (Wadley 2004) (Fig. 3.3).

The level overlying Level Ru, level G, which dates 20 600 BP, contains a retouched assemblage that is dominated by MSA tools such as knives, coupled with an increasing frequency of LSA tools such as bladelets and microlithic flakes (Clark 1997a; Wadley 1997) (Fig. 3.3). This assemblage is described by Wadley

(1997) as being neither “a ‘traditional’ MSA assemblage nor a Robberg-like industry” because it contains artifacts found in both industries. It is therefore suggested by both Clark (1997a; 1997b) and Wadley (1997) that level G represents a transitional level between the MSA and LSA. Clark (1997a) further points out that the assemblage in G is similar to that identified as transitional between the MSA and LSA at Sehonghong in Lesotho by Mitchell (1994) and this therefore “supports the notion of a localised shift in lithic technology” (Clark 1997a). Wadley (1997) also shows that not only are the tool types in level G different from those in overlying levels, but that the proportions of raw material types also differ and the frequencies of siltstones, sandstones and tuffaceous rock are higher in level G.

Above level G are various LSA industries, but because this project focuses on the MSA, these will not be discussed here. The points that form the research focus here come from layers JEN, LIN, CLI, BYR, LEN, THO, PAN, and MAD (Harper excavation) and from layer Dc (Wadley excavation).

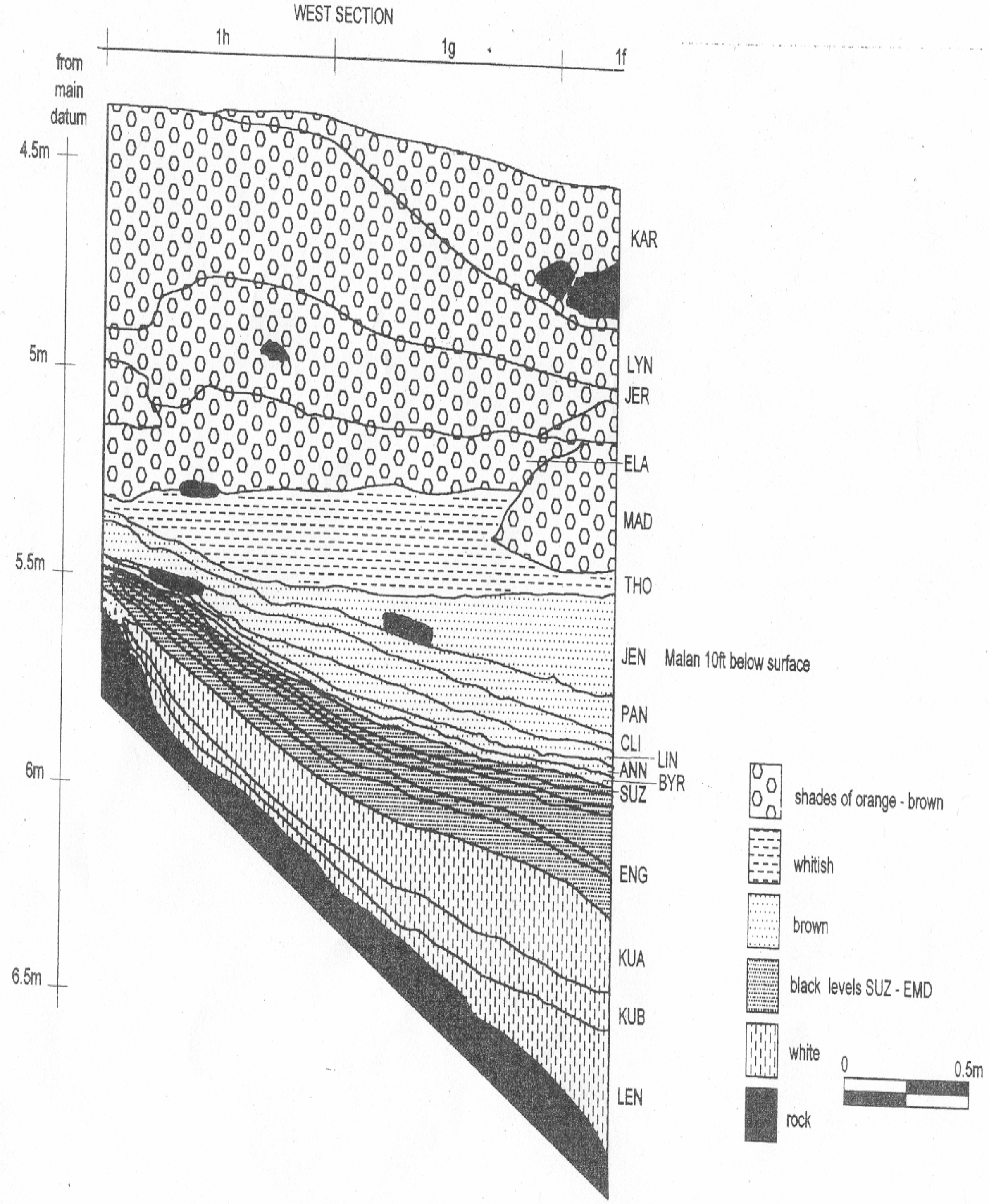

Fig. 3.2 The west section of Rose Cottage Cave MSA layers (From Valladas *et al*. in press).

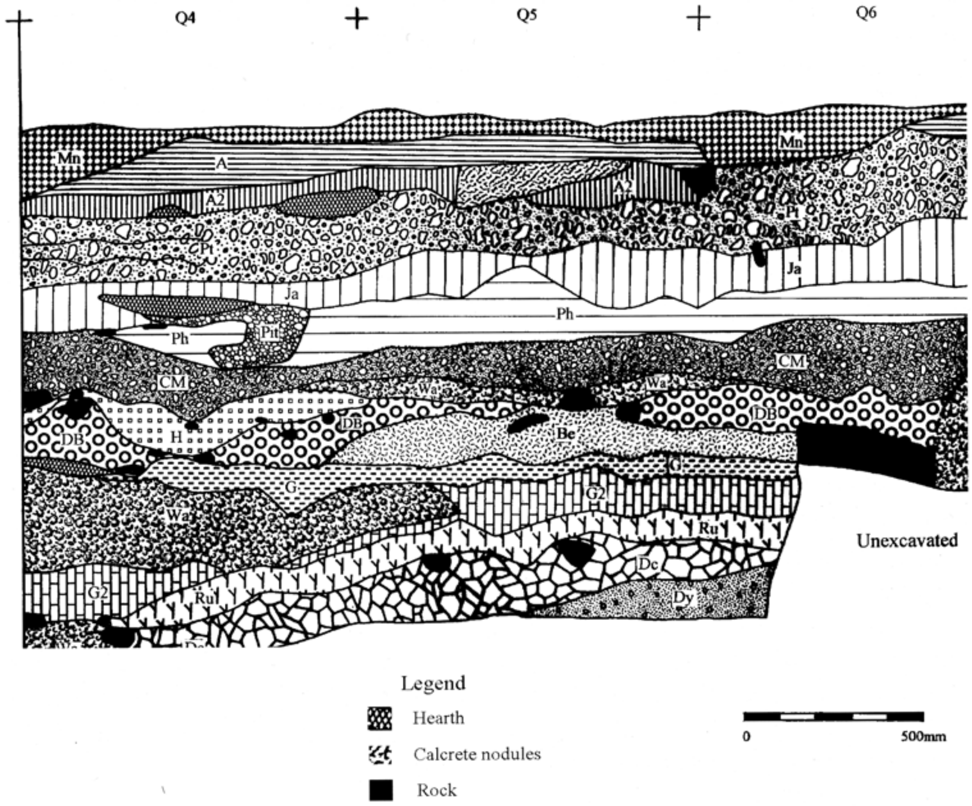

Fig. 3.3 Rose Cottage Cave profile of final MSA layers discussed above (From Wadley 2004).

CHAPTER FOUR

METHODOLOGY AND HYPOTHESES

This chapter describes the methodology used in analysing the Rose Cottage Cave points. The data set consists of 59 points, 16 of which are from layer Dc while 43 are from the various post-Howiesons Poort layers, namely: JEN, LIN, CLI, BYR, LEN, THO, PAN, and MAD. Ten of these points are incomplete, but these can be used for calculating tip angles.

Technological Analysis

The RCC points have been analysed for a number of variables that include the type of raw material; the type of blank from which they were produced, that is, whether from an ordinary flake or a Levallois flake, a blade or a bladelet; the location of retouch, for example, left and right; the type of retouch (whether invasive, abrupt, small or marginal) and the type of base, for instance, multifaceted platform and reduced platform) (see Table 5.1 for these variables).

In addition, the points were measured using digital calipers for length, the largest breath, the breath at 1cm and at 5mm from the tip as well as the largest thickness, and thickness at 1cm from the tip. These data were then registered in a table (Table 5.1). All these measurements were then used in calculations of means and standard deviations of different variables of the points and in a trigonometric formula to calculate the cross sections of the points as well as angles of their tips (Appendix 1 has details of these calculations). The formula used is the solution of right angles in which $B = 90° - A$ (see Fig. 4.1 for the illustration). The detailed trigonometric formula for the solution of angle B is to be found in Dibble & Bernard (1980). This formula was also used by Carter *et al.* (1988) to calculate edge angles of bladelets from Sehonghong, a rock shelter in Lesotho.

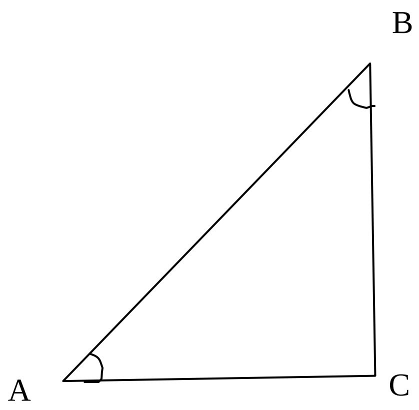

Fig. 4.1 Triangle illustrating the trigonometric formula.

Note: The triangle represents half of a point and B is half of the tip angle. Therefore, after calculating the value of B by subtracting A from C (which equals 90°), B was multiplied by 2 to get the full tip angle. These calculations were done using Microsoft Excel (See Appendix 1 for details).

<u>Hypotheses</u>

1. Broad points with large tip angles represent stabbing spears.

2. Small points with small tip angles represent arrowheads.

3. If there is a change through time in the size of points and their penetrating angles, we may be able to see the change from hunting with spears to hunting with bow and arrow.

CHAPTER FIVE

RESULTS

This chapter looks at the results of the technological analysis done on the two types of points from Rose Cottage Cave, that is, the thick, broad points from the various post-Howiesons Poort layers and the narrow, thin points from layer Dc. The chapter will describe the results of different measurements taken from the points, namely: length, breadth, and thickness and also the cross-sections as well as tip (penetrating) angles of the two types of points. Results of other variables looked at such as raw material type, retouch location as well as retouch type will also be dealt with (Table 5.1 summarises the results and Table 5.2 has the abbreviations).

Breadth, thickness and length of the thick, broad points.

The minimum breadth of the thick, broad points is 15mm while the maximum breadth is 32mm. The average breadth of this type of points is 21.6 ± 3.9 mm (see Fig. 5.1 for frequency distributions of thick, broad points breadths). The minimum length of this type of points is 23mm while the maximum length is 76mm and the mean length of these points is 39.6 ± 10.9mm (see Fig. 5.2). The minimum thickness of these points is 4mm and the maximum thickness is 11mm (Fig. 5.3 has frequency distributions of the thicknesses of these points). The mean thickness of these points is 7.4 ± 2.1mm.

Breadth, thickness and length of the Dc points.

The lengths of the Dc points range from 12mm to 27mm and the mean length of this type of point is 15.6 ± 4.0mm (see Fig. 5.4). The Dc points have a minimum breadth of 5mm and a maximum breadth of 10mm and the average breadth of these points is 6.9 ± 1.7mm (Fig. 5.5 shows frequency distributions of the breadths of Dc points). These points range in thickness from 1 to 2mm and the average thickness of these points is 1.8 ± 0.5mm (Fig. 5.6)

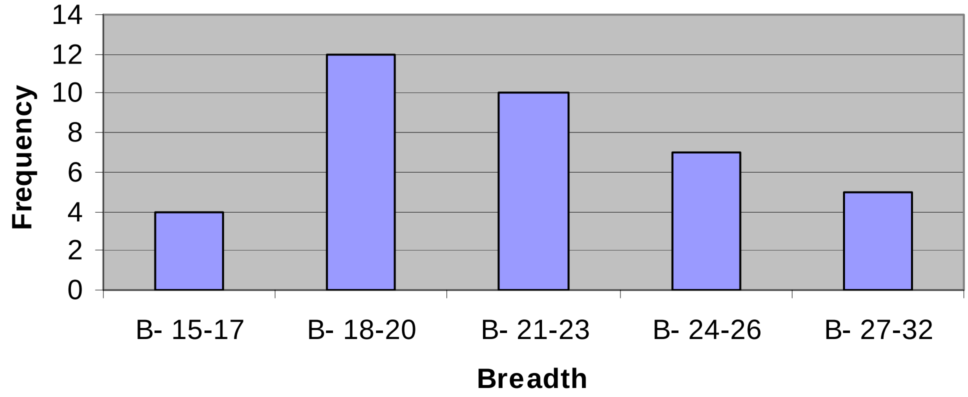

Fig. 5. 1 Frequency distribution of thick, broad points breadths (in mm).

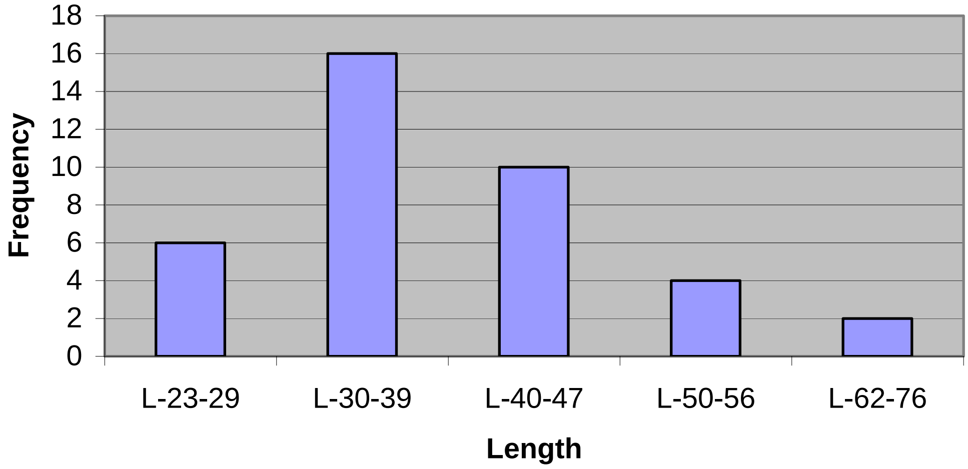

Fig. 5.2 Frequency distribution of thick, broad points lengths (in mm).

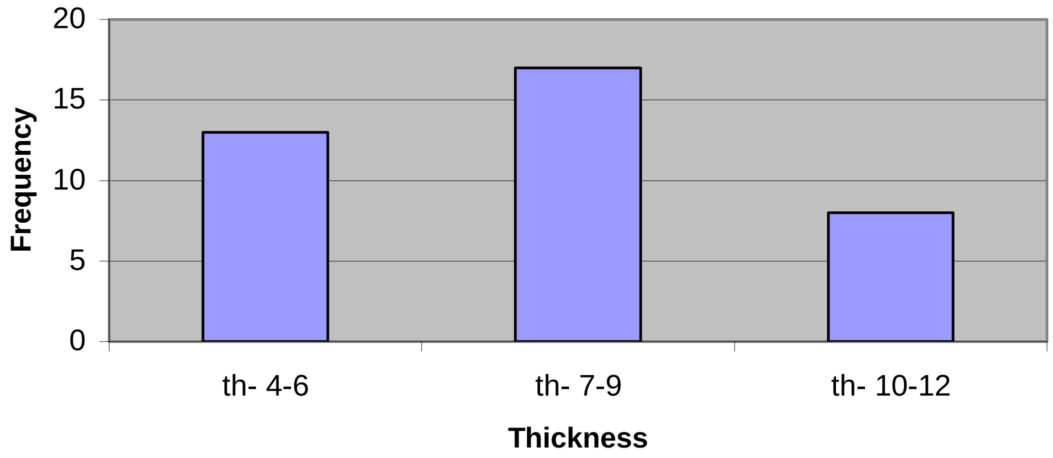

Fig. 5. 3 Frequency distribution of thick, broad points thicknesses (in mm).

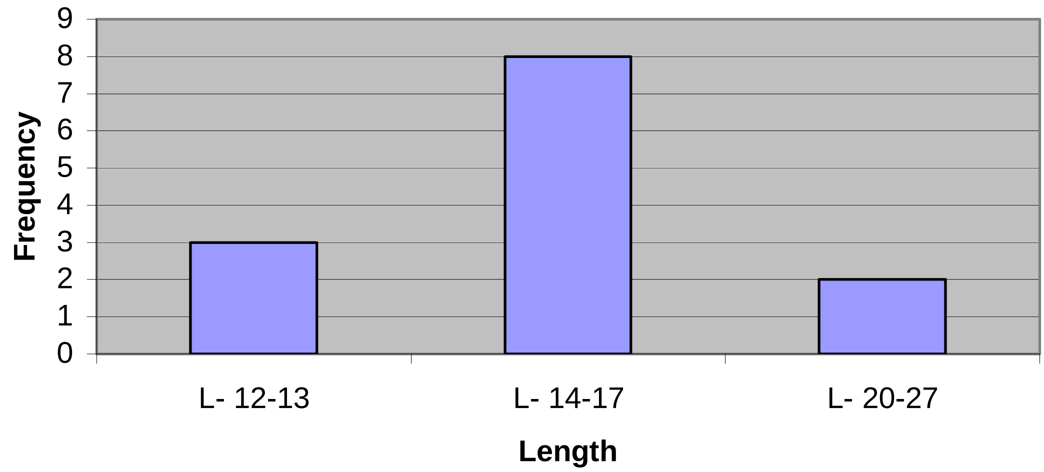

Fig. 5.4 Frequency distribution of Dc lengths (in mm).

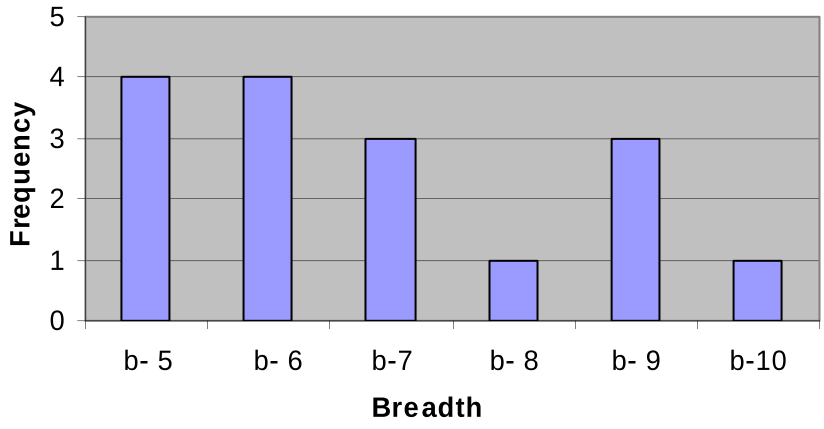

Fig. 5. 5 Frequency distribution of Dc breadths (in mm).

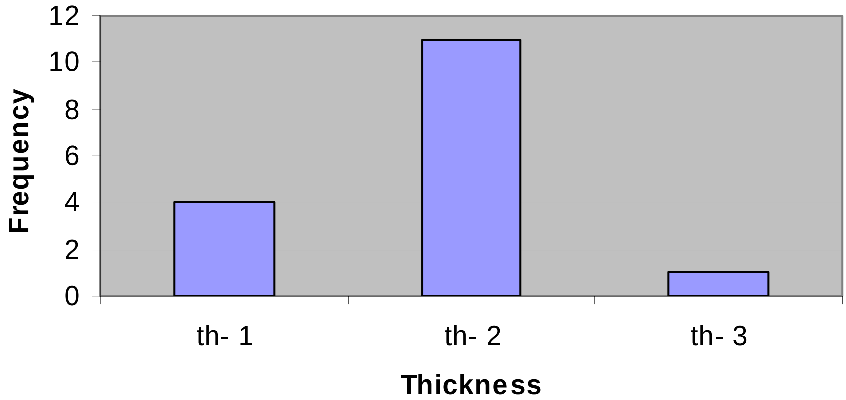

Fig. 5.6 Frequency distribution of Dc thicknesses (in mm).

TABLE 5.1. Measurements and other variables taken on Rose Cottage Cave points.

No.	Layer	Sq	RM	Type	Bordes type	Break	Frag	Blank	R Loc	R Type	Base	Ventral base	L	B	TH	B 5mm	B 1 cm	Th1cm
1	JEN	IG	O	UPT	MP	CO		FL	TOT	S	BD	RED	33	18	5	7	12	3
2	LIN	IG	H	UPT	MP	CO		FL	LPR	S	PLF	RED	41	22	6	8	12	6
3	CLI	IG	O	UPT	EMP	CO		FL	LR	S	PLFF		45	20	8	8	10	5
4	BYR	HG	O	PBPT	EMP	CO		FL	TOT	I	BD	RED	46	23	7	6	9	4
5	JEN	IH	O	UPT	MP	CO		FLEV	LR	S	PLFF		29	18	5	9	13	3
6	CLI	HG	O	BPT		CO		FLEV	TOT	I	PLFF		32	24	4	8	13	4
7	CLI	HG	O	UPT	MP	CO		FL	LR	S		RED	35	18	4	9	13	4
8	LEN	IG	T	UPT	EMP	CO		FL	LRP	I	PLFF		62	28	10	5	10	7
9	THO	IG IF	IND	UPT	DEJ S	CO		FL	LR	S	RET		41	27	9	10	17	5
10	PAN	IG	H	UPT	EMP	CO		FL	LPR	S	PLF F		52	21	10	10	16	6
11	JEN	HG	H	UPT	EMP	CO		FL	LRP	S	PLFPL		50	21	6	8	10	8
12	PAN	IG	H	UPTTIP		BR	D	FL	D	I			30	15	8	7	12	6
13	JEN	IH	IND	UPT	MP	CO		FL	LR	S			40	25	10	10	16	9
14	MAD	HG	QT	UPT	MP	CO		FL	LR	S	PLFPL		42	29	6	8	11	4
15	CLI	HG	O	UPT	MP	CO		FL	LR	SI	PLFC		34	20	8	7	12	6
16	THO	IH	O	UPT	EMP	CO		BL	LR	SI	PLFF		37	16	4	4	6	2
17	PAN	IG	O	UPT	MP	CO		FL	LR	S	PLFF		23	20	5	9	14	5
18	BYR	HG	H	UPT	MP	CO		FL	LPRP	S	PLFF		38	27	8	8	13	5
19	LEN	HG	T	UPT	EMP	CO		BL	LPR	I		RED	47	17	8	5	9	5
20	PAN	IG	O	UPT	DEJ S	CO		FL	TOT	SI	PLFF		30	24	7	10	17	7
21	PAN	IG	O	UPT	MP	CO		FL	LR	I	PLFF		29	19	6	7	12	6
22	CLI	HG	O	UPT	MP	CO		FLEV	LR	S	PLFF		38	25	8	10	16	5
23	JEN	HG	O	UPT	MP	CO		FL	LPRP	I	PLFR		32	19	6	8	12	7
24	THO	IH	O	UPT	DEJ S	CO		FL	LRPV	SM	PLFF		23	22	4	10	17	2
25	JEN	HG	O	UPT	MP	CO		FL	LPRV	I	PLFF		36	15	10	5	9	6
26	LIN	IG	O	UPT	MP	CO		FL	LR	I	PLFF		39	22	11	6	8	6
27	CLI	IG	O	BPT	MP	CO		FL	LR	I	PLFC		43	18	9	7	11	7
28	CLI	IG	O	BPT	MP	CO		FL	TOT	I	BD	RED	39	21	7	8	11	6
29	LEN	IG	T	UPT	EMP	CO		BL	LRP	S	PLFPL		76	26	8	7	9	7
30	THO	IH	O	UPT	MP	CO		FL	LR	I	PLFF		36	22	7	6	10	5
31	BYR	HG	O	UPT	MP	CO		FL	LR	I	PLFF		38	20	7	7	9	4
32	LEN	IG IF	T	UPTTIP		BR	D	FL	LPR	SM			-20	-9	-6	5	8	5
33	LEN	HG	O	UPT	MP	CO		FL	LR	I	OVAL	RED	46	21	9	7	12	6
34	CLI	I	T	UPT	MP	CO		FL	LR	I	PLFF		35	25	10	7	14	10
35	JEN	HG	T	UPT	EMP	CO		FL	LRP	S	PLFF		56	32	12	6	9	6
36	JEN	IG	O	UPT TIP		BR	D	FL	D	I			-24	-19	-9	7	11	8
37	JEN	IH	T	UPT TIP		BR	D	FL	D	S			-26	-24	-6	11	15	6
38	CD	Q4	O	PT		BR	MD	BLT	LR	A	BR		-13	5	2	4	5	1
39	CD	O4	O	PT TIP		BR	D	BLT	LR	A	BR		-9	9	2	6		
40	CD	P6	O	PT		CO		BLT	LR	A	PLFP		15	5	1	4	5	1
41	CD	P6	O	PT		BR	MD	BLT	LR	A	BR		12	5	1	4	5	1
42	CD	M4	O	PT		CO		BLT	LR	A	PLFPL		17	6	2	3	5	2
43	CD	M4	O	PT		CO		BLT	LR	A	STR		14	6	2	4	6	2
44	CD	N4	O	PT		CO		BLT		A	BR		12	6	2	4	6	2
45	CD	N5	O	PT		CO		BLT	LR	A	PLFP		15	7	2	5	7	2

46	CD	O5	O	PT		CO	BLT	LR	S	PLFF		14	6	2	5	6	2
49	CD	M5	O	PT		CO	BLT	LR	A	FIL		13	5	1	4	5	1
50	CD	N3	O	PT		CO	BLT	LR	A	PLFF		20	9	2	6	8	2
51	CD	N3	O	PT		CO	BLT	LRP	A	PLFP		14	7	3	5	7	3
52	CD	P4	O	PT		CO	BLT	RP	A	PLFF		15	7	2	4	6	2
53	CD	P4	O	PT		ACO	BLT	LPRP	A	BR		-17	10	2	6	8	2
54	CD	N4	O	PT		ACO	BL	LR	A	BR		27	9	2	4	5	2
55	CD	O4	O	PT		ACO	BLT	LR	A	PLFP		15	8	1	5	7	1
56	THO	HG	O	UPT	MP	CO	FLEV	LR	I	PLFF		29	24	7	11	17	5
57	PAN	IG	O	UPT?	EMP	CO	BL	L	IM	PLFBR		46	18	7	8	11	5
58	LEN	HG	T	LIMACE		CO	BL	TOT	I		RED	54	19	10	7	10	10
59	PAN	IG	O	UPT?		CO	FL	L	S	PLFF		24	21	4	9	15	4

Table 5.2. List of abbreviations used in Table 5.1

RAW MATERIAL

O = opaline H = hornfels T = tuff
QT = quartzite S = sandstone QZ = quartz
IND = indeterminate

TYPE

UPT = unifacial point BPT = bifacial point PBPT = partly bifacial point

SUB TYPE

MP = Mousterian point EMP = elongated MP Dej S= dejete scraper

BREAKAGE

CO = complete BR = broken ACO = almost complete, only the very tip missing
IND = indeterminate

RETOUCH LOCATION

L = left (complete) R = right (complete) LP = left partial
RP = right partial D = distal retouch only V = on ventral face
TOT = all over ALT = alternate

RETOUCH TYPE

M = marginal S = short, medium I = invasive A = abrupt

Continuation: Table 5.2

FRAGMENT

B = base PM = proximal + mesial M = mesial D = distal

TIP = only the very tip

BASE

PLF = platform

BD = base completely removed by retouch, broad and curved

STR = base worked by retouch

PLFBR = broken platform

IND = indeterminate

PLFF = PLF facetted

PLFPL = PLF plain

PLFD = PLF dihedral

PLFR = PLF ridge

PLFFIL = PLF filiform

PLFP = PLF punctiform

PLFC = PLF cortex

VENTRAL BASE

RED = reduced (with bulbar thinning)

BLANK

FL = flake FLEV = Levallois flake BL = blade BLT = bladelet

MESUREMENTS

L = length

B = breadth

Continuation: Table 5.2

B 5mm = breadth at 5mm from the tip

B 1cm = breadth at 1cm from the tip

TH = thickness TH 1cm = thickness at 1cm from the tip

Summary

There is intuitively a difference in the lengths, thicknesses as well as breadths of the two types of points as is indicated by the above discussion of the results of these measurements.

Cross-sections and edge angles of the broad, thick points

The cross-sections of the broad, thick points range from 0.4 to 1.9 cm and the mean cross-section is 0.81 ± 0.33 cm (see Fig. 5.7). The smallest tip angle of this type of points is 43° while the largest tip angle is 95.5° and the average penetrating angle of the thick, broad points is 74.1 ± 12.6° (Fig. 5.8).

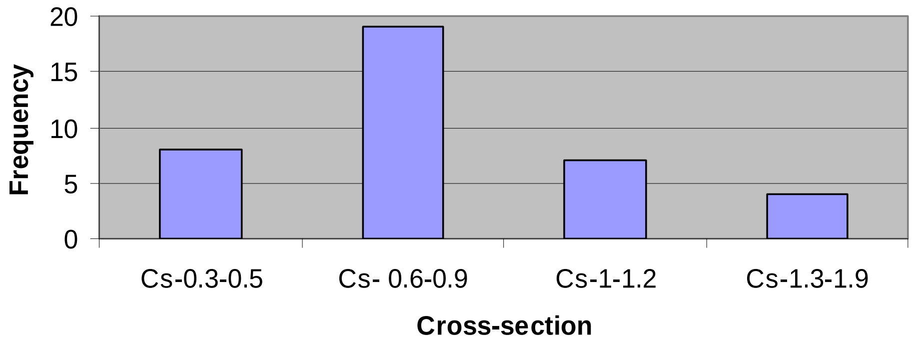

Fig. 5.7 Frequency distribution of thick, broad points cross-sections (in cm)

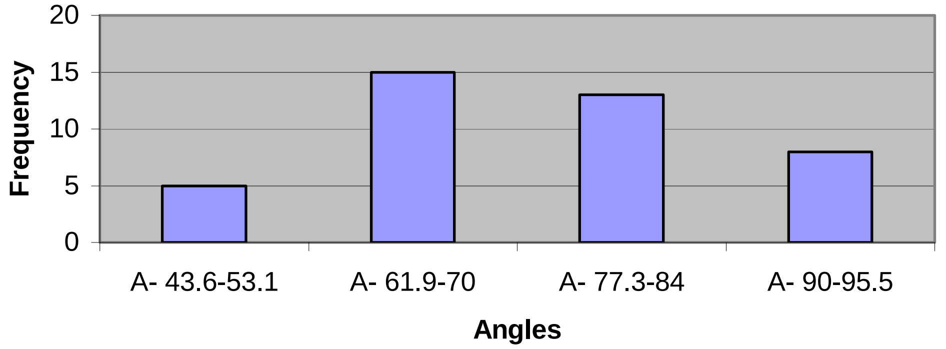

Fig.5. 8 Frequency distribution of thick, broad points tip-angles (in degrees).

<u>Cross-sections and edge-angles of the Dc points</u>.

The Dc points have cross-sections that range between 0.03 and 0.11 cm and they have a mean cross-section of 0.1 ± 0.03 cm (see Fig. 5.9). These points have tip angles which range from 33.4° to 61.9° and the average penetrating angle of the Dc points is 48.8 ± 8.3° (Fig. 5.10).

<u>Summary</u>

As is the case with the previous results, it is clear that there is a huge difference between the cross-sections and penetrating angles of the Dc points and the other post-Howiesons Poort points.

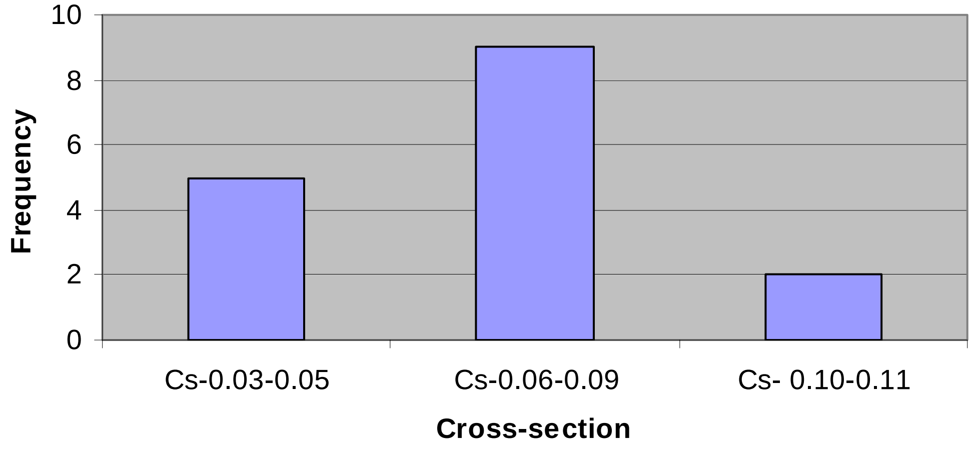

Fig. 5.9 Frequency distribution of Dc cross-sections (in cm)

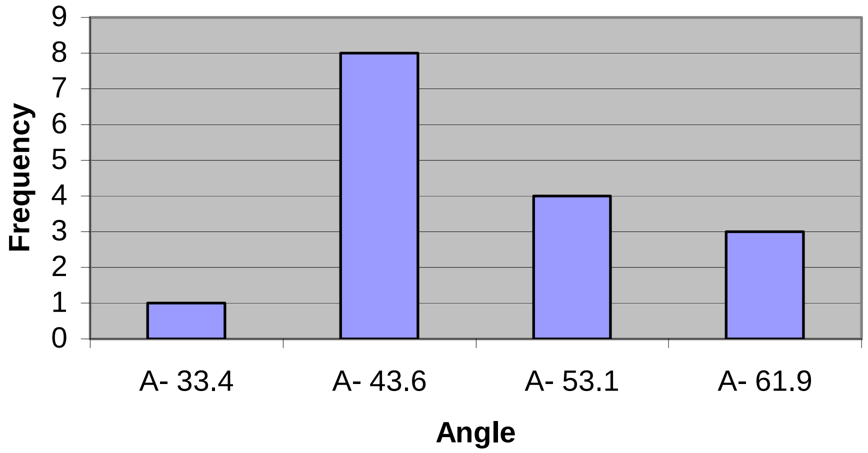

Fig. 5.10 Frequency distribution of Dc tip-angles (in degrees).

Raw materials: the thick, broad points.

There are only four types of raw materials from which the various post-Howiesons Poort points, excluding layer Dc, have been produced, namely: opaline, hornfels, tuff and quartzite. The most commonly used among these raw material types is opaline because out of the 43 points analysed, 25 are made from opaline. Following opaline is tuff (eight points), hornfels (five points) and quartzite is the least common raw material because there is only one point made from this raw material. There are also two points whose raw materials cannot be determined and so they have been put into a category of **indeterminate (IND)** (see Table 5.1).

Raw materials: Dc points.

All the 16 Dc points are made of clear opaline.

Summary

Of all the four raw material types from which both the Dc points and the other post-Howiesons Poort points are made, opaline is definitely the most common one.

Blanks and bases: the thick, broad points.

The thick, broad points have been produced from three types of blanks, namely: flakes (ordinary) (Fig 5.11), levallois flakes (Fig. 5.12) and blades. The majority of these points is produced from ordinary flakes. Points produced from flakes constitute 83.7% of this type of points. The rest of the points are produced from levallois flakes, which only constitute 9.3%, and from blades (7%) (see Table 5.1).

The thick points have different types of bases from the Dc points as is indicated in Table 5.1. The most common of these seems to be the facetted platform (PLFF) (Fig. 5.13) because 18 out of the 43 points from the various post-Howiesons Poort layers have this type of base. The other types of bases are not so common in these points. For instance, only three points have bases with plain platforms (PLFP) (Fig 5.14) while another three have bases completely removed by retouch and these bases are broad and curved (BD). There are also points with bases that have platforms with cortex (PLFC) (two) and one has an oval base and one a broken platform (PLFBR). Lastly, eight of these points have reduced ventral bases (RED) (Fig. 5.15).

Blanks and bases: Dc points.

There are only two types of blanks from which the Dc points are produced, namely: bladelets and blades. Almost all these points are made from bladelets except for one, which is made from a blade. Most of the Dc points have BD bases (six out of 16) and these are followed by punctiform platform (PLFP) bases (four). PLFF bases are found in three of the 16 points. The remaining three points have a straight base worked by retouch, a filiform platform (PLFFIL) base, and a PLFPL base (see Table 5.1).

Summary

The small Dc points and the broad points from the other post-Howiesons Poort layers are different with regard to the types of blanks from which they are produced as well as the bases they have. The majority of the former are made of bladelets, with the exception of one point made on a blade. The post-Howiesons Poort points have flakes as the dominant blank type. Blades are uncommon blank types and bladelets are absent.

Most of the post-Howiesons Poort points have bases with facetted platforms while blade (BD) bases are the most common amongst the Dc points. Another difference between the two types of points is that some of the Dc points have filiform platform (PLFFIL) and punctiform platform (PLFP) bases which the other type of points do not have. In addition, some of the latter have platforms with cortex (PLFC) and oval bases as well as reduced ventral bases while none of the former has such bases (see Table 5.1).

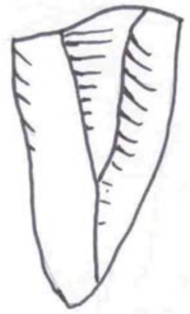

Fig. 5.11 Ordinary flake without retouch.

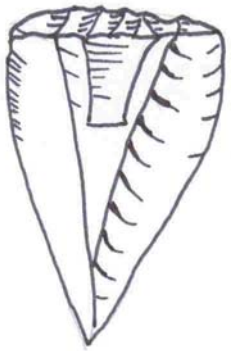

Fig. 5.12 The dorsal side of a covergent Levallois flake.

Fig. 5.13 Point with multi-facetted platform, ventral side.

Fig. 5.14 Point with a plain platform, ventral side.

Fig 5.15 Ventral side of a point with a reduced platform.

<u>Retouch type and location: the thick, broad points</u>.

The thick points have various types of retouch, namely: invasive (I) (Fig. 5.16), short (medium) (Fig. 5.17) (S) and marginal (M) retouch. Of these, the most common types seem to be short and invasive retouch because out of the 43 points analysed, 19 have short retouch and 18 have invasive retouch. There are also three instances where the two types of retouch have been combined. Marginal retouch is the least common type of retouch in all the cases where it has been used; it has been used together with other types of retouch (see Table 5.1).

Fig. 5.16 Invasive retouch on point dorsal side.

Fig. 5.17 Short retouch on the dorsal side of a point.

Most of the thick points are unifacial (see Fig. 5.18 and Fig. 5.19). Of the 43 points in this class, 39 are unifacial while only two each are bifacial (Fig. 5.20a and 5.20b) and partly bifacial. Most of these points (17) have retouch on the left and the right laterals (LR). In some cases the retouch is not found on the whole side, it is sometimes left partial (LP) or right partial (RP) and there are ten points with retouch that is located in this way. There are also six points which have retouch all over (TOT) and also two broken points that only have distal (D) retouch.

Fig. 5.18 Unifacial Mousterian points from Rose Cottage Cave.

Fig. 5.19 Unifacial Elongated Mousterian Points from Rose Cottage Cave.

Fig. 5.20a The dorsal side of a bifacial point from Rose Cottage Cave.

Fig. 5.20b The ventral side of a bifacial point from Rose Cottage Cave.

Retouch type and location: Dc points.

There is only one type of retouch that has been used on the Dc points, namely: abrupt (A) (Fig. 5.21) and all the points only have retouch on the dorsal side (see Fig. 5.22) Retouch is mostly found on both the left and right side (LR) (12 points out of 16). The rest of the Dc points have retouch on the following locations (one each): distal end, LRP, LPRP and RP (see Table 5.1).

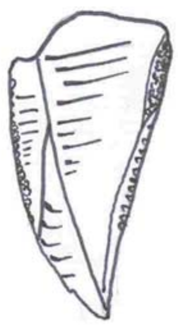

Fig. 5.21 Abrupt retouch on the dorsal side of a point.

Summary

As has been the case with the size measurements, the Dc points differ from the post-Howiesons Poort points with regard to the types of retouch found on them. As has been indicated, the retouch types used in Dc and the other post-Howiesons Poort layers are mutually exclusive. Another difference is that while there are some bifacial or partly bifacial points found in the other post-Howiesons Poort points layers, none of the Dc points is bifacial. The only thing that seems to be shared between the two types of points is the most common location of retouch, that is, Left-Right (LR). Additionally, in both types, there are instances of partial retouch on one side or even on both sides of the dorsal face.

Fig. 5.22 Some representative Dc points.

CHAPTER SIX

<u>DISCUSSION</u>

> Change in artifact form has traditionally helped archaeologists to place material assemblages in time and space. Form comprises the shape and surface configuration of an item including factors of size and decoration. Form changes as different materials, techniques, and actions or movements are employed to produce material culture (Larick 1985: 206).

It is clear from the above quotation that change in artifact forms happens for a reason. In other words, there is always some factor that is accountable for prompting change in material culture when such change is observed in archaeological assemblages. It is also clear from the above quotation that this change can be attributable to a number of factors, which can be economic or utilitarian and social, that is, cultural or symbolic. Ethnographic work among the Kalahari San of Botswana has shown that arrows have far more than functional significance, they also convey social information (Hitchcock & Bleed 1997). According to Larick (1985), the change in spear forms among the Masaai people of the Samburu District in Kenya was at a rate too random for utilitarian use. Instead the factors influencing change were symbolic because in this society the form of a man's spear readily communicated his economic, physical and social status. Therefore, "…a man's age grade (physical and social maturity), age set (birth cohort), and sequential position within his age set (junior/senior)" circumscribed the range of spears he could carry (*ibid*: 208).

However, in 1971, the change in spear forms within the Samburu society was due to a different factor, this time economic. The poaching of wild animals, especially elephants and rhinoceros became attractive to Kishili warriors when black marketers began to operate within the Samburu District. Because of the inexperience of the Samburu in hunting these animals, they had no techniques for hunting such large game. They therefore had to modify the shapes of their spear blades to prevent losing spears in unsuccessful kills (Larick 1985). Larick (1985: 209) points out that, “they filed the traditionally rounded blade bases to taper gradually into the neck of the foreshaft” so that the spears could move more easily out of shallow wounds. Larick (1985) further shows that these tapered-base blades developed into fashion that spread well beyond the few elephant hunters. This change of point forms due to change in hunting techniques has also been suggested by other scholars in an attempt to explain variability in projectile tips (Bleed 1986).

It is possible that similar changes took place in the past and that the differences, through time, in the Rose Cottage Cave points have an economic or social reason. This chapter attempts an interpretation of the results discussed in the previous chapter. As indicated earlier, there is a morphological difference between the Dc points and the thick, broad points. The two types of points differ with regard to length, thickness, breadth, penetrating or tip angles, as well as cross-sections. These points also differ in other attributes: for instance, the types of retouch used on them, the blanks from which they are produced and the types of bases. These differences between the older post-Howiesons Poort points and the younger Dc points mean that there was a technological change in manufacture. Point manufacturers shifted from producing thick, broad points with wider tip-angles to making smaller, thinner points with narrow angles.

In some cases, the form of raw materials and their availability or unavailability play a role in the change of artifact forms. For instance, Ellis points out that while some scholars explain the projectile point variation in terms of change in hunting techniques, or size of animals being hunted, and have used ethnographic data on projectile variability within certain groups as support:

> examination of these ethnographic references clearly shows that the changes in size and shape of projectile tips associated

> with different prey species almost always involved a shift in the material used to produce the tip…(Ellis 1997: 45).

Ellis (1997) further points out that the only ethnographic reference he has been able to find of possible variation in stone point form related to prey size has been among some North Alaskan Eskimo.

Tomka and Prewitt (1993) also indicate that the variability in stone points may be related to the form of raw material. For example, they show that the manufacture of a given point type from a coarse raw material such as small quartzite pebbles may result in thicker and smaller projectiles than the manufacture of the same type from highly siliceous, well-crystallized and larger flint nodules. However, in the case of Rose Cottage points, raw material is not the issue because the dominant raw material in both types of points is opaline, which probably occurred in cobbles (Clark 1997b). It is clear, therefore, that we cannot postulate that the change in technology was caused by the unavailability of a certain form of a particular stone type.

Size seems to be the best way to explain the differences in the two types of points and the choice of size was probably deliberate. I now examine the two types of points in association with the current literature on spear points and arrow points because the most logical explanation for the thick, broad points and Dc differences is functional.

<u>The thick, broad points.</u>

Knecht (1997) points out that large, heavy points have always been assumed to have been used as spear tips. In addition, Friis-Hansen (1990) points out that thrusting spears are "generally designed so they are easy to withdraw from prey, enabling a rapid second thrust to be delivered". This implies that the spear has to be strong, that is, thick, and have a broad tip to withstand breakage when being thrust repeatedly into an animal because, as Shott (2002) points out, size measures like weight and design measures like tip angle influence use life of a point. In addition, Ellis (1997) indicates that with regard to thrusting spears, “a delicate stone tip might be a liability because its usefulness could be more easily terminated by breakage”. He further shows that this breakage would be especially a liability in dangerous activities such as in hunting game like bears or in “hand to hand combat or in herd animal hunting, where repeated thrusts would be necessitated or at least favored” (Ellis 1997: 59).

Moreover, in Odell and Cowan’s (1986) experiments, heavier points are said to have generally lasted longer than thinner points when being thrust at animals. Tomka and Prewitt (1993) also show that the size of a point is determined by functional requirements and method of propulsion. They too support the notion that larger and heavier points were used as handheld spears. Even in recent times when metal is used to tip spears, thrusting spears are known to be thick and broader than thrown spears. For instance, thrusting spears used by a San group called Tyua in the Kalahari Desert of Botswana are said to be stout and thick (Hitchcock & Bleed 1997: 348).

Thick broad points from southern Africa seem to fall within the size range of spearheads that were thrust at prey. Villa and colleagues (in press) suggest that the Sibudu points are spearheads that were thrust at animals because their mean breadth is close to that of Clovis points which are known to be spearheads. The Sibudu points have a mean breadth of 27.2± 6.5 mm and that of the Clovis points is 28.7± 3.4 mm. The thick, broad points from Rose Cottage Cave have a mean breadth of 21.6± 3.9 mm and, although they are smaller than both Sibudu and Clovis points, they are probably also parts of thrusting spears. Certainly, they were too large to have been arrowheads. Their smaller size than the Clovis or Sibudu points is probably related to nodule size of opaline on which they were made.

The thick, broad points from Rose Cottage Cave fit the description of thrusting spears too, because they have big tip-angles, their average angle being 74.1 ± 12.6°. They are thick, their average thickness is 7.4 ± 2.1 mm. It is therefore highly likely that the Rose Cottage Cave broad, thick points were used to tip thrusting spears.

The Dc points.

With regard to size, the Dc points form Rose Cottage Cave are small. They have an average length of 15.6 ± 4.0 mm, an average breadth of 6.9 ± 1.7 mm and an average thickness of only 1.8 ± 0.5 mm. Their average tip angle is 48° ± 8.3°. The Dc points seem to fall within the range of arrow tips, both in terms of size as well as other attributes such as retouch type and the type of blank from which they were produced. For instance, they fit the description of microlithic points found on the Powell Mesolithic site in southern England and throughout much of northern Europe, in the early post-glacial period, where actual examples of hafted points have been recovered from waterlogged deposits (Barton & Bergman 1982). Experiments have validated the suggestion that these Powell points were used as arrowheads. Just like the Powell points and other northern European points, the Dc points are made on bladelets with generally straight profiles (see Table 5.1). Furthermore, as is the case with the Powell points which are said to be usually shaped by semi-abrupt or abrupt retouch, all the Dc points are shaped with abrupt retouch (see Table 5.1) (*ibid*: 238).

In the literature (Hewitt 1934; Patterson 1985; Whittaker 1987; Shot 1993), small points such as these have been known to be arrow points, it is therefore, very likely that these points were used to tip arrows. Patterson (1985) notes that there is a direct functional reason why arrow points are generally smaller than spear points and this is based on their ballistic performance. Patterson further shows that:

> An arrow is a relatively light projectile, compared to a spear. A fairly modest change in weight of the arrow point can significantly change the center of gravity (balance) of a lightweight arrow… (1985: 81)

Patterson (1985), therefore, suggests that weight is an important attribute for the classification of arrow and spear points (*ibid*: 81). Points were not weighed in this study, however, in future, they should be weighed.

According to Whittaker (1987), the most common lithic tools in Grasshopper Pueblo, a late Mogollan site near Cibecue on the Fort Apache Indian Reservation in east-central Arizona, are small triangular projectile points. These triangular points are said to be arrow points which are common in the late prehistoric Southwest (*ibid*: 4). Jelks (1993) points out that the standard practice has always been that small light points which appeared late in North America`s prehistory are arrow points. Tomka and Prewitt (1993) also indicate that smaller and lighter points are suitable for use as arrow tips. Moreover, Thomas's (1978) functional analysis used by Shott (1993, 1997) to determine functions of points from Childers and Woods, Late Woodland sites in Virginia, classified small triangular bifaces as arrow points. This validated the common assumption that these points were indeed used to tip arrows (*ibid*: 432).

In addition, the Dc points are also within the size range of Later Stone Age arrowheads described by Hewitt in his 1934 publication. The first of these points is from the Farm De Hoop and is described as a pedunculate arrowhead made of chalcedony. The tip of this point is broken and so even though it has a length of 19.3 mm the original length could have been 23 mm. The point is 9.3 mm wide and has a thickness of 2.7 mm (*ibid*: 521). The second point described by Hewitt (1934) is from a Windmill site, Thaba Nchu Commonage and is also missing a tip and is made of chalcedony. It has the following measurements, 10.4 mm-length (original length could have been 15 mm or more), 8.5 mm-width and 2.5 mm-thickness. The last two points described by Hewitt (1934) are both made of quartz and are from Farms Platrand and Khabanyana. The former has a length of 11 mm, width of 8 mm and a thickness of 3.2 mm while the latter measures 21mm-length, 10 mm-width and 3 mm-thickness. All these points have measurements which fall within the range of those of the Dc points (see Table 5.1 for comparisons) This supports the suggestion that the Dc points could have been used as arrowheads.

Implications for a Change from Spear Hunting to Bow and Arrow Hunting.

Spear Hunting

If the change in the hunting strategies of Rose Cottage Cave MSA hunters led to change in the technology of tool/weapon manufacture, it is also possible that it led to other changes, possibly social and economic. A number of scholars have proposed that thrusting spears were used for hunting mostly large animals. One of these scholars is Ellis (1997: 46) who, based on ethnographic and ethnohistorical work, points out that "all spears historically, whether stone-tipped or not, and with only the odd exception, were used on 'larger game' or in warfare". Ellis (1997: 46) goes on to show that the association of spears with large game is probably a product of the fact that it is much easier to successfully procure smaller game with simpler equipment such as throwing sticks or slings, or with the aid of traps or, "in the many historically known societies where it is also available, the bow and arrow". The Mbuti hunter-gatherers in the Ituri forest in Zaire (now known as The Democratic Republic of Congo) also used spear hunting when aiming at large animals such as elephants and buffalo (Terashima 1983).

Hitchcock and Bleed (1997) have also indicated that some San groups from the Kalahari Desert in Botswana have said that they hate to go after large animals with bows and arrows but preferred to use spears. In fact, one of these groups, the Tyua, were and are known to use spears for hunting large animals such as giraffe, rhinoceros and elephants. Hitchcock and Bleed (1997: 355) quote Mohr (1876: 355) as saying that in the 19th century the Tyua "seemed to be the pride of their masters, the Bamangwato, for whom they had swept this country of all the elephants with their spears alone". Among these people, spear hunts were undertaken not only for the purposes of obtaining meat, skins and other materials but were also carried out for social purposes. Before marriage the Tyua first had to prove to their prospective fathers-in-law that they were good hunters. Even bride price among these people was paid in the form of several large animals, preferably eland or gemsbok (*ibid*: 355). The Tyua and other San groups gave one of their reasons for using spears in hunting as their superiority for killing larger animals (*ibid*: 355).

Because thrusting spears were mostly used in dangerous situations, that is, in hunting large, dangerous animals or even gregarious prey, they were mostly used in group hunting. In support of this, Ellis (1997) shows that in order for hunting to be successful and to avoid injuries to hunters or even deaths caused by the animals they hunted, hunters had to form parties when spear hunting. Terashima (1983) also adds that spear hunting involves such great risk that it cannot be an ordinary hunting method used by individuals, it therefore has to be done by parties of hunters.

Moreover, S. Binford (1968 as cited in Chase 1991: 325) concluded on the basis of the faunal data from the Levant that towards the end of the Middle Palaeolithic, there was hunting of large herbivores during their seasonal migrations between the coastal plains and the highlands. She believed the hunting of these animals would have required cooperation of large numbers of adult males and therefore the sizeable aggregation of large herds (*ibid*: 325). Although Binford does not specify what types of weapons were used for hunting these herds of large prey, her suggestion supports the notion that hunting big animals required cooperative hunting and we do know that in southern Africa, these animals were hunted using spears (Chase 1991: 325). Wadley (1998) is also of the opinion that spear hunting is likely to have relied on large group size for game drives.

The Rose Cottage Cave spear hunters may have conducted themselves in the way that the Kalahari San and other spear hunting groups discussed above did. It is therefore possible that they too used cooperative hunting when using spears because as Wadley (1987: 93) points out, “there is convincing evidence that symbolic as well as technological continuities exist between southern African Stone Age people and modern San”. It therefore follows that if there are similarities between the Kalahari San and the other spear hunting groups discussed above, then, they too can be used to explain archaeological data or to make inferences about Rose Cottage Cave spear hunters. If this was the case, it is likely that Rose Cottage spear hunters lived in a large band, of even up to a hundred people, for purposes of uniting in meat procurement as other groups have done. As Wadley points out:

> Pleistocene people may have conducted themselves rather like the Ju/'hoansi in the elephant hunt described by Lee, or perhaps like the Mbuti net hunters. Mbuti band size averages between 50 and 60 people, which allows efficient net hunting by 10 or 11 men carrying spears and nets and a similar number of women who drive the game… Mbuti cannot have dispersal camps with fewer than 20 adults because this is the minimum number needed to hunt effectively. If a male-only hunting party was employed for net hunting, a band size of well over 100 would have been a requirement. Presumably spear hunters not using nets would have needed even more personnel than the Mbuti, and it seems unlikely that nets would have been employed in the Pleistocene spear hunts of southern Africa (Wadley 1998: 76).

Wadley (1998) also argues that judging by the sizes of southern African caves and shelters occupied during the Pleistocene, it is possible that not only men engaged in cooperative spear hunting. She argues that band sizes of southern African cave sites and shelters are unlikely to have been larger than the Mbuti hunters because many of these sites could house only between 50 and 60 people while some would not have accommodated more than about 30 people. Because she does not see how the people occupying these shelters could have organized drives and spear hunts without using women's labour, she argues that women were likely to be part of cooperative spear hunts (Wadley 1998). Since Rose Cottage is one of the southern African sites that were occupied during the Pleistocene, it is also likely that women took part in spear hunts organized by the inhabitants of this cave too.

In summary, it would seem that spear hunting was used by relatively big groups of hunters for the cooperative hunting of large game.

Bow and Arrow Hunting

If thrusting spears were used for hunting large animals and spear hunting required cooperative hunting, was it the same case with bow and arrow hunting? Bow and arrow hunting seems to have served a different purpose from spear hunting. Studies conducted by other scholars have indicated that bow and arrow hunting was used mostly in the hunting of small game (Terashima 1983; Ellis 1997; Hitchcock & Bleed 1997; Wadley 1998). Terashima (1983) notes that the Mbuti hunters use bow and arrow hunting when pursuing small animals such as porcupines and mongooses.

Furthermore, in contrast with spear hunting, bow and arrow hunting does not seem to have required large hunting parties. When doing ethnographic work among the Kalahari San of Botswana, Hitchcock and Bleed (1997) observed that among the Kua, (one of the San groups), bow and arrow hunting is often done in pairs. Terashima (1983) also points out that individual bow and arrow hunting is the basic pattern of the Mbuti hunting activity. He indicates that "a hunter sometimes goes strolling in the forest with a bow and arrows, usually without any particular purpose, and hunts whenever the opportunity presents itself" (Terashima 1983: 73).

Using these present hunters as our models, we can imply that there was possibly social change among the Rose Cottage hunters once they began using the bow and arrow technique. Wadley (1998) suggests that demographic change is evident in the early Holocene when extensive arrow use is evident and she argues that this is implied by a noticeable increase in the occupation of rockshelters and caves that can hold no more than ten to 15 people thus implying "a demographic shift to smaller bands of higher densities" (ibid: 77). This decrease in the numbers of people occupying camps could have been due to the fact that arrow hunting does not rely on large group cooperation but may be effectively conducted by individuals or small groups (Wadley 1998). Wadley (1998) goes on to show that the shift to individual or small group hunting with bow and arrow involved a shift to individual or family-based meat "ownership". The new evidence presented here suggests that at Rose Cottage bow and arrow hunting could have began even earlier during the Pleistocene; it is possible that it resulted in the replacement of the meat sharing rules that applied during spear hunting by individual or family-based meat ownership.

Bow and arrow hunting has always been associated with the use of poison (Allchin 1966; Ellis 1997; Hitchcock & Bleed 1997). The use of poison with the bow and arrow has probably been due to the fact that in most cases arrow tips were not designed with the intention of inflicting serious wounds but were designed as transporters of poison to prey. In support of this, Hitchcock and Bleed (1997: 354) indicate that "poisoned arrows have neither knock-down power nor the ability to open a serious bleeding wound. Their intended function is simply to introduce the poison".

In addition, Ellis (1997) shows that ethnographic literature suggests that almost all groups use some sort of poison when engaging in bow and arrow hunting. For instance, in California, the Great Basin and the Plateau, it was apparently a common practice to cover points with a variety of concoctions designed to enhance the effectiveness of the weapon (*ibid*: 55). These concoctions included "combinations of rattlesnakes' venom, urine, crushed insects, deer's liver, deer or rabbit's blood, and several other ingredients" (Ellis 1997: 55). Hitchcock and Bleed (1997) also point out that the research done on the biochemical composition of San arrow poison indicates that much of it was made from the larvae of a beetle and that it is highly toxic. It is highly likely that the Dc arrow points were also used with poison especially when looking at their morphology and size. These points are small (the average breadth and thickness of these points are 6.9 ± 1.7 mm and 1.8 ± 0.5 mm, respectively) and have narrow penetrating angles (the average tip angle being 48.8 ± 8.3°) and it is unlikely that they could have inflicted serious wounds on animals and so were probably just transporters of poison. Future residue analyses may be able to test this hypothesis.

According to Shott (1993), it has been suggested by some scholars that bow and arrow hunting was more effective than spear hunting and therefore more economically profitable. However, Shott (1993) does not agree with this. He argues that even though arrows are easier to use in close quarters and may be fired rapidly, are made fairly easily and require little raw material, gauging economic performance on ballistic properties is difficult (*ibid*: 436). Shott (1993: 437) further argues that controlled experiments of spear hunting and bow and arrow technique are not "faithful to the empirical conditions in which the respective weapons were used" and therefore cannot be taken to be a good basis for making effective comparisons of the two hunting techniques.

Shott (1993), however, points out that ethnographic data present a better understanding of spear hunting and bow and arrow hunting. He shows that ethnographic cases have shown that although hunting with spears is generally confined to a few resource species, such targets are generally large bodied thus yielding high returns to hunting effort (Shott 1993). In contrast, even though the bow and arrow is known for the great majority of diverse kills, these are considerably smaller on average than spear kills (*ibid*: 437). Shott (1993: 438) therefore concludes that "a simple comparison of bow-and-arrow and spear hunting can be as misleading as experimental studies, because the two techniques are not necessarily used in the same contexts".

Another factor that shows that bow and arrow hunting is not necessarily the most effective technique in comparison with spear hunting is that arrows (especially poisoned ones) kill very slowly and animals once hit must be tracked by the hunters (Hitchcock & Bleed 1997). The recovery of wounded animals by tracking is apparently not a certainty. Reported recovery rates vary from about 30-70% with lower figures in areas with high densities of predators and scavengers (*ibid*: 354). In support of this, Hitchcock and Bleed show that:

> Often tracking goes on for long distances. Sometimes hunters will note the tracks of the wounded animal and go back to camp and rest before resuming the hunt. The chances of recovery of a wounded animal depend in part upon where it was hit by the arrow, the virulence of the poison, and the animal's physical

> condition. If the hunters are fortunate, they will come upon the dying animal before other predators such as lions or hyenas do (1997: 354).

Hitchcock and Bleed (1997) indicate that the probability of recovering prey hit by spears is, on the other hand, higher than that of prey hit by poisoned arrows because, in spear hunting, animals die more quickly. They, however, point out that spear hunting, too, has its drawbacks. For instance, hunters face the risk of being injured or even killed by dangerous animals such as buffalo and gemsbok, which have horns, because they must get close to the animals to dispatch them (*ibid*: 356).

It has also been noted that spear hunting is an effective method throughout the year while bow and arrow hunting is restricted to certain times of the year (Wadley 1987; Hitchcock & Bleed 1997). For example, bow and arrow hunting among a San group, G/wi, is limited to the wet season aggregation camps when they have two different types of arrow hunt, that is, the day trip and the 'biltong hunt' which involves men being on camp for several days (Wadley 1987). The reason why bow and arrow hunting is restricted to the wet season is that during the dry season, poison supplies are exhausted and toxicity levels are reduced (Hitchcock & Bleed 1997).

Summary

The broad, thick points from Rose Cottage seem to be within the range of spearheads in the literature while the Dc points seem to be within the range of arrowheads. It is therefore likely that the former type were used as handheld spear tips while the latter were used as arrow tips. The use of these points in these ways could have resulted in social change from large bands associated with spear hunting to much smaller bands associated with bow and arrow hunting.

It is also clear from the above discussion that bow and arrow hunting and spear hunting both have their advantages and disadvantages and would therefore have complemented each other whenever possible in the past. If Dc points were used as arrow tips and the thick, broad points were spearheads, it is possible that this was also the case at Rose Cottage Cave. It is likely that even after the introduction of the bow and arrow, spear hunting was still in use in situations where bow and arrow hunting could not be used such as during the dry season or when hunting large-bodied animals.

CHAPTER SEVEN

CONCLUSION

This study was intended to examine the morphological differences between two different types of lithic points from Rose Cottage Cave. It was considered that this would, in turn, help to examine the possibility that the thick, broad points from the various post-Howiesons Poort layers were used to tip thrusting spears while the thin, narrow points, introduced after 30 000 years ago, were used to tip arrows that may have transported poison to prey. To achieve the objectives of the study, a technological analysis was used. Length, breadth and thickness were measured and penetrating angles as well as cross-sections of the tools were calculated.

The results indicate that the two types of points are very different. For instance, the type of blanks from which they were produced and the type of retouch found on them completely differ. The points also differ with respect to size, especially that of their penetrating angles, with the Dc points having smaller dimensions than the other group. All these attributes have been taken to be indicative of a change in technology at Rose Cottage towards the end of the MSA. It is suggested that this change in manufacturing technology could have been prompted by the change in hunting techniques or a change in animals hunted. Unfortunately, we cannot test the idea that the prey changed because Rose Cottage does not have bone preservation in the MSA.

After comparing the results of the point analysis with descriptions of other points in the literature, I propose that the thick, broad points were more likely to have been used as spearheads for thrusting spears while the Dc points were more likely to have been arrowheads. This proposition is a result of the fact that the former type is within the range of handheld spear points described in the literature while the latter seems to be within the range of arrow points.

If this was the case, there is a possibility of social change in Rose Cottage as hunting techniques changed. Spear hunting would have resulted in large aggregation groups that stayed together for purposes of cooperative hunting of large animals. These bands would not have needed rules that governed the distribution of meat because meat would have been communally owned and everyone would have been present at the hunt to share meat on the spot. However, with bow and arrow hunting, there would not have been a need for cooperative hunting as the animals hunted would have been generally small-bodied and less dangerous compared to large-bodied prey. This would have resulted in the decrease of large camps because people could hunt individually or in much smaller groups and so there would not have been a need for living in large bands. It is possible that as large groups were replaced by family-sized groups, individual or family ownership of meat could have been introduced.

It is also possible that as was the case with a majority of arrows from different parts of the world, the Dc points were also used with poison. This is especially possible when looking at the small size of these points. It is highly unlikely that they could have inflicted any serious wounds on game, therefore they could have just been transporters of poison. Moreover, if these points were indeed used as arrowheads, it is possible that bow and arrow hunting was introduced earlier than thought in Africa, that is, during the MSA rather than in the LSA (Wadley 1998).

It would have been good to know the type of animals that were present at Rose Cottage Cave during the MSA. However, preservation of Pleistocene bones is poor at Rose Cottage, therefore, one can not tell whether there is any general pattern of animals inhabiting this site during the use of the broad, thick points and also during the use of Dc points. This would help to test the hypothesis that spears were used with larger animals while arrows were used with smaller animals.

For future prospects, edge and residue analysis of the Rose Cottage points should be conducted to see whether they were used for functions besides hunting and whether the small points have poison in them.

APPENDIX I

CALCULATING MEAN, STANDARD DEVIATION, CROSS-SECTIONS AND TIP ANGLES IN EXCEL.

Example 1: Mean breadth of all the post-Howiesons Poort layers without Dc.

To calculate the mean breadth, the column with breadth figures was selected from the sheet with all the data (Table 5.1) and pasted into a new data sheet in Microsoft Excel. All negative values were removed from the data and the data was then sorted by ascending value. Then I went back to the Data menu and pressed Pivot Table, selected Layout and dropped B (breadth) into both columns (Excel automatically calculates Sum, but this is not needed). The next step was pressing Table Field List (on tool bar) and selecting count (this gives the grant total number). I then went to Table Field List again and selected average (mean).

Standard Deviation of the breadth

To calculate standard deviation I just continued from the last step of calculating the Mean breadth and pressed Table Field List, selected Standard Deviation).

Mean length, Mean thickness and their standard deviations

The same procedure as used above was followed, only that this time the columns selected from the data sheet were for length and thickness.

Calculating the Cross-sections.

To calculate the cross-section, the two columns B and Th were highlighted together in the data table (Table 5.1), copied and pasted on a new worksheet. The formula =(A2/2)*B2 was used to give the cross-section area (A2 is the thickness of the first thick point and B2 is its breadth). Thus thickness (A2) was divided by 2 and the result was multiplied by the breadth (B2). The same procedure was followed on the rest of the cells.

For calculating the mean and standard deviation of the cross-sections, the same procedure as the one used for calculating the mean and standard deviation of the breadth was followed.

The same procedure that was used in calculating all the values above was followed for Dc.

Example 2: Calculating the tip angles for Dc, their mean and standard deviation

To get the tip angles of Dc points, I multiplied angle B by 2 because B is only half of the angle. First I had to get the A angle. The column B 5mm was selected from the data sheet (Table 5.1) and copied and pasted on a new worksheet. The next step was getting the tangent of A using the formula 5/(A3/2). To get the angle, the formula ATAN (B3)* 180/P1 () was used. The formula for calculating B is (90° - C3)*2 (C3 is the first A angle). The same procedure was then followed for calculating the rest of the angles.

For calculating the mean and standard deviation of the tip angles for Dc the same procedure used before was followed and this also applied in calculating the tip angles of the other layers.

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