

**University of Alberta**

Lithic technology and hunting behaviour during the Middle Stone Age in  
Tanzania

by  
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## **Dedication**

This dissertation is dedicated to the memory of my late father, brothers and sister, Mr. Cosmas Magayane, Medard Magayane, Crosper Magayane and Ms. Flora Magayane and my late father-in-law, Mr. Jonathan Mkandala, for their commitment to my education. Their encouragement and support led me to achieve my academic dreams. I pray that the Lord rest their souls in peace in heaven, Amen!

## **Abstract**

In this dissertation, I examine the representation of projectile points in the Middle Stone Age (MSA) and Later Stone Age (LSA) of Tanzania, and the way in which such tools were used over time and space. This study reviews the different strategies used to produce points during the MSA and LSA. It also examines the mechanisms involved in raw material procurement, hafting technology, and the use of these tools as projectile weapons and how they evolved over time. It is clear that there were different kinds of multi-weapon systems in use in Tanzania during the MSA, LSA and the transition between them.

The points examined here are from three archaeological sites: Mumba, Nasera and Magubike. The samples analysed here reveal that triangular blanks were preferred for the production of points. Most of them were modified on their proximal ends to provide a suitable binding portion for hafting as well as for aerodynamic movement. Results from the Tip Cross Section Area (TCSA) and weight values suggest that spear and arrow projectiles coexisted in these three sites during the MSA and MSA/LSA transition. Both local and exotic rocks were used for the production of points. In previous studies, the appearance of exotic rocks in the archaeological assemblages was correlated with trade and exchange. But here the use of exotic rocks seems to be influenced by functional values such as durability, sharpness and brittleness.

Sharp and durable rocks such as chert and quartzite were needed for spears because of their high compression strength. This makes them better able to withstand unintentional breakage after being stressed by the force of impact.

Points made of brittle rocks, such as quartz and obsidian, were mainly used for light duty projectiles such as throwing spears (darts) and arrows, because they penetrate the body of an animal better and sometimes break more easily. The presence of points made of exotic or local rocks shows that functional variables were important for projectile technologies. The overall morphological and technological patterns revealed in this study suggest that foragers who made and used points had elaborate technological skills, abstract thinking and developed behavioural capability similar to those of other modern foragers.

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## CHAPTER 1: INTRODUCTION

### 1.1 Background information

The Middle Palaeolithic (MP) of Eurasia and North Africa and the Middle Stone Age (MSA) of sub-Saharan Africa are usually defined by the high frequency of radial and Levallois cores, Levallois flakes and retouched tools such as points and side scrapers (Goodwin and Van Riet Lowe 1929:95-145). Any chip, flake or flake fragment having at least one edge with secondary modification can be defined as a retouched tool (Mehlman 1989). The retouch may be unifacial or bifacial. Unifacial retouching involves modification on one surface of a piece, but bifacial retouching appears on both surfaces of a piece from opposite faces along the same edge (Mehlman 1989).

Sub-Saharan MSA occurrences range in age from 300,000 to 35,000 years ago (Clark 1988; McBrearty and Brooks 2000; Willoughby 2007). The MSA is associated with the appearance of the first anatomically modern humans, members of our own species, *Homo sapiens* (Bräuer 1992; Bräuer and Mehlman 1988). Genetic, fossil, and archaeological evidence, as well as new chronometric dates, strongly suggest that *Homo sapiens* evolved in Africa sometime between 200,000 to 150,000 years ago. They later extended their geographical range within and outside of the continent, completely replacing other archaic species of humans in Eurasia sometime between 60,000 and 25,000 years ago (Cann *et al.* 1987; Forster and Matsumura 2005; Macaulay *et al.* 2005; Mellars 2006; Willoughby 2007). The dispersal into Eurasia occurred around the beginning of the

sub-Saharan Later Stone Age (LSA) and is represented by the Upper Palaeolithic (UP) in Eurasia. The LSA is defined by the high frequency of bladelets, backed pieces, microlithic as well as geometric tools and ranges in age from between 60,000 and 8,000 years ago (Ambrose 1998, 2001, 2002, 2003; Skinner *et al.* 2003).

Culturally, the MSA is regarded by many Africanist archaeologists as the period in which complex lithic technology, efficiency and intensity of food acquisition, and symbolic cultural patterns evolved for the first time (Henshilwood and Marean 2003; McBrearty and Brooks 2000; Mellars 2005; Willoughby 2007). It is believed that advanced technological skills, along with more complex behavioural patterns, allowed people to sustain and to increase their range and population size in the midst of unfriendly environmental conditions. Together, this package of technological and social innovations is referred to as “behavioural modernity” (Mellars 2006). The technological and behavioural patterns of MSA humans have attracted attention from scholars and are still debated. Even though the human brain, and overall skeleton, was already effectively modern soon after the start of the MSA, their technology and behaviour patterns are often seen as inferior compared to those of their LSA descendants because their technology is similar to Neanderthal technology in Eurasia (Binford 1989; Klein 1999, 2000). Some scholars argue that complex technology, which involved the use of composite tools, arrowhead points and the colonization of harsh environments, must have appeared for the first time only during the LSA (Binford 1989; Klein 1999). Klein (1999) argues that this advancement was due to an abrupt change in

the human neurological system, something that cannot be easily revealed by anatomical studies.

## **1.2 The MSA and development of modern human behaviour**

Those who believe that modern human behaviour emerged for the first time during the MSA use technological inferences, such as the appearance of blade tools, end scrapers, points and consistency in tool edge modification as evidence for development of something new (McBrearty and Brooks 2000). These technological innovations are supported by the initial appearance of intensified evidence of symbolic behaviour such as beads and ochre. In addition, fish and shellfish were exploited for the first time in some of the MSA assemblages in sub-Saharan Africa, in places such as Blombos Cave, South Africa and Katanda in the Democratic Republic of Congo (DRC) (Henshilwood 2007; McBrearty and Brooks 2000; Yellen 1996). Some scholars believe that most, if not all, essential features of subsistence, culture, behaviour and technology that are found in the LSA can be traced back to the MSA (Clark 1988; Deacon 1989; McBrearty and Brooks 2000; Mellars 2005; Willoughby 2007, 2009).

Brooks *et al.* (2006) use the presence of pointed tools to argue for the increased competence of MSA people and also argue that their technological, behavioural, and food acquisition strategies were similar to those of LSA foragers. According to Brooks *et al.* (2006), the kinds of spearhead and arrowhead projectile points which are widely represented in the Upper Palaeolithic (UP)

assemblages of Eurasia are also abundant in MSA sites like Aduma in Ethiopia and Gi in Botswana. This idea is also supported by the recent microscopic residue analysis and metric measurements of MSA points from the Cartwright site in Kenya, as well as from Sibudu and Rose Cottage Caves in South Africa (Lombard 2007; Mohapi 2007; Wadley *et al.* 2009; Waweru 2007). Residue analysis of points suggests that they were hafted onto wooden handles by using a mix of ingredients such as ochre, animal fats and tree resins to form projectile weapons (Lombard 2007). Metric measurements of points, such as maximum length, thickness and width, suggest that they were used to form spearhead and arrowhead projectiles (Bretzke *et al.* 2006; Brooks *et al.* 2006; Mohapi 2007; Shea 2006, 2009; Shea and Sisk 2010).

Similar evidence comes from the Levant. Shea (1997) suggests that MP points from Emireh and Kebara levels IX-XII were used as tips for thrusting and/or throwing spears (atlatls or darts). Shea (2006a) goes further by examining the nature and form of hunting behaviour practiced by MP foragers. Using metric dimensions such as Tip Cross Section Area (TCSA), and edge modification on the base or butt of points, he concluded that MP points were used as tips to form thrusting or throwing spears. Shea (1997) defines thrusting spears as larger, longer, robust, short distance weapons formed by points and wooden handles and used for hunting in waterlogged, woodlands environment or trap situations. Throwing spears (atlatls or dart) are defined as aerodynamic weapons thrown by hand during hunting or warfare activities in open environments (Hughes 1998). Arrowhead points refer to the small, light duty ballistic weapons that are used

with bow and arrows for hunting or other related activities in open vegetation or grassland environments (Hughes 1998). The terms thrusting spears, throwing spears, bow and arrows are persistently used in this study, because they have been widely applied in prehistoric hunting weapons studies within sub-Saharan Africa and Levant (Brooks *et al.* 2006; Lombard 2007; Mohapi 2007; Shea 2006, 2009, 2010).

In Tanzania, the basic MSA and LSA lithic typological system in use today was developed by Michael Mehlman in the 1970s and 1980s, from sites such as Mumba and Nasera (Mehlman 1989). Mehlman aimed to avoid the industrial nomenclature inherited from elsewhere, which lacks local rationalization. His typological system also incorporated Merrick's (1975) typological system for central Kenya. Today, Mehlman's analytical style is widely applied in lithic studies within Tanzania and it has also been applied in this study.

Mehlman (1989:135) defines a point as a stone tool retouched along two edges to produce a triangular form. Tools of this type have convergent edges of unifacial or bifacial retouch that intersect at an angle of usually less than 45°. Points range in overall shape from sub-triangular to lanceolate and can be retouched on one (unifacial) or both edges (bifacial) (Mehlman 1989:135). Mehlman (1989) defined unifacial points as lithic tools with retouch near the tips on the ventral or dorsal surfaces. The piece may have a bifacial base resulting from thinning the bulb of percussion or from removal of the talon (or platform) on the flake blank. Bifacial points have retouch on both the ventral and dorsal

surfaces up to the point tip. In this study, points are defined based on Mehlman's types 35, 36, 37 and 42, which also includes Merrick's (1975) types D and G. Small triangular points (Bretzke *et al.* 2006; McBrearty and Brooks 2000) are included in the Levallois point category. Levallois are unretouched triangular points and with faceted or thinned butts (McBrearty and Brooks 2000). This study focuses on points from four sites in Tanzania: Mumba, Nasera, Magubike and Mlambalasi (Figure 1.1).

Mumba (35°17'47" E; 3°32'26" S) is located on the northwestern edge of Lake Eyasi and it was first excavated by Margit Kohl-Larsen in the 1930s (Mehlman 1989). Michael Mehlman re-excavated the site from 1979 to 1981, and documented a deep stratified archaeological sequence including the MSA, LSA and Pastoral Neolithic (Mehlman 1989). More recently, Mumba has been excavated and re-dated by a research team of Tanzanian and Spanish scientists. Their work suggests that the MSA assemblage dates between 132,000 and 110,000 and the MSA/LSA transitional industry (Mumba Industry) dates between 69,000 and 59,000 (Prendergast *et al.* 2007, Dominguez-Rodrigo *et al.* 2007, 2008, Gliganic *et al.* 2008). The MSA here is characterized by the presence of tools such as scrapers, points and utilized flakes (Mehlman 1989). The MSA tools exhibit systematic changes in terms of size and shape, which are reflected in the various industrial traditions recognized within the MSA assemblages (Mehlman 1989). LSA artefacts, on the other hand, consist of geometric and microlithic artefacts, mainly knapped by using bipolar technology.

Nasera (2°44'13" S; 35°21'29" E) is located in the eastern margin of the Serengeti National Park almost 27 km north of Olduvai Gorge. The site was test excavated by Louis Leakey in the 1930s and re-excavated by Michael Mehlman in the 1970s. Nasera is composed of deep archaeological deposits composed of the MSA, and both Pleistocene and Holocene LSA assemblages (Leakey 1936, 1975; Mehlman 1989). The MSA assemblage is characterized by scrapers, points, and utilized flakes knapped through the Levallois technology and chronometrically dated to 56,000 years ago (Mehlman 1989). The cultural chronology suggests that the MSA artefacts (Kisele Industry) are present between levels 12 and 25 (Mehlman 1989). It is succeeded by the Second Intermediate Industry (SII), with mixed MSA and LSA artefacts (Naseran Industry), present between levels 6 and 11. The Pleistocene LSA (Lemuta Industry), with macrolithic artefacts such as burins, crescents, trapezes, geometrics and backed pieces, is found in levels 4 and 5. A Holocene microlithic LSA, the Silale Industry, is found in the upper levels at Nasera.

Magubike and Mlambalasi are rock-shelters found in the Iringa region of southern Tanzania. They were first documented by Pamela Willoughby in 2005 and were then test excavated in 2006 and 2008 (Biittner *et al.* 2007). At Magubike (7°45'79", 35°28'39" E), two cultural strata composed of Iron Age and MSA artefacts were revealed in test pits 2 and 3. Test pit 1 has an Iron Age, LSA, mixed LSA/MSA and MSA deposit. The Iron Age artefacts, including pottery, slag, charcoal fragments, molluscs and microlithic artefacts appears in upper levels and extends down to about 50 cm below surface. An *Achatina* shell



fragment obtained from the Iron Age cultural sequence between 20 and 30 cm below surface was radiocarbon dated to about  $2,990 \pm 60$  BP (TO-13422). In test pit 2, the MSA artefacts started to appear around 50 cm below the surface, extending to 210 cm deep where bedrock was encountered. In test pit 3, the MSA artefacts were found associated with human remains, fossilized fauna and molluscs. An *Achatina* shell fragment obtained between 130 and 140 cm below the surface was radiocarbon dated to  $41,790 \pm 690$  BP (TO-13423), but Electron Spin Resonance (ESR) dates the MSA to around 150,000 BP (Anne Skinner, personal communication 2010).

Mlambalasi ( $7^{\circ}35'$  S;  $35^{\circ}30'$  E) is a rock-shelter found at an elevation of about 1029 m on the road to Ruaha National Park, approximately 50 kilometres west of Iringa city. Two test excavation units of  $1 \text{ m}^2$  were excavated inside the rock-shelter of Mlambalasi in 2006. Excavated materials from test pit 1 (inside the rock-shelter), range in age from the historic period and the Iron Age to a Pleistocene LSA. The Iron Age cultural deposits were composed of pottery, iron, slag, animal bones, shell shells and beads. The LSA cultural sequence was characterized by land snail shells, animal bones, stone artefacts, ochre and fragmentary human remains in the lower levels. The large artefacts, most likely representing an early LSA, started to appear below 110 cm deep. Detailed descriptions of these sites are provided in chapters 5 and 6.

In this study, the focus is on projectile points and hunting behaviour under the assumption that technology for food acquisition had undergone change over time. As time passed, projectile points changed in size and shape. The duration of

projectile technology provides one of the ways of testing the processes of lithic technological change and the origin of behavioural modernity. The size and shape of projectile points may also provide insights that can be used to examine the nature of changes in hunting and technology over time. Those changes also reflect prospects on the hafting technology suggested by edge modifications and residue remains.

The analyzed points often show intentional modification or thinning on the proximal ends or butts, which may be indicative of hafting technology. Many of these points are unifacial or bifacial, but some are partially notched or stemmed. Their sizes and shapes vary, but changes in projectile technology seem to be gradual. Weight and Tip Cross Section Area (TCSA) values suggest that small triangular points believed to be used to form arrowhead projectiles evolved for the first time during the late MSA. Their numbers increased over time, reaching a peak during the transitional period from the MSA to the LSA (Bretzke *et al.* 2006). The data accumulated in this study are compared with published and documented metric measurements from other MSA and LSA assemblages in sub-Saharan Africa, the Levant, as well as with ethnoarchaeological experimental evidence from North America, Kenya and South Africa (Brooks *et al.* 2006; Hughes 1998; Mohapi 2007; Wadley *et al.* 2009; Shea 2006, 2009; Thomas 1978; Waweru 2007). The comparative approach aims to determine whether the MSA and LSA points fall within the range of thrusting spears, throwing spears or arrowheads.

The available data from Mumba, Nasera, Mlambalasi and Magubike suggest that point sizes and weights decreased over time during the Stone Age. Other contributing factors to the decrease in size and weight of points include forms and types of raw material. For example, the quartz pebbles used to make LSA artefacts are significantly smaller in size compared to the other raw material types such as chert, quartzite and metamorphic rocks. Alternatively, variation in point size, TCSA value and weight for both MSA and LSA assemblages may suggest the coexistence of multiple weapon systems. Spears and arrowheads coexisted during the MSA and MSA/LSA transitional period, but arrowheads predominated during the latter. Edge modification strategies and the presence of points of average size indicate the use of spearhead and arrowhead technologies.

### **1.3 The Research problem**

Some archaeologists have challenged the idea that MSA foragers were effective hunters. They have been portrayed as scavengers (Binford 1989) or less effective hunters compared to their LSA successors (Klein 1992, 1999). It is argued that during the MSA, dangerous species such as wild pigs and buffalo (*Pelorovis*) were not hunted on a regular basis and hunters purposeful sought after defenceless species such as eland (Binford 1989; Klein 1999, 2001). Arguments against the practice of hunting in the MSA also rely upon the infrequency of certain skeletal elements and on the position of cut-marks on bone (Klein 1999). Inadequate representation of meaty limb elements in MSA faunal assemblages has been taken to imply late access to carcasses, after the most valued elements are

consumed by primary carnivores. This reflects scavenging rather than active hunting (Binford 1989).

By contrast, the remains of specific animal species associated with the MSA assemblage at Lukenya Hill in southern Kenya show evidence for a series of repeated events of specialized hunting for the now extinct alcelaphine antelope and hartebeest (Marean 1997). This implies that MSA foragers possessed the ability to hunt, track and kill prey of different sizes and even specific species (Marean 1997). The above arguments indicate that traditional interpretations such as the use of animal bones and associated stone tools as evidence for hunting behaviour, have failed to solve the ongoing debate about prehistoric hunting skills (Binford 1989; Klein 1999, 2001; Kuman 1986; Mellars 2005, 2006; Wendorf and Schild 1992). Recently, additional approaches have been introduced, focusing on stone tools. These are based on metric measurements, morphological patterns, usewear traces and residue remains on the point edges. In this way, one can focus on hafting technology, tool use and hunting behaviour (Bretzke *et al.* 2006; Brooks *et al.* 2006; Lombard 2007; Mohapi 2007; Shea 1997, 2006, 2009; Wadley and Jacobs 2004; Wadley *et al.* 2009).

In this study, the major problem that has been investigated is the utilization of points. These tools are well represented in Late Pleistocene archaeological assemblages in sub-Saharan Africa and are liable to be linked to hunting techniques. This study investigates the trend in technological development associated with direct confrontation with animals to distance hunting and how this can be seen in variation in tool size, form, and function (Hughes

1998; Shea 1997, 2006, 2009). Points also may provide information on the nature and form of applied hunting strategies. The ways in which points were made, hafted, and applied shows evidence for abstract thinking, planning depth, adaptation to environments and behavioural changes (Brooks *et al.* 2006; Hughes 1998; McBrearty and Brooks 2000; Shea 1997, 2006, 2009; Thomas 1978). The evidence for depth of planning and abstract thinking enabled prehistoric people make decision in the selection of raw materials and the production and use of composite tools (end-scrapers, points and burins) that require more skill and intensive labour investment. Another indication of abstract thinking is represented by the appearance of points made of bone and antler during the MSA, which show an increased competence of tool makers (McBrearty 2005). In the sub-Saharan MSA, bone points date to about 90,000 years ago have been recovered from Katanda, eastern Democratic Republic of Congo (DRC) (McBrearty and Brooks 2000; Yellen 1996).

Another area that is closely linked with development in lithic technology and hunting behaviour is the extension of human habitation to previously unoccupied regions. By the end of the MSA, foragers occupied much of the Old World (Mellars 2006). Technology is one of the factors that assisted early migrants from Africa in surviving in new territories. The available evidence suggests that these people had a wide knowledge of the seasonal distribution of environmental resources and exploited them through direct access or procurement through an exchange/trade network (Mehlman 1989; Merrick and Brown 1984). The use of an exchange network is widely expressed by the use of obsidian in

northern Tanzania and central Kenya. At Nasera in northern Tanzania, chert was taken from Olduvai Gorge about 27 km away or from Lake Natron about 65 km away. Obsidian was transported over 320 km from central Kenya to Mumba and Nasera (Mehlman 1989:28). But at Magubike, local chert, quartz, quartzite and metamorphic rocks were used to make MSA artefacts. Perhaps a functional value was one of the major driving forces for the use of different lithic raw materials during the MSA.

Quartz and obsidian are brittle and can be used to produce stone tools with sharp edges, while chert and quartzite are used to produce durable tools because of their high compression strength (Ellis 1997; Hughes 1998). Using ethnographic evidence from North America, Ellis (1997) argues that traded raw materials were easily workable and recycled and they enabled production of tools with great lethal wounding ability. It is not clear if obsidian and chert were traded in northern Tanzania because of their durability or brittleness. Alternatively, they may have been chosen because they could have been used to form small tools with sharp edges, which could cause lethal wounding after hitting the target. Lethal wounding causes heavy blood loss, a process that facilitates animal suffocation and immediate death (Ellis 1997). Sometimes exotic raw materials could have been chosen due to the cultural and symbolic values, such as gift giving or social status (Mehlman 1989). Functional values, such as lethal wounding ability, suggest that durable tools, especially those with great killing ability were potentially used for seasonal and ambush hunting like that documented at Lukenya Hill, Kenya (Marean 1997). This study examines the

forms and types of projectile weapons and ways in which they contributed to the development of modern behaviour during the MSA.

#### **1.4 Research objectives**

This study has one general objective and three specific objectives. The major objective of this study is to examine and discuss lithic technological organization and the uses of projectile points during the MSA and LSA.

##### **1.4.1 General objective**

This study uses points to examine the way in which prehistoric humans accumulated their food resources during the MSA. It examines the technology organization and hunting methods employed by these people. In previous studies, Shea (2006) used a number of variables to differentiate three kinds of projectile weapons. These include TCSA value, geometric ratio, weight, and edge modification on the base or butt of points. He concluded that points were used as tips to form thrusting, throwing spears or arrowhead projectiles (Shea 1997, 2006, 2009). Hughes (1998) argues that metric sizes, TCSA value and geometric ratios have great influence in the morphological appearance of a point as well as accuracy and sufficiency on hunting practices. Using similar methodological approaches, I plan to reconstruct the trend for the technological shift from spearhead to arrowhead projectiles in Tanzania.

It is predicted that distance hunting, using throwing spears or bows and arrows, increased the efficiency and productivity of hunters in the accumulation

of food resources, which might have contributed to population growth in sub-Saharan Africa in the late MSA period. Tool types, butt modification and edge modification, breakage patterns or striations on point surfaces should provide evidence that indicates the existence of hafting technology, specialization in tool uses and social networks. Skills and knowledge applied in making hafted tools may provide insight into complex technological and social organizations that link toolmakers, society and the surrounding environment. This study is, therefore, designed to examine the trend of technological development over time and changes in hunting strategies as they are reflected in the MSA and LSA assemblages from four sites in Tanzania: Mumba, Nasera, Mlambalasi and Magubike.

#### **1.4.2 Specific Objectives**

The specific objectives of this study are:

1. To examine the development of hafting technology and the existence of distance hunting techniques as reflected in the TCSA value, weight and butt modification strategies of point tools.
2. To examine metric morphological differences between MSA and MSA/LSA points.
3. To examine the percentage representation of points in MSA assemblages and the ways in which points changed through time and space.

#### **1.5 Research Questions**

Four research questions are significant in this study.



1. Are the LSA assemblages of Tanzania the product of unique cultural and technological behaviours that are not seen in the MSA assemblages?
2. What kinds of differences are revealed in the MSA and MSA/LSA assemblages and in which ways did points changed through time and space?
3. What is the proportional representation of points in the MSA and MSA/LSA in archaeological records of northern and southern Tanzania that reveals that they were among potential tools produced by the toolmakers?
4. Are the MSA points of northern and southern Tanzania parts of aerodynamic weapons like throwing spears and arrows or are they parts of the confrontation weaponry system such as thrusting spears?

### **1.6 Area of the study**

The study was accomplished by examining points from a number of MSA assemblages in northern and southern Tanzania. In the northern part of the country, the collections examined were taken from Mumba and Nasera because of their well established chronological and cultural sequences. Their cultural sequences include the MSA, MSA/LSA transition, LSA and the Pastoral Neolithic (Mehlman 1989). In southern Tanzania, a similar study was undertaken at the Mlambalasi and Magubike rock-shelters in Iringa region. Initial test excavations carried out at both sites revealed a rich cultural sequence composed of MSA, LSA, and Iron Age and historic assemblages. At Mumba and Magubike, the MSA

artefacts were found associated with the teeth of early modern humans (Bräuer and Mehlman 1988). Inferences drawn from this study are used to reconstruct prehistoric hunting behaviour and projectile technologies. As indicated earlier, previous studies in Tanzania were focused on typological and technological classifications and they have failed to address the use of points. I believe that this study may provide a new outlook for understanding the trend toward development of projectile technology and its influence in the development of behavioural modernity.

The study is a comparative one between MSA and MSA/LSA archaeological occurrences, and examines changes in hunting techniques over time and space. It has been argued that hunting techniques changed from thrusting to distance hunting over time in response to ecological conditions (Hughes 1998). Data from Iringa have been compared with that from northern Tanzania in order to understand trends in the change of hunting strategies across the country. Archaeological sites in northern Tanzania have well-defined chronological sequences from the earliest through the Middle and Upper Pleistocene and they have also provided substantial evidence for understanding the trend of technological and behavioural changes over time. This study was, therefore, designed to examine the trend of technological changes over time and changes in hunting strategies as they are reflected in the MSA and MSA/LSA assemblages from Mumba, Nasera, Mlambalasi and Magubike (Figure 1.1).

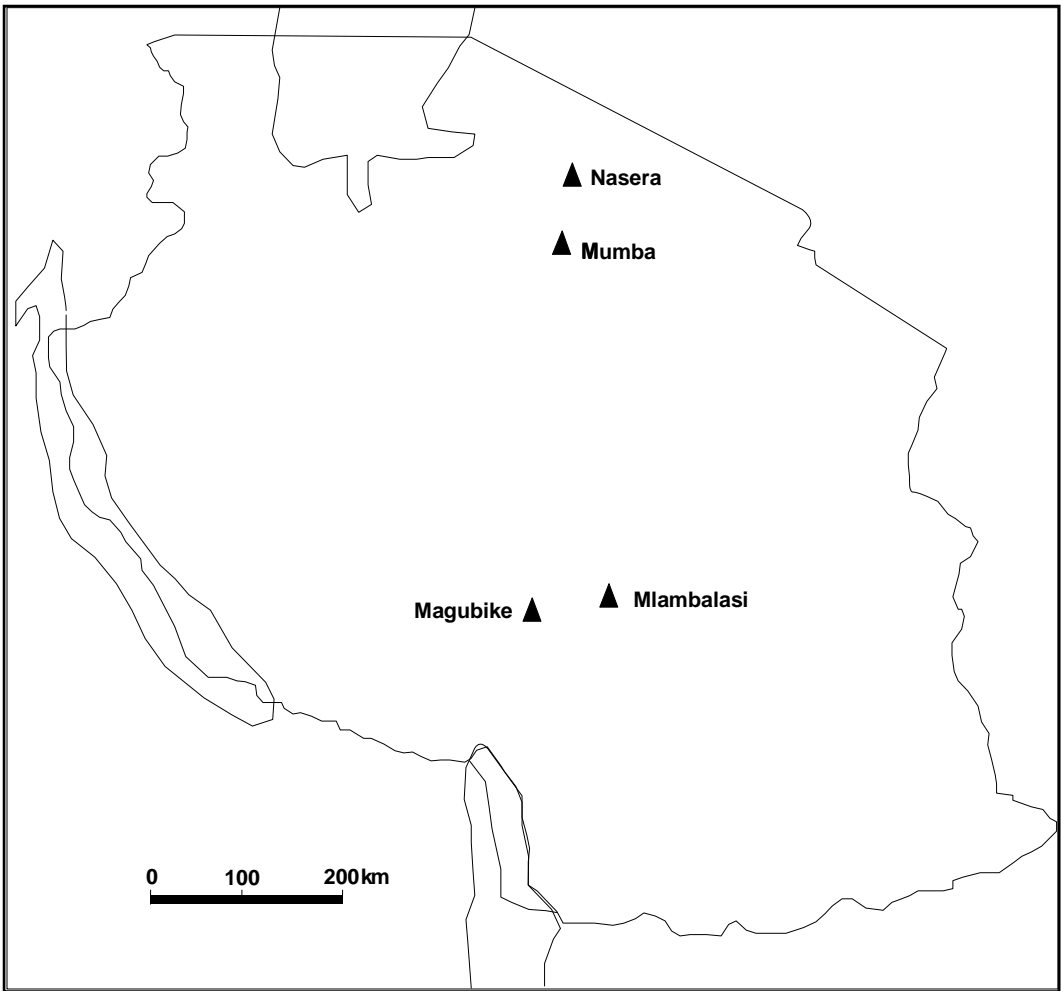


Figure 1.1. Map of Tanzania showing study sites.

The available evidence suggests that MSA points in sub-Saharan Africa and the Levant were used either as tips for thrusting spears, throwing spears or arrow weapon systems (Brooks *et al.* 2006; Shea 2006, 2009). These studies of points stimulated a new way to determine prehistoric subsistence strategies and the use of pointed tools over time and space (Shea 1997, 2006, 2009). Archaeological occurrences in the Levant are important for the study of prehistoric human behaviour because both Neanderthal and anatomically modern humans colonized this area at different times during the Middle Palaeolithic (Shea 1997, 2006). In the Levant, remains of anatomically modern humans found at Skhul and Qafzeh dated between 110,000 and 90,000 years ago. Middle Palaeolithic points from Qafzeh and Skhul indicate that they were used as inserts for both thrusting and throwing spears, indicating that arrowhead technology was limited in the Levant until 45,000 BP, when migrants from Africa colonized this area (Shea 2009; Shea and Sisk 2010). Therefore, my study intends to contribute significantly to our current knowledge about technological and behavioural capability of early modern humans in Africa who made and used MSA artefacts.

### **1.7 Dissertation organization**

This dissertation has nine chapters. Chapter 1 outlines the background information, research problem, study objectives, research questions, area of study, and organization of dissertation. The research problem is related to our current knowledge of the hunting behaviour and technological organizations during the MSA and LSA. The technological and behavioural capability of MSA foragers

have been outlined in order to create bases for further technological and functional studies. Technological perspectives are examined using tool production and raw material procurement. Hafting technology is reconstructed using butt modification strategies.

Chapter 2 gives a brief background of previous MSA and LSA research in East Africa. This chapter discusses previous research and the contributions made concerning the examination of prehistoric ways of life. It also reviews the representation of the MSA and LSA assemblages within the region. Absolute dates and chronological framework are described means for archaeological investigations in East Africa. The chapter also discusses the way in which previous archaeological interpretations have framed research interests for the MSA and LSA periods. It explains the biases among archaeologists in focusing on areas that are already well known archaeologically, while other regions remain unknown.

Chapter 3 discusses the modern and late Middle and Upper Pleistocene environments of East Africa and their implications for changes in prehistoric technologies and subsistence patterns. It draws some inferences that are useful for reconstruction of human subsistence behaviour in relation to the availability and distribution of environmental resources. The chapter explores the trend of environmental changes during the MSA and LSA periods. It also discusses the possible impacts of environmental changes on human culture and technology. Available evidence suggests that for most of the Middle and Upper Pleistocene, East Africa experienced unstable environmental conditions dominated by

prolonged series of drought and cold weather (Scholz *et al.* 2007). It is not clearly understood if ecological conditions were among the major causes for anatomical, technological and/or behavioural changes for our early ancestors who lived in Africa during the MSA.

Chapter 4 explains the technological and typological changes over time documented in the MSA and LSA assemblages of Mumba and Nasera rock-shelters. The examination of these sites explains the proportional representation of points and proposed hunting behaviour, based on raw material procurement and environmental settings. Barut (1994) argues that prehistoric hunters of northern Tanzania depended heavily on collective hunting strategies. They moved seasonally, depending on the location of hunted game. In this study, hunter movements and obsidian networks that linked northern Tanzania and central Kenya have been correlated in order to provide functional explanation related to hunting behaviour. I believe that obsidian was collected and carried away by foragers during their seasonal movements, which were influenced by the movement of hunted game. Perhaps obsidian was collected because of its functional value; it forms stone tools with sharp edges and great wounding ability. Foragers in tropical grasslands moved seasonally to places where migratory species are located; they followed animals moved behind them in order to increase hunting opportunities (Pickering and Bunn 2007).

Chapter 5 provides information related to our field survey experience in the Iringa region of southern Tanzania. It also discusses the background information on the geology, geomorphology, present environment and

archaeology of Iringa and its surroundings. This information is critical to the understanding of the cultural chronology of Iringa and for the examination of the availability and distribution of the resources needed for human survival. The review of previous archaeological research in Iringa aims to assist in the understanding for the prehistoric technological development and affiliated subsistence patterns. Ecological evidence suggests that during the Middle and Upper Pleistocene, most of Iringa and other parts of the southern highlands of Tanzania were characterized by woodland environments. This is in contrast to the northern part of Tanzania, which was characterized by tropical grasslands (Hamilton 1982). The archaeological potential of the Iringa Region was traditionally recognized through the archaeological finds from the Acheulian site of Isimila. Discoveries from our field survey, as well as test excavations at Magubike and Mlambalasi, revealed that Iringa was occupied continuously by early humans from the Acheulian through the historic and modern periods.

This chapter sets new strategies for the archaeological investigation of the Iringa Region that may create new outlooks and understanding about its archaeological potential. It became clear in our 2008 field survey in Iringa that evidence for prehistoric occupation is not limited to northern Tanzania. In East Africa, most Pleistocene archaeological investigations have continued to be carried out in areas documented by research pioneers in the early 1920s. Most of these areas are located within the volcanic regions of the Eastern Africa Rift Valley System (EARVS). In East Africa, it is generally assumed by archaeologists that well preserved archaeological sites are only found in volcanic

regions because rift sediments better preserve organic remains. Our recent field research revealed that regions outside the Rift Valley system, like Iringa, may also preserve an important Stone Age prehistoric record.

Chapter 6 describes the archaeological occurrences at Mlambalasi and Magubike based on test excavations conducted in 2006. Artefacts from these two sites are presented and discussed using cultural chronology, typological attributes, raw material procurement and the representation of points. The proportional representation of raw materials shows that prehistoric foragers depended more on local lithic raw materials than exotic ones. Results from this study suggest that rocks were chosen for artefacts due to functional requirements such as sharpness, brittleness and durability. The typological classification indicates that backed pieces and bipolar cores predominate in the MSA and LSA assemblages at Mlambalasi and Magubike. At Mlambalasi, true points were less represented, forming 1.1% of the entire tool sample. They were not sufficient enough for comparable statistical analysis; as a result, data from Mlambalasi was excluded for further functional and statistical analysis. But many small backed tools may have taken the role of points during the LSA.

Chapter 7 reviews some technological aspects with more emphasis on point production and hafting technology. The chapter describes the analytical techniques used in this study for the better understanding of lithic technological organization and the ways in which points have been produced, used and discarded. Interpretations are based on the presented statistical tables and graphs. It explains the ways in which ecological factors and the availability of raw



materials are related with technological development and food acquisition strategies. In this chapter, I examine production skills and knowledge applied to manufacture composite tools designed for a particular intent. I describe possible techniques that were applied to produce intended flakes suitable for the creation of pointed tools. Point edges and butts have been modified or thinned to allow hafting. Skills and labour investment in tool production indicate that toolmakers had developed modern technological capabilities.

Chapter 8 discusses the trend of change in hunting behaviours based on inferences drawn from geometric ratio, weight, TCSA value, durability and brittleness of the raw materials used to produce points. I use weight, TCSA value and geometric ratios to determine how points were produced and used. I examine the possibility that thick, broad, and large points were used as spearheads, which were thrust or hand delivered at animals and that narrow, thin and small points were used for ballistic weapons such as throwing spears and arrows. Tool sizes and weight are used to discuss the technological differences between spearhead and arrowhead projectiles. Durability and brittleness of raw materials are used to discuss hunting and subsistence strategies. The data is used in conjunction with technological variables in order to examine trends of change in technology and subsistence patterns over time and space. The understanding of hunting and food acquisition strategies is a very important factor in the understanding of behavioural patterns and subsistence strategies of early modern humans in Africa. It was evident from this study that arrowhead and spearhead projectiles coexisted at Mumba, Nasera and Magubike during the MSA and MSA/LSA transitional

period. Usewear analysis indicates that points performed a variety of activities including hunting, cutting, butchering and wood processing.

Chapter 9 discusses the research results and the answers to my research questions. Using data from ecological, technological, subsistence patterns, point uses and reviewed literature, I argue for the development in behavioural modernity starting from the MSA and passing through a gradual process before the commencement of the LSA culture. Arrowhead and spearhead technologies coexisted during the MSA at Mumba, Nasera and Magubike, but as time passed, arrowhead technologies predominated. My discussion and interpretations are mainly centred on the context of hafting and projectile technology and its evolutionary response to hunting strategies and development of behavioural modernity. Hunting strategies and projectile designs depended on the ecological setting and subsistence requirements. It appears that MSA foragers used a variety of projectile weapons, depending on the hunting situations and the nature of specific rock types available. Durable rocks such as chert and quartzite were used to make broad, thick and heavy projectiles needed for confrontation weapons in order to improve a hunter's safety. Suggestions and assertions for future studies are also incorporated in this chapter. Conclusions made in this study support the model of the existence of multi-weapon systems during the MSA and a gradual technological change from one cultural stage to another.

## **CHAPTER 2: PREVIOUS RESEARCH ON THE MSA AND LSA IN EAST AFRICA**

### **2.1 Introduction**

This chapter summarizes and assesses previous MSA and LSA studies in East Africa and their contributions towards the better understanding of developments in lithic technology and behavioural changes over the course of the late Middle and Upper Pleistocene. It also reviews the roots of archaeological research in East Africa and highlights the key themes raised in previous and current research. The purpose is to address the historical processes in archaeological investigation that have contributed to our current archaeological knowledge inside and outside of East Africa. An assessment of previous and existing records suggests that more research is needed with new directions such as the function of specific tools.

The chronological trend in archaeological investigation can be divided into two significant stages. First is the pioneer stage that describes what happened from the 1920s to the late 1970s. This stage represents a period in which archaeologists working in East Africa were not really interested in MSA and LSA research, because these cultures were thought to be quite recent and associated with modern African populations. It was assumed that MSA and LSA artefacts were still in use by modern hunters. Second is the post-pioneer stage that describes the trend for archaeological research from the early 1980s to the present. At this stage archaeologists resumed their research interests in MSA and LSA assemblages. This occurred after the realization that the MSA represents the

material culture of the first modern humans who originated in Africa (Robertshaw 1990). New evidence from radiometric dating and genetic studies indicated that Africa was the most likely homeland for all living human populations (Clark 1988; Cann *et al.* 1987; Mellars 2005, 2006).

## **2.2 The importance of MSA and LSA studies in East Africa**

East Africa is one of the regions where hominid remains, stone artefacts and fossil fauna have been found in direct association with each other, a combination that allows a long-term investigation of human biological and behavioural evolution. Pioneering researchers used the forms and types of artefacts in order to reconstruct cultural history and technological change over time and space. Changes in archaeological assemblages were directly correlated with cultural evolution and were linked to the different stages of hominid biological changes, such as *Homo habilis* and the Oldowan, *Homo erectus* and the Acheulian, archaic *Homo sapiens* or *Homo heidelbergensis* with the early MSA artefacts (Sangoan) and *Homo sapiens* with the true MSA and LSA (Goodwin and Van Riet Lowe 1929; Leakey 1976). In the Lake Eyasi basin, Sangoan artefacts were found to be associated with remains of *Homo heidelbergensis* and the traditional MSA with anatomically modern humans (Bräuer and Mabulla 1992; Bräuer and Mehlman 1988; Dominguez-Rodrigo *et al.* 2008; Mehlman 1989; Reck and Kohl-Larsen 1936). Recent studies and absolute dates have revealed that early modern humans (*Homo sapiens*) were responsible for both the MSA

and LSA assemblages in sub-Saharan Africa (Bräuer 1992; Bräuer and Mehlman 1988; Mabulla 1996; McBrearty and Brooks 2000; Mellars 2006).

In 1980s, the MSA was recognized for the first time as contemporary with the Eurasian Middle Palaeolithic, which was associated with Neanderthals. Genetics and new dates then documented the association of the MSA with modern humans in Africa at the same time. It is believed that near the end of the MSA, early modern humans migrated from Africa through the Levant or Red Sea to southern Asia and Australia, before proceeding to Europe (Mellars 2006). They entered Western Europe during the Upper Palaeolithic between 45,000 and 35,000 years ago (Klein 2000). The reasons for these movements are not clear and the technological and behavioural capabilities of MSA foragers are still debated. Archaeologists disagree on the time when technology and human behaviour really became modern and even the way in which modernity is defined. Clark (1988) contended that behavioural and technological shifts were evident in Africa during the MSA. In contrast, Klein (2000) asserts that MSA people were still pre-modern up until they began to exhibit LSA technologies.

Today there is increased evidence which suggests that major shifts in technology and human behaviour occurred during the MSA or during the transition from the MSA to LSA, sometimes also referred to as the late MSA (Mellars 2006). Some researchers argue that all essential behavioural and technological patterns found within the LSA are widely represented in the late MSA (Ambrose 2002; Mellars 2005, 2006). These include efficiency in tool design and hafting technology (Ambrose 2002; Lombard 2007; Wadley and

Jacobs 2004; Wadley *et al.* 2009; Willoughby 2009); more efficient means of food procurement, which involved tactical and skilled hunting (Brooks *et al.* 2006; Mohapi 2007; McBrearty and Brooks 2000); seasonality and specialized hunting (McBrearty and Brooks 2000; Marean 1997); use of bone tools and aquatic food resources (Henshilwood *et al.* 2001; McBrearty and Brooks 2000; McBrearty and Stringer 2007; Yellen 1996); symbolic objects such as beads and ochre (Bower 2005; Henshilwood and Marean 2003; Lombard 2007; Mehlman 1989; Mellars 2005).

More evidence of structured social relations among ethnic groups, such as exchange and trade, has been revealed from the presence of exotic raw materials. Trade might represent events in which goods or services are exchanged between different individuals or different ethnic groups. In East Africa, exchange networks may have started with the use of obsidian during the MSA, and they would have connected people from central Kenya, the Lake Victoria basin and northern Tanzania (Mehlman 1989; Merrick and Godwin 1984). According to this view, these expressions of behaviour evolved gradually and therefore the development of behavioural modernity primarily started during the MSA in Africa. Observed differences between the MSA and LSA could be explained as a result of time and ecological changes. Under those perspectives, the technological and behavioural intensification documented globally within the LSA culture, represents the peak for technological and behavioural development that existed in the embryonic stages in Africa during the MSA.

There is another school of thought which believes that behavioural modernity evolved during the LSA; therefore MSA foragers would have been cognitively pre-modern (Klein 2008). Klein (2008:270) believes that the transition from pre-modern to modern behaviour was an abrupt process that involved neurological change about 50,000 years ago. However, Klein does not explain the conditions that favoured selection for human biological changes during the LSA. Klein (1999) agrees that the issue of the evolution of behavioural modernity is still problematic, suggesting that archaeologists focus on East Africa where the MSA and LSA assemblages are separated by a transitional industry (Willoughby 2007). The study reported here, provides some insight into prehistoric lithic technology and hunting behaviour employed by the MSA and LSA foragers that could contribute to our current knowledge about the evolution of modern human behaviour.

### **2.3 MSA and LSA research trends in East Africa during the pioneer period**

In East Africa, archaeology is a young discipline, dating back around 90 years. Scientific research on the MSA and LSA is the most recently developed field, because previous researchers were focused on either the Plio-Pleistocene, in order to document the earliest stages of human evolution, or on the Holocene period, in order to document changes from hunting-gathering lifestyles to animal and plant domestication (Robertshaw 1990). The earliest research centred on the discovery, reporting and documentation of sites by colonial agents: explorers, travelers, missionaries and administrators. Although some significant MSA and

LSA sites such as Nasera and Mumba were surveyed and excavated between the 1920s and 1930s (Kohl-Larsen 1938; Leakey 1931, 1936; Leakey *et al.* 1972; Wayland 1934; Wayland and Smith 1923), this time periods research interest on the MSA and LSA remained underrated. It only became a major interest to archaeologists in the 1980s, after the development of new radiometric dating techniques, such as Electron Spin Resonance (ESR), Thermoluminescence (TL), and Amino Acid Racemisation on ratite shells (AAR) (Willoughby 2007). This paralleled mitochondrial DNA evidence, suggested that the last common ancestor of modern humans evolved in Africa between 150,000 and 200,000 years ago (Cann *et al.* 1987).

The earliest MSA and LSA archaeological studies in East Africa include the work of E. J. Wayland in Uganda, Louis and Mary Leakey in Kenya and northern Tanzania, and Ludwig and Margit Kohl-Larsen in the Lake Eyasi basin of northern Tanzania (Kohl-Larsen 1938; Leakey 1931, 1936; Wayland 1934; Wayland and Smith 1923). Although they made significant contributions in describing the chronology, cultural history and the cultural changes, their theories relied on European archaeological records and they were biased toward large shaped tools (Mehlman 1989; Prendergast *et al.* 2007). At this time, East African chronology and regional cultural history were given the highest priority. For instance, Wayland (1923) correlated Quaternary lacustrine and terrestrial sediments with the lithic assemblages of Uganda. He developed the pluvial and interpluvial theories to define series of climatic oscillations in tropical Africa (Chapter 3). The pluvial theory was developed to describe the cultural sequences,



trends for the climate changes and to date sites whereby northern hemisphere glacial were associated with wet or pluvial periods in Africa, interglacial with dry periods; we now know that it is the opposite, glacial represents dry and cool events, while interglacials warm and wetter in Africa.

The cultural chronology employed by these early workers followed the European tradition of defining cultures on the bases of types and general artefact characteristics. This approach identified prehistoric cultural entities on the basis of purported elements that had already been defined in Europe and other parts of Africa, such as South Africa, where archaeological investigations began quite early. The focus was on the cultural chronology within sites and not on the use of tools. Only large shaped tools, whole flakes and cores were collected during excavation (Prendergast *et al.* 2007). Faunal remains from archaeological deposits were studied only to provide a fossil index to aid in establishment of the chronology of the lithic assemblages (Mabulla 1996). Within such cultural schemes it was not possible to examine the broad technological perspectives and food acquisition techniques that supported human lives.

Despite these uncertainties, pioneering researchers made a remarkable contribution to the development of archaeology in East Africa. Louis Leakey was the first archaeologist to define the archaeological sequence in East Africa. He defined MSA assemblages from the central Rift Valley of Kenya as the Kenyan Mousterian and Stillbay, and LSA assemblages as the Kenyan Aurignacian and Capsian (Leakey 1931; Mabulla 1996). As noted before, these terminologies were borrowed from lithic industries first defined in Europe, North Africa and South

Africa (Mabulla 1996). In 1932, Louis Leakey excavated at Apis Rock, today known as Nasera rock-shelter in northern Tanzania, and recovered deep chronological sequences with MSA, MSA/LSA transition, LSA and Neolithic material (Leakey 1936). He classified the MSA artefacts as Levalloisian, Proto Stillbay and Stillbay industries. The MSA were succeeded by the MSA/LSA transitional industry termed as Magosian (from Magosi area in Uganda). He defined also the LSA Wilton and Kenya Capsian in upper levels (Clark 1988; Leakey 1936; Mabulla 1996; Mehlman 1989).

Between 1932 and 1939, Margit and Ludwig Kohl-Larsen conducted three expeditions within the Lake Eyasi basin in northern Tanzania. They discovered a surface scatter of archaeological materials and fossil hominid remains of three specimens (Eyasi I, II and III) from the surface of the North Eastern Bay (NEB) site (Dominguez-Rodrigo *et al.* 2007, 2008; Kohl-Larsen 1938; Leakey 1936; Mabulla, 1996; Mehlman 1989). These fossil remains were attributed to archaic *Homo sapiens* or *Homo heidelbergensis*, who used Levalloisian artefacts (Mehlman 1989). In 1938, Margit Kohl-Larsen excavated Mumba rock-shelter (formally Mumba Höhle), a large rock-shelter on the northwest shore of Lake Eyasi. She produced an archaeological sequence characterized by the MSA, MSA/LSA transition, LSA and Neolithic cultures (Kohl-Larsen 1938; Mabulla 1996; Mehlman 1989).

In Uganda, Wayland made an intensive geological survey. During this period, he defined and documented the Magosian and Sangoan industries near the shore of Lake Victoria (Clark 1988; Mabulla 1996; Wayland 1934). The

Magosian industry was characterized by mixed elements of MSA “Stillbay” and LSA “Wilton” (Wayland 1934). Wayland described the Magosian Industry as the transitional industry between the MSA and LSA, but some scholars believe that it was actually an accidental mixture of the two (Wendorf and Schild 1992). Wayland (1934) defined the Sangoan as the transitional industry between the ESA and MSA, composed of core axes, core scrapers, scrapers, choppers, bifacially modified pieces and utilized flakes. Variations of lithic industries were defined based on tool types, size and chronology. Changes in lithic industries were directly correlated with series of climatic changes defined by pluvial and interpluvial events (Wayland 1934).

The major goal of the pioneers was to provide a link between the cultural historical framework of Europe and archaeological records recovered in East Africa. They believed that human migrations and invasions or diffusion of ideas were the major causes for technological and cultural developments in Africa and the rest of world. Their objective was to trace and examine typological similarities in stone tools found in Africa and Europe. Terms like Levallois, Mousterian and Capsian were used to refer to lithic industries that had diffused from the northern hemisphere through the Levant, Egypt and the Nile valley to East Africa (Goodwin and Van Riet Lowe 1929). The Stillbay was assumed to have arisen in South Africa and the Sangoan in the Congo basin (Goodwin and Van Riet Lowe 1929; Mabulla 1996). The diffusion theory, and general terms remained in use until recently, when researchers started to use local names to define their sequences (Mehlman 1989).

In earlier times, diffusion was the most recognized theory to explain prehistoric cultural developments and achievements in East Africa. Indigenous technologies and any historical innovations were attributed to people outside of the region. The pioneering researchers used much of their time attempting to identify interregional similarities in order to describe the role of diffusion in technological and cultural changes. Today, there are significant changes in terms of archaeological theories, objectives and methods within and outside of East Africa, but one must continue to mention and use the work of the pioneers in this discipline. Indeed, the pioneers should be commended for their important contribution towards the development of archaeological studies in East Africa.

Between the 1950s and the early 1970s, archaeologists working within East Africa shifted their interests to the study of early hominids and cultures at Pliocene and early Pleistocene sites such as Olduvai, Peninj, and Isimila in Tanzania, Lake Turkana in Kenya, Nsongezi in Uganda and the Omo valley in Ethiopia (Clark 1988). In some of sites the record is millions of years old and represents earliest human occupation. Little work was done on the African MSA and LSA because they were considered to be very recent, not Palaeolithic at all (Clark 1988:243). The limited number of radiometric dates for these sites, which were available before the 1980s, reinforced such ideas. For example, the Acheulian site of Isimila in Tanzania was estimated to be around 60,000 years old (Cole 1965), suggesting that Acheulian technology continued in sub-Saharan Africa until this date. At the Lake Eyasi basin, the MSA and associated human remains were originally radiocarbon dated to about 30,000 years ago (Protsch

1981). The limited number of organic materials recovered from MSA and LSA assemblages was another reason that archaeologists working in East Africa preferred to work on Early Pleistocene sites, which were mainly located within the volcanic region of East Africa (EARVS). These sites tended to be rich in fauna, while MSA sites only contained fragmented and poorly preserved bones. The few faunal remains recovered from MSA contexts were thought to represent the existing species of African mammals, and therefore could not be very old (Mabulla 1996).

Human fossils of archaic *Homo sapiens* recovered from Lake Eyasi in Tanzania and from Kanjera in Kenya in the early 1930s, were regarded as relatively recent and therefore less interesting to Stone Age researchers. At that time, there was no indication that early modern humans might have evolved in Africa. This continual lack of interest in MSA and LSA studies affected the development of Middle and Upper Pleistocene archaeological research in East Africa. Much more emphasis was directed towards the Pliocene and Early Pleistocene record of hominid evolution, as well as to the Holocene studies of the Iron Age and Bantu language origins (Robertshaw 1990). The latter was important for newly emerging independent states, as it gave them a precolonial history. The British Institute in Eastern Africa (BIEA) focused its investigations on the Neolithic and Iron Age in order to document the trend of cultural and technological changes within the region before the invasion of European colonialists. But the major objective of BIEA at this time was to demonstrate that food production, iron smelting, and modern East Africans originated outside the

region (Robertshaw 1990). All of this supported the colonialist view of the East African past.

#### **2.4 The Post Pioneer period from early 1980 to the present**

There was a revival of research interest within the region beginning in the early 1980s. This revival could be attributed to the development of new radiometric techniques such as ESR, TL, and AAR dating in the 1980s and renewed stratigraphic studies, which showed that the MSA in East Africa was older than the effective upper limit of radiocarbon dating, at around 50,000 years ago. In some places, like Olduvai Gorge, the LSA assemblages seemed to be much older than this, and in fact could be as much as 60,000 years old (Skinner *et al.* 2003).

The post 1980s radiometric dating techniques showed that African modern human fossils and MSA artefacts could be dated to between 200,000 and 35,000 years ago (Bräuer and Mehlman 1988). This in turn supported the new mitochondrial DNA evidence, which suggested that the last common ancestor of modern humans evolved in Africa between 150,000 and 200,000 years ago (Cann *et al.* 1987). This realization and new dates renewed research interest in the East African Middle and Later Stone Age. The hominid fossils and artefacts collected by early pioneers were restudied, reinterpreted and re-dated and some sites were re-excavated in light of new methodologies and theories. New interpretations have revised and changed earlier views. Now it was being suggested that early modern humans and MSA cultural innovations had both originated and diffused

through one or many migration routes from sub-Saharan Africa to Eurasia, rather than the other way around (McBrearty and Brooks 2000; Mellars 2006).

Biological evidence and chronometric dating techniques improved archaeological knowledge in Africa and disproved the notion that Africa was a technologically backward continent. Before this, modern human remains associated with the African MSA were regarded as a representation of backwardness, since they were seen as much more recent when compared to Upper Palaeolithic humans in Eurasia (Clark 1957, 1964). For instance, new chronometric dates changed the Eyasi hominid's age from 30,000 years ago (Protsch 1981) to around 200,000 years ago (Bräuer and Mehlman 1988). Despite the realization of those problems, some theories, themes and methods related to MSA and early modern humans in East Africa have remained framed in traditional terms. Most research continues to focus on cultural historical issues: creating cultural chronology, typological classifications, and defining industrial variations. But other researchers have initiated new studies related to tool use, ecological responses to human culture, subsistence patterns and technological organization.

However, many of these new studies have been conducted at the same sites or places that were originally studied by the pioneers (Ambrose 2001; Mehlman 1989; Marean 1997; Merrick 1975), a process that made most areas within East Africa remain archaeologically *terra incognita*. Despite this, new research has made a great contribution towards the understanding of the origin of modern humans and their technologies, particularly focusing on themes related to

subsistence patterns and technological development (Ambrose 2001; 2003; Bower 1985; 2005; Clark 1988; Cohen *et al.* 2007; Dominguez-Rodrigo *et al.* 2007, 2008; Gramly 1976; Leakey 1976; Mabulla 1996, 2007; Marean 1990, 1997; McBrearty 1988; 1993; Mehlman 1989; Merrick 1975, 1984; Miller 1979; Onjala 2006; Willoughby 1996, 2001, 2007).

New dates show that in East Africa, the MSA ranges between 285,000 and 35,000 years ago, and is followed by some version of a LSA culture that dates between 60,000 and 7,000 years ago, depending on when domestication of plants and/or animals first appeared (Ambrose 2003; Dominguez-Rodrigo *et al.* 2007; McBrearty 1993; Manega 1993; Melman 1989; Skinner *et al.* 2003). Nowadays, the main research agenda is the origin and development of modern humans and their technology. This theme also takes account of food procurement and factors that led some modern humans to migrate from their ancestral homeland in Africa to Eurasia during the Upper Pleistocene. New dates and detailed studies, however, are still needed on themes related to tool use, technological organization, faunal analysis, paleoenvironmental reconstructions and other factors embedded in human cultures during the MSA and LSA to attain reliable conclusions.

Theories regarding population migration or invasion from outside East Africa as the cause of culture change are now being rejected due to new chronological, theoretical, genetic and human fossil evidence. Instead, culture change is more often thought to result from in situ development involving locally generated ideas, social interaction, and adaptation to changing environments, as well as to changing functional requirements of stone tools. More studies and



evidence are still needed to address these new ideas and theories that could contribute significantly to our current knowledge about the origin and development of modern human behaviour and culture. Right now, the available data from East Africa shows gradual technological change and continuity between the MSA and LSA. This trend is obvious in sites with deep stratigraphic cultural sequences where the MSA and LSA are both present, as well as transitional industries between them.

Generally, the current debate about the technological and behavioural differences between MSA and LSA humans is more focused on the quantity, rather than the quality, of archaeological remains. The nature of cultural evolution is hard to determine due to the limited technological, organic and symbolic objects found in MSA contexts. As was explained earlier, in this chapter, most of the criteria, methods, and theories employed in the assessment of the model of behavioural modernity were designed and developed based on archaeological records from Europe. These principles have limited validity in universal evolutionary trends within Africa, where modern humans and culture originated.

Revealed evidence suggests that despite the short history of archaeological research since 1980s, the region shows substantial evidence of technological change and development of modern behaviour during the MSA. New efforts are, however, faced with some problems. Some sites are not well dated and most research projects focus on typological classification rather than tool function. Despite these uncertainties, East and South Africa both present great potential for helping our understanding the evolution of behavioural modernity and provide

some exciting lines of evidence, such as new human fossils evidence or the processing of ochre and the production of ostrich and other eggshell beads (Ambrose 2001; Bower 1985; Brooks *et al.* 2006; Mabulla 1996; Mehlman 1989; Yellen 1996; Willoughby 2001, 2007, 2009).

## **2.5 Nomenclature and terminologies for the Stone Age assemblages of East Africa**

The application of the terms MSA and LSA in East Africa is the result of the declaration made by members of the first Pan African Congress on Prehistory and Quaternary Studies held in Nairobi in 1947 (Clark 1957). The congress decided to establish a consultative committee to develop guidelines for stone tool nomenclature for sub-Saharan Africa (Clark 1957, 1988; Mabulla 1996; McBrearty and Brooks 2000; Mehlman, 1989; Willoughby 1996, 2007). This committee decided to adopt the South African cultural system developed by Goodwin and Van Riet Lowe in 1929. Before the Nairobi conference, archaeologists working in this region never placed the East African archaeological assemblages into the three age cultural system developed for South African archaeological assemblages. As noted before, archaeological remains from this region were generically labelled using terms like Levallois or Stillbay that originated from sites outside the region (Leakey 1931, 1936; Reck and Kohl-Larsen 1936; Wayland 1934).

The southern African assemblages were classified into a three age cultural system, namely the Early Stone Age (ESA), Middle Stone Age (MSA), and Later

Stone Age (LSA) (Goodwin 1928; Goodwin and Van Riet Lowe 1929). Since 1929, these cultures (ESA, MSA, and LSA) have been used in South Africa to describe the chronological order of archaeological assemblages (Mehlman 1989). The ESA was defined using the earliest archaeological assemblages in South Africa. It now consists of the Oldowan and Acheulian industries. Oldowan assemblages represent the earliest stone tool technologies in Africa composed of simple flakes, choppers and unmodified cores (Leakey 1936; Mehlman 1989). Acheulian assemblages were composed of large bifacial tools such as hand axes, cleavers, picks, choppers and core scrapers (Mehlman 1989, 1991).

The MSA assemblages in Goodwin and Van Riet Lowe's (1929) original sense, included retouched points, flakes with faceted platforms, scrapers and other retouched tools made by peripherally prepared, radial, disc, and/or Levallois core technologies (Mehlman 1989). Goodwin and Van Riet Lowe (1929) defined the subsequent LSA as an archaeological occurrence that included blades, bladelets, backed tools, and microlithic tools made by bipolar and blade cores. Generally, LSA tools are small in size compared to those from the MSA. Originally, the LSA culture was correlated with earlier evidence of modern humans in Africa and it was defined based on the presence of microlithic tools, rock art, use of bows and arrows, intensification of use of plant and aquatic food resources as well as increased evidence of rituals, religion and symbolic objects such as ochre and beads (Phillipson 1977, 1980). Today, the Goodwin and Van Riet Lowe cultural divide is no longer tenable. Objects once thought to distinguish the LSA such as beads, ochre, shellfish, and bone objects are also found in the MSA contexts.

The Pan African committee decided to use the southern Africa typological system to construct a broad regional synthesis of spatial-temporal chronological framework in lithic technology and typological classifications suitable for all sub-Saharan Africa archaeological assemblages (Clark 1988). Despite the resolution made by the committee, archaeologists working in this region continued to use locally based names to describe the typological variability in artefacts. These descriptions included ESA, MSA and LSA, but often lacked chronological, cultural and technological meanings. The chronological meanings of the ESA, MSA and LSA were not well established at the time these terms were accepted, but on the basis of new dates an overall time span of the ESA is between 2.6 and approximately 0.25 million years ago (Klein 1999). As previously noted, the MSA dates between 250,000 and 35,000 years ago, while the LSA dates between 60,000 and 7,000 years ago, however, in some places both the MSA and LSA overlap these estimated dates (Manega 1993; McBrearty 1988, 1993; Skinner *et al.* 2003). There is a remarkable difference in artefacts found in various places across the region, which suggests that significant technological and cultural variations exist from one place to another (Clark 1988; McBrearty and Brooks 2000). Causes for this variation need more attention and probably could be explained through differences in technological organization, ecological adaptations and functional values such as tool use, as discussed in chapters 7 and 8.

The three age cultural system also lacks some scientific authenticity and it requires arbitrary criteria in some sites. This is particularly true for, in particular,

East Africa where the ESA, MSA and LSA may be separated by transitional periods (Ambrose 2002; Mabulla 1996; Mehlman 1989; Skinner *et al.* 2003; Willoughby 2007, 2009). Kleindienst (1967: 827) initially raised the issue of transitional industries in cultural sequences of East Africa. She proposed the need for a new cultural sequence in East Africa, which could incorporate the intermediate industries that separate the ESA and MSA as well as the MSA and LSA. Her request, however, was not universally accepted. Based on Kleindienst's (1967) description, the cultural sequences of East Africa are separated by the First and Second Intermediate Industries. The First Intermediate Industry (FII) represents the cultural change from Early Stone Age (ESA) to the MSA. The Second Intermediate Industry (SII) describes the transition from the MSA to the LSA. Today it is strongly argued that intermediate industries should be reinstated because they are obviously expressed in the archaeological record at Muguruk, the Kapthurin Formation, Lukenya Hill and Enkapune Ya Muto in Kenya, Kalambo Falls in Zambia, and Nasera, Mumba and the Lake Eyasi basin in northern Tanzania (Ambrose 2002; Clark 1974, 1988; Mabulla 1996; McBrearty 1992; Mehlman 1989).

## **2.6 The First Intermediate Industry (FII)**

In general, the MSA in East Africa is composed of the First Intermediate Industry (FII), the true MSA, and the Second Intermediate Industry (SII). This occurs because the intermediate industries were not incorporated into cultural evolutionary frameworks launched in 1947 to define stone tool assemblages for

sub-Saharan Africa (Kleindienst 1967). This is possibly due to the fact that intermediate industries were not as apparent in South Africa where the cultural evolutionary scheme originated (Willoughby 2007). The focus on intermediate industries could probably contribute to the ongoing debate about the emergence of behavioural modernity in sub-Saharan Africa. Some scholars continue to insist that the MSA represents the hallmark of the onset of behavioural modernity and complex technology in sub-Saharan Africa (Brooks *et al.* 2006; Clark 1988; McBrearty and Brooks 2000; Mellars 2005, 2006). The First Intermediate Industry (FII) in parts of East Africa includes the Sangoan and consists of core axes core scrapers, large flakes, scrapers, and bifacial points made from peripherally prepared and amorphous cores. Other lithic tools such as picks, hand axes and choppers are also present, indicating features of technological continuity and discontinuity between the ESA and MSA cultures (Cole 1965; Mehlman 1989).

The Sangoan was named after Sango Bay on the shore of Lake Victoria in Uganda where artefacts were first recognized by E. J. Wayland in 1930s. In northern Tanzania, Sangoan artefacts are locally termed as Njarasan and come from local salt flats near Lake Eyasi (Mabulla 1996; Mehlman 1989). Both industries (Sangoan and Njarasan) are characterized by heavy duty tools, particularly core axes, picks and core scrapers, as well as large flakes (Clark 1988; Mabulla 1996; Mehlman 1989). In this study, the term Sangoan has been used consistently because it represents a broad range of East African cultural entities.

Elsewhere in Tanzania, Sangoan artefacts have been found in several sites that include the Ngaloba Beds at Laetoli, the Upper Ndutu Beds at Olduvai Gorge and the Kiwira River basin in the Serengeti National Park (Hay 1976; Mabulla 1996; Mehlman 1989; Manega 1993; Masao *et al.* 2003). In Uganda, Sangoan artefacts are found at Nsongezi and Sango Bay in western Lake Victoria (Kleindienst 1967). Similar artefacts have recently been found at Kigwambimbi in Iringa, but a detailed study is highly recommended before making any meaningful conclusions. Related industries have also been recorded in the Koobi Fora Formation (Lake Turkana), the Kapthurin Formation (Lake Baringo), and from Simbi, east of Lake Victoria, in Kenya, as well as Porc-Epic Cave, the Middle Awash and Gademotta in Ethiopia (Clark 1988; McBrearty 1993; Tryon *et al.* 2005; Wendorf and Schild 1992; Yellen *et al.* 2005). Within the Kapthurin Formation, the Sangoan Industry is dated to about 285,000 years ago (Tryon *et al.* 2005) and bifacial points are well represented.

Generally, in East Africa, the Sangoan Industry is dated to between 285,000 and 200,000 years ago (Hay 1976; Clark 1988; Mabulla 1996; McBrearty 1993; Mehlman 1989; Tryon *et al.* 2005; Wendorf and Schild 1992; Yellen *et al.* 2005). Recently, the Upper Ndutu Beds at Olduvai and Ngaloba Beds at Laetoli have been re-dated to between 300,000 and 200,000 years ago by using the  $^{40}\text{Ar}/^{39}\text{Ar}$  technique (Manega 1993). Evidence from the Ndutu Beds at Olduvai Gorge suggests that this was an episode of arid and dry conditions represented by wind-worked tuffs (Hay 1976), which contradicts Clark's (1988:274) idea that the Sangoan was associated with a tropical woodland environment. Fossil pollen

evidence from the Upper Ndutu Beds, which is associated with the Sangoan Industry, suggests that the climate was semiarid and perhaps like today's climate (Hay 1976:157). This idea is reinforced by finds recorded at Simbi, where the Sangoan artefacts were found associated with fossil bovid bones and teeth as well as soil carbonates; both show the presence of savanna conditions (McBrearty 1993).

Previously, the transitional industries were rejected as they were not adequately defined and lacked reliable samples from stratigraphic sequences (Clark 1988). This situation has improved following the excavation of in situ layers in some sites such as Muguruk and the Kapthurin Formation in Kenya and Kalambo Falls in Zambia. Today, it is clear that the Sangoan artefacts overlie the Acheulian at Kalambo Falls, but underlie the MSA at Muguruk and Simbi in Kenya (Clark 1974; McBrearty 1988, 1992). Although Clark (1988) considers the Sangoan as an early MSA, McBrearty (1993) considers it to be an independent cultural innovation representing the transition from the ESA to MSA.

## **2.7 Traditional MSA assemblages**

In East Africa, traditional MSA artefacts are characterized by the predominance of smaller artefacts compared to the Sangoan ones and refined peripherally prepared core technologies such as Levallois, disc and radial cores. Tools include scrapers, points, burins, utilized flakes and backed pieces (Mehlman 1989). Bifacial and large cutting tools are rare. MSA assemblages are widespread in East Africa and have been found in open sites, caves and rock-



shelters. In this region, the MSA is characterized by significant inter-assemblage variation, with a range of different tools such as unifacial, Levallois and bifacial points; side, end, notched and convergent scrapers; as well as burins and backed pieces (Mehlman 1989). Tool morphology and retouch patterns also differ from one place to another (Clark 1988). The meaning of such variation remains largely controversial. Past interpretations have centred on ethnicity, in which variation is seen as the result of learned cultural traditions of different ethnic groups (Clark 1988). Clark (1988) described the wide range of MSA tool types in sub-Saharan Africa as the first clear evidence for regional ecological adaptation and the beginning of cultural identities. Raw material types and functional needs can also influence variation in tool form.

The main important MSA sites within East Africa have been found at Porc Epic Cave in Dire Dawa, Gademotta and Maggio in the north of Lake Turkana in Ethiopia, the Lake Nakuru Basin, Muguruk, Lukenya Hill, Prolonged Drift, Prospect Farm, East Turkana, and Enkapune ya Muto in Kenya (Ambrose 2001, 2002; McBrearty and Brooks 2000; Onjala 2006; Willoughby 2007). Other sites include Orichinga in Uganda, Loiyangalani in the Serengeti National Park, Mumba rock-shelter in the Lake Eyasi Basin, Nasera rock-shelter, a number of sites in the Lake Natron basin, and sites along the Songwe River basin in Mbeya Region, as well as Magubike near Iringa. All of the latter are in Tanzania (Figure 2.1). Reliable dates for MSA sites are lacking in many places within East Africa, but generally range from between 250,000 and 35,000 years ago. In northern Tanzania, the earliest date for a traditional MSA site came from the Post Moinik

Formation in West Lake Natron, which was dated by a uranium series to about 170,000 years ago (Bushozi 2003; Manega 1993). At Mumba in Beds VI-A & B, the MSA was dated to between 132,000 and 110,000 years ago (Mehlman 1989). ESR dates on mollusc shells date the MSA at Magubike to about 150,000 years ago (Anne Skinner, personal communication 2010).

## **2.8 The Second Intermediate Industry (SII)**

The Second Intermediate Industry (SII) or Mumba Industry in the northern Tanzania cultural sequence consists of flakes, scrapers, points, burins, blades, bladelets, large backed pieces, crescents and other cultural materials such as ostrich and land snail shell beads and ochre. Most of these are not commonly found in traditional MSA assemblages (Ambrose 2002; Bower 1985; Mehlman 1989; Skinner *et al.* 2003). Bipolar and peripherally prepared core technologies predominate in the SII assemblage, a process that provides substantial evidence for the technological and behavioural relationships between the MSA and LSA cultures. Available evidence suggests that most of the artefacts from the transitional industries between the MSA and LSA are more like the LSA ones (Prendergast *et al.* 2007).

This pattern does not occur in other parts of Africa, because many places appear to have been abandoned at the end of the MSA, between 50,000 and 25,000 years ago; they were only reoccupied close to the end of Upper Pleistocene (Willoughby 2007, 2009). At some sites in southern Africa, the MSA persisted during the LSA periods, ending about 20,000 years ago (Thackeray

1992). This trend is quite different in East Africa where the MSA and LSA are found in deep cultural sequences in some places, only separated by transitional industries. Sites in Tanzania (Mumba, Nasera and Kisese), Kenya (Lukenya Hill and Enkapune ya Muto), and Southern Somalia (Burr Heybe) suggest the presence of transitional industries between the MSA and LSA levels (Ambrose 2002; Brandt and Gresham 1989; Mabulla 1996; Mehlman 1989; Merrick 1975).

Stone artefacts from the Second Intermediate Industry are more diverse than those from any other MSA sites, but they are made of local and exotic raw materials similar to those from other MSA assemblages. At these sites, archaeological remains occurred at deeply stratified sequences. There is no clear technological discontinuity that can be revealed from stratigraphic sequences. All assemblages are arranged in chronological order. In these sites lithic assemblages that are transitional in nature separate the MSA and LSA. Correlations between the MSA and LSA assemblages in East Africa is one of the criteria used by researchers to regard this region as the ancestral place for all modern human populations and their accumulative behaviour (Mellars 2006). The late MSA culture or SII is regarded as a cultural stage for the major shifts in technology, adaptation and behavioural patterns.

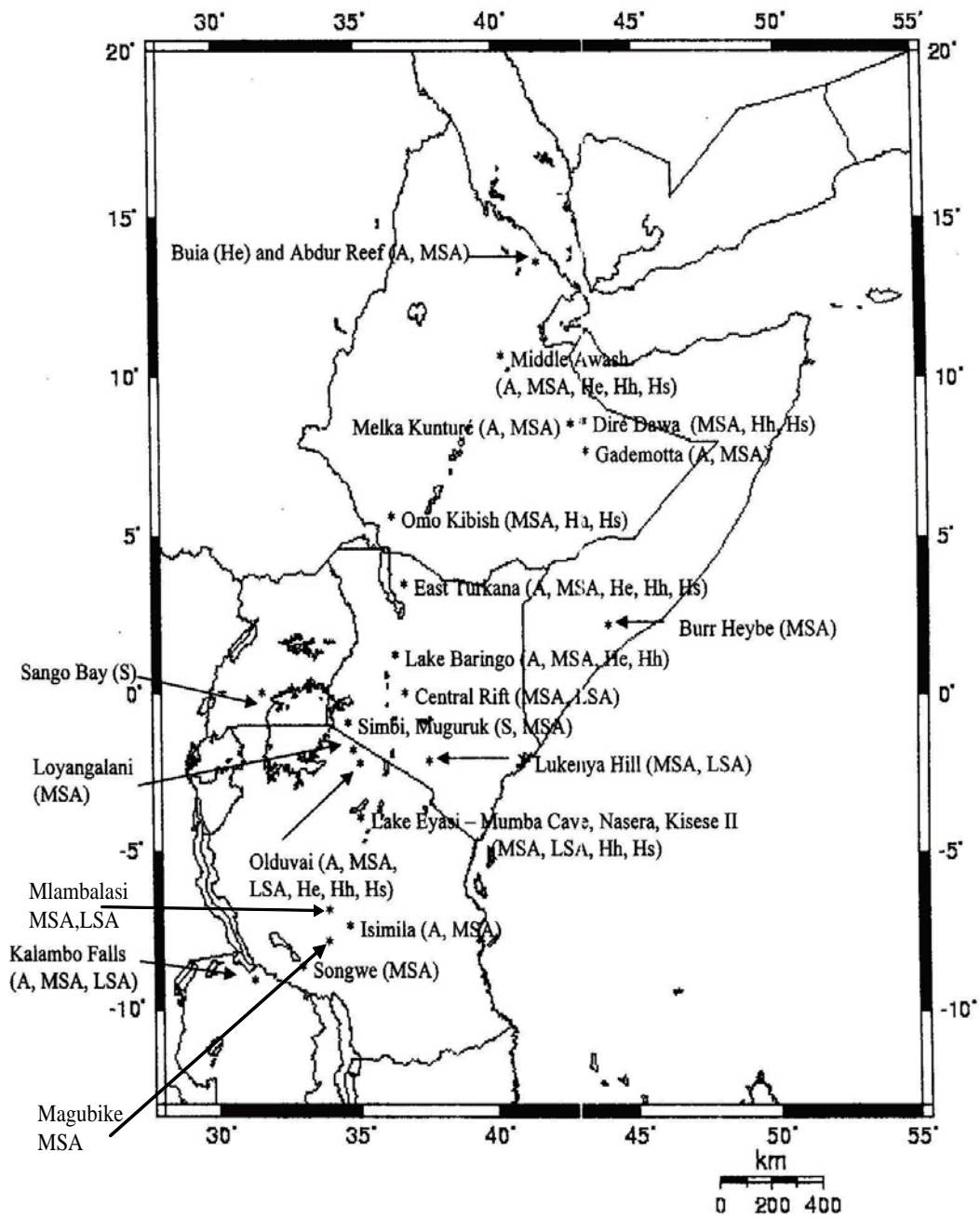


Figure 2.1. Map of Eastern Africa showing the spatial distribution of the Middle and Upper Pleistocene archaeological sites (adapted and modified from Willoughby 2007).

Faunal assemblages recovered from Loiyangalani in northern Tanzania and Katanda in the Democratic Republic of the Congo (DRC) suggest that late MSA humans utilized diverse food resources including aquatic foodstuffs (Bower 1985, 2005; McBrearty and Brooks 2000; Yellen 1996). At Mumba and Nasera, the MSA and MSA/LSA transition contains evidence for exotic raw materials in particular, chert and obsidian (Mehlman 1989; Merrick 1984), and symbolic revealing objects like ochre and ostrich egg beads (Mehlman 1989). Ostrich egg shell beads have also been documented with the MSA contexts at the Loiyangalani River site in Serengeti (Bower 2005). It is still difficult to determine the chronological sequence of this site. It is believed to have been disturbed by river flow over time, but available radiometric dates place the MSA horizon at Loiyangalani to about 70,000 years ago (Bower 2005).

Generally, the MSA/LSA transition at these sites is accompanied by both MSA and LSA technologies (Ambrose 2002; Mehlman 1989). The connection between the MSA and LSA revealed at these sites shows that the transition was a gradual process and occurred between OIS 4 and 3 (72,000- 35,000) years ago, soon after a period of prolonged series of drought and short burst rainfall (Scholz *et al.* 2007). Available evidence shows that the late Middle and Upper Pleistocene archaeological assemblages are more complex and characterized by progressions consisting of elements of both technological changes and continuity.

The presence of FII and SII industries in East Africa makes the region widely recognized as a place that can contribute significantly to the ongoing debate about the evolution of behavioural modernity. At Mumba, the SII is

believed to be the core for the evolution of arrowhead projectiles. Small points, which appear to have been used as arrowhead tips are more widely represented in transitional industries at Mumba and Nasera, compared to other MSA cultures (Chapter 8). The evolutionary trend from spearhead to arrowhead projectiles is still inadequately understood. The samples analysed here suggest that these two weapon systems coexisted during the MSA and Second Intermediate Industries at Mumba, Nasera and Magubike (Chapter 8). An additional problem is that there is little knowledge of prehistoric hunting behaviour and the ways it changed over time in Africa. Reviewed evidence suggests that points were among the universal tools made by MSA foragers. Perhaps, these projectile weapons contributed to the food acquisition and behavioural changes during the MSA. Using points, this study tries to investigate the particular adaptations and cultural traits that contributed to our present dominance of the earth, which might have started during the MSA in East Africa.

## **2.9 LSA assemblages**

Goodwin and Van Riet Lowe defined the LSA as a lithic assemblage characterized by bladelets, backed pieces, geometric and microlithic tools (Mehlman 1989). In East Africa, the LSA assemblages date between 45,000 and 7,000 years ago and are characterized by temporal and spatial variations in lithic assemblages. Generally, there are more LSA sites known in East Africa than MSA sites. This may reflect the greater intensity of research on the LSA than on the MSA (Robertshaw 1990). Dates for many LSA assemblages in East Africa are

controversial. Most have been approximated based on findings from other places outside East Africa, where the LSA was documented for the first time.

At Nasera, a radiocarbon date on bone dated the LSA or Lemuta Industry between 21,000 and 28,000 years ago (Mehlman 1989). Kisele II has provided a date of 18,190 years ago on charred ostrich eggshell found in the LSA levels (Deacon 1966). At Naisiusiu Beds, Olduvai Gorge,  $^{40}\text{Ar}/^{39}\text{Ar}$  dated LSA assemblage to about 45,000 years ago (Manega 1993). New ESR dates on equid teeth pushed back the LSA industry from the Naisiusiu Beds at Olduvai Gorge to around 60,000 years ago (Skinner *et al.* 2003). The latter date makes the LSA and Naisiusiu Beds the same age as the transitional industries from MSA to LSA elsewhere within the region; alternatively, it might represent the earliest known LSA industry in the world. Previously, the Naisiusiu LSA site was radiocarbon dated to 17,000 years ago (Leakey *et al.* 1972). If these new dates are correct, then the transition industries occurred much earlier in East Africa. It would put them close to the late MSA assemblages of southern Africa that dates to the beginning of the glacial phase or OIS 4 about 72,000 years ago (Wadley and Jacobs 2004).

Perhaps the cultural transmission from MSA to LSA was influenced by physical environmental changes documented across the region (Scholz *et al.* 2007). It is still unclear, however, how the environmental changes articulated with human technological and behavioural shifts. This occurs because archaeologists working in this region have not made any serious attempts to explain the selective pressure that would have favoured technological and behavioural changes.

Phillipson (1980) relates increasing numbers of microlithic tools to the use of bow and arrow technology for the hunting of small animals. Archaeological assemblages, however, indicate that there is no difference in the faunal remains associated with the MSA and LSA at Lukenya Hill, Nasera and Mumba (Marean 1990; Mehlman 1989). The increased numbers of microlithic tools in LSA assemblages throughout the late Pleistocene in Africa cannot be associated with hunting small mammals, although this trend may be valid in southern Africa, where the LSA appeared very late compared to other African regions. It is believed that much of South Africa was abandoned during the Last Glacial Maximum (Willoughby 2007, 2009). Generally, radiocarbon dates for faunal remains in the early LSA are problematic, and often yield highly unreliable results due to the tendencies for contamination with groundwater or acid soils, which destroys bone collagen (Brooks and Robertshaw 1990; Taylor 1987). Because of this, more reliable methods are needed. It is possible that the earliest LSA assemblages in East Africa and other places in sub-Saharan Africa spans beyond the effective time limit for radiocarbon dating. More new radiometric dates for LSA assemblages may significantly revise the chronology of Upper Pleistocene archaeological assemblages in East Africa.

## **2.10 The evolution of early modern humans and their behaviour**

Genetic studies in the late 1980s identified Africa as the continent of origin of all modern human populations. Mitochondrial DNA (mtDNA) shows that all modern human populations shared a common female ancestor in Africa



between 200,000 and 150,000 years ago (Cann *et al.* 1987). DNA is the basis of heredity and consists of two strands coiled in a double helix (Cann *et al.* 1987). Mitochondrial DNA is inherited through the female side and is found outside the nucleus in organelles that is used to convert sugar into energy (Cann *et al.* 1987). MtDNA samples, which were originally obtained from 147 individuals from five geographical areas (Africa, Asia, Australia, Europe and New Guinea), showed that Africa was the source of the human mitochondrial gene pool and that migrants from Africa colonized other areas over time (Cann *et al.* 1987). The conclusion made by Rebecca Cann and her colleagues in 1987 was a catalyst for more genetic studies. All subsequent genetic data such as Y-chromosome studies showed similar results for the human lineages (Bräuer 1992; Cann *et al.* 1987; Hammer 2002; Hasegawa *et al.* 1993; Ingman *et al.* 2000; Mellars 2005, 2006).

More recent mtDNA studies suggest that early humans dispersed from East Africa to the Middle East and Southern Asia between 60,000 and 35,000 years ago (Hasegawa *et al.* 1993; Macaulay *et al.* 2005; Mellars 2006). The evidence suggests episodes of rapid population growth in the ancestral African populations from about 80,000 to 60,000 years ago (Hasegawa *et al.* 1993; Mellars 2006). According to Mellars (2006), the peak in African populations was followed by an equally defined population growth in Eurasia from 60,000 to 35,000 years ago. The genetic evidence points out that remarkable expansion of modern human populations started in one small area in East Africa between 80,000 and 60,000 years ago, and expanded to western, northern and southern

Africa as well as Southern Asia between 60,000 and 35,000 years ago (Forster and Matsumura 2005; Macaulay *et al.* 2005; Mellars 2006).

New dating techniques support the model that places the start of modern human biological and cultural evolution in Africa during the MSA or Middle Palaeolithic (Bräuer and Mehlman 1988; Dominguez-Rodrigo *et al.* 2007; Hay 1987; Manega 1993; McBrearty 2005; McBrearty and Brooks 2000; Mehlman 1989; Willoughby 2007). In East Africa, hominid fossils from MSA assemblages are found throughout the region and show a clear picture of anatomical changes over time from archaic *Homo sapiens* (*Homo heidelbergensis*) to early modern humans. For example, in Tanzania, fossil crania representing archaic *Homo sapiens* include the skulls and bone fragments from the Ngaloba Beds in Laetoli (LH 18) and Lake Eyasi dated between 200,000 and 132,000 years ago (Bräuer 1992; Bräuer and Mehlman 1988; Dominguez-Rodrigo *et al.* 2008; Manega 1993). Early modern humans who were anatomically similar to modern humans succeeded early archaic *Homo sapiens* in Tanzania between 132,000 and 110,000 years ago. Samples of early modern humans in northern Tanzania include three isolated human teeth from Mumba rock-shelter dated to at least 132,000 years ago (Bräuer 1992; Bräuer and Mehlman 1988). Recently, seven isolated teeth of early modern human were found associated with the MSA assemblage at Magubike rock-shelter (Biittner *et al.* 2007).

There are more places in sub-Saharan Africa where remains of early modern humans have been found associated with MSA artefacts such as points, scrapers and burins. The late MSA assemblages in this region or the Second

Intermediate Industries were found associated with symbolic objects such as ochre, ostrich and land snail shell beads, and fossil fauna that suggest the development of modern human behaviour started during the MSA. In some places of sub-Saharan Africa, proportional representation of symbolic objects is limited and fragmentary probably because of preservation problems or due to the paucity of archaeological studies. Ongoing debates among archaeologists about the behavioural patterns, technological ability, and subsistence patterns of early modern humans in Africa may be related to inadequate research on the MSA (Ambrose 2002, 2003; Binford 1989; Henshilwood *et al.* 2003; Klein 1992, 1999; McBrearty and Brooks 2000; Willoughby 2001, 2007, 2009). It is commonly argued that the technology of MSA people was highly developed compared to that of other early hominids, since they made use of hafted tools (Lombard and Phillipson 2010). Advanced technology made it possible for MSA people to migrate and to adapt to unfamiliar environments, replacing the Neanderthal populations in Eurasia between 60,000 and 35,000 years ago (Mellars 2006).

Clark (1988:299) argues that shell beads and ochre were used for adornments, and that sometimes ochre was also used for decorating tools and equipment. New studies on technological organization and microscopic residue analysis suggest that ochre powder was mixed with other ingredients and was used as a hafting agent (Lombard 2007). In East Africa, pigments and ostrich eggshells in MSA contexts have been found in the Mumba Industry at Mumba and Nasera, as well as in Magubike and Loiyangalani suggesting that MSA foragers used them (Bower 2005; Mehlman 1989). There is no evidence of rock

art or intentional human burials in East Africa during the MSA period, while such features are widely distributed in LSA contexts.

At Loiyangalani in the Serengeti National Park, remains of catfish were found in the MSA contexts (Bower 2005). Studies of resource exploitation and taphonomic investigation of the site formation processes at Loiyangalani are still underway, but evidence of fishing during the MSA was also reported at Katanda in the Democratic Republic of Congo (DRC) dated to 90,000 years ago (Yellen 1996). Evidence from the MSA and LSA contexts at Mumba and Lake Natron basin shows the exploitation of giant tropical land snails (*Burtoa nilotica* and *Achatina fulica*) (Bushozi 2003; Mehlman 1989). Land snails are widely exploited by modern hunters of northern Tanzania (Marlowe 2003). Recently, more substantial evidence for systematic exploitation of shellfish and molluscs has been reported from the MSA context at Pinnacle Point near Mossel Bay in South Africa (McBrearty and Stringer 2007; Marean *et al.* 2007).

In South Africa, early modern humans may have controlled plant food by burning bushes to encourage the growth of plants such as corns or tubers during the MSA period, indicate systematic and organized foraging systems. One site with such evidence is Strathalan Cave (Deacon 2001; Thackeray 1992). Other carbonized lenses and burned residues of geophytes were found associated with the MSA tools at Klasies River (Deacon 1989, 2001). Burning activities may suggest that MSA foragers controlled their environment and that plant foods formed a major part of their diet as in modern hunting communities (Deacon 1989; Thackeray 1992). The subsistence patterns recorded from some MSA

deposits in eastern and southern Africa shows that most of the essential subsistence features found within the LSA can also be traced back to MSA times. Generally, these data support the conclusion made by Milo (1998), who suggests that MSA foragers utilized diversified food resources and were formidable hunters. They used points to form hunting tools and their hunting techniques and social behaviour patterns approached those of modern hunters (Milo 1998).

### **2.11 The status of points and resource exploitation in the MSA**

MSA foragers are linked with early evidence of planned hunting, since they used points as tips on spear shafts or arrows (Brooks *et al.* 2006; Shea 1997; 2006). Goodwin and Van Riet Lowe (1929:95-145) recognized the presence of scrapers and points as the defining characteristic of the MSA when they defined this culture in 1929. Points, scrapers, knives, and/or retouched blades and flakes seem to have been deliberate target forms for many toolmakers during the MSA (McBrearty and Brooks 2000). In sub-Saharan Africa, retouched points are among the earliest MSA artefacts and date back to 285,000 years ago at the Kapthurin Formation in Kenya (McBrearty 1993; Tryon *et al.* 2005). These points decrease in size over time; they also vary in shape from one region to another (Figure 2.2). Although the representation of points in MSA assemblages is widely recognized, study on their function started very recently. Based on the metric measurements, it is usually argued that these points were used for hunting activities (Brooks *et al.* 2006; Lombard 2007; Shea 2006, 2009). These changed over time as spears gave way to bows and arrows (Brooks *et al.* 2006).

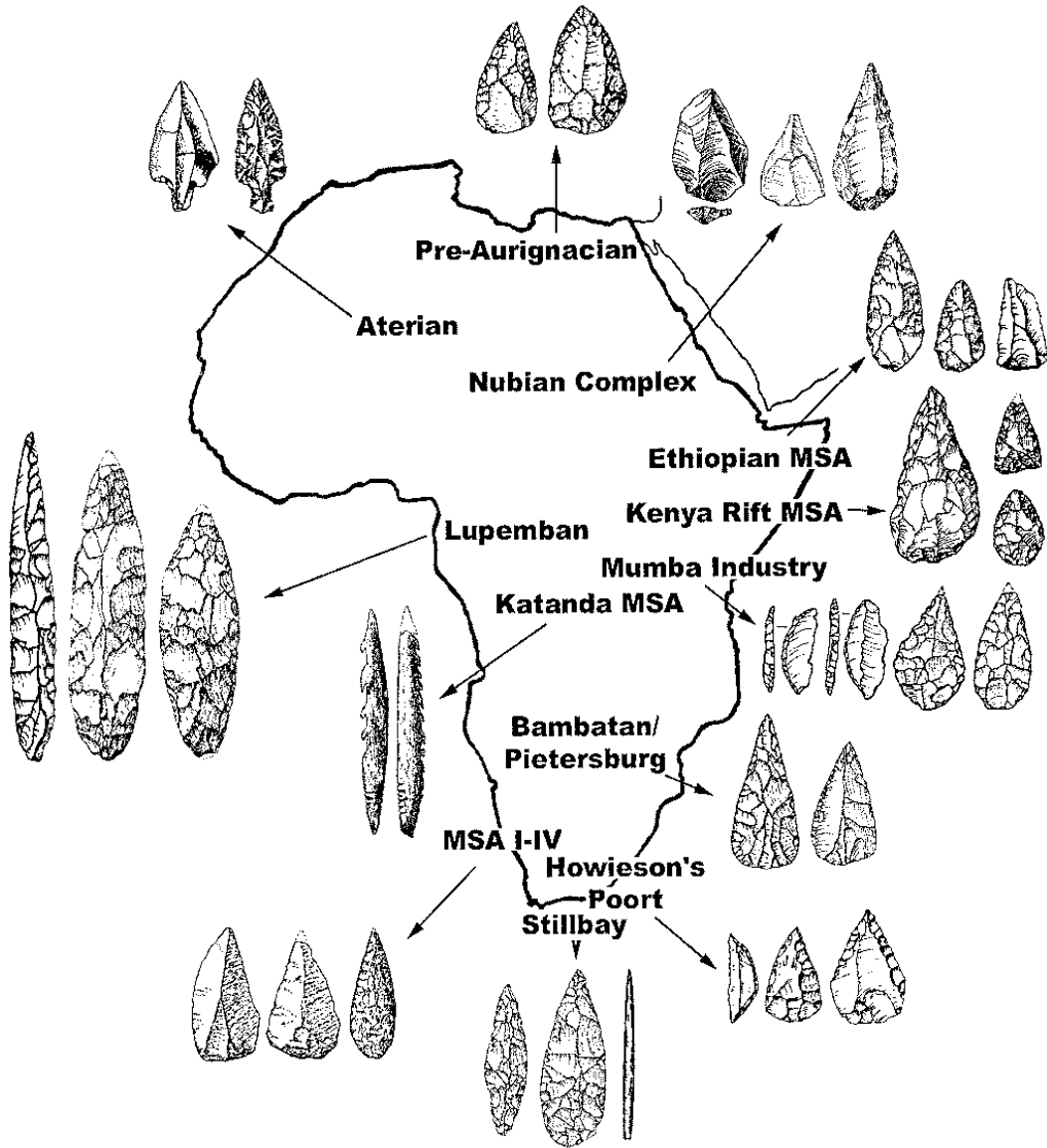


Figure 2.2. Map of Africa showing the distribution of MSA points (adapted from McBrearty and Brooks 2000)

MSA points are of appropriate size and thinned to allow for hafting (McBrearty and Brooks 2000). They are also characterized by inter-assemblage similarities and variations due to the shared technological traits and ecological adaptations (Clark 1988). For instance, points from MSA assemblages at Mumba, Naseru and Magubike are carefully made, thin and symmetrical. Some were made by striking flakes off the end or edges of flakes; this technique on points also occurs at Gi site in Kalahari Desert, Botswana (McBrearty and Brooks 2000). This suggests a dynamic and systematic design among the artisans during the MSA period (McBrearty and Brooks 2000). Again, it is said that MSA foragers were capable of hunting and killing diversified game including small and large mammals (Brooks *et al.* 2006; Mabulla 1996; McBrearty and Brooks 2000; Marean 1997).

In East Africa, points are recognized as markers of the onset of composite tools in archaeological records dated back to 285,000 years ago (McBrearty 1993). The earliest points come from surface collections at Sango Bay, Uganda and Muguruk in Kenya. These sites are located within the Lake Victoria Basin. Points of this region resemble Lupemban points from Kalambo Falls. These points are characterized by a high frequency of lanceolate shapes; some of them are thin, skilfully made, exceeding 30 mm in length (McBrearty 1988; McBrearty and Brooks 2000). Other early MSA points have been found in the Kapthurin Formation near Lake Baringo, Kenya and the Lake Ziway region of Ethiopia where they date to between 230,000 and 284,000 years ago (Deino and McBrearty 2002; McBrearty 1993; Wendorf and Schild 1992). Bifacial points dominate

Kapthurin Formation assemblages providing evidence for early development of projectile technology and an important milestone for improved competency and skills in hunting activities. Within the central Rift Valley region of Kenya Tryon *et al.* (2005), MSA points have been found at Prospect Farm, Nderit Drift, Cartwright and Lukenya Hill (McBrearty and Brooks 2000; Waweru 2007). These assemblages are dominated by triangular or Levallois points with both unifacial and bifacial retouch. Points from the central Rift Valley region are smaller in size than those from the Kapthurin Formation (McBrearty and Brooks 2000:496).

Using metric measurements, Brooks *et al.* (2006) argue that MSA points from the Aduma site in Ethiopia and Gi in Botswana were used as projectile points. This observation may suggest that arrowhead projectiles were present in sub-Saharan Africa between 100,000 and 65,000 years ago, about 35,000 years earlier than they are found in Europe. More studies from MSA sites in East and Central Africa have provided provocative evidence for the production of small stone and bone points (Ambrose 2001, 2002; McBrearty and Brooks 2000; Yellen 1995, 1996). However, a lack of study related to the function of points in East Africa has contributed to a failure to settle ongoing debate about the nature and form of hunting techniques employed by MSA foragers in the region. The assumption that small points represent the innovation of new hunting behaviour and projectile technology (McBrearty and Brooks 2000) does not explain the hunting strategies employed or the relationship between the adopted strategies and the local environment.



To some extent the ongoing debate concerning the function of points has been centred on two possibilities: points used for hunting activities or used for cutting activities (Brooks *et al.* 2006; Kuman and Clarke 1986; McBrearty and Brooks 2000; Wendorf and Schild 1992). Experimental studies of the MSA points from Lake Ziway, Ethiopia suggest that the points were mainly used as cutting or scraping tools (Wendorf and Schild 1992). This argument is supported by microwear study on points from Mumba, which suggests that points were used as cutting tools or hunting weapons (Chapter 8). These observations support the idea that MSA points performed different activities over their lifespan. Hunting weapons were often deliberately modified to facilitate hafting, either by thinning at the butt or by fabricating a tang (McBrearty and Brooks 2000).

More compelling evidence of points used in hunting comes from Klasies River in South Africa where a point tip was found embedded in a cervical vertebra of a large bovid (*Pelorovis*) in MSA deposits (Milo 1998). The body weight of a prehistoric buffalo has been estimated to be about 790 kg (McBrearty and Brooks 2000; Milo 1998). The modern descendant of *Pelorovis* is the tropical African buffalo (*Syncerus caffer*); although it is significantly smaller in size, it is regarded as one of the most dangerous game animals in Africa (Milo 1998). At Levant, a point tip was found embedded in neck vertebra of a wild ass (*Equus africanus*) in the Middle Palaeolithic assemblage dated by thermoluminescence to about 50,000 BP (Boeda *et al.* 1998). Although these findings tend to support the existence of some evidence of projectile technology, they could also indicate that

points may have been used for multiple functions such as hunting, butchering, or cutting practices.

In East Africa, faunal assemblages indicate that MSA and LSA foragers exploited small, medium and large mammals (Dominguez-Rodrigo *et al.* 2007; Mehlman 1989; Marean 1997). Clear evidence of hunting behaviour comparable to MSA and LSA human subsistence behaviour in southern Africa comes from Lukenya Hill in Kenya and Aduma in Ethiopia. Marean (1997) developed two models of prey specialization and seasonal fauna exploitation. He documented the series of repeated events of specialized hunting of extinct Alcelaphine antelope at GvJm-22 and hartebeest at the nearby site of GvJm-19, both located at Lukenya Hill (Marean 1997). Variation in fossil fauna from these sites suggests a difference in the season of occupation (Marean 1997). At GvJm-46, Marean (1990) observed no difference between the MSA and LSA foragers in terms of subsistence patterns. While the levels are chronologically and stratigraphically separated, both horizons are dominated by small alcelaphine bones. Body parts, patterns and bone cut mark frequencies are similar (Marean 1990). This could be interpreted as evidence for continuity in human subsistence behaviour during the MSA and LSA, regardless of the temporal difference in time. Perhaps, the exploitation model observed at Lukenya Hill was part of East African tropical grassland resource exploitation strategies that also involved an obsidian exchange network.

More evidence for seasonality and specialized hunting has been reported from the MSA assemblage at Gi in the Kalahari Desert, Botswana and Klasies

River in South Africa (Klein 1999; McBrearty and Brooks 2000). In the Kalahari Desert, tactical and mass animal killing was conducted at the Gi site, close to the end of rainy season, when water resources became more limited in the desert environment (McBrearty and Brooks 2000:497). Metric measurements on MSA points at this site suggest that they were used as tips for throwing spears or arrowheads (Brooks *et al.* 2006). Settlement patterns and hunting strategies documented at Gi are closely related to those of Nasera in northern Tanzania discussed in chapter 4.

The fauna assemblage from Klasies River suggests that MSA humans frequently hunted eland (Klein 1999). Klein (1999) argues that MSA foragers hunted defenceless animals such as eland because they were incapable of hunting aggressive animals like now-extinct buffalo (*Pelorovis*). The high representation of eland bones in archaeological contexts at Klasies River can also be interpreted as an indication of hunting less aggressive animals. Even today, modern hunter and gatherers of northern Tanzania pay great attention to hunting hartebeest, antelope and gazelle rather than aggressive animals like buffalo and/or wild pigs (Personal observation, 2004). More evidence for prehistoric hunting activities have been revealed from microscopic residue analysis and metric measurements on points at Rose Cottage and Sibudu Caves in South Africa (Lombard 2007; Lombard and Phillipson 2010; Mohapi 2007; Wadley and Jacobs 2004; Wadley *et al.* 2009), suggesting points were hafted on wooden shafts and used for planned hunting (Chapter 8).

## **2.12 Summary**

The summary of research on MSA and LSA hominids, cultures and chronological records presented in this chapter illustrates the trend of archaeological investigation and highlights major challenges facing archaeologists working in East Africa. These challenges include a lack of detailed research in many places, inappropriate theories adopted from previous researchers, unreliable dates and inadequate knowledge of past environments. These problems leave broader gaps and questions to be answered by palaeoanthropologists. The current knowledge about early modern human lifestyles and their resource exploitation strategies are inconclusive and fragmented. The past experiences that were reconstructed based on diffusion theories and Eurocentric analytical schemes should be revised. More research should be undertaken in uncovered areas, many sites need to be re-dated, cultural history needs to be reconstructed and cultural processes that include the technological organizations and food acquisition strategies need to be investigated and modernized.

Data from MSA and LSA assemblages suggest that hunting was mainly carried out near water sources, while sites located far away from water sources were mainly occupied during wet seasons. Hunting was performed using points, which were hafted on wooden shafts to form spears or arrowheads. Spears were thrust or thrown at animal prey, but sometimes hunting involved the use of other techniques such as ambush, stalking or tracking animals. Available evidence from metric measurements and residue studies suggests that points played a significant role during the MSA and early LSA. During the LSA, points were replaced by

backed pieces, which were hafted in wooden shaft to form projectile weapons (Lombard 2007; Lombard and Phillipson 2010). Both arrowhead and spearhead technologies can be traced back from late MSA assemblage of sub-Saharan Africa (McBrearty and Brooks 2000).

## CHAPTER 3: THE PAST AND PRESENT ENVIRONMENT OF EAST AFRICA

### 3.1 Introduction

East Africa lies between latitudes 4° N and 12° S and longitudes 30° E and 41° E. The region is bordered by the Indian Ocean on the east. The western or Albertine branch of the East African Rift Valley System (EARVS) separates East and Central Africa. In the north, the region is bordered by Sudan, Ethiopia and Somalia. In the south, the Ruvuma River separates the region from Mozambique and Malawi. East Africa also now represents a regional, political and economic federation that includes Tanzania, Kenya, Uganda, Rwanda and Burundi. Rwanda and Burundi, however, are often still referred to as a part of Central Africa in many sources (Bonnefille and Chalieu 2000; Hamilton 1982).

The physiography of East Africa is characterized by a highly diversified landscape including lowlands, plains, highlands, faults, and mountains, as well as lakes and river basins. These features are highly affected by air mass circulation dominated by monsoon winds that govern annual precipitation and the distribution of ecological resources over the landscape. Local environmental resources enabled early hominins to survive in this region for a long time. Early hominins (*Homo habilis*) and their lithic tools appeared at the beginning of the Quaternary about 2.6 million years ago in East Africa (Klein 1999).

In this study, the paleoenvironmental evidence of East Africa is discussed in conjunction with trends in lithic technology and behavioural changes over time.

Climatic shifts may have influenced early modern human behaviour that might have triggered a change in adaptive strategies, thus paving the way for significant biological and cultural changes (Ambrose 2003; Bonnefille 1996; Cohen *et al.* 2007; Scholz *et al.* 2007). The following description of present East African ecology and landscape provides a basis for the detailed discussion of the past environment (last 300,000 years) that sustained our early ancestors.

### **3.2 The modern environment of East Africa**

The modern landscape and hydrological system of much of East Africa is heavily influenced by the East African Rift Valley System (EARVS). Pleistocene volcanic activities that took place between 2.0 and 1.5 million years ago created two branches of the EARVS, which are characterized by mountain ranges, a series of plateaus, lowlands, lakes and river basins. Both branches of the EARVS pass through the inland plateau and currently contain both deep and shallow lakes, along with dry basins. The eastern branch or Gregory Rift starts in central-northern Tanzania and extends northwards through Kenya and Ethiopia to the Red Sea and Jordan Valley in the Middle East, thus becoming an extension of the Afroarabian Rift System (Figure 3.1). The rift is characterised by narrow faults, shallow and alkaline lakes, as well as escarpments and the high mountains that formed during the Pliocene and Quaternary periods (Aidan 2004). The best-known mountains within the region include Mount Kilimanjaro (5895 m) in Tanzania, Mount Kenya (5199 m) in Kenya, and Mount Ruwenzori (4127 m) in Uganda. With the exception of the Mount Ruwenzori and Rukinga highlands,

most of the highlands and mountains in East Africa are located within or close to the eastern branch of the East African Rift Valley System (Figure 3.1).

The western branch of the EARVS dominates most of the large and deep lakes in the region such as Lakes Nyasa, Tanganyika, and Edward as well as Mount Ruwenzori (Aidan 2004). Highlands and plateaus receive substantial precipitation and they are generally cooler than lowlands and coastal plains. Depressions and uplifting processes in the western branch also reversed the previously west-flowing rivers such as the Kagera and Katonga rivers, which flow eastwards. Currently, these rivers are the major sources of the water that feeds Lake Victoria and the Nile River (Hamilton 1982; Willoughby 2007). The Nile River and Lake Victoria catchments support most of the economic activities and livelihoods for millions of people in eastern and northeastern Africa today. Apart from volcanism, other factors such as the air mass circulation and orbital forcing played a significant role in climatic change and/or vegetation replacements within the region (Aidan 2004).

### **3.2.1 Climate**

In East Africa, the modern climate is subjectively influenced by the air mass circulations, in particular, the monsoon winds and the Inter-Tropical Convergence Zone (ITCZ) or Meteorological Equator Zone Range (MEZR). The ITCZ is a low-pressure zone where the northeast and southeast trade winds or monsoons of the two hemispheres meet (Hamilton 1982; Willoughby 2007). These seasonal winds bring heavy rainfall in the adjacent coastal and hinterlands.



Wind movements and the location of the ITCZ follow the movement and location of the sun. Over the oceans and at high latitudes the ITCZ remains near the geographic equator, but over land it forms an oblique northern dipping plane in the lower troposphere and migrates seasonally with the sun both northwards and southwards (Dupont *et al.* 2000; Willoughby 2007). April is the wettest month in East Africa with the ITCZ lying between longitude 3°N and 3° S. June to September is the dry and cold season when the ITCZ shifts towards the north. Starting in October, the ITCZ moves southwards followed by a rainy season that ends in January.

Monsoon winds from the Atlantic Ocean bring precipitation to the western portion of Lake Victoria, while winds from the Indian Ocean provide moist to most parts of the East African coast. The southeast monsoons off the Indian Ocean bring precipitation to the coast in June and July. During the summer, East Africa receives southeast monsoon winds from the Atlantic Ocean; these change direction after passing the Equator and become the southwest monsoon that brings summer precipitation to parts of the region in July and August (Figure 3.2). In September, some monsoon trade winds from the south Atlantic Sea cross the Congo basin, and bring moisture and rainfall to areas close to the western branch of Lake Victoria basin (Hamilton 1982).

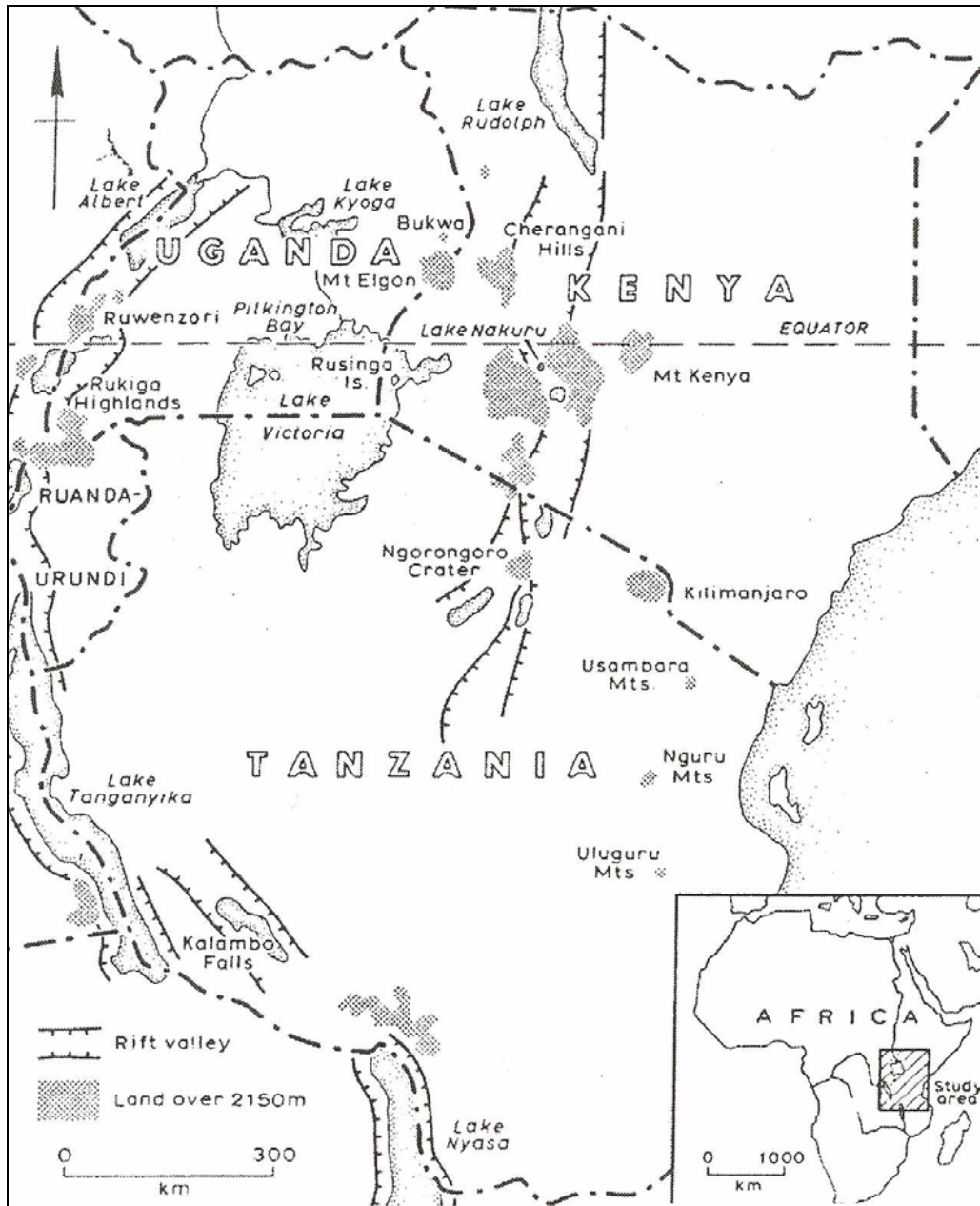


Figure 3.1. The physiography, geomorphology, Rift Valley System, mountain ranges and lakes of East Africa (adapted from Aidan 2004).

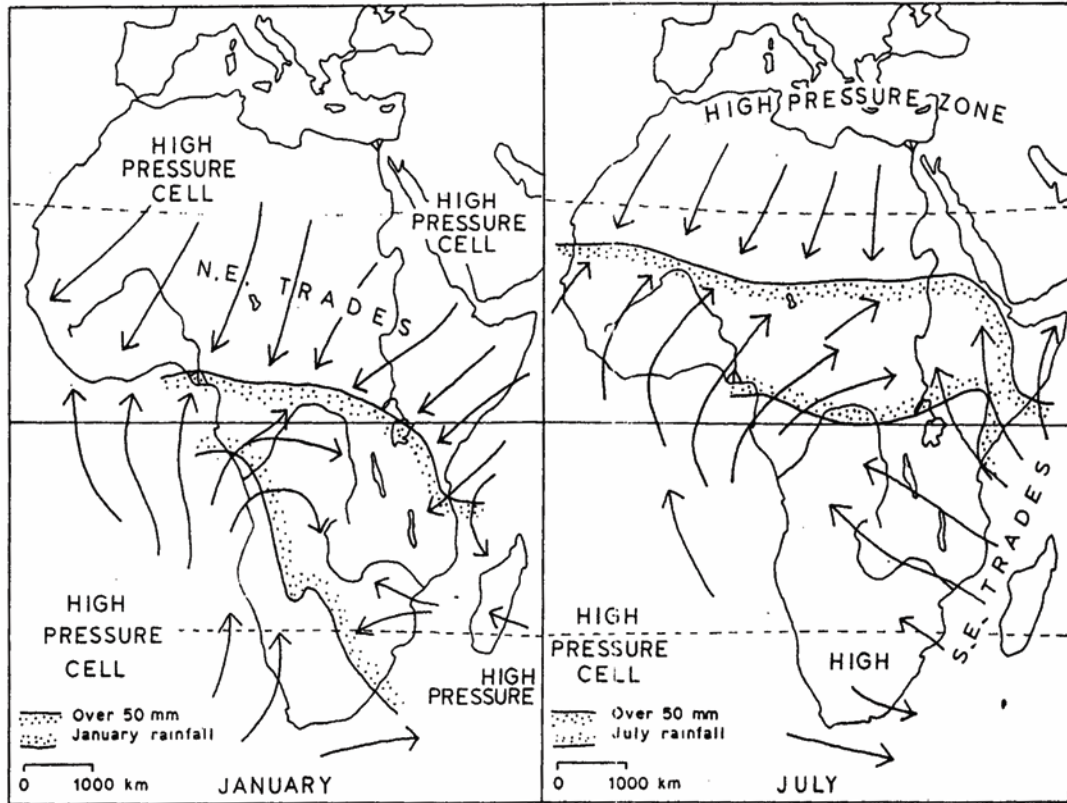


Figure.3.2. Map of Africa showing features of general circulation and rain belts in January and July (adapted from Hamilton 1982:12).

There are often two rainy seasons near the Equator, but only one further north and south. The equatorial zone mainly receives convection rain because of the high evaporation rates from local water bodies and precipitation from the dense equatorial forests (Hamilton 1982). The heavy rainy seasons within the equatorial zone and the western part of the Lake Victoria basin are mainly associated with lake water evapotranspiration, hydration and dehydration, a process that results in convection rains. The annual precipitation here ranges from 1200 to 1270 mm per year. The same trends characterize the northern part of Lake Malawi and Tanganyika, including the southern highlands of Tanzania, which receives rainfall of  $\geq 1000$  mm annually (Hamilton 1982:13). Other areas with high precipitation, between 850 mm and 1000 mm, include the western portion of the EARVS and the coastal plain; they receive much of their rainfall from the western and eastern monsoons respectively. Areas on the lee side of EARVS branches as well as those located far away from large water bodies receive reduced annual rainfall, ranging from 254 mm to 850 mm, because they are within the rain shadow area, or because they receive dry-winds with reduced moisture. These are the dry areas located in northern Tanzania as well as southern and northern Kenya. They receive a shortfall of rain and are faced with problems such as water shortage and salinity (Hamilton 1982).

### **3.2.2 Vegetation cover**

It is clear that in the past there were significant differences in the distribution and composition of the vegetation zones of East Africa. These

changes coincide with climatic fluctuations recorded in sediment cores obtained from East African lakes (Scholz *et al.* 2007). Globally, the origin of the modern environment can be traced back to the beginning of the Holocene, between 12,000 and 10,000 years ago, with slight changes in the mid-Holocene, between 5,000 and 4,000 years ago (Hamilton 1982; Scholz *et al.* 2007). As previously noted, the environmental settings in this region vary from one place to another. Some places are warm and wet while others are dry and hot, and a few parts are moderately warm and well watered.

The present vegetation patterns of East Africa might also have been influenced by volcanism and climate change during the Tertiary and early Quaternary. It has been argued that the modern vegetation and rainfall distribution patterns in East Africa have existed for a long time (Livingstone 1975). However, anthropogenic causes and increased population rates may have also shaped the present vegetation in East Africa. For example, Hamilton (1986) argues that deforestation in southern Uganda may have begun during the Neolithic, about 4,500 years ago. Similar trends of deforestation may have taken place in Iringa after the introduction of iron smelting, about 3,000 years ago (Chapter 6).

Based on the distribution of plant species and precipitation, Hamilton (1982) places current East African vegetation within five major geographical regions. These regions include the tropical montane forests located in the Lake Victoria Basin, which receive high rainfalls with an annual precipitation of 1270 mm. Here the vegetation is composed of tropical rain forests with scattered

wetlands. Other areas receiving high precipitation include the highland and mountain ranges, which receive greater than 1000 mm of rainfall annually.

The second region is the woodland savannah or the Zambezian, characterized by acacia, *miombo* woodland, and tall narrow-leaved grasses. This is mainly located in the southwest and southern highlands of Tanzania. *Miombo* is a Swahili term for a subfamily (Caesalpinioideae) of trees that include the closely related genera *Brachystegia*, *Julbernardia* and *Isoberlinia* (Hamilton 1982:19). *Miombo* woodland is classified in the tropical and subtropical biome and is very extensive in southern Tanzania, Zambia, eastern Angola and the southern part of the Democratic Republic of Congo (DRC). This region is also characterized by its humid and semi-arid climate (Hamilton 1982).

The Zanzibar-Inhambane regional mosaic is the third area. It occupies the Tanzanian and Kenyan coasts and the adjacent hinterland, as well as the islands in the Indian Ocean (Figure 3.3). This region is composed of a low relief, coastal plain, and a broad inland plateau. The coastal plain is narrow, about 15-70 km in width. Most of the inland lies below 200 m with some scattered hills and plateaus. The annual rainfall is over 1000 mm and the mean annual temperature is greater than 26°C. This region is characterized by shrub forests and edaphic grasslands as well as small areas of transitional woodlands and bush-lands (Figure 3.3).

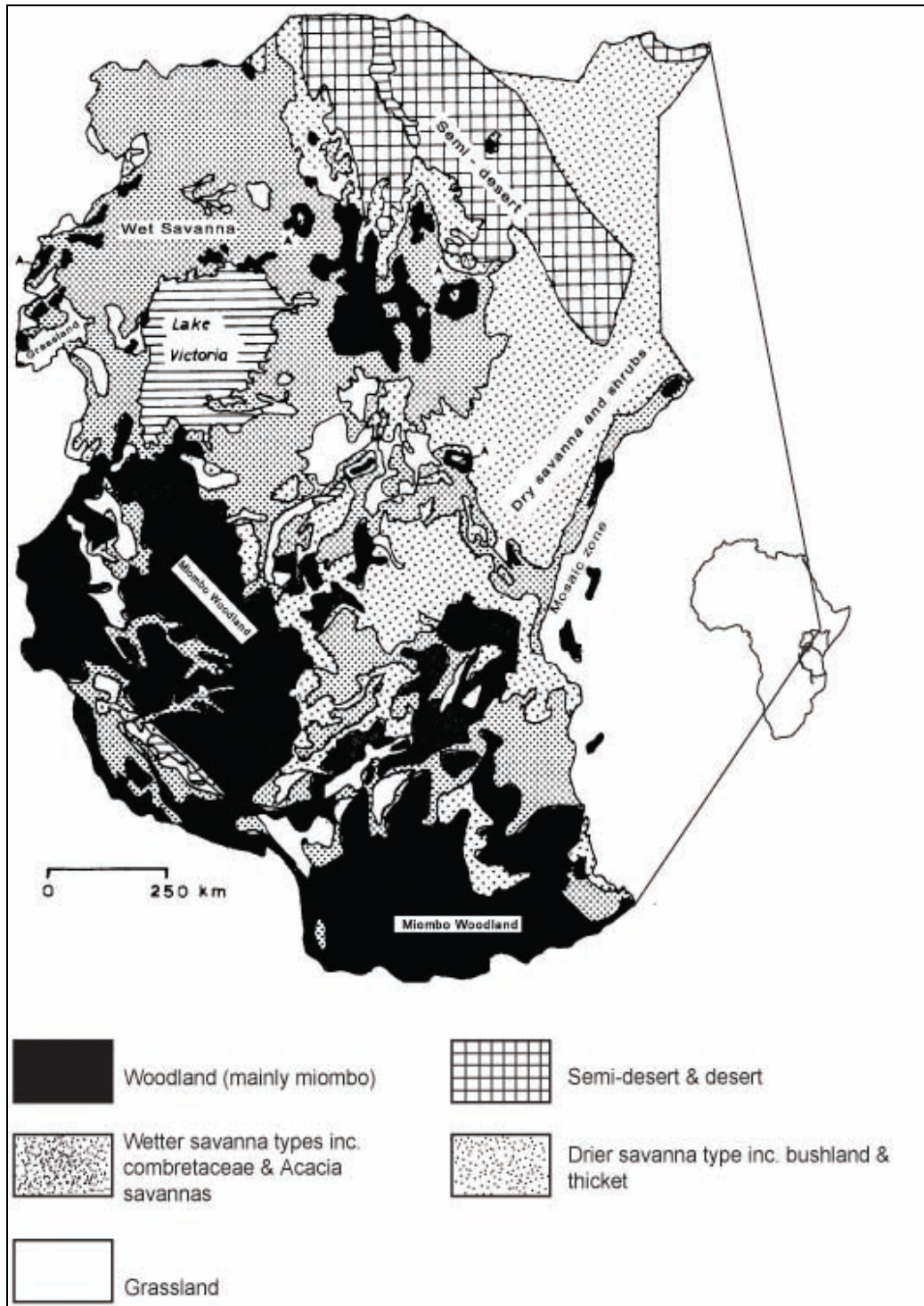


Figure 3.3. Contemporary vegetation patterns of East Africa (adapted from Hamilton 1982).

The fourth region is the tropical savannah grassland and shrubs located across most of Kenya, between the highlands and the coast margin, as well as in northern Tanzania. This region receives moderate rainfall with an annual precipitation between 500 and 850 mm, and has a mean temperature of 25°C. The vegetation cover is dominated by grassland with acacia and baobab and other thorny trees. The altitudes of these areas are below 1500 m and they are highly affected by the Rift Valley highlands, which block the monsoon winds coming off the Indian Ocean. This area supports most of the modern East African ungulates.

The fifth area is the semi-desert region, which is mainly located in northern Kenya, around the Lake Turkana basin; it receives an annual precipitation of less than 500 mm and it is the driest part of East Africa. The savannah grassland of this region supports a wide range of animal species with a long evolutionary history.

### **3.3 Factors for the global environment changes during the Quaternary**

The Quaternary represents the youngest geological period, and dates from 2.6 million years ago to present. It is divided into two geological epochs: the Pleistocene and Holocene (Lowe and Walker 1997). The Pleistocene extends from the base of the Gauss/Matuyama palaeomagnetic Chron boundary at 2.6 million years ago and ends at the beginning of the Holocene or the present interglacial (10,000 years ago). The Pleistocene is subdivided into three stages: the Lower, Middle, and Upper Pleistocene (Lowe and Walker 1997:1). These subdivisions are based on paleomagnetic records and climatic fluctuations, which



are also heavily influenced by the orientation of the earth's magnetic field in the southern or northern poles. The Lower Pleistocene ends at the base of the Bruhnes Normal Chron, which is dated at 780,000 years ago. The Middle Pleistocene ends with the beginning of the last interglacial about 128,000 years ago. The Upper Pleistocene ends with the warming of the Holocene about 10,000 years ago (Lowe and Walker 1997:3).

Quaternary geologists suggest that the earth has been in continuous climate flux since the start of the Quaternary (Lowe and Walker 1997; Oldfield 2005). These changes and their appropriate time frameworks can be inferred from proxy data obtained through deep sea and ice cores, tree rings, isotopic analysis, ocean dust and salinity or vegetation studies. These proxy records can be calibrated, quantified, dated, and interpreted with respect to the environmental settings they represent. A proxy record is a line of evidence that provides indirect data for past climatic conditions (Lowe and Walker 1997:17). It provides a way to reconstruct many significant climatic shifts of the earth's history. Additionally, those proxy data are useful for the understanding and reconstruction of large scale atmospheric processes and the earth system. The oscillations of the earth's atmospheric temperature at high latitudes changed from glacial to interglacial and back again (Oldfield 2005).

Changes in species of microfossils such as foraminifera and changes in ocean salinity can be determined from studies of deep sea cores. Changes in the ratios of the oxygen isotopes  $^{16}\text{O}$  and  $^{18}\text{O}$  in deep-sea sediments or ice cores indicate fluctuations in temperature and climate (Lowe and Walker 1997:149).

Deep sea cores are rich in  $^{18}\text{O}$  during glacial or cold periods because this isotope is heavier and is therefore less likely to evaporate during cold events (Lowe and Walker 1997). Interglacial or warm events result in more  $^{16}\text{O}$  in deep sea cores. Interglacial episodes are coupled with increases in ocean and lake levels due to the melting of ice (Lowe and Walker 1997; Willoughby 2007). Variations in physical properties of oxygen isotopes are used to define stages of temperature and precipitation fluctuations in the past. Stages of climatic changes revealed from oxygen isotopic analysis are conventionally known as Oxygen Isotope Stages (OIS) or Marine Isotope Stages (MIS) and they have been converted into a numerical system counting back from present or OIS 1 (Figure 3.4).

As previously noted, one of the natural transformations responsible for rigorous climatic shifts during the Upper Pleistocene is orbital forcing. A model for the earth's movements and orbital forcing was developed by Milankovitch (1879-1958) to explain causes for global climatic oscillations. These include the eccentricity of the earth orbit, changes in the tilt of the earth's axis and precession of the equinoxes. The eccentricity of the orbit is the rotation of the earth around the sun and shifts of the orbit from elliptical to circular and back again every 100,000 years. The variation of the orbit regulates the amount and distribution of the solar radiation reaching the earth crust that also effects the distribution of temperature and precipitation on the earth crust (Alley 2000; Willoughby 2007).

Another natural parameter that causes climatic oscillations is the rotation of the earth on its own axis or the tilt of earth's axis connecting the south and north poles. The rotation of the earth causes changes in angle of rotation from

21.4° to 24.4° and back again approximately every 41,000 years, a process that is conventionally known as obliquity of the ecliptic. Readjustment of the angle of rotation causes global cooling over time and the greater the angle, the more intense the seasons in both hemispheres (Lowe and Walker 1997:12-15).

The third parameter is the precession of the equinox that affects the distance of the earth from the sun due to the gravitational forces. The earth forms a complete circle every 19,000-23,000 years; at this point the portion of the earth nearest the earth orbit experiences the summer. The northern hemisphere may have summer and the southern hemisphere may have winter when the earth is close to the sun. This pattern took place at the beginning of the Holocene about 10,000 years ago (Oldfield 2005; Willoughby 2007).

Changes associated with the eccentricity of the earth's orbit occurred between 145,000 and 45,000 years ago and are related to the extended series of droughts and vegetation replacements in tropical Africa (Cohen *et al.* 2007). This process affected the solar radiation and global precipitation. In East Africa, it resulted in a remarkable drought and increase in tropical grasslands and grass dependant animals during the Middle and Upper Pleistocene (Bonnefille and Chalieu 2000). It is believed that processes for orbital forcing had greater contribution to climate shifts, particularly environmental fluctuations that influenced changes to human biological and cultural adaptive behaviour (Cohen *et al.* 2007). Cohen *et al.* (2007) argue that extreme aridity in sub-Saharan Africa between 140,000 and 70,000 BP was one of the factors leading to the movement of early modern humans from their motherland in sub-Saharan Africa.

In East Africa, Middle Pleistocene environments were characterized by explosive volcanic eruptions that resulted in marked changes to the landscape (Figure 3.1). Volcanism in the East African Rift Valley System (EARVS) occurred in three phases, the earliest starting during the late Pliocene in the eastern branch, followed by the formation of large mountains and deep lakes between 2.0 and 1.2 million years ago (Dawson *et al.* 1994; Mollel *et al.* 2009). The last phase started about 800,000 years ago and continued throughout the Upper Pleistocene and it formed young mountains such as Meru and Oldoinyo Lengai in northern Tanzania (Dawson *et al.* 1994). In East Africa, volcanic sediments associated with carbonatites dominate most of archaeological deposits and they preserve better, associated organic materials including faunal remains. The main stages of volcanic eruption at Mt Oldoinyo Lengai ejected between 400,000 and 250,000 years ago, and it was followed by another major explosive volcano about 1,250 years ago (Dawson *et al.* 1994). Volcanic ashes from the Oldoinyo Lengai are widely exposed in the Upper Nduu and Naisiusiu Beds at Olduvai Gorge dated between 300,000 and 45,000 years ago (Dawson *et al.* 1994; Manega 1993). The Yellow Tuffs and agglomerates that form the Nduu and Naisiusiu Beds are lithologically strikingly similar to the sediments found on the lower slopes of the western slope of the Mt Oldoinyo Lengai (Dawson *et al.* 1990). The appearance of MSA and LSA assemblages in Nduu and Naisiusiu Beds suggest that they may have been accumulated during the period of climatic instability characterized by volcanic eruptions, tilts, droughts and vegetation replacements (Dawson *et al.* 1990; Hay 1976; Wilkinson *et al.* 1986).

During the Upper Pleistocene about 78,000 years ago, the major volcanic discharge occurred at Mount Meru in northern Tanzania; this event breached the eastern caldera found on top of the mountain (Wilkinson *et al.* 1986). The impacts of volcanic activities in East Africa are not well established, but the Middle and Upper Pleistocene eruptions at Mount Oldoinyo Lengai and Meru probably formed high concentration of atmospheric carbonatite, which can be linked to the cold dry environment recorded in the Upper Ngaloba and Naisiusiu Beds at Olduvai and on the Mount Kilimanjaro between 300,000 and 120,000 years ago (Rosqvist 1990). Volcanic eruptions may have produced stratospheric dust or sulphuric aerosols resulting in the formation of aerosol clouds, long cold and dry events, snow cover in tropical mountains, as well as vegetation replacements recorded in East Africa between OIS 6 and 3 (Ambrose 2003; Hay 1976; Scholz *et al.* 2007; Somi 1993; Wilkinson *et al.* 1986). Vegetation replacements resulted in the expansion of tropical grasslands with great impact on human subsistence, technology and culture between OIS 5 and 4 or 135,000 and 35,000 years ago (Ambrose 2003). A similar volcanic eruption occurred on Mount Toba in southern Sumatra, Indonesia about 73,000 years ago (Ambrose 2003). This accumulated the highest amount of atmospheric calcium carbonate ( $\text{CaCO}_3$ ) or calcite and it is correlated with the global cooling at OIS stage 4 (75,000 - 60,000) years ago (Ambrose 2003).

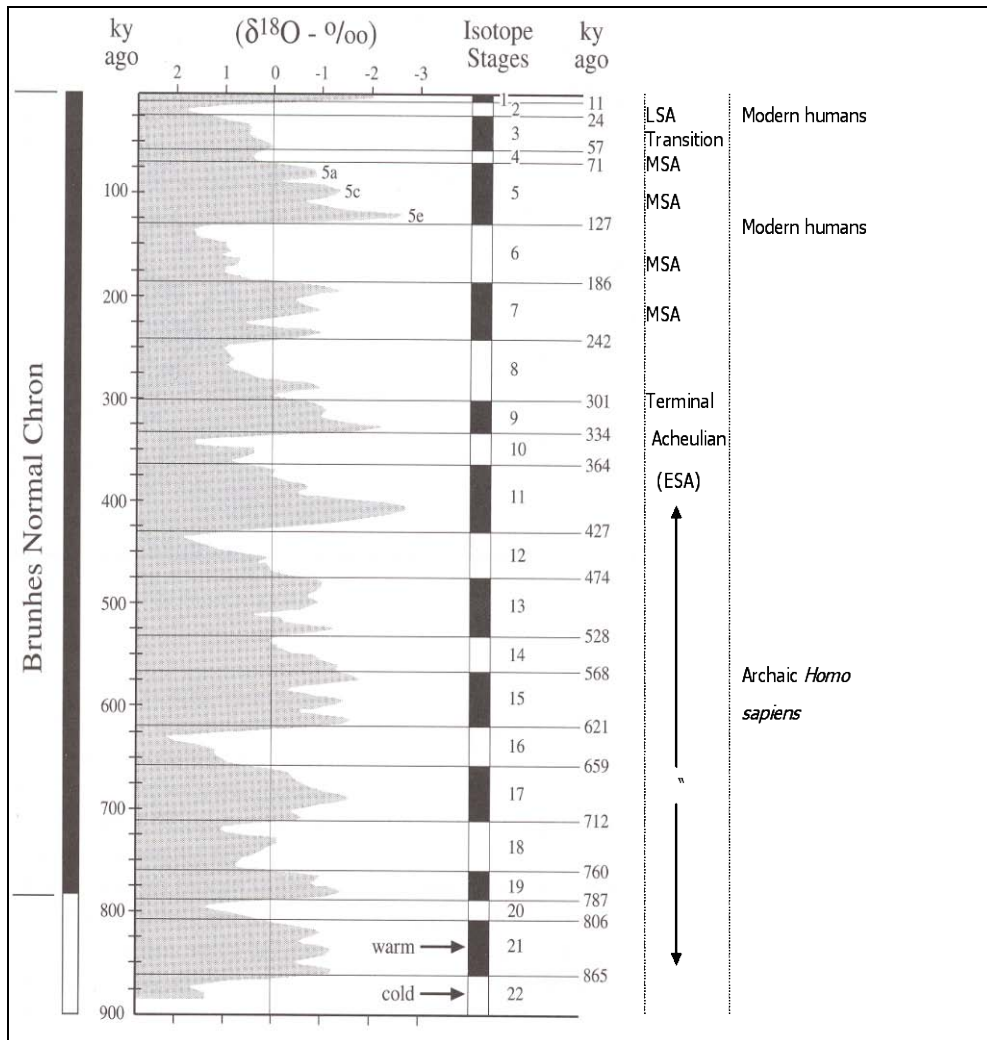


Figure 3.4. Oxygen Isotopic Stages and Stone Age cultures for the past 900,000 years. Records from deep-sea sediment cores: MD 900963 (Tropical Indian Ocean) and 677 (Equatorial Pacific Ocean) (adapted from Klein 1999).

In East Africa, archaeological and palaeoecological evidence suggests that the region experienced substantial climatic variability over the entire course of the Pleistocene (Cerling *et al.* 1997; Cohen *et al.* 2007; Bobe and Behrensmeier 2004; Scholz *et al.* 2007). Repeated episodes of climatic fluctuations during the Pleistocene were accompanied by varying stages of human biological and cultural evolution. The biological evolutionary trend passed through various stages before commencing the modern stage between 200,000 and 150,000 years ago (Cann *et al.* 1987). Early modern humans are believed to have developed behavioural and cultural flexibility reflected by innovations in technological skills and tool diversity, including the appearance of projectile weapons, as well as changes in their subsistence patterns in response to ecological changes (Brooks *et al.* 2006; Clark 1988; McBrearty and Brooks 2000).

### **3.4 The Pleistocene environment and archaeological occurrences in East Africa**

In East Africa, studies aimed at establishing the order of biological, cultural and climatic changes started from the beginning of the 1920s, when archaeological and palaeoecological studies were introduced within the region for the first time (Leakey 1931, 1936; Nilsson 1932; Wayland 1934). The reconstruction of prehistoric environments and chronologies was given the highest priority from the beginning of these archaeological studies. Pioneers such as Wayland (1934), Leakey (1931) and Nilsson (1932) are widely remembered as instrumental figures in this endeavour. E. J. Wayland (1934), the Director of the

Geographical Survey of Uganda, developed a glacial-pluvial hypothesis for the later sedimentary history of Uganda. He correlated Quaternary geological deposits and archaeological assemblages of Uganda with a series of climatic changes described as pluvial and interpluvial events. At the same time, the Swedish paleogeographer Eric Nilsson was working on the East African high mountains, such as Mount Ruwenzori in Uganda and Mount Elgon in Kenya. Using similar methods, the archaeological artefacts from Uganda and Kenya were correlated and arranged in chronological order (Leakey 1931; Nilsson 1932).

Tropical African climatic changes were directly correlated with glacial and interglacial events of the northern hemisphere (Nilsson 1932; Wayland 1934). The major concern for the pioneers was to provide the necessary temporal framework for establishing the relationship between climatic changes and archaeological assemblages in which other issues related to cultural, biological and ecological changes could also be addressed and interpreted (Leakey 1936; Wayland 1934). In the early phases of archaeological research in East Africa, the pluvial theory was widely accepted. The first Pan African Congress for Prehistory held in Nairobi, Kenya in 1947, passed the three-age system for the Stone Age, and also approved the use of the pluvial theory to reconstruct past environments (Alimen 1957). Several geologists, however, noted some flaws in its general application (Alimen 1957). It was pointed out that climatic changes in East Africa were influenced by local and regional precipitation as well as by broader tectonic activity and volcanism (Alimen 1957). Despite these disagreements, the pluvial theory continued to dominate East African archaeological and palaeoecological



research and writing until the beginning of the 1960s, when it was realized that the theory was too simplistic (Robertshaw 1990).

The discovery of radiocarbon dating in the 1950s revealed that the chronological sequences of East Africa were mainly influenced by regional climatic fluctuations rather than by global forces (Butzer and Cooke 1982). Although the pluvial theory was based on many misleading premises, it laid the foundation for scientific studies of the past climates in tropical Africa. Later studies of past climate in East Africa revealed that the region was seriously affected by glacial and interglacial episodes (Clark 1988; Cohen *et al.* 2007; Livingstone 1975; Marean 1997; McBrearty 1993; Somi 1993; Scholz *et al.* 2007; Willoughby 2007). It is widely accepted that our early ancestors and their cultural traits evolved and sustained in sub-Saharan Africa during a period of variable climatic conditions. The most recent lake core sediments drilled in lakes Malawi and Tanganyika in East Africa and Lake Bosumtwi in Ghana in West Africa indicate that a prolonged series of droughts in sub-Saharan Africa occurred during the Last Interglacial Maximum (LIM) between 135,000 and 75,000 years ago (Cohen *et al.* 2007; Scholz *et al.* 2007). Such unfriendly climatic conditions reduced food resources of hominids, and forced them to live in isolated refuges near water sources. If this is true, then parts of East Africa might have experienced unique ecological conditions that may have supported MSA foragers when they disappeared elsewhere on the continent.

### **3.4.1 East African environments during the past 300,000 years**

This section is concerned with environmental history within the region, over the course of the MSA and LSA. For much of this time, the climate differed greatly when compared to the present. There were short humid intervals and prolonged drought periods (Scholz *et al.* 2007). Fluctuations in temperature, humidity, and hydrology were the major characteristics of the late Middle and Upper Pleistocene period in tropical Africa.

The MSA assemblages in East Africa occur in that period of climatic instability and they were found in lacustrine and terrestrial sediments deposited during OIS 6 and 5, a period of climatic instability characterized by fluctuations in lake levels, glaciations and expansion of grassland (Hamilton 1982; Hay 1976; Scholz *et al.* 2007). Glaciations left their traces on the highest mountains and in ancient lakes (Rosqvist 1990). Three glacial stages belonging to this time period have been recorded on Mount Kilimanjaro. K-Ar dates of lava show that the first and second glacials occurred between 500,000 and 300,000 years ago (Mabulla 1996; Rosqvist 1990). The third occurred between 150,000 and 120,000 years ago (Rosqvist 1990). At Mount Kenya, evidence for early glaciations comes from the Teleki Valley located between the eastern and western flanks of the mountain (Charsley 1989). Thermoluminescence dates on the Teleki glacial suggest an age of 100,000 years ago (Charsley 1989).

Lacustrine sediments from Lakes Nyasa, Naivasha, Natron and Magadi suggest that MSA people lived during a series of environmental oscillations between OIS 8 and 6 (Somi 1993). The lacustrine sediments in the Lake Naivasha

basin in Kenya suggest increased lake levels between 400,000 and 200,000 years ago (Trauth *et al.* 2005). Isotopic composition of stromatolites in Lake Natron and the Magadi basin suggest three generations of high water stands in East African lakes. The first was dated at OIS 7 or 240,000 years ago; the second one occurred at OIS 5e (135,000 years ago); the last one was dated at about 108,000 years ago (Somi 1993). These climatic oscillations might have resulted in severe consequences for terrestrial and aquatic ecosystems that supported humans. According to Cohen *et al.* (2007), OIS 5e was a period of extremely aridity and most of the East African landscape changed into semi-desert.

Evidence from archaeological sites in East Africa and adjacent regions (Bonnefille 1997; Bonnefille and Chalieu 2000; Brand and Brooks 1984; Clark 1964, 1988; Cohen *et al.* 2007; Dominguez *et al.* 2007; Howell *et al.* 1962; Hay 1976; McBrearty 1993, Mabulla 1996; Mehlman 1989; Marean 1997; Onjala 2006; Scholz *et al.* 2007; Willoughby 2007), suggests that the MSA people evolved in sub-Saharan Africa during the period of uneven climatic conditions. For instance, cave sediments from MSA site at Burr Heybe in Somalia, dated by uranium series to OIS 8 and 7 or between 275,000 and 235,000 years ago, suggest an episode of humid and warmer conditions when compared to the present (Brandt and Brooks 1984). By contrast, pollen evidence from Lake Eyasi Basin (Eyasi Beds) and Ndutu Beds at Olduvai Gorge in northern Tanzania as well as Simbi in Kenya dated to between 300,000 and 200,000 years ago suggest that that period was associated with grassland environments with limited woodland near

the river and lake margins (Dominguez *et al.* 2007; Hay 1976; Mabulla 1996; Manega 1993; McBrearty 1993; Mehlman 1989).

The Upper Ndutu Beds are composed of conglomerates, sandstones, and eolian tuff dated by uranium series to between 300,000 and 200,000 years ago (Manega 1993). The beds consist of eolian sediments, weakly developed palaeosols and pollen evidence, strongly indicating grassland habitats (Hay 1976). The climate during the time of deposition of the Ndutu Beds was semiarid and perhaps much like today (Hay 1976: 157). A drier climate associated with the Sangoan is also reported at Nsongezi in the Kagera River basin of Uganda (Cole 1965; Clark 1988). Sedimentary analysis from the Sangoan at Nsongezi suggests that it was accumulated when the flow of the Kagera River was remarkably reduced (Cole 1965:521). A similar trend was documented at the Sango Bay site within the Lake Victoria basin (Cole 1965). There was remarkable evidence for an extended beach because of receded lake levels (Clark 1988:282). Olduvai is located east of Lake Victoria but not far away from the lake basin, and although the two sites are characterized by different climates today, it is likely that any major climatic changes in one area would have been felt in the other.

In East Africa, cultural and technological transformation from Sangoan to traditional MSA cultures has been accompanied by anatomical changes of humans from archaic *Homo sapiens* or *Homo heidelbergensis* to *Homo sapiens* or early modern humans. The process of anatomical and behavioural changes likely included demographic readjustment, and abandonment of some regions. At Simbi in south-western Kenya and Hayla Cave in Somalia, the MSA assemblage was

found in association with vertebrates and remains of grass leaves and stems (Clark 1988; McBrearty 1993). These suggest that the later Middle Pleistocene was more humid, with cooler and drier conditions during OIS 6, dating to between 195,000 and 135,000 years ago. At that time the temperature in tropical Africa was as much as 5° C lower than at present (McBrearty 1993). Humid climate is also recorded in MSA horizons at Muguruk, east of Lake Victoria in Kenya; these are estimated to be as much as 170,000 years old (McBrearty 1988). The lateritic soil of Member 4 in the Muguruk sequence also suggests periods of higher rainfall and humidity during the MSA period (McBrearty 1988). The evidence from the MSA sites suggests that most of the East African regions were characterized by variations in local environment like the present, but early anatomically modern humans were capable and adapted to the diversified environment.

### **3.4.2 The Last Interglacial Maximum (LIM)**

Paleoecological records from core MD79-254 obtained off the Mozambique coast indicate that 135,000 years ago, the sea surface temperature (SSTs) was cool and has been estimated to have been 24.1°C (Van Campo *et al.* 1990). Warm SSTs temperatures close to today's 26°C occurred during the interglacial stage estimated at 120,000 years ago (Van Campo *et al.* 1990). In the Lake Manyara basin in Northern Tanzania, at the beginning of OIS 5e, lake levels reached about 1036 metres above sea level. This is the highest and oldest lake-level recorded and dates to between 140,000 and 130,000 years ago (Somi 1993). At this time, the lake covered an area of 1,976 km<sup>2</sup> and contained a water volume

of about 169.2 km<sup>3</sup>; it also controlled the outlet to the north into the Natron-Magadi basin (Mabulla 1996; Somi 1993).

The second high-level stand at Lake Manyara occurred between 135,000 and 90,000 years ago (Somi 1993). But the situation at the Eyasi basin, located almost 80 kilometres to the west, was quite different. Lacustrine sediments were composed of reddened clay, clay-pellets aggregates and a great amount of calcium carbonate (CaCO<sub>3</sub>); this is dated by uranium series to 132,000 years ago (Dominguez-Rodrigo *et al.* 2007). These events indicate the decline of lake catchments (Dominguez *et al.* 2007; Mehlman 1989). Unfortunately, there are no detailed paleoenvironmental studies that have been undertaken in the Eyasi basin. More research in this area could probably give a more substantial explanation of the local climate patterns in the past.

Aridity and reduced precipitation between OIS 5d and 5a have been documented at lakes Nyasa and Tanganyika in southern Tanzania. Cores drilled at sites Ma105-1C in Lake Nyasa, and T97-52V in Lake Tanganyika, suggest prolonged droughts and reduced lake levels in East Africa at this time. Lake Tanganyika was reduced to almost 125 m below the modern levels, and salinity as well as alkalinity reached their highest states (Cohen *et al.* 2007; Scholz *et al.* 2007). Scholz *et al.* (2007) refer to these periods as “megadroughts”. Reduced precipitation might have influenced further expansion of grasslands at the expense of tropical montane forests and woodland vegetation (Scholz *et al.* 2007). Archaeological evidence suggest that, from OIS 5e to OIS 5a, most MSA humans

were confined to isolated refuges near the bodies of water (Clark 1988; Dominguez *et al.* 2007; Mabulla 1996; McBrearty 1993; Onjala 2006).

It is clear that the Last Interglacial Maximum was dominated by short cyclonic series of warm and cold events conventionally referred to as OIS 5e, 5d, 5c, 5b and 5a, which are dated to between 135,000 and 75,000 years ago. Available evidence suggests that at the beginning of OIS 5e the climate was warm and it led to high precipitation in most of the tropical Africa. In some places, such as southern Tanzania and other parts of southern Africa, increased precipitation led to the expansion of *miombo* woodlands (Dupont *et al.* 2000). This period also experienced the expansion of montane forest in the equatorial belt and West Africa as well as the reduced catchments of both Kalahari and Sahara deserts (Dupont *et al.* 2000: 113). Evidence from the Kibish Formation in Omo River valley, dated by uranium series to 130,000 years ago, suggests that the lake level stood at about 60 m higher than present (McBrearty 1993). Animal fossils from Bed VI-B at Mumba dated to OIS 5e (132,000 years ago) contain remains of hippopotamus, waterbuck and crocodile, strongly suggesting the existence of fresh water (Mehlman 1989). It is believed that Mbarai River, which carries its water into Lake Eyasi, extended its course closer to the Mumba rock-shelter.

A warm event took place approximately 115,000 years ago. The overlying Bed VI-A, dated by uranium series to 115,000 years ago, is rich in clay pellets and carbonates, including sands and gravels. These precipitates suggest that lake levels declined (Mehlman 1989). Mehlman estimated the decrease in Lake Eyasi levels at approximately 20 m below present levels. There was a rapid cooling

event about 110,000 years ago which is recorded in high latitudes (Dupont *et al.* 2000). In northern Tanzania and other parts in East Africa, a documented progression to aridity could have given way to the expansion of tropical grasslands which still exist in the area at present.

The period between 115,000 and 72,000 years ago was one of the extreme climatic changes dominated by drought and aridity events (Scholz *et al.* 2007). Palaeoenvironmental records indicate the formation of desert dunes across southwest Africa, implying that this period was extremely dry (Stokes *et al.* 1997). The Sahara Desert expanded and reached about 4° North (Stokes *et al.* 1997). The annual temperature in tropical Africa dropped somewhere between 7° and 10°C (Clark 1988). This resulted in a significant readjustment of vegetation zones over time. During that period, there was a great drop in temperature and the conditions become more arid (Barham 2001:71; Onjala 2006). Core sediments from the Gulf of Aden indicate an episode of arid and cold conditions, which started at the beginning of OIS 5d, about 115,000 years ago and extended to the end of OIS 5a, about 72,000 years ago (Clark 1988). This event is also supported by eolian deposits in the Kibish Formation in the Lake Turkana basin, dated by uranium series to between 115,000 and 92,000 years ago. Other evidence for arid climate has been found in cores drilled in Lakes Malawi and Tanganyika, which indicate a reduction in the amount of lake water of at least 95%. This is equivalent to almost 550 m below the present levels (Scholz *et al.* 2007). This represents an extraordinary loss of lake water and suggests that East Africa was much drier during this period compared to the Last Glacial Maximum (LGM) about 24,000



years ago (Scholz *et al.* 2007). The LGM is usually considered to be one of the most extreme cold periods in the ice age.

Ice core sediments and ice sheets at Mount Ruwenzori in Uganda estimate another glacial event in the East African mountains; this *Rwami* glaciations occurred about 100,000 years ago (Hamilton 1982). This episode was also linked with a decline in temperature of between 7° and 8° C below the present. This has been regarded as the period of driest climate in East African Mountains (Hamilton 1982; Nilsson 1932). At that time, rainfall was reduced to about 29% below the modern levels Clark 1988:253). More evidence for the extension of cold and arid conditions comes from eolian sediments in the Kalahari Desert. Desert margins in Africa expanded to almost five times their present extent sometime between 115,000 and 95,000 years ago (Stokes *et al.* 1997). The Kalahari Desert covered the southern part of DRC (Dupont *et al.* 2000: 95). These climatic processes led to the change in Sea Surface Temperatures (SSTs), an event that affected the location of the Inter-Tropical Convergent Zone (ITCZ). During that period, the monsoon winds were extremely dry and dusty (Stokes *et al.* 1997). Core sediments at Site 663 in the Atlantic Ocean in West Africa indicate increased eolian sediments (DeMenocal 1995), sharp cooling and droughts in the tropics between 115,000 and 72,000 years ago (DeMenocal 1995).

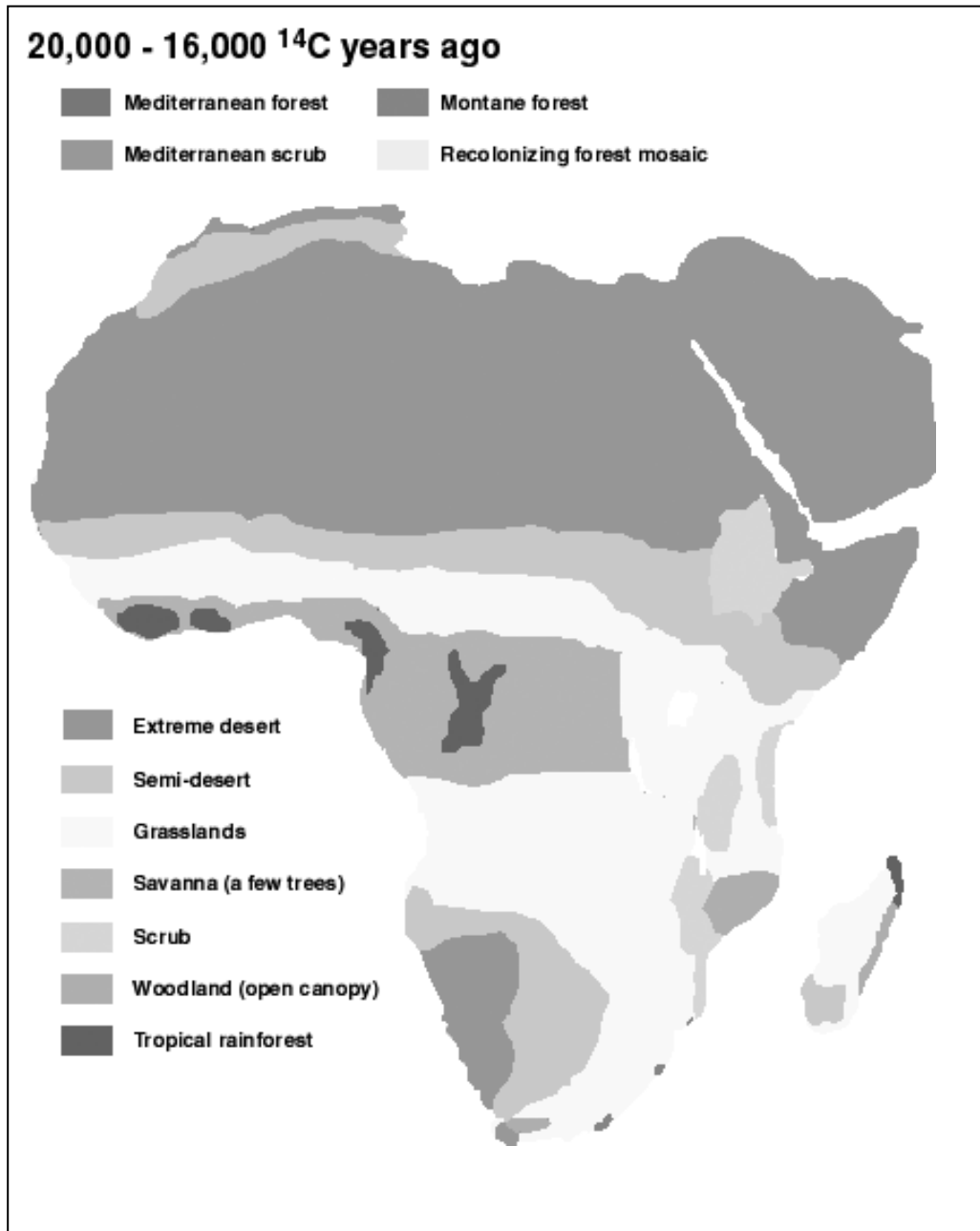


Figure 3.5. Africa during the Last Glacial Maximum (adapted from Adams *et al.* 1997).

During OIS 4, 72,000-58,000 years ago, most parts of tropical Africa received high precipitation that led to increased lake levels. At Mumba, Level V, dated by AAR to between 65,000 and 35,000 years ago, is composed of alluvial sediments, algal limestone and fish remains indicating a rise of lake levels. Level IV is radiocarbon dated to 37,000 years ago (Mehlman 1989:103) and indicates that at that time Mumba was within the lake margins (Mehlman 1989). This level is composed of very fine-grained sediments, well cemented by carbonates, including abundant fine-grained loamy sands, which indicate the presence of fairly permanent fresh water (Prendergast *et al.* 2007). This might suggest the extension of lake levels beyond the present state, up to 26 m above the modern level (Mehlman 1989). A study of zeolites in sediments from Lake Manyara at 60,000 years ago indicates the existence of humid conditions and increased lake levels beyond the modern condition (Livingstone 1975). Cores from Lakes Malawi and Tanganyika indicate more humid and stable climatic conditions resumed 72,000 years ago, which may also be linked with the emergence of fishing related activities (Cohen *et al.* 2007; Scholz *et al.* 2007; Yellen 1996).

During OIS 3, between 57,000 and 24,000 years ago, climatic conditions remain unstable. East African lakes received slightly more precipitation indicated by sediments from fresh water lakes in the western branch of the EARVS. Changes in lake levels in Lakes Nyasa, Tanganyika, Rukwa, Kivu, Edward and Albert (Figure 3.1) suggest that these lakes experienced the highest level of precipitation (Alley 2006; Hamilton 1982). They were in the highest stand at the beginning of the Last Glacial between 32,000 and 25,000 years ago, followed by a

period of drought that reduced water balance during the Last Glacial Maximum (LGM) between 24,000 and 12,000 year ago (Hamilton 1982). Sediments from Lake Massoko in southern Tanzania, dated by uranium series to between 45,000 and 25,000 years ago, suggest that most parts of southern Tanzania faced periods of humidity, which increased lake levels before the commencement of the Last Glacial Maximum (Garcin *et al.* 2006). Lake Massoko has potential for the palaeoenvironmental reconstruction because it has not been desiccated over the past 50,000 years (Barker and Gasse 2003). This is possible because its water level is supported by a shallow aquifer that flows through fractured volcanic rocks from the Rungwe volcanic chain towards Lake Malawi (Barker and Gasse 2003).

Additional evidence for climatic fluctuations has also been recorded from pollen cores drilled in East African swamps and radiocarbon dated between 43,000 and 39,000 years ago. This period is believed to have experienced more extensive and widespread forest and woodland vegetation than there is today (Bonnefille and Chalieu 2000:35). Pollen samples from the Kamilanzovu Swamp in Rwanda and Kashiru in Burundi suggest that the temperature stood at 4° C below the present and there were recognized expansions of woodland and forest vegetations across tropical Africa (Bonnefille *et al.* 1990; Bonnefille and Chalieu 2000). Fossil fauna from LSA assemblages at Matupi Cave and Ishango in the eastern DRC that are radiocarbon dated to between 40,000-22,000 year ago, contain pollen indicating forest conditions. Animal species represented include squirrel, giant forest hog, okapi, bongo, dwarf antelope, and red forest buffalo, as well as grassland and woodland dwelling antelope, suggesting a moist

environment in the equatorial zone (Barut 1997). The fauna remains, microlithic tools and bone tools, as well as harpoons, suggest that LSA people in this region utilized diversified food resources including fish (Barut 1997). In southern Africa, early LSA archaeological occurrences are less represented, suggesting reduced human population, a migration of prehistoric people to the north or paucity of research attention.

### **3.4.3 The Last Glacial Maximum (LGM): 24,000–12,000 years ago**

The Last Glacial Maximum represents a transitional period between the end of the Pleistocene and the start of Holocene. Globally, it represents the time when sea and lake levels were at their lowest hence the ice volume at the maximum (Barker and Gasse 2003; Oldfield 2005). In tropical Africa, this period was extremely cold and arid, and was associated with the expansion of deserts and grasslands where forests once existed (Figure 3.5). During the Last Glacial Maximum, most of the rift valley lakes dried up or reached their lowest levels and rivers were reduced. Lake core sediments suggest that the episode of cold climate began at the last phase of OIS 3 about 20,000 years ago and continued to the end of OIS 2 at 12,000 years ago (Garcin *et al.* 2006; Hamilton 1982; Willoughby 2007). Using lake level data, Hastenrath and Kutzbach (1983:151) estimate that precipitation might have been reduced to 10-15% below present levels 12,000 years ago.

In Lake Tanganyika, water levels dropped from 400 m to 350 m between 21,700 and 12,700 years ago, but the lake overflowed again between 13,000 and

12,000 years ago (Bonnefille and Chalieu 2000:43; Gasse *et al.* 2000; Thomas 2000:27; Willoughby 2007:92). Evidence from Lake Albert in western Uganda suggests that lake levels dropped to 54 m below the present levels between 22,000 and 18,000 years ago and only recovered starting around 13,000 years ago (Barker and Gasse 2003; Thomas 2000:27). Dunes built up in the Kalahari and Sahara deserts that suggest an increase in active dry and dusty monsoon winds in the tropics between 20,000 and 13,000 years ago (Braut 1997). This may suggest increased aridity and reduced precipitation in tropical regions.

Evidence from Lake Victoria suggests that the lake apparently dried up or nearly dried up during the Last Glacial Maximum 24,000 years ago (Barker and Gasse 2003; Hamilton 1982; Johnson *et al.* 2002; Thomas 2000; Willoughby 2007:92). At that period, the lake level dropped by 65 m below the present point (Thomas 2000:27; Livingstone 1975:261). Equatorial rainforest currently found in some areas west and north of the lake appears to have been replaced by grassland vegetation in most areas (Figure 3.5). Fossil pollen from Pilkington Bay on the northern shore of Lake Victoria (Figure 3.1), dated at 14,500 years ago, suggests the spread of grassland in the catchment of the lake; in addition, forests were reduced or were entirely absent (Hamilton 1982:194). Between OIS 3 and 2, from 32,000 to 24,000 years ago, the Nile River either disappeared or did not have enough water to make it all the way to the Mediterranean (Willoughby 2007; Wendorf and Schild 1992). Sedimentary evidence along the White Nile River shows that the river was higher than the present, between 12,500 and 11,400 years ago (Hamilton 1982). Generally, the modern situation for most East African rivers

and lakes commenced at the beginning of the Holocene between 12,500 and 9,500 years ago (Clark 1988; Hamilton 1982).

Pollen data suggest that during this period, tropical rainforest zones were restricted along the Equator and grassland vegetation expanded beyond the present state (Figure 3.5). Pollen cores, drilled within the Kagera River catchments in southern Uganda, Burundi, and Rwanda, which are radiocarbon dated to between 30,000 and 10,000 years ago, suggest the expansion of open woodland vegetation at the expense of tropical montane forests (Jolly *et al.* 1997). More pollen samples from East African high mountains suggest a dry period between 27,750 and 12,650 years ago (Hamilton 1982). For instance, pollen samples from Mount Elgon, Uganda, at about 1400 m elevation, suggest the extension of grasslands at high mountain catchments. This only ended at the beginning of the Holocene (Hamilton 1982:122). Pollen samples also show that montane forests were much smaller on the mountain at the end of Pleistocene (Hamilton 1982). The most abundant pollen types derived from montane forest trees are *Podocarpus*, *Olea*, *Juniperus* and *Myrica*, a combination which suggests the existence of a drier forest type than at the present time. More pollen samples from Mounts Kenya, Ruwenzori and Kilimanjaro radiocarbon dated to between 33,000 and 14,000 years ago indicate a series of climatic changes equivalent to those recorded at Mount Elgon. At that time period, trees in high mountains were mainly dominated by *Anthospermum*, *Artemisia*, *Clifortia*, Ericaceae, *Myrica*, *Dendrosenecios* and *Hagenia*. Less *Podocarpus* and *Olea* imply a reduction of montane forest through the higher mountains margins (Maitima 1991).

The abundance of *Dendrosenecio* suggests the existence of a short episode of moderately wet climate between 19,000 and 15,000 years ago, but the overall temperature decreased by at least 4.4° C below present conditions (Hamilton 1982:154; Livingstone 1975:256). More evidence for a cold and dry climate is revealed by abundant *Anthospermum* trees in the Rukinga Highlands in western Uganda dated to 13,000 years ago (Hamilton 1982:171). At that time there were no great changes in human culture; the LSA assemblage continued in most areas, but with more emphasis on local raw materials (Hamilton 1982).

In East Africa, the paleoenvironmental evidence all suggests cyclonic oscillation dominated with droughts and short wet conditions. In the past, East African vegetation alternated from woodland to tropical grasslands. The process affected the patterns of the distribution of ecological resources over the landscape in different phases of the late Quaternary. Although proxy data suggest a series of climatic fluctuations within the region, more studies and absolute dates are still needed to reveal its pattern. Most of the information dated beyond the effective age limit of radiocarbon dates, or 50,000 years, in this region has not yet been intensively studied and relatively little information from archaeological sites and core sediments has been analysed and published. The late phases of climatic instability are well documented in fluctuations of lake levels and vegetation in high altitudes. However, continuity between the present and Pleistocene vegetation is great in southern highlands or the Zambezian zone and the Serengeti ecosystem in northern Tanzania and southern Kenya. The Serengeti ecosystem, also support a number of modern East African ungulates that may have persisted



with less fluctuation from the later Pleistocene to the present (Clark 1988). Culturally, the revealed ecological changes showed a great interaction between human culture, subsistence patterns and physical environment. This suggests that human culture and physical environment are interdependent variables.

### **3.5 Implications of environmental changes for human culture and technology**

Evidence indicates that changes in the environment can sometimes be correlated with changes in material culture (Cohen *et al.* 2007). According to this view a products of material culture such as, artefact types, technologies and human behaviour should be correlated and examined with reference to environmental stimuli (Cohen *et al.* 2007). This scheme should also be used to examine empirical theories about prehistoric human behaviours and technological abilities. This trend is examined based on the availability and distribution of the physical elements (landscape, food resources, fresh water, raw materials and hunting opportunities) and behavioural aspects embedded in the cultural system (subsistence patterns, technological ability and social organization). Since both physical environment and cultural systems change over space and time, their relationships and products are also subjected to those changes (Cohen *et al.* 2007). From this perspective, the environment of the culture or biological event is as important as the artefacts or new species.

The processes in which adaptations took place and their products require a critical review of the environments where humans lived in the past. For instance, climatic factors may induce a fluctuation in the intensity and distribution of food

resources. In turn, this may influence changes in strategies for food acquisition over the landscape, which would then influence developments in technology. I believe that development in technology is a product of environmental stimuli and cultural or subsistence needs. In this discussion, environmental challenges and cultural needs are viewed as stimuli for adaptive strategies and technological development.

My discussion focuses entirely on the MSA culture because it is associated with the evolution of behavioural modernity and more complex lithic technology, in a period of changing environment. Although the MSA artifacts date to about 300,000 years ago, the available fossil records indicate that anatomically modern humans made their first appearance in East Africa during OIS 6 and 5 (200,000 to 135,000 years ago); this was a period of lowered temperature and drier environmental conditions. It seems clear that during the full glacial period, the climate of tropical Africa was essentially more arid, while the interglacials were periods of great humidity and climates close or similar to those of today (Scholz *et al.* 2007). There are repeated recorded episodes of changes in temperature, precipitation and vegetation patterns during the late Middle and the Upper Pleistocene (Hamilton 1982). Some researchers argue that such environmental changes influenced the regional lithic differentiation and cultural identity (Clark 1988; McBrearty and Brooks 2000). Climatic and environmental oscillations discussed above correspond with major biological and cultural changes in the human lineage.

Those scenarios that incorporate humans and environmental challenges can be easily understood by correlating the environment with other related ecosystem responses, such as crop physiology and precipitation, animal malnutrition and reproduction, under ever-changing conditions. For example, drier conditions may reduce plant food resources for animals, a process that can lead to insufficient reproduction. Ecosystem response scenarios suggest for multiple interacting and feedbacks for related variables (Oldfield 2005). This is in contrast to single-interacted feedback whereby climate physiology determines what humans can or cannot do.

Genetic evidence suggests that MSA human populations underwent a sharp contraction during the Last Interglacial Maximum, followed by a recovery in population during OIS 4, between 72,000 and 60,000 years ago (Mellars 2006). Human populations decreased because they experienced selective pressure on limited ecological resources, a process that may have reduced their reproduction rates. The Last Interglacial Maximum (OIS 5e-a) was accompanied by short-term series of climatic oscillations, a process that affected and reduced their adaptive rates (Mellars 2006). Drawing on the principles of evolutionary ecology, Foley (1989) argued that differences in environment can produce evolutionary diversity and marked differences in behavioural adaptations, leading to the evolution of new species or new technological organization.

Changes in the environment led MSA people to produce stone tools for specific requirements such as points for hunting (Brooks *et al.* 2006; Clark 1988; McBrearty and Brooks 2000; Shea 1997, 2006; Waweru 2007). If that is true, then

variations in points were intended for specific requirements in different environments. It is likely that broad and thick points were used for thrusting spears, useful for hunting in wooded environments, while small points were used for throwing spears and arrowheads, which useful in grassland environments (Hughes 1998). Presumably, hunting was a major subsistence activity and points were the major hunting weapons, while other stone tools such as scrapers and flakes performed other related activities. Points, utilized flakes and scrapers are the most predominant tool types in MSA assemblages (Clark 1988).

Because points require specialized skills and technology that could allow toolmakers to assemble different parts of composite tools, they might have been adapted to facilitate new strategies for acquisition of food as a response to the transformation of natural environment. If points were among the causes for substantial changes to humankind, including the expansion of their geographical range, increased population size and their sustainability in ever-changing climate, hunting might have played a significant role in acquisition of food resources. Presumably, hunting strategies such as the use of spears or bow and arrows, are related to the environmental adaptation.

Projectile technology involving the use of spears, is thought to have appeared for the first time during the MSA, about 285,000 years ago in the Kapthurin Formation in Kenya (McBrearty 1993). Clark (1988) argues that the appearance of points represents essential features of subsistence and technology that enabled MSA people to adapt and occupy varied environments. All significant lithic technological innovations took place during the MSA period. For

instance, in East and South Africa the late MSA or the Second Intermediate Industry that occurred for the first time during OIS 4 (72,000-57,000) years ago contain most of the significant technological characteristics found within the LSA (Mehlman 1989; Mellars 2005, 2006). This period also witnessed the transition from drought to humid climatic condition in sub-Saharan Africa (Scholz *et al.* 2007).

The late MSA culture, which has been dated to OIS 4, is regarded as the backbone of complex culture widely represented in the LSA assemblages (Ambrose 2002; Mellars 2006). In this study, it has been revealed that points and backed pieces from the LSA assemblages show a degree of imposed form, type, style, and functions, which reflects patterns of technological traits shared with their ancestors or with MSA foragers. Environmental challenges probably played a significant role in shaping the ways of life and sustainability in the ever-changing environments of our early ancestors. It seems learning and transfer of knowledge from one generation to another have their roots in our early ancestors, the MSA foragers. These cultural processes might have contributed much to our current social organization and complex technology. Perhaps efficiency in hunting became possible due to the invention of stone points as a response to the expanded grasslands and reduced plant foodstuffs during the MSA.

In northern Tanzania, this period is culturally defined by the appearance of the Second Intermediate Industry. It is present in several sites including Mumba, Nasera and Loiyangalani (Mehlman 1989:272). At Loiyangalani, the MSA assemblage is associated with remains of large game species found in the

Serengeti National Park today, although a large *Equus* might be an extinct species (Bower 1985, 2005; Clark 1988). Bones are broken in patterns common in assemblages processed by humans (Bower 2005). Nasera is located close to the major migratory route of modern ungulates and Loiyangalani is located close to the Loiyangalani River. These ecological factors may suggest that MSA people used these sites for planned seasonal hunting.

The evidence reviewed here suggests that tropical Africa experienced substantial climatic challenges in the past. Series of climatic oscillations during the Middle and Upper Pleistocene seriously affected the natural resources including terrestrial and aquatic resources. Episodes of climatic cycles persisted since the first appearance of the early modern humans and they depended much on the hunting and gathering way of life, until very recently at the beginning of the Holocene, when they started to domesticate animals and plants. For the entire period, stone tools were used to perform various activities; these were major tools used to support their lives. For humans, documented environmental challenges might have resulted in famine, malnutrition, and starvation. In order to overcome these challenges, they underwent physical and mental readjustments (Klein 1999, 2000), as well as technological advancements represented in the archaeological record (McBrearty and Brooks 2000). This suggests that prehistoric humans were forced to change their subsistence behaviour as a response to environmental challenges, which caused the biotic replacement and insufficient distribution of environmental resources over time in the landscape.

Unpredictable climatic conditions might have reduced plant foodstuffs, which would have been a major stress and threat to human lives. These things forced human beings to become more opportunistic, relying on both floral and faunal resources as a response to ecological deterioration. This situation may have also forced humankind to focus on more specialized technology, presumably tactical hunting techniques such as ambush, stalking, trapping and distance shooting like those which have been documented at Lukenya Hill in Kenya, Loiyangalani and Nasera in northern Tanzania, Gi in Botswana, and Gorgora in Ethiopia (Clark 1988; McBrearty and Brooks 2000; Marean 1970). These changes in culture and technology were influenced by the need for specialized skills to respond to the ever-changing environment. New skills might have led to increased human mental ability and cognitive behaviour never experienced before. It was during this period of climatic instability that MSA people started to look for exotic raw materials, in particular obsidian and chert in northern Tanzania because of their functional values (Chapter 8).

It seems that environmental instability forced people to progress from being relatively minor players in a restricted number of ecosystems, to becoming determinists and deliberately incorporating those changes into their cultural traits. Determination, technological capability and competence in their behavioural patterns might have allowed early *Homo sapiens* in Africa to focus on hunting and tracking prey. This technological trend is still used by modern hunting groups in sub-Saharan Africa. Hunting and tracking prey are highly sophisticated skills requiring scientific intellectual abilities; these skills are employed effectively by

modern hunters and gatherers (Pickering and Bunn 2007). It is likely that tracking and hunting could have originated in tropical grassland habitats during the MSA when the region was extremely dry. MSA foragers may have tracked prey in grassland and arid environments because the ground allowed distance visibility. Dry tropical grasslands predominate in the region in which early modern humans lived (Scholz *et al.* 2007).

Human responses to environmental changes are also revealed in late MSA assemblages dated to between 90,000 and 65,000 years ago when fishing became one of the major means of subsistence. Fish remains are found in MSA assemblages at Katanda in the Democratic Republic of Congo (DRC), Aduma in the Middle Awash, Ethiopia and Loiyangalani in the Serengeti National Park, Tanzania (Bower 1985; McBrearty and Brooks 2000; Yellen 1996). Increased precipitation could be directly linked to the abundance and sufficient distribution of aquatic food resources, which led MSA humans to focus on fishing, in contrast with early periods where aquatic remains were rarely found.

The period that ranges within OIS 5e to 5a, is also linked with movement of early modern humans outside Africa (Mellars 2005, 2006). Remains of early modern humans are found from this time in the Mugharet es Skhul and Jebel Qafzeh in the Levant (Mellars 2005). This may suggest that early humans moved in adjacent zones during the period of harsh and dry environment to look for hospitable areas for their lives. Pressure and challenges from climatic changes probably allowed MSA humans to develop more diversified tools including points made from organic materials, which are not expressed in archaeological records



due to the insufficient preservation conditions that characterize most of the archaeological sites in tropical Africa. Hot conditions and acidic soils that characterize tropical Africa today have destroyed forever most of the organic materials in the archaeological assemblages.

It is difficult to establish local physiographic factors for the direct perception of ecological variables and human cultures due to inadequate studies on the past environments in East Africa. But the available evidence suggests that the region was highly affected by Quaternary climatic oscillations (Foley 1989; Scholz *et al.* 2007; Somi 1993), a process which correlates with new lithic technological innovations and biological changes in sub-Saharan Africa. Most of the new experiences and skills were developed during OIS 5, 4 and 3, periods that witnessed major climatic fluctuations. At high latitudes, these periods witnessed major extinctions of megafauna as well as our close relatives, the Neanderthals (Foley 1989). This may suggest that anatomically modern humans from Africa who migrated to Eurasia during OIS 5, 4 and 3 respectively, were more skilled, and probably were mentally and physically stronger than their closest relatives, the Neanderthals. This allowed them to sustain themselves in unfamiliar and ever-changing environments.

The most important issue, which is less addressed by archaeologists, is the state and process of learning ability from past experiences practised by prehistoric people. This process led them to acquire and transfer to their descendants a body of knowledge in response to climatic instability. For instance, adaptation to new environments or new ways of life requires individuals to develop mechanisms that

will enable them to sustain themselves in a specific environmental situation. The process of learning requires individuals to spend much time and energy and their sensory organs obtained information from the physical environment and developed abilities or decision-making traits and to keep the results. The resulting knowledge and skills were applied in adaptation to the new environment and transferred to new generations. The adopted skills were not needed or used for operational needs, rather they were incorporated into their life system for future helpfulness and they were passed gradually from one generation to another.

The long-term impact from learning, adaptation and responses to nature, changed the cultural and technological patterns of prehistoric humans in response to their ecological needs. Learning and technological capabilities helped MSA foragers penetrate to almost all parts of the Old World; they probably used their adaptive advantages to dominate the environment over time and space. If that was the case, then our modern superiority over our environment and other species could be traced back to MSA foragers. In this work, learning, adaptation and technological ability have been considered to be among major physiological factors that led MSA foragers to respond effectively to a new biomass of grassland ecosystem in tropical Africa and later, to colonize other places around the world.

### **3.6 Summary**

Different lines of evidence produce varying scenarios of climatic changes during the late Middle and Upper Pleistocene. The stratigraphic signals of these

changes in tropical Africa revealed from the archaeological record, lake cores and pollen spectra analyses indicate ever-changing episodes from humid and wet to cold and dry conditions and back again, until the beginning of the Holocene. Our understanding of the climatic system of the past is vital to any estimate of the way in which prehistoric humans adapted and sustained themselves in ever-changing environment. In order to assess the likely future and anticipated level of technological development at that period, it requires us to quantify and reconstruct the operation of natural processes and human interactions in the past. Available environmental evidence suggests tropical grassland rather than forest inhabitants dominated during the MSA period (Butzer 1972; McBrearty 1993; Scholz *et al.* 2007).

In turn, series of climatic changes may have influenced the development of lithic technology and changed the means and ways of food procurement and other subsistence strategies. For instance, the climatic shift from cold and dry to warm and humid conditions as revealed from lake core sediments and archaeological records of East Africa (Hamilton 1982; Hay 1978; McBrearty 1993; Mehlman 1989; Scholz *et al.* 2007; Yellen 1996) coincides with the marked expansion of early human populations within the region (Mellars 2005, 2006) and changes in lithic technology marked by the first appearance of transitional industries from MSA to LSA.

Ecological systems of the past including climate, soil, hydrology and vegetation suggest that the world is still in a process of continuous change. This process started millions of years in the past and is completely interacted with

human culture and technology. We should understand that the interaction and feedback between nature and culture are among the driving forces of human adaptations and innovations. Such knowledge is very useful for the interpretation of the past materials and reconstruction of ways in which early humans existed.

Culture and nature were, and are, still alternating, hindering, or favouring each other. It is possible that technological shifts and regional variations of MSA industries that are most abundant in sub-Saharan Africa archaeological records, could be taken as possible response to local environmental adaptations as it was proposed by Desmond Clark in 1988. The coincidences of moist conditions, high demographic rate, new human habitats, and transitional industries from MSA to LSA or late MSA assemblages in Africa at the beginning of OIS 4 should be taken as a gradual biological and cultural transformation, influenced by climatic challenges and technological developments. The environmental challenges related to the historical and prehistoric volcanic eruptions should be established and used as inferences for the better understanding of the subsistence crisis that was faced by our prehistoric ancestors in different phases of the Quaternary. In addition, the evidence discussed shows some variations in ecological settings between southern and northern Tanzania. In the next chapters, variations in ecological settings are discussed in conjunction with hunting behaviour to examine the influence of ecological resources on human culture and technology.

## CHAPTER 4: MSA AND LSA OCCURRENCES AT MUMBA AND NASERA ROCK-SHELTERS, NORTHERN TANZANIA

### 4.1 Introduction

This chapter reviews the archaeological occurrences at Mumba and Nasera rock-shelters in northern Tanzania. The information presented in this chapter is based on a literature review as well as an analysis of collections from the two sites done by Mehlman (1989) that are stored at Olduvai Gorge, Tanzania. These sites have deep cultural sequences spanning the MSA, the MSA/LSA transition, the LSA and later cultures (Mehlman 1989). They contain extraordinary archaeological remains that include lithic artefacts, faunal materials, symbolic objects such as ostrich egg shell beads, and human remains (Bräuer and Mehlman 1988; Dominguez-Rodrigo *et al.* 2007; Mehlman 1989; Prendergast *et al.* 2007). There are few well-preserved sites of the age of Mumba and Nasera in East Africa. Many are either in disturbed contexts or lack fauna and other organic remains. This makes these sites critically important for the study of the origin and development of human behaviour (Bräuer and Mehlman 1988; Clark 1988; McBrearty and Brooks 2000, Mehlman 1989). Data from these sites suggest that change from the MSA to the LSA was a gradual process.

In 2007, I re-analysed points from Mumba and Nasera based on their types, metric measurements, edge modifications and usewear patterns in order to identify their representation and functional roles. Other variables investigated include the form of raw materials used to make these points. It seems that tool

makers depended on varieties of rock types, including both local and exotic ones. Local materials include quartz and quartzite which are widely distributed across the landscape of northern Tanzania. Exotic raw materials include obsidian obtained from over 320 km away in southern Kenya, and chert cobbles which were obtained from Olduvai Gorge, located almost 27 km south of Nasera or from the Lake Natron basin, located 65 km to the northeast (Mehlman 1989). The representations of rock types in the MSA assemblages at Mumba and Nasera suggest that toolmakers depended more on local rocks rather than exotic ones. However, exotic rocks were consistently exploited to make points, scrapers, burins and backed pieces. The analysed point samples (discussed in Chapter 8), suggest that, in addition to factors such as trade and exchange, the use of exotic raw materials was also influenced by functional requirements. The latter include sharpness, brittleness and durability of the specific rock types.

In northern Tanzania and central Kenya, prehistoric hunters may have moved seasonally following migratory animals (Barut 1994). Perhaps hunting groups carried away exotic rocks from their original sources when they were tracking migratory prey. This prediction is based on the fact that exotic rock types are rarer in the MSA and Second Intermediate Industries, indicating that toolmakers depended less on exotic lithic raw materials. Knowledge of the surrounding environment and the functional abilities of specific rock types were among the reasons for utilization of exotic lithic raw materials (Chapter 8). Obsidian and chert produce tools with sharp edges that better penetrate animal skin and underlying tissues than other kinds of rock (Ellis 1997).

## **4.2 The geology, geography and archaeology of the Lake Eyasi basin, Mumba and Nasera**

### **4.2.1 The Lake Eyasi basin**

Geographically, the Lake Eyasi basin is that region in Mbulu District, northern Tanzania that lies between 3°20'; 4°05' S latitude and 34°50'; 35°30' E longitude. It is located almost 65 km southeast of Olduvai Gorge and 50 km southwest of Karatu town (Figure 4.1). Archaeologically, the Stone Age record consists of open air lakeshore sites such as North West Bay (NWB) and West Bay (WB), as well as Mumba rock-shelter (Dominguez-Rodrigo *et al.* 2007, 2008; Kohl-Larsen and Kohl-Larsen 1938; Mabulla 1996; Mehlman 1989). The region is characterized by lacustrine sediments and carbonate mudflats (Mehlman 1989). It is marked by block-faulting and volcanoes at the southern termination of the East African Rift Valley System (EARVS).

Sedimentary deposits are found on the Precambrian and Archaean substrate of the Tanzanian Shield and Mozambique Belt (Foster *et al.* 1997). The Eyasi basin is marked by the Mang'ola and Yaeda-Endanyawishi grabens, as well as several unbroken plains with isolated hills and inselbergs. Other geomorphologic features include valleys and fault escarpments that range from 1030 m to 2030 m above sea level (Dominguez-Rodrigo *et al.* 2008; Mabulla 1996). Sedimentary deposits in this area are composed of alluvial soil and sand dunes, deposited on top of volcanic and granite-gneissic rocks (Figure 4.2). Pleistocene sediments within the lake basin has been dated by using uranium

series to about 1 million years ago, but the aeolian and floodplain deposits in the Mbarai River belong to the beginning of the Holocene (Dominguez-Rodrigo *et al.* 2008; Foster *et al.* 1997).

Modern lake levels are subjected to seasonal and annual precipitation that influences the rise and fall of the lake catchment. During rainy seasons, the lake is fed by seasonal rivers and springs, including the Mbarai River. In dry seasons, the lake is often completely dry and subjected to exposed clusters of carbonate mudflats, locally known as Njarasa (Dominguez-Rodrigo *et al.* 2007; Mehlman 1989:176). Similar ecological patterns characterized the region for most of the Pleistocene (Dominguez-Rodrigo *et al.* 2007). Clustered sedimentary exposures on the lake shore indicate a long history of fluctuations in lake levels.

Scientific research in the Lake Eyasi basin and at Mumba was initiated by Margit and Ludwig Kohl-Larsen in the 1930s (Kohl-Larsen and Kohl-Larsen 1938). They carried out an archaeological expedition that led to the discovery of dense archaeological open air sites containing stone artefacts, fossil fauna and human remains (Kohl-Larsen and Kohl-Larsen 1938). Dense surface scatters of stone artefacts and faunal remains were found in fossiliferous deposits exposed on the North East Bay (NEB) and West Bay (WB) sites. Stone artefacts were classified as Sangoan: core scrapers, choppers, large flakes and bifaces. These also represent the First Intermediate Industry (FII) (Mehlman 1989:272). As previously noted, the Sangoan artefacts were found associated with remains of archaic *Homo sapiens* (*Homo heidelbergensis*) and fossil fauna of modern and



extinct animal species (Dominguez-Rodrigo *et al.* 2008; Kohl-Larsen and Kohl-Larsen 1938; Bräuer and Mehlman 1988; Bräuer and Mabulla 1996).

In the 1930s, the North East Bay (NEB) and West Bay (WB) sites were discovered in close vicinity to one another, separated by less than 5 km (Dominguez-Rodrigo *et al.* 2007; Kohl-Larsen and Kohl-Larsen 1938). In 2004, Tanzanian and Spanish scholars carried out an intensive field survey, during which it was found that fossiliferous outcrops, with stone artefacts and fossil fauna, are currently exposed in the North East Bay site (Dominguez-Rodrigo *et al.* 2007, 2008). In the West Bay, exposed sediments with archaeological materials are relatively scarce since they are overlain by recent alluvial and lacustrine deposits (Dominguez-Rodrigo *et al.* 2007). In the North East Bay (NEB), the outcrop is over 3 metres deep and is formed by two geomorphologic strata: grey sands on top and red or brown zoelitic soils in the lower levels. Sedimentary units in both locations are cemented and show evidence of mixed sediments consisting of sandy clays, fossil fauna, gravels and root casts. Fossil fauna included hippopotamus and plant remains, which are found in the lower fossiliferous unit or red zoelitic soils; both suggest the presence of grassland and riverside forest (Dominguez-Rodrigo *et al.* 2008). The upper fossiliferous unit corresponds with Mehlman's (1989) sandy clay loam located below Bed VI-B at Mumba (Mehlman 1989).

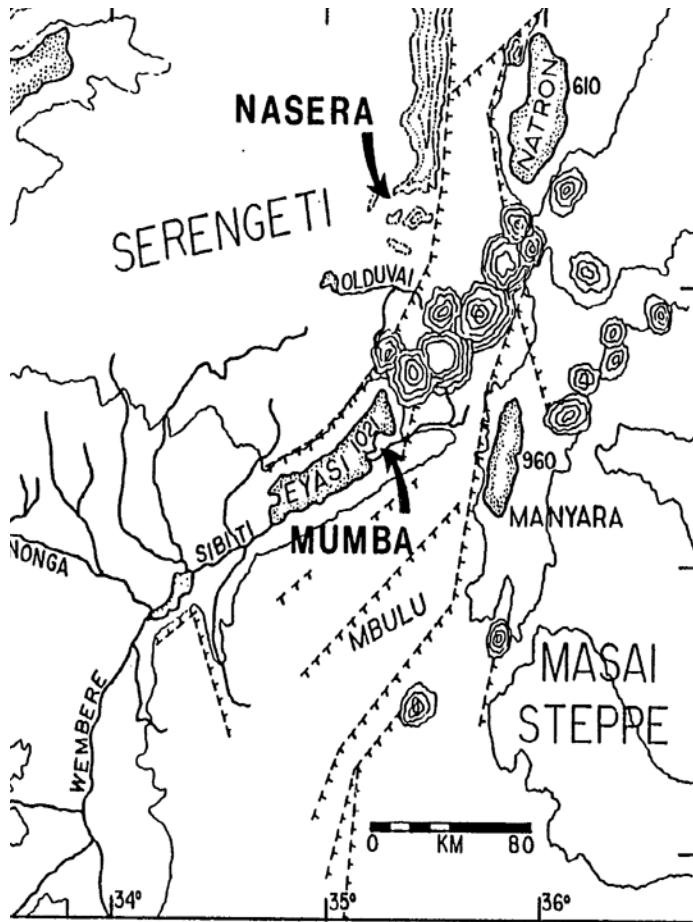


Figure 4.1. Map of northern Tanzania showing the location of Nasera and Mumba (adapted from Mehlman 1991).

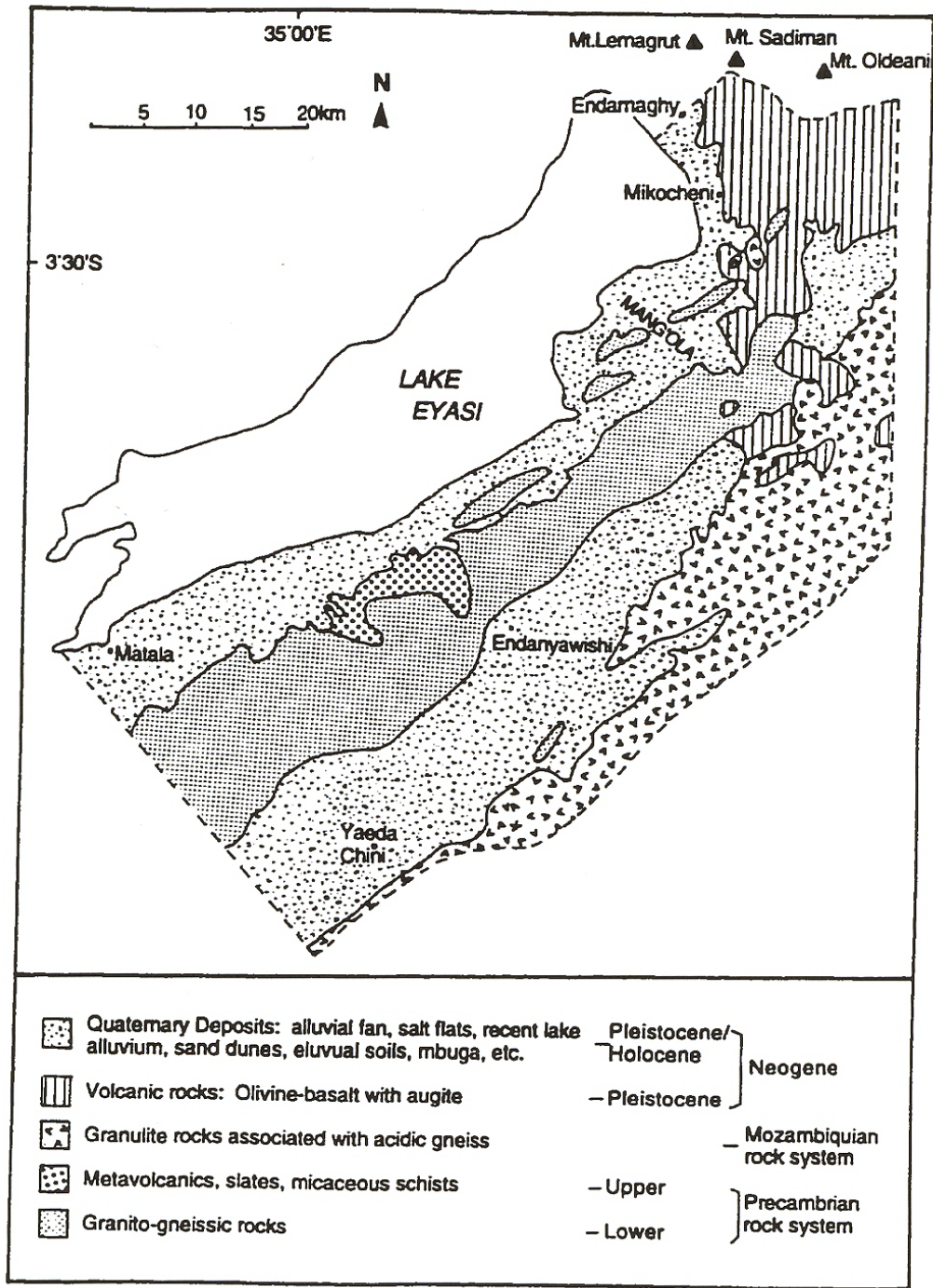


Figure 4.2. The geology of the Lake Eyasi basin. (adapted from Dundas *et al.* 1964; Pickering 1964; Mabulla 1996).

Thorium-Uranium (Th-U) dates show that the upper and lower fossiliferous horizons were produced during a high lake level stand. In the period 135,000-108,000 years ago, there were high stands in East African lake levels (Somi 1993). The variation of lake levels, frequent appearances of stromatolites and high calcium carbonate content in the lake sediments, all suggest a semiarid climate and an alkaline water depositional environment during the transitional period between the two fossiliferous units (Dominguez-Rodrigo *et al.* 2007). Lacustrine sediments from the North East Bay (NEB) site suggest that the lake basin was characterized by alluvial deposits suggesting the existence of a river channel (Dominguez-Rodrigo *et al.* 2008). The ancient Mbarai River entered the lake through the North East Bay (NEB); root cast remains suggest that this place was more wooded than today (Dominguez-Rodrigo *et al.* 2007).

In the Lake Eyasi basin, most of the hominid remains were found associated with Sangoan artefacts in the upper fossiliferous unit or grey sands (Bräuer and Mabulla 1996; Bräuer and Mehlman 1988; Dominguez-Rodrigo *et al.* 2008). Ludwig and Margit Kohl-Larsen discovered the first three hominid cranial fossils, one of them (EH01) a fairly complete skull (Bräuer and Mehlman 1988). Since then, three more hominid specimens have been discovered (a mandible, EH04, an occipital fragment, EH05 and a frontal bone, EH06) (Bräuer and Mabulla 1996; Bräuer and Mehlman 1988; Dominguez-Rodrigo *et al.* 2008). At Lake Eyasi, Sangoan assemblage lacks adequate numbers of points, suggesting that they were not favoured by toolmakers. Only one unifacial point was obtained during our field survey and test excavations at Lake Eyasi basin in 2004

(Dominguez-Rodrigo *et al.* 2007). Perhaps, trapping, stalking and scavenging were the major techniques used to capture animals, and lithic tools were used to process carcasses. This pattern differs from the Sangoan occurrence in the Ngaloba Beds at Laetoli almost 20 km north of Lake Eyasi, where points form 10.4% of the analysed tool assemblage (Mabulla, personal communication 2009).

Several extinct animal species were found associated with the Sangoan artefacts here. These include remains of baboon (*Theropithecus*), buffalo (*Pelorovis*), equid (*Hipparion*), a giraffid, a large carnivore, hippopotamus, wildebeest, bush pig, waterbuck, and antelope (Dominguez-Rodrigo *et al.* 2007; Mehlman, 1989). Although the Eyasi Beds were laid down during a time of climate instability, some of these species suggest that there were nearby grazing and fresh water opportunities. This also suggests that the site had an adequate supply of food resources and freshwater to support people. However, the lack of points in recent collections at the Eyasi basin (Dominguez-Rodrigo *et al.* 2007) does not allow for any meaningful interpretation of ways in which *Homo heidelbergensis* obtained animal carcasses.

#### **4.2.2 Mumba rock-shelter**

Mumba is a large rock-shelter located on the Lang'hangereri-Ishimijega Hill about 1050 m above sea level and 3.5 km east of the modern lakeshore (Mehlman 1989). This hill is part of the Precambrian metamorphic rocks of the Mozambique belt, which runs parallel to the northeast tectonic outcrops of the East African Rift Valley System. Today, the shelter faces the exposed alluvial

mudflats, suggesting that in the past the Mbarai River passed right in front of the shelter, running in a southward direction to Lake Eyasi (Dominguez-Rodrigo *et al.* 2007). The availability of permanent fresh water may have attracted prehistoric people to occupy the rock-shelter at Mumba at various times during the MSA and LSA. Later, the Mbarai River seems to have changed its course to the current point where it enters the lake southwest of Mumba (Dominguez-Rodrigo *et al.* 2007). This change might have been influenced by a high stand of the lake at the beginning of the Holocene and the long effects from erosion and alluvial deposits on the river courses (Mabulla 1996). Many types of sediments have been worn by the undulation of the lake water, which are intense during the rainy seasons and moderate in dry seasons.

Mumba was initially excavated by Margit Kohl-Larsen in 1938. She uncovered a deep cultural sequence containing MSA, LSA and Pastoral Neolithic records (Kohl-Larsen and Kohl-Larsen 1938; Mehlman 1989). Between 1977 and 1981, Michael Mehlman re-excavated the site and also studied the earlier collections (Mehlman 1989, Mabulla 1996, Prendergast *et al.* 2007). Mehlman (1989) identified the MSA occupation in Beds VI-B and VI-A, a Second Intermediate Industry (SII) in Bed V and Lower Bed III and a ceramic LSA in Upper Bed III (Mehlman 1989; Prendergast *et al.* 2007).

The oldest MSA artefacts were found in Bed VI-B (Figure 4.2). Mehlman (1989) termed the lithic assemblage from Bed VI-B as Sanzako Industry, using a Hadzabe name for the Oldean Mountain located north of Lake Eyasi. The Sanzako Industry contains high frequencies of side, double-sided, notched and

concave scrapers, points, bifacially modified pieces, and heavy-duty tools, such as small bifaces and choppers (Mehlman 1989:183). In the Sanzako Industry, true points form about 10.3% of the retouched tools. About 95% of the lithic artefacts are made from quartz. The remaining artefacts include quartzite, nephelinite, chert and obsidian. All lithic raw materials were locally sourced, except for the obsidian (Mabulla 1996; Mehlman 1989). The Sanzako Industry was found associated with three isolated molar teeth of early anatomically modern humans (*Homo sapiens*) (Bräuer and Mehlman 1988). A uranium-series dated on bone apatite from Bed VI-B dates to about 131,710 years ago (Mehlman 1989).

The faunal assemblage in Bed VI-B represents modern animal species; many of them are still found in the Eyasi basin today. These include warthog, buffalo, oryx, wildebeest and zebra (Melman 1989:199). Terrestrial sediments from Bed VI-B suggest that it was deposited during a dry climate marked by fluctuating lake levels with a decrease of at least 20 m below the present level (Mehlman 1989). The frequency of points is relatively low in the Sanzako Industry compared with the subsequent Kisele Industry. The majority of the analysed points in this study have thinned butts suggesting that they were hafted onto wooden shafts to form composite tools. More details on hafting strategies and tool use are presented in Chapters 7 and 8.

Mehlman (1989) identified another MSA industry, the Kisele in Bed VI-A at Mumba and levels 12 to 25 at Nasera (Mehlman 1989). Bed VI-A of the Mumba cultural sequence was dated by uranium series to between 110,000 and 72,000 years ago and it was probably deposited during arid conditions (Glignac

*et al.* 2008; Mehlman, 1989). At Nasera, a uranium-series dated on rhinoceros tooth fragments from level 17 gives an age of 56,000 years ago for the Kisele Industry (Mehlman 1989). But sediments from Level 25 at Nasera correlates to the Upper Ndotu Beds at Olduvai Gorge, which were dated by  $^{40}\text{Ar}/^{39}\text{Ar}$  to between 200,000 and 300,000 years ago (Manega 1993).

The Kisele artefacts are generally small in size and are more diverse compared to the Sanzako ones. Quartz is the predominant raw material, but other materials utilized include quartzite, nephelinite, chert, basalt and obsidian (Mehlman 1989). Chert cobbles are locally found in the Eyasi basin, while at Nasera they were transported between 27 km and 65 km from Olduvai Gorge or the Lake Natron basin (Barut 1994; Mabulla 1996; Mehlman 1989). Points, scrapers and bifacially modified pieces are the most distinctive implements. Backed tools are few in number and typical burins, heavy-duty implements and core tools are rare (Mehlman, 1989). The faunal remains associated with the Kisele Industry include hippopotamus, waterbuck, warthog, buffalo, crocodile, zebra, wildebeest and hartebeest.



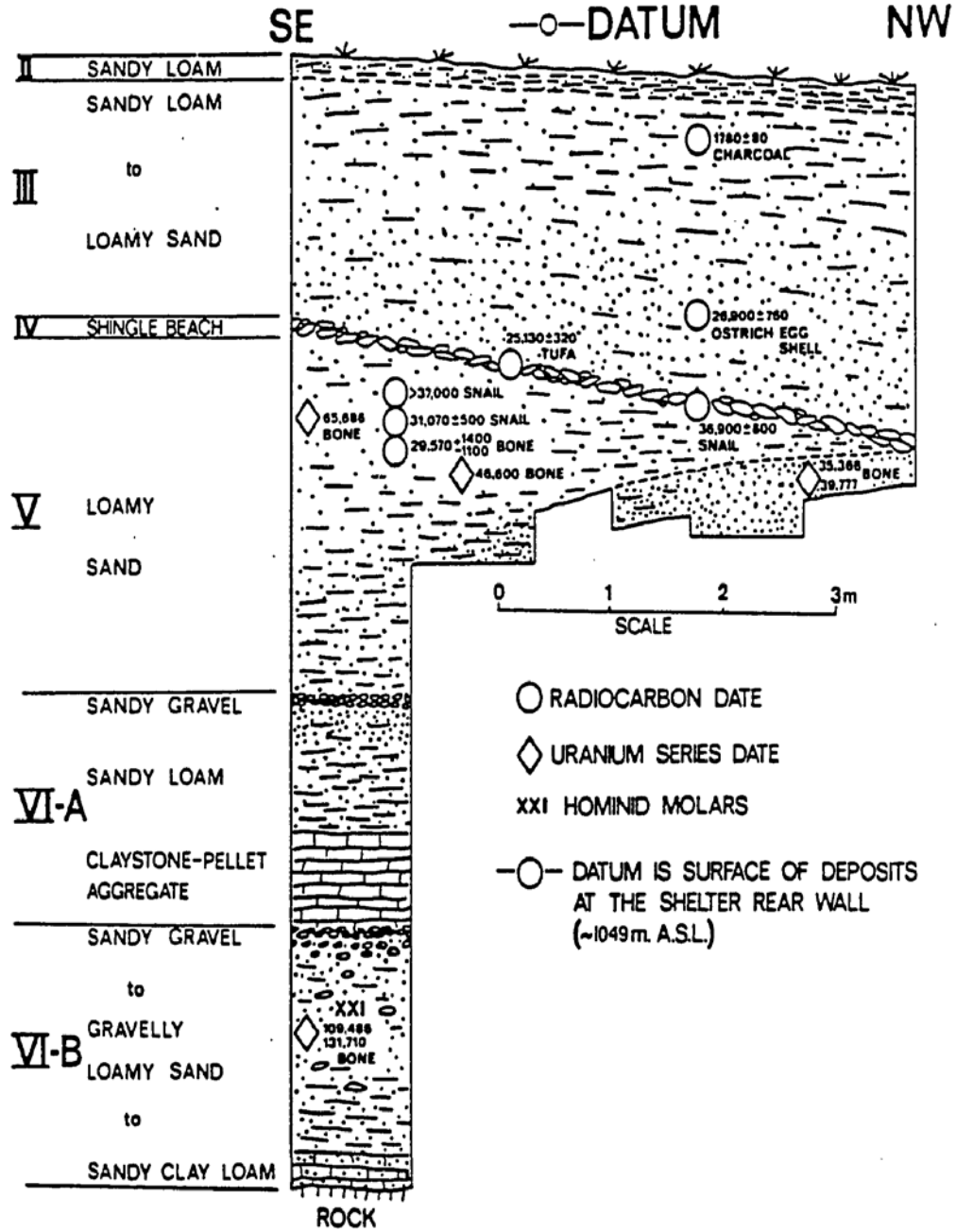


Figure 4.3. The stratigraphic sequences of Mumba (adapted from Mehlman 1989).

In the Kisele Industry, true points account for about 15% of modified tools at Mumba and 18% at Nasera (Mehlman 1989: 201). Points from the Kisele Industry are characterized by bifacial and unifacial types formed on Levallois flakes (Mehlman 1989:204). Some of the points had thinned, plain or faceted platforms. Some had steep retouch on their right lateral edges (Mehlman 1989). The majority of bifacial points are only modified on their tips. Metric measurements presented in Chapter 8 show that the majority of them lie within the range of throwing spearhead and arrowhead projectiles. According to Mehlman (1989), the Sanzako and Kisele artefacts are the most representative of the MSA in northern Tanzania.

In Bed V, Mehlman (1989) recovered the Second Intermediate or Mumba Industry. The Mumba Industry was dated by uranium series and OSL dates to between 69,000 and 35,000 years ago (Gliganic *et al.* 2008; Mehlman 1989). It is characterized by flakes and retouched tools made by Levallois, disc, radial and bipolar core technologies, but bipolar cores predominate, forming about 56% of the core assemblage. Other core categories include platform prepared (20%) and peripherally prepared cores (11%). Lithic artefacts include blades, notched scrapers, side and end scrapers, sundry scrapers, large backed pieces and bifacial, unifacial and Levallois points (Ambrose 2001; Bretzke *et al.* 2006; Mabulla 1996; McBrearty and Brooks 2000; Mehlman 1989). In the Mumba Industry, true points are relatively rare, forming about 4.3% of the analysed tool assemblages (Mehlman 1989:278). Compared to Sanzako and Kisele industries there was an increase in small Levallois or triangular points (McBrearty and Brooks 2000).

These make up about 19.1% of the analysed points belonging to the Mumba Industry.

A similar MSA assemblage has been found at Magubike in which bipolar knapping is common. They make up about 88.4% of the cores. At Magubike, true points are very rare, representing only 5.6% of MSA tools. Generally, points with thinned platforms predominate; these account for about 48.4% of MSA points (Chapter 7). Thinned points are followed in frequency by points with straight faceted platforms (39.5%). This suggests that some points were intentionally thinned to allow hafting or they were abandoned prematurely. Ample numbers of points with thinned platforms suggest that they were inserted on wooden shafts designed to be projectile weapons. Nevertheless, evidence from Magubike and Mumba Bed V suggest that as time passed, points were replaced by backed pieces, which may also have been used as inserts for spears and arrows (Lombard 2007). Points from the Second Intermediate Industry at Mumba and Nasera were reduced in size and form compared to those from the more typical MSA assemblages (Chapter 8), indicating that, as time passed, arrowhead projectiles became widespread.

At Mumba Bed V, the lithic artefacts were found associated with fauna, land-snail shells, ostrich egg shells, beads, and ochre (Mehlman 1989; 1991). The faunal remains include zebra, warthog, wildebeest, hartebeest, eland, gazelle, buffalo, oryx, impala, rhinoceros and waterbuck (Mehlman 1989). Bed V is characterized by alluvial deposits at the base and aeolian sediments on top (Prendergast *et al.* 2007). Bed IV contains algal carbonates, loams, clay pellets

and alluvial deposits suggesting that during this time, Mumba was within the lake margin (Figure 4.3). The lack of archaeological materials in Bed IV and the presence of clay pellet sediments suggest that, at that time, the site was abandoned after the rise of lake levels (Figure 4.3). Clay pellets indicate that lake levels rose to about 26 m above the present (Mehlman 1989).

Mehlman (1989) identified another Second Intermediate Industry or Naseran Industry in levels 6 to 11 at Nasera and Bed III at Mumba. At Nasera rock-shelter, the Naseran Industry was radiocarbon dated to about 27,000 years ago (Mehlman 1989:47). Perhaps new dating techniques for the Nasera cultural sequence may change this age (Glignic *et al.* 2008; Skinner *et al.* 2003). Mumba Bed III, was also radiocarbon dated, using ostrich eggshells, to about 27,000 years ago (Mehlman 1989). New radiocarbon and OSL dates from Bed III provided additional dates between 35,000 and 33,000 years ago (Conard and Marks 2006; Prendergast *et al.* 2007). The major difference between the Mumba and Naseran industries can be revealed in tool sizes. The Naseran artefacts are relatively small and probably contain a greater proportion of geometric tools than in the Mumba Industry (Mehlman 1989:280). In the Naseran Industry, small convex and end-scrapers are more widely represented than other categories of tool types (Mehlman 1989). Quartz dominates the lithic raw materials of the analyzed artefacts. Other artefacts recovered include many ostrich eggshell beads, drilled pieces and stone balls (Mehlman 1989).

At Nasera, true points make up about 14.2% of the tool assemblage in the Naseran Industry of levels 6 - 11 (Mehlman 1989). Recent technological and

typological analyses of stone artefacts from lower Bed III at Mumba suggest that the Naseran artefacts are closely related to early LSA assemblages from the Naisiusiu Beds at Olduvai Gorge (Prendergast *et al.* 2007). Their differences are simply typological and do not represent any technological changes (Prendergast *et al.* 2007). Artefacts from the Naisiusiu Beds, Olduvai Gorge and Bed III at Mumba are characterized by geometric tools knapped in various ways, especially using bipolar techniques (Prendergast *et al.* 2007). The decrease in tool sizes and increase in numbers of geometric tools in Naseran artefacts are sometimes referred to as the hallmark of the beginning of the LSA culture (Prendergast *et al.* 2007). If this interpretation is accepted then the stone artefacts from the Naseran Industry at Mumba and Nasera could be designated as LSA, dated to between 35,000 and 27,000 years ago. Therefore, the transitional industry at Nasera may need more detailed investigation. Alternatively, it may indicate gradual technological shifts from the MSA to LSA.

The Silale Industry at Mumba was found in Upper Bed III and contains cemented yellowish-red and dark brown clay soil (5YR 3/3). The Silale artefacts are characterized by many backed pieces, small convex scrapers, and geometric tools radiocarbon dated to between 8,000 and 7,000 years ago (Mehlman 1989). The lithic assemblage was found associated with drilled bones, ostrich eggshell beads, catfish remains and bones of modern animal species (Mehlman 1989; Prendergast *et al.* 2007). The middle portion of Bed III at Mumba contains several human burials, faunal remains, ostrich egg shells and *Achatina* shells. A radiocarbon date of 4,900 years ago on charcoal and bone collagen exists for the

human burial (Mehlman 1989:107). At Mlambalasi, Iringa, calibrated radiocarbon dates place the LSA assemblage and human burial between 13,490 and 13,160 BC (Table 6.1).

#### **4.2.3 Nasera rock-shelter**

The Nasera rock-shelter is located in the eastern margin of the Serengeti National Park (Mehlman 1989). Sedimentary deposits here are composed of volcanic tuffs and ashes formed after the volcanic eruptions at Oldoinyo Lengai between 400,000 and 250,000 years ago (Dawson *et al.* 1994). Today, the area surrounding Nasera and the Eastern Serengeti Plain is among the driest places in northern Tanzania (Mehlman 1989:24). Total annual precipitation averages about 500 mm with a peak in December, and the dry season lasts from June to November (Mehlman 1989). Nasera and its surroundings are affected by the rain shadow of the Ngorongoro highlands and volcanic mountains, which block out the northeast winds (Figure. 4.1). Local vegetation cover is characterized by short grasses standing about 60 cm tall. Grasses are dominated by *Sporobolus marginatus* and *Digitaria macroblephara*, with a few shrubs and acacia trees. Acacias are found adjacent to the highlands and mountain ranges (Mehlman 1989:26).

Insufficient rainfall has caused a scarcity of surface water within the region and the nearest permanent source of water is a small saline spring called Sukunwa on the Serengeti Plain, about 16 km to the northwest of Nasera (Mehlman 1989). During the dry season, limited water is found in the ephemeral

springs. Sometimes surface water stored on rocks may persist well into the early phase of the dry season. It is believed that, during most of the Pleistocene, northern Tanzania experienced similar climatic condition to present (Hay 1972). The MSA people in this region may have experienced droughts and a deficiency of fresh water, as modern people do now. For that reason, Nasera was likely to have been inhabited during wet seasons when standing water and ephemeral springs were present. In such circumstances, Nasera may have served as a seasonal hunting camp during the wet seasons or the early phases of dry seasons (Mehlman 1989).

A deficiency in water supply also may have affected the distribution of flora. As a result, Nasera and its surroundings sustained relatively meagre resident fauna during the dry season. Today, the area that surrounds Nasera and the Angata Selai plain (Figure 4.1) is teeming with a number of ungulates (wildebeest, Thomson's gazelle and zebra) during the wet season. These seasonal movements link the Lake Natron basin, Angata Selai, Serengeti and Masai Mara plains (Mehlman 1989). The location of the Nasera rock-shelter on the restricted major wildlife migration route makes this site likely to have been a potential hunting camp. This situation suggests that Nasera, Loiyangalani and Lukenya Hill, located almost 250 km to the northeast in southern Kenya, played similar roles as seasonal specialized hunting grounds (Bower 1985; Marean 1997).

Louis Leakey explored and excavated Nasera in 1932. He excavated trenches mainly on the western side of the shelter (Leakey 1936). Field notes recorded by Leakey in 1932, which are attached to Mehlman's (1989)

dissertation, show that the excavated trenches reached a maximum depth of 5 m; ten layers were recognized. Arbitrary divisions were mainly based on changes in sediment colour and texture. In 1932, Leakey identified deep cultural sequences ranging from the MSA to Holocene LSA. Mehlman (1989) re-excavated Nasera and identified four cultural sequences composed of the MSA (Kisele Industry), the MSA/LSA transition (Naseran Industry), an early LSA (Lemuta Industry) and a Holocene LSA (Silale Industry).

About 283,000 stone artefacts and 168,000 bone fragments were excavated (Mehlman 1989:28). Most of the stone artefacts from Nasera were made from quartz, with low frequencies of quartzite, chert and obsidian (Mehlman 1989:28). The nearest source of chert was either at Olduvai Gorge, located about 27 km away, or in the Lake Natron basin, located about 65 km northeast of Nasera (Figure 4.1). Obsidian was taken from Sonanchi, Eburru and Njorowa Gorge, south of Naivasha, about 250 km north of Nasera (Merrick and Brown 1984; Mehlman 1989). Arbitrary strata suggest that the MSA artefacts (Kisele Industry) belong to levels 12 to 25 (Mehlman 1989). The Second Intermediate Industry (SII) artefacts (Naseran Industry) were obtained from between levels 6 and 11 followed by the LSA (Lemuta Industry) between levels 4 and 5. The Holocene LSA artefacts (Silale Industry) were found in the upper levels (Figure 4.4).





The Lemuta Industry, which is believed to be the earliest LSA assemblage in East Africa thus far, has been recorded at Olduvai and Nasera (Mehlman 1989; Skinner *et al.* 2003). The term “Lemuta” refers to the prominent quartzite hill situated west of Nasera; the term was first assigned to LSA artefacts from the Naisiusiu Beds at Olduvai Gorge. Modified stone tools in the Lemuta Industry at Nasera consist of backed pieces and geometric tools such as crescents, burins, trapezes, small triangular points and scrapers. These are all made from local quartz and quartzite as well as from exotic raw materials, such as chert and obsidian (Mehlman 1989). Small convex scrapers dominate the scrapers and points make up about 4.3 % of modified tools (Mehlman 1989). Unifacial points make up about 56.3% of points; the next most common are small triangular (Levallois) ones (25%) and then bifacial points (18.8%). The Lemuta Industry at Nasera was radiocarbon dated to between 20,000 and 22,500 years ago (Mehlman 1989:45). At Olduvai Gorge, a similar industry has been recently re-dated through the use of uranium-series and Amino Acid Racemization (AAR) dating techniques, to between 45,000 and 60,000 years ago (Manega 1993; Skinner *et al.* 2003).

As was previously noted, the Nasera and Mumba archaeological deposits lack materials ranging from between 20,000 and 8,000 years ago (Mehlman 1989). This time period was dominated by a dry climate that characterized most of the tropical Africa during OIS 2. Mumba and Nasera may have been reoccupied in the first half of the Holocene, around 8,000 years ago, when wet conditions and sufficient distribution of surface water resumed (Mehlman 1989).

Similar condition characterized the archaeological deposits of Iringa where the late Pleistocene LSA assemblage dating to about 13,490 BC are present at Mlambalasi. The late Pleistocene LSA assemblage of Mlambalasi also has high frequencies of backed pieces, geometric tools, bipolar cores and human burial. Points are rare, making up about 1.1% of the stone tools. This trend indicates that in the late Pleistocene, the points were generally replaced by microlithic tools, backed pieces and geometric tools. It is likely that the early LSA (Lemuta Industry) of northern Tanzania is lacking at Mlambalasi.

#### **4.3 Settlement patterns, lithic raw material procurement and hunting behaviour at Mumba and Nasera**

Evidence from Mumba and Nasera suggests that MSA people stayed longer in one locality, or that they occupied similar localities repeatedly. This process resulted in the deposition of deep and dense archaeological occurrences. Their technology was primarily based on local raw materials, with little investment in exotic rocks. The MSA assemblages from these sites have a high proportion of points ranging between 10.3% and 15% at Mumba and 14.5% and 18% of the total numbers of tools at Nasera (Mehlman 1989). Points at Mumba increased from 10.3% of 1168 shaped tools in the Sanzako Industry to 15% of 1467 modified tools in the Kisele Industry. At Nasera, points reached 18% of 3589 modified tools in the Kisele Industry. During the MSA/LSA intermediate industries, points only represent about 4.3% of 1350 stone tools at Mumba. At

Nasera, the trend was different; points make up about 14.5% of 1462 in the Nasera Industry (Mehlman 1989).

Shea (1997) argued that MSA points were made, used and discarded more often in areas where ecological conditions were suitable for hunting. If Shea's interpretation is accepted then Nasera and Mumba could have been used in different ways during the Middle and Upper Pleistocene. Nasera was probably used for planned and repeated seasonal hunting, like Lukenya Hill and the Gi site in Botswana (Marean 1997; McBrearty and Brooks 2000). On the other hand, Mumba was used for an extended period of time because of a good supply of freshwater from the natural spring, plant food in the riverside forests, and hunted game.

The zooarchaeological evidence from Lukenya Hill suggests that MSA and LSA foragers adapted to the East African grasslands through seasonal resource exploitation (Marean 1997). Lukenya Hill was inhabited when migratory ungulates such as wildebeest and hartebeest were found locally (Marean 1990, 1997). In the Serengeti ecosystem, animals migrate seasonally depending on the availability of surface water and grazing opportunities. In order to increase chances for successful hunting, MSA foragers may have moved seasonally, alongside migratory game. This trend suggests that habitation plans at Lukenya Hill and Nasera were closely related and presumably, were influenced by planned and repeated site occupations.

Geographically, Nasera is located in the lee side of the Ngorongoro Highlands; these highlands cause the area to receive less annual precipitation.

Today, surface water is locally found in ground rocks or ephemeral springs in the wet season or at the beginning of dry seasons. Geographically, Nasera is oriented to the north, facing the game migration corridor. A deficiency of water in the dry season and in locations close to the annual animal migration route likely makes Nasera a planned seasonal hunting camp. Probably Nasera was occupied repeatedly at the end of rainy seasons when surface water was locally found and migratory game were present in the Angata Salei Plain located to the east. Nasera may have been occupied for long time periods during wet seasons, due to the easier accessibility of fresh water and grasses, which attracted a number of hunted game animals. A long stay produced a deep and dense MSA assemblage about 56,000 years ago (Mehlman 1989).

More supporting evidence comes from the faunal assemblage of Nasera that includes both residential and migratory species, such as hartebeest, wildebeest and gazelle (Barut 1994; Mehlman 1989). The presence of migratory animal species supports the theory that this area was used for repeated hunting related activities. In northern Tanzania and southern Kenya, tracking migratory animal species can also be closely correlated with the raw material procurement, particularly chert and obsidian. These exotic rock types were sourced from places located within animal migratory routes. Sources of chert and obsidian cobbles such as Olduvai Gorge, Lake Natron, Njorowa Gorge and Eburru are all located within the Serengeti ecosystem (Merrick and Brown 1984). Perhaps northern Tanzania and southern Kenya were occupied by foraging groups that pursued migratory animals seasonally during the MSA. On the way back to residential

camps they carried exotic rocks, such as obsidian and chert, as gifts or for functional needs. At Nasera and Mumba, exotic rocks were rarely represented indicating that trading and exchange were not a primary goal for toolmakers. People may have encountered these rocks routinely in their normal process of tracking hunted animals. Since chert and obsidian produced points with sharp edges and great wounding ability, toolmakers carried them for further functional or cultural requirements.

Generally, archaeological data from Mumba and Nasera suggest that changes in technology were gradual. Knapping skills, subsistence patterns and site uses were influenced by ecological requirements. In northern Tanzania, there seems to be a link between technological organization and ecological contexts. For example, points with faceted platforms suggest that Levallois core production was needed in order to produce projectile weapons. Moreover, exotic raw materials were sourced from areas located within the animal migratory routes that link southern Kenya and northern Tanzania. This brings together environmental resources including foods, raw materials and lithic technology to a common area. Therefore, technological changes were influenced by the nature and forms of intended uses and the availability or distribution of natural resources.

Evidence from Mumba and Nasera suggests that, as time passed, points became less significant. They were eventually replaced by varieties of backed tools, which were also used as insert for projectile weapons (Lombard 2007). As noted before, in the Mumba Industry, points only comprise up to 4.3% of the analysed stone tools. On the other hand, frequencies of bipolar cores increased

from 2.7% in the Kisele to 56% in the Mumba Industry. A similar trend appears at Magubike where bipolar cores and large backed pieces predominated in the MSA. At Magubike, points comprise 5.6% of the modified tools and bipolar knapping predominates even in the MSA assemblage (Chapter 6). Typological analysis suggests that early MSA artefacts, such as the Njarasan or Sangoan, are not represented in the MSA assemblage at Magubike, but they are abundant at Kigwambimbi, an open-air site located 3 km northeast of Kalenga.

#### **4.4 Summary**

Mumba and Nasera rock-shelters preserve a deep, MSA and LSA chronological sequence indicating long-term human occupation. Points were highly utilized during the MSA compared to the LSA. The number of points drops in the MSA/LSA assemblage or Mumba Industry compared to the traditional MSA. To some extent, during the Second Intermediate Industry, long-established MSA tools (scrapers, points and utilized flakes) were replaced by backed tools such as crescents that were used also as insert for spears and arrows (Lombard 2007). Backed tools are associated with a decrease in the frequency of points and an increase in bipolar cores. Stone tools underwent progressive changes in size and form. As time passed, microlithic tools increase suggesting that the change in lithic technology was gradual. The utilization of exotic raw materials in the MSA assemblages of northern Tanzania may indicate emerging modern cognitive behaviour among the inhabitants who occupied those sites.

Functional analysis (Chapter 8) indicates that obsidian can be used to form tools with the sharp edges that would be needed to cause an enormous wound after hitting a target (Ellis 1997). Stone tools made from chert are also sharp and durable enough to withstand unintentional breakage (Hughes 1998). This trend indicates that the MSA and LSA foragers who lived in northern Tanzania were skilled and understood their environment. They moved seasonally, depending on the availability of water and food resources. An adequate supply of points suggests that hunting was one of the integrated behavioural complexities that evolved during the MSA. Points enabled prehistoric hunters to increase their efficiency in hunting by hitting and killing intended prey with stone tipped weapons. Analysed samples discussed in (Chapters 7 and 8) indicate that heavy duty hunting tools such as thrusting spears were made from durable rock types such as chert, quartzite and other metamorphic rocks.

Although Mumba and Nasera have contributed greatly to the study of human cultural and biological evolution, there is need for more technological studies for the collections from these sites. In 2007, I found that many artefacts collected by Michael Mehlman are poorly stored. Tags, enclosed in plastic bags, have been destroyed by termites, and aluminum containers used by Mehlman to store those collections are in poor condition. This situation encourages the mixing up of artefacts. Mary Prendergast from Harvard University and I tried hard to replace the old tags and containers with new ones, but we were unable to replace all collections because of a limited budget and time constraints. Unfortunately, some collections described by Mehlman (1989) are not there; perhaps he kept



them to complete his study. For some reason, Mehlman was unable to study all his collections. Instead he focused on Kohl-Larsen's collections, which were collected using flawed procedures and biased sorting. Generally, excavation and artefact collection in the 1930s were biased towards large tools, cores, flakes and teeth of large mammals (Mehlman 1989:78). Rejected and discarded artefacts, particularly microlithic tools, bladelets and micro-fauna, can be seen in enormous dumps just outside the shelter. Methods applied for excavation and artefacts sorting in the 1930s were excellent for that time. However, hindsight suggests that they would not meet present-day standards.

Despite the great efforts made by Mehlman to generate more precise archaeological results, some materials he analysed are missing for further studies. These uncertainties make the archaeological industries of Mumba and Nasera little understood. Mumba and Nasera are among the most important sites for better understanding of prehistoric human behaviour and technological organization in East Africa. These sites have deep cultural sequences and detailed Middle and Upper Pleistocene paleoenvironmental records. Detailed studies of collections from Mumba and Nasera, which are stored at Olduvai, should be undertaken and missing collections should be traced and stored for future use. Perhaps well controlled excavations should be undertaken at Mumba and Nasera to obtain self sustained data that will uphold future research directions and interpretations.

## **CHAPTER 5: THE LANDSCAPE, GEOLOGY, ECOLOGY AND ARCHAEOLOGY OF IRINGA AND SURROUNDING REGIONS**

### **5.1 Introduction**

This chapter describes the landscape of Iringa and presents archaeological and ecological evidence collected during a field survey carried out in 2008, as well as from test excavations in 2006. It also discusses the human cultural evolutionary trend in southern Tanzania. In the past, the archaeological potential of Iringa was best known from the Acheulian assemblage at Isimila, located almost 20 km southwest of the town of Iringa. During our field survey and excavations, more archaeological sites were explored; these sites demonstrate that the archaeology of Iringa is not limited to the Acheulian (Howell *et al.* 1962; Cole and Kleindienst 1974; Giichi 1988). Many other cultural traditions are present. Recorded sites belong to the ESA, MSA, and LSA as well as Early and Late Iron Age (EIA and LIA) and the historical periods (Figure 5.1).

This chapter tries to explain in broad perspective the possible wild resources which were available in Iringa during the MSA and LSA. It also explores the ways in which these resources influenced prehistoric humans to adapt and to sustain the landscape of Iringa. Since foraging, hunting and scavenging were the most desirable methods of subsistence in the Stone Age, it is likely that natural environmental resources had great influence on human technological developments and behaviour changes. It is possible that most of the cultural traits, such as human settlements, lithic raw material procurement and

subsistence patterns, were influenced by the availability and distribution of natural environmental resources. Therefore, this chapter tries to assess the relationships among various physical and cultural attributes, which made the MSA and LSA foragers adapt to the landscape of Iringa during the Middle and Upper Pleistocene.

Unfortunately, updated archaeological and palaeoenvironmental evidence about the Iringa Region is sparse. Much of the available data were developed in 1960s and 1970s from the Acheulian site at Isimila (Howell *et al.* 1962; Cole and Kleindienst 1974). Lack of subsequent Stone Age investigation in this region made Isimila a principal source of archaeological and geomorphologic information for decades. The Acheulian assemblage at Isimila is composed of a wide range of artefacts including hand-axes, cleavers, core-scrapers, choppers, knives and picks (Howell *et al.* 1962; Cole and Kleindienst 1974). These artefacts were mainly located on an ancient lakeshore and they were found associated with fauna representing extinct aquatic and terrestrial animals such as hippopotamus (*Hippopotamus amphibious*), Equus (*Equus*), pig (*Afrochoerus*), bovids, and rabbit (*Lepus*) (Cole and Kleindienst 1974; Howell *et al.* 1962).

Since 2005, ongoing research in Iringa under the direction of Pamela Willoughby has provided archaeological evidence related to technological and behavioural development during the MSA and LSA. Therefore, most of the information presented in this chapter relies on data recovered from an archaeological field survey in Iringa carried out during the summer of 2008 and test excavations in 2006 and 2008 (Figure 5.1). This database has improved our

level of understanding about the nature and form of past and present environments and is being used to establish the kinds of adaptive behaviours and technologies that were used in Iringa during the MSA and LSA.

## **5.2 Geographical location and the modern climatic condition of Iringa**

Geographically, the Iringa Region is located in the southern highlands of Tanzania lying between 7°05' and 10°32' S; 33°47' and 36°32' E; it covers an area of about 58,936 square kilometres. The region is surrounded by three major mountain ranges; the Kipengere and Livingstone Mountains to the south and the Udzungwa Mountains to the northeast. Topographically, Iringa lies between 900 m and 2,700 m above sea level. Most of the region is composed of highlands and escarpments ranging from 1200 m to 2700 m; there are also a few lowland areas that range from 900 m to 1200 m above sea level (Masao 2005). The lowland areas are mainly found in the northern part of Iringa. The annual temperature varies according to altitude and wind movements. In the highlands, the annual average temperature is less than 15° C (Masao 2005). In the lowlands, the annual average temperatures range from 20° to 25° C. The warmest months are December and January with a maximum temperature of 25° C (Masao 2005).

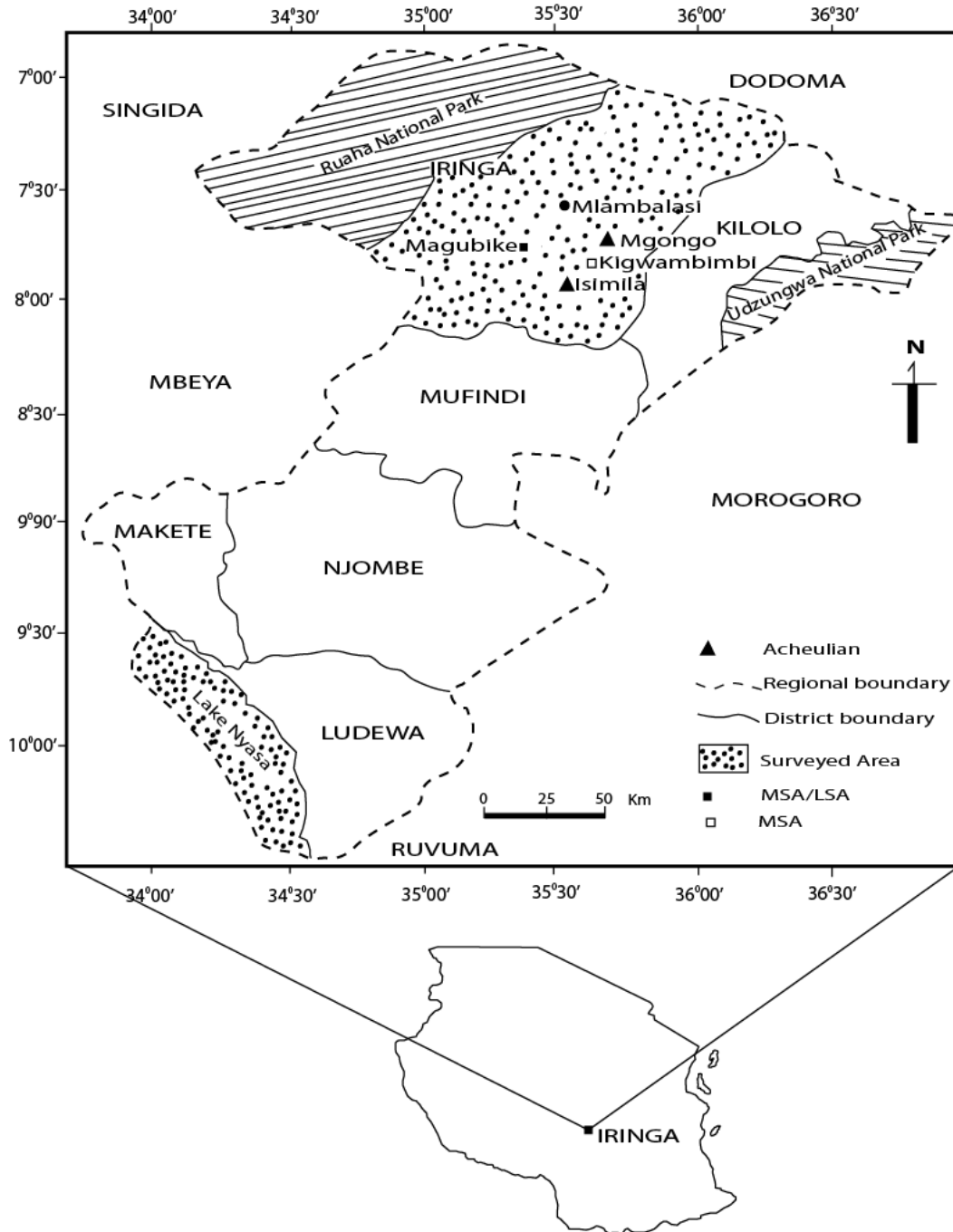


Figure 5.1. Map of the Iringa region showing administrative districts, national parks, the survey areas and archaeological sites.

Iringa has two major seasons, dry and wet. Although the timing varies somewhat from year to year, the wet season generally starts in November and ends in May. Generally, the month of February receives less precipitation and subdivides the wet season into two rainy seasons: November to January and March to May, respectively (Aidan 2004). In the southern highlands, the rains fall almost for the entire course of the wet season without a break. This occurs because of the southeast monsoon winds that pass through the Indian Ocean and bring moisture to this area. Across most of Iringa, the dry season spans from June to October. Generally, the highlands are less fertile due to leaching as a result of high precipitation.

### **5.2.1 Drainage system**

Iringa is endowed with many natural springs and river channels (Figure 5.2). The Great Ruaha River, which is a main river channel of Iringa, supports many irrigation schemes, as well as two hydro-electric power stations at Mtera and Kidatu. Most of these streams and springs run throughout a year. A few of them are ephemeral, meaning that they flow only during the wet seasons. Both ephemeral and permanent spring channels run from the highlands, and are connected to the Great Ruaha River, a major source of the Rufiji River that ultimately flows into the Indian Ocean (Vincens 1992). Places drained by the ephemeral springs are characterized by eroded gullies, gravel, alluvial and colluvial sediments. The Great Ruaha River catchments cover almost 475 km<sup>2</sup>, but the total catchment area in combination with tributaries is about 68,000 km<sup>2</sup>

(Vincens 1992). In its lower courses, the Great Ruaha River is characterized by wetland grasses and riverside forests. During our field survey, it was observed that most of the located MSA sites were close to the modern spring channels. This trend suggests that the Ruaha River and its tributaries played a significant role in supporting human life during the Middle and Upper Pleistocene. They may have served as sources of fresh water and provided potential opportunities for hunting and foraging.

Today, the river deposits provide the resources for agricultural activities in the region. Current agricultural activities, however, have led to the clearing of forests and increased land erosion. The massive soil erosion observed during our field surveys may have resulted from ongoing agricultural activities and increased human population. Clearance of vegetation cover leads to insufficient surface water infiltration into the soil and also influences sediment runoff and gully formations (Hassan 1985). Eroded gullies are located in the highlands and areas surrounding the ephemeral springs. They are characterized by red or yellowish alluvial sediments, silt sands, pillars, stone pebbles and exposed bedrock.

Gully erosion may have increased during dry stages in the Pleistocene, when rainfall was at the lowest state and most of southern Tanzania was less covered with vegetation, compared to the present (Finch *et al.* 2009; Garcin *et al.* 2006; Scholz *et al.* 2007). Unreliable rainfall also affected the depositional processes and increased soil erosion. In some places such as Isimila, Mgongo and Kigwambimbi, exposed stratigraphic sections show the meandering courses of ephemeral river channels and fan sediments, suggesting that these gullies have

been continually shifting positions, pirating flow from other gullies and restraining sediments deposited by previous gullies. Alluvial soils seem to be associated with Acheulian and MSA artefacts. The presence of Acheulian, MSA and LSA artefacts in Iringa suggest that the region was inhabited by people for most of the Pleistocene. Pollen evidence from Kalambo Falls in the southern edge of Lake Tanganyika argues for the continuity or minor changes of woodlands in the southern highlands for most of the Pleistocene (Clark 2001). The ongoing agricultural activities and the spatial distribution of archaeological sites close to the spring and river channels suggest that nature had, and still has, a great influence on human settlements, technology and subsistence.

### **5.2.2 Vegetation patterns**

The landscape of Iringa is covered by granite rocks, open grassland, shrubs, woodland and riverside forests (Figure 5.3). Woodlands and forests are mostly located in the highlands and within river catchments, while discontinuous grasslands and shrubs are mainly found in the lowlands (Kashaigili *et al.* 2007; Vincens 1992). This pattern suggests that there is a close relationship between the vegetation prototypes, drainage systems, annual precipitation, soil types and topography. As previously noted, the annual precipitation in this region varies depending on the topography, whereby the upland areas receive almost 500 mm annually more than the lowland areas (Vincens 1992). The effect of rainfall and topography on vegetation type is obvious. The highlands are dominated by tropical woodlands composed of combination of the *miombo* trees (Hamilton



1982; Vincens 1992). The lowlands and river basins are composed of bushes, grasses, waterlogged clay and poorly drained soils with marshes (Vincens 1992). During the rainy seasons, the lowlands and river basins are subjected to flooding and seasonal waterlogged plains locally known as *mbuga* (Howell *et al.* 1962; Vincens 1992).

Howell *et al.* (1962) used the Swahili term *mbuga* to refer to plains and grasslands at Isimila. *Mbuga* is notable for poorly drained black clay soil that becomes a quagmire in the rainy seasons (Cole and Kleindienst 1974:349). Today, *mbuga* is mostly found in lowland plains with less rainfall. *Mbuga* areas are used for grazing in dry seasons. *Mbuga* grasses include *Sporobolus consimilis*, *Themada trandra* and *Hyparrhenia setaria* (Cole and Kleindienst 1974:349). *Mbuga* grasslands are occasionally covered with sparse acacia trees, in particular *Acacia kirkii*, and *Xanthrophloea*; these are commonly found alongside spring channels. *Xanthrophloea* trees are locally referred in Swahili as *migunga maji* meaning “water trees;” they grow close to the river catchments, and have small yellow or white flowers (Mabulla 1996:151). In Iringa, *migunga maji* occurs in varying combination and densities. Within river catchments, they occur in high densities, giving a woodland appearance (Figure 5.3).

It is important to note that the composition and quality of vegetation described in this chapter are being modified by various human activities. Humans affect the vegetation through agricultural activities, overgrazing, uncontrolled fires and the cutting of trees for building materials and fuel (firewood and charcoal). Perhaps this uncontrolled usage of trees started earlier, between 3,000

and 2,000 years ago, the period in which farming and smelting communities (Bantu language speakers) moved into the region (Msemwa 2004). At Magubike, an *Achatina* shell fragment from the Iron Age assemblage obtained between levels 65 and 70 cm deep was radiocarbon dated to  $2790 \pm 60$  BP, (TO 13417), calibrated to about 1410 BC (Table 6.1). The immediate effects related to these anthropogenic factors include land erosion, aridity and decline of water volume in the Great Ruaha River. From the 1990s onwards, the flow of the Great Ruaha River was reduced to almost nothing and sometimes during the dry seasons, the river did not have enough water to maintain its normal flow capacity (Kashaigili *et al.* 2007). To some extent, vegetation modification has made the task of reconstructing the past environment and natural resources more difficult and uncertain. Nevertheless, pollen evidence from the Uluguru and Udzungwa Mountains suggest the existence of moderate precipitation and woodland environments for most of the Pleistocene, with minor fluctuations in southern Tanzania (Finch *et al.* 2009).

The distribution and availability of water and grazing opportunities may have attracted a number of hunted prey and hunting communities within the region. Increases in the number of hunted game gave more opportunities for successful hunting. The MSA and LSA sites located in Iringa, including Kigwambimbi, Mlambalasi and Magubike, were found close to good water sources, suggesting that water was a significant determinant for human settlement and subsistence. In some places, such as Kigwambimbi, and the Acheulian sites

of Isimila and Mgongo, water flow and erosion has exposed deposits with archaeological materials.

### **5.2.3 Wild food resources**

Unfortunately, southern Tanzania lacks detailed scientific information about the wild plant food resources utilized by prehistoric people. This is notable, especially when compared to the research that has been done in the northern parts of the country, such as Ngorongoro Conservation Area and Lake Eyasi basin (Peters *et al.* 1992; Woodburn 1968). However, available evidence suggests for the continuity between the past and present environments. Dense patches of *miombo* woodlands, acacia trees, deciduous bushes and enlarged riverside forests suggest the presence of edible wild plant food resources. Acacia trees also may have been used to provide edible gums or as glue for hafting, as is seen in the modern-day hunting and foraging community (Hadzabe) of Lake Eyasi (Woodburn 1968). Another tree that may have provided a large amount of food during the MSA and LSA periods is the baobab (*Adansonia digitata*). Baobab fruits and nuts are widely foraged and used by the Hadzabe and other people, as an essential staple food (Mabulla 1996; Marlowe 2003). Today, dense patches of baobab trees are widely distributed across the highlands and rocky outcrops along the highway from Iringa to Ruaha National Park, the Udzungwa Mountains and the Kitonga escarpment.





Figure 5.3. Vegetation pattern of Iringa.

The Ruaha National Park is located northwest of the Iringa District (Figure 5.1); it is endowed with a variety of wild animals with differing habitat preferences. Wild animals can be classified into three size categories which have a bearing on their edible meat content (Bunn 1982; Collins 2009; Klein 1999; Mabulla 1996). Large animals with over 200 kg of meat include the elephant, giraffe, zebra, eland and buffalo (Bunn 1982; Collins 2009; Mabulla 1996). Medium-sized animals with more than 40 kg of meat include the impala, springbok, Thomson's and Grant's gazelles, topi, wildebeest, hartebeest, oryx, warthog and great kudu. Small animals with less than 40 kg of meat include baboons, dik-dik, mongoose, hare and hyraxes (Mabulla 1996:155). The majority of these animals are found in the Ruaha National Park today and were likely found in many places of Iringa during the Pleistocene. In northern Tanzania, large and medium-sized animals are preferred by modern hunting groups (Bunn *et al.* 1988; Mabulla 1996). Faunal assemblages from Mumba, Nasera and Magubike suggest that large medium and small sized animals were targeted by prehistoric hunting groups during the MSA and LSA (Barut 1997; Collins 2009; Mabulla 1996; Mehlman 1989).

The diversity, quality, season of availability and distribution of wild food resources in Iringa may have varied in relation to landscape and ecological conditions. For instance, plant foods may have been more abundant in uplands and river catchments where dense tree patches were mainly located. Hunted game is likely to have been more abundant in river catchments during the dry seasons, the periods which experience deficits of water and foliage in many places.

Concentrations of hunted game in isolated places were most likely to have an effect during the Last Glacial Maximum (LGM), the period which is correlated with drought conditions and expansions of grassland environment in most of tropical Africa (Bonnefille 1996; Gasse 2000; Finch *et al.* 2009). During that time period, supplies of water, game and foliage were restricted to isolated places within the river and lake catchments. The presence of water and forage in the river and lake catchments may have attracted game appropriate for hunting and encouraged Stone Age foragers to occupy places close to water sources.

Because hunted game was restricted to river or lake catchments, hunting was one of the best options for subsistence. The short term impact of this on hunting behaviour may have been the invention of projectile weapons that could have increased the possibility of attaining adequate supplies of meat. This would also compensate for the deficit arising from inadequate supplies of plant foods, especially fruits and nuts. Despite the limitation of palaeoenvironmental and archaeological information of Iringa, the present distribution of vegetation can be used to develop some predictions related to subsistence requirements and adaptability of the prehistoric people who lived in this area prior to the entry of farming communities.

Changes in subsistence patterns from hunting and gathering to plant and animal domestication were introduced by farming and smelting communities that entered the southern highlands during the Early Iron Age (EIA) (Msemwa 2004). New residents may have reduced the natural habitats of animal and plant food resources through overgrazing and clearing forests for agricultural activities,

building materials and fuel. In addition, they likely killed many wild animals for food, protection and trophies. During a field survey at Magubike we observed many modern traps in rock-shelters, aimed at catching dik-dik and rock hyrax. Killing animals and the clearance of land have resulted in negative feedback on the ecological patterns in particular affecting the modern distribution and availability of wild food resources. Nevertheless, the availability and distribution of modern wild food resources suggest that Iringa was sufficient enough to support prehistoric foraging communities and that hunting was one of the major subsistence activities.

### **5.3 The Geology of the Iringa Region**

The bedrock of the Iringa region is composed of Precambrian migmatites, granite and Konse group outcrops, formed during the late Archean and late Neoproterozoic eras (Harpum 1970; Harris 1981; Howell *et al.* 1962; Kröner *et al.* 2001; Muhongo *et al.* 2001). The Precambrian granite rocks represent reworked remnants of the Tanzania Craton Archean (Figure 5.3). The granite rock outcrops comprise a sedimentary assemblage of quartz, quartzite, metamorphic, low grade micaceous schists; that form many of these rock-shelters and overhangs (Harpum 1970). The rock-shelters and overhangs were exploited by MSA and LSA foragers, as well as by their descendants. The geological history in Iringa only includes the Precambrian and the Quaternary. It is not like in the Rift Valley, where a long history of volcanism and tectonic activity which resulted in the rich fossil and archaeological record of humans and their artefacts, which is seen



elsewhere in East Africa. But some of the rock-shelters could have offered refuge for thousands of years.

Much of the Quaternary geological and geomorphologic data about Iringa came from the ancient lake and exposed gully at Isimila (Cole and Kleindienst 1974; Hansen and Keller 1971; Howell *et al.* 1962). Isimila sediments are characterized by alluvial sands; these outcrops are mainly exposed in the northern branch of the Isimila Valley (Howell *et al.* 1962). Howell *et al.* (1962) divided the sedimentary deposits of the Isimila into five stratigraphic units, identified as sands 1, 2, 3, 4 and 5 (Table 5.1). Further studies have revealed that previous descriptions were influenced by the archaeological occurrences, rather than geological sequences (Cole and Kleindienst 1974; Hansen and Keller 1971). It was then concluded that the sedimentary deposits at Isimila are composed of two geological units: the Lisalamagasi and Lukingi Members (Cole and Kleindienst 1974; Hansen and Keller 1971). The Lisalamagasi Member sediments deposited in the upper levels, formerly defined as beds 1 and 2, are characterized by clays and sandy clays soil (Table 5.1). The Lukingi Member sediments (Sands 3, 4 and 5) are characterized by clays, sand clays and sandstones (Table 5.1). Sediments underlying the Lukingi Member represent the earliest deposits and are composed of paleosol, colluvial and claycrete deposits; these overlie the granite bedrock (Cole and Kleindienst 1974; Hansen and Keller 1971).

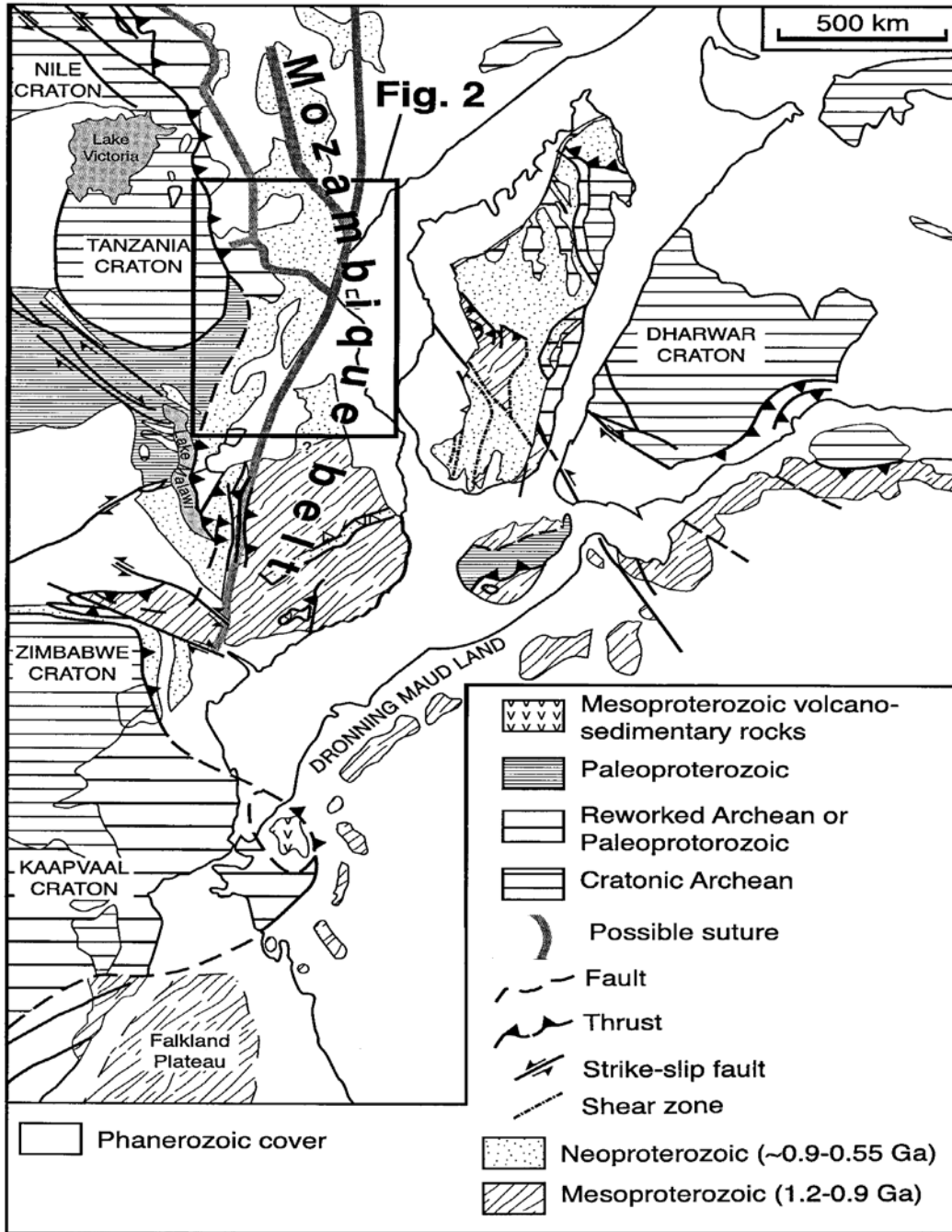


Figure 5.4. The geological sketch map of the eastern Africa indicating major sedimentary domains and the Mozambique belt (adapted from Muhongo *et al.* 2001).

Table 5.1. Summarized stratigraphic sequence for the Isimila Korongo (modified from Cole and Kleindienst 1974 and Howell *et al.* 1965).

| Geological Beds          |   | Type of sediments (Cole and Kleindienst 1974) | Original Units (Howell <i>et al.</i> 1965) |
|--------------------------|---|---|--|
| Isimila Formation        | Lisilamagasi Member                               | Colluvium: clay and sandy clay                | Sands 1: Clay, sandy clay and stone        |
|                          |   |   | Sands 2: Clay and sand clay                |
|                          | Lukingi Member                                    | Colluvium: clay, sandy clay and sandstone     | Sands 3                                    |
|                          |   |   | Sands 4                                    |
| Sands 5                  |   |   |  |
| Bedrock: Usagaran System | Paleosol, colluvium, claycrete, weathered bedrock |   |  |
|                          | Granite or granodiorite schists                   |   |  |

Table 5.2. Geographical location of archaeological sites and their cultural affinities (IA Iron Age, ESA Early Stone Age, MSA Middle Stone Age, LSA Later Stone Age).

| Site  | SASES    | Location               | Culture   | Lithic      | Fauna     | Pottery    | Iron       |
|---|----------|------------------------|-----------|-------------|-----------|------------|------------|
| Isimila                                       | HxJg-6   | 7°53'48"S & 35°36'12"E | ESA       | 3           | 0         | 0          | 0          |
| Isimila River                                 | HxJg-105 | 7°54'09"S & 35°35'46"E | ESA       | 166         | 0         | 0          | 0          |
| Mgongo  | HwJg-2   | 7°35'68"S & 53°42'88"E | ESA       | 5           | 3         | 0          | 0          |
| Kigwambimbi                                   | HxJg-103 | 7°47'65"S & 35°37'22"E | MSA       | 216         | 2         | 0          | 0          |
| Magubike                                      | HxJf-1   | 7°45'79"S & 35°28'39"E | MSA to IA | 251         | 0         | 2          | 7          |
| Mlambalasi                                    | HwJf-2   | 7°35'45"S & 35°30'14"E | MSA to IA | 1746        | 83        | 271        | 262        |
| Kessakilolo                                   | HwJf-100 | 7°43'41"S & 35°42'89"E | MSA to IA | 19          | 1         | 11         | 5          |
| Nyamihuu                                      | HxJf-3   | 7°40'51"S & 35°29'68"E | MSA to IA | 38          | 0         | 20         | 5          |
| Malunde                                       | HxJe-1   | 7°51'90"S & 35°06'54"E | LSA & IA  | 15          | 0         | 5          | 2          |
| Kikongoma                                     | HwJg-101 | 7°41'37"S & 35°35'24"E | LSA & IA  | 4           | 0         | 1          | 0          |
| Kibebe gully                                  | HxJg-104 | 7°50'03"S & 35°32'67"E | LSA       | 20          | 0         | 0          | 0          |
| Kalenga                                       | HwJg-101 | 7°45'22"S & 35°33'49"E | IA        | 1           | 0         | 45         | 2          |
| <b>Total number of archaeological remains</b> |          |                        |           | <b>2654</b> | <b>89</b> | <b>356</b> | <b>283</b> |

#### **5.4 The past environment of Iringa and surroundings**

Glynn Isaac (1986:237) has said that in order to understand past adaptations in ways that are more than just a reflection of ourselves, we must integrate knowledge of ecology and the understanding of alternative strategies for exploiting natural resources. Therefore, studying past ways of life requires researchers to recognize the importance of natural resources to human development and to understand the relationship between the physical environment and human behaviour. In the prehistoric world, technological development was correlated with and influenced by the environment in which humans existed. In this section, the past and present environments of the Iringa Region are correlated and integrated in order to improve our current understanding of human history.

This strategy explores a range of technological and subsistence options developed by prehistoric peoples and the ways in these options were influenced by the physical and cultural environments. Options and strategies may include variations in settlement, subsistence patterns, and in the technologies developed by our early ancestors in order to exploit different kinds of natural resources. To acquire these resources, prehistoric groups had developed the means of planned technology and foresight. The kinds and forms of technologies employed may also have been subjected to changes over time and space, depending on the physical and cultural transformation on the environment. This process may have influenced procedures for decision-making and adaptive strategies. Using such perspectives, it is obvious that the environmental stimulus interacted with and

influenced technological developments and behavioural changes of MSA and LSA foragers.

In the previous sections, I have explained that, in Iringa, information related to the Pleistocene environment comes mainly from the ancient lake and terrestrial sediments at Isimila. These sedimentary exposures suggest that the artefacts at Isimila were deposited at a time when the area was a swamp or pond, subjected to periodic inundations from a seasonal river (Cole and Kleindienst 1974). The coverage of swamp boundaries changed periodically. During the wet season, the entire valley was flooded, but the waters receded during the dry season, leaving behind a small swamp of standing water (Cole and Kleindienst 1974; Hansen and Keller 1971). Remains of root casts and alluvial deposits in the Lukingi Member suggest that during the Middle Pleistocene, most of Iringa consisted of woody vegetation. This means that the area had a higher precipitation than at present (Cole and Kleindienst 1974). Sedimentary deposits include colluvium sediments made up of clays, sandy clays and sandstones; these are associated with Acheulian artefacts and aquatic animal species such as hippopotamus (Cole and Kleindienst 1974:347). These sedimentary exposures were originally dated by uranium series to 270,000 years ago or between OIS 8 and 7 (Cole and Kleindienst 1974). The time range and the presence of wetland and woodland environments suggest that these sediments were accumulated during wet conditions.

The sediments of the Lisalamagasi Member were rapidly formed; almost 18 metres strata may have accumulated in few thousand years (Hansen and Keller

1971). These carbonized fine silt deposits were found associated with pollen of *mbuga* grasses and shrub woodlands, suggesting that they were deposited in a dry and arid environment characterized by short burst rainy seasons (Hansen and Keller 1971). Perhaps the Lisalamagasi Member at Isimila was deposited during the Last Interglacial Maximum (LIM), which was characterised by series of environmental fluctuations (Scholz *et al.* 2007). The Lisalamagasi Member has been estimated between 150,000 and 100,000 years ago (Hansen and Keller 1971). During that time period, most of tropical Africa experienced a prolonged series of droughts, brief periods of burst rainfall and expansion of grasslands (Scholz *et al.* 2007).

Evidence for the expansion of grassland vegetation comes from cores from Lakes Nyasa and Tanganyika, southwest of Iringa, dated to between 135,000 and 72,000 years ago (Scholz *et al.* 2007). By contrast, pollen records from the MSA occurrence at Kalambo Falls dated to between 86,000 and 65,000 years ago suggest that the Kalambo River was characterized *miombo* woodland, like today (Clark 2001). These variable records may suggest the existence of internal ecological variations from one place to another as is the case at present. Nevertheless, evidence related to the Pleistocene environment and associated cultures for the southern Tanzania remains limited. Additional evidence is needed to develop a meaningful conclusion.

Recent palaeoecological studies from Lake Massoko south of the Lake Rukwa basin suggest that in southern Tanzania, the transitional period from the MSA to LSA was characterized by a series of climatic oscillations. During OIS 3,

between 45,000 and 25,000 years ago, Lake Massoko was at its highest stages and the lake catchments were increased, covering most of the current lake basin (Garcin *et al.* 2006). Increased precipitation led to the expansion of the forests currently found on the lakeshore (Garcin *et al.* 2006). The situation was different during the Last Glacial Maximum (LGM) between 25,000 and 14,000 years ago, the period in which drought and aridity events were recorded in most of sub-Saharan Africa (Bonnefille and Chalieu 2000; Hamilton 1982). A series of drought and aridity events led to the decline of lake levels and reduced forests (Garcin *et al.* 2006).

Evidence from Lake Massoko was supported by pollen cores from the Mpugulu Basin, south of Lake Tanganyika, Udzungwa and Uluguru Mountains suggesting that tree densities of the *miombo* woodlands during the Last Glacial Maximum (LGM) were relatively less than today (Barut 1997; Finch *et al.* 2009; Vincens 1991). By contrast, fossil pollen records from the LSA assemblage at Kalambo Fall in Zambia dated to around 25,000 years ago, suggest that, at that time, *miombo* woodlands prevailed as they do today (Clark 2001; Livingstone 1971). This trend suggests both local ecological variations and continuity between the present and past environments.

The dominance of tropical woodland environments in the southern highlands may suggest that wild food resources observed during the field survey were more abundant during the Middle and Upper Pleistocene. The presence of woodland conditions may suggest that wild plant foods contributed significantly to supporting prehistoric foraging groups. Foraging groups probably developed

specific hunting strategies related to woodland ecological conditions, as was proposed by Hughes (1998). The Tip Cross Section Area (TCSA) value indicates that most MSA points at Magubike were used to make throwing spears (Chapter 8) suggesting that ecological conditions included much more woodlands and shrubs. However, additional evidence related to the landscape and natural resources is needed in order to reach a meaningful conclusion.

During the field survey, our main goal was to understand and explain ways in which prehistoric people exploited and used local and exotic resources, as well as the role of resources such as raw materials, drainage patterns, flora and fauna on technological development. To contribute to this, in 2008 we conducted an intensive archaeological field survey across the landscape of Iringa (Figure 5.1). We aimed to document the range of cultural and natural resources across the region and to increase our level of understanding of the relationships between physical and cultural objects left behind by our early ancestors. It was revealed from archaeological field surveys that Iringa is rich in archaeological resources and has much to contribute to our current knowledge of the origin and development of behavioural modernity.

## **5.5 The archaeological record of the Iringa region**

Present and previous research demonstrates that Iringa was been occupied by Stone Age people since the Acheulian, about 270,000 years ago to LSA (Biittner *et al.* 2007; Cole and Kleindienst 1974). The Acheulian assemblage date at Isimila is probably much too young; other sites dated long ago have been



redated as much older, for example, Olorgesailie in southern Kenya. New dates changed the Acheulian assemblage at Olorgesailie from 0.4-0.5 million years ago (Evernden and Curtis 1965) to 0.9 million years ago (Potts 1989). Understanding the chronological sequences and the ways in which prehistoric people adapted to and were sustained in Iringa is one of the objectives of this study. Moreover, the archaeological field survey was aimed at increasing our level of understanding and examining the technological ability and hunting behaviour developed by MSA and LSA foragers in this region.

To a great extent, our 2008 archaeological field survey was influenced by artefacts excavated from Magubike and Mlambalasi in 2006. Preliminary results from test excavations showed that LSA artefacts were mainly manufactured from local raw materials in particular, quartz and quartzite, while the MSA artefacts are made from a variety of rocks, including quartz, rock crystal, chert, quartzite and metamorphic rocks (Chapter 6). Indeed, at Magubike, it was noted that the MSA artefacts from test pit 1 were quite different from those in test pits 2 and 3 in terms of utilized lithic raw materials. In test pit 1, the raw materials are mainly characterized by white greyish chert, quartz, metamorphic and rock crystals. Test pits 2 and 3 consisted of metamorphic, quartzite, quartz, rock crystals and reddish, brown, whitish and greyish chert (Figure 6. 6 and 6.8). The presence of artefacts made on different types of chert and the existence of intra-assemblage variation in the MSA at Magubike raised questions that needed answers from field survey and further analysis. We needed to identify the source of chert and some metamorphic

raw materials and map out possible quarry sites from where these materials originated.

In addition, the field survey was aimed at examining the current distribution and availability of wild food and water resources described in the previous sections. These are needed in order to enlarge our understanding of the physical and cultural environment that supported early modern humans in Iringa. At Magubike, dense surface artefacts scatters covered a large area, including the main rockshelter, farmers' fields located on the slopes, as well as areas close to natural springs and upland areas north and northwest of the main rock-shelter. The spring channel faces the entrance to the rock-shelter and is located southeast of the main shelter. This small, natural spring may have served as the source of potable water during the MSA and LSA.

### **5.5.1 Archaeological field survey**

A field survey was conducted off and on for three months, from August to October 2008. As noted in previous sections, the survey aimed to identify sources of raw materials, to map out edible wild food resources and to document the spatial distribution of archaeological materials across the survey area. My focus was on the MSA and LSA occurrences, in order to reconstruct the distribution of sites across the landscape of Iringa. Initial field research strategies were developed based on topographic and geological maps. Topographic maps were obtained from the Department of Mapping and Survey in Dar es Salaam and geological maps were obtained from the Geological Survey of Tanzania in

Dodoma. However, these survey strategies were regulated in the field based on physical and cultural boundaries of the area. Some places were characterized by thick vegetation, tall grasses, and wetland environments. Under such circumstances, the survey was limited to accessible places such as eroded gullies, river banks and lands exposed through farming and other related activities. Other surveyed places included rock-shelters and overhangs, mainly located in hills, and along escarpments and highlands (Figure 5.3).

Surveyed areas were systematically and carefully examined and discovered sites were mapped out in grid systems, using a Global Positioning System (GPS) device. They were documented in survey forms and field notebooks, showing location designation such as latitude, longitude and altitude, along with information about site conditions and cultural designations. Documented sites were given names and designation numbers. Other documented variables included context, geomorphologic and environmental setting, and the size of surveyed area, quantity of artefacts, probable cultural affiliation, and future test excavation potential. Artefacts, ecofacts and features were observed, examined, documented and left in the field as they were found, rather than being collected immediately. A number of rock samples, as well as some artefacts, were collected from each survey area for further analysis.

Dense surface artefact scatters were given sampling units, photographed, marked and mapped out before collections. A GPS device and digital camera were used to obtain visual images and to document dense artefact scatters in each survey unit. These were then transferred to a computer database. The coverage

area for the survey varied directly, according to the logistic considerations. These included the density of artefacts, terrain and vegetation covers. Survey areas were selected on the basis of three major criteria: areas that represented different geomorphologic zones; areas that appeared to offer the best potential for the location of archaeological sites and raw material sources in relation to features such as rock outcrops, rock-shelters, river channels and elevated areas. Sometimes we were guided to places by local informants, Antiquities officers and District Cultural Officers. Once a particular area was selected for survey, it was recorded on the topographic and geological maps.

The survey strategies employed were those of systematic and random walkover. Strategies varied depending on the logistical considerations listed above. In places that offered excellent visibility, crew member were spaced at 3 to 5 metre intervals, this nevertheless varied according to the density of archaeological materials, terrain and vegetation cover. In heavily vegetated areas where systematic surface walkovers were difficult, surface surveys were limited to accessible areas, such as cleared land for farming, eroded gullies, river banks and trails. We identified and documented a number of new archaeological sites (Table 5.2) some of which are used in this study to describe the cultural chronology of and technological developments in Iringa, Tanzania.

### **5.5.2 Results from the archaeological survey**

As previously noted, during the field survey, the occurrences of artefacts throughout the survey area were observed, studied, and recorded in survey forms

and field notebooks. A few samples of artefacts and lithic raw materials were taken for detailed studies. However, we did not locate any quarry sites from which MSA people obtained the crypto-crystalline silica and metamorphic rocks used to manufacture the artefacts we recovered in 2006. They do not seem to be located in the surveyed area (Figure 5.1). Geologists from the Department of Geological Survey in Dodoma, Tanzania recommended Mbeya, located almost 300 km southwest of Iringa, as a possible source of some of these rock types. They proposed the Bukobanian outcrop exposed in Mbeya and Kigoma almost 500 km west of Iringa as possible sources of crystalline silica, chert and volcanic rocks. We went to Mbeya for, four days and collected rock samples from Chamoto Hill (IdIx-1), north of Igurusi village, and the Songwe River quarry site (idIu-19) located west of Njelenje village, for further analysis. Analysis of these rock samples is still in process (Biittner forthcoming).

Other ecological resources that may have attracted prehistoric people in Iringa were not fairly represented, probably because of human activity such as deforestation and farming. Scattered baobab trees were observed in the lowland plains alongside the highway, from Iringa town to Ruaha National Park. The only observed animals during the field survey were rock hyrax, but a wide variety of animal species are still found in protected areas such as the Ruaha National Park, located west of Iringa (Figure 5.1). However, permanent and ephemeral springs and river channels are abundant in many places. In some places, they are found in close proximity to archaeological sites. Generally, the geomorphologic patterns and wild food resources observed during the field survey suggest an even

distribution of environmental resources that supported MSA and LSA foragers (Figure 5.2).

A great deal of time was spent during the field survey to try to identify potential archaeological sites and the major cultural stage based on the quantity of artefacts distributed on the surface. For the Iringa region, these cultural stages include the Acheulian, FII (Sangoan), MSA, LSA and IA (Iron Age); these were identified using Mehlman's (1989) typological scheme. We identified one rock-shelter with rock paintings at Kessakilolo village, a few kilometres north of Iringa town. We also documented a number of localities of high density scatters of stone artefacts during our field survey. Cultural affinities from each archaeological site are summarized in Table 5.2. Most of the dense surface scatters of stone artefacts, pottery, and iron remains were found in open air sites, but in some places they were located in rock-shelters and areas surrounding rock-shelters or natural springs.

One of the areas surrounded by dense surface scatters of archaeological artefacts was Magubike Hill, the place in which the main Magubike rock-shelter is located. On Magubike Hill there are dense surface scatters of archaeological artefacts inside and outside of a large rock-shelter. Dense surface scatters were located north and northwest of the main rock-shelter and on the moderate slope, or farmer's field located southeast, facing the entrance of the main site. For instance, the upland area that extends northwest from Magubike to Kitwilu contains a surface record of lithics, pottery, as well as iron slag, tuyeres and furnaces. A huge Early Iron Age (EIA) smelting site (HxJf-11), comprised of a

dense surface scatter of iron remains (tuyeres, furnaces, slag and pottery), was documented at Kitwilu northwest of Magubike. Five other rock-shelters with archaeological remains were also documented in the area that surrounds Magubike Hill.

Another strategic area with dense artefact scatter was the moderate slope in the tobacco farm located southeast of the main rock-shelter. Many MSA artefacts are distributed on the surface, there are dense surface scatters on the southeast slope that faces the natural spring and the entrance to the main rock-shelter. In 2008, we excavated four 1 m<sup>2</sup> test pits to determine the relationship between surface and subsurface materials. Sedimentary deposits and the composition of artefacts suggest that they eroded from the rock-shelter. Archaeological artefacts were found in mixed contexts; sometimes the LSA and Iron Age materials were found below the MSA artefacts. We then decided to excavate two more trenches. The first (1 x 2 m<sup>2</sup>) test pit was established close to the entrance of the main rock-shelter and it was composed of deep cultural sequences with Iron Age, LSA and MSA artefacts in a stratified sequence. The test pit was about 2.5 m deep and we realized that this area was a part of the Magubike site excavated in 2006. Another (1 x 2 m<sup>2</sup>) trench was established in a small rock-shelter located in the northern side of the hill (HxJf-5). This rock-shelter was inhabited during the Early Iron Age (EIA) period and it was composed of EIA artefacts. Basically, we didn't get much from any test pit here, except close to the main rock-shelter, which gives us another 2.5 m cultural sequence composed of Iron Age, LSA and MSA deposits.

Another potential site was located at Kigwambimbi (7°47'S; 35°37'E) almost 3 kilometres from Kalenga (Table 5.2). Kigwambimbi (HxJg-103) is an open-air MSA site located close to the ephemeral river channel. Exposed alluvial sediments were found associated with dense artefacts scatters composed of cores, core scrapers, scrapers utilized flakes, flakes, flake fragments and points. On the basis of Mehlman's (1989) typological scheme, lithic artefacts from Kigwambimbi seem like Sangoan ones. Therefore, Kigwambimbi may span the transition stage between late Acheulian, documented at Isimila and the MSA at Magubike. Many of the artefacts at Kigwambimbi are made of quartz materials, possibly obtained at Igongwa Hill, located almost one kilometre east of Kigwambimbi. Although this site was not excavated, the cultural materials indicate that it could be a significant site that links Isimila and Magubike. Kigwambimbi evidence can, however, be useful in investigating the technological and behavioural shifts from the ESA to MSA. Another site representing a transitional stage from ESA to MSA is Isimila 2 (HxJg-6), located (7°53'S; 35°36'E), close to the major southern highway. It is comprised of the small quartz and chert artefacts as well as hand axes and cleavers. Unfortunately, materials collected in 2008 are not part of this study, due to time and financial constraints.

Results from the field survey and test excavations showed that Iringa is one of several regions in East Africa that may contribute significantly to the discussion of the emergence and development of modern human behaviour and technology. At Magubike, the MSA deposit also contained seven isolated teeth of an early modern human.



For a long time, Iringa was not an attractive area for most archaeologists. It is not clear, however, why archaeologists were less interested in working in Iringa. Stone Age researchers working in Tanzania are more interested in the northern part of the country where most of the known archaeological sites are located. These include Laetoli, Olduvai, sites in the Lake Eyasi basin, Mumba, Nasera, as well as sites near Late Natron and Loiyangalani (Barut 1994, Bower 1985, 2005; Dominguez-Rodrigo *et al.* 2007, 2008; Mabulla 1996; Manega 1993; Mehlman 1989, 1991; Prendergast *et al.* 2007). These sites contain datable volcanic and other sediments, as well as organic remains (Manega 1993). Like the northern sites, the Iringa sites do contain preserved organic materials, but they are found outside of the Rift valley.

There is an increasing need for broad, multidisciplinary studies linking Isimila, Kigwambimbi, Magubike and Mlambalasi. Artefacts from these sites represent the Acheulian, Sangoan (FII), MSA, LSA and IA cultures. A detailed and correlated study of these sites may assist in our understanding of the patterns of technological and behavioural changes that made early humans become modern during the MSA. The accumulated evidence could be correlated with data from previous research at Kalambo Falls, which is located close to the border between Tanzania and Zambia. Kalambo and Iringa are located in similar ecological systems in the southern highlands or the Zambezian floral region. Research results from the two areas could enlarge our current knowledge about the relationship between the physical environment and culture, and the way it has changed over time. The archaeological assemblage at Kalambo Falls consists of

Acheulian, early MSA (FII), MSA LSA and Iron Age (Clark 2001; Sheppard and Kleindienst 1996). I believe that integrated studies of closely related ecological zones could enable scientists to better understand the essential features that influenced behavioural and technological changes during the MSA.

## **5.6 Previous archaeological records in Iringa and surrounding regions**

As previously noted, the cultural history of Iringa was developed primarily using the Acheulian site of Isimila (Cole and Kleindienst 1974; Hansen and Keller 1971; Howell *et al.* 1962). Isimila is an open-air site located about 35°36'12E; 7°53'48"S, at an elevation of 1630 m above sea level (Howell *et al.* 1962). The history of archaeological research at Isimila can be traced back to 1927, when D. N. Grantham, a geologist from the Department of Geological Survey and Photography, Tanganyika, discovered it. Isimila site was published in 1933 as an example of erosion action in the Tanganyika territory (Howell *et al.* 1962). Intensive survey and excavations at Isimila were carried out by F. C. Howell and his colleagues from late the 1950s to the 1970s. The archaeological occurrences at Isimila were placed into the Acheulian, and were dated using uranium series (U-series) to 270,000 years ago (Cole and Kleindienst 1974).

The sedimentary deposits suggest that archaeological remains were deposited on the lakeshore, which gradually became a swamp, and finally filled up with alluvial sand during the Middle to Late Pleistocene (Cole and Kleindienst 1974; Hansen and Keller 1971; Howell *et al.* 1962). Acheulian assemblages at Isimila were probably deposited during the second half of the Middle Pleistocene,

a period in which woodland vegetation predominated (Cole and Kleindienst 1974). Another Acheulian occurrence was discovered by Japanese scientists at Mgongo, north of Iringa town, on the road to Dodoma (Giichi 1988). With the exception of a few Iron Age investigations (Msemwa 2004), there has been no other intensive archaeological research in Iringa since the 1980s. It was in 2005 when Willoughby, with assistance from the District Cultural Officer for Iringa Rural (*Iringa Vijijini*) Joyce Nachilima, visited and documented a few potential Stone Age archaeological sites in Iringa, including Magubike and Mlambalasi. Test excavations were carried out at both sites during the summer of 2006, and it was immediately clear that the archaeological record of Iringa was not limited to the Acheulian and Iron Age; it also includes the MSA and LSA (Biittner *et al.* 2007).

It is likely that the archaeological and ecological conditions of Iringa and Kalambo Falls are closely related. Kalambo Falls is located at 18°30'S; 31°15'E', south of Lake Tanganyika in Zambia. This site consists of Acheulian, MSA, LSA and Iron Age artefacts in stratified sequences (Clark 2001; Sheppard and Kleindienst 1996). The only difference between the archaeology of Iringa and that of Kalambo Falls is that at Kalambo, the cultural sequences were located at one locality. This is in contrast to Iringa, where a similar cultural sequence was located in different localities such as Isimila, Kigwambimbi, Magubike and Mlambalasi. However, these sites are located in closely related ecological and geomorphologic situations.

Kalambo Falls was discovered in 1953 by a team led by Desmond Clark; his team conducted field research from the mid 1950s to the 1960s. They identified numerous stratified archaeological occurrences belonging to the Acheulian, MSA, LSA and more recent assemblages (Clark 1964, 1969, 1974, 2001; Sheppard and Kleindienst 1996; Willoughby 2007). Archaeological occurrences at Kalambo Falls occur in alluvial and colluvial contexts like those observed at Isimila. Artefact edge wear patterns at Kalambo Falls show that they were relatively affected by post depositional processes (Sheppard and Kleindienst 1996). Fluvial action resulted in abrasion of artefact edges as artefacts were moved (Sheppard and Kleindienst 1996). Geomorphologic processes at Kalambo indicate that large artefacts are concentrated in sandy deposits (Sheppard and Kleindienst 1996). It seems that large artefacts were exposed for longer periods of time than the smaller ones. This process may have caused large pieces to be relatively high weathered compared to the small ones. However, Kalambo Falls artefacts suffered relatively little disturbance (Sheppard and Kleindienst 1996).

The Sangoan is referred to as the Chipeta Industry at Kalambo Falls (Clark 2001). It was recovered from fine to coarse sand and gravel deposits associated with extinct river streams or channels, while the MSA assemblages were found in gravel (Sheppard and Kleindienst 1996). The Sangoan artefacts contain foliates or leaf-shaped pieces, large bifacial points, core scrapers, and other heavy-duty tools, such as choppers and hand axes. The lithic artefacts were made of quartzite, chert, quartz, and chalcedony (Clark 2001). Amino acid racemization dating of wood from the underlying Acheulian layer shows that at Kalambo Falls, the Sangoan

dates to between 110,000 and 190,000 years ago (Clark 2001:246). A uranium-series on wood associated with the upper layer of Sangoan assemblage dates to between 65,000 and 86,000 years ago (Clark 2001:246). Based on tool types, forms and measurements it seems that there was a continuity between the late Acheulian and Sangoan assemblages at Kalambo Falls. Both Acheulian and Sangoan artefacts share some technological similarities in terms of core preparation and the wide distribution of core scrapers (Clark 2001; Willoughby 2007).

In Iringa, artefacts believed to represent a possible Sangoan occur in the alluvial deposits at Kigwambimbi. Thus far no detailed archaeological, geomorphologic or palaeoecological studies have been undertaken at Kigwambimbi, because the site was only recently discovered. However, at Kalambo Falls, similar assemblages have been found associated with the fossil pollen of *miombo* wood. Along with evidence from alluvial sediments, this suggests that during this period Kalambo Falls was characterized by a waterlogged environment, possibly wetter than today (Taylor *et al.* 2001:73). The sedimentary deposits were found associated with burned logs and fruits of trees dated to between OIS 5 and 4 (Robbins *et al.* 2000; Taylor *et al.* 2001:74).

At Kalambo Falls, the Sangoan assemblage is overlain by a MSA deposit, the Siszya Industry, which is characterized by increased numbers of Levallois flakes and other retouched flaked tools; such as small scrapers, proto-burins, becs and points (Clark 2001:89). The Levallois technique allowed for the efficient production of standardised preformed blanks suitable for the production of hafted

tools (Sheppard and Kleindienst 1996). The use of hafted tools is considered, then, to form the major technological difference between the ESA and MSA (Clark 1988, 1993). Remains of archaic *Homo sapiens* or *Homo heidelbergensis* have been found associated with the MSA at Kabwe or Broken Hill located south of Kalambo Falls (Braüer 1992; Willoughby 2007). These have been estimated to be around 400,000 years old (Braüer 1992). At Kalambo, the MSA is overlain by the LSA or Kaposwa Industry. According to Taylor *et al.* (2001), LSA assemblages were deposited during the LGM in OIS 2, the period in which climatic conditions in the southern highlands were relatively cold and dry.

In southern Tanzania, MSA and LSA assemblages have been reported from open air and rock-shelter sites along the Songwe River within the Lake Rukwa basin of Mbeya Region (Willoughby 1996a, 1996b, 2001, 2007). MSA assemblages were mainly surface materials collected along river terraces. Retouched tools include scrapers, bifacially worked pieces, unifacial and bifacial points, burins, becs, and heavy duty tools such as choppers, core scrapers, bifacial flakes and discoids. These were made of local raw materials, specifically quartz, quartzite, crypto-crystalline silica and volcanic rocks (Willoughby 1996a, 1996b; 2007; Willoughby *et al.* 2002). Test excavations revealed LSA assemblages along the river terraces were stratified above the MSA in terraces that are located on top of ancient lacustrine deposits. MSA localities have also been found in terraces of a second Songwe River which flows into Lake Nyasa (McBrearty *et al.* 1982 and 1984).

More MSA sites in the south have been reported from Kilwa and Tendaguru along the Indian Ocean coast (Chami and Chami 2001; Clark 1988; Karoma, personal communication 2006). Smolla first reported an MSA assemblage at Tendaguru in 1962 (Clark 1988). In this area, the MSA assemblage is located at a well-known dinosaur site in the Indian coastal zone, about 64 km northwest of Lindi town. The characteristics of the MSA include circular scrapers, side scrapers, side and end scrapers, flakes, radial, and Levallois cores. Most artefacts are made from local sandstones and quartzite (Chami and Chami 2003). Data from Tendaguru are, however, insufficient for establishing the industrial tradition or technological affinities, and more detailed studies should therefore be undertaken at both sites in order to reach a meaningful description.

In general, information related to the evolution of modern humans during the MSA in the southern highlands is poorly known. New discoveries at Magubike, Mlambalasi and future research at Kigwambimbi may contribute significantly to improving our level of understanding about prehistoric adaptation strategies and subsistence patterns. In addition, the uses of points and food acquisition strategies have not been given significant attention in previous studies. Previous studies, including the one undertaken at Kalambo Falls were focused on typological classification and description of industrial variation (Clark 1964, 1969, 1974, 2001). Studies of points may expand our knowledge of human technology in the past, as well as ways in which our prehistoric ancestors used to accumulate their food resources.

## 5.7 Summary

This chapter has described the geology, geomorphology, environment and the state of archaeological studies in Iringa and southern Tanzania in general. The physical environment variables interacted to influence past human technological organization, food acquisition strategies and adaptation over the Iringa landscape. This chapter has also examined the ecological and drainage system that could have influenced human settlement and the development of projectile technologies. Available palaeoenvironmental evidence suggests that Iringa, like other parts of the southern highlands, may have been dominated by tropical woodlands during most of the Middle and Upper Pleistocene. A prolonged series of droughts remarkably reduced the number of trees during the Last Interglacial Maximum (LIM) (Scholz *et al.* 2007). However, the vegetation cover varied significantly from one place to another, depending on altitude and annual precipitation. *Miombo* woodlands were most abundant in elevated areas, while the lowlands and wetlands in the river basins were dominated by thick grasses. According to Hughes (1997), these kinds of environments have limited visibility and humans hunted at short distances, using thrusting or throwing spears.

Archaeological data presented in this chapter suggest that the MSA and LSA occurrences in Iringa region and other parts of southern Tanzania are poorly understood. This study, and the ongoing archaeological project in Iringa region, can provide a base from which to build testable models for the explanation of prehistoric adaptations in southern highlands. Other themes that need to be accessed include the technological organization, hunting behaviour, subsistence



and settlement patterns. The palaeoenvironmental evidence from the southern highlands, obtained from the Mount Udzungwe; Isimila and Kalambo Falls, as well as from cores from Lakes Massoko, Nyasa and Tanganyika (Clark 2001; Finch *et al.* 2009; Garcin *et al.* 2006; Scholz *et al.* 2007) suggest that environmental conditions in this region suffered less vegetation replacement in the past than other places of the sub-Saharan Africa. It is possible that Iringa is one of the places that offered refuges to humans in the past, when the climate was greatly unstable.

The presence of MSA and LSA sites close to water sources may suggest that prehistoric foragers needed places located in close vicinity to food and water resources. Inhabited places had to have sufficient supplies of wild plant food and water for human subsistence and grazing opportunities for hunted game. The long-term impact of such behavioural responses was the formation of dense sites such as those recorded at Magubike and Mlambalasi. Both are located close to the river springs flowing to the Great Ruaha River. In places such as Iringa, wild foodstuffs and water resources seem to have been abundant year round. Semi-permanent residential camps may have been established within the river catchments. This behavioural response is one of the essential features for prehistoric human adaptation and settlement strategies (Kelly 1988). It is likely that Iringa served as a refuge where people could remain even in harsh environmental conditions.

## CHAPTER 6: TEST EXCAVATIONS AT MLAMBALASI AND MAGUBIKE

### 6.1 Introduction

This chapter describes results from test excavations carried out at Mlambalasi and Magubike in 2006. It also assesses the representation of points and the ways in which they changed over time. In test pit 1, at Mlambalasi, many lithic artefacts were recovered, as well as LSA human skeletal remains, fragmentary bones and molluscs. Radiocarbon dates indicate that many of the lithic artefacts and all of the associated human remains belong to the LSA. The stratigraphic and cultural chronologies indicate that upper levels were composed of historic and Iron Age materials, followed in sequence by a microlithic LSA, the human remains, and then a macrolithic LSA. Stone artefacts are dominated by bipolar cores, backed and microlithic pieces, the basic characteristics of the LSA (Ambrose 2002; Mehlman 1989). An *Achatina* shell fragment obtained from between 65 and 70 cm below the surface, was radiocarbon dated to about 12,940  $\pm$  90 before present (BP) (TO-13417). Additional *Achatina* shell fragments, obtained between from 110 and 120 cm below the surface were radiocarbon dated to about 11,710  $\pm$  90 BP (TO-13418) (Table 6.1).

In test pit 1, cultural sequences were found, composed of Iron Age in the top 50 cm, LSA from 50 to 70 cm, mixed LSA and MSA from 70 to 110 cm and MSA from 110 cm to bedrock at 180 cm. Organic materials were only recovered from the top levels. In test pits 2 and 3 at Magubike, two cultural strata consisting

of Iron Age and MSA artefacts were revealed. The Iron Age sequence extends down to about 50 cm below the surface. The Iron Age artefacts include pottery, iron and slag, charcoal fragments, faunal remains, molluscs, and microlithic tools. An *Achatina* shell fragment obtained between 20 and 30 cm below the surface was radiocarbon dated to about  $2,990 \pm 60$  BP (TO-13422) (Table 6.1). In test pit 3, the MSA artefacts started to appear around 50 cm below the surface and extended down to 210 cm, where bedrock was observed. The MSA artefacts were associated with seven fossilized human teeth, molluscs and fragmentary fossil fauna. An *Achatina* shell fragment from between 130 and 140 cm below the surface was radiocarbon dated to  $41,790 \pm 690$  BP (TO-13423). Preliminary electron spin resonance (ESR) dating in *Achatina* shell indicate that the MSA cultural sequence dates between 230,000 and 150,000 BP (Anne Skinner, personal communication 2010), well beyond the effective limit of radiocarbon dating. No LSA deposits have been recovered from test pits 2 and 3 at Magubike.

In order to develop a broad understanding of the cultural sequences, lithic artefacts from all three test pits excavated inside the rock-shelter at Magubike were combined together, based on their cultural affinities, tool types and chronological order. These data are compared to those from Mumba and Nasera, where massive and deep excavations were carried out for the most of the shelter's surface. Artefacts from Mumba and Nasera were arranged in chronological order, industrial traditions and cultural affinities (Mehlman 1989).

## **6.2 Excavations methods and procedures**

At both Mlambalasi and Magubike, test excavations were carried out using arbitrary levels, or spits of 5 or 10 cm. Trowels and brushes were used in excavation, except where we encountered dense faunal, human remains or datable materials. Dental picks or soft brushes were then used instead of trowels. Each excavation trench and level was assigned its own numbers such as test pit 1, level 1 (0 - 10 cm). All collections were bagged according to their levels and trench numbers. There was careful examination of sample condition, context, and associated materials before collecting all artefacts and ecofacts. Changes in tool types and cultural sequences were observed and noted as excavation proceeded.

Stratigraphy, artefacts, features and additional contextual information were recorded on sketch maps, scale plans, profiles, excavation forms, field notebooks and photographs. Munsell colours were recorded for sediments and arbitrary levels. Charcoal was collected wherever possible for dating purposes. With exception of test pit 1 at Mlambalasi, all other excavation units were taken down to sterile level, usually bedrock. Test pit 1 at Mlambalasi ended at about 120 cm below the surface due to the presence of numerous rock boulders.

## **6.3 Mlambalasi rock-shelter (HwJf-02)**

Mlambalasi (7°35.458'S; 35°30.142'E), is a rock-shelter located at an elevation of about 1029 m. It is located almost 50 km west of Iringa town, on the road to Ruaha National Park. Mlambalasi is the burial place of Chief Mkwawa (1855-1898), a former leader of the Wahehe or Hehe people, who strongly

resisted German colonization in the 19<sup>th</sup> century. Rather than surrendering, he fled from his capital of Kalenga to Mlambalasi. Eventually, Chief Mkwawa shot himself rather than being captured, and his head was cut off and eventually ended up at the Bremen Anthropological Museum in Germany (Biittner *et al.* 2007). His skull was returned to his family in Tanzania in 1954, and now rests in the Chief Mkwawa Memorial Museum in Kalenga. The Mlambalasi rock-shelter is located on the hill above the burial site under two large overhangs that separate the chambers. The surface of both chambers (which we labelled rooms 1 and 2) are littered with Iron Age (IA) and/or historical materials such as pottery, iron, slag, grindstones and stone artefacts.

Two excavation units of 1 m<sup>2</sup> were test excavated at Mlambalasi. Test pit 1 was established inside the rock-shelter in room 1. Test pit 2 was excavated on a slope just outside the rock-shelter northeast of test pit 1. Test pit 2 was located on the hill slope, and surface runoff associated with rainwater affected the depositional processes. It was excavated to a depth of 160 cm below the surface where bedrock was observed. Excavation of this pit was also made difficult due to the numerous underlying rock boulders. The stratigraphy was not apparent and the cultural sequence appeared in mixed contexts, indicating that it was disturbed by post-deposition processes. Moreover, dated samples from excavation unit 2 provided contradictory results, suggesting that they were collected from secondary deposits (Table 6.1). Therefore, artefacts from test pit 2 at Mlambalasi were excluded from further analysis in this study.

### **6.3.1 The stratigraphy, dating and the cultural chronology at Mlambalasi**

In test pit 1, a stratigraphic profile was drawn on the western wall (Figure 6.1). Sedimentary deposits in the upper levels (1-5) between 0 and 40 cm were composed of dark brown silt sands associated with pottery, beads, slag and microlithic artefacts (Figure 6.1). However, between 10 and 15 cm (level 3), there was a narrow consolidated course of grained greyish-white sands and ash indicating the application of fire. Sedimentary deposits associated with the Iron Age artefacts ceased at about 45 cm below the surface; below that, sediments were characterized by pale orange silt sand and were associated with LSA artefacts, molluscs and bones (Figure 6.1). Fragmentary human remains were abundant in level 8, between 65 and 100 cm below the surface (Figure 6.1). In level 8, sedimentary deposits became more consolidated and were composed of pale orange silt sands and gravels. Human remains were found associated with very few artefacts or faunal remains. Preliminary results suggest human remains, most likely representing a single adult, but there are also some fragmentary remains belonging to an infant (Biittner *et al.* 2007; Sawchuk 2008).

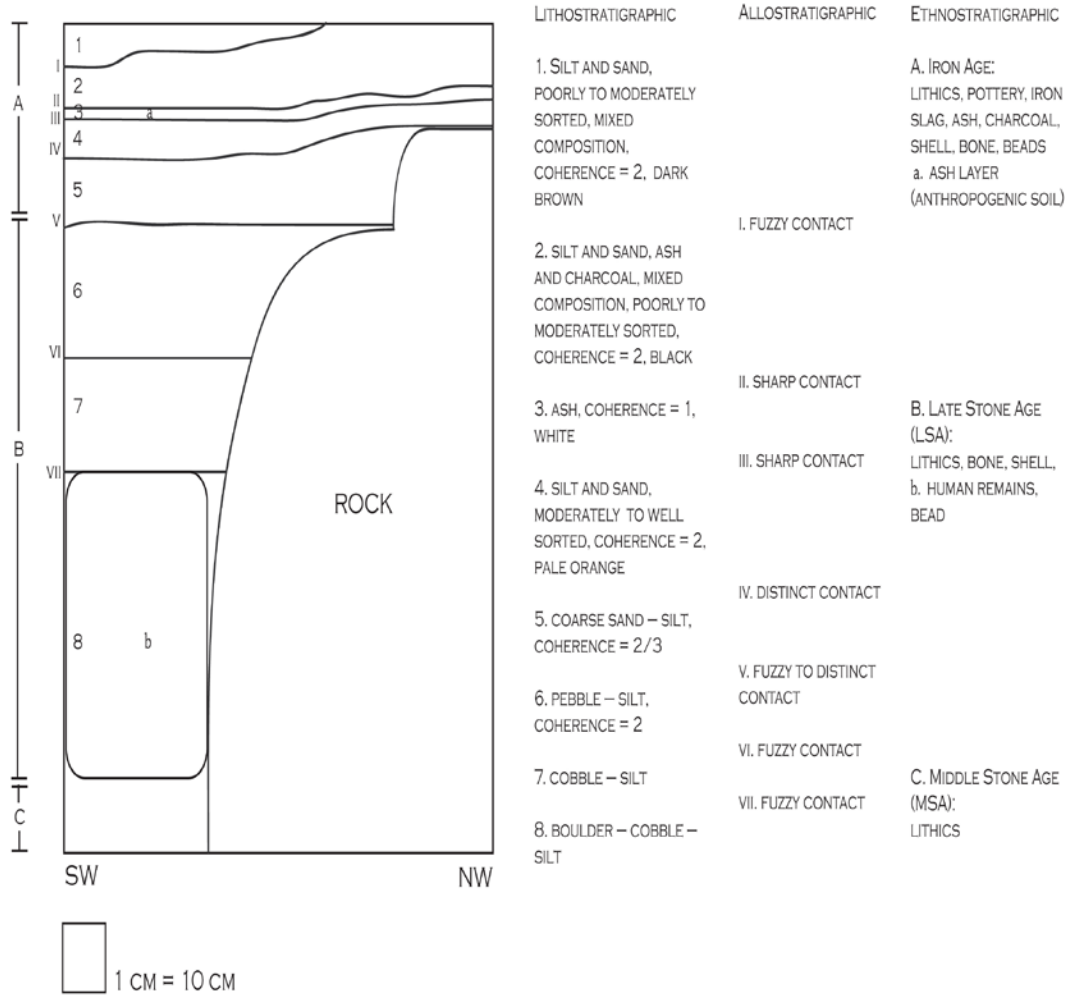


Figure 6.1. Stratigraphic and cultural chronologies at Mlambalasi (drawn by Biittner).

The number and density of artefacts increased remarkably at around 110 cm below the surface. Below this, a change in soil colour and texture was noted; the soil became more consolidated and characterized by silt sands, stone pebbles and rock boulders. Stone artefacts appeared to be larger than earlier in the sequence. Below 120 cm, enormous rock fall prevented any further work, so excavation ceased at this point. Artefacts collected from below 110 cm may represent the start of a different cultural sequence, either a Pleistocene LSA or a Second Intermediate Industry (Figures 6.2 and 6.3). However, more excavations and detailed studies are needed before making any meaningful conclusion.

Datable samples, including *Achatina* shell fragments, were sent to the Isotrace Radiocarbon Laboratory at the University of Toronto. *Achatina* shell sample obtained from the Iron Age (IA) sequence about 25 cm below the surface in test pit 1, was radiocarbon dated to  $460 \pm 50$  BP (TO-13416) (Table 6.1). This represents a late Iron Age or historical sequence. *Achatina* shell fragments obtained from LSA horizon between 65 and 70 cm, just above the human remains gave a radiocarbon date of  $12,940 \pm 90$  BP and calibrated to about 13,490 BC (TO-13417). More *Achatina* shell samples obtained from between 110 and 120 cm below the surface provided a radiocarbon date of  $11,710 \pm 90$  BP and calibrated to about 11,745 BC (TO-13418). Calibrated dates placed the LSA assemblage and human burial at Mlambalasi in the late Pleistocene between 13,490 and 11,745 BC (Table 6.1). The lithic artefacts sample obtained 110 cm below the surface, was not large enough to provide a comprehensive statistical analysis, and so was not included here.



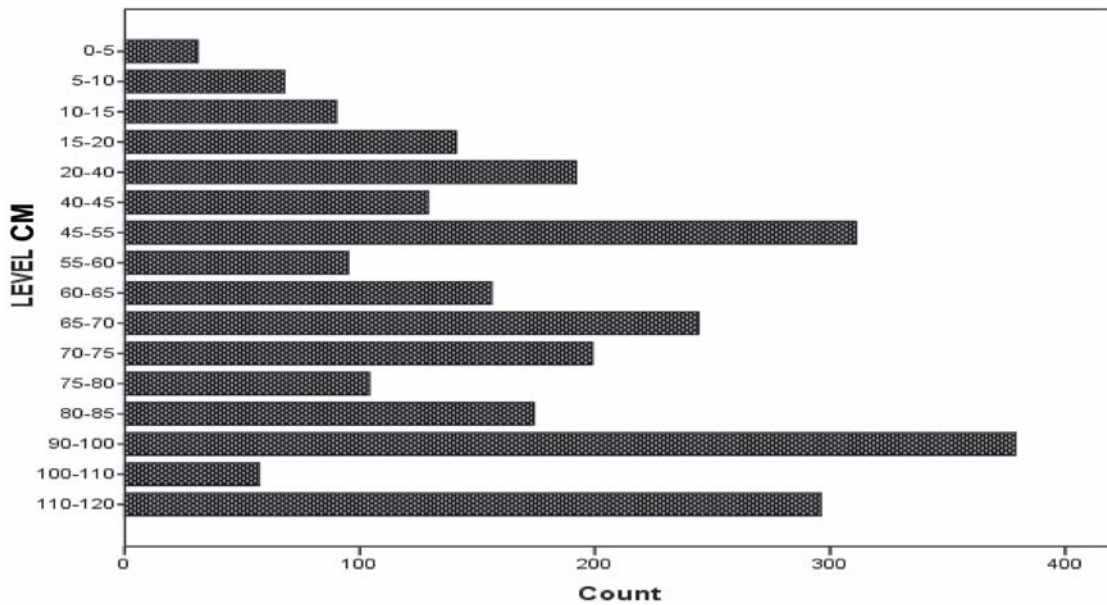


Figure 6.2. The distribution of lithic artefacts per level in test pit 1 at Mlambalasi.

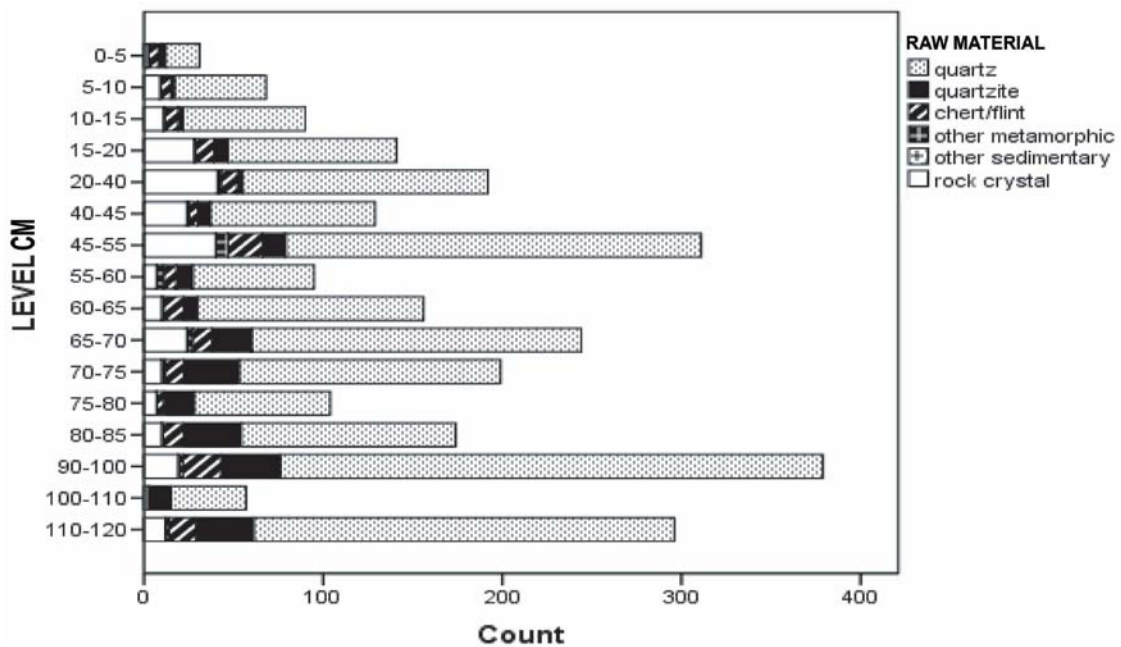


Figure 6.3. The presentation of lithic raw material types per level in test pit 1 at Mlambalasi.

Table 6.1. Uncalibrated and calibrated dates, as well as cultural chronology at Mlambalasi (HwJf-02) and Magubike (HwJf-01), in each test pit (TP).

| Site                       | Depth cm  | Sample                | Weight (g) | Lab. number | Uncalibrated date (BP) | Calibrated date ranges |
|----------------------------|-----------|-----------------------|------------|-------------|------------------------|------------------------|
| HwJf-2 TP 1; Iron Age      | 25        | Charcoal              | 424        | TO -13416   | 460 ± 50               | 1,420 – 1,450 AD       |
| HwJf-2 TP 1; LSA           | 65 – 70   | <i>Achatina</i> shell | 655        | TO - 13417  | 12,940 ± 90            | 13,490 – 13,160 BC     |
| HwJf-2 TP 1; LSA           | 110 – 120 | <i>Achatina</i> shell | 578        | TO 13418    | 11,710 ± 90            | 11,745 – 11,480 BC     |
| HwJf-2 TP 2; mixed deposit | 20 – 30   | <i>Achatina</i> shell | 607        | TO-13419    | 1,860 ± 60             | 75 – 235 AD            |
| HwJf-2 TP 2; mixed deposit | 110 – 120 | <i>Achatina</i> shell | 540        | TO-13420    | 3,050 ± 60             | 1,4405 – 1,260 BC      |
| HwJf-2 TP 2; mixed deposit | 150 – 150 | <i>Achatina</i> shell | 884        | TO-13421    | 6,090 ± 70             | 5,070 – 4,930 BC       |
| HxJf-1 TP 3; Iron Age      | 20 – 30   | <i>Achatina</i> shell | 505        | TO-13422    | 2,990 ± 60             | 1,315 – 1,125 BC       |
| HxJf-1 TP 3; MSA           | 130 – 140 | <i>Achatina</i> shell | 782        | TO-13423    | 41,790± 690            | —                      |

Table 6.2. The distribution of number of artefacts per level in test pit 1 at Mlambalasi.

| Culture          | Level cm | Frequency    | Percentage  |
|------------------|----------|--------------|-------------|
| Iron Age         | 0 - 5    | 31           | 1.2         |
|                  | 5 – 10   | 68           | 2.6         |
|                  | 10 – 15  | 90           | 3.4         |
|                  | 15 – 20  | 141          | 5.3         |
|                  | 20 – 40  | 192          | 7.2         |
|                  | 40 – 45  | 129          | 4.8         |
| <b>Sub total</b> |          | <b>651</b>   | <b>24.5</b> |
| LSA              | 45 – 55  | 11           | 11.7        |
|                  | 55 – 60  | 95           | 3.6         |
|                  | 60 – 65  | 156          | 5.9         |
|                  | 65 – 70  | 244          | 9.2         |
|                  | 70 – 75  | 199          | 7.5         |
|                  | 75 – 80  | 104          | 3.9         |
|                  | 80 – 85  | 174          | 6.5         |
|                  | 85 – 100 | 379          | 14.2        |
|                  | 100-110  | 57           | 2.1         |
| 110 – 120        | 296      | 11.1         |             |
| <b>Sub total</b> |          | <b>2015</b>  | <b>75.5</b> |
| <b>Total</b>     |          | <b>2,666</b> | <b>100</b>  |

Table 6.3. The distribution of lithic artefacts from excavation test pit 1 at Mlambalasi.

| <b>Tool Type</b>                                      | <b>Subtypes</b>            | <b>Number</b> | <b>Percentage</b> |
|---|----------------------------|---------------|-------------------|
| Shaped tools  | Backed pieces              | 1,405         | 81.6              |
|   | Scrapers                   | 188           | 10.9              |
|   | Bifacially modified pieces | 56            | 3.2               |
|   | Burins                     | 31            | 1.8               |
|   | Points                     | 19            | 1.1               |
|   | Becs                       | 10            | 0.6               |
|   | <i>Outils écaillés</i>     | 7             | 0.4               |
|   | Composite tools            | 3             | 0.2               |
|   | Core scrapers              | 3             | 0.2               |
| Total number of shaped/retouched tools                |                            | 1,722         | 100               |
| Cores   | Bipolar                    | 330           | 77.8              |
|   | Patterned platform cores   | 54            | 12.7              |
|   | Peripheral cores           | 35            | 8.3               |
|   | Amorphous cores            | 3             | 0.7               |
|   | Intermediate cores         | 2             | 0.4               |
| Total number of cores                                 |                            | 424           | 100               |
| Whole flakes  | Flakes                     | 208           | 81.2              |
|   | Blades                     | 28            | 10.9              |
|   | Utilized flakes            | 17            | 6.6               |
|   | Levallois flake            | 3             | 1.2               |
| Total number of whole flakes                          |                            | 256           | 100               |
| Others artefacts                                      | Angular fragments          | 257           | 97.3              |
|   | Pestle rubber              | 2             | 0.8               |
|   | Ground stone               | 2             | 0.8               |
|   | Stone disc                 | 1             | 0.4               |
|   | Anvil stone                | 1             | 0.4               |
|   | Hammerstone                | 1             | 0.4               |
| Total number of angular fragments and other artefacts |                            | 264           | 100               |
| <b>Grand total</b>                                    |                            |               | <b>2,666</b>      |

### 6.3.2 The distribution of lithic artefacts at Mlambalasi

Test pit 1 yielded a total of 2,666 stone artefacts (Table 6.3). These stone artefacts were found associated with faunal remains including fragmented remains of mammals, birds, rodents and molluscs. Only a few animal bones from the LSA deposit could be identified to genus, species or size class. They included *Equus*, and *Syncerus caffer* (Collins 2009; Collins and Willoughby 2010). The Iron Age deposit is composed of both domesticated and wild species such as *Equus*, various bovids (*Bos taurus* and *Syncerus caffer*) and caprines (goat and *Capra hircus*) (Collins and Willoughby 2010). Sizes were analysed using Bunn's (1982) analytical scheme, and represent three categories: small, medium and large mammals (Collins 2009). This pattern may suggest that the people who lived at Mlambalasi during the LSA and Iron Age utilized diversified meat resources.

About five types of cores were recognized. The most common core type in all the excavated levels was bipolar cores, which forms 77.8% of the cores (Table 6.3). Bipolar technique involved the use of casual technology, which requires minimal preparation on stone cobbles. It represents a nodule-smashing technique or recycling of cores into flakes (Odell 2000). Platform cores (single, double and multiple platform cores) form 12.7% of the total cores, while peripherally modified cores (radial, disc and Levallois) form 8.3% of the core types (Table 6.3). The presence of patterned platform and peripherally cores, which involves a systematic edge modification on stone cobble to form a striking platform, indicates inherited and shared technological traits with LSA and MSA foragers.

In sub-Saharan Africa, patterned platform and peripherally modified core technologies were most abundant during the MSA (Mehlman 1989; McBrearty and Brooks 2000). Nonetheless, patterned platform cores are known for true blade or bladelet technology abundant in the MSA and LSA assemblages of sub-Saharan Africa. In addition, the ample representation of angular fragments and cores (Table 6.3) indicates that tool manufacturing was carried out within the shelter. Tools were made and some of them were used, maintained or discarded in the shelter. The presence of different core types including peripheral cores, suggests that technological change from the MSA to LSA was a gradual process.

### **6.3.3 The lithic raw materials at Mlambalasi**

Lithic raw materials were almost constantly distributed over time in test pit 1. Quartz remains the most dominant material throughout the shelter's sequences. But quartzite, chert and rock crystal are also present (Figure 6.3). Today, local vein-quartz and quartzite outcrops, are locally found in the Konse metacalcareous and Precambrian granite outcrops that characterize most of the landscape of Iringa (Harpum 1970). Quartz and quartzite outcrops are ubiquitous on the uplands and surrounding plains. These materials are brought to the surface through ongoing geomorphologic processes such as land denudation, weathering and erosion processes. Chert sources were not revealed within the survey area (Chapter 5); they may have been obtained from early archaeological sites such as Isimila or from stream channels or possibly imported. The abundance of quartz

and quartzite artefacts suggests a pattern of localized raw material procurement and use during the LSA.

#### **6.4 The Magubike rock-shelter (HxJf-01)**

Magubike (7°45'790"S; 35°28'399"E), is a rock-shelter located in the vicinity of a small hill, a few metres northwest of Magubike village. This small hill, at an elevation of about 1541 m above sea level, is one of a number of Precambrian granite rock outcrops that form numerous shelters and overhangs across the landscape of Iringa. The rock-shelter is oriented in a southwest direction facing a small permanent spring channel. Farming and soil erosion have exposed artefacts in fields surrounding the site. But excavations in the fall of October 2008 on the hill slope southeast of the shelter suggest that these artefacts eroded from rock-shelters after the introduction of agriculture and iron smelting sometime within the last 3,000 years ago.

##### **6.4.1 The Stratigraphy at Magubike**

The stratigraphic sequence was recorded from the southern and an eastern wall of test pits 2 and 3 (Figure 6.4). The upper levels down to 50 cm below the surface were composed of Iron Age materials, in particular pottery, slag, charcoal fragments, molluscs and microlithic artefacts. The Iron Age sedimentary deposits are composed of greyish and light greyish silt sands. The upper levels at Magubike are clearly a result of anthropogenic actions. Greyish and light greyish silt sands, as well as remains of charcoal in the Iron Age deposits, indicate the use

of fire. Fire was probably introduced by iron smelters or smiths who were processing metal in the site. At about 50 cm below the surface, there was a large rock fall extending eastwards and covering most of the surface of test pit 2 (Figure 6.4), except in the western side where another test pit of one square metre or test pit 3 was excavated. Around 50 cm below the surface, MSA artefacts started to appear.

The MSA horizon is about 1.6 m thick in test pit 3, and extends from 50 cm to 210 cm below the surface, where bedrock was observed (Figure 6.4). Sedimentary deposits with MSA materials in test pits 1 and 3 are similar. The artefacts are mixed with gravel and rubble that appears to have resulted from rock weathering. In test pit 3, seven isolated human teeth were found associated with MSA artefacts, *Achatina* shell fragments and fossil bones. Five human teeth came from 130 to 140 cm below the surface, while two of them came from 150 to 160 cm below the surface. As previously noted, initial ESR estimates place the deposits with the human teeth at between 230,000 and 150,000 years BP (Anne Skinner, personal communication 2010). The occurrence of weathered rock gravels (saprolites) and fallen rock boulders in the MSA assemblage indicates that it was deposited in unreliable climatic conditions characterized by alternating series of prolonged droughts and rain bursts that encouraged rock-falls and weathering processes. There is evidence of water percolating through the deposits, since many MSA artefacts are coated with cement.

In tropical Africa, rock falls as well as chemical and physical weathering are universal processes in the formation of lands and sediments (Buckle 1978).

Fallen rock boulders, like those found underneath test pits 2 and 3 at Magubike, may have resulted from climatic instability that characterized most of tropical Africa during the Last Interglacial Maximum (LIM), between 135,000 and 72,000 years ago (Scholz *et al.* 2007). Although the sedimentary deposits show some elements of alluvial fans, the orientation of the shelter does not suggest for the existence of an extinct stream channel or surface runoff inside the rock-shelter of Magubike.

#### **6.4.2 The cultural chronological sequence at Magubike**

Test pit 1 was excavated in a side chamber to the direction of the main shelter. It revealed a deep cultural sequence ranging from the Iron Age to the MSA. Iron Age artefacts extend from the top of the sequence down to 50 cm below the surface (Table 6.4). The Iron Age culture was mainly characterized by pottery, iron and microlithic artefacts. This was followed by LSA artefacts, which continue until about 70 cm below the surface. Then the number of artefacts drops markedly, and appears to be a mixture of LSA and MSA types (Figure 6.5). Archaeological deposits with many MSA artefacts start below 110 cm and go down to bedrock, which was reached about 180 cm below the surface.

The MSA sequence in test pit 1 was characterized by many stone artefacts, but organic materials were not preserved. Stone artefacts are dominated by local quartz and quartzite, as well as metamorphic rocks, white-greyish chert and crypto-crystalline silica (Figure 6.6). As previously noted, no possible quarry sites for chert have been identified within survey area. The LSA artefacts were



unevenly distributed in test pit 1 at Magubike, accounting for about 878 out of 6,575 stone artefacts excavated from the test pit and 4.6% out of the total 18,900 artefacts excavated at Magubike in 2006 (Table 6.4).

Test pit 2 was located in the main shelter a few metres from the entrance. Excavation stopped at 60 cm below the surface due to the presence of a large rock boulder. Instead, we added another 1 x 1 m<sup>2</sup> excavation (test pit 3) directly west of test pit 2, where there appeared to be no fallen rocks. As noted before, artefacts from test pits 1, 2 and 3 were combined together to provide a comprehensive meaning for human subsistence and technological development at Magubike (Table 6.4).

The cultural archaeological sequences of excavation units 1 and 3 suggest that Magubike was often occupied, abandoned and reoccupied in different phases of the Middle and Upper Pleistocene, as well as in the Holocene (Figures 6.5 and 6.6). About 18,900 stone artefacts were collected from the three test pits at Magubike. About 2,437 artefacts, comprising 12.9% of the total were from the Iron Age, 878 (4.6%) were from the LSA, 174 (0.9%) were from mixed contexts of the LSA and MSA and 15,411 (81.5%) were from the MSA (Table 6.4).

Microlithic artefacts in the Iron Age levels are dominated by small backed pieces, particularly the category of divers backed tools. The latter represent micro-burins and other miscellaneous backed items. Points are rare and bipolar cores predominate (Table 6.5). Other implements include grinding stones, pestle rubbers and lobed axes, as well as a stone disk with ground peripheries (Table 6.5). The spread of iron production to southern Tanzania appeared after the entry

of Bantu language speakers and/or Iron Age communities involved in iron smelting, ceramic manufacturing, farming and animal keeping (Msemwa 2004). The direct association of Iron Age materials and microlithic tools may suggest that at some point, iron smelters and hunting and gathering communities coexisted in Iringa. Alternatively, iron smelters and hunting communities may have traded among each other, exchanging iron tools for other needed commodities. It is also possible that Iron Age people continued to make the same small stone tools as their LSA predecessors. Since my focus is on the hunting behaviour among the MSA foragers, more attention was directed toward the MSA assemblage of Magubike that appears below 100 cm in test pit 1 and below 50 cm in test pits 2 and 3.

In test pit 1, the MSA occupation reached its highest peak between 130 and 150 cm below surface, but in test pit 3, the highest peak was between 170 and 190 cm below surface (Figures 6.5 and 6.7). The fossil fauna include *Achatina* shells and fragmented bones suggesting that the occupants of Magubike utilized a varied range of food resources including molluscs. Even though faunal remains were very fragmented, a few of them were identifiable. Fossil bones from the MSA sequence include *Equus* and *Syncerus caffer*, but most could only be assigned to size and meat bearing categories. When this is done, it appears that remains of large, medium and small sized animals are all present (Collins 2009).

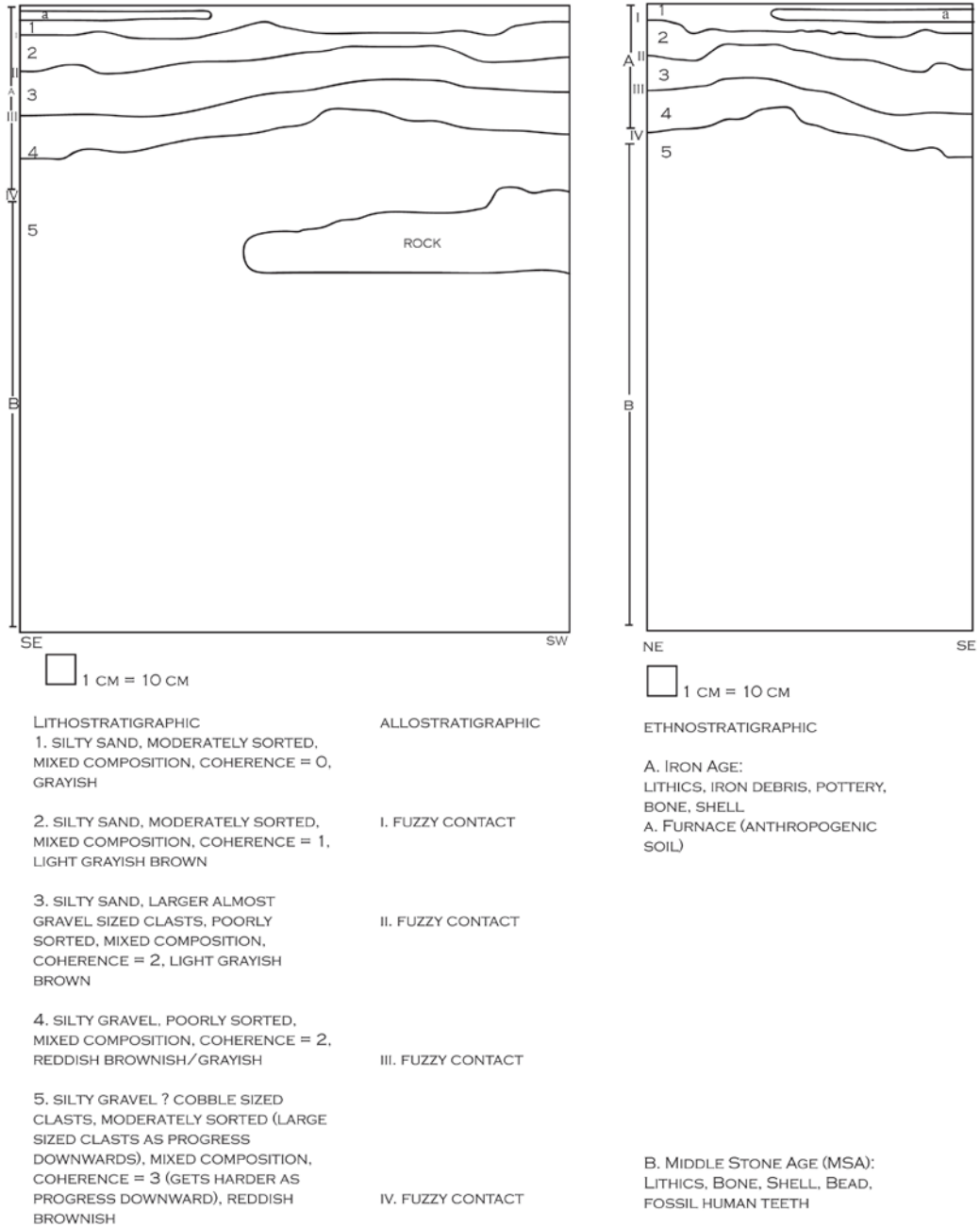


Figure 6.4. Stratigraphic and cultural chronologies at Magubike: excavation test pits 2 and 3 in the southern and eastern walls (drawn by Katie Biittner).

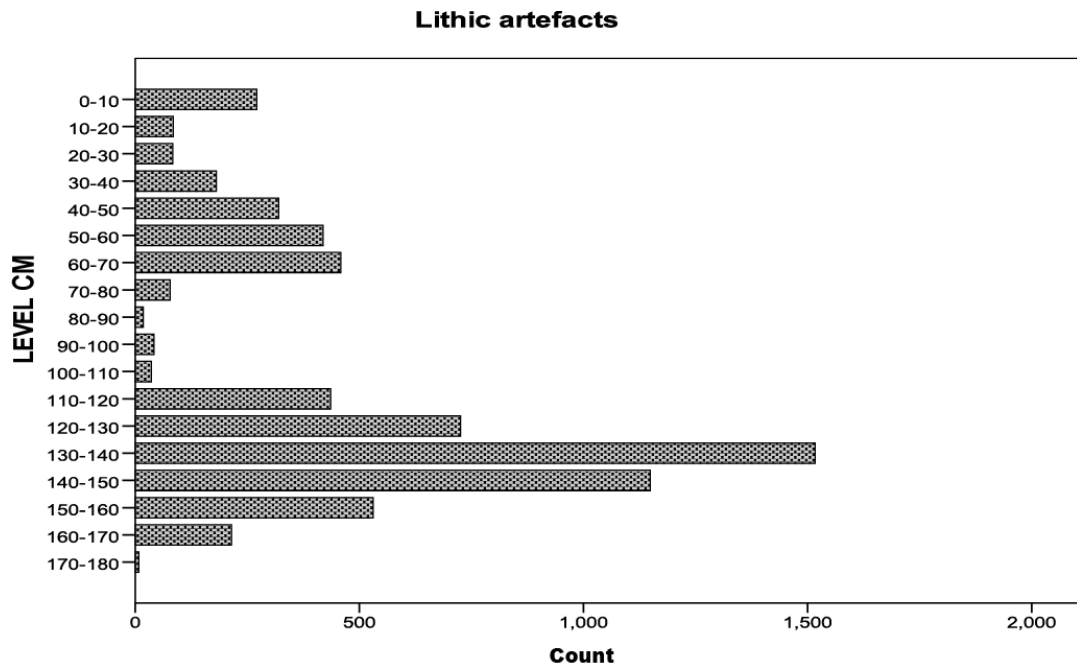


Figure 6.5. The distribution of lithic artefacts per level in test pit 1 at Magubike.

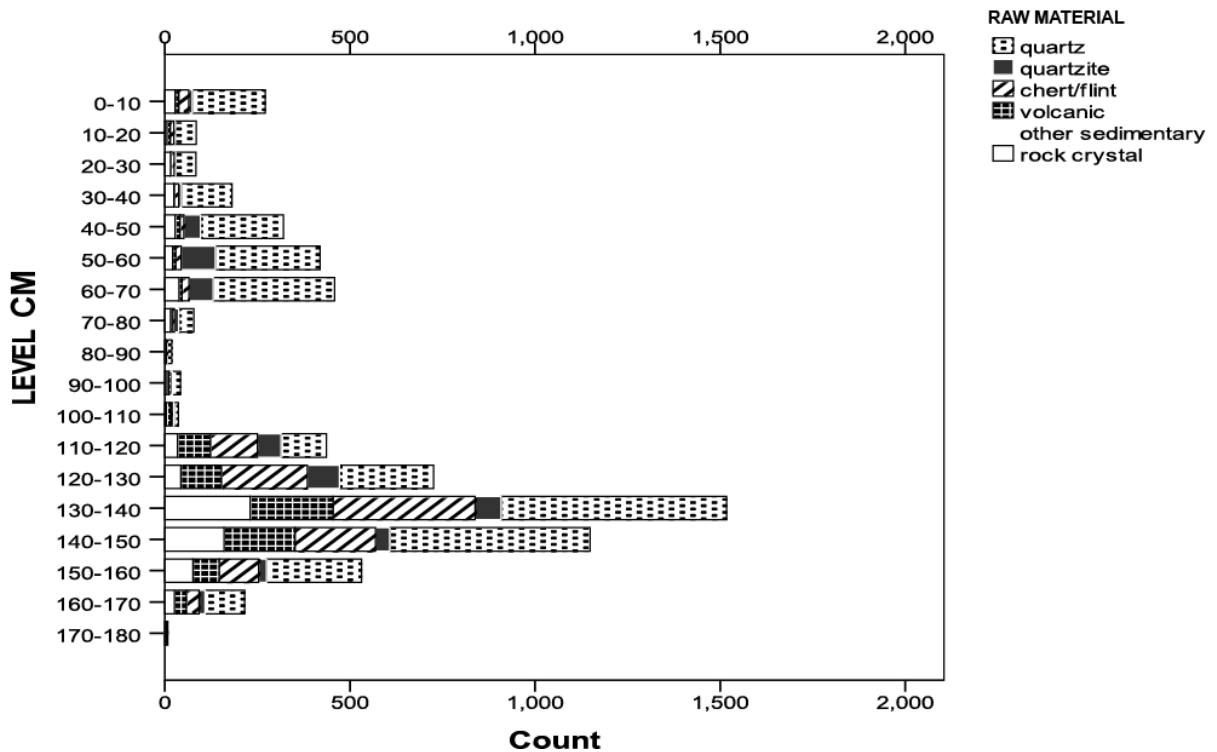


Figure 6.6. The distribution of lithic raw material types per level in test pit 1 at Magubike.

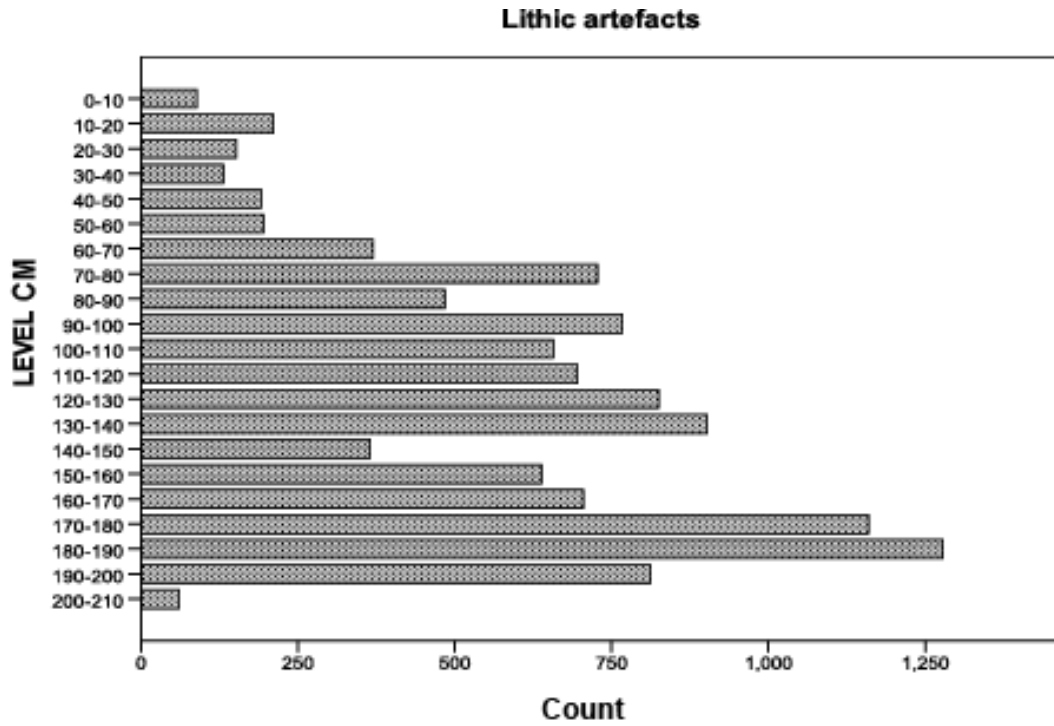


Figure 6.7. The distribution of lithic artefacts per level in test pit 3 at Magubike

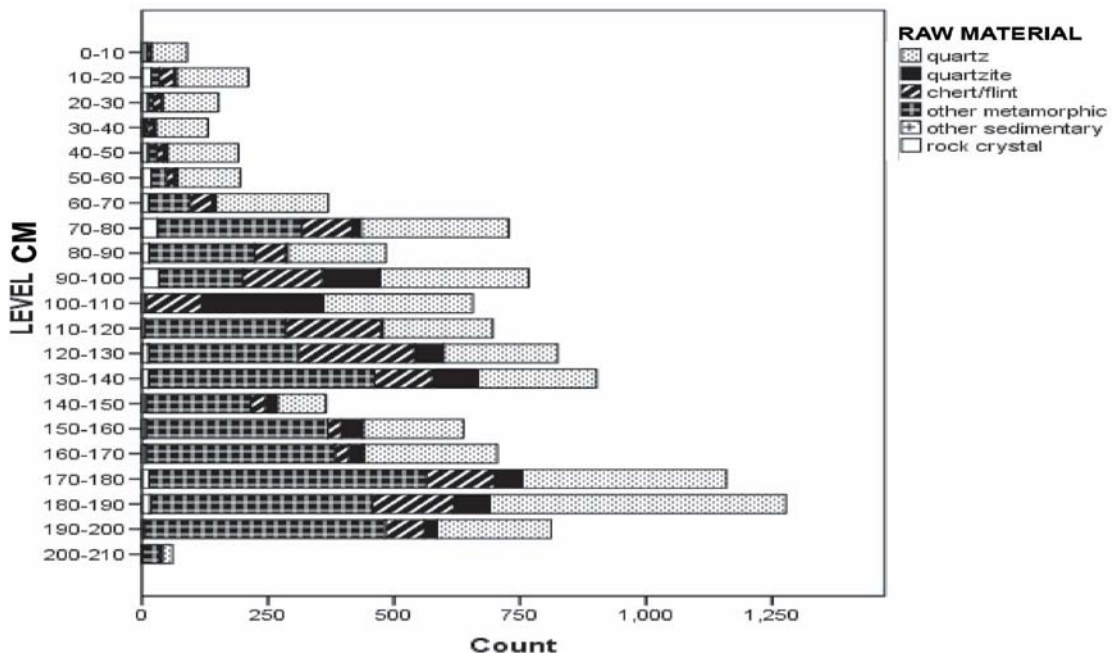


Figure 6.8. The distribution of lithic raw material types per level in test pit 3 at Magubike.

Table 6.4. The distribution of artefacts per level from all excavated test pits at Magubike.

| Culture            | Level cm  | Number       |            |               | Number        | Percentage |
|--------------------|-----------|--------------|------------|---------------|---------------|------------|
|                    |           | Test pit 1   | Test pit 2 | Test pit 3    |               |            |
| Iron Age           | 0 – 10    | 271          | 43         | 89            | 403           | 2.1        |
|                    | 10 – 20   | 85           | 190        | 211           | 486           | 2.6        |
|                    | 20 – 30   | 84           | 172        | 131           | 387           | 2.0        |
|                    | 30 – 40   | 181          | 136        | 152           | 469           | 2.4        |
|                    | 40- 50    | 320          | 211        | 191           | 722           | 3.8        |
| Sub total          |           | 941          | 752        | 744           | 2,437         | 12.9       |
| LSA                | 50 – 60   | 419          | -          | -             | 419           | 2.2        |
|                    | 60 – 70   | 459          | -          | -             | 459           | 2.4        |
| Sub total          |           |              | -          | -             | 878           | 4.6        |
| Mixed<br>MSA/LSA   | 70 – 80   | 78           | -          | -             | 78            | 0.4        |
|                    | 80 – 90   | 18           | -          | -             | 18            | 0.1        |
|                    | 90 – 100  | 42           | -          | -             | 42            | 0.2        |
|                    | 100 – 110 | 36           | -          | -             | 36            | 0.2        |
| Sub total          |           | 174          | -          | -             | 174           | 0.9        |
| MSA                | 50 – 60   | -            | 186        | 195           | 381           | 2.0        |
|                    | 60 – 70   | -            | -          | 370           | 370           | 2.0        |
|                    | 70 – 80   | -            | -          | 728           | 728           | 3.9        |
|                    | 80 – 90   | -            | -          | 484           | 484           | 2.6        |
|                    | 90 – 100  | -            | -          | 767           | 767           | 4.0        |
|                    | 100 – 110 | -            | -          | 657           | 657           | 3.5        |
|                    | 110 – 120 | 436          | -          | 696           | 1,132         | 6.0        |
|                    | 120 – 130 | 726          | -          | 825           | 1,551         | 8.2        |
|                    | 130 – 140 | 1,517        | -          | 902           | 2,419         | 12.8       |
|                    | 140 – 150 | 1,149        | -          | 365           | 1,514         | 8.0        |
|                    | 150 – 160 | 531          | -          | 638           | 1,151         | 6.1        |
|                    | 160 – 170 | 215          | -          | 705           | 920           | 4.8        |
|                    | 170 – 180 | 8            | -          | 1,160         | 1,168         | 6.2        |
|                    | 180 – 190 | -            | -          | 1,278         | 1,278         | 6.8        |
| 190 – 200          | -         | -            | 812        | 812           | 4.3           |            |
| 200 – 201          | -         | -            | 61         | 61            | 0.3           |            |
| Sub total          |           | 4,582        | 186        | 10,643        | 15,411        | 81.5       |
| <b>Grand total</b> |           | <b>6,575</b> | <b>938</b> | <b>11,387</b> | <b>18,900</b> | <b>100</b> |

Table 6.5. Distribution of lithic artefacts in different cultural stages at Magubike.

| Tool type                               | MSA           | MSA/LSA    | LSA        | Iron Age     | Sub total     | %    |
|---|---------------|------------|------------|--------------|---------------|------|
| Backed pieces                           | 2,722         | 37         | 349        | 641          | 3,749         | 69.9 |
| Scrapers                                | 818           | 18         | 58         | 91           | 985           | 18.4 |
| Points                                  | 224           | 0          | 0          | 8            | 232           | 4.3  |
| <i>Ōutils écaillés</i> or scalar pieces | 128           | 4          | 16         | 30           | 178           | 3.3  |
| Bifacial modified pieces                | 82            | 2          | 2          | 10           | 96            | 1.7  |
| Burins                                  | 71            | 0          | 2          | 9            | 82            | 1.4  |
| Bec                                     | 24            | 1          | 2          | 10           | 37            | 1.2  |
| Total number of tools                   | 4069          | 62         | 429        | 799          | 5,359         | 100  |
| <b>Cores</b>                            |               |            |            |              |               |      |
| Bipolar cores                           | 1,321         | 16         | 176        | 314          | 1,827         | 89   |
| Peripheral cores                        | 121           | 4          | 16         | 11           | 152           | 7.5  |
| Platform cores                          | 43            | 0          | 2          | 17           | 62            | 3.0  |
| Amorphous cores                         | 7             | 1          | 1          | 0            | 9             | 0.4  |
| Intermediate                            | 2             | 0          | 0          | 0            | 2             | 0.1  |
| Total number of cores                   | 1494          | 21         | 195        | 342          | 2,052         | 100  |
| <b>Whole flakes</b>                     |               |            |            |              |               |      |
| Flakes                                  | 4,293         | 24         | 90         | 273          | 4,680         | 88.1 |
| Blade                                   | 335           | 2          | 3          | 34           | 374           | 7.0  |
| Levallois flakes                        | 156           | 0          | 0          | 0            | 156           | 2.9  |
| Utilized flakes                         | 82            | 0          | 8          | 14           | 104           | 2.0  |
| Total number of flakes                  | 4,866         | 26         | 101        | 321          | 5,314         | 100  |
| <b>Debris</b>                           |               |            |            |              |               |      |
| Angular fragments                       | 4,981         | 64         | 153        | 970          | 6,168         | 100  |
| Sundry ground stone                     | 0             | 0          | 0          | 2            | 2             | 100  |
| Pestle rubber                           | 1             | 1          | 0          | 3            | 5             | 100  |
| <b>Grand total</b>                      | <b>15,411</b> | <b>174</b> | <b>878</b> | <b>1,903</b> | <b>18,900</b> |      |

Table 6.6. The distribution of the shaped tools in the MSA assemblage at Magubike.

| Tool type                               | Number       | Percentage |
|---|--------------|------------|
| Backed pieces                           | 2,722        | 66.9       |
| Scrapers                                | 818          | 20.1       |
| Points                                  | 224          | 5.6        |
| <i>Ōutils écaillés</i> or scalar pieces | 128          | 3.1        |
| Bifacial modified pieces                | 82           | 2.0        |
| Burins                                  | 71           | 1.7        |
| Bec                                     | 24           | 0.6        |
| <b>Total number of tools</b>            | <b>4,069</b> | <b>100</b> |

Table 6.7. The representation of point types in the MSA assemblage at Magubike.

| Point category | Number     | Percentage |
|----------------|------------|------------|
| Levallois      | 146        | 65.1       |
| Unifacial      | 67         | 30         |
| Bifacial       | 11         | 4.9        |
| <b>Total</b>   | <b>224</b> | <b>100</b> |

In the MSA assemblage, about eight bones belonged to the small size bovid category. Another three pieces belonged to the medium size, and seven bones belonged to the large size (Collins 2009). Few faunal identifications help with the indication of ecological conditions. In fact, soil acidity did not favour the preservation of faunal remains. But Mlambalasi, Magubike and Isimila do represent some of the Stone Age sites in southern Tanzania with faunal remains. Poor preservation of faunal remains characterises the majority of the MSA assemblage in sub-Saharan Africa (McBrearty and Brooks 2000; Mehlman 1989). This trend makes it difficult to reconstruct prehistoric hunting behaviour.

As previously noted, the faunal assemblage was not limited to mammals, but also included molluscs such as *Achatina* shell fragments as well as birds, reptiles and turtles. This might suggest that MSA foragers used a wide range of wild food stuffs (Collins 2009). Today, *Achatina* snails provide a substantial food resource to hunter-gatherers in northern Tanzania. Despite the limited faunal remains, it is obvious that the people who occupied Magubike during the MSA used a variety of food resources.

#### **6.4.3 The distribution of lithic artefacts at Magubike**

In terms of the lithic assemblage, the general pattern indicates that backed pieces predominate in the Stone Age assemblage of Magubike, regardless of the time range or cultural stage (Table 6.5). Whole flakes, blades and Levallois flakes were abundant throughout the assemblage. Some of them had faceted platforms, indicating the use of Levallois knapping techniques (Table 6.5). Bipolar cores



predominate, accounting for about 1,321 (88.4%) out of 1494 cores recorded in the MSA assemblage (Table 6.5). Only small numbers of more typical platform prepared and amorphous cores were excavated (Table 6.5). Scrapers and points, which are regarded as among of the defining characteristics of the MSA culture, are less represented at Magubike compared to those from Mumba and Nasera. At Magubike, scrapers make up 20.1%, and points make up 5.6%, of the analysed tools in the MSA assemblage (Table 6.6). The normal representation of scrapers and points samples indicate that they were often made and utilized by MSA foragers (Table 6.6). It is likely that backed pieces produced through bipolar technique played a large role at Magubike during the MSA and all later periods.

At Mumba and Nasera, the MSA assemblage is dominated by peripheral and prepared platform cores (Mehlman 1989). In contrast, peripheral, amorphous and prepared core platforms are less represented in the MSA assemblage at Magubike compared to the bipolar ones (Table 6.5). A similar trend for the dominance of bipolar cores in surface MSA and LSA assemblages was recorded in Songwe River Valley, southwest Tanzania (Willoughby 1996, 2001). The dominance of bipolar cores and even backed pieces in the MSA and LSA assemblage at Mlambalasi and Magubike implies that technological shifts passed through a gradual process and spanned a thousand decades before reaching another cultural stage. Alternatively, variations in knapping and tool types between the MSA assemblages of northern and southern Tanzania may support the idea of regional ecological adaptation and ethnicity (Clark 1988).

The increased frequencies of backed pieces and a few scrapers and points suggest that backed pieces were preferred and easily made by using small flakes smashed out through bipolar techniques. Backed flakes or blades were used to create standardized geometric and microlithic tools including triangles, trapezes, crescent and burins. Similar techniques were most abundant during the LSA, the period in which bipolar and backed tools become predominant. In northern Tanzania, an increased use of bipolar cores is among some of the significant features of the Second Intermediate Industry (Mehlman 1989). Moreover, it has been taken by some scholars as an important milestone of technological and behavioural development during the MSA and LSA (Ambrose 2001, 2002).

In the MSA/LSA assemblage recorded in Bed V at Mumba (the Mumba Industry), backed pieces and bipolar cores were described as among the defining characteristics of the Second Intermediate Industry (Mehlman 1989). At Mumba, backed pieces make up almost 14% of the retouched tools (Mehlman 1989). They are correlated with the development of arrowhead projectile technology in the region (Phillipson 1980:230). Backed pieces account for about 66.9% out of 4,069 shaped tools from the MSA assemblage at Magubike (Table 6.6). They are followed in frequency by scrapers (20.1%), points (5.6%), *outils écaillés* or scalar pieces (3.1%), and bifacially modified pieces (2%) as well as burins and becs, which make up less than 2% each (Table 6.6). Regardless of the dominance of backed pieces in the MSA assemblage at Magubike, the TCSA value on points indicate that they were used as inserts for spears and arrows. This is discussed further in Chapter 8.

Levallois points predominate, accounting for about 146 (65.1%) of points from the MSA assemblage at Magubike. Unifacial points form 30% and bifacial points 4.9% of the analysed sample (Table 6.7). These point categories are the most common in the MSA assemblages of sub-Saharan Africa. In general, points are less represented at Magubike compared to Mumba and Nasera. Although their numbers are low, the overall pattern suggests that they were among the potential tools made and used by MSA foragers at Magubike. Weapons made from stone points and backed pieces may have formed efficient hunting tools such as spears and arrows used for hunting activities (Chapter 8). Perhaps, hunted game was hit by using stone tipped projectiles and sometimes spears were thrown at animals, which were stalked or trapped in wetlands or marshes. The perennial spring channel of Magubike may have served as a source of potable water, foraged plant food and hunting opportunities. Alternatively, the low frequency of stone points may suggest that hunting was carried out far away from the site.

Ethnographic enquiries from North America suggest that projectile tips may break during use and might be lost in the field (Keeley 1982). Broken or damaged points may often have been abandoned and not brought back to occupation or manufacturing sites. Only a few points still in good condition may have been taken back to camp for retooling or reuse (Keeley 1982). It is likely that at Magubike, points dislodged or damaged during hunts were left in the field. This observation is based on the ethnographic enquires from the San of South Africa and Tyua of Botswana (Yellen *et al.* 1976). These two hunting communities of southern Africa are known for discarding a significant number of

arrows in the field during hunting events (Yellen *et al.* 1976). They spent little time, effort or energy in the search for lost arrows after shooting them (Yellen *et al.* 1976). If a similar trend happened at Magubike during the MSA, recovered points from test excavations may not represent the actual frequency in which points were made and used.

#### **6.4.4 The lithic raw materials at Magubike**

The overall patterns for the distribution of raw materials indicate that, presumably, all raw materials were locally found (Biittner forthcoming). The archaeological assemblage is dominated by local quartz, quartzite, metamorphic rocks and chert (Figures 6.6 and 6.8). For instance, out of 1,295 cores from test pit 3 at Magubike, quartz predominated, accounting for about 800 (61.7%). Other cores were made from metamorphic rocks (267 cores or 20.7%), chert (122 or 9.4%), quartzite (79 or 6.1%) and rock crystal (25 or 1.9%). As noted in previous sections, quartz, quartzite and metamorphic rock cobbles are abundant on the surface around the highlands in the metacalcareous and granite outcrops. They are widely scattered throughout the highlands, riverbeds and lowland plains. Quartz, quartzite and metamorphic rocks at Magubike vary in grain size; some pieces tend to have smaller grain sizes, often approaching transparent rock crystal. It is likely that prehistoric tool makers used a variety of quartz, quartzite chert and metamorphic rock types scattered in different places across the landscape of Iringa.

Interestingly, the chert used in test pit 1 differs from that in test pit 3. In test pit 1, chert raw materials are whitish in colour compared to the ones of test pit 3, which include reddish brown, whitish and yellowish brown pieces. The variation in the form and types of lithic raw materials at Magubike may suggest multiple quarry sources and/or seasonality occupations. The shelter was probably repeatedly occupied in different seasons or at different times by prehistoric foragers. The site may have been occupied, abandoned and reoccupied repeatedly by prehistoric humans in different seasons of the year depending on the availability of food and water resources.

Alternatively, Magubike was occupied by hunting and foraging communities who tracked migratory animal species seasonally in different areas of southern Tanzania. Hunters and foraging groups may have moved seasonally in different places of Iringa and southern Tanzania at large, depending on the locations of hunted species and other edible food resources. Foragers may have carried back to camp reasonable amounts of rocks for functional or cultural needs. The trend for raw material procurement at Magubike suggests that tool makers were familiar with the surrounding environment and that they utilized various types of rocks depending on their physical characteristics. Chert pebbles produces durable and sharp tools. Detailed information about the functional criteria is discussed in Chapter 8

## **6.5 Similarities and differences in the LSA and MSA assemblages of southern and northern Tanzania**

Excavations carried out at Mlambalasi and Magubike have revealed significant results, which may contribute significantly to the ongoing debates about the technological and hunting behaviour employed by MSA and LSA foragers. At Magubike, the cultural sequence is composed of a deep sequence of strata with MSA, LSA and Iron Age occupations, similar to those from Mumba and Nasera. By contrast, Iron Age cultural remains are not abundant at Mumba and Nasera. The archaeological sequence of Magubike lacks a Pastoral Neolithic culture, which was present at Mumba and Nasera (Chapter 4). Nevertheless, results from Magubike and Mlambalasi can be used to develop a conceptual framework of technological shifts and subsistence behaviour from MSA to LSA culture in southern Tanzania. It is likely that the LSA of Mlambalasi represents the late Pleistocene LSA culture, more excavations on lower sequences of Mlambalasi are encouraged to reach a meaningful conclusion on the ways in which prehistoric foragers adapted to the landscape of Iringa.

At Mlambalasi, the distribution of artefacts per level indicates that LSA artefacts varied in number, but they increased over time. Material composition at Mlambalasi indicates the presence of a human burial between 65 and 100 cm below the surface (Figure 6.1). The faunal assemblage indicates that LSA foragers used a variety of wild food resources, including animals of different sizes and molluscs. The distribution of archaeological remains at Magubike and Mlambalasi suggests that most activities, such as tool manufacturing, food processing and

human settlement were carried out inside and outside the rock-shelters, but in close vicinity to the shelters. Available radiocarbon dated and cultural sequences suggest that Mlambalasi rock-shelter was utilized by LSA foragers and Early Iron Age people in different periods. The occurrences of Iron Age artefacts, together with chipped stone tools in the upper levels, may suggest the existence of trade and exchange between hunter-gatherers and iron smelting communities or the transitional period from stone to metal barbed spears and/or arrows.

Material composition and radiocarbon dates obtained from the uppermost LSA assemblage at Mlambalasi suggests that the human burial and the LSA artefacts were accumulated during the late Pleistocene, radiocarbon dated to between 11,480 and 13,490 BC. The available evidence indicates that the LSA occurrence of Mlambalasi is younger than that of the Lemuta Industry of Nasera and Olduvai Gorge, northern Tanzania dated between 35,000 and 60,000 years ago (Ambrose 2002; Manega 1993; Skinner *et al.* 2003). The MSA archaeological assemblage at Magubike is radiocarbon dated to about 42,000 years ago, fairly close to the MSA (Kisele Industry) of Nasera that is dated to 56,000 years ago (Mehlman 1989). Nevertheless, ESR dates placed the MSA sequence of Magubike much earlier, to between 230,000 and 150,000 BP. This is much older than the MSA sequences at Mumba, which are dated to between 132,000 and 110,000 BP (Dominguez-Rodrigo *et al.* 2007; Mehlman 1989; Prendergast *et al.* 2007). Indeed, the representation of points at Magubike, Mumba and Nasera differs: at Mumba, points represent 15% of retouched tools, at Nasera, 18% and at Magubike, 5.6%. The variations in time range, frequency of points and artefact

composition among the MSA assemblages of Mumba, Nasera and Magubike makes the correlation of these sites more complicated and uneven. More work and reliable dates are needed to reach a meaningful conclusion.

In terms of raw materials, local quartz and quartzite dominate lithic assemblages at Mumba, Nasera and Magubike, but other rock types such as chert, metamorphic and rockcrystal were less represented. It is likely that Stone Age foragers of Tanzania relied heavily on tools that could have easily been manufactured from quartz and quartzite pebbles because of their accessibility. Small rounded quartz pebbles are commonly found and can easily be knapped to produce a range of sharp tools. Tools with sharp edges were commonly needed for arrowhead production (Hughes 1998). Hughes's idea is supported by our analysed sample, where points made of quartz have a lower Tip Cross Section Area (TCSA) value of about 69.5 mm<sup>2</sup>, suggesting that they were used for arrows or small spears (darts) (Chapter 8). Quartzite and other metamorphic rocks may have been potential raw materials for MSA foragers in woodland conditions of southern Tanzania (Clark 2001). In woodlands, hunting spears made from durable rocks such as quartzite and chert were necessary, to minimize unintended breakage. Points made of quartzite have a high Tip Cross Section Area (TCSA) value of 87.7 mm<sup>2</sup>, indicating that they were used for spears (Chapter 8). Strategies for procurement of exotic raw materials during the MSA could perhaps be associated with functional requirements needed for different weapon systems.



## 6.6 Summary

The analysed lithic assemblage at Magubike revealed that peripheral and platform prepared cores, which dominate the MSA assemblages in northern Tanzania, are less represented in Iringa. Peripheral and platform prepared cores are key characters in most of the early MSA industries such as the Sanzako and Kisele in northern Tanzania, but at Magubike, bipolar cores predominate. The dominance of bipolar and backed pieces in both LSA and MSA assemblages at Mlambalasi and Magubike suggests that the MSA assemblage of Iringa represents different technological trait employed by prehistoric foragers of southern Tanzania.

Regardless of the cultural stages and chronological order, analysed stone tools from both Mlambalasi and Magubike are dominated by backed pieces knapped using bipolar technology. In all MSA and LSA assemblages, bipolar cores predominate, accounting for about 1,321 (88.4%) of core categories in the MSA assemblage at Magubike and 330 (77.8%) in the LSA assemblage at Mlambalasi (Tables 6.3 & 6.5). Backed pieces comprise about 66.9% of modified tools in the MSA assemblage at Magubike and 81.6% of the LSA tools at Mlambalasi (Tables 6.3 and 6.5). An increase in bipolar technology and backed pieces in the MSA assemblage at Magubike implies that in southern Tanzania, bipolar technique and backed tools played a large role in tool manufacturing and use compared to northern Tanzania, where platform and peripheral cores, scrapers and points predominated (Mehlman 1989).

To some extent, points were less represented in both the MSA and LSA assemblages of Iringa. Points comprise about 5.6% of the analysed MSA tools at Magubike and about 1.1% of the LSA tools at Mlambalasi. Even though points are less represented at Magubike compared to Nasera, where they comprise 18% of the modified tools and Mumba where they represent 15%. Their appearance may suggest that they were occasionally made and used to perform a variety of activities. However, the dominance of backed pieces in the MSA occurrences at Magubike may reflect the beginning of the shift in technology from scraper and point tools to microlithic tools and backed pieces. Microliths and backed pieces have been described as the defining characteristics of the LSA culture in East Africa (Ambrose 2002; Barut 1997; Mabulla 1996; Mehlman 1989; Phillipson 1977, 1980).

The lithic artefact composition at Magubike and Mlambalasi (Tables 6.3 and 6.5) indicates continuity in technology between the MSA and LSA. The backed tools and bipolar cores that characterize most of the LSA assemblage of East Africa may have been inherited from MSA foragers, as was revealed at Magubike. Inherited or transmitted technological and behavioural traits have been given less attention by many archaeologists working in East Africa. Generally, the representation of lithic artefacts recorded at Mlambalasi and Magubike could represent shared and inherited technological skills used by MSA and LSA foragers in Iringa. It reveals a gradual technological shifts or continuity in adaptation in closely related environments during the MSA and LSA.

Evidence from Magubike indicates that backed pieces, widely represented in the LSA in East Africa, first appeared during the MSA. The variation in the numbers of points in the MSA assemblages of Mumba, Nasera and Magubike may reflect patterns of different adaptation strategies employed by prehistoric peoples in relation to their ecological condition. Available environmental records suggest that for most of the Pleistocene, southern Tanzania was characterised by a woodland environment, in contrast to the northern part of the country, which was characterized by grasslands (Clark 2001; Hamilton 1982). More reliable dating techniques are recommended for the MSA and LSA assemblages of Tanzania in order to develop reliable cultural and ecological chronologies, which will lead us to trustworthy interpretations and conclusions.

## **CHAPTER 7: POINT PRODUCTION AND HAFTING TECHNOLOGY**

### **7.1 Introduction**

This chapter presents the results of the attribute analysis of points from Nasera, Mumba and Magubike. It describes the different strategies applied by toolmakers to produce such points during the MSA, as well as during the MSA/LSA transition. Measured attributes were chosen to reflect morphological and technological patterns that can be used to differentiate various typological, knapping and edge modification features employed by Stone Age people in Tanzania. Points are classified into three categories, according to their morphological appearance and technological patterns; these are unifacial, bifacial and Levallois. Unifacial retouch occurs on one surface; usually the dorsal, but bifacial pieces are retouched on both the dorsal and ventral surfaces. Levallois points were formed with triangular flake blanks; they are characterized by the dorsal scars converging at an angle  $\leq 45^\circ$ .

The measurements of blanks, such as length, breadth, thickness, weight, and raw material type suggest that these criteria had a significant impact on the end product of points. Points were also viewed within a framework of raw material procurement and butt treatments. Butt treatments were examined by looking at possible effects of hafting requirements. A total of 261 points from Mumba, Nasera and Magubike have been analyzed and results are organized using the chronological framework of the MSA and Second Intermediate Industry. As previously noted, three kinds of point types (bifacial, unifacial and

Levallois) are present in all assemblages regardless of their ages (Table 7.1). The presence of similar kinds of points in both periods suggests that imposed form and technological skills were passed on from one generation to the next.

Although the majority of points were made from local quartz and quartzite, some of them were made of exotic raw materials, in particular chert and obsidian. Given the high frequencies of local rocks at Mumba, Nasera and Magubike, the analysed samples suggest that fine grained rock types such as obsidian and chert were often imported and used for making stone tools. The edge and butt modifications suggest that people who made and used points had advanced technological skills.

## **7.2 Typological attributes of analysed points**

The majority of the analysed points are small and triangular and some have been deliberately modified on their butts for hafting. They may have been hafted and used as armatures for spears or arrows. Blank forms and butt modifications indicate that they were made to produce composite tools used for planned hunting. Although the majority of the points are unifacial, some have a great degree of bifacial working either just on the butt, over part of the edge, or over the entire ventral and dorsal surfaces. The degree of retouch on points varies from marginal to completely invasive (Figures 7.1 to 7.4).

Triangular flake blanks were more desirable because they required minimal modification to achieve the desired shape and edge angles. Technologically, the production of hafted tools involved much investment in the

selection of raw materials, preparation of blanks, retouching and assembling stone tips and wooden shafts to form a composite tool. It is likely that hafting technology needs a well organized manner using sophisticated skills.

Unifacial points predominate, accounting to 52.9% of the analysed sample of 261 pieces. Levallois points comprise 33.3% and bifacial points amount to 13.8% (Table 7.1). The distribution of points in the MSA and MSA/LSA transition periods at Mumba, Nasera and Magubike (Chapters 4 and 6) suggest that they were an important tool type for prehistoric people. However, points from Mlambalasi were excluded from this study because they were rarely represented in the LSA assemblage; they constitute only 1.1% of the retouched tools (Chapter 6). Such unreliable representations of points in LSA assemblage do not provide sizeable data for statistical analysis. It is possible that during the LSA, hunting weapons were made in a different way. Most likely, geometric tools, such as microlithic tools, performed a similar role to points (Lombard 2007). Since the technological attributes are based on metric, measurements such as maximum length, width, thickness, TCSA, weight and penetration angle, broken or damaged points were excluded from the analysed sample.

### **7.3 The production and morphological characteristics of points**

In Tanzania, points are widely represented in MSA and Second Intermediate Industry assemblages, but there is little knowledge of how these early weapon armatures were utilized. In previous studies, scholars were more focused on typological, technological and chronological descriptions to explore

the ways in which tool types changed over time and place, in order to create the regional culture history (Clark 1988; McBrearty and Brooks 2000; Mehlman 1989; Willoughby 1996, 2001, 2007). Typological and chronological differences were used to identify the evolution of cultural and behavioural complexity. Analyzed points suggest that typological descriptions do not reveal the uses of these tools. For instance, toolmakers invested a lot of time, energy and skills into flaking, retouching and hafting stone tools, which is not reflected in typological and chronological descriptions.

These technological attributes are shown in the variation of blanks, retouch patterns and treatment of the butts. Sometimes a combination of these technological attributes was applied to meet functional requirements. It is likely that invasive retouch was applied in order to provide a morphological structure, needed for aerodynamic motion, while marginal retouch was used to re-sharpen tools. Often edge and surface modifications determine the distribution of weight around the midline of the piece and it is an important technological attribute in projectile armature (Yellen 1996).

### **7.3.1 Point blank form and bulbar definition**

Generally, many of the points were made from triangular flakes or Levallois flakes (Figures 7.1, 2, 3 and 4). Presumably, they were knapped from prepared platform cores such as single, double or Levallois core types. The majority of them have feather terminations indicating a controlled force for the production of flakes. A feather termination is a smooth termination that produces

the distal end, with a very sharp edge (Andrefsky 1999; Odell 2004). The mechanism involved to detach a flake used to make point can be described based on the features that characterize a specific element such as striking platform, bulb of percussion and compression rings. In this study, the bulb of percussion has been used to determine the nature of material and applied force that have been used to detach a flake.

The production of a flake blank by using a hard hammer such as hammerstone, soft hammer such as wood, bone, antler or punch to detach a flake can normally be detected depending on the form of bulb of percussion. Hard hammer percussion produces a prominent or scarred bulb of percussion and soft hammer percussion produces a normal or less developed bulb of percussion. Points with normal bulbs form 60.5% and prominent bulbs comprise 25.7% of the analysed 261 pieces (Table 7.2). They indicate that hard or soft hammer percussion were altered for the production of stone points. Sometimes, the occurrences of points with thinned and pointed bulbs may indicate the existence of hafting technology. Perhaps bulbs were removed or thinned to allow hafting.

When points are oriented perpendicular to their platforms, the majority of them appear to have been made on end-struck blanks. However, a few of them were made on side-struck flakes. The side-struck points were removed from a prepared core with a flake blank that was directed obliquely to the long axis of the point. Regardless of the orientation of the platform, the majority of the modified points were marginally retouched. At Mumba, almost all points from the MSA assemblage were made from end-struck blanks. Points made from side-struck



points comprise 12% at Magubike and 16.6% at Nasera (Table 7.4). Points made from side-struck flakes have been also reported from Rose Cottage Cave and Gi site in Botswana as well as some MSA sites in Zimbabwe (Brooks *et al.* 2006; Mohapi 2007). This variation in blank formation may reflect different adaptations and extractive activities among toolmakers (Clark 1988; McBrearty and Brooks 2000).

### **7.3.2 Platform preparation**

As noted in Chapters 5 and 6, the majority of MSA points were made on well prepared platforms. Most of the platforms were intentionally thinned to allow hafting. Thinned points are characterized by a narrow platform, with curved or pointed proximal ends. A few of them were characterized by long narrowed parts on the proximal ends, which provide stem-like appearances (Figure 7.5). Nevertheless, moderate numbers of points were characterized by a straight faceted platform, indicating that they were not intentionally narrowed on their proximal ends. Some points have faceted platforms, indicating that they were knapped using Levallois technology. Points with thinned platforms predominate, accounting for about 48.4% of the analysed 190 MSA points. These are followed in frequency by those with straight butts, which comprise about 39.5.3% of the total. In the MSA/LSA transition assemblage, points with thinned butts comprise 59.2% of analysed 71 pieces, while those with a straight platform comprise about 29.6% of the total (Table 7.3). This pattern of butt modification indicates

continuity in knapping between the MSA and the transition assemblage from the MSA to LSA.

Specific core types, such as single platform, double platform and/or Levallois cores, were often roughed out and prepared before flakes used to make points were removed. This trend of platform preparation indicates a more complex reduction strategy, in which small chips of flakes are removed through well-controlled forces with the use of a soft hammer (Kuhn 1995). When force is systematically applied it involves removing small chips from one surface or both faces and an edge of the core. Sometimes core platforms may have been modified by removing a big piece from the one edge to form a plain surface. This strategy usually forms symmetric and more perfect geometric cores, such as single platform, double platform or/and Levallois cores. These core types were needed to create suitable flake blanks required to produce points. In terms of striking platform size, there is no significant difference between broad and restricted platforms, suggesting that this was not a limiting factor in selecting the primary blank for points. Points with broad platforms were deliberately thinned at their bases in order to provide a haft. In general, these variables suggest that points were made from flakes, which were originally designed and intentionally modified to produce a blank intended for specific requirements.

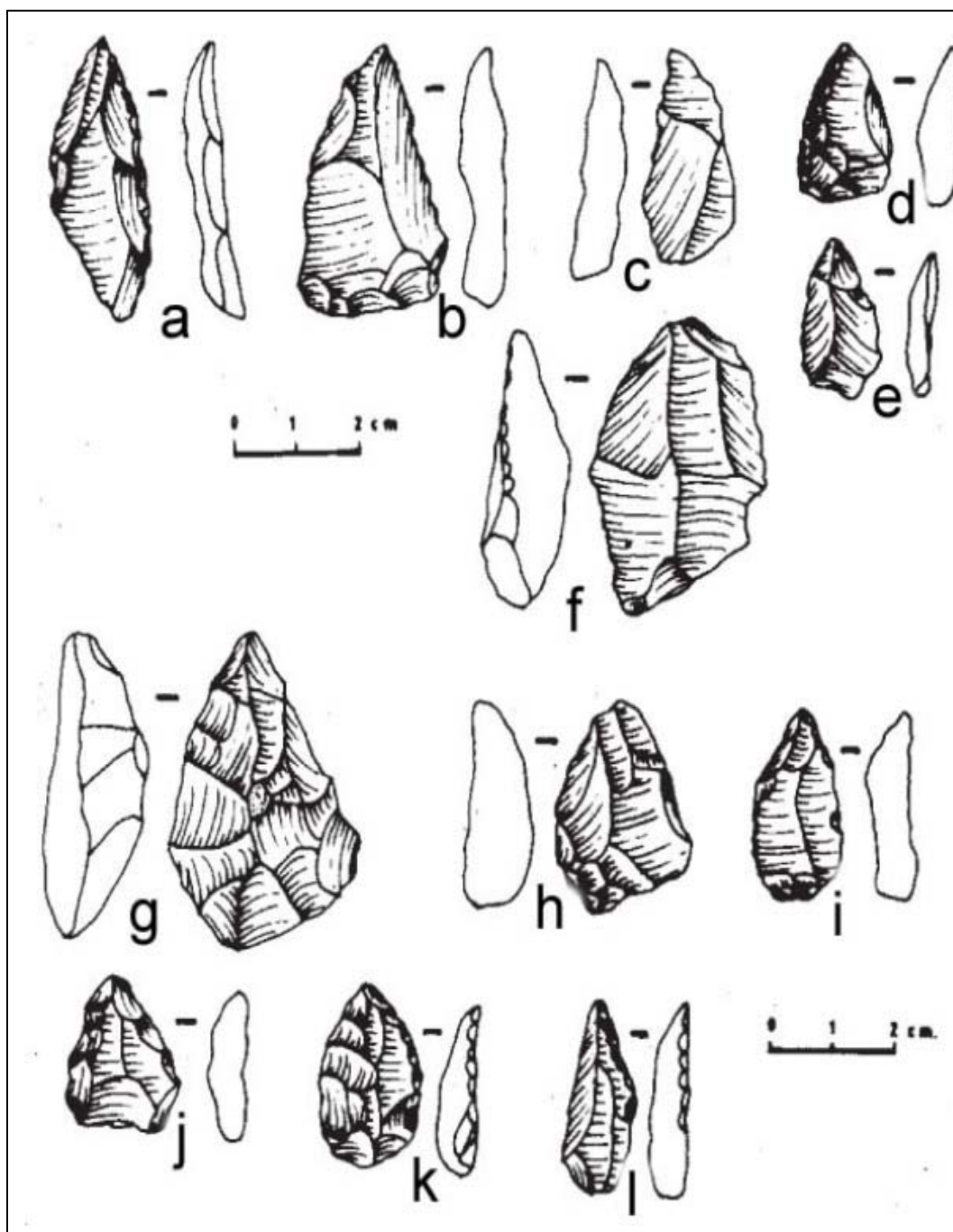


Figure 7.1. MSA points from Nasera: a, b, d, f, h, I, j – unifacial points; c, e, l - Levallois points; g, k – bifacial points. Raw material: a, d, e, i – chert; b, c, g, h, j, k, l – quartz; f- quartzite.

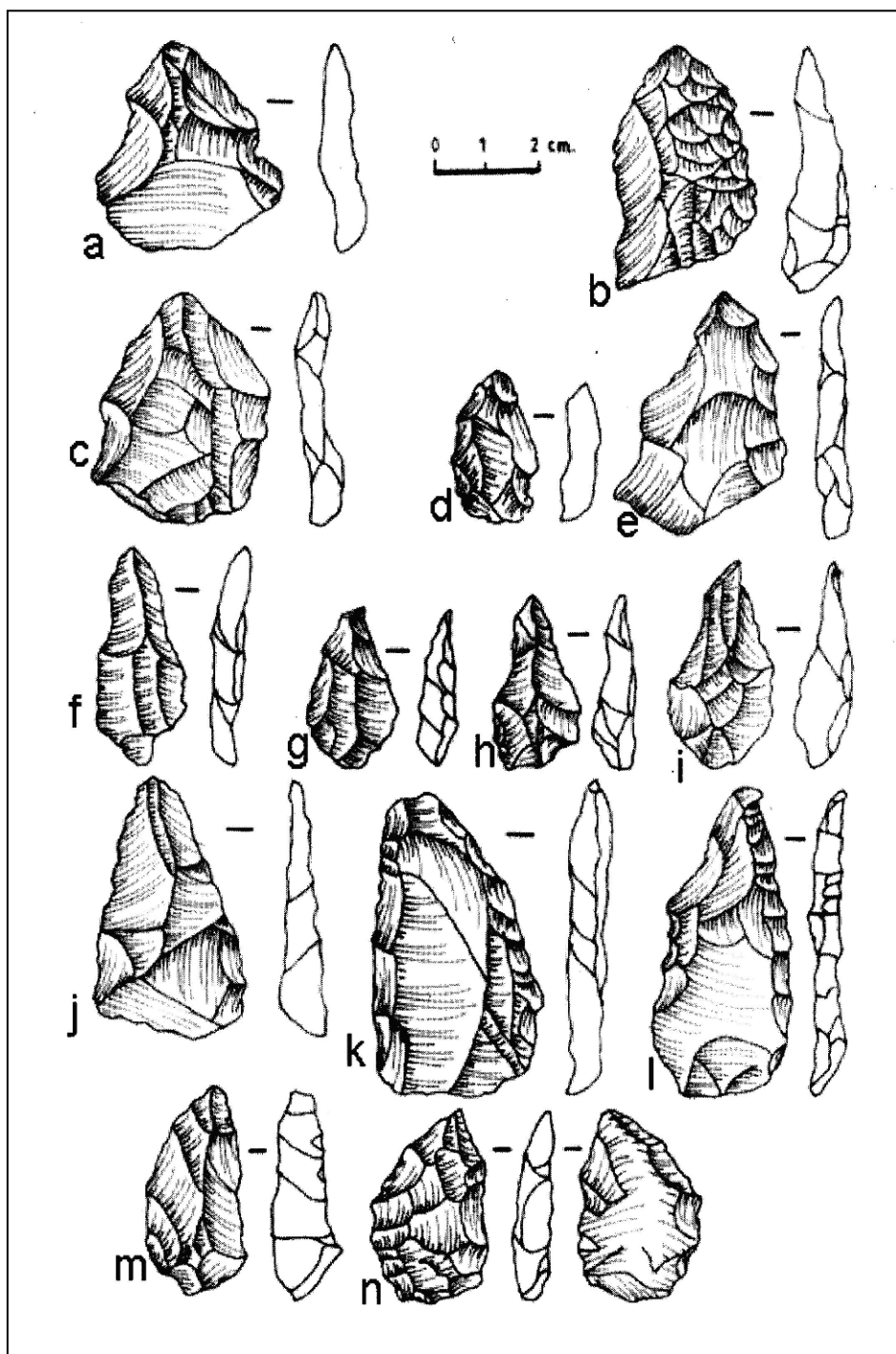


Figure 7.2. MSA points from Magubike: a, b, c, d, e, f, g, h, i, k and l - unifacial points; j and m - Levallois points; n - a bifacial point. Raw material: b, c, f, g, h, i and m - quartz; a - chert; e and j - quartzite; d, k, l and n - metamorphic.

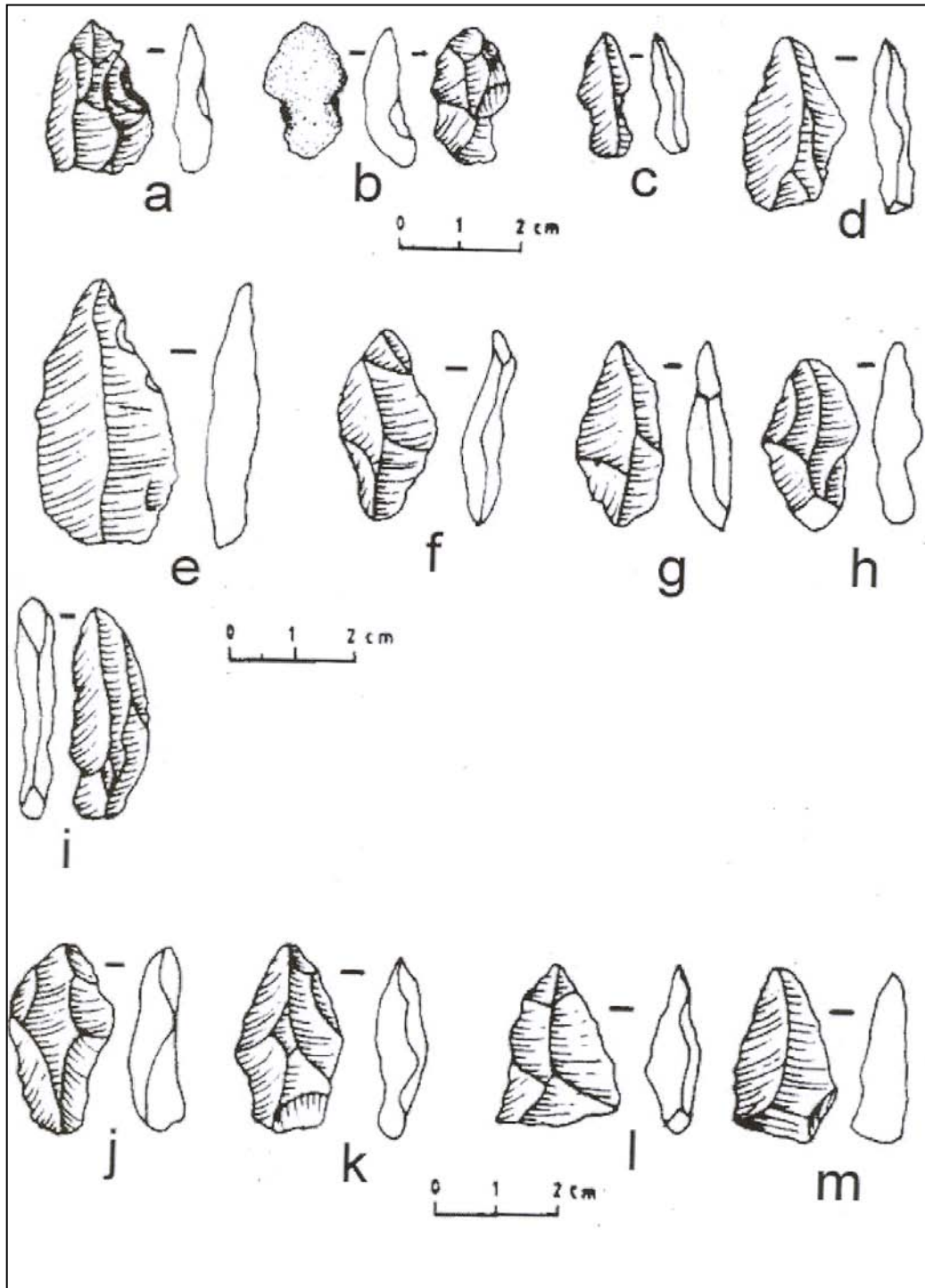


Figure 7.3. MSA points from Mumba: a, b, c, j, k – unifacial points; d, e, f, g, h, i, l and m -Levallois points. Raw materials: a, b, c, d, h and i – quartz; e, f, g and k– chert; j, l and m – quartzite.

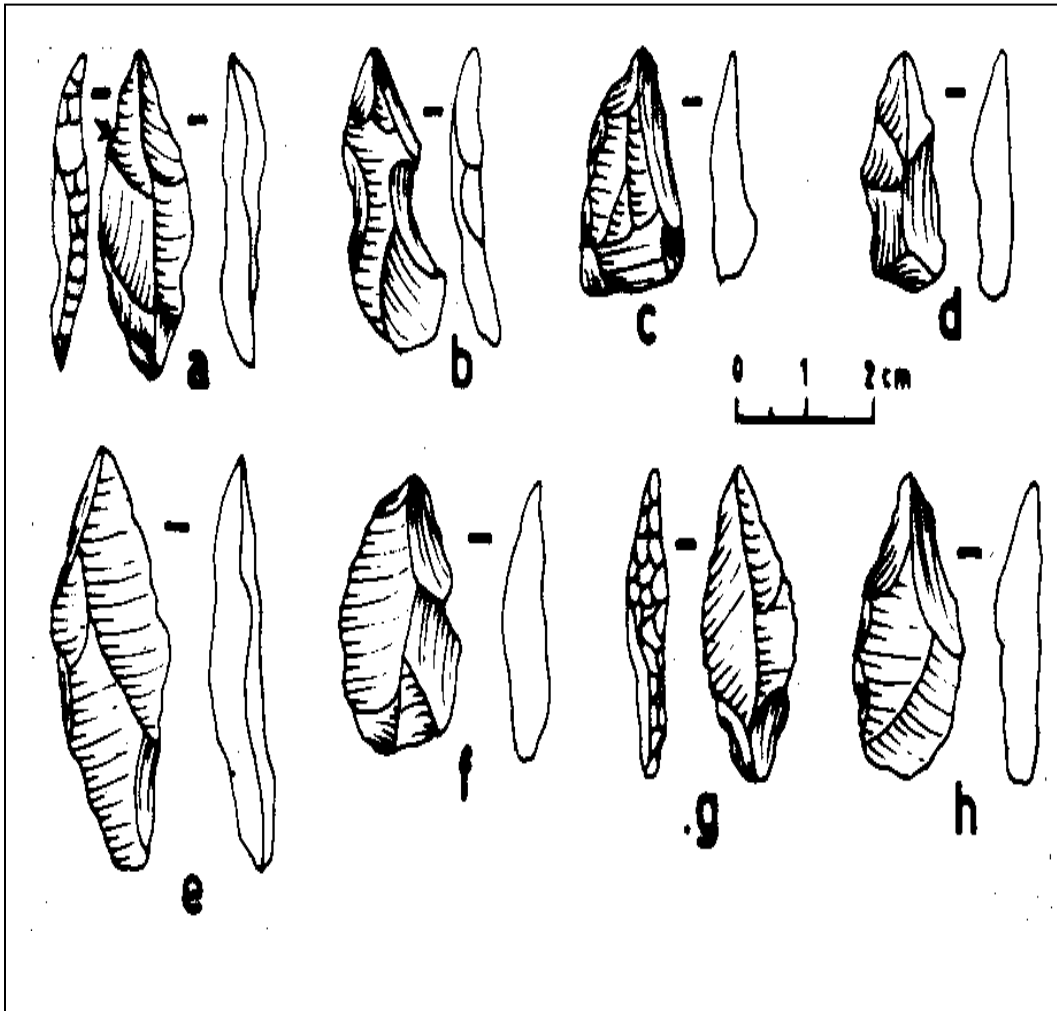


Figure 7.4. Points from the MSA/LSA transition at Mumba: a, f and g- Levallois points; b, c, d, e and h –unifacial points. Raw materials: a - rock crystal; b, c, f, g and f – quartz; d and e – chert.

Table 7.1. The representation of point types.

| Type         | Mumba Bed VI A&B | Mumba Bed V | Nasera Level 12-25 | Nasera Level 7-11 | Magubike   | Total number | %          |
|--------------|------------------|-------------|--------------------|-------------------|------------|--------------|------------|
| Unifacial    | 30               | 32          | 9                  | 13                | 54         | 138          | 52.9       |
| Levallois    | 18               | 7           | 4                  | 7                 | 51         | 87           | 33.3       |
| Bifacial     | 9                | 8           | 3                  | 4                 | 12         | 36           | 13.8       |
| <b>Total</b> | <b>57</b>        | <b>47</b>   | <b>16</b>          | <b>24</b>         | <b>117</b> | <b>261</b>   | <b>100</b> |

Table 7.2. Point bulb definition.

| Bulbar definition | Frequency  | Percentage |
|-------------------|------------|------------|
| Normal            | 158        | 60.5       |
| Prominent         | 67         | 25.7       |
| Pointed           | 14         | 5.4        |
| Crushed           | 11         | 4.2        |
| Scared            | 10         | 3.8        |
| Not developed     | 1          | 0.4        |
| <b>Total</b>      | <b>261</b> | <b>100</b> |

Table 7.3. Platform modification strategies.

| Culture      | Number | Type of modification | Frequency  | Percentage |
|--------------|--------|----------------------|------------|------------|
| MSA points   | 190    | Thinned              | 92         | 48.4       |
|              |        | Straight             | 75         | 39.5       |
|              |        | Convex               | 15         | 7.9        |
|              |        | Stemmed              | 3          | 1.6        |
|              |        | Notched              | 3          | 1.6        |
|              |        | Concave              | 2          | 1.1        |
| MSA/LSA      | 71     | Thinned              | 42         | 59.2       |
|              |        | Straight             | 21         | 29.6       |
|              |        | Notched              | 4          | 5.6        |
|              |        | Stemmed              | 3          | 4.2        |
|              |        | Convex               | 1          | 1.4        |
|              |        | Concave              | 0          | 0          |
| <b>Total</b> |        |                      | <b>261</b> | <b>100</b> |

Table 7.4. The morphology of the blank form for points.

| Assemblage       | Blank form  | Frequency | Percentage |
|------------------|-------------|-----------|------------|
| Mumba VI A and B | End-struck  | 57        | 100        |
|                  | Side-struck | 0         | 0          |
| Mumba V          | End-struck  | 47        | 100        |
|                  | Side-struck | 0         | 0          |
| Nasera 12-25     | End-struck  | 14        | 87.5       |
|                  | Side-struck | 2         | 12.5       |
| Nasera 7-11      | End-struck  | 20        | 83.3       |
|                  | Side-struck | 4         | 16.6       |
| Magubike         | End-struck  | 152       | 88         |
|                  | Side-struck | 38        | 12         |

### **7.3.3 Morphological characteristics of dorsal scar patterns**

Dorsal flake scar patterns indicate that convergent and irregular scars predominate. For instance, within the MSA, 83.2% of the points have convergent dorsal scars, removed from the same direction. This is followed by points with irregular or radial dorsal scars removed from different directions, which comprise 15.8%. Points with cortical portions on their dorsal surfaces amount to only 1.9% of the analysed sample. Only rarely do points retain cortex, indicating that primary flakes were not selected for this role during the MSA. Within the MSA/LSA transition, points with convergent dorsal scars include 67.1% of the total, while those with irregular dorsal scars make up most of the rest (32.7%). Cortical points make up only 1.4% of the points. Similarities between the points from both periods indicate the continuity and shared technological traits between MSA foragers and their descendants.

The dominance of points with single or uni-directional convergent dorsal scars indicates that single platform and/or Levallois cores were chosen when making pointed tools. The data presented in Table 7.5 indicate that there are few points with irregular dorsal scars in these assemblages. So there appears to be a lack of well-defined core preparation techniques. Irregular scars may suggest the use of double, multiplatform or peripheral core reduction strategies (Mabulla 1996). The low frequency of cortical points and increased numbers of points with multiple dorsal scars indicates that tertiary flake blanks were favoured for the production of points.



#### **7.3.4 Retouch patterns**

Retouch refers to the small chips removed from flake edges in order to thin or sharpen a tool, and for rejuvenating or transforming an artefact into other tool forms (Andrefsky 1999; Bleed 1986; Waweru 2007). Re-sharpening is the improving of a dulled tool to provide a fresh, sharp cutting edge (Blead 1986). Retouch can be applied during tool manufacturing or afterwards as part of tool maintenance. In the manufacturing stage, retouch is primarily aimed at transforming a flake blank into a tool (Andrefsky 1999). In the case of points, this includes thinning or stemming the butt to allow hafting and also to retouch tool margins in order to sharpen or shape their edges. Retouch undertaken during maintenance usually involves re-sharpening the tool. As noted in previous sections, sometimes retouch on point tools was aimed at distributing weight around the midline in order to streamline the armature and to allow for aerodynamic motion (Andrefsky 1999; Yellen 1996).

Often retouch patterns can be used to describe types of tools. For example, unifacial and bifacial points can be distinguished based on the location and morphological attributes of retouch. Retouch on most pieces is either continuous or discontinuous, and can cover most of the edges of a point. The majority of points studied here were found to have more than one type of retouch. Some of it was aimed at sharpening the edges or is applied for hafting. Retouch for hafting was restricted to the proximal end or butt of a flake blank (Figures 7.1 to 7.4).

Retouch aimed at thinning or sharpening leaves characteristic scars on the surface of the tool. There are three kinds of retouch scar forms. These are

marginal, semi-invasive and invasive (Mabulla 1996:427). Marginal retouch shows shallow scars, indicating the use of a hard hammer for edge modification or sharpening. Individual retouched flaked scars are between 2 mm to 3 mm wide on the point surface. Points with marginal retouch account for about 68.4% of the MSA sample and 52.1% of the Second Intermediate Industry (SII). Semi-invasive retouch measures between 3 mm and 4 mm on the point surface. Points with semi-invasive retouch account for about 26.3% in the MSA and 29.1% in the Second Intermediate Industry (SII) (Table 7.6). Invasive retouch is more than 4 mm wide and accounts for about 5.3% of the MSA points and 18.3% in the Second Intermediate Industry (SII) at Mumba and Nasera (Table 7.6). This trend may suggest that there was correlation in technology between these two periods.

Unifacial retouch is also presented in the distal ends of a point. It is dominated by marginal edge modification and is widely distributed throughout the MSA and Second Intermediate Industry (SII). In most cases marginal retouch is continuous. Marginal and semi-invasive retouch covers a portion of point surface (Table 7.6). This may suggest that a preference for a particular type of retouch was probably due to functional requirements rather than style. The selection of retouch patterns among the prehistoric toolmakers of Tanzania might have been governed by the intended end products or type of points.

Table 7.5. The dorsal scar patterns of points.

| Culture      | Dorsal scar pattern         | Number     | Percentage |
|--------------|-----------------------------|------------|------------|
| MSA          | Single direction convergent | 158        | 83.2       |
|              | Single direction irregular  | 30         | 15.8       |
|              | cortical                    | 2          | 1.0        |
| MSA/LSA      | Single direction convergent | 47         | 67.1       |
|              | Single direction irregular  | 19         | 27.1       |
|              | Radial                      | 3          | 4.2        |
|              | Cortical                    | 1          | 1.4        |
|              | Multidirectional            | 1          | 1.4        |
| <b>Total</b> |                             | <b>261</b> | <b>100</b> |

Table 7.6. Retouch patterns on points in the MSA and MSA/LSA assemblages.

| Culture      | Retouch type  | Number     | Percentage |
|--------------|---------------|------------|------------|
| MSA          | Marginal      | 130        | 68.4       |
|              | Semi-invasive | 50         | 26.3       |
|              | Invasive      | 10         | 5.3        |
| Sub-total    |               | 190        | 100        |
| MSA/LSA      | Marginal      | 37         | 52.1       |
|              | Semi-invasive | 21         | 29.6       |
|              | Invasive      | 13         | 18.3       |
| Sub-total    |               | 71         | 100        |
| <b>Total</b> |               | <b>261</b> | <b>100</b> |

Table 7.7. The morphological characteristics of point-tip shapes in the MSA and MSA/LSA assemblages.

| Culture      | Site      | Pointed    |              | Oblique   |             | Broken    |             |
|--------------|-----------|------------|--------------|-----------|-------------|-----------|-------------|
|              |           | Number     | %            | Number    | %           | Number    | %           |
| MSA          | Magubike  | 83         | 70.7         | 13        | 11.2        | 21        | 18.1        |
|              | Mumba     | 40         | 70.2         | 8         | 14          | 9         | 15.8        |
|              | Nasera    | 11         | 68.8         | 3         | 18.8        | 2         | 12.5        |
|              | Sub-total | 134        | 70.4         | 24        | 12.7        | 32        | 16.9        |
| MSA/LSA      | Mumba     | 37         | 78.7         | 6         | 12.8        | 4         | 8.5         |
|              | Nasera    | 24         | 100          | 0         | 0           | 0         | 0           |
|              | Sub-total | 61         | 85.9         | 6         | 8.5         | 4         | 5.6         |
| <b>Total</b> |           | <b>195</b> | <b>74.8%</b> | <b>30</b> | <b>11.6</b> | <b>36</b> | <b>13.5</b> |

### 7.3.5 Point bit-shape and penetration angle

The most common shapes for points are triangular blanks with pointed distal ends (Chapter 8). A pointed distal end with acute angle is critical for the penetration of a projectile, and sharp and thinner tips penetrate better than the oblique and thicker ones. The penetration angle should be sharp and acute enough to enter the body of prey (Hughes 1998). Point tips were classified into four major categories: pointed, oblique, rounded and broken. Points were oriented at a right angle ( $90^\circ$ ) to the midline and tip or penetration angle has been measured at the convergence of lateral margin by using a protractor. The angle was then calculated using a geometric formula for triangular configuration (Dibble and Bernard 1980; Shea 2006). Penetration angle reflects the function of a specific projectile weapon; points with acute angles have added functional advantage because they penetrate animal skin and underlying tissues better (Ellis 1997). The mean penetration angle for throwing spears and arrowheads ranges between  $36^\circ$  and  $49.2^\circ$  and for thrusting spears is about  $54.8^\circ$  (Villa *et al.* 2008). In this study, a point with a sharp converging tip measuring  $45^\circ$  was defined as an acute point.

As previously noted, the size of the point angle governs the penetration power of a projectile into an animal body. Normally animal skins and underlying tissues are elastic and tend to stretch on impact (Odell and Cown 1986). For successful hunting, points used with arrows and spears needed to be sharp, acute and broad enough to make a wound of adequate size to allow the shaft to penetrate prey (Hughes 1998). Point-tips can often be sharpened through retouch.

Odell and Cown (1986) found that retouched points mounted onto wooden shafts were more efficient in penetrating carcasses when compared to unretouched ones. Butt thinning and edge retouch are used to sharpen edges and point-tips and can streamline the weight around the midline to facilitate aerodynamic properties. Streamlined points have reduced weight and thickness and penetrate prey better, although they break more easily (Waweru 2007).

In this study, points with acute angles comprise 96.3% of the MSA assemblage; this indicates that most of them could have been used as spears or arrowhead projectiles. They also comprise about 97.2% of the MSA/LSA assemblages recorded at Mumba and Nasera. Points with acute angles have very sharp tips indicating that they were made to create serious injuries or wounds, and to allow shafts to penetrate underlying inner tissues of an animal after hitting the target. If force is applied to the hafted and pointed tool, it is obvious that the pointed edge of the tool would penetrate the animal's skin and underlying tissues to create large wounds and cause enormous bleeding.

Points with pointed or sharp angles comprise about 70.5% of the MSA pieces and 85.9% of those in the Second Intermediate Industry. Points with broken bit shapes comprise about 16.8% of the MSA and 5.6% of the Second Intermediate Industry. Those with an oblique bit-shape comprise about 12.6% of the MSA and 8.5% of the Second Intermediate Industry (Table 7.7). A fair representation of points with broken tips indicates that they were often damaged during the manufacturing process or during use. Alternatively, it may indicate that retooling took place at these sites. Another category of points with oblique bit-

shapes were found throughout the MSA and the MSA/LSA transition (Table 7.7). Points with oblique bit-shapes may have undergone several stages of repair during their use history before being discarded (Bleed 1986).

Repairs, reshaping and maintenance may have changed the points from acute bit-shapes to oblique ones, completely transforming the tool type. For instance, reshaping can alter a point into a convergent scraper (Bleed 1986). Alternation of point forms may suggest that they performed a wide range of applications in their life history including hunting, scraping, cutting and/or drilling (Chapter 8). Once the morphological transformation of a stone tool occurred, it may also alter its function (Bleed 1986; Wendorf and Schild 1992). Morphological transformation is not limited to the alteration of tool function. It is possible that bifacial points, which are abundant throughout the MSA and MSA/LSA transition at Mumba and Nasera, began as unifacial points. Presumably, in their earlier stages they were retouched on one side. Later, they were reshaped on other sides to create a bifacial appearance.

#### **7.4 Raw material procurement and use**

As noted in Chapters 5 and 6, the MSA foragers of northern and southern Tanzania imported some exotic raw cobbles and used them to make point tools and other stone artefacts. Imported exotic rocks include obsidian and chert. The selection and uses of these exotic raw materials may suggest that the people who originally introduced projectile technology had wide foraging range and organised social networks (Merrick and Brown 1984). The TCSA value suggests that points

made from durable rocks such as chert and quartzite were mostly used with spears (Chapter 8). It is likely that prehistoric foragers who made and used points made from quartz, quartzite, chert, obsidian and metamorphic rocks at Mumba, Nasera and Magubike during the MSA, depended on spearhead and arrowhead technologies.

Elsewhere tools made of exotic raw materials or cores were often meant for long-term use when compared to other artefacts made by using local raw materials (Bleed 1986; Rolland and Dibble 1990). Tools made of exotic rocks underwent various stages of reworking, repairing and maintenance. These processes often reduced their size. This process made stone tools produced from exotic rocks look smaller when compared to those made of local raw materials (Bleed 1986; Rolland and Dibble 1990). However, this pattern was not apparent on the analysed points from Mumba, Nasera and Magubike.

The mean dimensions and standard deviations of points made of exotic materials, such as chert and obsidian; do not indicate any substantial variation in size when compared to those made of local quartz, quartzite and metamorphic rocks (Tables 7.8 and 7.9). Points made of local quartz cobbles were deliberately smaller when compared to those made of exotic ones. This trend indicates that the nature and form of utilized stone cobbles had a significant impact on the form and size of the end products (Tables 7.8 and 7.9). For instance, the mean dimensions of MSA points made from quartz are 30.2 mm in length, 18.9 mm in breadth, 7.1 mm in thickness and 4.6 g in weight. Point made of obsidian has a length of 37.4 mm, a breadth of 17.4 mm, a thickness of 6.7 mm and a weight of 4.1 g (Tables

7.8 and 7.9). Points made of chert have a mean length of 34.4 mm, breadth of 22.5 mm, thickness of 6.7 mm and weight of 5.7 g (Table 7.8).

Metric measurements show that points made of exotic rocks such as obsidian and chert were larger than those made from local raw materials, such as quartz (Table 7.8). Points made of exotic raw materials were not reduced in size to minimize production costs. As previously noted, the natural configuration of the stone core used for tool production has a significant impact on the end product, especially on tool size and form. On the other hand, the functional requirement for the specific tool type played a larger role. For instance, points needed for spears were significantly larger than those used for arrows (Brooks *et al.* 2006; Shea 2006, 2009).

Quartz is normally found as small rounded pebbles, while chert at Olduvai Gorge and Lake Natron is naturally found in large rock pieces. The analysed sample from Mumba and Nasera indicates that decreases in size and weight are correlated to chronological sequence rather than to type of raw materials. The mean dimensions and weight values indicate that older points, such as those from the MSA, are larger and heavier when compared to younger ones such as those from the MSA/LSA transition (Tables 7.8 and 7.9). Variation in the mean dimensions of points among these MSA and MSA/LSA assemblages may suggest that point size and weight decreased as time passed. Presumably points were used in different ways, depending on the physical and morphological characteristics of each specific rock type; durable rocks such as quartzite and chert were used for



spears, while brittle ones such as quartz and obsidian were employed for small spears (darts) or arrows (Hughes 1998).

Presumably, toolmakers collected a certain amount of exotic rocks such as chert and obsidian with specific functional requirements in their minds. These rock types were chosen because of their ability to form tools with sharp edges and/or durable to withstand unintentional breakage. The location of quarry sites for obsidian and chert within the East African ungulate migratory corridor may suggest that exotic rocks were often collected and transported to the archaeological sites by groups of hunters, who tracked migratory game (Chapter 4). As a result, the use of exotic materials for tool production appears at an earlier time at Mumba and Nasera, in the MSA (Mehlman 1989; Merrick and Brown 1984), when compared to Eurasia where it occurred during the Upper Palaeolithic (Rolland and Dibble 1990).

The physical requirements that led MSA foragers to import exotic rocks include brittleness, sharpness, lethality, hardness and/or durability of the specific rock type. Imported rock types, such as obsidian and chert, have great wounding ability and break off easily in animal bodies after hitting their targets (Ellis 1997). Once a portion of rock remains in the animal's body, it can cause great damage and exacerbate internal bleeding. Sometimes exotic rocks were acquired from a distant source because they could be reworked or because they were strong enough to resist unintentional breakage during use. Point tools made of durable rocks were needed for repeated hitting of an animal's body during spear hunting (Ellis 1997; Hughes 1998). Measurements of TCSA values (Chapter 8), suggest

that chert, quartzite and metamorphic rocks were used to make heavier and broader points compared to other rock types. For instance, the mean metric measurements and weight of MSA points made of metamorphic rock are significantly greater than other rocks (Table 7.8). It seems the selections of raw materials were influenced by a number of factors including the characteristics of specific rock type and functional requirements.

### **7.5 Butt treatment and hafting technology**

In sub-Saharan Africa, the understanding of prehistoric hafting technology remains less understood, due to the fact that environmental conditions hinder the preservation of organic materials, including wooden shafts. The most common kinds of projectile weapons in an archaeological context are point tips (McBrearty and Brooks 2000). These points were hafted to wooden or other kinds of organic shafts, but these shafts are not preserved in an archaeological context. As a result, our understanding of prehistoric subsistence behaviour depends on the quality and amount of information that can be attained from stone points. The hafting information presented in this chapter largely depends on the modifications made to point butts to allow hafting.



Figure 7.5. MSA points with possible hafting elements from Mumba, Nasera and Magubike (pointed a, b and f; thinned d, g, h and i; notched c; stemmed e and k; straight j; convex l). Raw material: sedimentary rock a; chert b, f and h; quartzite k; quartz c, d, e, g, i, j and l.

Table 7.8. The mean dimensions of MSA points by rock types.

| Raw material      | Number | Weight g | Length mm | Breadth mm | Thickness mm |      |
|-------------------|--------|----------|-----------|------------|--------------|------|
| Quartz            | 117    | Mean     | 4.6       | 30.2       | 18.9         | 7.1  |
|                   |        | SD       | 3.5       | 6.7        | 5.1          | 2.1  |
| Quartzite         | 19     | Mean     | 6.3       | 33.4       | 21.6         | 7.3  |
|                   |        | SD       | 5.3       | 10.3       | 7.2          | 2.2  |
| Chert             | 22     | Mean     | 5.7       | 34.4       | 22.5         | 6.7  |
|                   |        | SD       | 4.3       | 8.9        | 6.4          | 2.2  |
| Metamorphic rocks | 30     | Mean     | 7.5       | 36.9       | 22.8         | 7.1  |
|                   |        | SD       | 5.5       | 11.6       | 5.6          | 1.7  |
| Obsidian          | 1      | Mean     | 4.1       | 37.4       | 17.4         | 6.7  |
| Rock crystal      | 1      | Mean     | 13.7      | 43.2       | 27.3         | 10.3 |

Table 7.9. The mean dimensions of points by rock types in the SII assemblage.

| Raw material | Number | Weight g | Length mm | Breadth mm | Thickness mm |     |
|--------------|--------|----------|-----------|------------|--------------|-----|
| Quartz       | 54     | Mean     | 2.5       | 26.        | 13.2         | 5.9 |
|              |        | SD       | 2.6       | 6.9        | 4.5          | 2.4 |
| Chert        | 13     | Mean     | 4.1       | 30.1       | 18.0         | 6.8 |
|              |        | SD       | 4.3       | 7.6        | 4.3          | 3.3 |
| Rock crystal | 3      | Mean     | 2.1       | 33.3       | 14.1         | 4.0 |
|              |        | SD       | 0.9       | 7.1        | 4.7          | 1.2 |
| Quartzite    | 1      | Mean     | 2.8       | 29.5       | 15.8         | 6.0 |

Table 7.10. The representation of butt treatment of points in the MSA and SII.

| Culture    | Site     | Thinned | Straight | Convex | Concave | Notched | Stemmed |
|------------|----------|---------|----------|--------|---------|---------|---------|
| MSA        | Mumba    | 30      | 23       | 0      | 3       | 1       | 0       |
|            | Nasera   | 4       | 7        | 3      | 2       | 0       | 0       |
|            | Magubike | 55      | 43       | 12     | 2       | 2       | 3       |
| MSA/LSA    | Mumba    | 19      | 19       | 2      | 0       | 4       | 3       |
|            | Nasera   | 17      | 3        | 2      | 1       | 0       | 1       |
| Total      |          | 125     | 95       | 19     | 8       | 7       | 7       |
| Percentage |          | 47.8    | 36.4     | 7.3    | 3.1     | 2.7     | 2.7     |

Table 7.11. The magnitude of bulb definitions of points in the MSA and SII.

| Culture      | Thinned    |             | Prominent |             | Removed/reduced |            | Scarred   |            | Crushed   |            |
|--------------|------------|-------------|-----------|-------------|-----------------|------------|-----------|------------|-----------|------------|
| MSA          | 127        | 55.0        | 37        | 14.1        | 13              | 5.0        | 10        | 3.8        | 3         | 1.1        |
| MSA/LSA      | 31         | 11.8        | 30        | 11.6        | 1               | 0.4        | 1         | 0.4        | 8         | 3.1        |
| <b>Total</b> | <b>158</b> | <b>66.8</b> | <b>67</b> | <b>25.7</b> | <b>14</b>       | <b>5.4</b> | <b>11</b> | <b>4.2</b> | <b>11</b> | <b>4.2</b> |

Today, it is increasingly accepted that the evidence for hafted points coincides with the appearance of early modern humans in sub-Saharan Africa, during the MSA (Lombard 2007; Wadley and Jacobs 2004; Wadley *et al.* 2009). Hafting skills may explain the explosion of point tools as a part of a broader process for the development of modern behaviour capability during the MSA (Brooks *et al.* 2006; Clark 1988; Lombard 2007; McBrearty and Brooks 2000; Shea 1997). It represents an important milestone in the development of skilled technology in terms of labour investment, behavioural organization, time and functional specialization. In general, hafting requires more time, labour and effort. The amount of labour and time involved in hafting technology may have encouraged hunters to minimize risks of equipment failure and to improve their functional versatility (Brooks *et al.* 2006). If that applies, then the MSA points may represent a more advanced technology compared to other early artefacts abundant in ESA sites.

Hafting preparation involved butt treatment, which is sometimes used for typological or stylistic clarification (Clark 1988), but it is a product of functionally equivalent choice. There are many ways to shape the proximal end of a point, so the choice made likely has cultural or stylistic significance. Butt modification was achieved through retouch of the proximal end of a point. The butt is the location of the bulb of percussion and it is also the thickest part of the point. In order to facilitate hafting, butts were modified to render a point suitable for binding to a shaft. Analysed samples indicate that prehistoric foragers used a variety of techniques and methods to modify the proximal ends of points for

hafting or for assembling composite tools. Butt patterns include pointed, convex, straight, thinned, stemmed, and notched (Figure 7.5).

Thinning point butts was the most common method selected in East Africa (Mehlman 1989; Mabulla 1996). Points with thinned butts are conical or pointed in shape, with a gradually curved surface on the proximal end. Sometimes thinning of the butt resulted in a pointed, stemmed or convex appearance for some of the stone tools. Their butts have been thinned either by removing the bulb of percussion or by narrowing the platform (Figure 7.5). Thinned points amount to 47.8% of the sample analysed here (Table 7.10). Points with thinned butts are followed in frequency by those with straight butts accounting for 36.4% of the analysed sample (Table 7.10). Points with faceted straight butts are triangular in shape and have a wide platform. There are a number of points with a convex butt which make up 7.3% of the total, while those with concave butts make up about 3.1% (Table 7.10).

Other butt modification categories which are rarely represented in East Africa are notching and stemming (Figures 7.5 c, e and k). A notch is a small V or U-shape or circular cut in the surface or edge of an artefact. Notches are well suited for hafting with a mixed of ingredients made of animal tendon, tree resin and powdered ochre (Lombard 2007). Notches allow the binding to stay in place and do not alter the artefact's shape. Notch hafts are also said to be aerodynamic, providing a balance between shafts and tips during flight (Hughes 1998). Sometimes when binding is applied to unnotched pieces, it protrudes from the side of the point. Stemmed and notched points are relatively small compared to

other categories of analysed points. These are rare, only comprising about 2.7 % of the total for each (Table 7.10). Stemmed points have a long tanged portion which connects the tip with the shafts (Figures 7.5 e and k). It is likely that the modification of point butts is done in order to insert the stone pieces into a hole made in the wooden shaft. In addition, points with thinner butts and elliptical shapes exhibit better performance in terms of accuracy, penetration and distance covered (Waweru 2007).

The shape of the butt is an important variable because it links the tip and the shaft. For the majority of MSA points, the butts have been thinned to avoid the possibility of the point-tip sticking out or protruding over the shaft. A thinned and curved butt controls the aerodynamic motion and pressure that flow over shafts, which govern the penetration power of a projectile into prey. The aerodynamic properties of a tip shape can be quantified by the ratio of maximum breadth and maximum length (Hughes 1998). Ethnographic evidence from North America indicates that mean ratio between the breadth and length ratio for projectile weapons is equivalent to or less than 0.5 (Hughes 1998).

Regardless of the culture and chronological sequences, the presence of points with thinned, straight, convex, concave, stemmed and notched butts or removed bulbs of percussion suggests that point tools were hafted onto wooden shafts. Data presented in Tables 7.10 and 7.11 indicate a consistent picture of butt modification strategies throughout the MSA. Persistence in butt modification or butt treatment can both be interpreted as means for the development of hafting technology, which started during the MSA. Stone points were deliberately

modified to provide an additional part for the binding. The treatment of the butts does not appear to represent stylistic variation, but rather a clear morphological requirement for hafting and aerodynamic motion. Presumably, narrowing the butts of the points for hafting aimed to ensure that haft binding or adhesives did not protrude much from the wooden shaft.

Microscopic residue analysis on artefacts from Howiesons Poort and Sibudu Cave in South Africa indicates that vegetal remains, animal tendons, bees wax and powdered ochre were mixed and used to stick together stone tips and wooden shafts (Lombard 2007). The sample analyzed here indicates that the manufacturing processes of composite tools such as projectile points require considerably greater planning. They include the collection of binding materials, thinning butts on points, the preparation of wooden shafts and the assembling of the tools to prepare them for use. This process requires considerably more time, effort and advanced skills, which are seen by many archaeologists to be consistent with the development of modern behaviour (Brooks *et al.* 2006; Clark 1988; Lombard 2007; McBrearty and Brooks 2000; Wadley and Jacobs 2004).

This observation is also supported by ethnographic information from modern hunting groups of northern Tanzania. For instance, the Hadzabe travel over five km to look for stave woods; sometimes they spend over two hours to prepare a bowstring, using thin and spiralled pieces of animal skin or tendon. When they are not hunting, they spend most of their day processing, decorating and modifying shafts and iron barbed tips. Sometimes they spend the day collecting and processing binding materials. They will travel over 50 km looking



for poison materials (Marlowe 2003; Woodburn 1968). The Hadzabe use nails to produce iron-barbed arrowheads (Personal observation 2004). Skills observed from the Hadzabe suggest that manufacturing of composite bow and arrows requires complicated abilities and a significant level of knowledge and advanced thinking ability. Advanced technological skills enabled MSA people to combine collected different ingredients, which were used for the construction of bow and arrows. Technological organization needed in projectile technology, such as the collection and processing of suitable stave wood shafts, processing spearheads or arrowheads and collection of binding materials, were probably needed to produce MSA projectile weapons.

Perhaps points were hafted onto wooden shafts, a process that needs advanced technological skills. Hafted points had a great influence in hunting efficiency because they penetrate deeply into animal body (Guthrie 1983:289). If hafting was a major technological achievement during the MSA, it is likely that wooden shafts were retained or preserved for a long time, a process that encouraged prehistoric foragers to keep using the same wooden shaft for a long time rather than manufacturing a new one. Keeley (1982) has noted that arrow and spear shafts are expensive to make and thus are not discarded often, but tips may break during use and be disposed. Keeley's observation is also supported with ethnographic studies among the Gomo of Ethiopia suggesting that lithic tools persisted for a long period of time with limited changes in their size, weight and morphology because wooden shafts were usable for a long time with minor modifications (Weedman 2006).

## 7.6 Summary

The samples analyzed here show that triangular flake blanks were shaped for the production of points. They were produced using Levallois and prepared platform cores. These points were inserted onto wooden shafts to form arrow and spear projectiles. Arrowhead projectiles have reduced TCSA values compared to the spears and they are capable of travelling much greater distances than spears (Waweru 2007:100). Both spearhead and arrowhead projectiles were made with a mixture of unifacial, bifacial and Levallois points. In terms of cultural composition, there are some typological and technological similarities throughout the MSA and MSA/LSA transition. Similarities in tool types and morphological attributes may indicate the maintenance of technological traits, which passed from one generation to the next. Alternatively, they might indicate a possible network and interactions among different ethnic groups that occupied East Africa during the Middle and Upper Pleistocene.

The points studied here suggest that MSA toolmakers required more time and advanced skills to produce a single tool. Most points were made with well-prepared blank forms. A dominance of points with plain and faceted platforms suggests that Levallois methods were regularly used. Production systems and retouch patterns indicate that most of the points were fabricated to improve their functional and hafting requirements. The majority of them are characterized by modified edges and thinned, stemmed, convex, pointed and sometimes notched butts. The overall technological requirements suggest that stone based projectiles were carefully designed and hafted onto wooden shafts. In this study it has been

revealed that this hafting requirement remained constant throughout the MSA and MSA/LSA transition. The process of assembling diverse elements such as point tips and wooden shafts to form a composite tool should be seen as an important milestone in the development of modern behaviour during the MSA.

From a technological point of view, several inferences can be made about raw material procurement and the competence of people that created MSA points at Mumba, Nasera and Magubike. Presumably, these sites were multi-purpose camp sites, as it is seen in their faunal and artefact compositions (Mehlman 1989, Collins 2009). They may have been used as hunting camps as well as in the manufacture and maintenance of artefacts. Bringing the concept of lithic raw material procurement and use systems, the analysed sample indicates that exotic and local lithic raw materials were both utilized in closely related manner. Foragers depended as much on local rock types as on exotic ones, but measurements of size and weight suggest that the nature and forms of the lithic raw material were the most important determinants. Points made of different rock types have closely related characteristics, but differences are obvious, based on cultural chronology and age, indicating the trend toward reduction in size and weight over time.

Presumably, points were used in different ways: as spearheads, arrowheads and sometimes as knives. In terms of retouch patterns, it seems as if points made of local and exotic raw materials both were retouched and utilized in closely related ways. This observation contradicts the conclusions of Bleed (1986) that artefacts made by using exotic raw materials were more utilized, maintained

and preserved for future use compared to those made with local raw materials. Bleed argues that tools made of exotic raw materials were more retouched and their size was significantly reduced to minimize time, energy and labour costs. Minimizing costs could have been widely represented in the late Upper Palaeolithic of Eurasia and America, but it was not obvious in Tanzania during the MSA and MSA/LSA transition.

## **CHAPTER 8: PROJECTILE TECHNOLOGIES AND HUNTING BEHAVIOUR**

### **8.1 Introduction**

This chapter discusses the evolution of prehistoric weapon systems used for hunting, warfare and other related activities. Researchers interested in prehistoric subsistence patterns are very concerned with hunting behaviour and the form of tools used to obtain meat resources. Hunting tools, such as throwing spears or bows and arrows, enabled humans to exploit a far greater range of potential animal prey than our nearest primate relatives (Shea and Sisk 2010). These projectile weapons have a greater effective range, are more readily transportable and allow multiple shots at a target (Shea and Sisk 2010). These criteria are regarded as a significant indicator for the evolution of behavioural modernity and advanced technological capability among early modern humans (Brooks *et al.* 2006; Lombard 2007; Mohapi 2007; McBrearty and Brooks 2000; Milo 1987; Shea 1997, 2006, 2009; Shea and Sisk 2010; Waweru 2007).

Subsistence patterns are thought to have been largely dependent on competence in hunting, which is a central issue in prehistoric food acquisition and technological organization (McBrearty and Brooks 2000). Therefore, deciphering the functions of points may enable researchers to understand the ways in which prehistoric people obtained foods and gained control over their surrounding environment. Churchill (1993) argues that the development of projectile weapon

systems is the key issue to a better understanding how technology and subsistence behaviour changed through time during human evolution.

Thomas (1978) examined ethnographic and experimental collections from various places across North America and concluded that prehistoric weapons incorporating points can be subdivided into three systems based on their metric dimensions and design features. These include thrusting spears, throwing spears, and bow and arrows (Thomas 1978; Hughes 1998). Thrusting spears are confrontational weapons, used over a short distance between the hunter and the prey. Throwing spears and bows and arrows are regarded as true projectile weapons that aided prehistoric hunters in acquiring meat for subsistence (Shea 2006, 2009). They are referred to as aerodynamic weapons that are shot or thrown through the air in order to hit the target (Hughes 1998). According to Hughes (1998), the design features and metric dimensions of a specific projectile govern its penetration power, accuracy, durability, portability and distance covered.

Studies carried out in North America suggest that point tips were inserted into spears and arrows to form projectile weapons long before the introduction of metal tips. Recent experimental studies on MSA/MP points from the Levant, Ethiopia, Botswana, Kenya and South Africa, suggest that they were used as inserts for spear and arrow projectiles (Brooks *et al.* 2006; Mahopi 2007; Shea 2009; Waweru 2007). This chapter examines ways in which MSA points from Mumba, Nasera and Magubike could have been used. It also examines the possibility that broad and thick points were used for thrusting or throwing spears, while narrow and thin points were used as inserts for arrows. It is argued that

spear projectiles changed in size and form as time passed, reaching the arrowhead stage between 100,000 and 50,000 years ago (Shea 2009; Shea and Sisk 2010). Brooks *et al.* (2006) believe that in sub-Saharan Africa, arrowhead projectile technology evolved during the MSA between 135,000 and 72,000 years ago. Results from the analysed samples from Mumba, Nasera and Magubike suggest that spear and arrow projectiles coexisted in northern and southern Tanzania during the MSA, between 150,000 and 35,000 years ago. Perhaps each had its role in hunting different kinds of prey.

## **8.2 The antiquity of projectile technology**

Globally, the antiquity of projectile weapons in the form of spears can be traced back as far as 400,000 years ago at Schoeningen in Germany, where wooden spears were found associated with bone remains exhibiting cut-marks (Daniel 1997; Thieme 1997). Yet their shaft diameters suggest that they were used as thrusting spears or hand delivered spears (Shea 2006). In sub-Saharan Africa, points are believed to have been used as inserts for projectiles and appeared for the first time during the MSA about 285,000 years ago, in the Kapthurin Formation, Lake Baringo in Kenya (McBrearty 1993; McBrearty and Brooks 2000). So far, there is no usewear evidence or wooden shafts that have been found in the MSA assemblages to prove this, due to the poor preservation of organic materials in the tropical environments. The most durable materials available are stone points, thought to have been inserted onto wooden shafts to form different kinds of projectile weapons. Regardless of the deep chronological

antiquity of points in MSA assemblages in sub-Saharan Africa, efforts to identify their functional roles have only recently begun (Bretzke *et al.* 2006; Brooks *et al.* 2006; Mohapi 2007; Shea 2006, 2009; Villa and Lenoir 2009; Waweru 2007).

Some evidence related to hunting with projectiles was found in the late 1980s, such as the MSA point found embedded in a cervical vertebra of a large bovid (*Pelorovis*) in South Africa (Milo 1998). A few attempts were made to determine if that point was part of a projectile weapon. Until the present, it is not clearly understood if the point was present in the animal vertebra because of hunting or meat processing activities (Klein 1999; Milo 1988). Another attempt was made at Lukenya Hill in Kenya, where cut-marked or smashed bones from residential and migratory animal species were found associated with MSA artefacts, indicating that people had primary access to carcasses and they repossessed valuable meat prior to carnivores (Marean 1997; Marean and Assefa 1999). No formal functional study has been carried out, however, to identify the mechanisms that enabled prehistoric hunters to catch prey at Lukenya Hill.

In South Africa, organic residues have been identified on MSA points from Sibudu and Blombos Cave. This led to the identification of blood and hair tissues on point tips, indicating that they were used as hunting weapons or cutting tools (Lombard 2007; Wadley and Jacobs 2004). Despite these conclusions, in many places across sub-Saharan Africa, points continue to be described only in terms of their morphological appearance and typological attributes, which are less relevant for functional studies (Clark 1988; Mehlman 1989). The vast majority of these points indicate design and morphological features related to hafting or



aerodynamic properties, suggesting that they served as hunting weapons (Brooks *et al.* 2006; McBrearty and Brooks 2000).

They may have been hafted onto wooden shafts to form thrusting spears, throwing spears or arrows. As previously noted, thrusting spears are confrontational weapons delivered into a prey at close proximity, so they are not expected to have extremely refined aerodynamic properties (Shea 2006). Points characterized by aerodynamic properties are thought to have been used with throwing spears or arrows. They were thrown at prey from a well-defined distance in order to increase the hunter's safety. Thrusting spears were the most abundant weapons in the Levant during the Middle Palaeolithic and they were found associated with both Neanderthals and early modern humans (Shea 1997, 2006, 2009).

In sub-Saharan Africa, MSA points dating to between 100,000 and 50,000 years old were mostly used as inserts for throwing spears and arrows (Brooks *et al.* 2006; Shea 2009). The majority of them were thinned on their butts to facilitate hafting or to make sure that the point did not stick out from a foreshaft. Their weights are distributed around the mid-line to facilitate aerodynamic motion (Yellen 1996). Recent studies on TCSA values reveal that arrowhead projectiles probably existed in sub-Saharan Africa during the MSA (Brooks *et al.* 2006; Lombard 2007; Lombard and Phillipson 2010; Mohapi 2007; Shea 2009; Waweru 2007; Wadley *et al.* 2009). In previous studies it was believed that arrowhead technology reached sub-Saharan Africa only during the early LSA period about 40,000 years ago (Ambrose 1998, 2002; Phillipson 1980).

### **8.3 Methodological approach for the study of projectile weapon systems**

It is reasonable to suppose that criteria governing projectile technology in North America functioned in the same way as they do elsewhere, regardless of variation in age and ecological setting. Metric measurements of the stone tips are used in this chapter as the baseline for an assessment of the evolution of projectile technology in Tanzania. The results are used to assess the ways in which MSA points were used. This study assesses if the MSA points were part of aerodynamic weapons such as throwing spears and arrows or if they were part of the hand-held weapon system such as thrusting spears.

Projectiles or aerodynamic weapons use a propulsive device to transfer kinetic energy in order to hit a target (Churchill 1993). Recent studies of usewear, residue traces and metric measurements have aided in the understanding of the functions of points, suggesting that all three kinds of prehistoric weapons (thrusting spears, throwing spears and bows and arrows) co-existed in sub-Saharan Africa during the MSA (Brooks *et al.* 2006; Lombard 2007; Mohapi 2007; Shea 2009; Villa and Lenoir 2009; Wadley *et al.* 2009; Waweru 2007). In this study, MSA points from Mumba, Nasera and Magubike are assessed in the light of chronological, metrical measurements and usewear criteria in order to understand their functional roles. Results from this study are compared with ethnographical and experimental data from North America, as well as with MSA/MP points from the Levant, South Africa, Ethiopia, Botswana and Kenya in order to explore the technological differences between arrow and spear-headed weapons.

Archaeological, experimental and ethnographic data suggest that metric measurements of points may provide information for the identification of different kinds of weapon systems. Projectiles can be differentiated through the study of their length, breadth, thickness, weight and Tip Cross Section Area (TCSA) values (Hughes 1998; Shea 2006, 2009; Shott 1993; Thomas 1978). These measurements indicate that thick, broad, and large points were used as spearheads, which were thrust or thrown at animals. On the other hand, narrow, thin and small points were used as arrowheads. Thicker and broader points were necessary for making spears because they can withstand tension, fracture and unintended breakage after hitting a target. Thinner and narrower arrowheads are necessary for arrows because they travel fast and better penetrate a target from a reasonable distance (Hughes 1998). But Hughes (1998) also noted that experimental points used with spears and arrows were not always consistent in weight, size and shape; sometimes they overlapped each other (Hughes 1998; Waweru 2007).

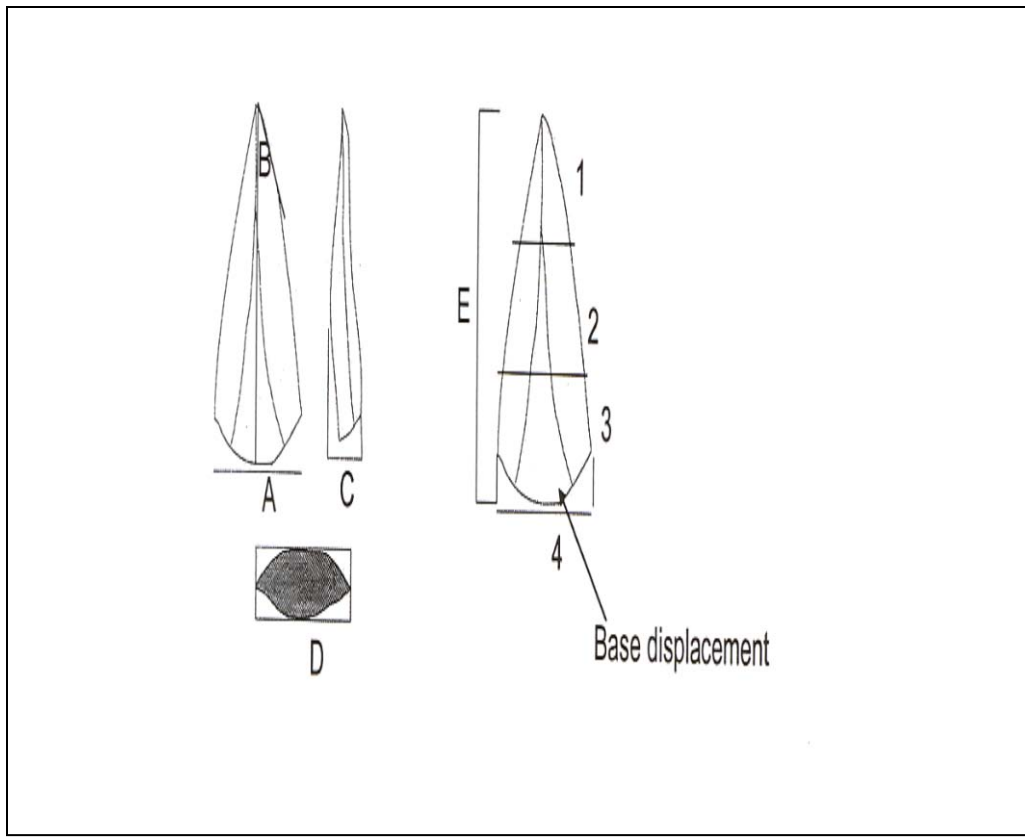


Figure 8.1. Point attributes and measurements: A maximum width; B penetration angle; C maximum thickness; D tip cross section area; E maximum length; 1 distal end; 2 medial; 3 proximal end; 4 base/butt (modified from Shea 2006).

In this study, the model developed in North America and used in the Levant and some African MSA sites is employed to analyse the functional role of points from Mumba, Nasera and Magubike. Measurements of different variables on the points illustrated in Figure 8.1 were taken using a digital calliper and involved the maximum dimension for each variable. Measurements were approximated to the nearest 0.1 mm (Figure 8.1). The results from metric measurements were used to calculate the geometric ratio, TCSA value and standard deviation (SD). Other assessed variables include the mean value of the maximum length, breadth, thickness and weight. Weight was measured in grams using a digital scale. According to Hughes (1998), the mean values of weight and TCSA, as well as the breadth/length (B/L) and platform breadth/breadth (PB/B) ratios, are defining characters of point form, performance and penetration power because they control aerodynamic motion and durability of a projectile.

For instance, the weight and TCSA value of points determine size of wooden shafts and kinetic energy need to transfer a device to a target (Hughes 1998). They also define the distance covered by a particular kind of a projectile and influences accuracy and efficiency of a projectile (Hughes 1998; Shea 2006). B/L and PB/B ratios, penetration angle and weight govern the velocity, speed and portability of a projectile. They also define the kind of wound made by the projectile when it comes in contact with prey (Brown 1940; Christenson 1997; Ellis 1997).

## **8.4 Projectile weapon systems**

Stone tipped projectile weapons were manufactured by Stone Age people for the purpose of forming composite tools used for hunting and related activities such as cutting and wood or bone processing (Shea 2006; Wendorf and Schild 1992). Composite tools (projectiles) are generally composed of different types of materials such as a wood shaft, sinew wrap and stone tip. Projectile weapons possess diagnostic and aerodynamic design characteristics as explained in Chapter 7. They are small in size, light, thinned in the butt and retouched on the edges to improve their aerodynamic motion, portability and penetration (Hughes 1998). As previously noted, aerodynamic projectiles include throwing spears and arrows (Hughes 1998; Shea 2006, 2009; Thomas 1978). Thrusting spears are not considered to be aerodynamic devices, because they are not released from human hands during hunting. The analysed data indicate that three kinds of weapon systems (arrowheads, throwing spears and thrusting spears) coexisted in Tanzania during the MSA.

### **8.4.1 Arrowhead projectiles**

Arrowhead projectile weapons are composed of bows and arrows. They represent a sophisticated and complex projectile weapon system compared to spears (McEwen *et al.* 1991). A simple bow is commonly made up of a pliable piece of wood, with a string tied to both ends (McEwen *et al.* 1991; Waweru 2007:112). When the string is pulled back, the bow gathers tension. When the string is released, the bow acts as a spring device from which to shoot arrows, one

at a time, at a target (Waweru 2007). An arrow is formed by a wooden shaft and stone or metal tip attached onto the distal end by using mixed ingredients such as mastic, sinew, animal tendon and powdered ochre or glue (Lombard 2007; Wadley and Jacobs 2004). Arrowhead projectiles are light, small and thin because of their aerodynamic requirements. Point tips attached onto shafts are small and have sharp acute angles to facilitate their penetration into the prey (Ellis 1997). The lightness and sharpness of arrows enable them to travel faster and penetrate deeper into the prey's body, causing a lethal wound and extensive bleeding (Ellis 1997).

#### **8.4.2 Throwing spear projectiles**

A throwing spear an (atlatl or dart) is formed from a stone tip attached onto the distal end of light wooden shaft (Thomas 1978). Throwing spear projectiles are symmetrical in form; their butts and edges are retouched to facilitate hafting, distribution of weight, as well as aerodynamic ability and wounding capability. Points used for throwing spears are broad because wooden shafts attached to them are larger and are designed to withstand unintentional breakage. They are characterised by sharp acute angles, which enable them to penetrate animal skin and underlying tissues, causing a lethal wound. According to Hughes (1998), design features of tips used for throwing spears and those used for arrows are closely related, sometimes overlapping each other. Data from this study indicate that TCSA values for throwing spears range between 55.3 mm<sup>2</sup> and 82.7 mm<sup>2</sup> (Table 8.5)

### **8.4.3 Thrusting spears**

Thrusting spears are hand delivered weapons used over a short distance between the hunter and the prey (Hughes 1998). They are expected to be broader, thicker, and heavy enough to withstand the impact force that may cause unintentional breakage (impact fractures). Their performance criteria are governed by penetration power and durability. Durability is needed for repeated impact into the body of an animal and to increase a hunter's safety (Hughes 1998; Thomas 1978). Sometimes tips designed as inserts for thrusting spears were made from rocks with high compression strengths and low tensile strengths such as basalt, chert and quartzite. These appear to control impact force better than other materials and have a low rate of unintentional breakage (Hughes 1998). Despite their flightless characteristics, thrusting spears are said to have a high return rate compared to other prehistoric projectile devices, so they were often used for hunting large mammals (Hughes 1998).

## **8.5 Metric Measurements and geometric ratios**

### **8.5.1 Length, breadth, thickness and platform breadth**

Point length is the maximum distance between the distal and proximal ends of a flake or blade. It is constrained by the size of the core from which the flake blank was detached, as well as by retouch and thinning of the butt. The function of a projectile weapon depends on its length, because length influences the weight and flexibility, as well as the ability of the spear or arrowhead to disperse energy efficiently (Hughes 1998). Ideally, the length of points can be



adjusted to meet the functional requirements of a specific weapon system depending on its functional requirements.

Breadth is the greatest distance perpendicular to the long axis of a point. This variable also contributes to the weight of the projectile weapon. Spear tips were wider and heavier than arrow tips because spear tips were attached onto broader wooden shafts. Ideally, the ratio between breadth and length of a specific assemblage is consistent and it defines the balance, stability and shape of a specific tip (Hughes 1998). The broadest portion between the point breadth edges of points in conjunction with thickness determines the TCSA value and penetration power of the projectile (Hughes 1998).

The maximum thickness refers to the maximum measurement at a right angle to the lateral margin (Clark and Kleindienst 1974). Ideally, projectile weapons were thinned on their proximal ends or medial portions to facilitate hafting and to distribute weight along the midline. However, points should be thick enough to withstand the impact force that may create fractures or unintentional breakage. Points with small breadth and narrow thickness are better for penetration, because of their reduced TCSA values.

Table 8.1. Estimated mean values of North American stone tips used as inserts for the ethnographic and experimental thrusting spears, throwing spears and arrows (Hughes 1998; Shea 2006, 2009; Shott 1993; Thomas 1978).

| Weapon system                 | Length<br>(mm) | Breadth<br>(mm) | Thickness<br>(mm) | Weight<br>(g) | TCSA<br>(mm <sup>2</sup> ) | SD | B/L<br>ratio |
|-------------------------------|----------------|-----------------|-------------------|---------------|----------------------------|----|--------------|
| Ethnographic arrowheads       | 29.7           | 14.7            | 3.9               | 2.1           | 33                         | 20 | 0.5          |
| Experimental arrowheads       | 29.5           | 14.7            | 4                 | 3≤11          | 47                         | 20 | 0.5          |
| Throwing spears (dart)        | 46.2           | 22.9            | 4.9               | 4 ≤9          | 58                         | 18 | 0.5          |
| Experimental thrusting spears | —              | —               | —                 | —             | 168                        | 89 | 0.5          |

Table 8.2. Mean maximum breadth, length and breadth/length ratios for points from Mumba, Nasera and Magubike.

| Variable  | Number | Breadth (mm) | Length (mm) | B/L ratio |
|---|--------|--------------|-------------|-----------|
| North America ethnographic arrowheads           | 132    | 14.7         | 29.7        | 0.5       |
| North American Ethnographic throwing spearheads | 10     | 22.9         | 46          | 0.5       |
| Mumba MSA points                                | 57     | 15.8         | 34.1        | 0.5       |
| Nasera MSA points                               | 16     | 19.8         | 33.2        | 0.6       |
| Magubike MSA points                             | 117    | 22.4         | 33.9        | 0.6       |
| Mumba MSA/LSA points                            | 47     | 14.8         | 27.1        | 0.5       |
| Nasera MSA/LSA points                           | 24     | 12.9         | 26.8        | 0.5       |

Table 8.3. Metric dimensions and ratios between the maximum platform-breadth and overall breadth.

| Site                      | Number | Breadth (mm) | P-breadth (PB) (mm) | PB/B ratio |
|---------------------------|--------|--------------|---------------------|------------|
| Mumba MSA (Beds VI A & B) | 57     | 15.8         | 11.4                | 0.7        |
| Nasera MSA (Levels 12-25) | 16     | 19.8         | 16.2                | 0.8        |
| Magubike MSA              | 117    | 22.4         | 20.0                | 0.8        |
| Mumba SII (Bed V)         | 47     | 14.8         | 12.3                | 0.8        |
| Nasera SII (Levels 6-12)  | 24     | 12.9         | 10.5                | 0.8        |

### **8.5.2 The ratio between the maximum breadth and length (B/L)**

According to Hughes (1998), the ratio between the maximum breadth and the maximum length defines the aerodynamic properties and shape of points. A low ratio of breadth/length (B/L), measuring less or equal to 0.5, represents long lanceolate bit shapes, while points with breadth/length ratios slightly greater than 0.5 represent short triangular or elliptical points (Hughes 1998). In most cases, points with low breadth/length ratio values, equal to or less than 0.5, represent elongated points used for spearhead and arrowhead projectiles. Ethnographic and experimental studies carried out in North America indicate that points with breadth/length ratios below 0.5 were lanceolate in form and were mainly used as inserts for spears (Hughes 1998). Nevertheless, most North American spearhead and arrowhead projectiles have breadth/length ratios close or equivalent to 0.5 (Hughes 1998; Shott 1993; Thomas 1978).

In this study the breadth/length ratio value was used to examine the shape and aerodynamic properties of the MSA and MSA/LSA transition points from Mumba, Nasera and Magubike. Measurements of breadth and length were taken on 261 points; 190 points were from the MSA assemblage and 71 from the MSA/LSA transitional assemblages. The analysed samples reveal that breadth/length ratios range between 0.5 and 0.6, indicating that they were used as inserts for spears and arrows (Table 8.2). Triangular points with sharp angles, elliptical blanks and smooth and thinned butts are the most common in the MSA assemblages in sub-Saharan Africa (Clark 1988; McBrearty and Brooks 2000; Mehlman 1989).

### **8.5.3 The ratio between the maximum platform breadth and overall breadth**

The mean ratio value between the platform breadth and overall maximum breadth was measured in order to examine whether butt modification was a continuous process aimed at meeting hafting requirements and functional needs. In this study, platform-breadth is also referred to as butt-breadth. It was measured as the maximum breadth at the proximal end of the specific point. The PB/B ratio value needed for aerodynamic and hafting requirements is ideally less than 1. A ratio value greater than or equal to 1 indicates that the butt was slightly thicker and was unmodified for hafting (Hughes 1998). Point-platforms were shaped to form a smooth binding portion connecting stone tips and wooden shafts. Thicker points with greater PB/B ratio values tend to protrude from wooden shafts, hindering the penetration power of a projectile into prey. The results from analysed samples at Mumba, Nasera and Magubike show that the ideal platform-breadth/breadth value was less than 1. This indicates that they were often thinned to meet hafting, aerodynamic and penetration requirements (Table 8.3).

Data presented in Table 8.3, indicate that the maximum platform-breadth value is smaller than the maximum breadth of the points, indicating that their butts were intentionally reduced in size to allow hafting. Although thinning the butt is partially due to the hafting requirements, it may also have been aimed at meeting aerodynamic and penetration needs. The platform-breadth/breadth ratio values for the MSA points at Mumba, Nasera and Magubike range between 0.7 and 0.8 (Table 8.3). This indicates an intentional thinning of point butts. Slight variations in the platform-breadth/breadth ratio values among the MSA points

from these sites suggest that variation in butt shapes and sizes may have resulted from a number of manufacturing processes and use constraints. Factors related to the manufacturing processes include thinning, sharpening, core size, flake blank size and quality or form of lithic raw materials. Sometimes points with broad and thick platforms were needed for spears, while those with thin and narrow platforms were used as arrows.

## **8.6 Weight**

Weight is an important parameter because it balances and stabilizes the thrown or thrust weapon (Hughes 1998). It determines covered distance, penetration power, durability and accuracy of the specific weapon system. Because of the difference in weapon systems, the weight required for spearheads and arrowheads differs. In order to balance a projectile, broad and heavier projectiles are used with large spear-shafts. Lighter projectiles are used with throwing spears or arrows (Brooks *et al.* 2006; Hughes 1998). Sometimes, the mean weight for tips used with throwing spears and arrows overlaps, depending on the size of the wooden shafts in which they are inserted (Evan 1967). Experimental and ethnographic evidence show that the ideal mean weight of stone tips used for arrowheads and throwing spearheads ranges between 3 g and 11 g (Table 8.4).

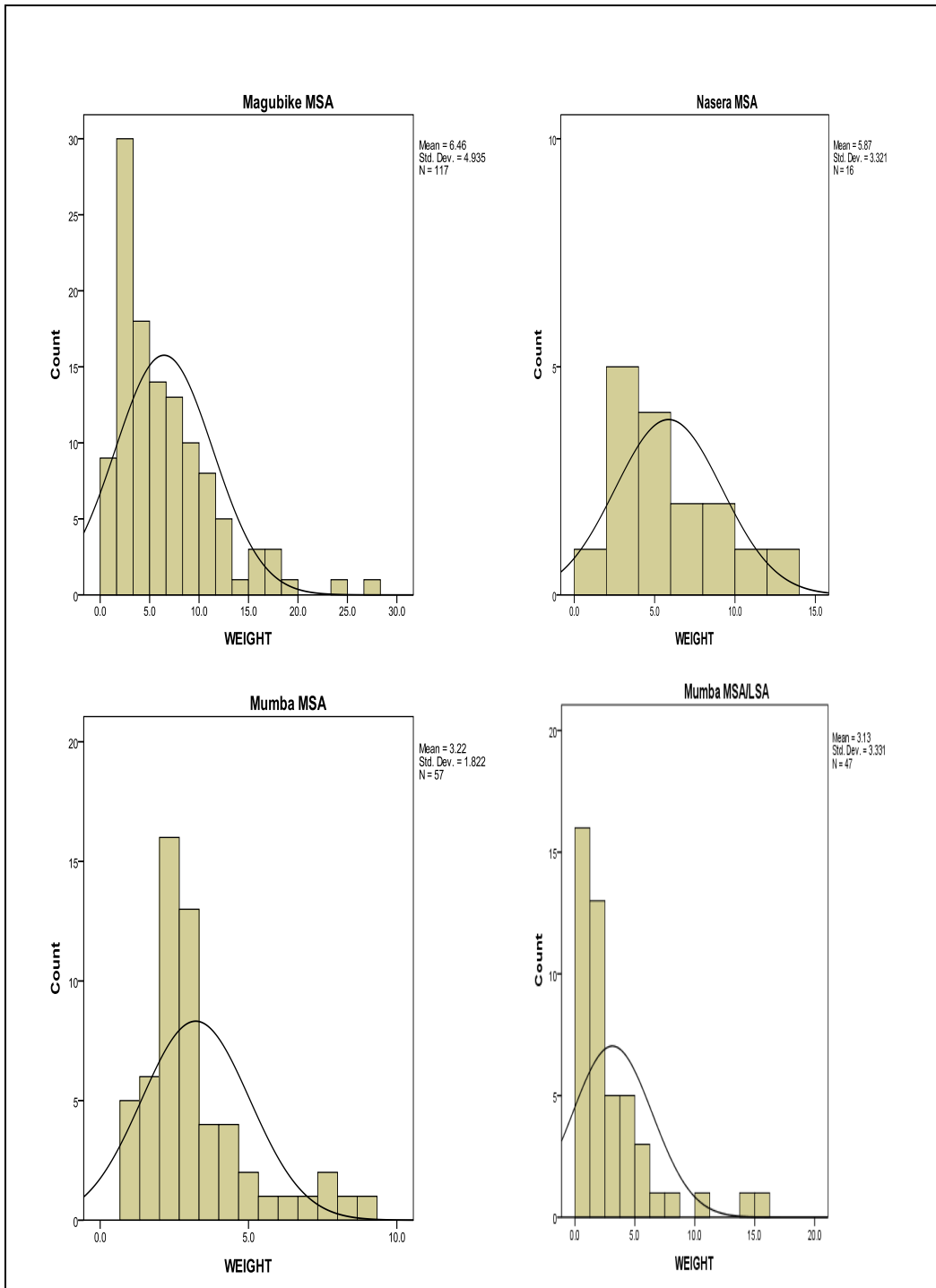


Figure 8.2. The normal distribution of the point weight values of the MSA and SII points from Magubike, Nasera and Mumba.

Table 8.4. Mean weight value and SD of ethnographic, experimental and archaeological points.

| Variable                         | Number | Weight (g) | SD   | Source                    |
|----------------------------------|--------|------------|------|---------------------------|
| Ethnographic arrowheads          | 132    | 3.1        | 0.3  | Thomas 1978               |
| Experimental arrowheads          | —      | 11.0       | —    | Hughes 1998               |
| Ethnographic throwing spearheads | 10     | 4.4        | 2.1  | Thomas 1978               |
| Experimental throwing spearheads | —      | 9.0        | —    | Hughes 1998               |
| Tabun Middle Palaeolithic points | 9      | 12.6       | 6.0  | Brooks <i>et al.</i> 2006 |
| Cartwright's MSA points          | 72     | 10.2       | 7.4  | Waweru 2007               |
| Gi MSA points                    | 299    | 11.8       | 7.2  | Brooks <i>et al.</i> 2006 |
| Early Aduma MSA points           | 16     | 50.1       | 43.9 | Brooks forth coming       |
| Aduma MSA points                 | 68     | 8.8        | 6.0  | Brooks forth coming       |
| Mumba MSA points                 | 57     | 3.2        | 1.8  | Sample analysed here      |
| Mumba MSA/LSA points             | 47     | 3.1        | 3.3  | Sample analysed here      |
| Nasera MSA points                | 16     | 5.9        | 3.3  | Sample analysed here      |
| Nasera MSA/LSA points            | 24     | 2.3        | 1.8  | Sample analysed here      |
| Magubike MSA points              | 117    | 6.4        | 4.9  | Sample analysed here      |

Table 8.5. Mean TCSA and SD of ethnographic, experimental and archaeological projectiles (K  $\approx$  1000 years).

| Weapon systems                 | Age (ka) | Number | TCSA (mm <sup>2</sup> ) | SD   | Sources                        |
|--------------------------------|----------|--------|-------------------------|------|--------------------------------|
| Ethnographic arrowheads        | —        | 118    | 33                      | 20   | Shea 2006, 2009; Thomas 1978   |
| Experimental arrowheads        | —        | —      | 47                      | —    | Hughes 1998                    |
| Ethnographic darts             | —        | 40     | 58                      | 20   | Hughes 1998; Shea 2006, 2009   |
| Ethnographic thrusting spears  | —        | 28     | 168                     | 89   | Shea 2006                      |
| Levant UP (Emireh points)      | 30-4     | 47     | 132                     | 85   | Shea 2006                      |
| Levant MP points               | 80-130   | 749    | 135                     | 67   | Shea 2006                      |
| Kebara IX-XII Levallois points | —        | 61     | 55                      | 19   | Shea 2009                      |
| Epic Cave unifacial points     | 77.5     | 76     | 45                      | 9    | Ambrose 2002; Shea 2009        |
| Epic Cave bifacial points      | 77.5     | 22     | 49                      | 9    | Ambrose 2002; Shea 2009        |
| Cartwright's MSA points        | —        | 74     | 91.1                    | 36.7 | Waweru 2007                    |
| Rose Cottage MSA points        | 57-33    | 47     | 78                      | 33   | Mohapi 2007                    |
| Sibudu Cave MSA points         | 60-36    | 21     | 116.2                   | 41.5 | Villa & Lenoir 2009            |
| Klasies River MSA I-II points  | 115      | 150    | 86                      | 19   | Shea 2009                      |
| Blombos Cave Still Bay points  | 73-140   | 90     | 45                      | 20   | Henshilwood <i>et al.</i> 2001 |
| Aterian tanged points          | 30-50    | 29     | 59                      | 13   | Shea 2009                      |
| Magubike MSA points            | 150      | 117    | 82.7                    | 40.9 | Sample analysed here           |
| Mumba Beds VIA & B points      | 110-132  | 57     | 55.3                    | 23.1 | Sample analysed here           |
| Nasera MSA points              | 56       | 16     | 80.2                    | 35.3 | Sample analysed here           |
| Mumba MSA/LSA points           | 65-35    | 47     | 51.4                    | 38.7 | Sample analysed here           |
| Nasera MSA/LSA points          | 27       | 24     | 38.6                    | 23.9 | Sample analysed here           |

The overall mean weight for the analysed point samples shows that the majority of them fall within the range of arrowhead and throwing spears (Table 8.4). Their mean weight values fall within the range of throwing spears and arrows, measuring between 2.3 g and 6.4 g (Table 8.4). With the exception of points from the MSA site of Aduma in Ethiopia, the majority of points from the MSA sites of sub-Saharan Africa, indicate that their mean weight falls within the range of arrowheads and throwing spearheads.

At Magubike, the distribution of MSA points shows two clusters of weight values (Figure 8.2). The first cluster, with a mean weight value ranging between 1 and 11 g (Figure 8.2), represents points used as tips for throwing spears and/or arrows. The second cluster has a mean weight value of greater than 12 g at Nasera and 15 g at Magubike, suggesting that some points were used as tips for thrusting spears (Figure 8.2). However, the frequency distribution at both Nasera and Magubike indicates that thrusting spear weapon systems were not preferred.

An assessment of the mean weight values for different types of raw materials indicates that heavier, broader and thicker points were made from metamorphic and quartzite rocks (Table 8.6). The distribution of weight values depicted on the x axis (Figure 8.2), suggests the existence of multi-weapon systems (arrows, throwing spears and thrusting spears) at Magubike and Nasera. At Mumba, the weight values indicate that the analysed sample falls within the range of arrowhead and throwing spearhead projectiles (Figure 8.2), but lighter points ranging between 2 and 4 grams were common. At Nasera and Magubike the amounts of points tend to decrease as they get heavier, indicating that lighter



points were preferred (Figure 8.2). However, heavier points are fairly represented, indicating that thrusting spears were occasionally utilized. Perhaps the variation in point weight revealed at Nasera, Mumba and Magubike is due to the functional requirements where heavier points were needed for thrusting spears and lighter ones for throwing spears and/or arrows.

### **8.7 Tip Cross-Section Area (TCSA)**

The tip cross-section area (TCSA) value is an important parameter because it binds the stone tip and wooden shaft and determines the limit of penetration (Thomas 1978). Projectile weapons with thin elliptical cross sections are excellent for hafting and penetrate prey better than thick ones. Projectiles with thick or broad TCSA values go along with spears and they withstand unintentional breakages or impact fractures better than thin ones (Hughes 1998). Points with low TCSA values often break on impact when used as inserts for thrusting spears (Hughes 1998; Shea 2006).

Because TCSA governs an attachment area that connects foreshaft and stone tip, its morphological appearance is crucial for functional requirements such as penetration power and ballistic requirements. In most cases, penetration power is facilitated by thinning the butt to avoid protrusion of portions of the point on to the wooden shaft. Experimental and ethnographic studies undertaken in North America indicate that estimated mean TCSA value for thrusting spears range between 168 mm<sup>2</sup> and 210 mm<sup>2</sup> (Hughes 1998). Shea (2009) argues that points with mean TCSA values exceeding 100 mm<sup>2</sup> perform better when used with

thrusting spears and those measuring less than 100 mm<sup>2</sup> perform better when used with throwing spears. Estimated mean value for arrowheads range between 33 mm<sup>2</sup> and 47 mm<sup>2</sup> (Hughes 1998; Shea 2006; Thomas 1978). Sometimes the mean TCSA value of arrowheads and throwing spearheads (darts) projectile overlap each other (Hughes 1998:365). The idea of overlapping raised by Hughes (1998) was supported by recent experimental study on duplicated MSA points in Kenya, whereby points with TCSA value equivalent or slightly greater than 70 mm<sup>2</sup> performed better with bow and arrows (Waweru 2007).

Statistical data presented in Table 8.5 indicate that African MSA points, including those from Mumba, Nasera and Magubike, were used as arrowheads or throwing spearheads. The TCSA values of the MSA points analysed here fall within estimated the TCSA value of throwing spears, and range between 55.3 mm<sup>2</sup> and 82.7 mm<sup>2</sup> (Table 8.5). Samples from Mumba show significantly smaller than estimated TCSA values for throwing spears (Table 8.5), indicating they may have been used as tips for arrows or throwing spears. The analysed data shows that arrowhead projectiles were widely utilized during the MSA/LSA transitional industries at Mumba and Nasera. At Mumba, the mean TCSA value of points from the transitional industry is about 51.4 mm<sup>2</sup>, slightly greater than the estimated value of arrowhead projectiles. But the overall patterns suggest that they were used either as arrowheads or throwing spearheads (Table 8.5). At Nasera points from the transitional industry have an estimated mean value of 38.6 mm<sup>2</sup>; this falls within the range of an arrowhead weapon system (Table 8.5). When compared to ethnographic, experimental, and archaeological records from

other MSA points of sub-Saharan Africa and Middle Palaeolithic (MP) points from the Levant (Table 8.5), it shows that points from Mumba, Nasera and Magubike were used as tips for throwing spears and/or arrows.

### **8.8 Variation in weapon systems**

Variations in weapon systems at Mumba, Nasera and Magubike were assessed using a Kolmogorov-Smirnov (KS) test. This test compares the differences in cumulative distributions for two independent samples. Figures 8.3a and 8.3b, compares the TCSA value distributions for the MSA points from Magubike, Mumba and Nasera and to identify if they were used in different ways, depending on hunting situations and/or ecological adaptations. The cumulative distributions of the TCSA values in Figures 8.3a indicate that there was discrepancy in the TCSA values between the MSA points from Magubike and Mumba. The distributions of TCSA values have a maximum difference of 0.432 ( $p < 0.016$ ) indicating that the two samples are different (Figure 8.3a). The difference seen in the TCSA values among the MSA points at Mumba and Magubike may suggest the existence of different weapon systems.

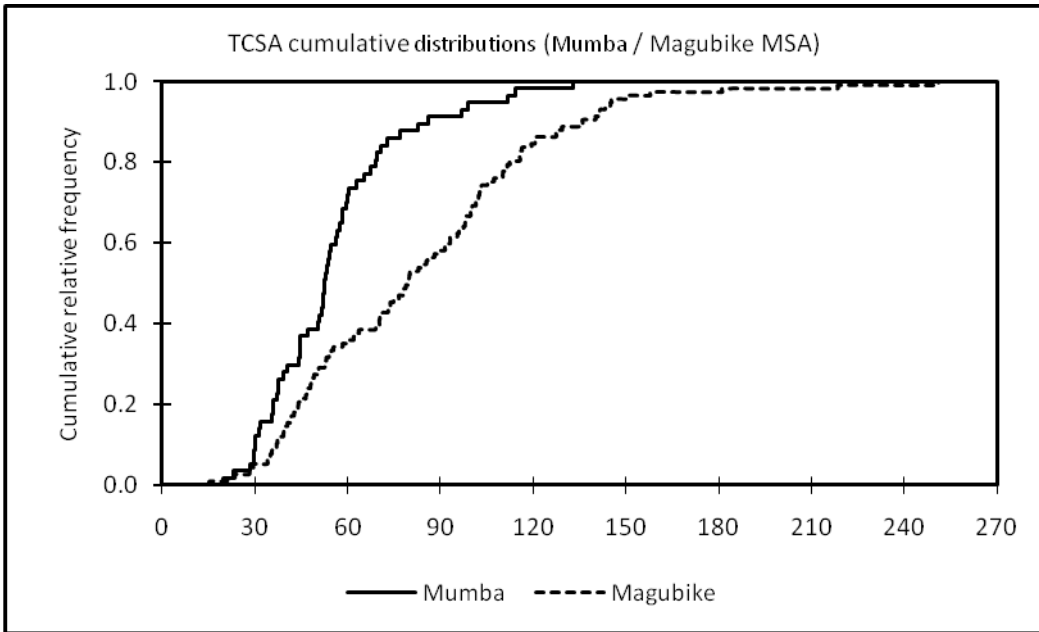


Figure 8.3a. Cumulative distributions of the TCSA values on MSA points from Mumba and Magubike.

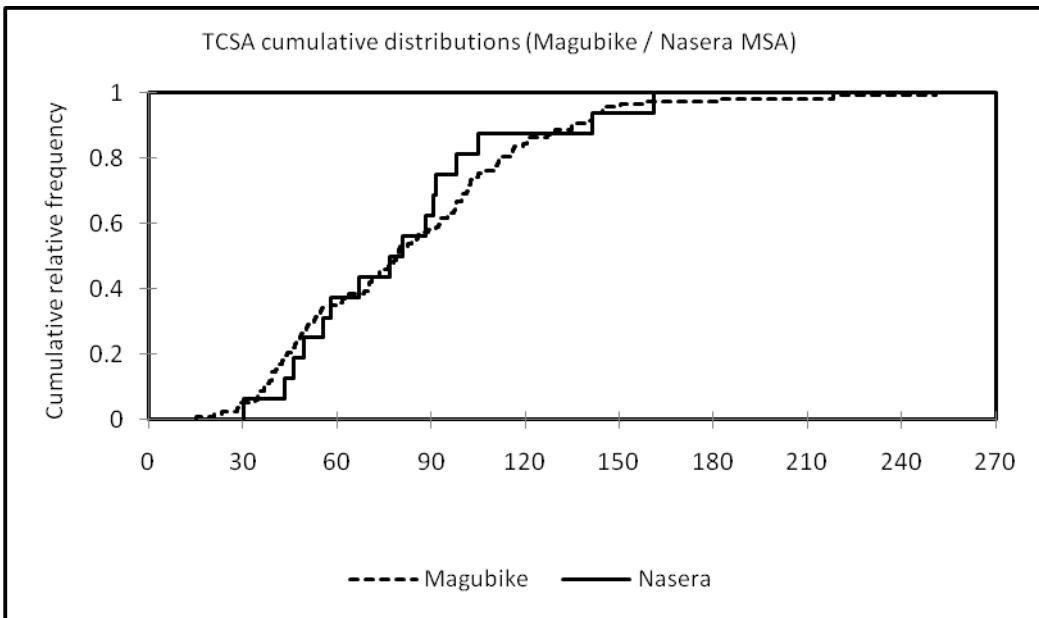


Figure 8.3b. Cumulative distributions of the TCSA values on MSA points from Magubike and Nasera.

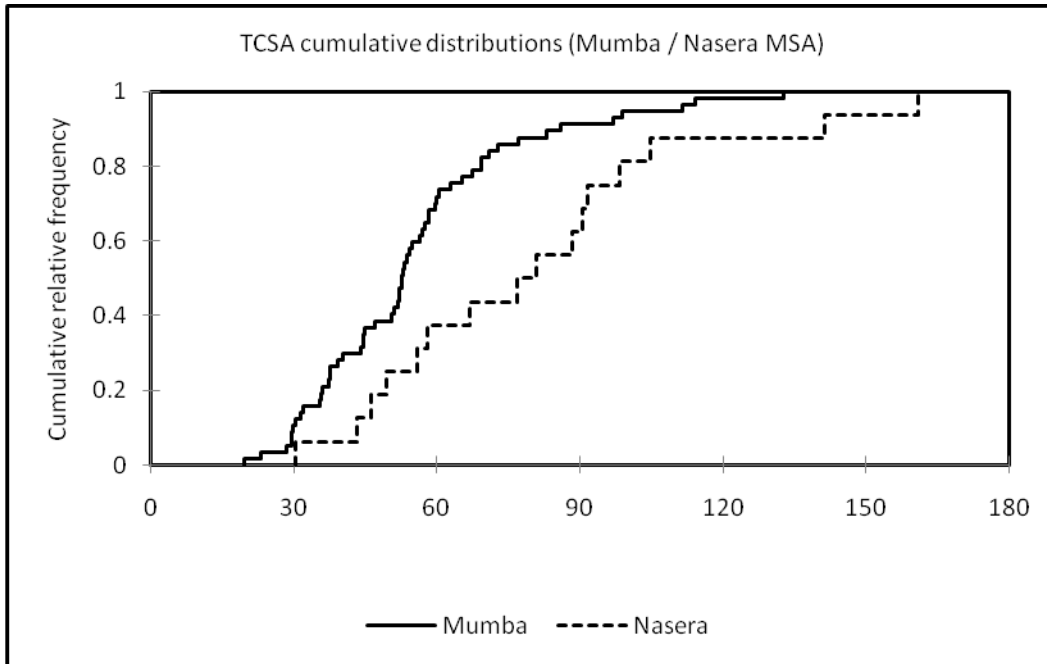


Figure 8.4a. Cumulative distributions of the TCSA values on MSA points from Mumba and Nasera.

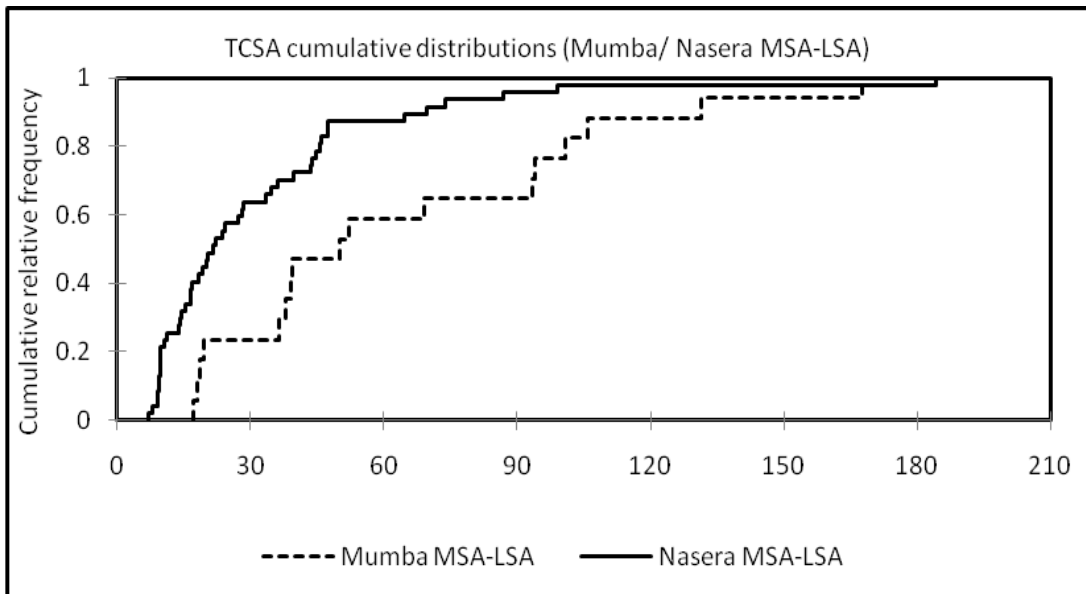


Figure 8.4b. Cumulative distributions of the TCSA values on MSA/LSA transition points from Mumba and Nasera.

The technological skills and hunting strategies employed by MSA people at Magubike were somehow different when compared to those applied at Mumba. Probably, these variations in weapon systems were partially influenced by ecological settings such as the woodlands of the southern highlands versus the grassland of northern Tanzania (Clark 2001; Hamilton 1982). Nevertheless, the cumulative distributions of the TCSA values for the MSA points from Magubike and Nasera (Figures 8.3b) have a maximum difference of 0.160 ( $p < 0.008$ ) indicating that the two samples follow the same distributions. Evidence from Mumba, Nasera and Magubike suggest that the MSA points in sub-Saharan Africa were probably used in various ways depending on functional requirements, hunting situations and/or ecological adaptations.

The hypothesis for different weapon systems and the continuity in technological skills between the MSA and MSA/LSA assemblages was further assessed by looking at the cumulative distributions of TCSA values for the MSA and MSA/LSA points from Mumba and Nasera. Samples from the MSA and MSA/LSA transition at Mumba and Nasera follow the same distributions, but the TCSA values have maximum differences of 0.422 ( $p < 0.016$ ) for the MSA points and 0.467 ( $p < 0.015$ ) for the MSA/LSA transition assemblage. This trend suggests that lithic points from Mumba and Nasera were used in different ways (Figures 8.4a and 8.4b). The mean TCSA values (Table 8.5), indicate that two weapon systems, throwing spear and arrow projectiles, coexisted at Mumba and Nasera during the MSA and MSA/LSA transition. Nevertheless, the TCSA values suggest that arrowhead projectiles were more abundant during the MSA/LSA

transition. It is likely that, as time passed, spears were greatly replaced by the bow and arrow weapon system. This trend reveals that technological change was a continuous process and that changes in weapon systems from spearheads to arrowheads passed through a gradual process.

The results from the Kolmogorov-Smirnov test indicate the existence of different weapon systems at Mumba, Nasera and Magubike in the MSA and MSA/LSA transition. Prehistoric foragers may have been capable of using throwing spear and arrow projectile technologies. Spears are commonly made from durable rock cobbles. When hunting with spear, the ratio of food gained relatively to the amount of energy invested is significantly higher compared to arrows. But arrows are regarded as superior for accuracy and distance shooting (Hughes 1998).

The two weapon systems: spears and arrows coexisted and they were utilized in a comparable ways. The idea of the existence of multi-weapon systems was underestimated in previous studies. Many researchers keep focusing on one way to determine whether MSA points were used as spearheads or arrowheads (Brooks *et al.* 2006; Mohapi 2007; Shea 2006, 2009; Waweru 2007). A moderate variation of the cumulative distribution of the TCSA values may suggest that MSA points were used in various ways. Perhaps they were used as inserts for different hunting weapons, including spears and arrows. Ethnographically, the use of multi-weapon systems in hunting has been documented among modern groups such as the Tyua of the Kalahari Desert in Botswana (Hitchcock and Bleed 1997). Tyua hunters use spears to hunt large mammals such as giraffe, rhinoceros or/and

elephant, and arrows for hunting small and medium sized mammals such antelope or hartebeest (Hitchcock and Bleed 1997). Among the Tyua, spears are not only used for the purpose of obtaining meat, but also for social and symbolic status (Hitchcock and Bleed 1997).

### **8.9 Durability**

Both the ecological setting of Magubike and the appearance of thrusting spears, support an idea raised by Hughes (1998), that confrontational weapons were widely used in woodland environments. Weapons needed for hunting in close proximity were made from durable rocks that could withstand impact fractures. Durability can be examined by calculating compression and tensile strengths, which define the ability of a specific rock type to withstand impact force stress (Hughes 1998). Both compression and tensile strengths are measured in a unit of force per unit area (mpa). Rock types with high compression strengths have high values for the maximum load a material can support without fracture; this is when they are stretched to the original cross section area (Hughes 1998). This pattern indicates that the TCSA values and compression strengths can influence the capacity of a specific tool to withstand fractures and unintentional breakage. Rocks with high compression strengths are characterized by lower tensile strengths; this combination allows them to withstand higher impact force because of their high elasticity capability (Hughes 1998). Stone tools made from durable rocks such as chert and quartzite are flexible and can completely or



partially return to their original size and shape after impact force stress (Hughes 1998).

Ideally, points with high TCSA values are correlated with spearhead technology because they can better withstand impact stress without fracture when thrown into prey. Volcanic (basalt), quartzite and chert are regarded as durable materials because of their high compression and low tensile strengths (Table 8.6). Rocks with high tensile strengths, such as obsidian and quartz, are brittle in the sense that they can often break easily when affected by impact force stress (Hughes 1998). These are more abundant in many archaeological sites because they can make sharp tools that better penetrate an animal's body. They break easily in the body of the prey, a process that facilitates internal bleeding and animal suffocation (Allies 1997:56). Stone points made from brittle rocks are reliable for hunting with bow and arrows where a portion of the point embedded in animal body can cause animal suffocation and limit the distance the animal can travel after being shot.

The mean dimension in a box plot (Figure 8.5), indicate that points made from durable rocks such as chert and quartzite have high TCSA values. Brittle rocks such as quartz and obsidian were used with lighter tools such as arrows and light spears. Points made from quartz and obsidian are characterized by low TCSA values compared to those made from quartzite and chert (Table 8.6). This trend is apparent when the TCSA values of points made from different raw materials are compared (Figure 8.5). The need for durable rocks for spearhead projectiles is obvious at Magubike where quartzite and metamorphic rocks were

regularly utilized, probably because of their accessibility and durability. The selection of durable rocks for spears should not only be correlated with the purpose of obtaining meat; it also indicates the level of intelligence and technological capability of the toolmaker.

Spears points were made of durable rocks, perhaps because they were designed to store added weight and increased durability. As previously noted, durability is one of the design features needed for repeated penetration of an animal without breakage. The number of points made from quartzite and other metamorphic rocks at Magubike (Figure 8.5 and 8.6), may suggest that spear projectiles were reliable in the woodland environment that is said to have characterized the southern highlands of Tanzania for most of the Pleistocene (Clark 2001; Hamilton 1982). Although points made of obsidian rocks are less represented (Figure 8.5), their presence may suggest that they were distance-sourced because of their sharpness and brittleness capabilities. Chert has the added advantage that it can make durable tools with high compression strengths and sharp edges (Ellis 1997; Hughes 1998). Distance-sourcing of obsidian and chert as well as the dominance of quartz in the MSA and MSA/LSA transition assemblages suggest that penetration and aerodynamic were also important variables in projectile technology. Points made from quartz predominate, indicating they were designed to enhance penetration and the aerodynamic requirements. The presence of points made of chert, quartzite and metamorphic rocks at Magubike (Figure 8.5 and 8.6) indicates that durability was an ideal advantage in spear hunting.

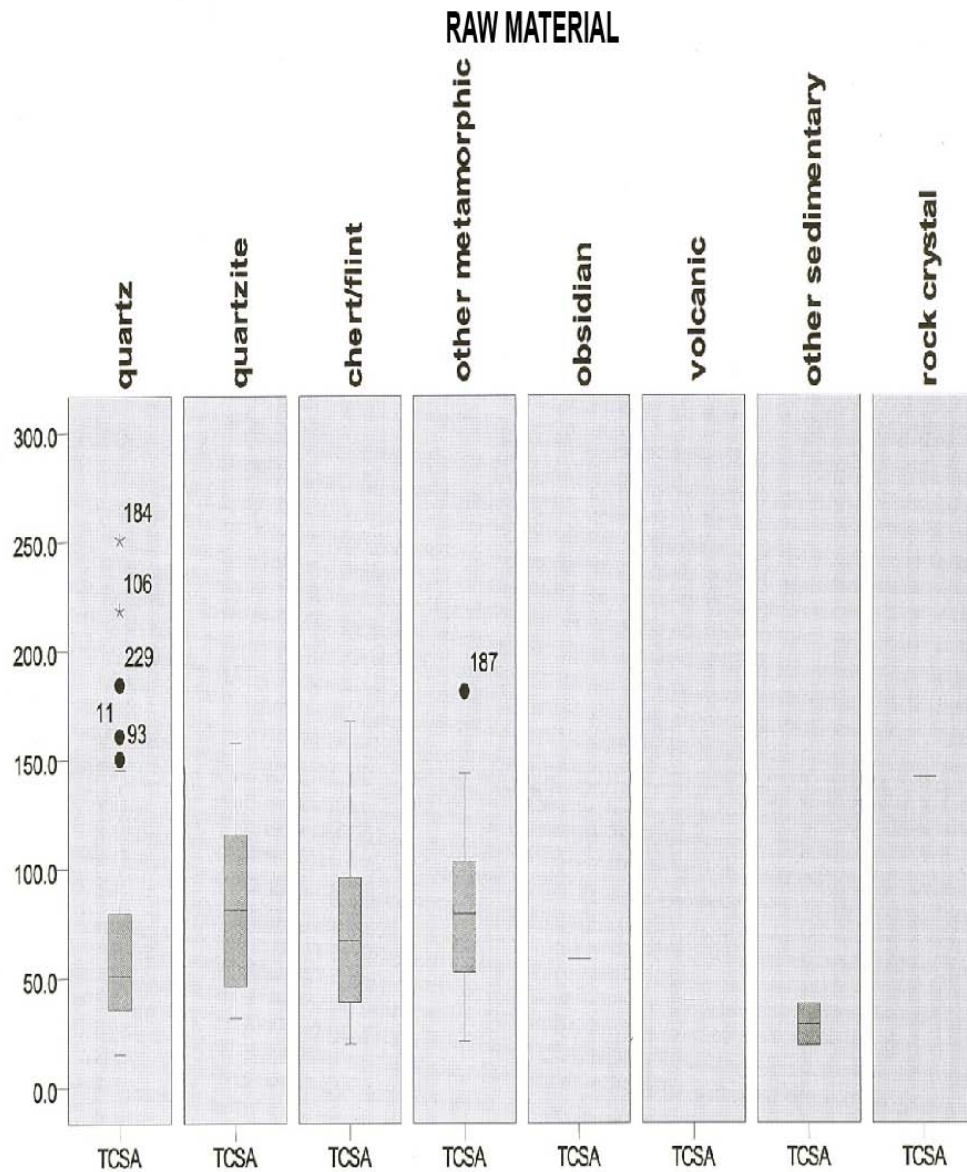


Figure 8.5. The box plot chart indicating the variation of the mean TCSA values of points for different types of raw materials.

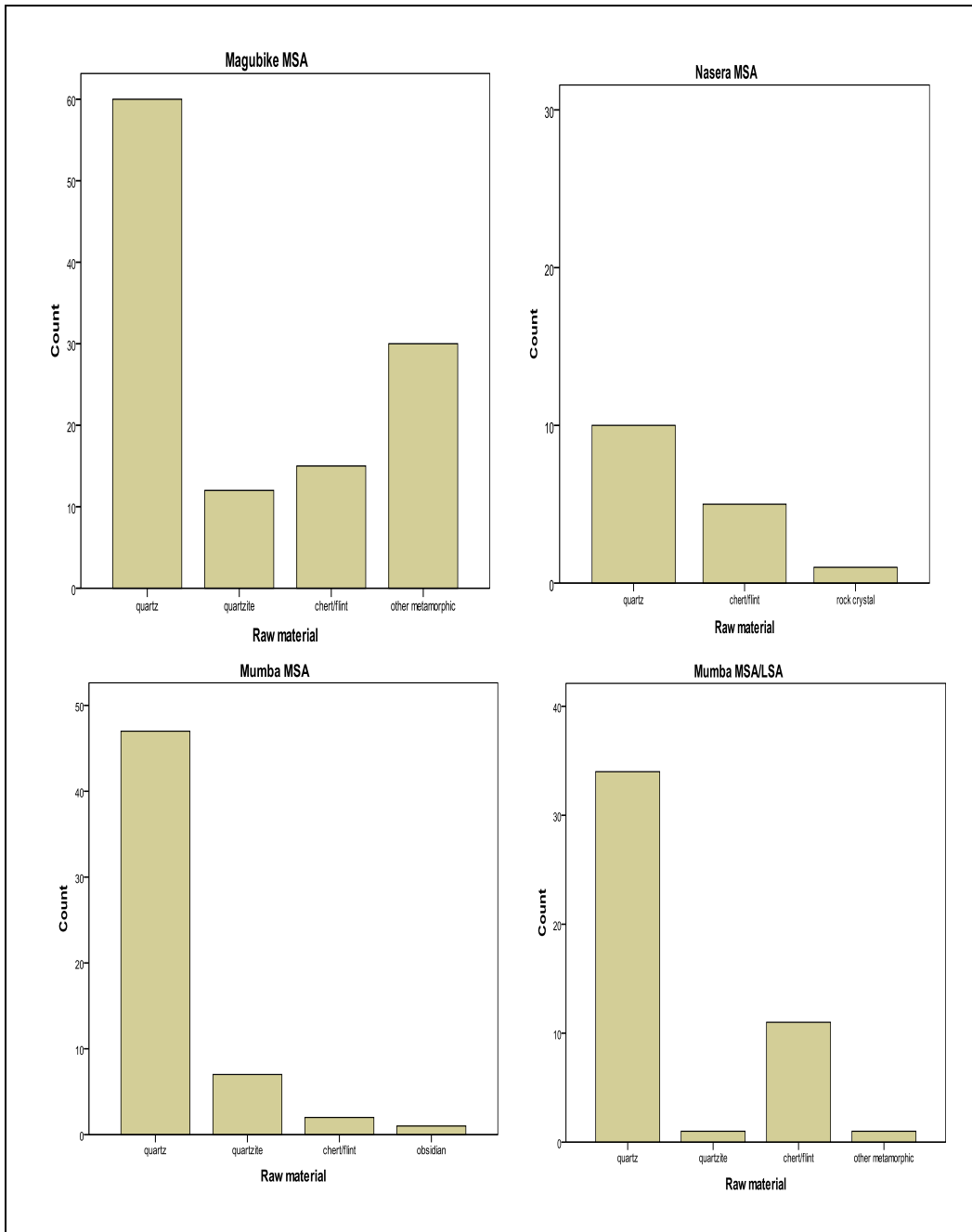


Figure 8.6. The lithic raw materials used for the MSA and MSA/LSA points at Mumba, Nasera and Magubike.

Table 8.6. The TCSA values, tensile and compression strengths of different lithic raw materials (Hughes 1998; Luedtke 1992).

| Raw material type | TCSA (mm <sup>2</sup> ) | Tensile strength (mpa) | Compression strength (mpa) |
|-------------------|-------------------------|------------------------|----------------------------|
| Metamorphic rocks | 83.1                    | —                      | —                          |
| Volcanic (basalt) | —                       | 10 - 29                | 279                        |
| Quartz            | 69.5                    | 167 - 329              | —                          |
| Quartzite         | 87.7                    | 10 - 29                | 302                        |
| Obsidian          | 58.3                    | 215 - 346              | 0.15                       |
| Chert             | 73.6                    | 6                      | 329                        |

Table 8.7. The usewear and impact damage analyses on point samples from Mumba.

| Cat #   | Level | Rock type | Preservation     | Worked material | Type of motion/impact              |
|---------|-------|-----------|------------------|-----------------|------------------------------------|
| M-5-18  | V     | Quartzite | Abraded          | -               | Not identifiable                   |
| M-5/19  | V     | Quartz    | Eroded           | -               | Longitudinal motion                |
| M-6A/4  | VIA   | Quartz    | Eroded           | -               | No striation or polish associated  |
| M-6A/6  | VIA   | Quartz    | Good             | Possible weapon | Impact damage and burination       |
| M-6A/20 | VIA   | Quartz    | Partially eroded | -               | Longitudinal motion and striations |
| M-6A/28 | VIA   | Quartz    | Oxides preserved | Possible wood   | Longitudinal motion                |
| M-6B/61 | VIB   | Quartz    | Oxide preserved  | Possible bone   | Longitudinal motion and striations |
| M-6B/65 | VIB   | Quartz    | Partially eroded | Possible weapon | Impact edge damage and burination  |
| M-6B/71 | VIB   | Quartz    | Good             | Definite weapon | Hafting damage and striations      |
| M-6B/73 | VIB   | Quartz    | Normal           | Possible weapon | Impact edge damage and burination  |

## **8.10 Microwear analysis of the MSA points**

An electron microscopic usewear analysis of some points was possible because of great assistance from Ms. Márquez Balén of the Regional Community Archaeological Museum in Madrid, Spain, who did most of the laboratory work and illustrations. Usewear traces are aimed at assessing functions and material contacted by the analysed point samples (Kay 1996; Odell 1988). Signals related to functions of the analysed point samples were delineated through the trace of microscopic polishes, striations and edge damages (Kay 1996; Odell 1996). Therefore, electron microscopic analysis was undertaken to trace possible signals that could be used to distinguish projectile and non-projectile actions and to some extent material worked (Kay 1996; Keeley 1977, 1980). Ideally, when a stone headed projectile hits a high density substance such as bone or the heavier skin of large mammals, the impact force stress often results in breakages or fractures and symmetrical striations that are distinguishable from non-projectile activities (Hughes 1998; Kay 1996). Fractures related to projectile actions occur at the distal ends and/or close to the proximal ends where wooden shafts and stone tips are connected with hafting ingredients, such as animal tendon, beeswax, tree resin or powdered ochre.

The analysis procedures included an assessment of the state of preservation, direction of motion, edge damage, presence or absence of traces and location of traces. About 10 MSA points collected in 2007 at Mumba were examined. The analysed samples were sent to the Madrid Community Museum in 2008, soon after the attribute analysis of Mumba collections was completed. A

limited sample was taken for microscopic analysis, due to financial issues and the state of preservation of selected samples. The usewear patterns on the analysed samples were delineated based on the state of tool edge morphologies, position of traces, edge damage, striations and polish distributions on a specific point.

As noted in Chapter 4, materials excavated by Michael Mehlman from Mumba and Nasera were not stored appropriately for microwear analysis. This led to micro and macro-breakage. Indeed, it was possible to distinguish breakage related to storage procedures or post-depositional actions, from that created through usewear. At the microscopic level, post-depositional processes are characterized by chaotic striations, abrasion and micro or macro-edge damage. In some cases, abrasion may cause the disappearance of the possible usewear indicators because of the poor state of preservation. Sometimes the disappearance of usewear signals can be linked with under utilization because in a specific case, the tool has not been used for a sufficient length of time (Finlayson and Mithen 1997).

### **8.10.1 Methodological approaches to microwear analysis**

Cleaning procedures were careful undertaken in order to avoid micro- or macro-wear damage. All samples were washed in a solution of water with non-ammonia soap in an ultrasonic tank (Grace 1988, 1989; Levi-Sala 1987). Then they were washed with acetone solvent in order to remove the stains. If no carbon was detected on the surface, no acid was applied. If carbon was detected, chloride hydroxide (ClH) and potassium hydroxide (KOH) acids were used to remove it

(Keeley 1977, 1980; Knutsson 1988). Carbonated samples were washed in a 50% solution of chloride hydroxide acid (CIH) for five minutes and then with clean water. After that, the artefacts were put into another solution of 50% potassium hydroxide (KOH) for another five minutes and cleaned with distilled water in the ultrasonic tank to remove organic residue and to reduce the likelihood of chemically pertaining tool surfaces.

Two electron microscopes were used to trace the usewear and impact damage patterns. An Olympus BX51 stereomicroscope with 5, 10, 20 and 50 magnification was used to trace polish, striation and rounding patterns. An Olympus DP71 binocular microscope with 0, 7 to 9 magnifications was used to trace micro-scars and possible residue remains on tool edges. A magnification range of 100 and 500 diameters, using a reflected-light and differential-interferences microscope with polarized light, was used to register some usewear signals on tool edges. At magnification greater than 100 diameters, an analyst was able to distinguish usewear signals, from natural edge damage or any other modifications related with flaking procedures.

To evaluate wear traces, the full range of magnifications were employed, from 100 to 200, and then to 500 diameters. Both bright and dark field illuminations were used (Balén, personal communication 2010). A tool surface scan of both ventral and dorsal surfaces (as well as of the edges of tools) was done at magnifications of 100 and even 200 diameters. Further examinations at 500 diameters were done whenever possible, to better characterize wear traces. The orientation and location of the photomicrographs were recorded relative to those



of artefacts (Figures 8.7, 8.8 and 8.9). Photomicrography size was determined by photographing a micrometer disk scale at the appropriate magnification. Wear traces were further described, even when not photographed (Balén, personal communication 2010). The location of wear traces discovered at intermediate-range magnifications, relative to edge damage, was also noted in the comparison between microscopic and lower-powered magnifications (Kay 1996). In most cases, there was a direct correlation between edge damage and wear traces near or at the tool edge. As previously noted, alternations and edge damage related the post-depositional processes were noted and differentiated from those related to tool uses, based on their morphological characteristics (Knutsson 1988).

#### **8.10.2: Results of the microwear analysis**

Although microwear analysis was undertaken on limited samples of MSA points from Mumba (Table 8.7), the analysed samples have provided some evidence of tool uses. The main identified tool motion is a longitudinal, cutting motion, but some points have striations and impact damage, suggesting that they were used as projectiles (Table 8.7). At least four points have been found with a smooth and flat polish indicating that they have been used in a longitudinal motion, which is indicative of butchering or cutting actions (Keeley 1977, 1980). Cutting produces progressive striations that are parallel or longitudinal to the cutting edge. For wood processing, tool edges produced rounded polishes (Figure 8.7) similar to those produced by actions on wood. Rounded polishes were often associated with striations perpendicular to the edges. Another point was found

with a little spot of smooth and flat polish similar to that caused by working on bone (Table 8.7). A tool used for bone processing normally produces smooth and flat polish with linear marks parallel to the edge. A modern hunter-gatherer community of northern Tanzania, the Hadzabe, occasionally uses arrow tips for extraction of bone marrow (Personal observation 2004).

Sometimes ambiguous microwear traces appear on the projectiles. These suggest impact and carcass penetration, and are apparent on the proximal ends towards the binding portion. These burin or flute-like polishes often occur on point edges or high spots, or on sloping surfaces near the distal end or penetration angle (Grace 1988; Kay 1996). Polishes often occur with similarly oriented striations (Figures 8.8 and 8.9). Impact striations that are indicative of projectile functions are nearly symmetrical directed towards the penetration portion, like those indicated by micro-photographic numbers 1 and 2 (Figure 8.9). These sometime may result in the breakage of the distal end, like that delineated on micro-photographic number 1 and 2 (Figure 8.8).

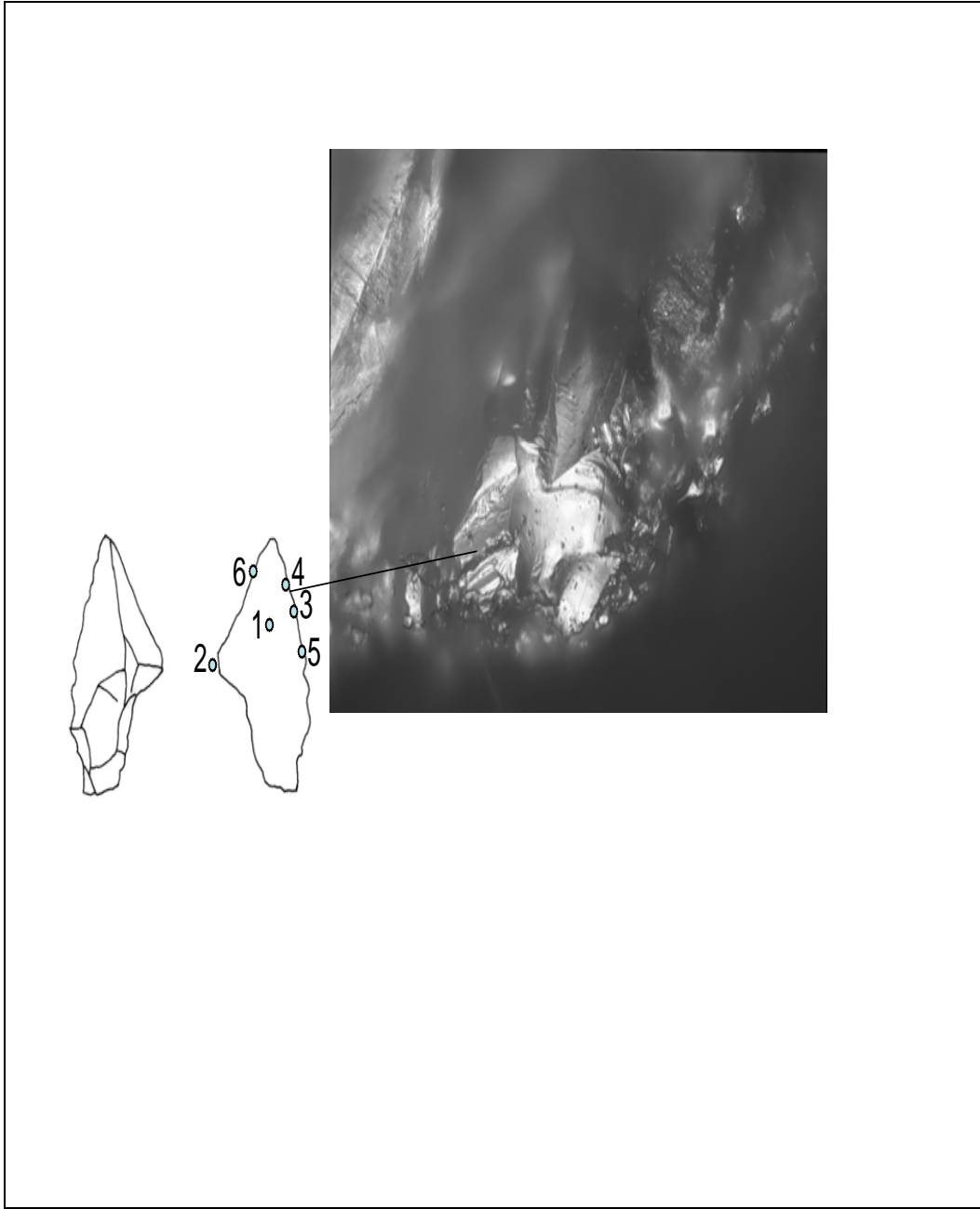


Figure 8.7. Microscopic photograph at 500X on the interior surface with rounded polish, similar to those provoked by actions on wood (illustrated by Márquez Balén).

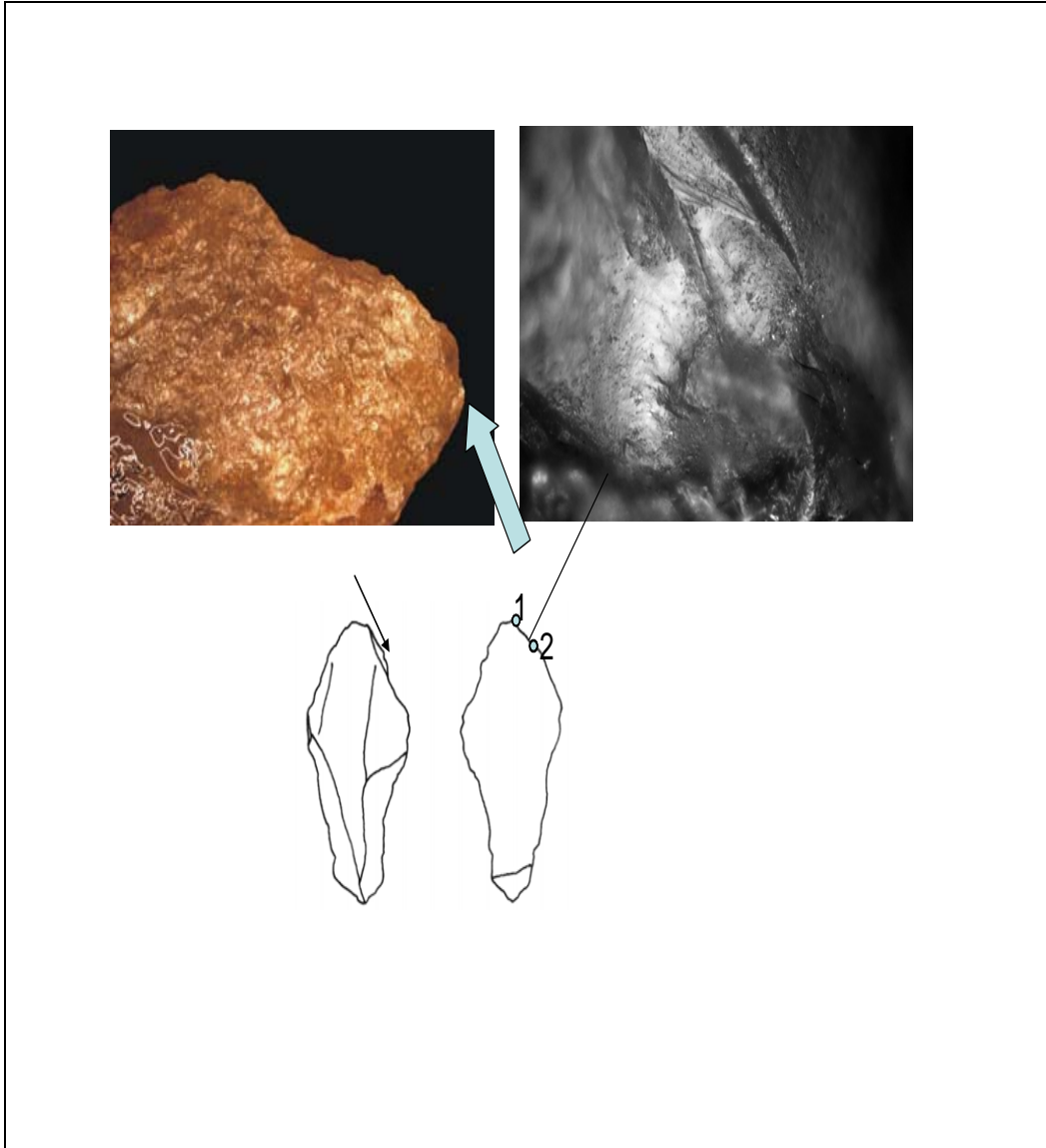


Figure 8.8. Microscopic photograph at 200X, photograph 1 & 2 on the interior surface indicating a burin-like breakage around the tip, which can be correlated with impact damage. Small striations have been found at the ventral side-right edge, which appear parallel to the edge. Polishes are lacking, probably because of post-depositional processes (illustrated by Márquez Balén).

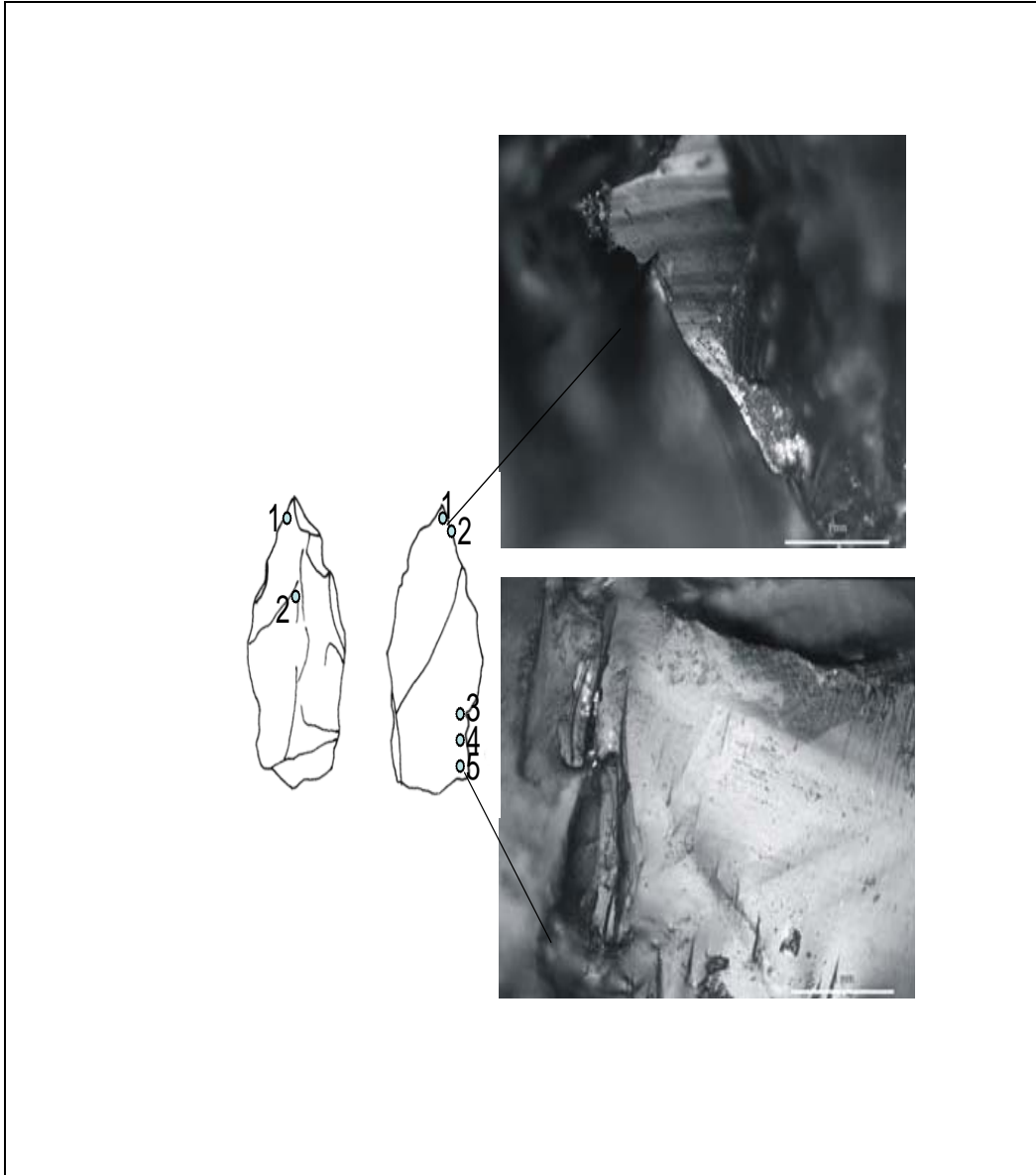


Figure 8.9. Impact striations on top and microscopic haft damage below, viewed at 200X diameter Photograph 1 and 2 indicates impact striations that occur on the dorsal and ventral surfaces produced by projectile actions. Photographic 5 indicates fluted scar that is also indicative of projectile action. Other fractures on proximal ends are associated with non-use processes (illustrated by Márquez Balén).

Four points from the analysed sample displayed features related to projectile action (Table 8.7). They have been found associated with striated micro-polishes, impact damage and fluted scars on the hafting portion, which are all very similar to those of impact fractures. One point has been found with striations on the ventral and interior surfaces and with fluted scars on the hafting portion (Figure 8.9), suggesting that it was used, reworked and reused as a projectile (Balén, personal communication 2010). Figure 8.8 indicates a flute-like signal on the proximal end of the point indicating projectile actions. Another damage pattern, like that indicated on Figure 8.9, does not represent impact damage. It may have been produced by retooling or through non-use processes.

### **8.11 Implications of these studies**

Hunting practices have been integrally correlated to the type of weapons employed. According to Shea (2009), points with TCSA values of less than 100 mm<sup>2</sup> are not common features of the Levantine and European records until after 40,000–50,000 years ago. The timing of the appearance of specific projectile technologies and their origins remains valid in Africa, where arrowhead projectiles made their first appearance during the MSA (Shea 2009). The samples analysed for this study suggest that projectile technology evolved in Africa prior to 100,000 years ago (Shea 2009). For instance, MSA points with TCSA values of 55.1 mm<sup>2</sup> appear at Mumba Beds VIA and VIB and are dated to between 135,000 and 110,000 BP. At Magubike, the initial ESR dated the MSA assemblage to around 150,000 BP (Anne Skinner, personal communication 2010). The TCSA

values depicted on points at Mumba and Magubike suggest that arrow and spear technology coexisted in Tanzania during the MSA, from at least 150,000 to 110,000 BP.

With reference to the TCSA value of the analysed samples (Figures 8.3a, 8.3b, 8.4a and 8.4b) it is likely that throwing spears and arrows were the most common hunting weapons in Tanzania during the MSA. At Magubike, there might have been additional hunting options, which involved the use of thrusting spears. Three weapon systems, (thrusting spears, throwing spears and arrows) coexisted at Magubike during the MSA. The absence of thrusting spears in northern Tanzania could be accounted for by stylistic differences, ecological adaptations, or symbolic status in ceremonial services (Clark 1988; McBrearty and Brooks 2000; Hitchcock and Bleed 1997). Modern hunters of the Kalahari Desert (Tyua) use both spears and arrows for hunting, but spear hunting is most common for specialized hunting, whereby large mammals are targeted for symbolic needs. Young Tyua men who wish to get married must first prove to their prospective fathers-in law that they are good hunters by killing a large mammal (Hitchcock and Bleed 1997). For Hadzabe hunters of northern Tanzania, killing large mammals is accompanied by ritual practices involving traditional dance (*Epeme*) (Personal observation, 2004).

When comparing the TCSA values on points from the MSA and MSA/LSA assemblages at Mumba and Nasera, it is likely that projectiles were in continuous evolution, from spearhead to arrowhead, over time. These changes occurred gradually, reaching their highest stage during the transitional period

from MSA to LSA, between 65,000 and 35,000 years ago. At Mumba, points used for spears were less represented during the transitional period from the MSA to LSA, suggesting the pattern for technological change over time. As time passed, spearhead projectiles were replaced by bows and arrows. This trend may suggest that prehistoric hunting using spears or bow and arrows was governed by a number of criteria, including functional, ecological, symbolic and time factors.

Data recorded at Mumba, Nasera and Magubike suggest that hunting efficiency depended on the context in which the activity was taking place. For example, chert, quartzite and metamorphic rocks were needed for spears at Magubike because of environmental constraints; spears were needed to hunt large mammals in a woodland environment. Exotic raw materials were vital to meet specific functional requirements such as durability, brittleness and sharpness, essential in successful hunting. Hunting efficiency had to be increased in the face of environmental challenges or cultural needs. Environmental and cultural expectations may have encouraged the development of new projectile technologies in Tanzania during the MSA.

## **8.12 Summary**

Analyses of functional and usewear attributes are necessary to determine tool use and the hunting behaviour of prehistoric foragers who lived in northern and southern Tanzania during the MSA. Usewear on points from Mumba suggests that sometimes they played multifunctional roles, including hunting, cutting, drilling or wood processing. Metric measurements, such as TCSA and weight



values on point samples from Mumba, Nasera and Magubike, indicate that the majority of points fit well within the estimate ranges for throwing spears and bow and arrow technologies. Spear and arrow projectiles coexisted in southern and northern Tanzania during the MSA, between 150,000 and 35,000 years ago. Spears were utilized less in northern Tanzania during the MSA/LSA transitional period between 65,000 and 35,000 years ago, and they were rarely produced at Mumba (Figure 8.6). Geometric ratios, including breadth/length and platform-breadth/breadth (Tables 8.2 and 8.3), suggest that the majority of points were made from triangular flake blanks with thinned, elliptical, pointed or thinned butts. The resemblances in point shape and weight observed among arrowheads and spearheads indicate complex technological patterns and a correlation between the arrow and throwing spear weapon systems, as originally suggested by Hughes (1998).

The majority of throwing spearheads and arrowheads are characterised by a mean weight of less than 11 g. The spears demonstrate slightly higher weights and more variations in TCSA values than the arrowheads. Variations in TCSA values suggest the existence of small light throwing spears with mean TCSA values less than or equal to 82.7 mm<sup>2</sup> (Table 8.5). Thrusting spears are evident at Magubike; their approximate mean weight is about 15 g, with cumulative distributions of TCSA values of greater than 150 mm<sup>2</sup> (Figures 8.3a and 8.3b). It is likely that spears were made from durable rocks (Table 8.6). This trend suggests that durability was an added advantage for thrusting spear technology.

In terms of subsistence requirements, the uses of spear and arrow weapon systems reveal that animals of different sizes must have been hunted by MSA foragers. For instance, the use of spearheads may reflect the hunting and killing of large mammals, because spears have an added advantage over arrows in terms of return rate. However, bow and arrow hunting is efficient in accuracy and distance hunting shooting, in particular, for small and medium-sized animals (Hughes 1998; Villa and Lenoir 2009). As noted in previous sections, the use of spears and arrows has been recorded among modern hunting communities of southern and central Africa (Bailey 1991). Results from this study support the existing idea that arrowhead technology has a deeper antiquity in sub-Saharan Africa than other regions across the world (Lombard and Phillipson 2010; Shea 2009).

The innovation of multi-weapon systems during the MSA indicates developed cognitive behaviour that encouraged toolmakers to design, craft and reuse tools with the focus on specific subsistence and functional requirements or cultural expectations. The reliable representation of throwing spear and arrow tips suggests that aerodynamic projectiles have a functional advantage in terms of effectiveness, accuracy and hunter safety. The dominance of spears with reduced weights and arrow tips suggests that portability was another added advantage in designing and manufacturing prehistoric projectiles. Apart from the trade and symbolic status that have been traditionally linked with distance sourcing of raw materials, this study has revealed that functional criteria such as durability, sharpness and brittleness played a significant role for uses of local and exotic rock types.

## **CHAPTER 9: DISCUSSION AND CONCLUSIONS**

### **9.1 Introduction**

This chapter discusses the general implications of the research, summarizes the findings and provides suggestions for further research directions. In the discussion, the specific objectives and research questions are addressed again, in reference to the ways in which MSA and LSA foragers used points and adapted to life in the rock-shelters of Mumba, Nasera, Mlambalasi and Magubike. Also examined are the distribution and patterning of utilization of points and their implications for understanding hunting behaviour. The general conclusion in this study favours the existence of different weapon systems in Tanzania during the MSA. The accumulated data indicate that MSA points were used for different activities such as hunting, cutting and wood processing.

In terms of technological organization, raw material procurement and weapon systems, it is likely that toolmakers had wide knowledge of their landscape and the physical characteristics of the rock types needed for tool manufacture. Durable rocks with high compression strengths, such as chert, quartzite and metamorphic rocks, were used for spearhead projectiles. On the other hand, brittle rocks with high tensile strengths and sharp edges, such as quartz and obsidian, were mainly used for arrowheads. It is important to note that this study suggests that technological and behavioural changes from the MSA to LSA were gradual, rather than abrupt.

## **9.2: The distribution of archaeological artefacts in the study sites**

Field survey and test excavations conducted across the landscape of Iringa in 2006 and 2008 yielded archaeological localities belonging to the Acheulian, MSA, LSA, Iron Age, and historical periods. Surface scatters with Acheulian artefacts were already known from Isimila and Mgongo. But they were also seen, west of the main site, at a locality we labelled Isimila 2. The MSA, LSA and Iron Age artefact scatters were found in several rock-shelters and open air sites (Chapters 5 and 6). The presence and distribution of surface artefacts in the majority of surveyed areas reflects patterns of adaptations and utilization of Iringa Region by prehistoric humans, possibly continuously from the Acheulian to the present. The presence of Sangoan-like artefacts at Kigwambimbi, and deep stratified assemblages of MSA, LSA and Iron Age cultures at Magubike and Mlambalasi, defines the archaeology of Iringa. Nonetheless, as argued in Chapter 5, it is likely that surface and sub-surface archaeological occurrences of Iringa had been affected by natural and anthropogenic post depositional processes. These processes may have disturbed the patterning of archaeological deposits, as was revealed in the excavation of unit 2 at Mlambalasi and within the farmer's field at Magubike (Chapter 6). But on the other hand, they have exposed many new archaeological sites.

The distribution of artefacts across the landscape of Magubike suggests that human activities were not limited to inside rock-shelters. They seem to have occupied the entire landscape surrounding the Magubike Hill. Archaeological deposits including MSA, LSA and Iron Age artefacts were found in stratified

contexts inside and outside the rock-shelter. In addition, an Iron Age smelting site was discovered nearby. The occurrences of MSA, LSA and Iron Age artefacts in deep sequences at Magubike, with the latter culture stratified above the older ones, indicate a continual utilization of a site over time by prehistoric foragers regardless their cultural stages and technological differences. This suggests that whatever changes occurred, including technological shifts from MSA to LSA, these places remained important sites for human occupation. It is possible that the MSA foragers of Magubike had behavioural and cognitive capabilities that are comparable to those shown by the LSA foragers who used the same sites. The continuity in forager usage of rock-shelters from the MSA times to LSA also has also been reported at Mumba and Nasera, suggesting that people with similar behaviours and cognitive capabilities utilized these rock-shelters (Mehlman 1989). This pattern is unusual, when compared to other parts of South Africa, which shows a long gap in occupation from the MSA to the LSA

The inferences drawn from archaeological assemblages of Mumba, Nasera and Magubike suggest that the potential cognitive behaviour that defines “behavioural modernity” was already in place during the MSA. The occurrences of MSA, LSA and later cultures, such as the Pastoral Neolithic and Iron Age, demonstrate the continuous utilization of rock-shelters by prehistoric and historic communities in closely related ways. This suggests that, despite strong evidence for substantial cultural and technological changes over time, the pattern of human utilization of rock-shelters does not appear to have changed markedly. This trend of incessant utilization of rock-shelters by MSA and LSA foragers shows that

shelters were important features of prehistoric forager settlements, regardless of temporal differences (Mabulla 1996). It also implies that the cultural and biological needs of MSA and LSA foragers were closely related, and that they responded to these needs in comparable ways.

Since land-use and settlement patterns are closely attuned to resource distribution, it is possible that Mumba, Nasera and Magubike were sometimes utilized differently, depending on the availability and distribution of ecological resources. It is also possible that the means for the utilization of wild resources changed over time and space, depending on the availability and distribution of the local ecological enticements (Ambrose and Lorenz 1990; Barut 1994). At Magubike, material recovered suggests that MSA foragers were more mobile than their descendants, the LSA foragers. They possibly utilized more exotic rock types, particularly chert and metamorphic rocks, when compared to the LSA foragers. It is not known exactly what led MSA people to focus on chert and metamorphic rocks at Magubike, but the need for durable stone tools that can withstand unintentional breakage may have been one of the factors. The analysed data indicate that points made of chert, quartzite and metamorphic rocks have the high TCSA values needed for spear projectiles. For chert it is an average of 73.6 mm<sup>2</sup>, for metamorphic rocks, 83.1 mm<sup>2</sup>, and for quartzite 87.7 mm<sup>2</sup>. This suggests that they were used for spears. Spear hunting was likely to be most favourable in the woodland environments that characterized most of Iringa during the Pleistocene (Clark 2001; Finch *et al.* 2009; Garcin *et al.* 2006; Hamilton 1982).

With reference to the ecological model proposed by Hughes (1998), specifically that spear hunting was most common in woodland and wetland environments, this perception was not clear in this study. This is probably due to unreliable palaeoenvironmental data and the absence of many absolute dates. Although it is generally accepted that MSA cultures of Tanzania occurred within a period of global glacial and interglacial climatic fluctuations, definite dates and local palaeoclimatic evidence are lacking. Globally, the period of global climatic fluctuations and great change in human culture and biological patterns is referred to as Oxygen Isotopic Stages (OIS) 6 to 3, between 250,000 and 35,000 years ago (Clark 2001; Hamilton 1982; Klein 1999, 2000; Scholz *et al.* 2007; Willoughby 2007). Biologically, they mark the emergence of early modern humans between 200,000 and 150,000 years ago, and later the expansion of human geographical territories inside and outside Africa, between 60,000 and 35,00 years ago (Bräuer 1992; Cann *et al.* 1987; Millars 2006).

It is not clear to what extent global climatic oscillations affected the availability and distribution of local wild food resources in Iringa and the ways in which climatic fluctuations contributed to changes in humankind during the MSA. Indeed, it was found in this study that advancement in technological skills that include innovations in projectile technology, first appeared in Tanzania during the MSA. New technological skills may have allowed people to sustain themselves in unstable and unfriendly environmental conditions during the MSA (Brooks *et al.* 2006; McBrearty and Brooks 2000; Scholz *et al.* 2007).

### **9.3 The distribution of points in the MSA and LSA assemblages of Tanzania**

In order to understand the importance of points during the MSA and LSA, it was important to examine the representation of points in the lithic assemblages of Mumba, Nasera, Magubike and Mlambalasi. This information is important for the determination of how prehistoric foragers organized their lives and obtained resources. The representation of points in the MSA, MSA/LSA transitional period and LSA is also used in this study to test the continuity or change model in hunting behaviour as proposed in Chapter 1. Although the study areas are located in separate geographical locations, including southern and northern Tanzania, it was revealed from the analysed samples that there were fewer points in the LSA assemblages when compared to the MSA ones. Evidence from Mlambalasi suggests that points were replaced by backed and geometric tools during the LSA (Chapter 6). At Mumba, points were also less common in the MSA/LSA transition, indicating that the amount of point manufacture and use decreased as time passed.

In Chapters 4, 6 and 7, I reported that points were represented in all of the MSA assemblages, but lacking in the LSA culture at Mlambalasi, where points make up about 1.1% of analysed tools. The lack of points in the LSA assemblage at Mlambalasi may indicate a technological change, where backed pieces replaced other formal tools. All the MSA assemblage at Mumba, Nasera and Magubike yielded a fair number of points, ranging from 18% of the tools at Nasera to 5.6% at Magubike. At Magubike, however, backed pieces produced through bipolar knapping were the most abundant tool types throughout the MSA and LSA. They



make up about 66.9% of the modified tools within the MSA. This either reflects the intentional use of backed pieces this far back in time, or post-depositional movement of small items into the MSA levels. But the absence of a true LSA deposit in test pits 2 and 3 might allow us to reject this latter explanation. Recent evidence from South Africa indicates that backed pieces such as crescents were used as inserts for either arrows or spears (Lombard 2007; Lombard and Phillipson 2010). An increase of backed pieces in the MSA assemblages at Magubike in Iringa may indicate ecological adaptation and regional identity (Clark 1988). Alternatively, it may imply that Iringa and other places of southern highlands developed different technological traits during the MSA and LSA compared to those of northern Tanzania.

Patterns for the distribution of lithic artefacts indicate that points were among the major tools made and used by MSA foragers. In some MSA assemblages, such as at Magubike, where backed pieces and bipolar cores occur in moderate frequencies, it indicates that technological shifts from MSA to LSA passed through a gradual process. Alternatively, variations in the distribution of points within the MSA in Tanzania may suggest that MSA sites were utilized in different ways depending on their locations, as well as the distribution of wild food resources and potable water. As was discussed in Chapter 4, it is likely that Nasera was used as seasonal hunting camp during the wet season, when surface water and migratory prey were locally found (Barut 1994; Mehlman 1989). Mumba and Magubike may both have been used for long-term settlement, tool manufacturing and/or maintenance (Mabulla 1996; Mehlman 1989). It is likely

that Mumba and Magubike also sometimes served as hunting camps. Indeed, in most cases they served as residential bases where food processing and tool manufacturing took place (Mehlman 1989). Today, the modern hunters (Hadzabe) of northern Tanzania use rock-shelters as overnight camps or as residences during the rainy season (Mabulla 1996). Both prehistoric and modern foragers used rock-shelters, suggesting that there has not been a change in their function from MSA times until recent times.

With reference to the dynamic of technological and behavioural organization of the early modern humans who lived in southern and northern Tanzania during the MSA, points may have been used as parts of projectile weapons used for hunting. As previously noted, they were less abundant at Magubike, when compared to Mumba and Nasera. This may partially imply variation in ecological settings or in utilization of sites. It is possible that at Magubike, hunting was carried out far away from the site. As a result, a certain number of points disappeared in the field (Keeley 1982). Alternatively, the variations in the distribution of points in the MSA assemblage of Mumba, Nasera and Magubike may represent a range of local ecological adaptations and even ethnic differences (Clark 1988). The MSA foragers of Magubike probably depended on backed pieces produced through bipolar technique, because of the presence of numerous small rounded quartz pebbles in the vicinity.

Regarding the decrease in the number of points in the MSA assemblage at Magubike, and in the MSA/LSA transitional industry at Mumba (Chapters 4 and 6), it seems as if they were deliberately replaced by backed tools over time. It is

repeatedly argued that the spread of backed pieces and bipolar core represents the first appearance of arrowheads during the LSA (Ambrose 2002; Phillipson 1980). Consequently, the wide representation of backed pieces and bipolar cores in the MSA assemblage at Magubike in Iringa should be taken as evidence for the innovation of arrowhead technology during the MSA and/or the continuity in technological organization between the MSA and LSA foragers.

#### **9.4: Subsistence needs and raw material procurement**

Since raw material procurement is generally embedded within the subsistence system, the proportion of exotic raw materials in the archaeological record in these sites can be used to define the size of a territory and the degree of land use (Barut 1994; Binford 1979; Mabulla 1996; Mehlman 1989). For instance, highly mobile foragers will use a high proportion of exotic materials, while less mobile foragers will use most locally materials. Sometimes the mobility system could be influenced by other subsistence needs, such as tracking migratory prey or seasonal occupation of archaeological sites (Barut 1994).

On the basis of the small sample of chert and obsidian at Nasera and Mumba, I broadly argue that trade and exchange were not primary factors for distance-sourcing of exotic rocks in northern Tanzania. The location of Nasera rock-shelter close to an ungulate migratory corridor may imply that, when animals were locally found, foragers may have adapted and concentrated here (Chapter 4). They would have moved seasonally within larger home ranges, tracking hunted game, water, and plant food resources at the end of rainy seasons when surface

water was found in various places (Mehlman 1989). Ethnographic evidence suggests that during dry periods, hunter-forager communities tended to nucleate in small territories close to wild food and water (Barut 1997; Heinz 1979). As a result, individual territorial groups rarely encounter others (Heinz 1979).

These group territories were concentrated around the water and food resources available on the local landscape. In some cases, exotic rocks were accessible to foraging groups moving seasonally within their territories (Barut 1994, 1997). Sometimes they collected and carried a certain amount of exotic rocks to residential camps for tool manufacturing, as part of their regular subsistence or foraging systems. In Tanzania and in East Africa in general, the exchange of exotic lithic raw materials can be seen in a chert network between Nasera and the Lake Natron basin and/or Olduvai Gorge, as well as in an extensive obsidian network of central Kenya and northern Tanzania (Mehlman 1989; Merrick and Brown 1984). These lithic raw material exchange networks of northern Tanzania are confined within the migratory corridor of East African ungulates that presently link Masai Mara National Park in Kenya, the Serengeti National Park and the Lake Natron Game Reserve in Tanzania (Chapter 4).

Foragers were perhaps more concerned with tracking animals, and on the way back they carried low amount of obsidian and chert, because of their functional requirements or symbolic needs (Chapters 4 and 8). It is likely that the sources of obsidian and chert were visited repeatedly as part of food procurement strategies in the northern corridor. Along the way, they carried some obsidian and chert to Nasera, and to a lesser extent to Mumba, for tool manufacturing because

of their functional or cultural values. A high carrying cost in terms of covered distance, energy and time may have been another reason for the under-representation of exotic materials at Mumba and Nasera. For example, only one MSA obsidian point was found at Mumba.

The analysed samples from Mumba, Nasera, Mlambalasi and Magubike do not indicate the existence of substantial contact between prehistoric peoples of southern and northern Tanzania. It is likely that hunter-forager groups of northern and southern Tanzania were confined within their local geographical boundaries. This led them to depend on local quartz, which allowed them to carry out activities close to the raw material sources, a process that simplified raw material procurement, use and discard. The reliance on local lithic raw materials is widely supported by the low proportion of exotic chert at Magubike and Mlambalasi. Although chert is preferred for making sharp tools with great wounding ability, it were little utilized by MSA foragers in at Magubike and Mlambalasi, perhaps because of high carrying costs and inaccessibility.

At these sites (Magubike and Mlambalasi), chert pebbles were quarried from unknown sources. It is likely that chert was imported because of its functional value. The TCSA value suggests that points made of chert were used as insert for spears (Chapter 8). For that reason, spears were the best hunting weapons in the woodland environments that characterized southern Tanzania for most of the Pleistocene. Nonetheless, more Stone Age archaeological research is needed in the southern regions of Tanzania, before coming to a meaningful conclusion.

On the other hand, the use of local lithic raw materials such as metamorphic rocks and quartzite for spear tips is regarded as part of a foresighted plan, because weapons needed for confrontation and repeated hitting penetration of prey need durable materials. Chert also has a high degree of compression strength like quartzite and metamorphic rocks; therefore, the number of chert points at Magubike could be correlated with similar functional values. As previously noted in Chapter 8, points made of quartz are most abundant in the MSA and LSA assemblages of Tanzania. It is possible that quartz was favoured because of its physical characteristics, including sharp edges and low compression strength. These characteristics make quartz points effective in making wounds and they easily break off in an animal's body after being stressed by impact force (Ellis 1997; Hughes 1998). According to Ellis (1997), raw materials with sharp edges or those which break easily after hitting a target were needed in order to facilitate internal bleeding and animal suffocation.

Functional criteria indicate that the selection of raw materials was either influenced by durability, sharpness or brittleness of a specific rock type. Points made of durable rocks had the added advantage of withstanding stress from impact force. Those made from brittle and sharp materials, such as obsidian and quartz, were needed for the creation of lethal wounds. The choice of lithic raw materials suggests that stone points were designed for specific requirements (Ellis 1997; Bleed 1986). The exploitation of exotic lithic raw materials suggests that MSA foragers had extensive knowledge of the landscape and the natural resources available in their surrounding environment. Their ways of life and

technology were based on the distribution of natural resources over the landscape. Extensive knowledge of the surrounding environment enabled them to improve their technology and to design tools for specific functions, such as points for hunting. The functional values embedded in the utilization of raw materials indicate that the people who used them understood the physical characteristic of specific rock types. It also implies that MSA foragers who imported exotic raw materials had abstract thinking, cognitive and high intellectual capabilities, which are amongst the baseline traits for decision making.

### **9.5 The organization and uses of projectile technology**

The organization of projectile technologies at Mumba, Nasera and Magubike has been broadly highlighted in Chapters 7 and 8. In this section, I discuss insights related to the technological, subsistence and behavioural aspects. As shown in Chapters 7 and 8, the majority of points were made from triangular flake blanks which were intentionally modified to provide a binding portion and a blank for hafting requirements. The dominance of triangular points with thinned platforms conforms to a systematic pattern of tool production and modification. Cores were carefully selected, prepared and systematically flaked using peripheral, platform or Levallois reduction strategies. Some of the resulting blanks were then selected for further edge modification to form points. Points were either retouched along their edges or thinned on their butts to provide the appropriate portions needed for hafting. However, variations observed in terms of point sizes, weight, TCSA values and retouch patterns suggest that these tools

were manufactured and modified according to their functional needs. Dynamic and design features of MSA points, such as thinning the butts suggest that toolmakers had the capability for foresight and they were designed to fulfil well elaborated functional requirements.

The combination of points with thinned, straight, convex, concave, stemmed, notched butts (Chapter 7) suggests that hafting technology was already in place during the MSA. As noted in previous chapters, points were deliberately modified on their butts to provide additional binding portions. Residue analysis of point edges suggest that materials such as powdered ochre, tree resin, animal tendon, waxes and glue were used as hafting media during the MSA (Lombard 2007; Wadley and Jacobs 2004; Wadley *et al.* 2009). The skills and technologies assembled for the production of projectile weapons required substantial time, effort and abstract thinking. All of these can be correlated with the development of modern cognitive behaviour. Archaeologists should accept that hafting was one of the oldest technological achievements of our MSA ancestors.

Through the analysis of Tip Cross Section Area (TCSA) and weight, it was found that there were both changes and continuities across the two cultural stages (the MSA and MSA/LSA transitional at Mumba and Nasera). These values suggest that MSA points were used as inserts for different weapon systems, in particular spears and arrows. TCSA and weight values have been considered as among the ways to distinguish weapons of different systems (Hughes 1998; Shea 2006, 2009; Thomas 1978). It was found that MSA points were used as inserts of different weapon systems including thrusting spears, throwing spears and arrows



(Chapter 8). Evidence for the existence of thrusting spears in the MSA comes from Magubike; here they were made of quartzite and other metamorphic and rocks. At Mumba and Nasera, at least two kinds of projectile points (throwing spears and arrowheads) coexisted during the MSA and MSA/LSA transitional periods (Chapter 8).

Arguing regarding morphological characteristics and metric measurements of points, it seems as if the prehistoric people who occupied Mumba, Nasera and Magubike during the MSA and transitional period from MSA to LSA, used multiple weapon systems for hunting. Points were used as inserts for both arrowhead and spearhead projectiles during the MSA and MSA/LSA transition, suggest some elements of continuity in tool production. The coexistence of diverse weapons may suggest that the patterns of hunting behaviour between the MSA and MSA/LSA foragers of Mumba and Nasera were not remarkably different. Perhaps there was a continuity or gradual change in the organization of the hunting systems. The uses of spearheaded and arrow-headed weapons during the MSA and MSA/LSA periods contradict an idea that technological and behavioural shifts from MSA to LSA were an abrupt process (Klein 1999, 2000).

An element of continuity between the different cultural stages in Tanzania is also supported by the abundance of backed pieces and bipolar cores in both the MSA and LSA assemblages of Magubike, Mlambalasi, as well as in the Songwe River Valley in southern Tanzania (Biittner *et al.* 2007; Willoughby 1996, 1997, 2002, 2009). Backed pieces and bipolar cores are defining characteristics of tropical African LSA assemblages (Ambrose 1998, 2001, 2002; Barut 1997;

Mabulla 1996; Phillipson 1977, 1980). Continuity in bipolar knapping strategies and production of backed tools within the MSA and LSA assemblages in Tanzania implies that the behavioural and cognitive abilities of the MSA people were comparable to those of the LSA foragers. It is likely that the prehistoric foragers who occupied Magubike during the MSA had comparable cognitive behaviours and technologies to the LSA people who followed them. Both used projectile weapons made of points or backed pieces, depending on their immediate needs or hunting situations.

This suggests that technological and cultural changes occurred gradually and continuously, even over the MSA/LSA transition. However, the existence of small points believed to be used as inserts for arrows and throwing spears at Mumba, Nasera and Magubike (Chapter 8), indicate complex technology that allowed toolmakers to use different kinds of weapon systems, depending on the hunting situation. Available data from sub-Saharan Africa and the Levant suggest that points were used as inserts for both spears and arrows (Brooks *et al.* 2006; Mohapi 2007; Shea 1997, 2006, 2009; Waweru 2007). In South Africa and the Levant, they were used as inserts for either thrusting or throwing spears (Mohapi 2007; Shea 2006, 2009; Villa and Lenoir 2009; Wadley *et al.* 2009). In East Africa it seems they were used as inserts for throwing spears or arrows (Brooks *et al.* 2006; Waweru 2007). Perhaps, continuity in some aspects of lithic technology and hunting strategies between the MSA and later cultures reflects closely related technological skills between the MSA and LSA foragers, which depended much on the local lithic raw materials and ecological situations.

Additional evidence that points were used as hunting weapons is supported by faunal accumulation, residue analysis and usewear records (Lombard 2007; Lombard and Phillipson 2010; Wadley *et al.* 2009; Wadley and Jacobs 2004; Waweru 2007). As noted in Chapter 2, in South Africa a piece of a point was found embedded in vertebra of an extinct buffalo (*Pelorovis*) at Klasies River Cave 1 in South Africa, suggesting that points were used for hunting (Milo 1988). In Kenya, fauna assemblages composed of both migratory and residential species were found with cut-marks in the MSA and LSA assemblage at Lukenya Hill, indicating planned and specialized hunting (Marean 1997).

The residue, microwear and usewear analyses of samples from the MSA assemblage at Sibudu and Blombos Caves in South Africa have shown that these tools were hafted onto wooden shafts using mixed ingredients (Lombard 2007; Wadley and Jacobs 2004; Wadley *et al.* 2009). Stone tips and wooden shafts were bound together with the use of mixed ingredients such as beeswax, tree resin and powdered ochre; heat was sometimes applied to strengthen bound materials (Lombard 2007; Wadley *et al.* 2009). In this study, microscopic analyses of edges and surfaces of selected points showed edge damage and/or striations which suggest that points performed a wide range of activities including hunting, cutting, butchering and wood processing (Chapter 8). Presumably, points were used in various ways, such as spearheads, arrowheads and/or knives. Such technological organization indicates developed mental ability and intelligence among the MSA forgers who made and used them.

The line of evidence from this study indicates the MSA foragers of Tanzania used multi-weapon systems depending on the hunting situation, nature of hunted game and ecological setting. Potential prey behaviour is likely to have influenced early human choices of hunting techniques, such as the use of heavy-duty weapons (spears) when dealing with large terrestrial African animal species such as buffalo, wild pigs, rhino, elephant or giraffe to increase hunters' safety. Design features aimed at protecting a hunter are the use of durable materials; increased TCSA, high weight values and the distribution of the weight in the midline of a point to allow aerodynamic motion (Hughes 1998; Yellen 1976). The existence of different kinds of weapon systems suggests that in East Africa, the MSA foragers were focused on a variety of animal species including large, medium and small-sized prey.

The above conclusion is also supported by faunal evidence from Lukenya Hill, Magubike and Mumba where migratory and residential animal species of different sizes have been found associated with MSA and LSA assemblages (Collins 2009; Marean 1997; Mehlman 1989). Toolmakers were capable of designing different kinds of tools depending on prey preference and hunting situation. This pattern implies that MSA forager were opportunistic hunters. They hunted animals of different sizes, like modern hunting communities such as Hadzabe. It is possible that hunting made a huge contribution to human subsistence during the MSA when projectile technology was introduced for the first time (Brooks *et al.* 2006; McBrearty and Brooks 2000; Shea 1997, 2006, 2009; Waweru 2007).

## 9.6 Behavioural implications from points

Technological aspects embedded in points indicate many diverse aspects of cognitive behaviour. The process of forming composite tools such as assembling points was in place for the first time in Africa during the MSA. The majority of those points were designed to meet aerodynamic requirements, so that they could be thrown through the air to hit a target (Brooks *et al.* 2006; Shea 1997, 2006, 2009). Similarities of the MSA points indicate that specialized hunting and hunter safety were among the design criteria for the evolution of projectile technology during the MSA. The use of long-distance sourced lithic raw materials with specific functional values such as durability, brittleness or sharpness indicates that technological organization, social network, efficiency and effectiveness in hunting all played a significant role in the design of projectile weapons.

Durable materials such as chert and quartzite were needed for spearhead projectiles. The analysed samples indicate that brittle rocks such as obsidian and quartz were used to manufacture arrowhead projectiles. Design features of weapons based on the physical characteristics of specific rock types help determine the level of intelligence and cognitive ability of our early ancestors or the MSA foragers. It is likely that these people behaved like or similar to the modern hunting communities. Hafting and processing projectile weapon system both suggest the existence of mental templates in the minds of craftsmen who designed and made points. The notion of a mental template was best described by Deetz (1967) as an idea that existed in the minds of craftsmen, and when the idea

is expressed in tangible form, it results in important objects designed for intentional uses. Based on the types of projectile weapons revealed at Mumba, Nasera and Magubike, the notion of mental template and efficiency in hunting is obvious, based on the ways in which prehistoric people designed and used different kinds of projectile weapons depending on the ecological condition and hunting situation.

For instance, the contexts of thrusting spears, which involve groups of people and stalking game, require quite different strategies from throwing spears or bow and arrow hunting. Thrusting spears were used in close proximity to prey, which is dangerous for hunters. To increase a hunter's safety, designers may have chosen to make and use heavy-duty equipment from durable raw materials such as quartzite. The need for safety can also be reflected on tool form and high TCSA values, aimed to withstand damage from impact force. Because heavyweight tools do not involve carrying weapons for long distances, they were used in well-defined situations, not far from residential camps. Under such circumstances, hunters were supposed to remain in well-defined areas for a number of days and hunting tools may have been stored or processed near the hunting localities during the hunting season.

Spears were likely used in restricted locations during the dry season, when animals had restricted water and foraging sources. Arrows or throwing spears were most likely used at extended distances because they are portable (Hughes 1998). The deep and dense archaeological occurrences recorded at Mumba, Nasera and Magubike support the idea that MSA foragers and their descendants

stayed longer and repeatedly occupied similar localities. These sites performed multi-purpose roles, including settlement, tool manufacturing, assembling of tools and food processing. The majority of them, including Mumba and Magubike were located close to water sources indicating that they also used for planned hunting and/or foraging.

Planned foraging and hunting strategies may have enabled MSA people to accumulate enough food resources, particularly animal protein and fat. In turn, the accumulated energy from food resources played a significant role in the rise of human population within Africa during the late MSA period, between 80,000 and 60,000 years ago (Mellars 2006). It seems that efficiency and capabilities of our early ancestors in food acquisitions and control over environment played a big role in our current ecological dominance, social organization and complex technology. Perhaps hunting became possible due to the invention of points. The combination of technological and social organization observed in this study signifies an important stage in the development of modern cognitive behaviour during the MSA.

## **9.7 Conclusions**

This study began as an investigation of MSA and LSA forager lithic technology and hunting behaviour in northern and southern Tanzania. The main focus was on an examination of the existence and magnitude of change in hominid behaviour and technologies during the Middle and Upper Pleistocene. The major problem I wanted to address was the nature of change or continuity in

hominid behaviour between the MSA and LSA at Mumba, Nasera, Magubike and Mlambalasi, and how this is reflected in projectile technology and hunting behaviour. The research involved the study of museum collections from Mumba and Nasera; surface archaeological and ecological survey; and limited test excavations at Mlambalasi and Magubike. The focus of the archaeological surface survey was, first, to record the representation of archaeological artefacts and their cultural affinities across the landscape of Iringa, and second, to identify the source of lithic raw materials used for tool manufacturing at Magubike and Mlambalasi. Unfortunately, due to time and financial constraints, field logistics and the scope of my study, we were not able to identify possible quarry sites for chert, which are abundant in the MSA and LSA assemblages at these two Stone Age sites. Nonetheless, my colleague Katie Biittner is working on the issue of raw materials sourcing and forager mobility system across the landscape of Iringa and neighbouring regions (Biittner, forthcoming).

The specific objectives and research questions of this study were outlined in Chapter 1, and further described throughout the dissertation. The general objective was to examine the technological organization and hunting techniques used by prehistoric people in these regions in order to accumulate their food resources. The focus was on points, which have been used as one of the defining characteristics of the MSA across sub-Saharan Africa (Clark 1988; Goodwin and Van Riet Lowe 1929; McBrearty and Brooks 2000). I decided to use the North American approach for the analysis of functional attributes (Thomas 1978), because it has been applied in the MSA/MP points from the Levant, Ethiopia,



Kenya, Botswana and South Africa (Brooks *et al.* 2006; Mohapi 2007; Shea 1997, 2006, 2009; Villa and Lenoir 2009; Waweru 2007). Typologically, points were identified based on Mehlman's classification (Mehlman 1989).

The results of the analysis of technological and weapon systems are presented in Chapters 7 and 8. The implications of this analysis are explored in previous sections of the current chapter. My inferences have been taken from point types, metric dimensions, raw material procurement and uses, as well as variations in weapon systems. The study shows that there are no significant technological differences between MSA and MSA/LSA assemblages in these regions. This has been further interpreted as indicative of continuity in hominid behaviour between the MSA and later cultures, at least in food acquisition strategies and settlement patterns.

In summary, MSA points from Mumba, Nasera and Magubike indicate some elements of uniformity in terms of type, size, form and high dependence of local quartz raw materials rather than exotic rocks. The patterns of localized lithic raw materials procurement and uses for both MSA and LSA have been interpreted to indicate shared technological skills and adaptation. In other words, both MSA and LSA foragers depended much on local lithic raw materials. This pattern differs from other parts of the Old World (Eurasia), where Upper Palaeolithic (UP) foragers had wider-ranging patterns of raw material procurement than the Middle Palaeolithic (MP) foragers (Montet-White 1991). Technologically, the analysed samples indicate that the dominance of unifacial over bifacial retouch, with an emphasis on butt modification to allow hafting. As noted in previous

sections, the archaeological deposits at Mumba, Nasera and Magubike are quite deep; both MSA and LSA artefacts occur with the younger culture stratified above the older ones. These sites indicate more or less continuous utilization of rock-shelters by both MSA and LSA foragers. This implies that both groups behaved or adapted similarly in settlement and utilization of rock-shelters.

Regarding the second specific objective, to identify morphological differences between the MSA and MSA/LSA assemblages, it was found that points were somehow different in terms of size, Tip Cross Section Area (TCSA) and weight values (Chapter 8). There were insignificant decreases of point size, weight and TCSA values over time at Mumba and Nasera, but both MSA and MSA/LSA points were used as inserts for throwing spears and arrows, but sometimes they performed non-projectile functions such as cutting, scraping or wood processing. Nevertheless, arrowhead technology predominated in the MSA/LSA transitional period at Nasera (Chapter 8). This inference suggests that an idea of distance shooting to minimize risks to hunters was already in place at the end of the MSA. In places where spear weapons were in use like Magubike, durable rocks such as metamorphic, chert and quartzite were widely used. Using specific raw materials such as quartzite to make spears indicates developed technological skills and cognitive behaviours aimed at reducing risk. Ideally, broad points made from durable rocks may have been launched or lodged repeatedly in prey with limited breakage.

Although points made of obsidian were not numerous enough to allow for quantitative analysis, points made of chert may suggest that exotic materials were

needed to form tools with sharp and/or brittle edges (Ellis 1997). The tendency to minimize risks to hunters and the use of sharp tools for wounding purposes indicates a high level of intelligence and thinking capability among toolmakers. It also implies that prehistoric weaponry systems used by MSA foragers would have involved sophisticated technological skills and cognitive thinking. It is likely that chert was distance-sourced because of its sharpness and durability, traits that allow it to withstand unintentional breakage or impact fractures.

Durability was among most important functional requirements, which is indicative of advanced intellectual and technological capability of the toolmaker. As previously noted, spear hunting requires repeated hitting of prey. Durable rock can be lodged in prey without breakage, so this might be an indicative of modern cognitive thinking. Evidence from Magubike suggests that our traditional thinking that spears have been used by less developed people lacks scientific justification and should be reversed. Raw materials with high compression strengths were used for spears and those with low compression strengths were used for both spears and arrows (Table 8.6).

Accumulated data indicate that both spear and arrow weapon systems require elaborate technological skills such as hafting and assembling techniques. Throwing spears and arrows confer the advantage of distance shooting and can reduce injuries to hunters (Churchill 1993; Hughes 1998). Arrows travel at high speeds and have the added advantages of portability and accuracy when compared to spears (Hughes 1998). Since arrows are often lodged in prey after shooting, they leave blood spoor that can be traced and the animal captured when

weakened from blood loss (Pickering and Bunn 2007). Arrows can also be used to deliver poison to the prey. As previously noted, prehistoric poisoned arrowheads have been found in Neolithic assemblages in Egypt dated to 4,500 years ago (Clark *et al.* 1974). Modern hunter-gatherers (the Hadzabe) of northern Tanzania use poisoned metal tips in hunting animals of medium and large sizes. Non-poisoned arrowheads are used by the Hadzabe for hunting small mammals and birds. The uses of poisoned arrowheads have been cited as a signal of advanced cognitive behaviour (Shea 2006, Brooks *at al.* 2006; Wameru 2007). There is no clear evidence thus far indicating that MSA points were used with poison.

Arrows are regarded as superior to throwing and thrusting spears because of their aerodynamic motion, portability, repeated launching and accuracy (Hughes 1998; Shea 1997, 2006, 2009). Likewise, spears have been cited as more efficient in killing large game, due to their high kinetic energy impact on prey. This suggests that spear return rates were greater than those for arrows (Churchill 1993; Odell 1988; Shott 1993). Ethnographic enquiries in sub-Saharan Africa indicate that the two weapon systems are not mutually exclusive and are widely used by modern hunters (Bailey 1991; Hitchcock and Bleed 1997; Laurence and Bartram 1997; Mohapi 2007). Spears are widely used by Efe pygmy of the tropical forests in Zaire. While bows and arrows are widely used by modern hunters of northern Tanzania (Pickering and Bunn 2007), their counterparts in Southern Africa and the Kalahari Desert use both spears and arrows (Hitchcock and Bleed 1997; Laurence and Bartram 1997). It appears that all kinds of weapons

represent advanced technological innovation, high intellectual capabilities and cognitive thinking capability.

Mumba, Magubike and Mlambalasi have also provided unique opportunities in terms of hominid and faunal remains. Remains of isolated teeth of early humans at Mumba and Magubike offer a rare opportunity to study not only human biological evolution, but also the people who produced these sites and their cultural practices. In addition, the occurrences of a late Pleistocene LSA burial at Mlambalasi and Pastoral Neolithic (NP) burials at Mumba can be used to investigate the demographic, biological affinities and cultural practices of more recent people.

This study has made its contribution to current problems about the origin and development of modern behaviour. Evidence from this study suggests that behavioural differences between the MSA and LSA foragers of southern and northern Tanzania are due to a variety of factors, such availability and distribution of food resources, local environment, the availability of lithic raw materials and/or demographic stress rather than neurological change or the inferior behaviour of MSA foragers. Nevertheless, more research on hunting behaviour, microwear analysis, metric dimensions, reconstruction of the past environment and absolute dates remains to be done so that we are not making declarations based on generalized remarks. These goals could be reached with collaborations with other ongoing research projects in Tanzania, including the Iringa archaeological research project under Pamela Willoughby.

### **9.8: Limitations of this study**

The analysed point samples indicate that MSA and MSA/LSA foragers used a wide range of hunting weapons, including spears and arrows. With reference to sub-surface archaeological artefacts from Mlambalasi and Magubike as well as point types from Mumba and Nasera, it seems as though the pattern of change in technological organization took a gradual process rather than abrupt changes. It is likely that these projectile weapons were used to hunt, track and kill animals of different sizes and species. This inference of hunting preferences is, however, limited as additional information for the faunal exploitation behaviour of early modern humans is needed for further clarifications. But the available faunal evidence from the MSA and LSA assemblage in Tanzania (Collins 2009; Mehlman 1989) is preliminary and is not adequate to make significant conclusions at this point in time.

The distribution of surface and sub-surface MSA and LSA artefacts across the landscape of Iringa discussed in Chapters 5, 6 and 8 indicates that MSA foragers may have used exotic lithic raw materials in particular, chert to make spearhead projectiles. On account of time and financial constraints, we made a limited surface survey in Iringa District and Songwe River Valley, Mbeya, but sources of these exotic rocks are not known at present. It is not clear how large areas should be surveyed to yield this information. It is suggested that more surveys that will include different experts such as archaeologists, geologists, geomorphologists and ecologists should be undertaken across the landscape of Iringa and neighbouring regions. Nonetheless, it should be noted that uses of these

exotic raw materials were not limited to points; they were also used with other tool types. It is possible that the need for exotic raw materials was not always based on function; sometimes it could be influenced by other cultural and/or subsistence requirements. In due time, other scholars looking at prehistoric forager mobility systems or typological classifications might come up with different interpretations.

Lastly, as previously noted, reliable palaeoenvironmental evidence and absolute dates for the Iringa region and other archaeological sites of East Africa are lacking. New data may lead to different predictions, models and interpretations about the MSA forager subsistence behaviour and adaptations. This information is likely to come from new areas such as Iringa, and may result in new dimensions and strategies for the reconstruction and understanding of how people lived in the past.

In spite of these limitations, this study demonstrates that prehistoric foragers who occupied the landscapes of Mumba, Nasera, Magubike and Mlambalasi had advanced technological organizations and hunting skills. The study is of great contribution to the ongoing archaeological research project in the Iringa Region under Pamela Willoughby. The Iringa project has already changed our traditional thinking about the archaeology of Tanzania, which has concentrated on Plio-Pleistocene, Pleistocene and historical sites of northern Tanzania and along the coast. At present, Iringa has been identified as one of the most significant areas for future archaeological investigations, in particular the

topics related to the origin and behavioural development of early modern humans (*Homo sapiens*) in sub-Saharan Africa.

### **9.9: Future research directions**

In future research, I will give more attention to the archaeology of Iringa and other unsurveyed areas of southern Tanzania. I will work closely with the members of the ongoing research project in Iringa. Future work will focus on surface surveys, data recovery, spatial archaeological recording, mapping out of potential archaeological sites, excavations of a number of sites with potential archaeological occurrences, and public awareness. The laboratory work will give more attention to typological, technological, functional, and microwear analyses. Reliable dates and collecting information for palaeoecological and land-use reconstruction will be given significant priority.

I will devote more effort to resolving the chronology of the Isimila site and its associated Acheulian artefacts. There is a great need to refine our current knowledge of climatic change in the Isimila basin and the environmental consequences that led to the extinction of the ancient lake during the Pleistocene. The study of the archaeology and past environment of Isimila is therefore crucial for the understanding of the interplay between culture and nature, which led to the disappearance of archaic humans and the emergence of early modern humans and their integrated behaviour patterns between 200,000 and 150,000 years ago (Cann *et al.* 1987). Dates for the disappearance of the ancient lake at Isimila are not



known, but it was sometime between the Middle and Upper Pleistocene (Cole and Kleindienst 1974).

Additional archaeological information is expected from the Kigwambimbi, Magubike and Mlambalasi sites, which have been discussed in detail in my dissertation. If the cultural remains from Isimila, Kigwambimbi, Magubike and Mlambalasi are compared, we may be able to attain clues about the chronology of human biological and cultural changes over time in Iringa. Archaeological remains from these sites indicate that the landscape of Iringa was continuously occupied by prehistoric people from the Acheulian to the Iron Age. Information generated from this study has proved beyond doubt that Iringa is a significant region for the understanding of the origin and development of modern human behaviour. These issues constitute a long and multidisciplinary approach that will link Isimila, Kigwambimbi, Magubike and Mlambalasi, to Willoughby's previous sites in the Songwe River and Lake Rukwa basin.

Although the Iringa research project is broad in nature, it is possible to plan and conduct short-term research projects with relatively small teams and budgets. This strategy will be discussed with the principal researcher of the Iringa Project. These short-term projects may involve a field school for archaeology students from the University of Dar es Salaam. I and other experts from the ongoing Iringa Project will supervise those students. University students will play a part in further surface surveys, documentation, mapping and excavations of some archaeological sites that have revealed potential archaeological evidence. For Mumba and Nasera, my focus will be on tracing missing collections and

improving storage and documentation facilities. Depending on the availability of financial support, I would like to obtain sustained data and reliable dates for both Mumba and Nasera, which will uphold future research directions and interpretations for the collection from these two important Stone Age sites.

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## APPENDIX

**Variables recorded for Iringa (note that metric variables were also recorded for Mumba and Nasera)**

| <b>Variable #</b> | <b>Variable Name</b> | <b>Value Labels</b>  |
|-------------------|----------------------|--|
| Variable 1        |                      |  |
| Site name         |                      |  |
| Mlambalasi        |                      | (100) HwJf-2 room 1<br>(101) HwJf-2 room 2<br>(102) HwJf-2 slope<br>(103) HwJf-2 slope and room 1<br>(104) HwJf-2 outside shelter<br>(105) HwJf-2 tp1<br>(106) HwJf-2 tp1 - remove rock at 85 cm<br>(107) HwJf-2 tp1 south wall cleaning<br>(108) HwJf-2 tp1 wall<br>(109) HwJf-2 east of tp1<br>(110) HwJf-2 tp1 rock removal<br>(111) HwJf-2 tp1 |
| Magubike          |                      | (112) HxJf-1<br>(113) HxJf-1 tp1<br>(114) HxJf-1 tp2<br>(115) HxJf-1 tp3<br>(116) Walk to HxJf-2<br>(117) HxJf-2<br>(118) HxJf-4 (above HxJf-2)<br>(119) Walk back from HxJf-2<br>(120) HxJf-3<br>(121) HxJh-1 Kitelewasi<br>(122) Mumba<br>(123) Nasera<br>(199) missing  |
| Variable 2        |                      |  |
| Level 1           |                      | (00) surface<br>(01) 0-5 cm<br>(02) 5-10 cm<br>(03) 0-10 cm<br>(04) 10-15 cm<br>(05) 15-20 cm<br>(06) 10-20 cm<br>(07) 0-20 cm   |

- (08) 20-25 cm
- (09) 25-30 cm
- (10) 20-30 cm
- (11) 30-35 cm
- (12) 35-40 cm
- (13) 30-40 cm
- (14) 20-40 cm
- (15) 40-45 cm
- (16) 45-50 cm
- (17) 40-50 cm
- (18) 45-50 cm
- (19) 50-55 cm
- (20) 55-60 cm
- (21) 50-60 cm
- (22) 60-65 cm
- (23) 65-70 cm
- (24) 60-70 cm
- (25) 70-75 cm
- (26) 75-80 cm
- (27) 70-80 cm
- (28) 80-85 cm
- (29) 85-90 cm
- (30) 80-90 cm
- (31) 90-95 cm
- (32) 95-100 cm
- (33) 90-100 cm
- (34) 100-105 cm
- (35) 105-110 cm
- (36) 100-110 cm
- (37) 90-110 cm
- (38) 110-115 cm
- (39) 115-120 cm
- (40) 110-120 cm
- (41) 120-125 cm
- (42) 125-130 cm
- (43) 120-130 cm
- (44) 130-135 cm
- (45) 135-140 cm
- (46) 130-140 cm
- (47) 140-145 cm
- (48) 145-150 cm
- (49) 140-150 cm
- (50) 150-155 cm
- (51) 155-160 cm
- (52) 150-160 cm
- (53) 160-165 cm

- (54) 165-170 cm
- (55) 160-170 cm
- (56) 170-175 cm
- (57) 175-180 cm
- (58) 170-180 cm
- (59) 180-185 cm
- (60) 185-190 cm
- (61) 180-190 cm
- (62) 190-195 cm
- (63) 195-200 cm
- (64) 190-200 cm
- (65) 200-205 cm
- (66) 205-210 cm
- (67) 200-210 cm
- (99) Missing

Variable 3  
Level 2

- (01) Mumba level V
- (02) Mumba level VIA
- (03) Mumba level VIB
- (04) Nasera level IV
- (05) Nasera level V
- (06) Nasera level VI
- (07) Nasera level XII
- (08) Nasera level XIII

Variable 4  
Cultural  
Designation

- (00) not known
- (01) ESA
- (02) MSA
- (03) LSA
- (04) Neolithic
- (05) Iron Age
- (06) ESA + MSA
- (07) MSA + LSA
- (08) LSA + Neolithic
- (09) LSA + Iron Age
- (10) Neolithic + Iron Age
- (11) LSA, Neolithic + Iron Age
- (12) MSA, LSA, Neolithic + Iron Age

Variable 5  
Stone raw  
material

- (1) quartz
- (2) quartzite
- (3) chert/flint
- (4) basalt

|   |  |
|---|--|
|   | (5) obsidian<br>(6) other volcanic<br>(7) other sedimentary<br>(8) rock crystal  |
| Variable 6<br>Physical<br>condition                                     | (1) fresh<br>(2) moderately abraded<br>(3) heavily abraded   |
| Variable 7<br>Patination  | (1) none<br>(2) light<br>(3) heavy   |
| Variable 8<br>Weight (gms)  |  |
| Variable 9<br>Stone artefact<br>general category<br>(From Mehlman 1989) | (1) trimmed pieces=tools<br>(2) core<br>(3) debitage<br>(4) non flaked stone including ground stone  |
| Variable 10<br>Tool type  | (01) scrapers<br>(02) backed pieces<br>(03) points/perçoirs<br>(04) burins<br>(05) bifacially modified pieces<br>(06) becs<br>(07) composite tools<br>(08) outils écaillés<br>(09) heavy duty tools<br>(10) others |
| Cores   | (11) peripherally worked core<br>(12) patterned platform<br>(13) intermediate<br>(14) bipolar<br>(15) amorphous  |
| Debitage  | (16) angular fragments<br>(17) specialized flakes<br>(18) flakes<br>(19) blades<br>(20) Levallois flakes   |
| Non-flaked  | (21) hammerstones<br>(22) anvil stones   |



- (23) pestle rubbers
- (24) polished axes
- (25) stone discs
- (26) sundry ground/polished
- (27) manuports

Variable 11  
Subtype

- (001) small convex scrape
- (002) convex end scraper
- (003) convex double end scraper
- (004) convex end and side scraper
- (005) circular scraper
- (006) nosed end scraper
- (007) convex side scraper
- (008) convex double side scraper
- (009) nosed side scraper
- (010) sundry end scraper
- (011) sundry double end scraper
- (012) sundry end and side scraper
- (013) sundry side scraper
- (014) sundry double side scraper
- (015) concave scraper
- (016) concavity
- (017) notch
- (018) sundry combination scraper
- (019) convex end + concave combination scraper
- (020) convex side + concave combination scraper
- (021) divers scraper
- (022) convergent scraper
- (023) scraper fragment
- (024) crescent
- (025) triangle
- (026) trapeze
- (027) curved backed piece
- (028) straight backed piece
- (029) orthogonal truncation
- (030) oblique truncation
- (031) angle-backed piece
- (032) divers backed
- (033) backed awl/drill/perçoir
- (034) backed fragment
- (035) unifacial point/perçoir
- (036) Levallois point/perçoir
- (037) bifacial point
- (038) straight-backed point or diver microlithic tools
- (039) primeval stemmed point

- (040) dihedral burin
- (041) angle burin
- (042) mixed/other burin
- (043) discoid
- (044) point blank
- (045) bifacially modified piece
- (046) becs
- (047) sundry composite tool
- (048) burin + other composite tool
- (049) backed + other composite tool
- (050) scraper + other composite tool
- (051) outils écaillés
- (052) core/large scraper
- (053) biface/pick
- (054) core chopper
- (055) sundry modified
- (056) cutting edge
- (057) bulbar thin/talon reduced
- (058) tool fragment
- Cores
  - (059) part-peripheral core
  - (060) radial/biconic core
  - (061) disc core
  - (062) Levallois core
  - (063) pyramidal/prismatic/single platform core
  - (064) divers single platform core
  - (065) single platform core/core scraper
  - (066) opposed double platform core
  - (067) opposed double platform core/core scraper
  - (068) adjacent double platform core
  - (069) adjacent double platform core/core scraper
  - (070) multiple platform core
  - (071) platform/peripheral core
  - (072) platform/peripheral core/core scraper
  - (073) platform/bipolar core
  - (074) platform/bipolar core/core scraper
  - (075) bipolar/peripheral
  - (076) bipolar core
  - (077) bipolar core fragment
- Debitage
  - (078) amorphous/casual
  - (079) core fragment
  - (080) angular fragment
  - (081) trimmed/utilized angular fragment
  - (082) blade segment-medial or distal
  - (083) trimmed/utilized blade segment
  - (084) plain burin spall
  - (085) tool spall

|                 |  |
|-----------------|--|
|                 | (086) whole flake                      |
|                 | (087) trimmed/utilized flake           |
|                 | (088) flake talon fragment             |
|                 | (089) trimmed/utilized flake           |
|                 | (090) whole blade                      |
|                 | (091) trimmed/utilized blade           |
|                 | (092) blade talon fragment             |
|                 | (093) trimmed/utilized blade           |
|                 | (094) Levallois flake                  |
|                 | (095) trimmed/utilized Levallois flake |
| Non-flaked      | (096) hammerstones                     |
| or ground stone | (097) edge anvil                       |
|                 | (098) pitted anvil                     |
|                 | (099) edge and pit anvil               |
|                 | (100) pestle rubber                    |
|                 | (101) dimpled rubber                   |
|                 | (102) lobed axe                        |
|                 | (103) other axe                        |
|                 | (104) pecked disc                      |
|                 | (105) dimpled disc                     |
|                 | (106) sundry ground/shaped item        |
|                 | (107) manuports                        |

#### Variables 12-16

For all whole flakes/blades and flake tools as well as flake/tool fragments (all measurements to 1 decimal place)

12 length (L) (mm)

13 breadth (B) (mm)

14 thickness (mm)

15 platform length (mm)

16 platform breadth (mm)

#### Variables 17-24

Flakes and flake tools

|                      |                            |
|----------------------|----------------------------|
| 17 Bulbar definition | (1) pointed                |
|                      | (2) prominent              |
|                      | (3) normal                 |
|                      | (4) Scarred                |
|                      | (5) crushed                |
|                      | (6) absent (not developed) |

- 18 Flake termination
- (1) feather
  - (2) hinge
  - (3) step
  - (4) over shoot
  - (5) indeterminate
- 19 Striking platform facets
- (1) cortical (not modified)
  - (2) plain (no facets)
  - (3) faceted
  - (4) pointed
  - (5) thinned
  - (6) crushed
- 20 Dorsal flake scar patterns
- (1) absent
  - (2) one direction parallel
  - (3) on directional convergent
  - (4) one directional irregular
  - (5) two directional opposed
  - (6) two directional convergent
  - (7) two directional irregular
  - (8) radial
  - (9) multi-directional
  - (10) flake with single scar
- For flake tools
- 21 Type of retouch
- (1) marginal
  - (2) semi-invasive
  - (3) invasive
  - (4) none/missing
- 22 Position of retouch/  
backing
- (1) distal end
  - (2) distal right
  - (3) distal left
  - (4) medial right
  - (5) medial left
  - (6) proximal right
  - (7) proximal left
  - (8) proximal end
- 23 Distribution of retouch/  
backing edges
- (1) continuous total
  - (2) continuous partial
  - (3) discontinuous
  - (4) indeterminate

24 Morphology of retouch/  
backing (1) scaled  
(2) stepped  
(3) sub-parallel  
(4) parallel

Variable 25 - 30

For points/percoirs, triangular and curved backed pieces

25 Bit-shape (1) pointed  
(2) oblique  
(3) rounded  
(4) broken

26 Penetration angle (1) abrupt ( $90^\circ \leq$ )  
(2) semi-abrupt ( $45^\circ > 90^\circ$ )  
(3) acute ( $10^\circ \geq 45^\circ$ )  
(4) very acute  $< 10^\circ$

27 Basal blank form (1) side struck  
(2) end struck  
(3) undetermined

28 Treatment of base/butt (1) thinned  
(2) straight  
(3) concave  
(4) convex  
(5) stemmed  
(6) notched

29 Displacement of  
blank (1) blank-left  
(2) blank-centre  
(3) blank-right  
(4) undetermined

30 Tip Cross Section Area  
(TCSA) (0.5 x maximum butt length x maximum thickness)

Variables 31 – 35

Cores

31 Length of flake scars (mm) 1 decimal place

32 Width of flake scars (mm) 1 decimal place

33 Stage of core  
abandonment (1) to early ( $1 \leq 3$ ) scars  
(2) premature ( $4 \leq 6$ ) scars

- (3) exhausted ( $7 \leq$ ) scars
- 34 Primary type of scars
- (1) flake predominate
  - (2) blade predominate
  - (3) flake-blade predominate
  - (4) indeterminate
- 35 Platform preparation
- (1) continuously faceted
  - (2) discontinuously faceted
  - (3) plain (non-faceted)
  - (4) cortical (not modified)
  - (5) indeterminate