East African Middle Stone Age technology and the Emergence of Modern Human Behaviour

By

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ABSTRACT

This dissertation is based on the philosophy that technology entrenches itself in the social and geographic landscape, and can be studied in order to shed light on past behaviour. Also, Middle Stone Age assemblages, dating between 300,000 and 30,000 years ago in sub-Saharan Africa, represent a well-preserved technological system containing behavioural patterns that can be used to answer questions on the emergence of modern human behaviour. Literature on the origin and timing of modern human behaviour does not always include the evidence from East Africa, due to limited research and information. Lithic technology reflects past behaviour, and helps to understand when early humans became culturally modern. The objectives of this work were to identify technological patterns during the Middle Stone Age period; to find out whether or not there is variation between and within the Middle Stone Age assemblages studied; and to propose answers about the causes of this variation, and what they represent in behavioural terms.

Data were collected from cores, flakes, and selected tools from five previously excavated Kenyan Middle Stone Age sites. Morphological and metrical data were collected from each artefact using a number of variables. Lastly, the data gathered were analysed and interpreted in light of current debates and anthropological theories on the beginnings of modern behaviour. There was marked variation in Middle Stone Age assemblages, which could have been caused by a number of factors including environmental conditions, resource type and availability, and choice of different reduction techniques and strategies of tool manufacture. Technological patterns reflect early stages of modern human behaviour, with little standardisation within the assemblages. These Middle Stone Age assemblages contain significant evidence of modern human behaviour which is reflected in raw material procurement, exchange patterns, adaptive behaviour, and mastery of craftsmanship. From these results, it seems that modern human behaviour evolved over time, and is manifest in developmental stages during the Middle Stone Age in several sites and assemblages from East Africa. This knowledge, built from the technological assessment, helps to explore aspects of the emergence of modern human behaviour in East Africa.

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DEDICATION

This dissertation is dedicated to my wife Belia and our children, James, Grace, Tabitha and James Jr., whose love and support never wavered during the long period I was away. Your prayers and encouragement renewed my strength.

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Chapter 1: Introduction

> *Therefore, since I myself have carefully investigated everything from the beginning, it seemed good also to me to write an orderly account for you, most excellent Theophilus. (Luke 1:3 [Barker et al. 1995])*

1.1 Background

Modern human behaviour has been defined as behaviour mediated by socially constructed patterns of symbolic thinking that involves actions and communications that allow for material and information exchange of a cultural nature across generations and contemporaneous communities (Henshilwood and Marean 2003). How this is identified in the prehistoric record remains a hotly debated issue in palaeoanthropology. Areas of concern include the indicators, origin, age, and spread of modern human behaviour; and these remain points of disagreement among researchers despite several decades of debate and discussion. This is caused by two factors.

First, there is no coherent body of theory defining modern human behaviour that can act as a guideline for investigations in different parts of the world (Gibson 1996; Renfrew 1996; Foley and Lahr 1997; Deacon 2001). Second, traits such as symbolic artefacts and art; blade and microlith technology; shaping of bone, antler and ivory into tools and other ornamental objects; standardisation and increased diversity of artefact types; use of wider geographic range and increased social and exchange networks have all been used as markers for modern human behaviour. Although researchers have placed emphasis on these empirical records (traits) as signalling modern human behaviour (Clark and Lindly 1988, 1989a, 1989b; Hayden 1993; Klein 2000; Lindly and Clark 1990a; McBrearty and Brooks 2000; Mellars 1995; Thackeray 1992; White 1982), the universal applicability of such traits is questionable. This situation has hindered possible breakthroughs in the debate. Researchers, therefore, continue to explore different ways of finding answers to the questions at hand.

A major question is whether modern human behaviour emerged earlier than 40,000 years BP (before present) during the Middle Stone Age (hereafter referred to as MSA) in Africa, or did it develop during the transition to the Later Stone Age (hereafter referred to as LSA) about 30,000 to 40,000 BP. These periods correspond to the Middle Palaeolithic and Upper Palaeolithic in North Africa, Asia and Europe; and date to about 300,000 to 40,000 BP and 40,000 to 10,000 BP respectively. The dominant cultural stages at this time in sub-Saharan Africa are the MSA and LSA, which are characterised by Levallois flakes and retouched pieces made on flakes, with points as the distinguishing implement for the former, and blade, bladelet, and microlithic tools for the latter (Brooks *et al.* 1990; Grün and Stringer 1991).

Another question concerns what precisely characterizes modern behaviour in the prehistoric record. Unfortunately, an acceptable list of characteristics defining modern human behaviour which is applicable throughout the Old World and which can be temporally and spatially documented remains elusive. A list (for example, Table 2.1) prepared for European sites (Klein 1992; Mellars 1989) indicates that modern human behaviour emerged about 30,000 to 40,000 years BP, coinciding with the arrival of *Homo sapiens* and the cultural transition from the Middle Palaeolithic to the Upper Palaeolithic. Henshilwood and Marean (2003) call this the "Later Upper Pleistocene model" for the emergence of modern human behaviour. Its supporters (Ambrose 1998; Ambrose and Lorenz 1990; Binford 1984, 1985; Clark 1988, 1989; Gamble 1994; Tattersall 1995) argue that it is only during the early LSA or very late MSA that behavioural modernity can be identified in Africa. Accordingly, even if MSA hominids were anatomically modern, they were not behaviourally modern until some time after 50,000 years ago. The model also gives key features of the MSA/Middle Palaeolithic as consisting of: (a) simple material culture lacking bone implements, fishing and fowling gear, variation in lithic technology, and use of exotic raw materials; (b) basic subsistence with no fishing, capture of flying birds, hunting of prime adult or dangerous animals such as the Cape buffalo, and emphasis on scavenging; and (c) the absence of symbolic behaviour such as the use of art, personal ornaments, and ochre use for other than utilitarian ends (Klein 1995; Gamble 1994; Henshilwood and Marean 2003:629).

Africa provides crucial biological and evolutionary developments that underlie the emergence of essentially modern human populations (Mellars 1989:367). Genetic studies, though questioned in a number of ways (Wolpoff 1989), indicate a possible emergence of modern genotype in Africa. This hypothesis has resulted in arguments for early behavioural changes by researchers such as Foley (1989), who argue that the emergence of anatomically modern humans may have represented a speciation event in the savannah and woodland environments of sub-Saharan Africa, as opposed to the ecologically harsher environments of Eurasia, with changes in the biological and anatomical features being directly connected to behavioural patterns. He suggests that these could have led to new approaches in foraging and subsistence as well as technological and social developments.

These developments are contained in archaeological records that have been questioned and discussed (Ambrose and Lorenz 1989; Binford 1984; Clark 1982, 1983, 1989; Deacon 1989; Klein 1979, 1983, 1989; Van Noten 1982; Volman 1984), and that portray Africa as the suitable origin for both biological and cultural modernity. The building of a case for the rise of modern human behaviour in Europe during the transition from the Middle to Upper Palaeolithic period, therefore, came as a surprise that started the current debate on the antiquity and distribution of cultural modernity in the archaeological record.

A list of traits signalling the presence of modern human behaviour was designed using European Upper Palaeolithic material. It is less applicable in other parts of the world because of different rates of accumulation and preservation of archaeological materials as well as research intensity. Moreover, some of the traits such as the use of bones are now known to have occurred earlier in African assemblages, leading to the argument that modern behaviour may have appeared earlier there (McBrearty and Brooks 2000; Henshilwood and Marean 2003), as discussed in Section 2.3. If this were true, it would mean that both biological and cultural evolution first occurred in Africa before appearing in other parts of the world. Genetic and fossil evidence (Section 2.1) tend to support this position. According to this scenario, a single African origin for modern humans before 100,000 BP was followed by a spread to other parts of the Old World, particularly southwestern Asia and Europe, where archaic east Asian and Neanderthal populations were replaced without gene exchange by about 30,000 BP in what has been termed the "Out of Africa 2" hypothesis (Aiello 1993; Quintana–Murci *et al.* 1999; Relethford and Jorde 1999; Day and Stringer 1982; Hawks *et al.* 2000; Stringer 1996; Wilson and Cann 1992). This hypothesis differs from the "multiregional evolution" one which argues for independent development of modern human forms in every area of the Old World (Thorne and Wolpoff 1992), and the "Weak Garden of Eden" hypothesis that argues for independent development after the eruption of Mt. Toba 70,000 years ago, an event which caused population bottlenecks (Ambrose 1998).

The link between biological and cultural modernity, however, remains unconfirmed because direct correlation between hominid species and successive cultural developments has not been observed in the archaeological record (Section 2.4). Equally problematic is understanding the temporal and spatial aspects of modern behaviour. This may be due to varying preservation of perishable materials. Attempts to solve this problem have led to increased reliance on the study of well-preserved materials resulting from the use of stone or 'hard' technology, as opposed to 'soft' technology, or more perishable tools.

Both 'hard' and 'soft' technologies are forms definitely present in the MSA, forming a way of life that defined the organization and work of societies. As a system, technology involves procedures and organization that reflect a people's general worldview and complexity (Franklin 1990; Parkman 1972). It embraces all sectors of social and economic realms of each society. More complex technologies, such as those of hunter-gatherer societies or the current developed-world technologies, are equated to higher developments and therefore to people having higher cognitive abilities, meaning they had conscious intellectual ability or elements of perception such as thinking, reasoning, remembering, imagining, and learning. Using this assumption, we can examine the prehistoric record to trace the beginnings of complexity and higher organizational abilities that reflect conscious intellectual activity. 'Soft technology' is perishable; and is not found in many MSA archaeological sites in sub-Saharan Africa due to the fact that most sites are open-air ones, and so are exposed to both anthropogenic and natural erosion factors. Unfortunately, forms of this technology, including the use of bone and signs of hafted tools as discovered in the European Upper Palaeolithic, remain significant in defining modern behaviour. ‘Hard technology’, which survives better in the archaeological record, forms an alternative for exploring behaviour in areas where other evidence has been lost. It may reveal patterns reflecting the day-to-day activities of the populations that employed it. Stone tools available from the MSA period can, therefore, be scrutinised in order to understand the day-to-day activities of the populations that made them, despite the loss of the soft technology repertoire.

Technology also defines power and influence over others to whom technological skill is imparted through teaching or training. It may further reflect how a society used its technological skills to control or survive in particular environments. It therefore entrenches itself in the social landscape, defining social structures and relationships between groups, individual societies, geographical regions; and, most importantly, reveals human–environment relationships. Technological patterns, therefore, can help explain the culture of prehistoric societies. This makes technology an important aspect in understanding the behaviour of populations implicated in the emergence of modern behaviour or cultural modernity.

1.2 The scope of research

The research presented here is an attempt to increase our knowledge of the emergence of modern human behaviour through an investigation of East African MSA technological systems. In the past, these lithic assemblages and sites have been used as chronostratigraphic markers and as a source of artefact morphological-typological information. A chronostratigraphic marker is any chronologically significant event or layer (biological, isotopic, isotopic-ratio, paleomagnetic, or cultural) recorded in a stratigraphic sequence that can be directly related to and/or tied to any other chronostratigraphic marker that may be of known date(s) (Lindsay 2003). Morphological typology, on the other hand, refers to the use of artefact forms to create artefact classes. Mary D. Leakey (*et al.* 1972) used both concepts in the late 1960s and early 1970s to study the stratigraphic sequence of cultural materials and hominids at Olduvai Gorge, Tanzania. Similarly, Mehlman (1977) applied the concept in the 1970s to study the Nasera and Mumba Höhle archaeological sequences in northern Tanzania, and Merrick (1975) for stone assemblages in Central Rift Valley sites in Kenya. Behavioural inferences, however, have been limited, so have had little to contribute to the on-going debate on the emergence of modern human behaviour. An understanding of the technological system can generate behavioural patterns that characterized the day-to-day activities of these early hominids. Raw material sourcing and transport to sites, methods of manufacture, the nature or type of artefacts, and settlement or site location, all form part of a system within which behavioural decisions played a key role. Once the patterns within these subsystems are identified, it should be possible to evaluate the level of complexity of the behaviour that created such patterns.

MSA assemblages were examined from five sites in two geographic regions, the Central Rift Valley and Lake Victoria Basin of Kenya (Figures 1.1 and 3.3). The two regions are examples of the varied environments occupied by the Middle and Upper Pleistocene hominids responsible for these assemblages. By examining these materials, it may be possible to understand the emergence of the earliest forms of cultural modernity. The use of two regions and a number of sites also enhances the possibility of an increased understanding of how technological systems may have developed, and how these populations adapted to different environments.

In order to understand the MSA technological system within these regions and sites, an in-depth lithic analysis of cores, whole flakes, and selected tools (scrapers and points) was carried out on five previously excavated assemblages. These assemblages were compared to study patterns of technological variation and their causes. Did the variation result from unique circumstances at individual sites, or was it as a result of decisions that cut across different environments? The patterns also make it possible to draw conclusions as to whether or not MSA assemblages contain elements of modern human behaviour.

The research uses four main premises based on earlier work (1) Definitions that have been used to interpret both temporal and spatial aspects of the emergence of modern human behaviour are limited and do not apply universally. (2) Many Middle Pleistocene (from about 780,000 to 126,000 years BP) and Later Pleistocene (from about 126,000 to 11,430 BP) lithic assemblages from East Africa have not been directly studied to understand the earliest aspects of modern behaviour. The dominant cultural stages at this time in sub-Saharan Africa are the MSA and LSA. These correspond to the Middle Palaeolithic and Upper Palaeolithic in North Africa, Asia and Europe; and date to about 300,000 to 40,000 years BP and 40,000 to 10,000 years BP respectively. They are characterised by Levallois flakes and retouched pieces made on flakes, with points as the distinguishing implement for the former, and blade, bladelet, and microlithic tools for the latter (Brooks *et al.* 1990; Grün and Stringer 1991). (3) MSA assemblages represent a well-preserved technological output in the form of individual artefacts made through a

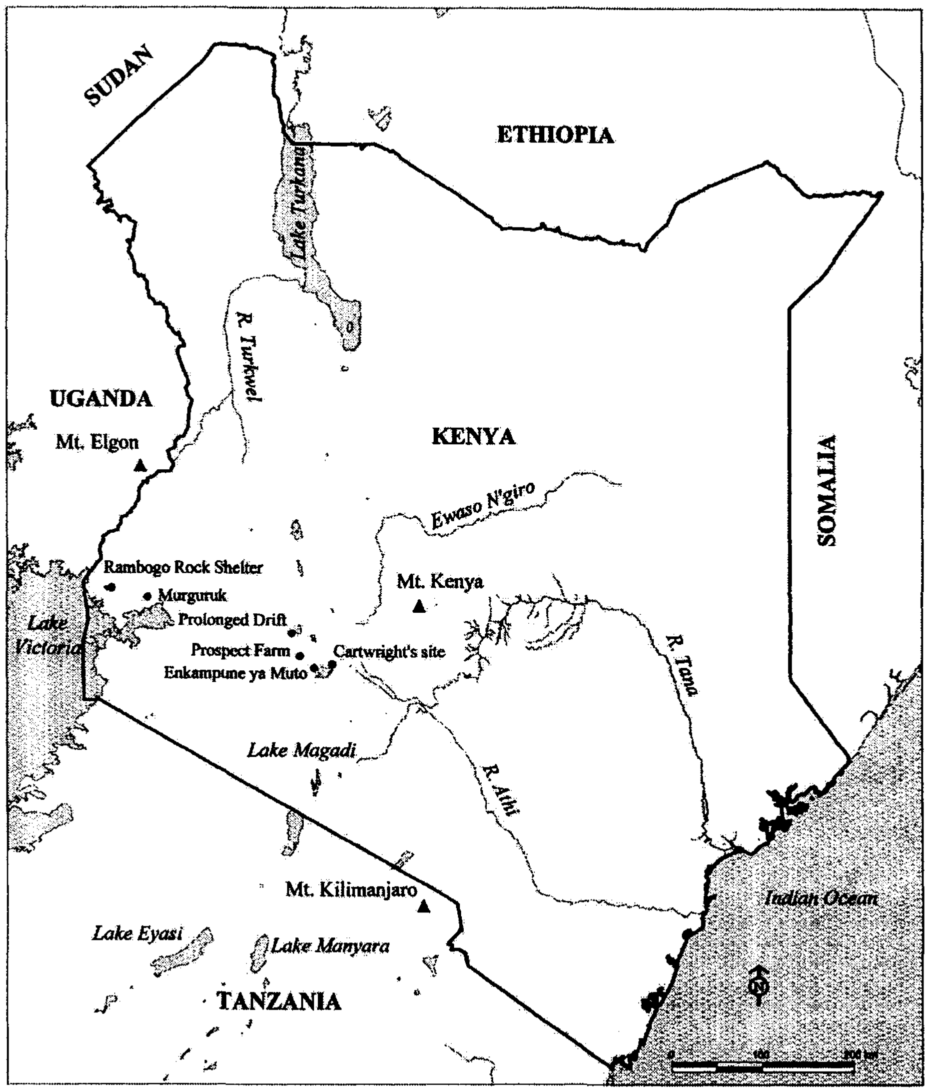


Figure 1.1: Map of Kenya showing the location of MSA sites used in this research.

chain of activities which therefore contain behavioural patterns that can be used to answer questions on the emergence of modern behaviour. (4) Technology entrenches itself in the social and geographic landscape, and can therefore be studied to shed light on the earliest forms of modern behaviour.

Following the above premises, two overriding objectives have been used in this work, and are stated below.

(1) To reconstruct and describe the technological system, while identifying the major patterns present.

(2) To assess the extent to which the technological patterns reflect modern human behaviour during the MSA period, in relation to traits given by researchers as characterising cultural modernity.

To realise these objectives, three hypotheses have been used, and are stated below.

(i) That modern human behaviour was present during the MSA and that this is reflected in the various components of the technological system.

(ii) That there is variation within and between MSA assemblages caused by behavioural decisions made by hominids in the course of lithic manufacture and use and that such decisions bear similarity to those of modern hunter-gatherer societies.

(iii) That modern human behaviour developed gradually during the MSA period contrary to the argument of a sudden appearance in Europe at the start of the Upper Palaeolithic.

Overall, the goal of this investigation is to identify aspects of modern human behaviour involved in the technological system. Lithic raw material procurement, use of the environment, where and how tools were produced, and the decisions associated with these activities, together provide a wide range of variation in behaviour useful in understanding the beginnings of cultural modernity. The primary target, therefore, is to identify variations in the different assemblages, and then to find the causes of such variation and to link these to behavioural patterns. Once this is done, the second concern is whether or not there was any formal standardization of artefacts or reduction processes, and how these vary within and between sites. All of these issues form key elements of discussion in this research.

This research uses two intertwined levels of investigation. First is the descriptive level, which establishes the technological activities that created the assemblages; and second is the analytical level, which provides the interpretation of the activities using statistical measures to identify patterns within the assemblages. Patterns of raw material use, core types, flake morphology and size, as well as tool attributes, provide information on the various decisions that were made by MSA hominids. Together with current models based on the activities of hunter-gatherer societies, this information will aid in the assessment of the cognitive abilities of the makers of the MSA assemblages studied here.

1.3 Structure of the dissertation

This dissertation has seven chapters. Chapter 1 is a general introduction outlining the background and the objectives of the research. Chapter 2 discusses the current knowledge and approaches that have been used in defining and understanding modern human behaviour. It shows that the debate on this topic is still in its infancy, pointing out limitations in the various approaches, and the lack of a theoretical basis for this topic. While the use of traits to signal the presence of cultural modernity seems to be in vogue, it has equally attracted disagreements between those who see such traits as emerging only during the transition from Middle to Upper Palaeolithic period, and those who see the traits as appearing gradually before 40,000 BP in various parts of the Old World (Mellars 1989; McBrearty and Brooks 2000). A number of the traits have great antiquity, extending well into the MSA/Middle Palaeolithic and earlier periods associated with archaic *Homo sapiens*. This means, they may not be suitable for assessing the emergence of modern human behaviour. Nevertheless, the use of traits as a means of assessing and tracing the emergence of modern behaviour has been applied in this work, as it is the only method available to researchers currently. The views expressed here, regarding the presence of modern behaviour in earlier periods, based on some of the traits, are, therefore, built upon the current use of such lists, rather than on independent assertions originating from the results of this work. This work, and the results presented here, is also treated as being initial, or a pilot research in this subject. More work needs to be done towards the production of a body of a coherent theory that will help in defining what qualifies as cultural modernity in the prehistoric record.

Chapter 3 discusses Middle and Upper Pleistocene global, African, and East African environments and their possible effects on MSA hominid adaptations, behaviour, and settlement patterns. Chapter 4 gives a brief background on MSA research in East Africa, and describes individual sites used in this research along with their environmental context. Environmentally/climatically induced behavioural patterns, as reflected in the settlement strategies or location of MSA sites, provide the contextual base for discussion of the cognitive ability of MSA hominids to live in such environments.

Chapter 5 discusses assemblage variability, and establishes the nature and causes of such variability. Results of lithic analysis are presented in both descriptive and analytical forms. Observation involving three principal vectors, namely, (1) technology, (2) morphology, and (3) raw material, are used to infer major elements of the technological system. The ability to make various artefacts, or to have a varied tool kit, may indicate the number of activities carried out by the early hominids and therefore reflect behavioural decisions made by them. Because of this, I argue that MSA hominids possessed cognitive abilities enabling them to assess conditions and make suitable decisions, a process that qualifies as modern behaviour and which contributed to the variation exhibited in the assemblages.

Chapter 6 presents a synthesis of the technological system. It illustrates how the major elements point toward the existence of modern human behaviour as proposed by various researchers dealing with archaeological and ethnographic hunter-gatherers. Results of lithic morphological analysis and comparisons to assess standardization within the assemblages are also undertaken. The question of whether there is formal standardization of artefacts and production processes is also addressed. Tracing standardization in the MSA/Middle Palaeolithic has been attempted in North Africa and the Levant (Chase 1991; Marks *et al.* 2001). From these works, it is evident that there is no significant difference between MSA/Middle Palaeolithic and LSA/Upper Palaeolithic, in terms of stone tool standardisation. This means that the trait may not be suitable for use as an indicator for cultural modernity. Nevertheless, it continues to be used by researchers, raising the question of authenticity of the method currently used in understanding the origins of modern human behaviour.

Lastly, Chapter 7 presents the conclusions of this work, and provides some comments for future research.

Chapter 2: The antiquity of modern human behaviour

The potential for complex culture (modernity) may have been present since the beginning of physical modernity. (A. Clark 1999:116)

2.1 Introduction

The past two decades have seen debate on the emergence of modern human behaviour catapulted to a position of global anthropological interest. This has come about because of a number of reasons. First, the association of this behaviour with traits in the prehistoric record considered to mark the earliest forms of cultural modernity has set off a heated debate, and second is the 40,000 years BP boundary set for the appearance of modern behaviour. This is based on the interpretation of the European Middle-Upper Palaeolithic transition, but may not reflect the emergence of modern human behaviour in other parts of the world. Lastly, there have been major concerns regarding the applicability of the traits to the materials found in other parts of the world for understanding this topic of discussion. Studies of alternative areas and time periods offer the promise of understanding the temporal and spatial aspects of modern human behaviour. At the same time, researchers are focusing on new data to solve the pending problems.

Until recently, modern human behaviour was thought to first appear around 40,000 years ago, marked by the onset of Upper Palaeolithic cultural traditions in Europe (Klein 1970; Clark 1982). This event is supposed to represent the beginnings of symbolic behaviour and rational use of the environment. It is suggested that modern human behaviour emerged suddenly, and that this "revolution" was associated with the arrival of anatomically modern humans (*Homo sapiens sapiens*) in Europe, where their Upper

Palaeolithic cultures replaced the Middle Palaeolithic cultures of the Neanderthals (*Homo neandertalensis)*. It was assumed that the appearance of cultural and biological modernity were parallel events, at least in Europe.

Table 2.1 contains some of the traits previously cited as proof of modernity. However, recent research has shown that some of the traits used to define modern human behaviour such as use of symbols, presence of rituals like burial practices, hunting, and standardization of tools, just to mention a few, transcend the limits of the European Upper Palaeolithic developments in time and space. Similar traits, dating to periods earlier than 50,000 years ago, have been documented in Africa and southwestern Asia (Section 2.3). The claim for parallelism between cultural and biological modernity also remains unresolved. The limited evidence for the appearance of modern human behaviour found throughout Africa does not allow conclusions to be made on the relationship of these behavioural patterns with anatomically modern humans found in the continent between 250,000 and 130,000 years ago (Stoneking *et al.* 1992; Goldstein *et al.* 1995; Nei 1995; Stringer and Andrews 1988; Tischkoff *et al.* 1996; Brauer *et al.* 1997; Klein 1995). Early signs of the emergence of modern human behaviour in various parts of the Old World, as well as an earlier emergence of anatomically modern humans in Africa, present a record that calls for a re-examination if the antiquity of cultural modernity is to be established.

In the 1980s and 1990s, new approaches and research provided more information on this topic. The claim for a European Upper Palaeolithic "revolution" or the idea that the first revolution happened in Europe alone has been questioned and weakened by additional data (McBrearty and Brooks 2000; Henshilwood and Marean 2003). Evidence from the African continent and the Levant indicates a greater antiquity for the emergence of modern human behaviour there than in Europe. This has led to the establishment of alternative explanations; for example, "gradual development" in which modern behaviour is seen to emerge slowly during the MSA throughout Africa (McBrearty and Brooks 2000; Henshilwood and Marean 2003), as opposed to a "revolution" in which it suddenly appeared in Europe during the Upper Palaeolithic period (Mellars 1989b). Chronometric dating and the investigation of varied geographical regions with different cultural zones have also provided information that has questioned the definition of modern human behaviour. Evidence from both mitochondrial DNA (Stoneking *et al.* 1986; Cann *et al.* 1987; Wilson *et al.* 1987; Stringer and Andrews 1988; Stoneking and Cann 1989; Wilson and Cann 1992; Goldstein *et al.* 1995; Nei 1995; Tischkoff *et al.* 1996) and the fossil record (Stoneking *et al.* 1992; Brauer *et al.* 1997; Klein 1995) suggest that anatomically modern humans emerged in Africa by 200,000 years ago. This challenges the explanation based on the European Middle to Upper Palaeolithic record that modern human behaviour developed at the same time as biological modernity. It is most unlikely that anatomically modern humans shelved the use of their cognitive abilities for more than 200,000 years and only put them to use at the beginning of the Upper Palaeolithic (Europe) or LSA period (Africa).

There have been a lot of developments since the initial definition of modern human behaviour using European material. This chapter presents encapsulated information on the current views defining modern human behaviour, its antiquity based on material evidence, the relationship between cultural and biological modernity and, lastly, the status of theoretical developments in this topic.

2.2 Defining modern human behaviour

The emergence of modern human behaviour now joins questions of Pliocene-Pleistocene hominid behaviour, the origins of agriculture, and the origins of the state (Henshilwood and Marean 2003:636) as dominant topics shaping anthropological inquiry. It has grown from a simple definition using a list of cultural traits indicative of modernity into a global research agenda that now calls for a multiplicity of techniques and methodologies.

In the study of Middle and Upper Palaeolithic assemblages in Western Europe, scholars realized that there was a marked difference between the two periods (Stringer and Gamble 1993:179). Upper Palaeolithic assemblages show a higher degree of complexity and tool workmanship. Modification, involving retouch, was more elaborate. The shaping of microliths to produce a variety of tool categories was also more demanding technologically, while the production of composite tools required the creation of artefacts with multiple parts. Using these differences, it was concluded that Upper Palaeolithic cultures belonged to people who were behaviourally modern and had cognitive abilities similar to people of today. Characteristics or cultural traits within this "superior package" of behaviour were used to define and mark the beginnings of modern behaviour, and then these "modern traits" were applied to various assemblages in time and space. Within this framework, Upper Palaeolithic cultures were seen as being characterized by an artistic burgeoning; and expansion in the range, style in tool making and use of raw materials. Artefacts contained long, slender blades; bone, antler and ivory pieces; jewellery, ornaments; and artwork as can be seen in the Aurignacian industry (Stringer and Gamble 1993:179; Mellars 1991, 1996a). In contrast to the Upper

Palaeolithic, Middle Palaeolithic assemblages lacked complexity, deliberate patterning, and variation. This condition made the difference between the two cultures very distinct, and supported the claim for a Middle to Upper Palaeolithic Cultural Revolution (Mellars 1991; 1996a; Farizy and David 1992). This conclusion, however, carried inherent weaknesses and ambiguities that have become the subject of debate in attempts to develop an acceptable definition for modern human behaviour.

The use of "modern cultural traits" seems to have been a construction of a time-space framework reflected in the sudden shift from the Middle to Upper Palaeolithic in Europe. The concept was developed as a time specific and geographically constrained event, which cannot be applied elsewhere without modifications. The shift was also explained by the arrival of *Homo sapiens* in Europe about 40,000 years ago. The cultural burgeoning and innovations of that time were thus attributed to these newcomers. In subsequent years of research, however, signs of modern human behaviour were sought elsewhere, particularly in Africa and the Levant, where anatomically modern humans first appeared. These geographical regions have since provided materials from which modern cultural traits have been obtained for comparison with the European record. The time-line set at the Middle to Upper Palaeolithic (MSA to LSA in Africa) boundary for the emergence of "modern cultural traits" now stands challenged by data that tend to push back modern human behavioural traits into the Middle Palaeolithic or MSA.

In the face of new evidence and in response to the claim for a cultural revolution in Europe (Mellars 1991; 1996a; Farizy and David 1992), an alternative proposal for a gradual development of modern human behaviour was developed (McBrearty and Brooks 2000; Henshilwood and Marean 2003). The new evidence points to Africa as the place where the first appearance of this behaviour occurred. Proponents of this model consider the Upper Palaeolithic revolution model as "blind" to evidence from other parts of the world. Attempts to apply the traits recognized in Europe to African material reveal limitations in differences in terms of geography, environment, and site preservation. The "revolution" and "gradual development" models thus continue to compete in investigations of modern human behaviour. Recently, however, the use of traits as a way of defining and understanding modern human behaviour has been challenged (Henshilwood and Marean 2003). Instead, a focus on developing a universal body of theory has been proposed, which could explain why some of the changes we consider modern might have appeared at different times and places.

Despite the suggestion to abandon the use of a suite of traits in defining modern human behaviour, it is evident that the methodology will remain helpful, as it provides a means of defining and understanding the antiquity of that behaviour. The identification of patterns incorporating symbolism, manipulation of the environment for adaptive purposes, and social organization go beyond being mere traits to become the defining pillars for modern human behaviour. As a result, modern human behaviour is now defined as either: (a) the presence of a suite of cultural traits considered to mark modernity in the prehistoric record (Table 2.1); (b) the presence of symbolic behaviour – symbolism; (c) a systematic use of the environment; or (d) a combination of all these. The understanding of these levels at which attempts to define modern human behaviour have been made in the past is paramount to the development of an acceptable definition. For example, to consider a trait as resulting from modern human behaviour, we need to

TRAIT NAME	NATURE IN THE ARCHAEOLOCAL RECORD
Increased artefact diversity	• Multiple artefact types. • High artefact turnover with industrial replacements in shorter intervals of time.
Standardization	• Uniform artefact size and patterns. • Technological similarities gained from the learning process.
Complex Technology	• Blade technology. • Microlith technology. • Development of composite tools. • Curation procedures.
Diversification of raw material use	• Use of bone, ivory, and other organic materials, such as wood. • Use of varied rock types for tool manufacture.
Ornamentation	• Use of various kinds of beads for body adornment (ostrich egg shell beads, bone pendants, tooth pendants).
Structuring and Living space	• Separation of activity areas: Hearth or fireplace, sleeping area, flaking area, garbage dumps.
Symbolism	• Rituals – grave goods, supernatural beings. • Cave paintings and other art forms.
Economic intensification	• Exploitation of plant and animal resources, land and aquatic resources, dangerous animals, small and big animals.
Geographical expansion	• Occupation of nearly all environments.
Social networks	• Trade and exchange between societies. • Other forms of social links.

Table 2.1 List of traits used in defining modern human behaviour (Information from McBrearty and Brooks 2000).

understand what the qualifying elements are. We also need to understand what symbolism is, and how the use of the environment reflects modern behaviour.

2.2.1 A definition based on cultural traits

Table 2.1 and Section 2.3 provide a range of traits that are supposed to define modern human behaviour. The initial lists (Mellars 1973: table 3; Gamble 1994:157 – 74) were developed using European Upper Palaeolithic materials, in contrast to Middle Palaeolithic materials from the same areas. The presence or absence of these traits was used as a yardstick to judge whether or not an assemblage was a result of modern behaviour, since it was assumed that Middle Palaeolithic people lacked these traits. This approach has been criticized by many researchers for its reliance on traits obtained from the European record alone (Deacon 2001; Foley and Lahr 1997; Gibson 1996; McBrearty and Brooks 2000; Renfrew 1996). Henshilwood and Marean (2003) observe that most of these traits are not applicable outside Europe because of different preservation conditions. Apart from being context-specific, they could also be explained by factors other than modern human behaviour, such as population pressure or resource fluctuation leading to increased innovation to boost survival. Because of this, it seems that reliability of the use of traits to establish comparisons between assemblages to resolve current concerns regarding the antiquity of modern human behaviour can only be limited in scope.

While traits provide a definition centered on the European time-line of ca. 50,000 to 30,000 years ago, a review of the African record (McBrearty and Brooks 2000) points toward greater antiquity for some of the same features. This presents the problem of regionally differentiated traits, and means that each region could have a different list. For example, the presence of worked antler in Upper Palaeolithic assemblages has been interpreted as evidence for diversification in the use of resources. Organic tools and other by-products of manufacture are clearly missing from the African record, where even the intensive use of bone as a raw material is late except for isolated cases (Section 2.3). While it can be argued from this trait that the users of antler in Europe were more modern than their counterparts in Africa, the truth of the matter is that the presence and absence of this particular trait in both regions, respectively, may be due to chance survival of this organic material in the two geographical and ecological regions.

In addition, the fact that more research has been done in Europe than elsewhere seems to amplify the Upper Palaeolithic developments. Southwestern Europe, from which most of the traits were drawn, represents only a small area with an abundant archaeological record compared to other areas. The area remains the best-studied and documented part of the world for this period, due to a well-preserved archaeological record in sheltered caves and rock shelters. The area cannot, therefore, be compared accurately with other regions, particularly the vast African continent where there are large areas that remain poorly investigated. Whereas hominid activities, and the patterning resulting from such activities, have been studied and documented in much of Europe, the same remains to be realized for much of Africa. Furthermore, European materials are generally better preserved compared to the African ones, since they lie in cave sites that were repeatedly or continuously occupied. Such sheltered sites protected archaeological materials, including those of organic nature, from destructive erosion and bio-perturbation forces that affect the archaeological record in open-air sites in sub-Saharan Africa. This condition sharpens the distinction between the Middle and Upper

Palaeolithic levels at various sites. The African condition is far from being similar. Klein (*et al.* 2002) and other current researchers in Africa see the continent's prehistory as less studied and documented, but holding promise for new data in anthropological enquiry. Large areas, for example the East African region, may hold keys to providing new data for understanding modern human behaviour. Such regions should be the focus for developing theory to explain this important topic.

The use of traits in defining modern human behaviour as exemplified in the Middle to Upper Palaeolithic paradigm therefore has limitations. These must be overcome if the simplistic method of "presence and absence of traits" is to count in the current search for deeper understanding. Data providing additional traits continue to come from other parts of the world hitherto un-investigated. Besides, the Middle to Upper Palaeolithic paradigm has ignored other factors that could be alternative explanations for the emergence of the so-called modern traits. For example, Oswalt (1973, 1976) observed a decreasing trend in technological complexity among modern or recent hunter-gatherer societies, extending from the Arctic, where there was more complexity, to tropical environments, showing less complexity. This difference could be the result of environmental demands on technological adaptation; and could explain complexity involving innovation, diversification, and experimentation in various ways within the immediate environment. Localized conditions and adaptation requirements may lead to specialised adaptive changes or a complete overhaul of technology to guarantee survival within a particular environment. When this happens, the archaeological record is drastically changed as new features are introduced. This could have happened at the start of the Upper Palaeolithic (or LSA in sub-Saharan Africa) to create the array of traits that have been regarded as marking the beginnings of modern human behaviour. The use of traits to characterize and define modern human behaviour should, therefore, be done with caution and alongside other supporting evidence and/or explanation grounded in acceptable anthropological theory.

2.2.2 A definition based on symbolic behaviour

Modern human behaviour may be defined as behaviour mediated by socially constructed patterns of symbolic thinking (Henshilwood and Marean 2003:635). It involves actions and communication that allow for material and information exchange and cultural continuity between and across generations and contemporaneous communities. This modern definition applies to most of the Upper Palaeolithic/LSA cultures, where the archaeological record reveals external symbolic storage (visible outside expression) of information in the form of artwork, personal ornamentation, lithic style, and the social use of space (Wadley 2001); but its application to earlier periods calls for an understanding of hominid biological developments and the physical structure that enhanced major social changes which form the dividing line between modern and archaic humans. A distinct element that glues the entire definition is contained in the phrase "socially constructed pattern of symbolic thinking" (Henshilwood and Marean 2003:635). The beginning of modern human behaviour, therefore, seems to correlate with the emergence of symbolic thinking and the ability to use symbols to organize behaviour, as in social interactions and various forms of exchanges.

A major extension in this study has been made to understand the development and meaning of symbolic thinking or symbolism as a clear hallmark of modern behaviour.

Research has concentrated on the creation, use, and manipulation of symbols (Chase 1991), as well as the definition of symbolism and establishing how its correlates can be detected in the prehistoric record. There are clear signs of symbolism in Upper Palaeolithic/LSA cultures in the form of works of art, ritual behaviour, and representational tool technology. This contrasts with the absence or the faint appearance of these features before 40,000 years ago. The record favours the sudden rise of symbolism in all its forms at about this time onwards. Available evidence, however, indicates that the earliest forms predate both the Upper Palaeolithic in Europe and the Levant and LSA in sub-Saharan Africa; and may indicate that modern human behaviour developed long before the technological and cultural innovations of 40,000 years ago.

Given the difficulty in tracing the existence of symbolism in the archaeological record for periods earlier than ca. 40,000 years ago, archaeologists have had to struggle not only to understand its external expressions but also to picture the developmental process of this trait in an evolutionary manner. Chase (1991) has defined a symbol as something the meaning of which is determined by arbitrary convention. It is therefore a referential sign, as stated by Peirce (1932/1960). Thus, when we talk of symbolic thinking, we put in place a kind of abstract connotation that goes beyond mere reference to fulfill other functions, whether social, technological and so on. This kind of behaviour is developmental.

Wadley (2001), citing Deacon (1997:74), proposes three levels for the development of symbolism, namely: iconic, index, and symbolic referencing. Iconic referencing is seen as the earliest form of symbolic behaviour, whereby icons point to their referents by resembling them. For example, a picture or drawing of an eland depicts the living animal. Index referencing develops from this form by establishing associations between things; for example, an eland hoof print on the sand becomes an index for the animal through association. At the last stage, symbolic referencing involves establishing relationships among indices and icons to develop symbols that arbitrarily point to their various referents. In this development, the word *eland* becomes a symbol, having no natural link to the animal it refers to but becoming linked to that animal through arbitrary convention or abstraction. This forms the final stage of development for symbolic thinking, and marks the point at which symbols begin to be stored outside the human brain in the form of expressions that may be imprinted on cultural materials, and other forms such as language and belief systems. Typically, researchers are able to identify these forms of out-of-brain storage in the form of artwork, ornamentation, artefact styles, and spatial patterning (Wadley 2001:207) in the recent prehistoric archaeological record. The problem in this pursuit, however, is not simply the one of detecting symbolism earlier than the Upper Palaeolithic/LSA; but, as pointed out by Chase (1991), the difficulty in interpreting and understanding the early forms. There is always the danger of generating arguments based on the understanding of modern symbols rather than a pure necessity to investigate prehistoric symbols. Furthermore, the majority of prehistoric symbolic behaviour such as non-material ritual practices, language, and social beliefs and associations is rare if not completely absent from the archaeological record; and in most cases is subjected to inferences of convenience.

Take, for example, Middle Palaeolithic/MSA signs for symbolic behaviour. These illustrate how frustrating and difficult it can be to characterize and define early forms of modern human behaviour. The evidence is scarce, and in most cases may be confused with or taken for natural phenomena rather than resulting from hominid activities. The dividing line between deliberate hominid action reflecting symbolic activity, hominid action without any links to symbolism, and results of natural events creating some of the spatial arrangements observed as symbolic, is not easy to place. Besides, most of these early forms of symbolic behaviour present the problem of interpretation, with researchers usually providing varied views on the same forms of evidence. How best to ascertain aspects of symbolism from remains such as lithic material, burials as rituals, or other forms of ritual and arts, therefore continues to be a major concern for palaeoanthropologists who study human biological and cultural evolution.

Chase and Dibble (1987) provided a review of the archaeological evidence and interpretation of Middle Palaeolithic symbolism in Europe. Their conclusion that the evolution of modern human behaviour was mosaic in nature and weakly developed at this time compared to the Upper Palaeolithic period, as well as their acceptance of the presence of aesthetic sense as reflected by various artefacts and manuports, makes a case for greater antiquity of modern behaviour even in Europe. In modern times, aesthetic sense always accompanies symbolic behaviour; and the two may not be easily separated. If this has been the case from the beginning, then there should be symbolism in the Middle Palaeolithic. The scanty appearance may therefore be interpreted as resulting from stage development and experimentation, taphonomic factors resulting from great antiquity, social choices in the face of new inventions, and the sparse populations at the time. The high proportion of symbolism in the subsequent periods definitely reflects the opposite of these factors. It is therefore apparent that modern human behaviour may be defined by the appearance of symbolism in the archaeological record, mainly in the form of art, personal ornamentation, rituals, style in lithics, and the formal use of space, whereby discrete activity areas, such as hearths and dumping zones, or the positioning of artefactual debris are clearly recognizable. According to Kolen (1999:141), these represent the "mythical ordering of space" in dwelling places which is a characteristic of all modern humans. Wadley (2001:209) argues that these archaeological records represent storage of symbolism out of the brain, which is a sign of modern behaviour; and that once people begin to store information in symbols outside their brains, they are modern and the frequencies of different types of such storage becomes irrelevant in terms of the definition.

2.2.3 A definition based on use of the environmental

Archaeological sites, whether open-air or in caves, provide documentation of past hominid activities and interaction with the environment. The data are robust, and in most cases comprise archaeological sediments with large accumulations of occupation layers containing: (i) animal remains resulting from hominid subsistence activities, and (ii) artefact assemblages signifying technological advancements. Both inform us about site layout as well as other behavioural patterns. These data provide the basis for inferences about exploitation patterns; and of specific raw material types, organizational abilities, and other forms of hominid manipulation and/or use of the ecological niche. Each piece of data, however, has its own inherent problems of interpretation; and may reflect unique circumstances in particular areas. Also, the response by different populations to different environmental conditions that results in the observed archaeological remains, does not allow for a blanket or single story in terms of manipulation of the environment. These problems are all too apparent in discussions of the available information on how hominids managed and exploited their environments (Binford 1984; Klein 1976, 1978, 2000). This notwithstanding, the concept of systematic use of the environment has been incorporated in attempts to define modern human behaviour. Tables 2.2 and 2.3 contain some of the features under this category that have been put forward as characterizing modern human behaviour. Whether these features are good indicators for the origins of cultural modernity remains a debated issue.

But how does hominid manipulation of the environment signify modern behaviour? Researchers believe that structured living space, where different areas are designated for different activities, reveals a formalized conceptualization of a living space that is akin to sophisticated cognitive abilities (Binford 1989; Hodder 1987). Modern humans are known to be highly organized, especially within their living areas. For many years, deliberate modification of the living area has been documented as a common feature attributed only to *Homo sapiens* in the archaeological record. This feature has been used to distinguish European Upper Palaeolithic from Middle Palaeolithic sites (Farizy 1990; Mellars 1996).

The spatial distribution of archaeological materials and features at a site, detailing the placement of activity areas such as the hearth relative to food processing areas, garbage dump, sleeping areas, and storage, has thus been used to assess the cognitive ability of the hominids involved. The presence and absence of a logical link between materials and/or activity areas tells us whether the hominids were modern or archaic in behaviour. This organizational concept has been used as a measure for modern behaviour; and therefore most of the Middle Palaeolithic/MSA occupation sites, which lack clear arrangements, have been considered a result of archaic rather than modern behaviour.

The problem with this kind of interpretation, which also sees clear patterns at the LSA/Upper Palaeolithic sites and attributes them to modern behaviour, is that other factors that could have contributed to the lack of patterns in the earlier periods are not given serious consideration. In normal circumstances, only permanent and long-occupied sites would build up the type of patterning or structuring that may reflect the standard specifications required for modern behaviour. MSA/Middle Palaeolithic occupation sites, unless they were in cave settings where repeated occupations were possible, were not occupied for longer periods as were LSA/Upper Palaeolithic occupation sites. Sparse populations and mobility patterns in exploiting widely distributed resources only allowed for temporary and shorter settlements at best (Ambrose and Lorenz 1990). Such ephemeral sites had only temporary structures. Besides, where the occupation period was longer, there were chances of existing patterns being destroyed as later occupants created new patterns, a situation that may magnify the patterns of later periods and completely erase or overshadow earlier patterns. Caves, which preserve occupation features better than open-air sites, also have the problem of limited space, which may lead to the magnification of activities and spatial patterning due to restricted space where occupation debris are deposited.

Just as structured living space signifies organised use of the environment and therefore characterizes modern human behaviour, careful exploitation of environmental resources is a landmark for modern human behaviour. Increased intensification of resource use, greater planning depth, seasonal scheduling of hunting and fishing, and exploitation of resources that require labour-intensive strategies, all reflect higher cognitive abilities (Mellars and Stringer 1989; Nitecki and Nitecki 1989). These features characterize the life of Upper Palaeolithic/LSA hunter-gatherer societies; but are scarcely visible in the Middle Palaeolithic/MSA cultures, whose people have been considered less efficient hunters (Klein 1976, 1978, 1989a, 1992, 1994, 1995, 1998, 1999, 2000), and possible scavengers (Binford 1981, 1984).

While these conclusions claim support from various assemblages in time and space, comparison of Middle and Upper Palaeolithic (MSA/LSA) environmental exploitation patterns remains wanting. Intensification of resource use, for example, may be a product of several factors, including population pressure leading to depletion of commonly utilized resources and experimentation with and eventual use of new resources. MSA/Middle Palaeolithic populations may have been relatively lower than those of the LSA/Upper Palaeolithic (Ambrose 2001:23). At least, in East Africa, this can be inferred from the scarcity of MSA occurrences. Also, where MSA occurrences are found, there seems to be limited quantity of materials compared to LSA. This scenario may have resulted from short durations of occupation at MSA sites, or smaller number of occupants at such sites. However, the latter explanation seems to be more appropriate given the steady rise of populations through time.

Resource distribution and availability were also different for MSA and LSA periods. Middle Palaeolithic/MSA groups had more resources relative to the small population size. Consequently, resources that would reduce energy expenditure and require less labour while providing maximum return were most likely preferred and exploited. This would explain the absence of the so-called "dangerous species" from the archaeological record as far as hunting of various animals is concerned during this earlier period. Greater intensification of resource use at the Upper Palaeolithic (LSA) period could also be understood in the context of present-day human behaviour and management of the environment. Population increases and demand for resources have contributed to greater intensification in the use of environmental resources to an extent that humans can today use nearly everything found within their environments, including garbage which is recycled and used as raw material. If demand was not that great, only a few resources would be put to use even in the present-day industrial world. So, whether it is right to use intensification of resource use as reflecting advanced environmental management and therefore higher cognition to define modern human behaviour, remains to be decided in future research and discussions on this topic.

Environmental and seasonally-oriented exploitation patterns may be assessed using archaeological materials, some of which are highly sensitive to diagenesis. Bones, for example, may provide evidence for modern human behavioural traits such as: (i) diversification in the exploitation of different animal species; (ii) exploitation of marine resources such as fish and seal (southern Africa); and (iii) use of bones as raw material for tool making or for other purposes such as rituals. The presence or absence of bones and bone tools at a site, however, is largely dependent on the preservation condition of the sediments in which they are deposited.

Conditions like those found in much of tropical Africa, where sediments derived from acidic ancient basement rocks will destroy bones. These contrast with alkaline conditions, especially the limestone environments and/or caves found in temperate regions of southern Africa that enhance bone preservation. Alkaline conditions and deep caves that act as freezers for good bone preservation have been documented mainly in Europe and the extreme ends of the African continent (Avery *et al.* 1997; Henshilwood and Sealy 1997). But even in these places, taphonomic factors, and the time that has lapsed since occupation, make the Middle Palaeolithic/MSA bone remains less likely to survive. Furthermore, processes of decalcification and organic decomposition will over time compact sediments so that the stratigraphic units will have different time resolutions depending on age. These problems make it illogical to attempt direct comparisons of Middle Palaeolithic/MSA and Upper Palaeolithic/LSA periods in terms of modern behavioural traits reflecting environmental management. Comparison of different regions, for example, Europe and Africa, also becomes tricky, as localized preservation conditions dictate the survival of various items in the archaeological record. Having said this, it is important to note that the limited delicate/perishable materials such as bone and bone tool remains of great antiquity in the Middle Palaeolithic/MSA may be only a reflection of what has been lost due to time and environmental impact on archaeological remains. These delicate materials, wherever their traces can be found, should therefore attract more attention in the characterization and definition of modern human behaviour, instead of concentrating on the evidence of the Upper Palaeolithic/LSA period.

2.3 Archaeological evidence for modern human behaviour

Although it has been argued that most traits for modern human behaviour only appear in the archaeological record at the beginning of the Upper Palaeolithic, the empirical record from recent investigations indicates that there was neither a sudden change nor its emergence in one particular place. The sporadic and spontaneous appearance in all areas where anatomically modern humans were found prior to 40,000 BP is supported by improved dating methods that have put questionable finds within their correct chronological settings, and by better understanding of past climatic conditions which have improved the quality of inferences made from sediments. The cultural innovations that characterize the beginnings of the Upper Palaeolithic, which suggest sudden change from the Middle to Upper Palaeolithic, therefore stand challenged. Evidence, including traces of various forms of symbolic behaviour, rituals, and technological pointers to increased patterning in the later Mousterian assemblages, speak of a tenuous boundary for the emergence of cultural modernity. This boundary issue remains a problem compounded by difficulties that surround the interpretation of the earliest forms of artwork, burials and other rituals, organized and planned hunting patterns, social organizations and exchange patterns, and, lastly, technological patterns reflecting symbolism, all of which point towards modern human behaviour. Traits linked to these cultural practices traditionally accepted as signalling modern behaviour were present, albeit in small quantities, during the Middle Palaeolithic/MSA period and across the entire Old World, with the majority, and perhaps the earliest ones, appearing in Africa. The understanding of these earliest forms, however, becomes complicated because of limited research and data, accurate dates, and research bias amongst scientists.

2.3.1 Ritual behaviour

Ritual activity is one of the many forms of symbolic behaviour that characterize modern human behaviour. This is clearly present in Upper Palaeolithic/LSA cultures, as well as later ones. One clear example is that of burial of the dead, which in the European Upper Palaeolithic occurred in both caves and open-air sites; and included an assortment of grave goods such as stone and bone tools, shells, ivory beads or pendants, animal bones, and red ochre (Harrold 1980). Burials of this nature, found in dug pits (graves) and containing grave goods of various types, were most likely deliberate; and have been associated with modern mortuary practices of *Homo sapiens* starting about 40,000 BP. Evidence for deliberate burials in the preceding Middle Palaeolithic of Europe and MSA of Africa remain scarce and ambiguous due to taphonomic processes and nineteenth-century recovery techniques (Gargett 1989, 1999). However, there is evidence (comments to Gargett 1989; Defleur 1993; Mellars 1999) for the presence of deliberate interments of Neanderthal remains in Europe during the Mousterian period.

In an examination of mortuary variability in Middle Palaeolithic Eurasia, Pettit (2002:8–9) recognizes intentional burial practice as one of the earliest forms of symbolic behaviour. Burial forms developed from simple categories involving caching of bodies, which date to about 250,000 years ago, to ritualised burial forms where bodies were prepared and buried with assortments of grave goods, dating to about 27,000 years ago. This development is archaeologically difficult to determine, and may only be inferred by looking at the nature of burials and any associated ritual activities reflecting respect for the dead. Treatment of the dead, as is the case in modern times, reflects awareness of self, the other people, and the natural world. These three levels of awareness sparked off increased desires to respect and ritualize the disposition of the dead members of society as a way of creating harmony between the living, the 'living dead,' and the natural world.

In Europe and Asia, Neanderthal skeletal remains provide possible examples of deliberate burials at Krapina (Croatia), La Chapelle-aux-Saintes, La Ferrassie, La Quina, Le Moustier, Regourdou, Roc de Marsal (France), and Spy (Belgium); Amud, Kebara, and Tabun (Israel); Kiik Koba, (Crimea); Teshik-Tash (Uzbekistan); and Shanidar in Iraq (Harold 1980; Johanson and Edger 1996:100). However, a number of remains from these sites (e.g., the Krapina and Shanidar burials) look suspicious; and could have resulted from cave collapse. Remains from La Chapelle I, La Ferrassie I and II, Roc de Marsal, Amud, and Kebara are clearly deliberate burials (Harrold 1980; Gargett 1999). At Qafzeh, 15 *Homo sapiens* individuals were found but only four seem to have been deliberately interred, based on association with materials implying ritual activity (Vandermeersch 1981, Bar-Yosef *et al.* 1986). The use of ochre found in association with human remains, fires, and inedible molluscs (Hovers *et al.* 2003:508), the presence of grave goods consisting of shells and deer antlers associated with Qafzeh 11 (Vandermeersch 1981; Bar-Yosef and Vandermeersch 1993), all seem to be ritualistic and a deliberate act of disposing the dead. A series of dates from thermoluminescence (TL), electron spin resonance (ESR), and amino acid racemization (AAR) indicate that burial rituals at Qafzeh date to between 120,000 and 90,000 years BP (Schwarcz *et al.* 1988; Valladas *et al.* 1988; Brooks *et al.* 1993b; Bar-Yosef 1998).

A date of 60,000 years BP has been given for burial activities at Kebara Cave, Israel (Schwarcz *et al.* 1989; Valladas *et al.* 1998). Here evidence for symbolic behaviour includes preparation of a burial area by cutting the grave through two underlying hearths, and intentional positioning of a Neanderthal body in an upright position with the head exposed. According to the excavators, the head was eventually removed for extended ritual practices, possibly after the decay of the body. The recovery of the mandible, hyoid, and right upper molar in their anatomical positions confirm intentional hominid rather than carnivore activity.

If the problem of documentation and difficulty in understanding early burials in the European and southwest Asian Middle Palaeolithic mentioned above is any indication, the pattern that emerges for Africa is that of scanty evidence of great antiquity, and fewer reliable dates for earlier burials. At Bodo, Ethiopia, a temporal bone bearing cut marks has been interpreted as the result of either post-mortem ritualized skull treatment or cannibal activity similar to modern cannibalism practiced at Klasies River in South Africa (according to White 1987; Deacon and Deacon 1999). Evidence for cannibalism is derived from the state of human remains, which are fragmentary and show cut-marks and burning similar to those of non-human bones which were presumably food remains. A partial cranium, two mandibles, post-cranial bones (BC1 and BC2), and a nearly complete infant skeleton (BC3) found at Border Cave, South Africa, further present a case for deliberate burial (Beaumont *et al.* 1978). These were recovered in 1940 in the process of guano mining. Recovery techniques were poor, and there is the possibility of intrusion of these materials into lower layers (Parkington 1990). The dates have been estimated to between 100,000 and 90,000 BP (Beaumont *et al.* 1978) from AAR dates of 105,000 BP on ostrich eggshell fragments from an overlying layer (Miller *et al.* 1993, 1999). One perforated *Conus* shell associated with the infant skeleton (BC3) has been interpreted as ritualistic, and underscores the presence of symbolic behaviour at this site (Cook *et al.* 1945; Wells 1950; Beaumont and Boshier 1972). The problem here seems to lie less with the dating than with the quantity of the evidence and understanding the meaning or link between the infant and the 'pendant'.

The complete juvenile skeleton, aged between 8 and 10 years, found at Taramsa Hill, Egypt (Vermeersch *et al.* 1998), mirrors the activities at Kebara mentioned earlier. It was found in a seated position with the legs flexed and the head facing upwards. The associated lithic materials were made using Nubian Levallois lithic technology, where prepared cores were used to produce laminar (or blade-like) Levallois blanks and foliate points (Guichard and Guichard 1965; Van Peer 1992). This arrangement reflects deliberate interment of great antiquity, despite the absence of other grave goods, and the fact that the overlying layer is an intact MSA deposit (McBrearty and Brooks 2000). The site has been dated to between 80,000 and 50,000 years BP using optically stimulated luminescence (OSL).

Although details of earlier rituals can mostly be obtained from burials and their associated grave goods, they definitely existed in other forms, as all rituals do not necessarily involve death. The archaeological record is, however, lacking direct evidence of these ‘other’ forms of ritual. Nevertheless, the presence of these ‘other’ rituals may be inferred from the use of pigments documented at Middle Palaeolithic and MSA sites. Pigments made from iron and manganese oxides have been documented at Middle Palaeolithic sites (Bordes 1952; Marshack 1981; Damars 1992; Mellars 1996), and limestone ochre in the Mousterian levels at Grotte de Neron in France (Combier 1989; de Beaune 1993) and Cueva de Castillo and Cueva Morin in Spain (Kraybill 1977). In Africa, granite slabs with ochre traces in a late MSA level at Nswatugi, Zimbabwe, indicate the use of pigments (Cooke 1971; Walker 1995; Larson 1996). The Apollo 11 cave, Namibia, also provides evidence for the use of pigment in its painted slabs that have been dated by ^{14}C to between 28,000 and 26,000 BP. These dates are, however, suspect and anomalous, as they are too young for the MSA association. The overlying MSA Howieson’s Poort level has been dated using a series of 62 isoleucine epimerization dates on ostrich eggshell (Miller *et al.* 1999). The slabs may indicate a form of portable art, or the general use of pigments in ritual settings where decoration of body and other surfaces carry symbolic meaning.

2.3.2 Art

Artworks involving the production of body ornaments, portable art pieces, and complex cave and rock paintings and engravings have been used as hallmarks of modern human behaviour. While these are rare in the European Middle Palaeolithic, the Upper Palaeolithic record indicates an increased use of art and art forms as a means of symbolic behaviour, or communication within and between populations. Apart from the classic cave art dating to the Upper Palaeolithic period found in Europe's major caves, traces of portable art are known to be present in the period predating the beginning of the Upper Palaeolithic. These come in the form of carvings made of stone, bone, antler, and ivory; and consist of depictions of human heads; carvings of female bodies with breasts and vulva, generally known as Venus figurines; carved animal heads and bodies; perforated animal bones, seashells, and teeth usually strung together to form necklaces (Conkey 1987; Dobres 1992a; Johanson and Edgar 1996). Because of the presence of these materials in archaeological sites, it can be argued that art pieces may have been carried or worn as talismans or for decorative purposes; and therefore their presence heralds the symbolic contexts that appear in the subsequent periods.

Africa records some of the earliest forms of artwork in the MSA period. While these may be considered less artistic and ambiguous in nature, they are indeed the precursors of later developments. A number of perforated, drilled, and shaped items dating to as early as 130,000 BP have been reported from various parts of Africa; and form artistic roots of greater antiquity than is provided for by the Upper Palaeolithic/LSA occurrences. Moreover, by the terminal phases of the MSA at various sites across the continent, ornamentation and the use of beads made of ostrich eggshell, for example, had become common, as indicated by the spatial distribution of various forms. A number of notched items, especially bones, some of which bore patterned incisions such as cross-hatching, begin to appear during the MSA at sites such as Blombos, South Africa, where they are dated by OSL to >73,000 years BP (Henshilwood and Sealey 1997; Gore 2000: 100). Diepkloof, South Africa, and Apollo 11, Namibia, provide other unique examples where incised ostrich eggshell fragments indicate possible use as water containers (Wendt 1972; Vogelsang 1998). AAR dates on ostrich eggshell provide an antiquity of >83,000 years BP for these finds (Kokis 1988; Miller *et al.* 1999).

Acquisition and preparation of pigment also indicate a great antiquity for art and other forms of ritual. Pigment processing has been inferred from a number of sites. These include: (i) the Porc Epic site in Ethiopia, where 298 ochre fragments were found and dated to >77,000 BP using obsidian hydration (Clark *et al.* 1984; Clark 1988); and (ii) Twin Rivers, Zambia, where three pieces of ochre have been dated to ca. 230,000 years using U-series dates (Barham and Smart 1996; Barham 1998). Ochre-stained grindstones at the MSA site of Enkapune Ya Muto (EYM), Kenya, (Ambrose 1998a: 384) and GnJh 15 in the Kapthurin Formation, Baringo, Kenya, further point to greater antiquity, with dates of >42,000 and 280,000 years respectively (Van Noten *et al.* 1987a, 1987b; Cornelissen *et al.* 1990).

2.3.3 Environment

The contention that modern human behaviour has an antiquity not dating beyond ca. 40,000 BP has been argued using two significant points involving the use of the environment. First is the structuring of the living space, which at the beginning of the Upper Palaeolithic/LSA period is seen in the deliberate modification of occupation areas. Researchers (Binford 1989; Hodder 1987) consider this a sophisticated cognitive function unique to *Homo sapiens,* and a feature that distinguishes European Upper Palaeolithic from Middle Palaeolithic sites (Farizy 1990; Mellars 1996). Second, as mentioned in section 2.2.3, is the systematic use or exploitation of environmental resources, which is believed to be one of the landmarks for modern human behaviour. The limited evidence for these types of behaviour in the Middle Palaeolithic/MSA sites tends to suggest that cultures preceding ca. 40,000 BP resulted from archaic hominid behaviour. Although this situation is true for most of the sites studied in Europe, there is evidence that both structuring of living spaces and intensive exploitation of the environment date earlier than the beginnings of the Upper Palaeolithic/LSA. A number of sites in Africa point towards this conclusion.

Tables 2.2 and 2.3 draw attention to some of the early forms of modern behaviour, which push its antiquity back to the MSA period. Despite the questionable state of some of the evidence at various sites, Table 2.2 indicates that by the MSA period occupation areas were deliberately created and organized, with sites like Rose Cottage Cave in South Africa showing discrete activity areas such as the hearths (Wadley 2001). Evidence from northern and sub-Saharan Africa (Table 2.2) for post holes and stone wedges that supported poles, stone cairns that acted as boundaries and markers for other functions, and the distinct hearths as well as activity areas at various sites, all point to similar developments seen during the LSA. The use and exploitation of the environment as presented in Table 2.3 equally points to an intensive and a systematic exploitation pattern akin to that of later periods. This body of evidence may therefore be interpreted as supporting greater antiquity and also gradual or evolutionary development of cultural modernity as opposed to a sudden appearance at ca. 40,000 BP. However, there is need for more research to clarify questionable antiquity, particularly in Africa where a lot of data remain uncollected. An examination of how the East African environment was used indicates dependence on animal protein, plant resources, and aquatic resources, particularly fish that provided omega 3 fatty acids (Ambrose 2001). These made the MSA people well adapted to their environments, with improved nutrition leading to infant survivorship and population increase by about 80,000 years ago. Exploitations within the Central Rift Valley and the links with Lake Victoria Basin and northern regions of Tanzania (Merrick 1975; McBrearty 1986; McBrearty and Brooks 2000) further indicate modern behavioural patterns that predate the cultural innovations of Upper Palaeolithic/LSA from ca. 40,000 to 30,000 BP.

2.3.4 Technology and social interaction

Although researchers have used technological innovations and greater social interaction during the European Upper Palaeolithic to place the beginnings of modern human behaviour at ca. 40,000 BP (Mellars and Stringer 1989), the accuracy of this date continues to be challenged in the face of more recent evidence. Evidence from both European and African sites (Tables 2.4 and 2.5) indicates that specialized technologies (blade and microlith technology, composite tool technology), diversification of artefact forms, standardization, and use of more raw materials, were not unique features of the Upper Palaeolithic/LSA, as they are also found during the Middle Palaeolithic/MSA. Modern-type social interaction predating 40,000 BP (Merrick and Brown 1984; Mehlman 1977, 1979, 1989; Michels *et al.* 1983; McBrearty 1986) has also been inferred from the available evidence for long transportation of lithic raw materials in East Africa.

Table 2.4 provides examples of archaeological evidence for early technological innovations, which are particularly useful in providing support for an early antiquity beyond ca. 40,000 BP. Given the large number of sites and early dates at some of the sites for innovations such as blade technology, it is unfortunate that the beginning of cultural modernity is still considered to correspond to the European Upper Palaeolithic. It is also unfortunate that researchers have not resolved this issue using the well-preserved evidence from technological systems present at various sites. It is, indeed, difficult to stop thinking about an early antiquity for modern human behaviour because the relatively complex technological patterns of the Middle Palaeolithic/MSA clearly reflect higher cognitive abilities associated with *Homo sapiens.* While Middle Palaeolithic/MSA evidence may be described as limited in quantity and clarity (in terms of measures of standardization and style), the general concept of modernity is captured in the uniformity of blades produced, regional specialization in the production of point forms, and the production of composite tools. These were probably curated and used to perform many functions. The dates for these range between 350,000 and 50,000 years ago for blade technology, between 230,000 and 50,000 years ago for production of points, and between 65,000 and 35,000 years ago for geometric microliths and standardization at various

European and African sites (see Table 2.4 for details), and indicate great antiquity for cultural modernity.

Diversification of raw materials and use of local and exotic lithic materials, at various sites during the Middle Palaeolithic/MSA (Merrick *et al.* 1994) also render support for great antiquity for cultural modernity. The use of bone and antler for the manufacture of organic tools, and the transportation of lithic raw materials such as obsidian (Table 2.5) over long distances, agree fairly well with the activities of the Upper Palaeolithic/LSA associated with modern *Homo sapiens*.

2.4 Biological versus cultural modernity

The parallel evolution of hominid biology and culture remains unconfirmed. While the two processes may be considered to have occurred in tandem, albeit slowly, before 50,000 years BP when biological evolution became relatively stable and cultural development more rapid (Klein 1999), there is no strict correlation between a hominid species and various cultural traditions that occurred before this period. General association between biological and cultural development means that Acheulian artefacts belong to *Homo erectus*, which means that the early materials belonging to the Early Stone Age or Lower Palaeolithic may be attributed to the earliest species, *Homo habilis*. The Middle Palaeolithic/MSA has been attributed to the Neanderthals in Europe, Southwest Asia, and North Africa; and archaic *Homo sapiens* in sub-Saharan Africa. Members of our own species, *Homo sapiens,* are seen to be responsible for LSA/Upper Palaeolithic assemblages. Their high cognition ability resulting from a neurological change in brain configuration is seen as one factor explaining the rapid cultural

TYPE OF STRUCTURING	SITE	DATE/ PERIOD	REFERENCE
Stone pavement	Katanda, Democratic Republic of Congo (DRC).	70,000 to 90,000 years ago	Brooks *et al.* 1995; Yellen 1996.
Activity area (from stone debris)	Simbi, Western Kenya.	60,000 to 200,000 years ago	McBrearty 1993b.
Windbreaks	Orangia, South Africa, and Mumbwa Cave, Zambia.	Early LSA	Klein 1989b.
Post holes	Le Chaperon Ronge, Morocco, and Seggedin, Niger.	MSA/Middle Palaeolithic	Debènath 1994; Debènath *et al.* 1986.
Stone wedges (for pole support)	Grotte Zouhra, Morocco.	Middle Palaeolithic	Debènath 1994; Debènath *et al.* 1986.
Stone cairns	El – Guettar, Tunisia; Windhoek, Namibia; Mumbwa Cave, Zambia.	MSA/Middle Palaeolithic	Debènath 1994; Fock 1954; Clark 1982.
Hearths	Klasies River, South Africa (Howiesons Poort level); Mumbwa Cave, Zambia.	MSA	Henderson 1992; Deacon 1995, 1998; Barham 1996.

Table 2.2 Structuring of 'living space': Archaeological evidence from different parts of Africa.

NATURE OF ENVIRONMENTAL USE, EXPLOITATION and ITEMS EXPLOITED	SITE(S) OR ARCHAEOLOGICAL LEVELS	DATE (S) OF OCCURRENCE	REFERENCE
Deliberate hunting: • Minimum Number of Individuals (MNI) on long bone shafts • Cut marks and butchery patterns	Layer 1 at Die Kelders, South Africa. Klasies River Cave 1, South Africa; Lukenya Hill, E. Africa.	MSA MSA	Marean 1998; Marean and Kim 1998; Batram and Marean 1999; Marean *et al.* 2000. Milo 1998; Marean 1997.
Selective hunting: • Eland hunting • Extinct Alcelaphine bovid	South African sites Lukenya Hill – GvJm46, Kenya.	MSA MSA	Klein 1989a. Miller 1979; Marean 1992, 1997.
Hunting dangerous animals: • Adult *Pelovoris* • Zebra – *Equus burchelli* and *Equus capensis* • Cape Warthog – *Phacochoeorus aethiopicus*	Klasies River, S. Africa # Gi, Botswana	MSA MSA – ca. 77,000	Milo 1998. Brooks and Yellen 1987; Kuman 1989.
Aquatic resources: • Cichlid fish • Deep water fish • Nile Perch • Marine molluscs, small fish and deep-water fish – *Cymatoceps nasutus* and *Aries feliceps*. • Adult catfish (*Clarias*) – rivers	White Paintings Shelter, Botswana. Site 440, Northern Sudan. Bir Tarfawi – Grey Lake Phase 1 and 2, Egypt. Blombos Cave, S. Africa Katanda, Democratic Republic of Congo.	75-50,000 MSA Middle Palaeolithic MSA > 75,000 - MSA	Robbins *et al.* 1994; Robbins and Murphy 1998. Wendorf and Schild 1992. " Henshilwood and Sealy 1997.
Other Resources: • Molluscs • Shellfish • Land snails from the Maghreb • Giant land snails (*Burtoa nilitica*) • Angulate tortoise (*Chersina angulata*) • Plant food – Cf. Grinding stone processors.	Haua Fteah, Libya; Berard, Algeria; Temara, Mugharet el-Aliya and Zouhra, Morocco. Klasies River, Die Kelders and Herold Bay, S. Africa. Mumba Rock Shelter – Bed V, Tanzania. Die Kelders, S. Africa. Bir Tarfawi, Egypt; Katanda, DRC; # Gi, Botswana; Mumbwa, Zambia.	Middle Palaeolithic MSA Middle Palaeolithic MSA MSA MSA/Middle Palaeolithic	McBurney 1967; Klein and Scott 1986; Roubert 1966; Roche and Tixier 1976; Debènath and Sbihi–Alaoui 1979. Shinger and Wymer 1982; Deacons and Geleijuse 1988; Deacon 1989, 1995; Avery *et al.* 1997; Goldberg 2000; Klein and Cruz-Uribe 2000; Brink and Deacon 1982. Mehlman 1989; Lubell 2004. Klein 1994; Klein and Cruz-Uribe 2000. Wendorf *et al.* 1993b; Brooks *et al.* 1995; Yellen *et al.* 1995; Brooks and Yellen 1987; Barham 1998.
Various environments: • Deserts • Forest	Desert Aterian assemblages, N. Africa. Njuinye, Cameroon; Mosumu, Equitorial Guinea and Lupemban Industry, Congo River Basin.	Middle Palaeolithic Late MSA to early LSA–>34,000	Marks 1975; Williams 1976; Clark 1980; Debènath 1994; Kleindienst 2000b. Mercadar and Marti 2000.

Table 2.3 Exploitation and use of various environmental resources: Early archaeological evidence from Africa.

developments that started from ca. 50,000 years BP.

The Middle Palaeolithic in Europe and southwest Asia is mainly associated with the Neanderthals while the Upper Palaeolithic is associated with *Homo sapiens,* as indicated from the cultural associations at various sites. This notwithstanding, data from various parts of the Old World indicate that correlating biological and cultural developments in a strict sense is problematic. Acheulian artefacts, for example, are found in Europe; yet the presence or widespread occupation of *Homo erectus* in this continent remains under question (Stringer 1981, 1984; Jelinek 1982). Similarly, the association of Neanderthal remains with the Chatelperronian industry, which is Upper Palaeolithic in nature, at the sites of Saint-Césaire and Arcy sur Cure, France (Leveque and Vandermeersch 1980, 1981; Harold 1983), invalidates the strict correlation between Neanderthals and Mousterian technology. In South Africa, remains ofanatomically modern *Homo sapiens* have been found in association with MSA artefacts at Border Cave (Cooke *et al.* 1945; Beaumont and Boshier 1972) and Klasies River (Singer and Wymer 1982). Elsewhere in sub-Saharan Africa, hominid remains exhibiting anatomically modern features have been found in association with MSA artefacts as well as LSA artefacts. These contradictions indicate that while the biological and cultural evolutionary succession of *Homo erectus* to archaic *Homo sapiens* to modern *Homo sapiens* and Early Stone Age to MSA to LSA are correct on their own, more than one hominid species may have existed during the Middle and early Later Pleistocene period. Because of this, it may not be possible to establish a firm link between biological evolutionary developments and those cultural stages that led to eventual cultural modernity. It is only from 40,000 BP that biological and cultural modernity can be seen clearly from the archaeological record.

Although Klein (1999) argues for the rise of cultural modernity at 40,000 years BP based on hominid anatomical developments, especially neurological changes in the brain, the presence of anatomically modern hominids with modern features preceding this date stand in favour of a greater antiquity than 40,000 to 30,000 years ago BP. Hominid fossils and archaeological remains at several sites across Africa (See Table 2.6) fulfill most, if not all, of the character traits given for anatomically modern humans.

The general morphological characteristics of anatomically modern humans include a higher forehead, moderate to absent brow ridges, lack of occipital torus, a rounded occiput with no bun, a skull with maximum width high on the vault, and a cranial capacity ranging from 1000 to 2000 cc (Campbell and Loy 2002; Olivier 1969). Facial features include alveolar prognathism in certain populations and no maxillary prognathism; a developed chin, a general reduction of tooth size, with molars being the smallest of all in the *Homo* groups; and M3 agenesis. In the postcranial features, there is reduction in robusticity of various elements including muscle markings, bones which have thinner walls, and reduced size of birth canals.

Human fossil remains appearing before and/or associated with MSA occurrences in sub-Saharan Africa exhibit some of these features. Some of the remains have therefore been referred to as archaic *Homo sapiens,* and in some cases given specific species names. For example, the Kabwe (Broken Hill) skull was called *Homo sapiens rhodesiensis* (Campbell 1964), while Florisbad remains were referred to as *Homo (Africanthropus) helmei* (Dreyer 1935). The Kanam mandible, initially designated by a committee of the Royal Anthropological Institute as *Homo sapiens* (Leakey 1933), was later renamed *Homo kanamensis* by Leakey (1935: 9); while Weinert (1939) referred to the Lake Eyasi hominid remains as *Homo (Africanthropus) njarasensis*. These together with other remains from Saldanha, Cave of Hearths (South Africa); Olduvai Bed II, Kanjera, Kabua, Baringo, Singa, Mumba Rock Shelter, Lake Ndutu, Laetoli, Porc Epic, Bodo and Omo I – III (East Africa) generally fit the description of archaic *Homo sapiens* or *Homo heidelbergensis*. Other fossils associated with the MSA which have been described as anatomically modern have been recovered from the South African sites of Skildergat Cave, Zitikama Rock Shelter, Tuinplaas, Klasies River, Matjes River Rock Shelter, and Border Cave (Keith 1931; Klein 1970; McBrearty 1986).

Table 2.6 shows the evidence for some of the earliest hominids belonging to our own species. This evidence, especially from South African sites, once any lingering questions over their dating and association with cultural materials reflecting behaviour, such as complex technology and systematic use of the environment, are resolved, provides a strong case for the presence of anatomically modern populations as well as the early development and presence of cultural modernity in Africa. Moreover, while it is not possible to affirm the correlation between the hominid biological developments and those in the cultural realms, it is clear from the evidence available that behavioural changes were gradual. The modern behavioural patterns that become distinct at the beginning of LSA in Africa and Upper Palaeolithic in Europe, southwest Asia, and North Africa were present in the MSA/Middle Palaeolithic cultures and patterns as seen at some of the South and East African sites presented in previous sections. At some of these sites, for example Border Cave and Klasies River, biological modernity and cultural modernity seem to have occurred in tandem. At these two sites, there is an unquestionable link between the Howiesons Poort industry, exhibiting blade and microlithic technology, which are marks of modern human behaviour, and the anatomically modern *Homo sapiens* found at these sites. This scenario points to the possibility of the presence of modern behaviour as early as the beginning of anatomical modernity (Clark 1999:116), and that the gradual development of the same depended on factors found within the environments that the hominids occupied.

2.5 Discussion

The use of European Upper Palaeolithic cultural patterns to define modern human behaviour and to set its antiquity at 40,000 years ago has generated enormous debate among researchers. This has been precipitated by finds in Africa which predate 40,000 years BP, as well as by new approaches developed to collect, date, and understand archaeological materials. MSA modern behavioural patterns are very scarce; and perhaps consist of only a fragmentary collection of evidence from a couple of sites, compared to the overwhelming evidence from the LSA/Upper Palaeolithic patterns. It is only a combination of some of these patterns that stand out as demonstrating the presence of cultural modernity. Although features that are not well developed as to the specifications for modern human behaviour characterize some of the MSA sites and materials, there is a general acceptance that the hominids of the MSA possessed the capacity for modern behaviour. Behavioural patterns in structuring of living space, technology, exploitation of the environment, and social networks serve as indications of a transition to cultural modernity during the period. These patterns and the level of cultural modernity exhibited, indicate that the capacity for modern behaviour existed prior to ca. 40,000 years ago; and that its development started in the MSA and progressively developed towards the later periods.

Research on the African MSA in relation to the on-going debates about modern human behaviour is still wanting. While a number of researchers have attempted to assemble evidence for a greater antiquity for modern behaviour (McBrearty and Brooks 2000), more work will be required to collect the much-needed data and information that remain hidden in several un-investigated areas and sites. Along with this will be the need to develop methodologies for extracting information from archaeological sites and materials, as well as to build a body of theory to guide research on this topic.

Defining and setting the antiquity of modern human behaviour using archaeological traits only reveals the weaknesses of the entire process. While trait lists remain useful in pointing to the patterns and exact evidence to look for in the archaeological record, the presence of similar traits in the earlier periods indicates that such traits alone cannot be used as a means of defining and setting the antiquity of modern behaviour. If symbolism, blade and microlith technology, systematic use of the environment including exploiting seasonal patterns, and social networks are considered hallmarks of modern behaviour, then a number of MSA sites in Africa exhibiting these patterns qualify as having been a result of modern behavioural patterns (see Tables 2.2 to 2.5). On the other hand, if patterns observed at the MSA and earlier periods are to be rejected as non-modern, then a new set of rules has to be established to explain the presence of modern human behaviour in the archaeological record. Alternatively, MSA materials exhibiting these patterns should be considered initial stages in the developmental process, in which case the antiquity of modern behaviour will be pushed beyond the 40,000 BP mark into the MSA.

The definition and timeline may seem simplistic, as has been the case in counting of traits to state whether a cultural pattern is archaic or modern. However, there are profound implications for understanding the development of cultural modernity. A number of sites shown in Tables 2.2 to 2.5 are associated with rituals, such as showing treatment of the dead; signs of the use of ochre; ostrich eggshell beads; perforated implements; blade tools; microliths that were probably hafted; points with features that indicate they were used as composite tools; and bone and wooden fragments, some of which have incised lines. Such features are traditionally linked to modern hunter-gatherer societies of the Upper Palaeolithic/LSA. Their presence in the Middle Palaeolithic/MSA challenges the currently-held view that modern human behaviour does not have a greater antiquity, and is linked to neurological changes that occurred about 40,000 years ago.

The appearance of these patterns, especially the blade technology of the Howieson's Poort industry in South Africa, indicates that the concept of abrupt cultural changes from the European Middle to Upper Palaeolithic (Mellars 1989) did not occur elsewhere in the Old World. Instead, it seems that cultural modernity developed gradually in different environments, with each environment playing a role in the pace and direction of that development. Accumulation of archaeological materials and types may have changed abruptly after the arrival of anatomically modern humans by 40,000 BP. Elsewhere, changes were gradual in nature. This is demonstrated by the subsistence patterns where exploitation of resources expanded from dependence on plant resources and some form of scavenging activities to full-blown exploitation of small and large animals, as well as use of both land and aquatic resources. This point is best demonstrated by modern cultures where the resource base has been greatly expanded to include almost everything within the environment. This was not the case a few years ago. Future studies in this topic should attempt to isolate possible factors that led to the rapid cultural changes of the Upper Palaeolithic/LSA apart from those currently posted in the debate.

Linked to the discussion on the definition and antiquity of modern human behaviour is the issue of the origin and spread of anatomically modern humans. The general agreement discussed earlier is that anatomically modern humans were present in Africa by at least ca. 200,000 years ago and spread from there to other parts of the world, arriving in Europe by 40,000 years ago along with their Upper Palaeolithic cultures. The assigning of particular cultures to early hominid groups, however, remain problematic, as, historically, hominid species may have overlapped both temporally and geographically. Moreover, because of gradual development of cultural modernity, we see contradictions in putting strict correlations between biological and cultural modernity, as discussed in Section 2.4. There is, however, no disagreement that anatomically modern humans (*Homo sapiens sapiens*) were responsible for the Upper Palaeolithic/LSA cultures, within which there is great innovation, symbolic behaviour, and technological complexity. This stage implies increased development compared to the earlier periods, but less development compared to later periods. In this way, the MSA may be conceptualized as a period for laying the foundations for cultural modernity by hominids who were themselves in the first stages of their biological modernity. These hominids exhibited cultural modernity to the level of their needs. Enhanced cultural development only occurred when those needs compelled them to expand to new regions, where they met more challenging circumstances, which in turn called for further innovation and greater cultural complexity after 40,000 BP.

Modern human behaviour seems to have great antiquity beyond the beginning of Upper Palaeolithic/LSA period. There are still problems of what characterizes modern behaviour in the archaeological record, as well as the lack of data from some sections of the world with potential for providing information on this topic. The current interest in understanding this topic should lead to the establishment of a theoretical framework upon which future researchers can base their methodologies and results.

TECHNOLOGICAL INDICATORS FOR CULTURAL MODERNITY	SITE(S) or INDUSTRY	DATE	METHODS OF DATING	REFERENCE
Blade Technology: • Europe	Coquelles, France; Crayon, England; Le Rossori, Belgium. Acheuleo-Yabrudian/ Mugharan industry at Tabun. Haua Fteah, Libya (Pre-Aurignacian industry).	250 Ka 350 Ka <250 Ka 127 – 75 Ka	TL ESR OIS 5 (Correlation)	Conard 1990; Revillion and Tuffrean 1994; Revillion 1995. McBurney 1967; Chazan 1994; Klein and Scott 1986.
• Africa	Klasies River (Howiesons Poort Industry), S. Africa.	120 Ka		Sampson 1972, 1974; Volman 1984; Kuman and Clark 1986; Kuman 1989.
	Gademotta and Aduma, Ethiopia. Baringo (Kapthurin Formation), Kenya.	> 235 Ka > 280 Ka		Wendorf and Schild 1974; Brooks 1996, 1999; Tallon 1978.
Point Technology: • Hafting and composite tools	Klasies River and Blombos Cave, S. Africa; ≠ Gi, Botswana.	MSA		Kuman 1989; Wendorf and Schild 1993.
• Regional specialization	Nile Valley **Tanged/truncated forms.**	Middle Palaeolithic		Van Peer 1991, 1998.
	Congo River and Lake Victoria Basins **Lanceolate forms** (Mumba Rock shelter, Tanzania; Twin Rivers, Zambia; Gademotta and Kukuleti, Ethiopia).	130 Ka 230 Ka		McBrearty 1988. Mehlman 1989, 1991; Barham and Smart 1996; Wendorf *et al.* 1994.
	Southern Africa's **Leaf-shaped forms** (Blombos Cave, S. Africa and # Gi, Botswana	80 – 70 Ka	TL and AAR	Henshilwood and Sealy 1997; Brooks *et al.* 1990.
Geometric microlith technology: (Tools measuring >20mm or >30mm)	Uluzzian industry, Italy.	Ca. 35 Ka		Andrefsky 1998; Clark and Kleindienst 1974. Mehlman 1989; Brooks *et al.* 1993 b.
	Mumba Rock Shelter, Tanzania (evolution of points).	65 Ka	U – Series and AAR	
	Klasies River (Howiesons Poort microliths, S. Africa.	MSA		

Table 2.4 Technological advancements akin to LSA modern technological behaviour before 40,000 BP. TL = thermoluminescence, ESR = electron spin resonance, OIS = oxygen isotope stage, AAR = amino acid racemisation and U-Series = uranium series dating methods.

Table 2.4: Continued.

TECHNOLOGICAL INDICATORS FOR CULTURAL MODERNITY	SITE (S) or INDUSTRY	DATE	METHODS OF DATING	REFERENCE
Standardization: - Microliths	Klasies River – Howieson's Poort industry, S. Africa, and Mumba Rock Shelter, Tanzania (Mean of 30-45mm).	MSA		Keller 1973; Volman 1984; Deacon 1984; Rust 1943; Rozoy 1985.
- Projectile points	Klasies River Howieson's Poort industry, S. Africa, and Mumba Rock Shelter, Tanzania.	65 – 30 Ka		Mehlman 1989, 1991; Brooks *et al.* 1990.
Diversification of raw materials:	Grotte d'el Mnasra, Morocco (Khormusan industry pointed bone objects.	60 – 40 Ka		Marks 1968; Wendorf and Schild 1992.
	Kabwe, Zambia	125 Ka or > 780 Ka	AAR and Olduvai Gorge calibration.	Clark 1959.
- Bones	Border Cave, S. Africa (Howieson's Poort Warthog tusk daggers (?)	80 Ka		Beamont 1978; Volman 1984.
	Klasies River (Howieson's Poort level 19 of shelter 1A – bone point).	80 – 65 Ka		Bada and Deems 1975; Deacon *et al.* 1986; Deacons and Geleijuse 1988; Deacon 1989; Grün *et al.* 1990.
	Katanda, DRC (barbed bone points).	ca. 90 Ka	TL and ESR on sand; ESR and U – Series on tooth enamel; AAR on molluscs' shells and ostrich eggshell.	Brooks *et al.* 1995; Yellen *et al.* 1995; Yellen 1998.
	Blombos Cave, S. Africa (21 assorted bone tools/ objects).	72 Ka		Henshilwood and Sealy 1997.
	White Paintings Shelter, Northern Botswana (bone points).	MSA/ LSA transition > 30 Ka		

MATERIAL	SOURCE	DESTINATION SITE	DISTANCE MOVED	DATE/CULTURE	REFERENCE
Obsidian	• Njorowa Gorge, Central Rift valley (CRV), Kenya	Songhor, Western Kenya	145 Km	MSA	McBrearty 1986.
	• Eburru and Sonanchi, CRV, Kenya	Muguruk, Western Kenya	185 and 190 Km	MSA	McBrearty 1986.
	• Masaai Gorge, Sonanchi and Eburru, CRV, Kenya	Nasera Rock Shelter – Kisele industry, Northern Tanzania	240 Km	MSA	Merrick and Brown 1984; Mehlman 1989.
	• Central Rift Valley, Kenya	Mumba Rock Shelter – Bed VI (MSA Sanzako and Kisele industries, Northern Tanzania)	320 Km	130-100,000 from U-Series dates (MSA).	Mehlman 1977, 1979, 1989, 1991.
	• Central Rift Valley, Kenya	Lukenya Hill – GvJm16.	135 – 105 Km		
	• Kisanana, CRV, Kenya	Prospect Farm, CRV, Kenya	75 Km	>120,000	Michels *et al.* 1983.
	• Sonanchi and Njorowa Gorge, CRV, Kenya	Prolonged Drift – GrJi11, CRV, Kenya	45 – 55 Km	MSA	Merrick *et al.* 1994.
Fine-grained raw material	• Howieson's Poort	Klasies River, South Africa	(?)	MSA	(?)

Table 2.5 Long distance transportation of raw materials and possible social interaction during the MSA period: evidence from East and Southern Africa.

SITE	HOMINID FOSSIL REMAINS	SPECIES DESIGNATION	CULTURAL AND FAUNAL ASSOCIATION	RELATED FOSSILS	DATES	REFERENCE
Kabwe (Broken Hill), Zambia	Skull and femoral fragments	Archaic *Homo sapiens – Homo sapiens rhodesiensis.*	Stillbay and Sangoan MSA stone tools; mammalian bones	Olduvai Gorge Hominid 9; resembles Neanderthals	>110,000 BP (AAR). 125,000 BP (final Cornelia Faunal stage)	Campbell 1964; Clark 1988, 1990; Leakey 1961; Rightmire 1976; Bada *et al.* 1974.
Florisbad, South Africa	Skull	*Homo sapiens (Homo Africanthropus helmei)*	MSA artefacts Wooden artefacts; mammalian fauna	Kabwe Skull.	?	Dreyer 1935, 1938; Drennan 1935, 1937; Galloway 1937, 1938; Tobias 1974.
Saldanha, South Africa	24 pieces of calvaria; Mandubular remus	*Homo sapiens*	Acheulian and MSA artefacts; Fauna of 50 species represented, including 19 extinct ones	Resembles Kabwe skull at the supraorbital and occipital region	Younger fauna AAR dated to ca. 40,000 BP; older fauna @ 600–300, 000 BP	Sampson 1974; Oakley 1957; Vrba 1982.
Cave of Hearth, South Africa	Juvenile mandible with teeth	Archaic *Homo sapiens.*	Final Acheulian artefacts	Resembles Neanderthals, N. African *Homo erectus*; Porc Epic jaw.	Later Pleistocene	Mason 1962, 1967; Cooke 1962; Tobias 1961: 28, 1966, 1968, 1971.
Olduvai Gorge Bed II	OH I (Intrusive)	*Homo sapiens*	-	-	-	Leakey *et al.* 1933.
Kanam, Kenya	Mandible	*Homo sapiens (Homo kanamensis)*	Pre–Chellean artefacts; *Deinotherium* and 2 species of mastodon	Porc Epic mandible; Atlanthropus specimen from Rabat, Morocco.	Middle Pleistocene	Leakey 1932: 722, 1932, 1933.
Kanjera, Kenya	Cranial fragments (3 individuals); 1 femoral fragment	*Homo sapiens*	Chellean artifacts. *Elephas antiquus recki*, mastodon, *Hipparion*	-	Middle Pleistocene	Leakey 1935: 9

Table 2.6 Hominid fossils associated with MSA cultures indicating link between biological and cultural modernity. TL = thermoluminescence, ESR = electron spin resonance, OIS = oxygen isotope stage, AAR = amino acid racemisation and U-Series = uranium series dating methods.

Table 2.6: continued.

SITE	HOMINID FOSSIL REMAINS	SPECIES DESIGNATION	CULTURAL AND FAUNAL ASSOCIATION	RELATED FOSSILS	DATES	REFERENCE
Kabua I, Turkana Kenya	Cranium and mandible	*Homo sapiens*	-	-	-	Rightmire 1975:37
Baringo, Kenya	Hominid BK67 – mandible; Hominid BK 8518	Early *Homo sapiens;* *Homo sapiens* (?)	-	-	>250,000 BP	Leakey *et al.* 1969; Tallon 1978; Wood and Van Noten 1986.
Singa, Sudan	Skull	Archaic *Homo sapiens*	Stillbay MSA stone tools.	Djebel Irhoud I and Omo II	-	Locaille 1951
Lake Eyasi, Tanzania	250 cranial fragments– Eyasi I-IV	*Homo sapiens (Homo Africanthropus njarasensis*)	Handaxe fragments; Levallois MSA artefacts; rolled and unrolled fauna	Kabwe, Bodo and Saldanha	130,000BP (Thorium/Uranium)	Mehlman 1984: 498; Weinert 1939.
Mumba Rock Shelter, Tanzania	Unerupted molars	*Homo sapiens*	MSA artefacts	-	110–130,000BP (Thorium/Uranium)	Brauer 1980, 1984 a: 342.
Lake Ndutu, Tanzania	Skull	Archaic *Homo sapiens*	Nondescript industry: flakes, irregular cores, spheroids and hammerstones	Kabwe, Omo II and Saldanha	500–600,000BP (AAR on bone from the floor).	Rightmire 1983; Mturi 1976.
Laetoli, Tanzania	Skull – Laetoli Hominid 18	Early form of East African *Homo sapien.*	MSA artefacts; Reptilian, Avian and mammalian fossil fauna	Eyasi I and Kanjera calvarium	-	-
Porc Epic, Ethiopia	Mandibular fragment	*Homo sapiens*	Stillbay MSA industry	-	-	Clark 1954: 210
Bodo d'Ar, Ethiopia	78 cranial fragments	Archaic *Homo sapiens*	Acheulian artefacts; fish, hippopotamus, crocodile bones; equids, bovids, giraffids, suids and 2 non-human primates	Kabwe	Middle Pleistocene.	Conroy *et al.* 1978; Kalb *et al.* 1980.

Table 2.6: continued.

SITE	HOMINID FOSSIL REMAINS	SPECIES DESIGNATION	CULTURAL AND FAUNAL ASSOCIATION	RELATED FOSSILS	DATES	REFERENCE
Omo I–III, Ethiopia	Two complete calvaria, facial fragments, Cranial and axial skeleton, complete and fragmentary upper and lower limb bones	*Homo sapiens*	Large and medium bovids, *elephas*, *loxodonta*, black and whilte rhino and *cercopithecoid* primates	Kabwe, Bodo and Laetoli hominid 18 as well as Florisbad	130,000 BP (Thorium/ Uranium dates).	
Border Cave, South Africa	Cranium: frontal, parietal and temporal parts; an occipital fragment and right zygomatic bone; 2 mandible, post cranial bones and acomplete infant skeleton	*Homo sapiens sapiens*	MSA – Howieson's Poort industry	Modern Negro males	100–80,000 BP	Cooke *et al.* 1945; Beaumont and Boshier 1972.
Klasis River, South Africa	Numerous cranial and postcranial fragments; Fragmentary left clavicle, radial and innominate fragments; Parietal Fragment – 41658 MSA II; Frontal Fragment – 16425 MSA II. Mandible 41815	*Homo sapiens sapiens* " "	MSA – Howieson's Poort industry	Modern Negro and Khoisan populations	Layer 38 dated to 110,000 BP (AAR) MSA II Layer 15 dated to 100 – 80,000 BP (OIS 5e).	Shackleton 1969; Shackleton and Opdyke 1973; Bada and Deems 1975; Singer and Wymer 1982: 147.
Skildergat Cave, Zitikama Rock Shelter, Tuinplaas and Matjes River Rock Shelter, South Africa	*Homo sapiens sapiens*	-	Terminal MSA or early LSA	-	-	Keith 1931, 1933; Klein 1970.

Chapter 3: Pleistocene MSA environments and their impact on human behaviour and adaptation

> *The ancient ecosystems, their stability as well as their intensity, all shaped history to the extent that humans reacted to them, modifying old behaviours and inventing new ones.*
> *(Kusimba 2003:44)*

3.1 Background to Pleistocene environments

The Pleistocene marks the first and longer Epoch of the Quaternary Period, which includes the past 1.8 to 2.6 million years of earth history. It is preceded by the Pliocene Epoch dating to about 5.4 to 2.5 million years ago, which is the last stage of the Tertiary Period that began 65 million years ago. The Pliocene marked the final stage of a Cenozoic global cooling trend that paved the way for the Quaternary ice ages. The climate during this time was warmer than present, with sea levels rising 30 m higher than present due to less ice volume at the poles (Denovan and Jones 1979; Hallam 1984). During the mid-Pliocene, about 4 to 3 million years ago, temperatures reached their peak compared to earlier and later periods, as changes in ocean circulation patterns and higher concentration of greenhouse gases in the atmosphere took effect.

A report by members of Project for Integrated Earth System Modelling (PRISM 1996) indicates that there were moister conditions during the early mid-Pliocene, which supported greater forest and tree cover with minimal desert conditions. North Africa, for example, was moister before 3 million years ago than at present. Semi-arid vegetation covered much of what is today the Sahara belt, while tropical forest and moist savannah extended to about 21° N. In Eastern Africa, especially Ethiopia and north-western Kenya, pollen (Bonnefille 1996) and soil stable carbon isotope (Kingston *et al.* 1994) evidence suggests tropical open woodland vegetation in areas which are currently semi-arid or treeless dry grassland. May (1996) argues for a possible coast to coast Pliocene tropical forest cover across Africa. This is based on the presence of red lateritic soils of this date in equatorial East Africa, east of the modern Rift Valley. In Southern Africa, open woodlands and warm temperate forests prevailed in areas that are currently under arid shrub vegetation. These environments supported the early hominids, such as *Australopithecus africanus* (3.3 to 2.3 million years ago) and *Australopithecus robustus* (2.0 to 1.5 million years ago) in Southern Africa, and *Australopithecus anamensis* (4.2 to 3.9 million years ago), *Australopithecus afarensis* (4.0 to 2.9 million years ago), *Australopithecus africanus* (3.3 to 2.3 million years ago) and *Australopithecus aethiopicus* (2.5 million years ago) in Eastern Africa (Scott and Partridge 1994).

The last part of the Pliocene, from about 3 million years ago, saw the beginning of an environmental shift toward drier and cooler conditions. Evidence at the Pliocene-Pleistocene boundary around 2.6 to 1.8 million years ago indicates the start of glacial and interglacial cycles that were to characterize much of the Quaternary (Jong 1988). Pollen and other evidence indicate widespread grassland in places like Eastern Africa, shrubs in Southern Africa and desert extension in North Africa (Cerling 1992). There was also a contraction of rainforest zones, and the replacement of large mammal browsers with grazers. Pollen, dust and isotope indicators of aridity and cooler conditions increase from the Pliocene to Pleistocene, with environments becoming cooler and more arid than present. This chapter discusses the Pleistocene environments in Africa, with emphasis on hominid adaptations and settlements in Africa and particularly the East African region; and how these impacted on behavioural shifts and patterns.

3.2 Global Pleistocene conditions

The Pleistocene is divided into three stages: Lower, Middle and Upper Pleistocene (Fuller *et al.* 1996). This division is based on the global palaeomagnetic record, and random fluctuation of intensity and direction of the earth's magnetic field. Elements in rock sediments exhibit magnetic alignment either toward the magnetic North or South Pole. Normal polarity occurs when the elements are aligned north. Reversed polarity occurs when the alignment changes toward the South Pole. Between 3.6 and 2.6 million years ago, the earth experienced a normal polarity phase named the Gauss Normal Chron. This was followed by the Matuyama Reversed Chron between 2.6 million and 780,000 years ago. Another normal polarity, named Bruhnes Normal Chron, began at 780,000 years ago and continues today. Within the Matuyama Reversed Chron, a short period of opposite (or normal) polarity occurred, and was detected in the Bed I sediments at Olduvai Gorge in Tanzania, East Africa. This Olduvai Sub-Chron (or Event) has been dated to about 1.8 to 1.6 million years ago, and marks the beginning of the Pleistocene. However, other evidence, such as the record of climatic cycles, suggests that the Quaternary started about 2.6 to 2.4 million years ago (Pillans and Naish 2004). Using these dates, the Lower Pleistocene has been dated to 2.4 million to 780,000 years ago (or 1.8 million to 780,000 years ago if one accepts the dating for the Olduvai Sub-Chron). The Middle Pleistocene has been dated to 780,000 to 128,000 years ago, while the Upper Pleistocene to 128,000 to 10,000 years ago.

The Pleistocene was characterized by alternating glacial and interglacial conditions. Forbes (1846) termed it the 'Glacial epoch'. About 50 glacial and interglacial cycles occurred during the entire Quaternary, with at least ten during the last 800,000 years (Shackleton *et al.* 1990). During these cycles, mid-high latitudes experienced tremendous advancement and retreat of ice sheets and valley glaciers. Expansion and contraction of areas affected by cold climates also occurred. At the lower latitudes, desert and savannah margins shifted over long distances. Weathering rates and pedogenic processes varied corresponding to changes in temperature and precipitation. River regimes fluctuated, and sea levels rose and fell accordingly. Plant and animal populations were forced to migrate and adapt in response to these changes in the environment.

A number of factors have been given as causing the unstable climatic conditions witnessed during the Quaternary. During the late Pliocene, continental drift joined both North and South America, hitherto separate sub-continents. A land bridge, which is today the Isthmus of Panama, was formed (Cane and Molnar 2001). This event affected ocean water circulation, with warm water [from the Pacific Ocean] flowing north as the Gulf Stream to warm the North Atlantic. Consequently, Europe became warmer than parts of North America falling within the same latitudes. The different temperatures in Europe and North American continents may have caused a drop in temperatures in the Northern Hemisphere, leading to the glacial conditions that followed during the Pleistocene.

Another event linked to effects of continental drift was the closure of the Indonesian seaway around mid-Pliocene times, and the associated displacement of New Guinea northwards (Cane and Molner 2001). More water from the North Pacific found its way into the Indian Ocean, causing a cooling effect that altered the precipitation patterns of the East African region. This created dry conditions that became critical for early hominids developing in the region at the time. The closure of the Indonesian seaway and the displacement of New Guinea northwards may have decreased atmospheric heat transport from the tropics to the higher latitudes, leading to lowered temperatures. All these events may have sparked off the formation of northern ice sheets, eventually culminating in the global glaciations and climatic oscillations during the Pleistocene (Cane and Molnar 2001: 157).

Climatic cycles witnessed during the Pleistocene have also been explained through a model developed by Milutin Milankovitch (1879 – 1958), who proposed that changes in the eccentricity of the earth's orbit, changes in the tilt of the earth's axis and the precession of the equinoxes contributed to the earth's oscillating cooling and warming during the Quaternary. These features controlled the amount and distribution of the solar radiation reaching the earth, with radiation in turn driving the growth and melting of the major ice sheets. This led to climatic oscillation of about 19,000 to 23,000 years between 5 and 1.8 million years ago. This pattern changed to 41,000 years after 1.8 million years ago. By 900,000 years ago, the pattern further shifted to 100,000 years (deMenocal 1995: 55). The tilt and eccentricity of the orbit controls the intensity of the seasons, while precession controls the interaction between them and therefore determines where each season falls in the earth's orbit (Imbrie *et al.* 1984). Currently, when the earth is farthest from the sun the Northern Hemisphere experiences summer while the Southern Hemisphere winter and vice versa.

Evidence for global climatic oscillations in the past has been obtained from the analysis of oxygen isotopes ^{16}O and ^{18}O in deep-sea sediments and ice (core) masses. Remains of both planktonic and benthic organisms in deep-sea sediments contain oxygen in their shells or bodies that correspond to the isotopic amounts found in the ocean waters at the time the organisms lived. The ratio of the two oxygen isotopes ($\partial^{18}O$) is used to determine ocean temperatures or volume of water at the time the organisms lived. Deep-sea sediments are rich in ^{18}O during glacial events, as this isotope is heavier and therefore evaporates less during reduced temperatures. Abundant ^{18}O during glacial events can also be used to show low sea levels, as water becomes locked up on land as ice. On land and ice masses, however, less ^{18}O and more ^{16}O characterizes glacial periods. Water evaporating from the oceans is rich in ^{16}O and therefore enriches the ice masses where it is deposited during precipitation. During warm (interglacial) periods, the reverse occurs as increased temperatures over the ocean waters leads to evaporation and precipitation which eventually makes ice masses rich in ^{18}O, and ^{16}O depleted.

Emiliani (1955) and Shackleton (*et al.* 2002) have used information from the analysis of oxygen isotope quantities to define a series of Oxygen Isotope Stages (OIS) and sub-stages that have been used to understand the history of Quaternary climatic changes. The stages define cold and warm conditions, and may also be used to understand water volume in the oceans as well as sea water salinity in the past (Kukla *et al.* 2002: 6).

Figure 3.1 shows the major stages for the late-Pleistocene period to the present. Counted from the present back in time, odd numbers indicate warm (interglacial) conditions while even numbers indicate cold (glacial) conditions. Stage one (OIS 1) refers to the present Holocene warm conditions that began about 10,000 years ago. Stage two (OIS 2) covered 30,000 to 10,000 years ago; and contains the Last Glacial Maximum (23,000 to 17,000 years ago) when world temperatures dropped greatly, leading to extreme cold and aridity. Stages 3 – 7 (OIS 3 – 7) lasted from 250,000 to 30,000 years ago, with unstable long and short as well as cold and warm conditions alternating.

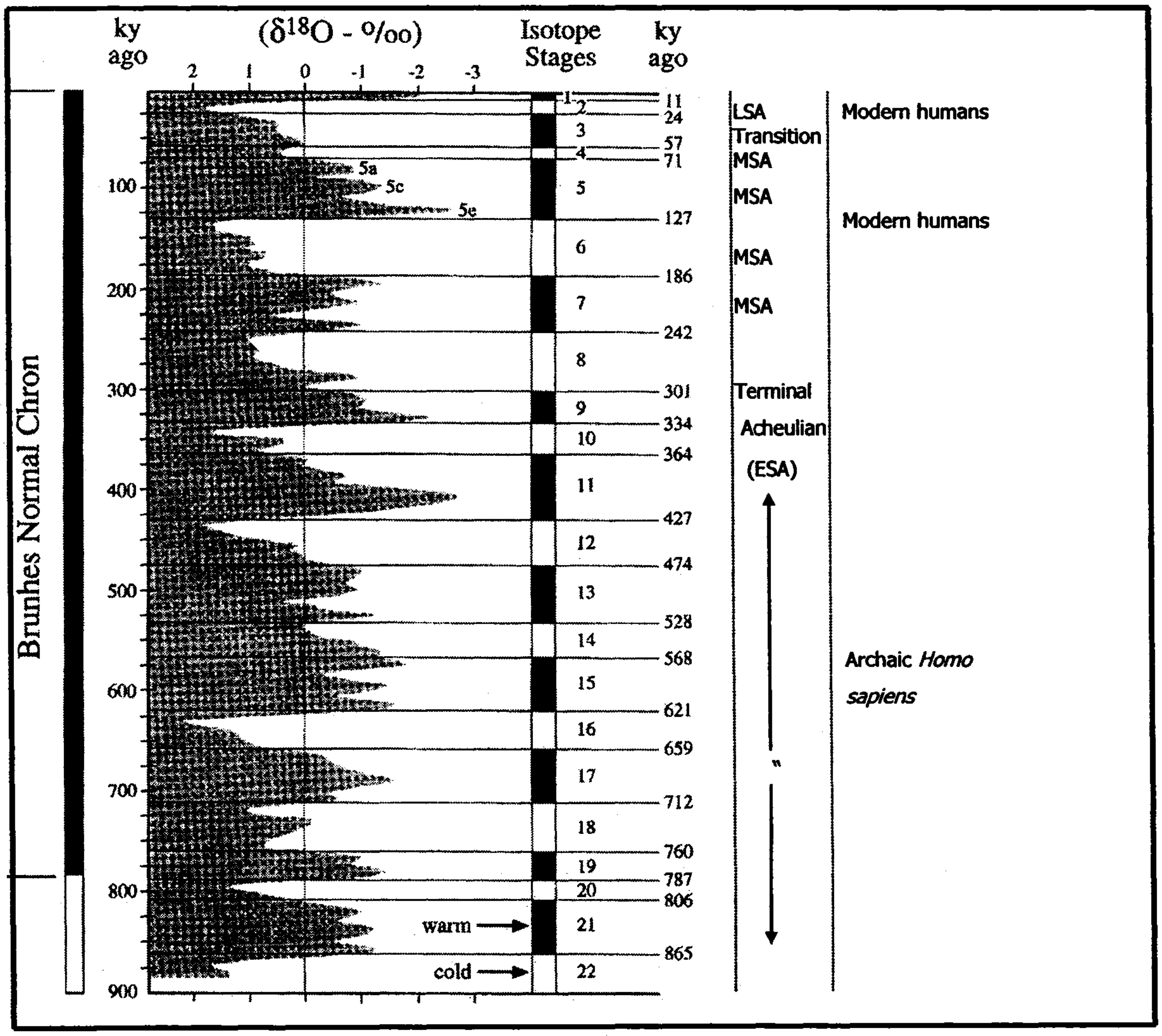


Figure 3.1 Oxygen isotope stages and Stone Age cultures in sub-Saharan Africa for the past 900,000 years. Records obtained from deep-sea sediment cores: MD900963 in the tropical Indian Ocean and 677 in the equatorial Pacific Ocean (modified from Klein 1999:59).

OIS 1 corresponds to Holocene or post-glacial period; while OIS 2 corresponds to Upper Palaeolithic cultures in Europe, south-western Asia and North Africa and to the LSA in Sub-Saharan Africa. Stage 3 (OIS 3), dating to about 60,000 to 30,000 years ago, also corresponds to the Upper Palaeolithic and LSA period; but includes a cultural transition from Middle Paleolithic to Upper Paleolithic in the north and MSA to LSA in Sub-Saharan Africa. Stages 4 – 7 (OIS 4–OIS 7), dating to about 250,000 to 60,000 years ago, were very unstable, with a series of long and short cold and warm conditions. This time corresponds to the Middle Palaeolithic in Europe and MSA in Sub-Saharan Africa. This time span was very critical in both biological and cultural evolution, as it witnessed the emergence of anatomically modern humans in Africa and their expansion to Asia and Europe in what has been termed the "Out of Africa 2" hypothesis (Cann *et al.* 1987; Wilson and Cann 1992). The earlier migration of hominids from Africa involved expansion of *Homo erectus* to Asia and some parts of Europe (Foley and Lahr 1997). This period of instability also witnessed a substantial diversification and cultural innovation that eventually gave birth to the complex cultures of the Upper Palaeolithic and LSA. To what extent these changes should be linked to the unstable climatic conditions facing the world at the time remains a topic of research and discussion.

3.3 Pleistocene hominid adaptations to environmental changes

The later Middle and Upper Pleistocene periods in Africa correspond to Middle and LSA cultural adaptations. Potts (2001:5) reports marked climatic and landscape changes within which *Homo erectus, Homo helmei* and eventually anatomically modern *Homo sapiens* successfully adapted. The hominid responses to these changes may have led to new behavioural abilities that caused an increase in the number of tool types found in the toolkit, and innovation within the socio-technological sphere. This development contrasts sharply with the earlier Acheulian techno-complex that lasted longer but shows neither change nor serious innovation. Middle Pleistocene environmental conditions may have resulted in the behavioural changes reflected in hominid activities.

At the Pliocene-Pleistocene boundary, wet and dry conditions dominated the African climatic scene, causing ecological fragmentation and genetic isolation among species. Arid adapted species of plants and animals emerged, including members of the genus *Homo* that eventually gave rise to anatomically modern humans. Within the East African geographical zone, vegetation changed from closed canopy to open savannah at the end of mid-Pliocene. As temperatures continued to decrease and precipitation became more seasonal (deMenocal 1995:57), drier environments such as the South African *fynbos* scrub vegetation emerged (Patridge 1997:9).

Adams (*et al.* 1997) provides an outline of the environmental history of Africa. Evidence from ocean and lake cores, the Pretoria Salt Pan in South Africa and the pollen record from off the west African coast, indicate a widespread rainforest during interglacial periods (OIS 1 and OIS 5) but a great reduction of the same during glacial periods (OIS 2 and OIS 4). Such changing conditions remained a major driving force in hominid adaptation and cultural development throughout the entire continent.

Stage 6 (OIS 6) lasted from 195,000 to 128,000 years ago (Figure 3.1). It marked the start of periodic cold conditions that were to affect the environment, forcing both plants and animals to adapt to oscillating cold-dry and warm-wet conditions. Cold conditions led to the expansion of savannah grassland and open dry forest, which reached the northern coastal region of the Gulf of Guinea in West Africa. The Sahara expanded to about 14°N while the Namibian desert also pushed its way to the north. Pollen records from the Gulf of Guinea indicate a decrease in both rainforest zones and mangrove forest. Drier conditions eventually reached their climax during the Last Glacial Maximum (LGM) about 18,000 years ago and toward the end of the Pleistocene; but the onset of these conditions saw two significant events in prehistory. Modern humans appeared in Africa (OIS 8 – OIS 6) with a substantial level of cognitive ability that enhanced their survival. At the same time, MSA cultural traditions emerged with innovations not found in the preceding Acheulian culture. In Europe, the physically-adapted Neanderthals roamed the cold environments, making use of Middle Palaeolithic technology.

Between 128,000 and 75,000 years ago, the world experienced a reprieve from intense cold conditions of OIS 6 as conditions marking OIS 5e (interglacial) set in. This period, although considered generally to be warm, was unstable, with episodes of cold and warm phases numbered 5e to 5a marking OIS sub-stages. At the beginning of sub-stage 5e, warm conditions were experienced in Africa and Europe, causing an expansion of warm taxa, such as hippopotamus, to northern areas like Britain. African forests expanded, and vegetation covered desert areas. West Africa recorded an increase in rainforest and mangrove swamps and a decrease of dry forest and savannah, while deserts shifted to higher latitudes in the face of the increased temperatures and precipitation. Similar conditions were to be repeated only during the Holocene (Dupont *et al.* 2000:113). By 115,000 years ago, however, temperatures dipped, leading to a reduction in rainforest zones. This marked the OIS sub-stage 5e and 5d boundary, characterized by a pronounced decrease in temperatures and increase in volumes of continental land ice in both Europe and North America. The ripple effects of these global conditions affected Africa's climate, with arid adapted vegetation such as *Podocarpus*, mainly found on high cold areas, expanding to other areas during sub-stages 5d, 5b, and 5a. Between 110,000 and 90,000 years ago there was increased aridity (Adams *et al.* 1997), leading to the development of semi-arid vegetation, including the *miombo* woodland that characterizes the Zambezian Vegetation Zone found in Tanzania, Zambia, and Zimbabwe. This consists of tall, densely spaced leguminous trees such *as Brachystegia, Jubelnardia,* and *Isberlina* (Barham 2001:71).

Clark (1988:251) argues for a model in which MSA hominids during this period adapted to local conditions, leading to regional distinctiveness in the toolkit. A similar model has been supported by Foley and Lahr (1997, Lahr and Foley 2001) as well as Barham (2001). They see the effects of climatic conditions acting as a push and pull to particular regions, with the Sahara desert playing a major role in the distribution of hominids as it expanded and contracted. The first modern humans to leave Africa reached the Near East during this period. The evidence of their occupation dated to about 100,000 years ago has been found at Mugharet es Skhūl and Jebel Qafzeh (Bar-Yosef 1989a, 1989b).

Intense cold conditions returned during OIS 4 (75,000 to 58,000 years ago). A fall in sea levels due to glacial conditions was experienced, associated with the expansion of desert margins in North Africa. Rainforests were reduced, and only recovered slightly during OIS 3. West African mangrove forests were drastically reduced except for the areas along Ivory Coast and north-western area of the Gulf of Guinea. *Podocarpus* spread to places like Angola and the Congo.

Increasing the intensity of the cold conditions of this period was the eruption of Mt. Toba in northern Sumatra, Indonesia, dated to 68,800 ± 7000 (by isothermal plateau fusion track - IPFT) and 73,000 ± 3000 (by single crystal laser fusion – SCLF) (Ambrose 1998b). This event created a global cooling, leading to extremely unpredictable conditions, which forced hominids to adjust by moving to new areas. Forest areas in Africa collapsed, even along the Congo Basin (Dupont *et al.* 2000:116; Barham 2001:75). In the north, extreme conditions drove the Neanderthals southward into the Levant, where they occupied sites such as Mugharet et Tabun and Amud in Israel and Shanidar Cave in Iraq (Akazawa *et al.* 1998).

During OIS 3 (57,000 to 24,000 years ago) climatic conditions remained unstable. Sea levels stood at 70 m below present, with extreme arid conditions being recorded in places like Southern Africa between 43,000 and 40,000 years ago (Adams *et al.* 1997). In North Africa and the Levant, slightly moister conditions prevailed between 28,000 and 22,000 years ago. The period was generally cooler and moister compared to OIS 2, which contained the Last Glacial Maximum (Thomas 2000:28). Evidence from the Pretoria Salt Pan indicates a drop in temperature of about 2° to 3°C during OIS 3 and OIS 2 (Patridge 1997:15).

This period marked the transition from Middle Palaeolithic to Upper Palaeolithic in Europe, Asia, and North Africa, and MSA to LSA in sub-Saharan Africa. It also marked the entry of anatomically modern humans into Europe with a new technology and modern worldview (Mellars 1989, 1991, 1993). A number of archaeological sites in Africa, however, record no signs of occupation during this time and especially after 50,000 years ago. This has been interpreted as reflecting abandonment of sites due to dry and cold conditions. Archaeological records at Die Kelders and Blombos Cave, South Africa, show no occupation after 50,000 years ago until about 2,000 years ago, when LSA people with caprines reoccupied the site. At Rose Cottage Cave, a LSA occupation dating to 20,000 years ago occurs after a long gap from earlier levels (Wadley *et al.* 1997). Limited early Late Stone Age sites during this period have been reported at Matupi Cave, Eastern Congo (van Noten 1977), Enkapune Ya Muto, central Kenya (Ambrose 1998b), and at Border Cave, South Africa, dating to around 40,000 years ago.

OIS 2 includes the Last Glacial Maximum (LGM). Extreme cold and dry conditions made the Sahara desert expand to 14° N, similar to its extent during OIS 6. The Namib Desert also moved to about 12° S (Dupont *et al.* 2000:119). Much of the tropical forest shrank into forest refugia in several areas. These include Equatorial Guinea, the coastal region of Cameroon and Gabon, eastern Congo, coastal regions of Liberia and Ivory Coast, the western fringes of Uganda, Rwanda, and Burundi, the Indian Ocean coast of Tanzania, northern Mozambique, and in the Ethiopian highlands (Dupont *et al.* 2000:96; Barham 2001:75). Ice covered Africa's mountains and the two extreme ends, as is indicated by periglacial features present today (Owen *et al.* 2000; Figure 3.2). Conditions became so dry that a possible abandonment of North Africa has been suggested (Close 1986). These conditions also explain the lack of more transitional sites or levels in sub-Saharan Africa, and the absence of signs of occupation at previously occupied sites like Die Kelders Cave 1 and Klasies River in South Africa.

Due to hyper-aridity, sea levels dropped by about 120 m to 140 m, with coastlines in both southern and northern Africa retreating by about 100 km. Rivers were reduced and possibly failed to complete their course of flow; for example, the Nile flowing from the East African highlands to the Mediterranean Sea. Pollen records from the western Rift Valley lakes and the general interlucustrine region of Uganda, Rwanda, and Burundi show a reduction in forest and an increase of dry grassland and ericaceous scrub vegetation. Some lakes dried up as savannah open woodland expanded. Forests were confined to areas along major water-courses between 30,000 and 10,000 years ago (Adams *et al.* 1997). Lake Victoria dried out around 20,500 years ago, and was only 65 m deep during the LGM (Thomas 2000:27). Paleosol evidence from the same region indicates that Lake Albert, located along the western Rift Valley, was reduced to 54 m below its present level, leaving only 10 m of water by around 18,000 to 13,000 years ago. Lake Tanganyika, the world's second deepest lake, dropped in level from 400 m to 350 m by 21,700 to 12,700 years ago (Cohen *et al.* 1997).

Unpredictable and changing climatic conditions during the Pleistocene led to serious behavioural challenges for hominids and particularly anatomically modern humans. Adaptation involved developing strategies suitable for survival in different environments. This challenge led to innovations that gave rise to MSA cultures during OIS 6 and also to LSA cultures about OIS 3. Klein (1992) argues for a neurological change in early *Homo sapiens* populations as the driving force to complex cultures marking the Upper Palaeolithic in Europe and Late Stone Age in Africa. Other scholars (Sherrat 1997:281; Foley and Lahr 1997; Lahr and Foley 2001), however, see the effects of Quaternary global changes as forcing behavioural advancement in attempts to cope with challenging environments. Africa was most affected by these Pleistocene environmental changes (Foley 1987a, 1989). Hominids responded to both local and global environmental changes by (i) experimenting with new technologies and becoming more innovative and (ii) moving to new areas or experimenting with new food resources available in the environment and also developing social networks as a way of ensuring support mechanisms. *Homo helmei* moved into Eurasia during OIS 7 while *Homo sapiens* moved into Europe and other parts of the world during OIS 4 to OIS 3 (Foley and Lahr 1997:19). These movements by early hominids may be interpreted as global adjustments to climatic conditions and the pursuit of resource availability. As discussed in Section 2.4, technological advancement and innovations accompanied some of these periodic migrations.

Conditions after the Pleistocene beginning about 13,000 years ago to the present are covered by OIS 1 (the Holocene Epoch). Increase in moisture and precipitation led to the recovery of lakes and rainforests, and the development of vegetation cover over desert areas. A number of fresh water lakes appeared, and water resources became abundant and easily exploited. East African lakes and rivers provided easily accessible Nile perch, a fish species that continues to be exploited in the region today. In West Africa, a record increase in mangrove and rainforest occurred, with the rainforest grading into savannah grassland in the Guinea and Congo areas without a marked boundary. *Podocarpus* vegetation, indicating cold conditions, disappeared from West Africa during early Holocene; and has since remained restricted to the continent's high areas (Dupont *et al.* 2000:118).

3.4 MSA cultures in Africa and the environmental challenge

During the first half of the twentieth century, a proposal by Goodwin (1928, 1929) to divide African prehistory into Early, Middle, and Later Stone Age periods based on the technological and typological features of artefacts brought into existence the term MSA.

This division was officially accepted at the third Pan-African Congress on Prehistory held in Livingstone, Zambia, in 1955 (Clark 1957b: XXXiii). The relative stratigraphic position of the three stages was therefore confirmed for the African continent. Subsequent research supported this scheme. At Kalambo Falls (Clark 1969, 1974), the Cave of Hearths in the Transvaal (Mason 1962, 1967), and Olduvai Gorge in Tanzania (M.D. Leakey *et al.* 1972), Acheulian materials belonging to Early Stone Age were found to underlie those of MSA. LSA materials were also confirmed to overlie MSA at Kalambo Falls and the South African sites of Klasies River (Singer and Wymer 1982) and Nelson Bay Cave (Klein 1972a, 1972b). Farther north in East Africa, sites including Magosi in northeastern Uganda (Wayland and Burkitt 1932; Clark 1957a; Cole 1967a), Nasera in northern Tanzania (Mehlman 1977), and the Central Rift Valley sites in Kenya (Merrick 1975) indicated that MSA is overlain by LSA. However, some of the sequences needed confirmation due to site disturbance and artefact displacement. This notwithstanding, the tripartite division has been applied in the study of the continent's prehistory.

Clark (1977) proposed a different technological division that used modes to define phases of prehistoric technologies. According to this scheme, Modes 1 and 2 referred to the Oldowan and Acheulian industries of the Early Stone Age, while Mode 3 referred to all forms of MSA industries. Modes 4 and 5 defined the LSA and the later Neolithic cultures respectively. The scheme was mainly applied in Europe; and did not work well in Africa, where the terms Early, Middle and Late Stone Age continued in use.

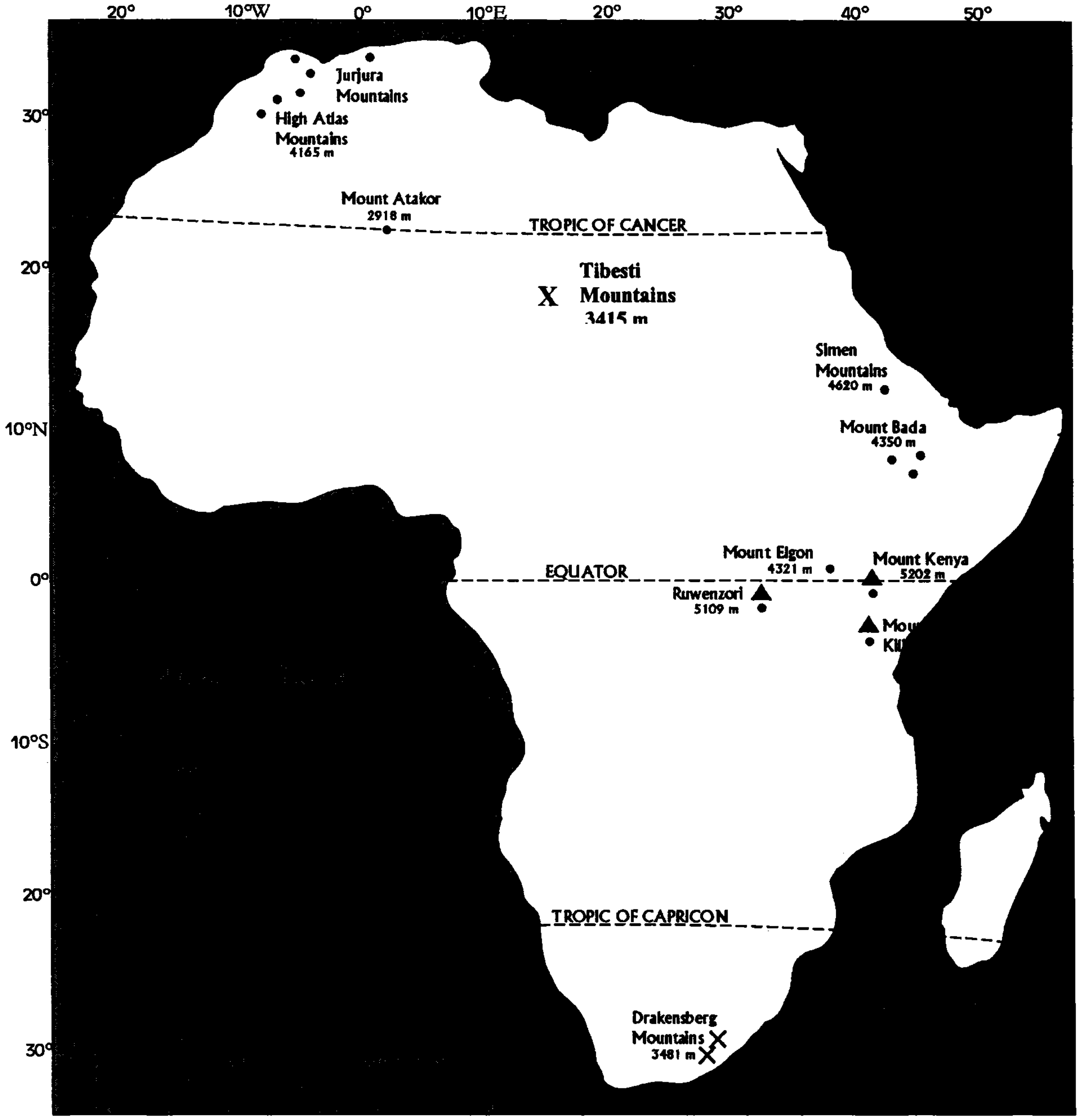


Figure 3.2 Map of Africa showing centers of Pleistocene glaciations and present-day evidence of glacial activity (drawn with information from Owen *et al.* 2000).

Defined mainly as a flake tool industry, the MSA is characterized by the use of either prepared core (Levallois) or radial core production techniques to produce triangular flakes with convergent dorsal scars. Such flakes are then used or retouched into various tools that comprise MSA assemblages. Both bifacial and unifacial points are the typical implements that distinguish MSA occurrences across the continent (Goodwin 1929:97). The African MSA corresponds to the European Middle Palaeolithic, with both making use of the Levallois technology in the production of flakes and tools.

Flakes and flake tools in the MSA reveal innovation and technological advancement in which a complex reduction system with possible predetermined shapes and sizes was realized through the prepared core concept. The dominance of flakes and flake tools also make the MSA different from the ESA, dominated by core tools, and the LSA, dominated by blade tools from blade technology that relied mainly on pressure flaking technique.

Most MSA points exhibit worked or prepared platforms and a series of dorsal scars. Their shapes resemble that of Acheulian handaxes; but these artefacts are smaller and more refined, with facetted butts. These implements were probably used for a variety of functions, such as hunting both small and large animals, and for fishing. However, their exact use remains under investigation (Volman 1984).

Other implements characterizing the MSA include scrapers of various forms, flake tools, and retouched pieces of various forms similar to those in Bordes' type-list for Europe (Gamble 1986:396-7) and other classificatory schemes such as Merrick (1975), used here.

Examinations of the archaeological record in Africa indicate a marked variability that is regionally restricted within the MSA. Small triangular or heart-shaped points with large tangs dominate North African assemblages. Some European Middle Palaeolithic small heart-shaped forms resemble these North African forms, and may indicate limited interaction between the two regions. In the later periods, especially after 40,000 PB, North Africa enjoyed links with Europe and southwestern Asia, as the Sahara desert cut it off from the rest of sub-Saharan Africa. In southern Africa, leaf-shaped forms are dominant; and differ from the East African region, where crescent-shaped points with curved edges deliberately dulled or backed become dominant.

The cause of this regional variation remains a subject of investigation. However, response to different environments and resource availability may be cited, causes leading to different technological patterns and adaptive strategies. Different heterogeneous raw materials across the continent favour the use of particular style and strategies in making tools. South African implements are made on fine-grained quartzite or silcrete, chalcedony, and chert. These are better-quality raw materials than lava or basalt, commonly used for stone tool manufacture elsewhere south of the Sahara. This factor may contribute to the fine leaf-shaped forms and the standardised technology of the MSA in the region. Environmental conditions during the unpredictable Middle Pleistocene climates also cushioned and isolated populations in different regions of Africa within which independent adaptive strategies emerged. These factors remain strong candidates for the driving force leading to the variation within the MSA (Clark 1962, 1965, 1970, 1982a).

Assemblage composition also indicates the presence of both inter-assemblage and intra-assemblage variability. The former refers to the variation between assemblages, while the later defines variation within individual assemblages. Inter-assemblage variability recognized within the European Middle Palaeolithic (Bordes 1950a, 1950b, 1953, 1961, 1972; Bordes and Bourgon 1951) led to the production of the Bordean-type list (Gamble 1986) which defines and describes artefacts found in the Middle Palaeolithic assemblages. The cause of this variability became a major subject of research. This led to studies on attribute analysis system (Crew 1972, 1975a, 1975b) and a global classification system to determine how technology adapted to aid in economy of energy expenditure within given environmental systems (Munday 1976). These studies foreshadowed that of environmental factors, such as raw material availability, that dominated lithic studies in both Europe and Africa. Other aspects that were developed to understand variability include studies on the reduction sequence (Jelinek 1977); and analysis of style in lithic artefacts, particularly in the retouched tools. The latter has remained the subject of theoretical debates (Binford 1989; Close 1977a; Sackett 1982; Stiles 1979), with applications for terminal Pleistocene (Close 1977b; Close *et al.* 1979) and Holocene (Gendel 1982) assemblages. Applying some of these trends, Van Peer (1991) identified environmental factors along with socio-economic factors as influencing inter-assemblage variability in his study of North Africa. Some of the factors he identified include raw material size, distance from source, time for technological evolution, and passage of rules of manufacture between groups and from generation to generation.

Understanding variability within the MSA seems to go beyond the confines of sites and particular regions. Section 3.2 and 3.3 indicate very unstable climatic conditions within which MSA cultures emerged. These called for flexibility in developing survival strategies. The effects of ice sheet cover over the Northern Hemisphere after 2.8 million years ago were felt in Africa more than anywhere else. The cold glacial North Atlantic sea surface temperatures (NASST) influenced the continent's climate causing periodic cooler and drier conditions. The effects of NASST increased after 1 million years ago as glacial cycles increased in magnitude around 900,000 years ago at a duration of 100,000 years. Vegetation shifts occurred in places like East Africa, where closed canopy was replaced by open savannah vegetation, starting in the mid-Pleistocene. This development marked a progression toward reduced and seasonally contrasted precipitation. This condition differed from that of earlier Miocene to mid Pliocene (8 to 3 million years ago), when the climate was more stable, with sub-tropical West and East Africa remaining considerably warmer and moister than present. During this period, wet lowland rainforest vegetation occupied areas that today support seasonally dry savannah grasses and shrubs (Hamilton 1982; Yemane *et al.* 1985; Bonnefille *et al.* 1987; Cerling 1992; Leroy and Dupont 1994).

The earliest stone tools date to 2.6 to 2.4 million years ago (Harris 1983). These Oldowan assemblages gave way to the Acheulian industry about 1.4 million years ago (Asfaw *et al.* 1992). Fossil African bovid and rodent evidence indicate that there was a major shift toward arid-adapted species between 2.7 and 2.5 million years ago (Wesselman 1985). By 1.7 million years ago, East African bovid assemblages reflect an increase of arid-adapted species, as intense aridity lasted to about 1.6 million years ago. Savannah vegetation expanded within the East African region (Cerling 1992).

A final phase of increased aridity and arid-adapted species is documented in the African Bovidae fossil record close to 1 million years ago. This marks the end of the first less-intense period of alternating wet and dry conditions, with punctuation in aeolian variability and concentration around 2.8, 1.7, and 1.0 million years ago (DeMenocal 1995; Partridge 1997). Cooler and drier conditions intensified after 1.0 million years ago, leading to ecological fragmentation and genetic isolation that gave rise to more arid-adapted animal species.

Robust australopithecines emerged around 2.7 million years ago during these changing climatic conditions (Klein 1988; Feibel *et al.* 1989). They were followed by the members of the genus *Homo* in East Africa around 2.3 million years ago. The first *Homo*, *Homo habilis* lived for a short duration, becoming extinct around 1.6 million years ago. The *Homo* line, however, continued through *Homo erectus,* which emerged around 1.8 million years ago (Feibel *et al.* 1989); and most likely overlapped with *Homo habilis* both in time and space. Due to the harsh climatic conditions, hominids migrated [as they contracted] to climatically favourable areas. *Homo erectus*, for example, moved to Southeast Asia between 1.8 and 1.6 million years ago (Swisher *et al.* 1994). Technological advancement also occurred, with the emergence of the earliest Oldowan tools around 2.6 to 2.4 million years ago (Harris 1983), followed by the Acheulain tools around 1.4 million years ago (Asfaw *et al.* 1992).

Evidence at Kalambo Falls indicates that the climate during the final stage of the Acheulian industry was relatively dry, with aeolian sands being found in association with artefacts (Clark 1960:318). Similar situations were recorded in Angolan sites in the Zambezi and Vaal drainage basins. These arid conditions continued to the beginning of ESA-MSA transitional industries, especially the Sangoan, present in a number of sites in sub-Saharan Africa.

Pollen evidence at Kalambo Falls indicates drier conditions during the Sangoan transitional occupation than the Acheulian period (Bakker 1969; Clark 1969:232). This period, marking the beginning of the MSA, was relatively drier than today (Clark 1964, 1966; Bakker and Clark 1962; Clark and Bakker 1964). In Angola, Sangoan materials described by Clark (1963, 1966) and Leakey (1949) were found in deposits of Kalahari sand. This sediment implies a northward migration or expansion of the Kalahari Desert under cold-arid conditions. Further north, MSA-associated fauna at Andelee site in Middle Awash Valley, Ethiopia, suggests an environment consisting of riverine woodland with sub-arid habitat (Kalb *et al.* 1982). In northern Tanzania, MSA fauna, including wildebeest at Mumba Höhle, indicates savannah conditions (Mehlman 1977).

This body of evidence points toward MSA environments as consisting of open savannah with scattered mountain or riverine forest refugia. Conditions alternated between cool/dry and warm/wet as dictated by the glacial cycles. The savannah supported various animals, particularly the African bovids, upon which hominids depended for their food requirements. Hominids also utilized plant and other forest resources where conditions allowed. The MSA, therefore, thrived during very unstable and challenging climatic conditions of OIS 6 to OIS 4 (Shackleton 1969, 1975; Shackleton and Opdyke 1973). The effects of these conditions on hominid adaptation resulted in improved behavioural and technological patterns almost similar to those of the LSA.

3.5 MSA environmentally restricted adaptation in the Central Rift and Lake Victoria Basin

The Central Rift Valley is the highest point of uplift on the East African Dome in Kenya. It is characterized by three major lake basins: Nakuru-Elementeita, Naivasha, and the former Pleistocene Lake Suess basins. The Nyandarua Mountains reach an elevation of 4,000 m from a base level of 2,400 m on the Kinangop Plateau; and run in a north-south direction, marking the eastern part of the region. The western side is marked by the Mau Escarpment that rises to a height of 3,100 m. The region slopes gently off on the west toward the Lake Victoria Basin (LVB), while its southern portion slopes down to the Loita-Mara Plains, forming part of the northern Serengeti Plain ecosystem (Figure 3.3).

The Lake Nakuru-Elmenteita and Naivasha basins are found at elevations of 1,890 m and 1,760 m respectively. Together with the four volcanic mountains of Suswa, Longonot, Ol Njorowa, and Eburru, the basins form the physical features that define the Central Rift Valley region. Quaternary lacustrine sediments and volcanic ash cover lowland areas within these basins. During the Holocene period, when rainfall reached its highest peak, land below 2,000 m in the Naivasha basin and below 1,940 m in the Nakuru-Elmenteita basin was submerged for more than 1,000 years (Ambrose 1984). Currently, however, the region receives a minimal amount of rain, ranging between 600 and 900 mm per year. This supports graded vegetation of scattered tree grassland below 2,200 m, denser bush vegetation and woodland between 2,200 m and 2,300 m, montane forest above 2,400 m and bamboo and montane moorland grassland above 2,500 m, [which are dependent on altitude] (Ambrose 2001).

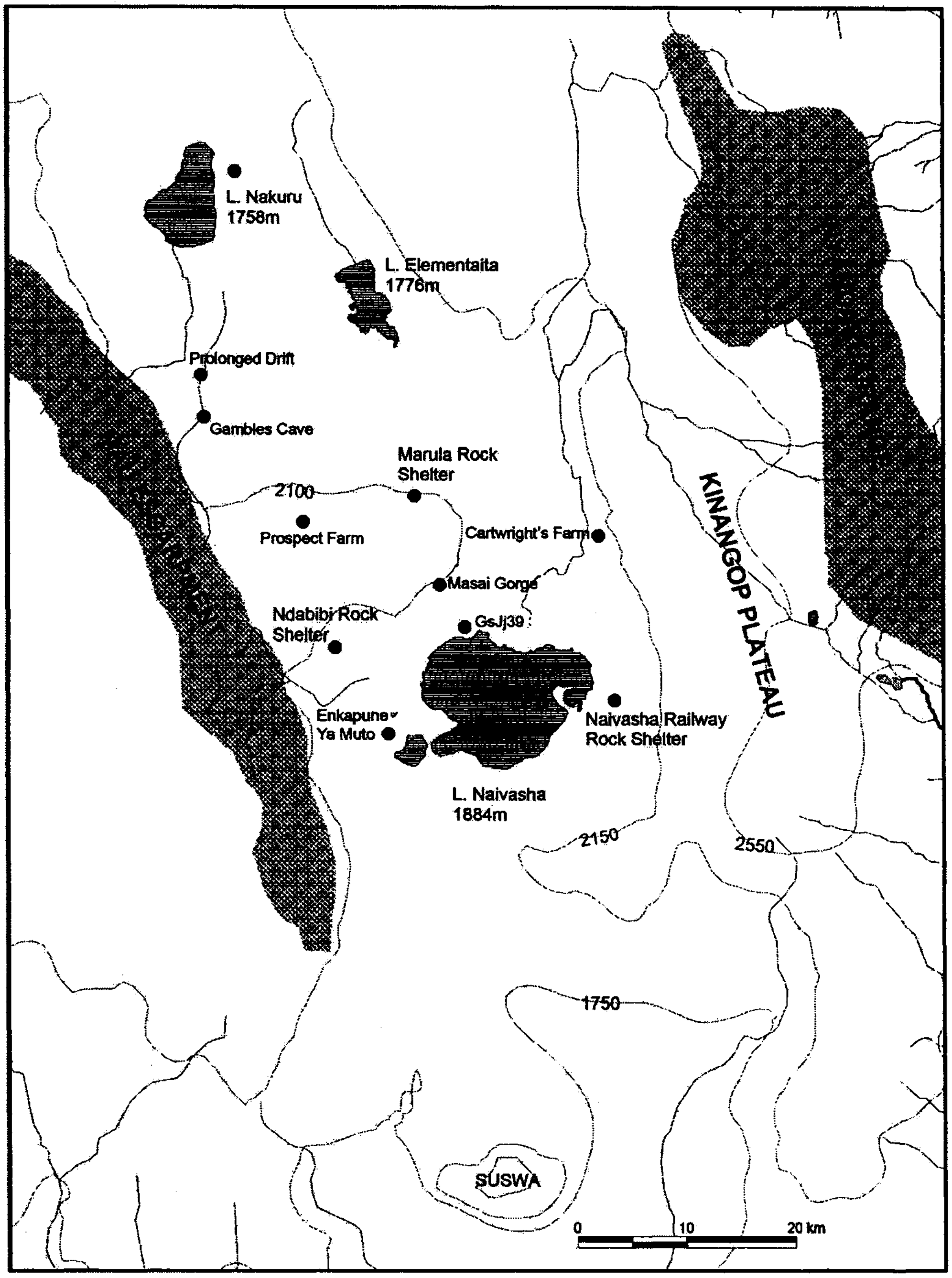


Figure 3.3 Map showing the Central Rift Valley and some of the MSA sites used in this work (redrawn using information from Ambrose 2001).

Late Pleistocene global changes affected this region, leaving high lake stands dated to >22,000 years ago, and low lake stands and dry basins between 20,000 and 12,000 years ago (Butzer *et al.* 1972; Richardson 1972). High lake stands that could be older than 40,000 years ago have not been securely dated; but probably correspond to OIS 5 (interglacial) and the warm inter-stadials of the last glacial (Isaac *et al.* 1972), which were contemporary with the MSA cultures.

The beginning of the Holocene was warm and moist, leading to the overflow of Lake Naivasha at 2,000 m with a stable shoreline at 1,940 m. Lakes Nakuru and Elmenteita merged and were at overflow at 1,940 m (Butzer *et al.* 1972). Archaeological faunal remains indicate that montane forest expanded to lower elevations (Maitima 1994), causing an expansion of animal species to lower altitudes (Ambrose 1984, 1986). During mid-Holocene, however, dry conditions made the lakes shrink and dry out between 3,400 and 3,000 years ago (Richardson 1972). The savannah-forest ecotone moved to higher elevations, above 2,600 m (Ambrose and Sikes 1991).

These changes in the Central Rift reflect those witnessed globally during Pleistocene climatic cycles with alternating glacial and interglacial periods. Plant and animal species responded to these changes accordingly. The savannah-forest ecotone may have expanded during the warmer periods of OIS 7 (the penultimate interglacial), the warmer sub-stages of the last interglacial (OIS 5a, 5c and 5e), and current one or the Holocene (OIS 1); and contracted during the cold periods. These shifts affected hominid activities and settlements in the Central Rift as well as elsewhere within the continent.

Figure 3.3 shows some of the MSA and LSA sites found in the Central Rift Valley. These are, but, a few of the archaeological sites found in this region, including those examined in this work, which belong to the MSA period. The sites contain evidence that include densities of bone and flaked stone found in scatters and sequences across the landscape. A number of studies provide information on past environments and the nature of settlement distribution in this region. Ambrose and DeNiro (1989) use carbon and nitrogen isotope ratios on mammal bones and teeth to provide evidence for microhabitat in which prey animals lived. Past forest zones or vegetation patterns have been inferred from the analysis of soil profiles for carbon isotope ratios (^{13}C and ^{12}C [$\delta^{13}C$]) for C-4 plants (tropical grasses) and C-3 plants (trees, shrubs, and other broad-leafed plants) respectively (Ambrose and Sikes 1991). To understand the microhabitat context of sites, and to test the ecotonal settlement preference model proposed by Isaac (1972), stable carbon isotope ratio analysis of paleosols at sites has been used (Cerling 1984; Cerling *et al.* 1989, 1991, 1997; Ambrose and Sikes 1991). Single crystal laser fusion $^{40}Ar/^{39}Ar$ (SCLF) dating of volcanic tephra found in association with archaeological occurrences at sites provide dates, and permit correlation with global paleo-climates (Hu *et al.* 1994; Renne *et al.* 1997). And lastly, lithic raw material source and use patterns have been used to reconstruct social and territorial systems within the region (Merrick *et al.* 1994; Ambrose and Lorenz 1990). How far do these studies contribute to the understanding of hominid behaviour in reaction to the environmental changes that reflected global climatic patterns? Are the behaviours reflected in the MSA assemblages and sites in conformity with or pointing toward those of hunter-gatherer societies with modern human behavioural patterns as defined in Section 2.2.2 of this work? These questions form part of the main objectives of this work, and are addressed in the remaining parts of the dissertation.

Chapter 4: Material and Research Methodology

> *...Sampling is not an option but an imperative that should be embraced willingly, not reluctantly. It is not a second-best strategy forced on us by lack of resources, but a responsible use of whatever resources may be available to us, whether small or large. (Orton 2000:6)*

4.1 Site geography and research history

MSA assemblages from five sites – Prospect Farm, Enkapune Ya Muto, Prolonged Drift, Cartwright's Farm and Muguruk – were investigated in this work. The assemblages included Prospect Farm – Locality I and II, Phase I – IV; Enkapune Ya Muto – Endigi Industry; Prolonged Drift – Occurrence I; Muguruk – Members 4 and 6; and Cartwright's Farm, surface and test-excavated materials. These are but a small fraction of sites and assemblages reported and investigated within East Africa. A brief review of the history of past MSA research in the region will provide the background needed for a picture of where the sites fit.

The first MSA artefacts in East Africa were reported and defined by L.S.B. Leakey (1931) at sites on the Kinangop Plateau. These yielded bifacially pressure-flaked foliate and triangular points belonging to the Stillbay Industry, which got its name from the South African site of Stillbay but was later found distributed from Ethiopia to South Africa along the eastern part of the continent. The industry consisted of a variety of stone tools produced by the Levallois technique, similar to the Mousterian of North Africa and Europe, with leaf-shaped bifacial points as index fossils. With more discoveries in eastern and southern Africa, the Stillbay Industry was divided into four parts: proto-Stillbay, pseudo-Stillbay, developed Stillbay, and later Stillbay (Leakey 1931, 1960) to account for minor differences between artefacts from different areas. The divisions were also based on the degree of refinement of points, as well as the absence and presence of LSA elements such as blades, bladelets, and microlithic backed pieces. The divisions were, however, ambiguous and most often contradictory.

Because of unclear explanations of the Stillbay and how it was subdivided, Anthony (1972, 1978) expressed reservations on the use of the term. Sampson (1974:88) also called for the abandonment of the term; and proposed the use of a new term, the Bambata Industrial Complex, based upon the work of Armstrong (1931) at Bambata Cave in Zimbabwe. Meanwhile, assemblages characterised by points (both foliate and triangular forms) and other artefacts struck from disc or bipolar cores continued to be reported in East African sites, and were linked to the Stillbay Industry. These included sites in the Nakuru-Elmenteita and Naivasha basins (Merrick 1975) as well as at Prospect Farm (Anthony 1972). Other sites where similar materials were found include Wetherall's site and Cartwright's Farm (on the Kinanop Plateau), Malewa Gorge and Nderit Drift bordering the Naivasha basin. Some of these sites are shown in Figure 3.3.

Leakey also defined a Levalloisan Industry (or Kenyan Mousterian) which was believed to predate the Stillbay. This was defined using materials from both Central Kenya and the Lake Victoria basin, including parts of Uganda (O'Brien 1939). This industry was identified at the site of Muguruk (Cole 1963:176), and was characterised mainly by tools with scant marginal retouch made on flakes from prepared cores. The later or upper Levalloisian Industry contained points as index fossils, and may have been transitional to the Stillbay that was characterised by leaf-shaped bifacial points.

Other research resulted in the definition of intermediate or transitional industries at the lower and upper ends of MSA. The Sangoan Industry was seen to mark the Acheulian to MSA transition. This industry was defined using materials collected from

Sango Bay in southwestern Uganda (Wayland and Smith 1923) with similar materials later found in Angola, Congo, Kenya, and Zambia. It is mainly characterised by heavy-duty tools such as picks, choppers, and core scrapers, which are also found in the Acheulian (Kleindienst 1962); but include a new type, core axe, defined by Clark (1965:840) as a heavy, often parallel-sided tool with flaking concentrated around the working end and having an unworked butt.

The Lupemban and Magosian Industries on the other hand, were seen as marking the MSA to LSA transition (Wayland and Burkitt 1932; Clark 1957a; Leakey 1945; McBrearty 1986; Merrick 1975). The Lupemban materials were first discovered at Matadi in the Lower Congo region (Clark 1972b:548); but the term comes from the mining exposures on the Lupemba Stream near Tshikapa, in Zaire about 60 km north of the Angolan border. This industry is characterised by lanceolate and foliate bifacial points, Levallois debitage, points made on blades, scrapers, and polished axes. The Magosian Industry, defined from the type site of Magosi in northern Uganda and characterised by flake and blade components, was abandoned as an intermediate industry when the materials were found to be a mixture of Middle and LSA industries (Cole 1967a).

Research on the MSA period, however, remained very sparse, as there were only a few known well-stratified sites that could provide information on how the industries graded into each other. Most of the assemblages also came from small or shallow open-air sites, or thin lenses within stratified rock shelter or cave sites. Problems of mixed Middle and LSA materials, as occurred with the Magosian implements at the type site of

Magosi in Northern Uganda (Cole 1967), also threatened the understanding of cultural succession at various sites.

Despite the low volume of research compared to the Early Stone Age and LSA, the MSA in East Africa has received continued attention, with researchers investigating topics such as typological variation and the current concerns with the emergence of modern human behaviour. From Olduvai Gorge, Clark (1982a) reported MSA artefacts with an older industry identified from the Ndutu Beds described by M.D. Leakey (*et al.* 1972). These contained informal scrapers and choppers of lava, and flakes from Levallois cores. At Nasera rock shelter on the Serengeti Plains, Mehlman's (1977) work revealed the presence of MSA with unifacial points and scrapers. Other research in Tanzania has been carried out by John Bower along the Loyangalani River in Northern Tanzania (Bower 1985), Audax Mabulla in the Lake Eyasi region (Mabulla 1996), and Pamela Willoughby in the Mbeya Region of the Lake Rukwa basin in southwestern Tanzania (Willoughby 1996).

In Ethiopia, Wendorf and Schild (1974) compared assemblages that consisted mainly of bifacial points, convergent and denticulate scrapers, and Levallois flakes to the French Mousterian materials. A number of MSA sites reported in this region (Clark 1988:255, figure 5) remain under investigation by both European and American researchers in collaboration with local archaeologists. In the Sudan, Shiner *et al.* (1971) described MSA artefacts from collections dominated by denticulate scrapers and crude Levallois debitage. Materials from surface collections resembling the Stillbay implements have also been described by Guichard and Guichard (1965, 1968), while other industries from the Sudan have been described as Mousterian by Marks (1968a), based on the absence of points and other Levallois flake-tools as well as a low proportion of Upper Palaeolithic type tools such as end scrapers, borers, burins, and backed knives, which he terms the Nubian Mousterian.

Marks (1968b) also describes the Khormusan Industry in the Sudan as being the terminal MSA industry in the region. It may be considered terminal MSA as it contains varied stone tools, tools made of bones and ground hematite, small-sharp points that were probably used as arrow tips, and other implements used during the following Upper Palaeolithic. The industry remains MSA, as it is characterised by a high proportion of Levallois debitage, denticulates and burins. Waechter (1965:143) grouped the Khormusan industry with the Stillbay of sub-Saharan Africa; but similarities are refuted by Marks (1968:387), due to the absence of bifacial points at the Khormusan sites.

Most of the MSA sites or occurrences reported before the 1970s have become subjects of renewed investigation since the late 1980s in order to collect more data with which to answer current anthropological questions such as the emergence of modern human behaviour. Focus is being put on hominid adaptation and behaviour through time as well as technological changes through time. The role of climatic and subsequent environmental changes have featured more in the investigations done within the Rift Valley sites extending from Ethiopia to the southern parts of Tanzania. Changing environmental conditions within the region in response to global climatic changes during the mid to late Pleistocene period may have been a trigger to the development of various industries found in the East African region, some of which are specific to particular environments. The sites examined in this work and which are described below indicate some link between the conditions and the technological adaptations resorted to by the hominids.

Prospect Farm

Prospect Farm is located on the north-western slopes of Mt. Eburru, Central Rift Valley, at an elevation of approximately 2,120 m (0°36' S latitude and 36° 11' E longitude). It is a stratified open-air site in pumiceous sediments found on Ridge 2 (Anthony 1978) which extends from the volcanic cone of Mt. Eburru. Located between montane forest and grassland on a piedmont fan, this site is unique among MSA sites in the Central Rift and the East African region as a whole due to its richness in terms of the volume of MSA materials and the presence of datable volcanics and paleosols. These contain information on technology, chronology of the site and environment, useful in understanding behavioural and adaptive patterns during the mid-late Pleistocene period.

Anthony (1978) identified three localities at the site during the 1963–1964 field seasons. Ridge 2 on which most of the occurrences were concentrated revealed the presence of MSA, LSA and Neolithic materials. Three excavations, one at Locality I and two at Locality II (Figure 4.1) exposed 36 stratigraphic levels (Figure 4.2, Table 4.1). The two localities are separated by a distance of about 1km. The stratigraphy has not been described in any great detail. Table 4.1 gives the simple units Anthony (1978) used. Her colour and soil texture description of each unit presents a problem, as other researchers do not find it easy to understand or correlate these with the general stratigraphy of the region. The two top levels do not contain any archaeological materials. Archaeological materials recovered from Level 3 have been designated LSA Eburran 2 Industry (Ambrose 1984:156). The youngest MSA occurrence (Phase IV) is found at Level 4, which is underlain by two sterile levels overlying Levels 7, 8 and 9 containing Phase III assemblages. Phase II assemblages appear in Levels 13, 16 and 19 while Phase I assemblage comes from Level 33. I and other researchers (Ambrose, personal communication 2003) think that a re-investigation of Prospect Farm stratigraphy would be necessary for understanding the geological and climatic patterns at the time the site was occupied.

An assemblage of 37,000 lithic artefacts was recovered from these excavations. These materials were distributed in five well-separated and superimposed archaeological horizons. Four of these occupied the Prospect Farm Formation (Anthony 1978), and were designated Phases I to IV from the oldest to the youngest. These formed different phases of MSA occurrences within the formation. A fifth horizon or phase occupied the layer immediately on top of the Prospect Farm Formation and was found embedded within a paleosol. Materials from this horizon belonged to a later period dated to 10,560 ± 1650 BP (Ambrose 2001:30), which falls within the LSA period and corresponds to the Eburran Industry at Prospect Farm.

Most of the materials from Prospect Farm, with the highest concentration from Locality I (Anthony 1967, 1972 1978; Merrick 1975), were analyzed by Anthony, except for materials from the upper horizon overlying the Prospect Farm Formation which formed scatters of LSA Eburran phase at the site. Most of the LSA assemblages in East African sites are dominated by backed microliths, scrapers and outils écaillés (Merrick 1975), while the Eburran Industry (Ambrose *et al.* 1980), formerly known as the Kenya Capsian (Leakey 1952), apart from the possibility of containing a variety of these materials, has a distinctive feature of the target flake form being a long, narrow blade

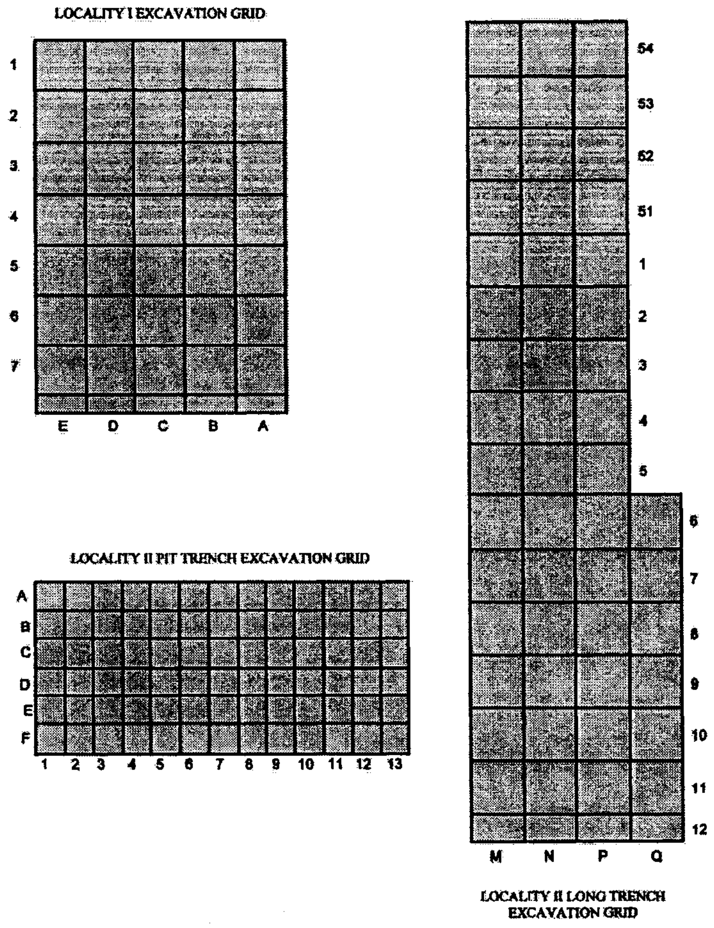


Figure 4.1: Layout of excavation grids at Prospect Farm: Locality I, Locality II–Pit Trench and Locality II–Long Trench (modified from Anthony 1978:54, 57 and Kelly 1996:258).

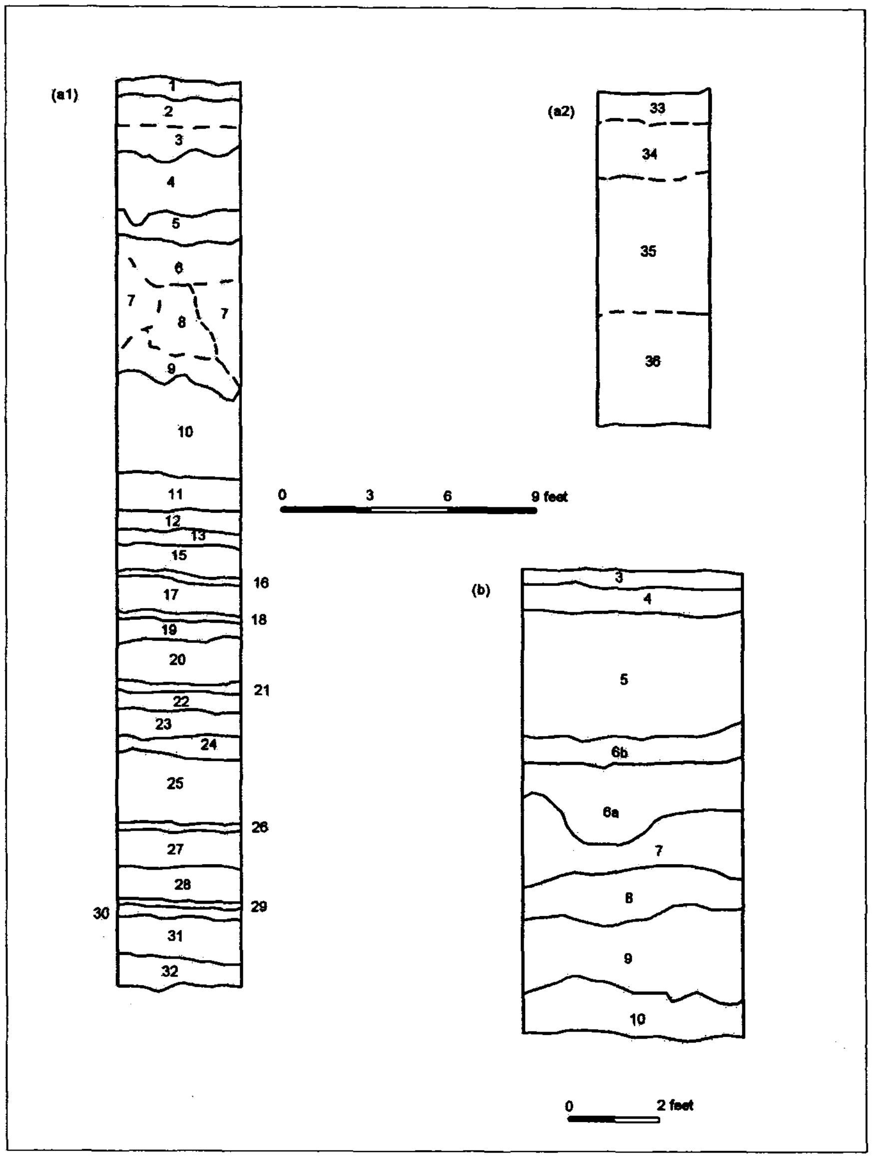


Figure 4.2: Prospect Farm stratigraphic profile at Locality II (a1 and a2) and Locality I (b). Modified from Anthony (1978:52–53)

Level and Locality	Archaeological Associations	Description
1 - L II	None	Brown top soil.
2 - L II	None	Reddish-brown top soil.
3 - L II & I	Kenya Capsian (Eburran) material	Blocky-based dark red-brown subsoil.
4 - L II & I	Top of Prospect Farm Formation	Tan tuff with white pumice.
5 - L II & I	Sterile	Orange tuff.
6 - L II & I	Sterile	Tan tuff with green while pumice.
7 - L II & I	Phase III artefacts in abundance	Pink tuff with green white pumice.
8 - L II & I	Phase III artefacts	Rose red tuff.
9 - L II & I	Sparse artefacts	Blocky-based orange tuff.
10 - L II & I	Sterile	Unconsolidated grey-tan pumice.
11 - L II	None	Compacted hard tan tuff.
12 - L II	None	Loose golden tuff.
13 - L II	Scattered flakes	Hard tan tuff.
14 - L II	None	Very thin grey-tan pumice.
15 - L II	None	Hard tan tuff.
16 - L II	Thin layer of Phase II artefacts	Ferruginous tuff.
17 - L II	None	Khaki tuff.
18 - L II	None	Weathered green pumice.
19 - L II	Scattered flakes	Tan tuff.
20 - L II	None	Orange tuff.
21 - L II	None	Orange tuff with grey pumice.
22 - L II	None	Large unconsolidated grey pumice.
23 - L II	None	Unconsolidated tan pumice.
24 - L II	None	Unconsolidated khaki pumice.
25 - L II	None	Large unconsolidated grey pumice.
26 - L II	None	Unconsolidated grey and tan pumice grit.
27 - L II	None	Unconsolidated tan pumice with ferruginous bands.
28 - L II	None	Unconsolidated grey pumice.
29 - L II	None	Unconsolidated grey and tan pumice grit.
30 - L II	None	Unconsolidated pink-tan tuff with grey pumice.
31 - L II	None	Unconsolidated tan tuff with scattered grey pumice.
32 - L II	None	Unconsolidated grey pumice.
33 - L II	Phase I artefacts	Hard pale pink tuff with lateritic pellets. Marks the top of pre-Prospect Farm Formation.
34 - L II	Sterile	Hard orange-red tuff.
35 - L II	None	Hard orange tuff and heavily weathered greenish pumice.
36 - L II	None	Hard tan tuff.

Table 4.1 Description of stratigraphic levels at Prospect Farm as per 1963–64 excavation (Information from Anthony 1978:52–53).

produced from long narrow cylindrical or pyramidal cores with convex flake release surfaces (Ambrose 1984:228). Such cores were heavily prepared on the flake release surface resulting in individual flakes with finely facetted platforms. Mean width/length ratio of backed tools range from 0.29 to 0.35.

Materials from Phases II–IV were later re-analyzed by Merrick (1975). Samples of artefacts from Phases I–III were also analyzed to understand lithic raw material source use patterns in East African prehistory in a regional program of chemical analysis of obsidian sources (Merrick and Brown 1984; Merrick *et al.* 1994). Later work by Alison Kelly (1996) further reorganized and sampled the materials for a comparative study of MSA assemblages in East Africa.

Volcanic pumice and ash horizons found interstratified in the sequence containing the MSA assemblages provided material that could be used for chronometric dating. Unfortunately, the only dates available for the Prospect Farm site are those from obsidian hydration measurements by Michels (*et al.* 1983). Samples from various horizons including the four high-density MSA occurrences were dated. Phase I materials were too patinated to provide reliable dates. Phase II materials were dated to 80,000–88,400 BP. Phase III, which was observed at three different levels, seems to represent separate occupations. The oldest at the junction between levels nine and ten was dated to about 120,000 BP; level-nine occupation was dated to between 106,000 and 108,000 BP, and the youngest part of this phase from the top of level eight to the junction between levels eight and nine dated to between 46,500 and 53,100 BP. Phase IV, found from the top of level seven and more concentrated at level four, was dated 46,700 to 53,600 BP (Michels *et al.* 1983, table 3). Ambrose (personal communication, 2003) has since carried out a test excavation to obtain samples for dating and also to correlate the stratigraphic sequence with other Central Rift localities. The results of this work are yet to be published.

Artefacts are mostly obsidian, and are typically MSA: points, disks and other artefacts made with Levallois techniques. Phase I assemblages are dominated by smaller tools than those found in other phases, with a length range of 17–57 mm, mean and median of 31 mm and a mode of 28 mm (Anthony 1978:62). Phase II has more cores than formal tools (cores = 103, tools = 62); and also show increase in length, width and thickness (length range of 18-65 mm, mean 40.25 mm, median 40 mm) for formal tools over the dimensions of the Phase I materials (Anthony 1978:184, 188). Tool forms, however, seem to be similar from Phase I to III; and include a variety of scrapers, such as triangles, tanged scrapers, circular scrapers and backed points. Phase IV contains both unifacial and bifacial discoids made from thin Levallois flakes, designated by Merrick (1975) as cutting knives. Phase IV is also characterized by few tools and cores and a large quantity of debitage. This phase is presumed to be a transition between the local MSA and Second Intermediate technologies (for example, the Lupemban found in other areas) at Prospect Farm, marked by the disappearance of points and Levallois technologies and the appearance of small discoidal knives and scrapers.

The position occupied by the Prospect Farm site, between montane forest and savannah grassland, conforms to the general observation that MSA occurrences within the Central Rift are clustered in a restricted range of elevations, defining a microhabitat preference for ancient forest/savannah ecotone (Isaac 1972; Bower *et al.* 1977). The ecotonal settlement pattern for MSA sites in the Central Rift was developed by Glynn Isaac (1972; Isaac et al. 1972) after conducting a systematic survey of artefact densities in surface exposures along an altitude transect from the floor of the Nakuru Basin to the north slopes of Mt. Eburru. Four ridge crests on Mt. Eburru showed that median artefact densities reached a peak of 44 per m² at 2,140 ± 60 m. Densities on the Rift floor were less than 10% of this value and even lower on the exposed slopes of Mt. Eburu up to about 2,400 m (Isaac 1972). This showed a restricted distribution of sites, therefore leading to the ecotonal settlement pattern model. Prospect Farm, which has multiple occupation horizons with interstratified volcanics at an elevation around 2,100 m, lies within the zone of highest artefact densities in Isaac's survey; and therefore exemplifies the type of site fulfilling the ecotonal settlement preference model (Anthony 1967, 1972, 1978; Merrick 1975). Four high-density MSA occurrences at the site are separated by volcanic pumice and ash horizons, and provide opportunities for obtaining new dates to back up obsidian hydration dates obtained by Michels (*et al.* 1983) for proper correlation with paleoclimates documented in deep sea and ice cores.

Such ecotonal positioning was a strategic measure to maximize efficiency in resource exploitation, a behaviour that was perfected during or at the end of the MSA. Hunter-gatherer societies such as the Okiek (Ndorobo) occupying similar locations benefited from resources obtained from both forest and grassland localities (Ambrose 1984, 1998). This settlement strategy also allows for mobility in response to environmental changes controlling the abundance or scarcity of food resources; and calls for an understanding of land-carrying capacity, productivity and labour-efficient means of food acquisition. Behavioural patterns that go with this seem to have been present with the earlier MSA occupants at Prospect Farm, where settlement strategies followed similar trends to those amongst hunter-gatherer societies of later periods.

Artefact composition and distribution at the Prospect Farm site provide additional evidence on hominid behaviour and cognitive capacities. Analysis of artefact samples from the site for raw material sources indicates that non-local materials increase in percentage from earliest to latest occurrences (Ambrose 2001:35; Merrick and Brown 1984:140). The earliest MSA horizon shows that 91% of obsidian was obtained from 10 to 15 km away, and about 19% from 40 km away from the Njorowa Gorge within the Naivasha Basin. The youngest occurrences, however, show that 37% of obsidian came from 10 to 15 km away and 60% from 30 km away, while only 1% came from 40 km away, with the source now being the Sonanchi area within the Naivasha Basin. Despite this trend, the quantity of non-local obsidian obtained from distances more than 75 km away was only 2%, indicating limited long-distance exploitation and interaction.

These distributions could be directly related to environmental factors and hominid cognition. The oldest occurrences date to the earlier Last Interglacial (Michels *et al.* 1983). Ambrose (2001) argues that during this early period, favourable climatic conditions contributed to high resource densities and predictability. Hominids had small closed territories, with little or no scheduled residential mobility and inter-group interaction. This is evidenced by the lack of distant materials at the sites. The latest MSA occurrences, on the other hand, reflect lower resource density and predictability in the environment. This favoured frequent and scheduled residential mobility, and led to a high frequency of more distant resources within sites. It also led to larger home ranges, and favoured frequent regional exchange and interaction between populations or bands (Ambrose 2001:37). Based on the restricted nature of the distribution of sites around 2,100 m above sea level, the pattern of exploitation during the MSA period for the

Central Rift Valley sites, such as Prospect Farm, seem to conform to Isaac's (1972) ecotonal settlement pattern, where sites are located between two ecotones for the purpose of exploiting resources from both areas.

Thus site and artefact distribution, as well as composition, suggest that during warmer, humid interglacials and interstadials, occupations at Prospect Farm were concentrated and larger, without outside interaction creating a lower frequency of non-local lithics. On the other hand, during drier glacial conditions toward the onset of the Last Glacial, decreased abundance and predictability of food resources led to increased mobility, exploitation of larger territories, and occupation of higher ground. Due to increased mobility and interaction, sites remained smaller and the percentage of non-local materials increased at sites. These behavioural shifts in response to environmental change are similar to what Ambrose (1986) observed between the early Holocene wet phase and the middle Holocene dry phase in the Central Rift as well as throughout highland Kenya and northern Tanzania during the LSA Eburran occupations. Cognitively, therefore, both MSA occupants at Prospect Farm and Holocene settlers may have had equal behavioural capacities in response to environmental changes.

Enkapune Ya Muto

This site is located on the Mau Escarpment at an elevation of 2,400 m west of Lake Naivasha, in the Central Rift Valley (Figure 3.3). It is a rock shelter with a deep sequence of occupation containing several LSA industries stratified above a MSA industry. This lowest horizon, labelled RLB4 in Figure 4.3, has been designated the Endigi Industry (Ambrose 1998:382). The entire stratigraphic sequence contains artefacts, volcanics and organic remains such as bones and ostrich eggshell remains that provide information on past environments as well as technological changes over time.

Ambrose (1998) conducted two excavations at the site, in 1982 and 1987, during which he examined archaeological occurrences dating to the middle Holocene dry phase in highland East Africa. His goal was to test the model for forest-savannah ecotone preferences by the Holocene hunter-gatherer societies. He also wanted to document the transition to food production during the later middle Holocene, as well as obtain a complete cultural sequence and accurate dates for the MSA/LSA transition.

The Endigi Industry (RLB4 horizon) at Enkapune Ya Muto is a late MSA occurrence dating to the same period as the Prospect Farm Phase IV MSA assemblage. It probably dates to the unstable periods of OIS 3/4. Radiocarbon dates of 41,400 ± 700 BP have been assigned to it though these are thought to be too recent. The LSA DBL1 horizon about 1.2 m higher in the sequence has been dated to 39,900 BP, indicating that the radiocarbon dates assigned to this horizon may only be estimates and that the MSA here most likely dates 50,000 and 59,000 BP (Ambrose 2001:34).

The location of this occupation below a LSA horizon (DBL1) without any unconformity suggests proximity to the MSA/LSA transition. It represents a sparse MSA occupation, with lower artefact and bone densities (5.92 flaked stone artefacts and 4.24 g of bone per $0.01m^3$) compared to those of the Eburran (Ambrose 2001:34). This suggests low occupation intensities and infrequent use of the site during the later stages of the MSA period. Materials consist of flakes and flake-tools, with a limited number of points. Most artefacts exhibit the presence of faceted platforms and radial dorsal scar patterns. These are distinctively MSA; and differ substantially from the LSA materials in layer

DBL1 upwards, characterized by semi-polyhedral and flattened discoidal core forms from which equilateral flakes were struck. Other LSA types include inversely backed microliths and small, wide, well-standardized convex end scrapers with steep retouch along one or both sides.

Faunal remains recovered contain both forest and savannah species; and include one equid, one tragelaphine and one cercopithecine monkey (Ambrose 2001:34; Marean 1992). As is common in other MSA occupation levels or sites, association with large quantities of fauna is limited.

Artefacts are made of quartz, chert and obsidian. Quartz and chert sources are about 65 km away, and are more abundant in MSA than LSA levels. Obsidian also comes from sources within the Naivasha Basin, the nearest of which is about 10 to 15 km away (Ambrose 2001:24, figure 1). Materials from more distant places, such as chert and obsidian, may indicate a broadening of the social base in which exchange networks were established. Such behavioural patterns and the expansion of territorial exploitation through inter-territorial interaction were probably influenced by the unstable OIS 3 interstadial global climatic conditions evidenced by climate that fluctuated on a short time span, and sea level about 70 m lower than present (Kukla *et al.* 2002). The conditions caused changes within micro-habitats such as the Central Rift Valley, and had global impacts that included the expansion of hominids into the Near East and south-eastern Asia and Europe in what has been termed 'Out of Africa 2' (Stringer 2002).

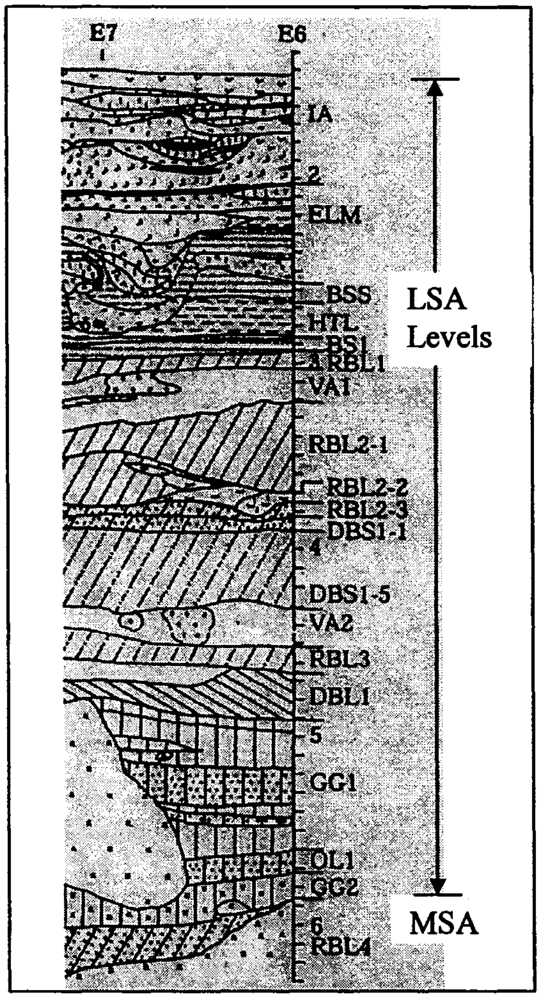


Figure 4.3 Stratigraphic profile of Enkapune Ya Muto (EYM) showing the position of the MSA Endigi Industry–RBL4 (Modified from Ambrose 1998:382).

Prolonged Drift

Prolonged Drift (GrJi11) is located on the alluvial valley floor of the Lake Nakuru Basin. It is found on the banks of Enderit River at an elevation of 1820 m (0° 29' S latitude and 36° 06' E longitude) in a locality where a number of LSA artefacts were surface collected by L.S.B. Leakey, and includes an area that has been designated site GrJi1, which is an LSA occurrence. The first excavation at these MSA occurrences was carried out by Isaac (*et al.* 1972) in order to define archaeological cultures and establish a stratigraphic sequence within the basin.

Merrick (1975) provides the first detailed report of the site. Distinct MSA levels were found in alluvial gravels, sands, silts and diatomaceous deposits of a channel fill. This is Formation A; and dates to >30,000 BP, based on correlation of the overlying "Makalia ash" with ash and pumice layers in a dated core from Lake Elmenteita, which records the last major eruption of the Menengai volcano (Merrick 1975:234). Excavations at three channels revealed MSA bearing levels spread over a distance of 70 m along the river in three artefact concentrations designated occurrences I–III. However, artefacts from Occurrences II and III were greatly worn due to natural (water) action. Only Occurrence I, with no signs of running-water artefact-wear, was interpreted to have resulted from human action. These materials were analyzed by Merrick (1975) and Kelly (1996), and are the ones sampled for use in this work.

The Occurrence I assemblage is dominated by flakes and flake fragments, with scrapers being the common tools. Points and other bifacial pieces are rare, while backed pieces and blades are completely absent. Cores are almost absent, or were transformed into tools. The assemblage composition qualifies Occurrence I as MSA, even though there are very few standardized tool types.

Almost all artefacts (98%) are made of obsidian, and over 95% of these come from Sonanchi (46%) or Ol Njorowa Gorge (50%) some 40 and 50 km away respectively, within the Naivasha Basin. The remaining 4% come from Masaai Gorge, which is 30 km away (Merrick *et al.* 1994, table 4; Ambrose 2001:35). Other nearby obsidian sources were not exploited. This has been interpreted as suggesting a highly mobile subsistence strategy and inter-territorial interaction, or preference for particular sources of raw material (Merrick *et al.* 1994:43). The long-distance acquisition of raw materials could also be the result of an expansion of the social and territorial base in the face of decreased resource predictability during the Last Glacial period, when the site was possibly occupied. Ambrose (2001) thinks the MSA occurrence forms an opportunistic settlement system in a risky ice age environment. Even though this interpretation echoes Merrick's conclusion that the occurrence was a hunters' camp of short duration, high artefact densities indicate longer occupation spans and larger territorial exploitation. Faunal remains recovered from this MSA level together with ones from the LSA site (GrJi1) have been neither analyzed nor published.

Muguruk

The Muguruk site is located on the banks of the Muguruk River 3 km north of the Winam Gulf, Lake Victoria, along the Kisumu-Bondo road and 10 km from the modern city of Kisumu. It lies at an elevation of 1,180 m (0° 5' S and 34° 38' E). It was discovered in the deposits belonging to the Muguruk Formation laid down during a low velocity fluvial situation (McBrearty 1986). The formation is 12 m thick, and lies on top of Ombo phonolite, which is a Miocene basement rock system providing >95% of the raw material on which the site's artefacts are made.

Discovered in 1936 by Archdeacon Owen, the site was designated a type-site of the "Lower Tumbian Industry" (L.S.B. Leakey and Owen 1945). This became known later as the Sangoan-Lupemban tradition, and was named the Ojolla Industry by McBrearty (1986, 1988). Above the industry were found two MSA levels/occurrences that were designated "Pundo Makwar Industry," which was divided into Member 4 (45 cm thick) and Member 6 (40 cm thick). Member 4 consisted of red-clayey sands while Member 6 consisted of over-bank sands and silts (Figure 4.4). About 12,000 artefacts were recovered from these two MSA horizons, spread within a deposit of 40-45 cm thick. Formal tools are few, comprising only 2.5% of the total assemblage. Flaking debris resulting from the reduction of radial and Levallois cores is dominant. Of the formal tools, scrapers prevail; only four pieces are points. Flake tools are mostly unifacially retouched.

About 97% of all artefacts are made of local ombo phonolite, which is a grade of lava. Nine obsidian artefacts recovered from Members 4 and 6 are foreign to the region. Analysis of these obsidian samples indicate that they were obtained from Sonanchi Crater, Central Rift, some 190 km away, and from Mt. Eburru, some 185 km away (Merrick and Brown 1984; Merrick *et al.* 1994). Ambrose (2001:35) argues that such long distances through which raw materials were transported from source suggest expanded/increased home range size, radiating mobility patterns and inter-group exchange networks.

Faunal remains have not been recovered from Muguruk, and this makes reconstruction of the environment difficult. The absence of Pleistocene volcanics in the region also makes dating the site impossible, as methods such as $^{40}Ar/^{39}Ar$ cannot be used. However, Member 5, which is contemporaneous with Member 2, contains calcrete sediments that suggest dry conditions during the later Sangoan-Lupemban occupation period. If Clark's (1964, 1965) suggestion that the Sangoan is an adaptation to a wooded environment is accepted, then the drier nature of Members 2 and 5 would place these levels toward the end of the Sangoan period and during the OIS 4 stadial, which is characterized by the beginnings of unstable and intense cold conditions. This gave way to the OIS 3 Interstadial, which was equally unstable and cold. It was during these unstable conditions that the MSA levels were occupied. To what extent the technological changes and the long-distance exchange patterns and interaction can be attributed to these climatic forces remains to be established.

Cartwright's Farm

Cartwright's Farm (GsJj75) is located on the Kinangop Plateau east of the Central Rift region overlooking Lake Naivasha. It is found at an elevation of 2,420 m (0° 35' S latitude and 36° 27' E longitude). Discovered early in the twentieth century, the site remained largely un-investigated, with only surface samples collected by Leakey and Turner before the 1940s. Merrick did a formal excavation at the site in 1982–83, but the results of this work remain unpublished; and most of the materials, now kept at the National Museums of Kenya (NMK), have no provenience records, which have been lost in the course of many years of storage. In a recent work by Waweru (2002), involving surveys and excavations in 2001 and 2002, more artefacts were collected and the

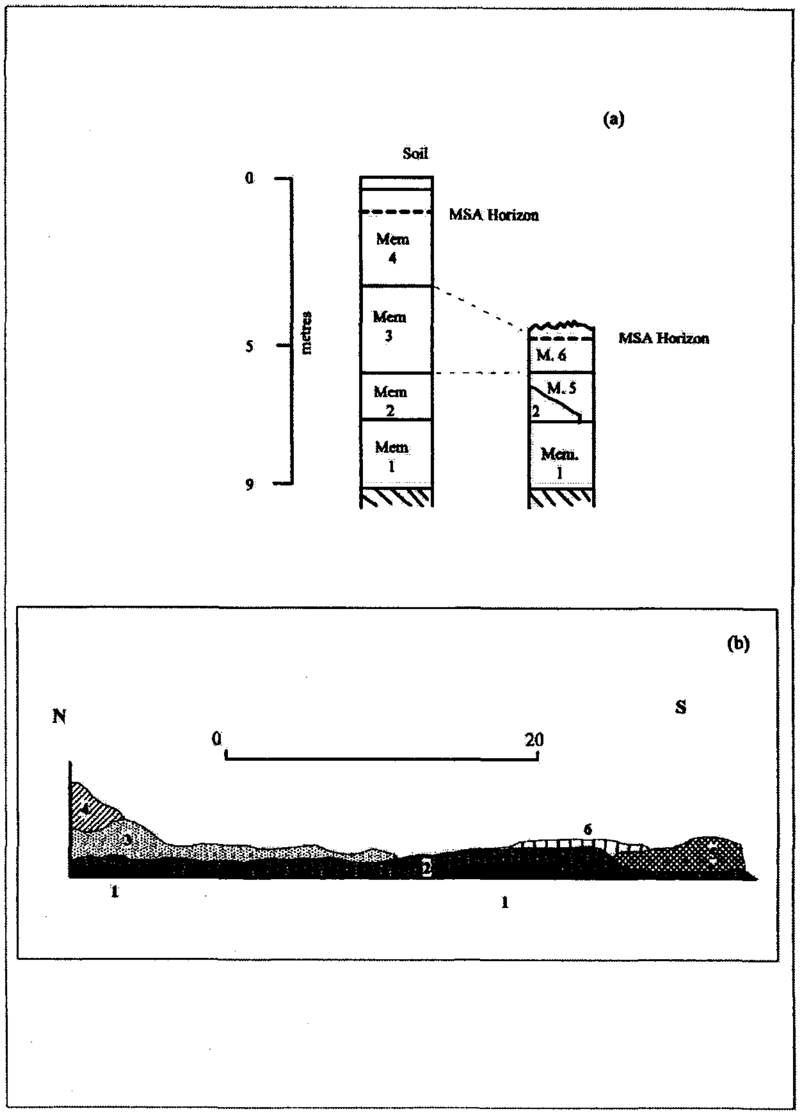


Figure 4.4: Muguruk (a) stratigraphic profile and (b) section (modified from McBreaty 1986:116).

stratigraphic profile re-examined.

Thirteen units consisting of tuffaceous material have been identified as forming the site sequence (Waweru 2002). The artefact-bearing Horizon M contains a clayey paleosol that promises more information, particularly on the dating of the site. A date of 440,000 BP was initially assigned to the site (Evernden and Curtis 1965). This remains controversial and in dispute on stratigraphic grounds, and the fact that it seems to be too early for a MSA occurrence in the region. The oldest secure dates for the MSA in East Africa are those from the Kapthurin Formation fixed at >285,000 BP (Deino and McBrearty 2002:208).

Both surface and test excavated materials were grouped by Leakey (1931, 1936) into two industries, named Pseudo-Stillbay and Basal Aurignacian. The criteria for separating the materials into these two industries remain unclear. Besides untrimmed flakes, the assemblage contained backed blades, triangular points and scrapers. Waweru (2002) recovered similar materials, which also showed that the site has not been disturbed and that some of the points were used as projectiles. Such points exhibit bifacial flaking, invasive retouch and basal thinning; and are symmetrical in shape, suggesting hafting.

Most of the artefacts are made of obsidian obtained from three sources, namely Sonanchi, Kinangop and Njorowa Gorge, about 35, 5 and 16 km away from the site respectively. These distances may indicate (i) a broadening of the social base, meaning interaction with other groups, including inter-regional exchange networks; and (ii) widespread foraging habit and knowledge of resource distribution within a sizeable environmental range during the MSA period. The on-going work at the site and the region as a whole is expected to shed more light on the behavioural patterns during the MSA and later periods of occupation in this region.

4.2 Sampling Procedure

The five sites (Prospect Farm, Enkapune Ya Muto, Prolonged Drift, Cartwright's Farm, and Muguruk) contained MSA assemblages that were too large (37,000 for Prospect Farm, 5,019 for Prolonged Drift, and 12,232 for Muguruk) to be analyzed completely with the resources and time limits faced during this study. Basic sampling was therefore necessary to bring research activities under control. This exercise focussed heavily on the quantity of artefact categories chosen for analysis at the different sites, and also on some significant problems involving the various assemblages.

In the time available, the plan was to sample those artefacts that would best reflect the technological system and subsequent core reduction techniques in order to establish behavioural patterns resulting from such activities. Cores and flakes were identified as suitable for this purpose. I therefore decided that all cores from the five sites would be analyzed. I added a separate category of core fragments to take care of those broken pieces of core that could be grouped as neither cores nor tool fragments.

Sampling of flakes was a bit more complex. The initial plan was to sample a limited number of whole flakes by level, phase, and/or trench from the various assemblages, namely: Prospect Farm Phases I–IV, the Enkapune Ya Muto Endigi Industry, Prolonged Drift Occurrence I, Cartwright's Farm, and Muguruk Members 4 and 6. This plan was abandoned after realizing that some of the artefacts (flakes) did not have adequate provenience records. Incomplete records and the mix-up of materials, especially at Prospect Farm, posed a problem that could not be resolved, but was managed through careful sampling and reorganisation of materials. It was not possible to organize materials according to levels, trenches, and phases. Because of this problem, all of the whole flakes from Prospect Farm were selected (complete sample) for analysis. It was also not possible to use the phase categorization under these circumstances. Similar strategies were adopted in selecting flakes for analysis from Enkapune Ya Muto, Prolonged Drift, Cartwright's Farm, and Muguruk. The approach produced a more representative sample of artefacts (whole flakes) from the various assemblages without the confusion over the levels and phases, as it would have been if the different phases were used.

A slight alteration was made to the above strategy, when it came to the analysis of Muguruk materials. These materials were analyzed after those from the Central Rift, and toward the end of the study. Faced with a large quantity of whole flakes from the two MSA levels, completion of the work would not have been possible within the time that remained, so just a few flakes from the two levels were picked for analysis. This led to the analysis of a small, but nonetheless a statistically significant quantity (over 100 pieces) of flakes from Muguruk.

Sampling of tools from the five sites was done by picking pieces from each bag labelled as containing tools or trimmed pieces. Attempts were made to select samples representative of various tool categories, to reflect the range of variability in terms of tool types in the various assemblages. For Muguruk, selection of tools also suffered from lack of time, and only a few scrapers were analyzed.

Sampling decisions like the ones discussed here are common in archaeological investigations, and affect the inferences archaeologists can make on different sets of objects. Such decisions are never without problems that may appear at various levels, from field recovery to laboratory analysis and interpretation of data. Under such circumstances, a researcher's intention is always to minimize sampling problems in order to derive the best representative population, and also to deal with those variables or factors beyond control in the best way possible to maintain the integrity of the study. In any case, any large assemblage that may be considered complete still remains a sample of the entire cultural enterprise of those responsible for the materials studied from prehistory.

This study is definitely not devoid of limitations, biases, and errors in its sampling and methodological strategies. The results should therefore be considered in the light of the prevailing circumstances dictating the use of the sampling strategies and materials analyzed. Some of the problems faced that were beyond control in the present study include the following:

(1) Limited resources that dictated the use of previously excavated materials, some of which have been in storage for the last half century and therefore containing compromised records and information acquired over the years. The work also lacked adequate equipment and some of the procedures in the analysis had to be postponed and only completed while back in Canada. Artefact photos could not be taken, and only a few were scanned for illustration. Also, time limits did not allow for the analysis of larger and complete samples.

(2) There was an incomplete assemblage at Prolonged Drift, where part of the materials, especially tools, had been exported to the United States of America and was therefore not available for this study. Also, most of the non-tool artefacts from Cartwright's

Farm were not available in the collection as these were not recovered during the early surface collection of materials and test excavations at the site. The main concern, when materials were first collected from Cartwright's Farm, was to obtain tools, which could be used in defining major stone Industries. The sample from this site is, therefore, richer in tools but has only limited number of debitage, as shown in Table 5.4.

(3) Other problems included incomplete excavation and artefact records, and less straightforward catalogue methods used after the materials were brought to the laboratory.

4.3 Material and research methodology

Detailed measurements were recorded for cores, flakes, and the sampled tools. Since these materials were excavated previously (Ambrose 1998; Anthony 1978; Isaac *et al.* 1972; Leakey 1931, 1936; McBrearty 1986; Merrick 1975), and have been re-analyzed over the years (for example, Merrick 1975; Kelly 1996), data recording started after my discussion with, and the consequent approval by the head of the Archaeology Division, National Museums of Kenya, of the laboratory research I was going to conduct. Materials from the five sites were made available to me for the purpose of realising the goals of this work. I reorganised the materials and created temporary additional catalogue numbers. Excavation notes, maps, and sketches found at the National Museums of Kenya, where the lithic materials are stored, were also examined for information on recovery and post-excavation processing of artefacts. Information on stratigraphy, and geological and environmental setting at the various sites was obtained from secondary data, mainly published works and theses.

The five sites and the named assemblages were chosen for a number of reasons, as follows:

1. They represent varied environments that may reflect general hominid behaviour during the MSA. Prospect Farm and Prolonged Drift are found on a high elevation lake basin (Nakuru–Elmenteita basin) within the Central Rift. Enkapune Ya Muto and Cartwright's Farm, on the other hand, are found at high elevations adjacent to or on the boundary of the Lake Naivasha basin. Their locations indicate a strategy to exploit both savannah and forest resources. MSA occurrences within the Central Rift are common at elevations between 2,000 and 2,200 m (Isaac 1972; Bower *et al.* 1977). Isaac used these occurrences and ethnographic analogy with the Okiek hunter-gatherer communities in the region (Blackburn 1982) to propose a model of preference for settlement in the montane forest/savannah ecotone. Ambrose (1984, 1986) also used archaeological occurrences for the Holocene period and ethnographic analogy with the Okiek to establish an ecotonal settlement pattern in the region. He argues that if this pattern of settlement was maintained throughout the late Pleistocene, then the ecotone should have shifted to higher elevations during colder dry periods and to lower elevations during warmer wetter periods (Ambrose 2001:23). Lastly, Muguruk is found in a medium elevation lake basin. Site and assemblage composition reflects proximity to forest resources, and probably date prior to the formation of the Winam Gulf of Lake Victoria (McBrearty 1986, Isaac 1972). Clark (1964, 1965) proposes an adaptation to a wooded environment during

the earlier periods of MSA occupation at the site, marked by the Sangoan Industry, followed by an arid period that created open grassland and in which the later assemblages were made. These varied environments form suitable representations within which to assess hominid behavioural patterns.

2. The MSA assemblages at these sites were of sizeable quantity, and were best suited for the statistical requirements upon which this investigation was based. For example, Prospect Farm had on record 37,000 lithic artefacts distributed in Phase 1 – 4,326, Phase 2 – 7,712, Phase 3 – 13,692 and Phase 4 – 11,791; while Prolonged Drift Occurrence 1 had 5,019 and Muguruk Members 4 and 6 had 6,509 and 5,726 respectively. There is also a high density of artefacts per cubic meter (Prospect Farm – 842 m^3, Prolonged Drift – 1,745 m^3 and Muguruk – 868 m^3 [Kelly 1996]).
3. The sites were also selected because the various assemblages have been analyzed and confirmed as belonging to the MSA. Assemblages contain flakes and flake-tools, and both unifacial and bifacial points with prepared platforms. At Enkapune Ya Muto, where there is a sequence from MSA to the recent Neolithic, the MSA Endigi Industry level is typologically and technologically distinct, with flakes bearing faceted platforms and radial dorsal scar patterns dominating. Outils écaillés and scrapers are dominant tool types, and the levels are clearly not transitional to the LSA (Ambrose 1998:384).

As mentioned earlier, the chipped stone artefacts were studied in order to reconstruct and compare MSA technological systems. Whole flakes were chosen because un-retouched flakes or blades do not have features that can be attributed to function or other forms of modification. Distinct forms, such as Levallois flakes, and how they relate to the type of cores in the assemblage(s), are therefore suitable for understanding technological patterns and chain of operation in the production of artefacts. These behaviour-driven activities form the base upon which patterns to explain modern human behaviour during the MSA is derived.

The context of whole flakes at a site provides evidence for technological practices as well as other activities that were carried out at the site. Percentage frequencies of flakes in relation to other stone debris, as well as flake sizes, provide a means of assessing site formation processes. And lastly, size of flakes in relation to raw material sources provides a means to understand curation of artefacts, and the range of exploited environments.

A number of variables were selected to provide information on technological patterns and aspects of (modern) human behaviour. These variables are described below. Data were collected consistently by assigning artefacts to types, taking linear and weight measurements, and recording artefact attributes. The data recorded were later used in a computer-aided analysis presented in the next chapter of this dissertation. A number of variables were used to assess variation within and between assemblages by use of Analysis of Variance (ANOVA). This method uses the null hypothesis that population means are equal (Norusis 1988). It then examines variability in samples and determines whether there is reason to believe that population means are unequal.

The One Way ANOVA used in this work arranges cases based on values for one variable. Two conditions, (i) that data must be from a random sample, and (ii) that variances in all groups must be equal, should be met if results are to be authentic.

However, One Way ANOVA provides reliable results of population variation even if the conditions are not strictly met.

The results and value of ANOVA is obtained from an interpretation of the F-value or statistic. If the null hypothesis is true, that is, the population means are equal, meaning similarity within or between populations, then the F-value should be closer or equal to one (1). Larger F-values (greater than 1) mean the null hypothesis is false, and population means are unequal indicating variation in the population. However, to ascertain the significance of the F-value, the obtained value is compared with an F-distribution chart, which is mathematically defined. This provides a significance level or probability, which is then used to reject or accept the null hypothesis. At a level of 0.00005, the null hypothesis is accepted and population means are treated as equal or similar. Less than this, the null hypothesis is rejected and the population means are treated as different, indicating variation.

4.3.1 General organizational variables

This group of variables was mainly for organisation purposes. Since I was dealing with more than one site, it was necessary to design a means of creating a single analysis with distinct parts. This necessitated the assignment of codes to sites, and the creation of case numbers for individual artefacts analysed. General variables therefore included: (i) site, (ii) case, (iii) raw material, and (iv) distance to raw materials.

(i) Site

Assigning each artefact piece a code representing the site it came from was the first step in the analysis. Assemblages from each of the five sites were organized and analyzed in a sequential order, making use of previous records and the new catalogue numbers for individual pieces created in this work.

(ii) Case number

Case references are assigned to artefacts in an assemblage to reflect the overall quantity of materials or population size at a site. Case numbers were assigned to artefacts as a means of controlling the population of the analysed material from the five sites. These reflected artefact counts irrespective of site and assemblage.

(iii) Raw material and (iv) Raw material distance

These variables are significant in any lithic analysis. Identification of raw material types and the distances they are transported or moved within the environment provides information on technological organization. Distance travelled by hominids while transporting raw materials may be obtained from the link between the location of an archaeological occurrence and raw material source or sources. This may reflect links between groups of people occupying the site and raw material source areas, if such people are different. Raw material type and distance from source may also help in understanding mobility patterns, and aid in building of models explaining resource acquisition within a given territory. More raw material types at a site may also reveal differential treatment of the various raw material types; and therefore help in establishing whether specific raw materials were selected for the manufacture of particular artefacts, or whether specific raw materials were heavily exploited relative to the others.

The variables were aimed at establishing raw material preference for artefact manufacture during the MSA. They were also to aid in the understanding of environmental exploitation patterns, any possible inter-regional or social networks, and the technological behaviours resulting in artefact accumulation and sizes at the various sites. The overwhelming use of obsidian as a raw material within the Central Rift and at the sites studied made it possible to apply the results of Merrick and Brown's (1984) study of obsidian source and patterns of utilisation in this work. Consequently, distances between sites and respective raw material sources within the Central Rift have been used in making cases for inter-regional links. Other raw material types make up less than 5% of the total analysed artefacts within the Central Rift, while artefacts at Muguruk in the Lake Victoria Basin are almost 99% lava.

4.3.2 Artefact-based variables

These variables include those aimed at ordering the artefacts in a hierarchy that reflects typological relations. They also include those specific to the measurements of linear and weight attributes. Artefact ordering or hierarchy variables include: (i) general category of artefacts, and (ii) artefact category subtypes, while linear and weight attributes include (iii) dimensions – length, width, maximum width and thickness, (iv) platform dimensions – length, width and thickness, (v) core maximum dimension, and (vi) core weight. The significance and differences between the artefact order variables are explained below.

(i) General category

This was mainly a typological ordering of the artefacts analysed. The five main categories included cores, tools, flakes, blades and general waste/debitage. Typological descriptions are important in classifying assemblages and in making inter-assemblage comparisons using frequency distribution charts of various artefact types. This involves use of detailed typological data and analysis. For this work, however, emphasis was put on the technological features in the various assemblages in order to explore the organization of lithic technology during the MSA. This involved an examination of the general morphology of artefacts and their dimensional attributes, as well as other elements of both quantitative and qualitative attributes. These indicate how each artefact was produced as well as its position in the reduction sequence.

The typology devised by Merrick (1975) was used in this classificatory framework. The adoption of this existing typological system made possible the comparison of the assemblages, some of which were previously studied using the same typological system (Merrick 1975). Artefacts examined were put into their respective categories using this typology whenever possible. This became necessary particularly in the hierarchical sorting of artefacts into general categories, tool types, and tool subtypes as explained below.

(ii) Artefact category subtypes

This variable divided the main artefact types into smaller groups. For example, tools were divided into types such as scrapers, points and so on. Subtype categories further divided individual tool categories into subtypes. Scrapers, for example, were divided into the various types of scraper forms present in the assemblage. Categories that were unidentified in the typology were included under new created categories. Some of the added categories included core fragments and notched side scrapers.

(iii) Dimensions – length, width, maximum width and thickness

Data on artefact dimensions were taken for all measurable categories of flakes and tools. Digital calipers were used in this exercise, and measurements taken in millimetres.

Length was measured as the longest line from the striking platform to the end of a flake or tool. Where no striking platform was visible, as was the case with artefacts bearing crushed platforms, length was measured as the longest part of the artefact parallel to the edge. Width was measured at the midpoint perpendicular to the line forming the length, while maximum width was measured at the widest visible part of the artefact also perpendicular to the line forming the length of the artefact. Lastly, thickness was taken at the thickest part of the artefact from the ventral to the dorsal surface; but not at the point containing the bulb.

These measurements are significant in exploring flake size and shape. Size distribution patterns indicate the type and amount of both reduction and sharpening undertaken by the artisans (Shott 1994:71). Such distributions are normally different for different reduction processes (Patterson 1990). Size distribution may also reflect disturbances and transport of materials either from or to the site. An assemblage consisting mainly of larger pieces of artefacts with no smaller ones could indicate grading of materials by water action sweeping away smaller and lighter materials (Schick 1986).

Overall, dimensional attributes help establish what stages of core reduction are represented in the assemblage. Stage-one reduction produces large flakes with distinct cortical cover and few or no dorsal scars. Further reduction in the sequence to produce, for example, standardized artefact types usually involves trimming of pieces; and therefore results in the production of smaller pieces. Dimensional attributes of such smaller pieces in terms of both waste and desired products are helpful in determining the level of standardization in assemblages. Comparing ratios of such dimensions aids in exploring the question of whether shapes and sizes approach a standard form. This information may then be used to establish the level to which standardized lithic technology was put to use.

(iv) Platform dimensions – Length, width and thickness

Platform length defined the largest dimension found on an artefact's striking platform area. Width was measured perpendicular to length, while thickness measured the dimension perpendicular to both length and width. These measurements were taken in millimetres.

(v) Core maximum dimension and core weight

These variables were used to establish core sizes. Cores come in different shapes, a feature which makes consistent dimensional measurements for size calculation almost impossible. Core maximum dimension defined the longest dimensional measurement on cores. A combination of this measurement taken in millimetres, and core weight taken in grams gives an estimate of core size useful in comparing cores. Andrefsky (1998:138-140) explains that this method of multiplying the two values provides a means of ranking the cores in terms of sizes.

Assessment of size becomes important in exploring behavioural activities leading to the discard of cores recoverable in archaeological sites. Does the size correspond to raw material nature and size, or is it a product of technological manoeuvres by the hominids; for example, reducing a core to its smallest possible state as dictated by the value of the raw material at hand?

4.3.3 Qualitative and other variables

Data on (i) abrasion, (ii) cortex, (iii) platform facets, (iv) scar pattern, (v) plan form, (vi) retouch angle, area and intensity, and (vii) blank form were collected.

(i) Abrasion

This is a measure of how weathered an artefact is. It was used to assess whether artefacts were disturbed and transported from their original contexts, or if they were recovered from their original positions of discard. Fresh flakes and tools show sharp edges and shiny surfaces. Where patination occurred on the surface of artefacts due to the condition of the matrix, uniformity is clearly exhibited on the artefact surface. Worn out pieces, on the other hand, show dulled edges and surfaces as a result of movement and contact with other materials. Abrasion marks may also be identified as striations or haphazard lines on artefact surfaces, especially cores that have no edges that can be examined.

(ii) Cortex

A measure of cortex (the natural, weathered, exterior surface of the rock, as opposed to an interior or flaked surface, [Addington 1986:104]) on flakes is important in establishing at what reduction stage a flake was detached from the core. It may also indicate whether or not tool production took place at the site or not. Many cortical flakes at a site may indicate initial core reduction, while less or non-cortical flakes may imply tool production.

Coding schemes such as Toth numbers (Toth 1982:73-75) have been used in the past, where each flake is assigned a number based on the amount of cortex. Toth's Type I refers to a flake with a totally cortical dorsal surface, indicating that it is the first to come from a core. Type II is partially cortical on the dorsal surface, so are possibly second in the reduction of the core. Type III flakes contain cortex on the butt section but none on the dorsal surface. These may result from removing a flake from the ventral surface of a flake having cortex on the dorsal surface, with the cortical part becoming the butt of the flake. Type IV is defined as having no cortex on the butt but completely cortical on the dorsal surface. This type is the first to come from the second face of a cobble in a bifacial flaking. It may also come from the beginning of unifacial trimming of a flake with cortical dorsal surface, with flakes being removed from the dorsal surface. Type V is mainly non-cortical at the butt but partially cortical on the dorsal surface. This may come from bifacial flaking or unifacial working of a flake with cortical dorsal surface. Type VI is completely non-cortical, and represents later stages of reduction when pieces being reduced have no cortex on them. Type VII defines all other flakes that cannot fit in the other categories of flake categorisation.

Toth (1982) used the numbers to define the hierarchical position within the reduction trajectory that the particular flake occupies. This exercise requires that materials being analyzed be subjected to controls that ensure complete recovery and proper post-excavation processing of materials. Use of such codes was therefore not possible in this work, as most of the flakes analyzed lacked records of such controls, and have suffered a significant amount of mix-up over the years since their recovery. A simple method of determining whether or not there was cortex on flakes was therefore adopted to categorize all the flakes analyzed. This was used alongside other variables such as length, width, thickness and nature of platforms to understand technological stages and patterns represented by the assemblages.

(iii) Platform facets and (iv) Scar patterns

Each flake and tool was examined for platform scars or facets, and the pattern of scars on the dorsal surface. Cortical or plain platforms, just like cortical flakes, indicate initial stages of core reduction, while heavily faceted platforms indicate tool production, with the facets showing trimming work before the striking of flakes. The facets may therefore, also indicate at what stage a piece was removed, and what reduction technique was used to produce it. Facetted platforms therefore mean use of Levallois technology. A large number of facets indicate platform preparation in the removal of flakes during a reduction process. Such striking platform preparations provide evidence for prepared core technique used during the mid-late Pleistocene period. Other evidence for this technique are radial and parallel scars or facets on cores and flakes that characterize MSA assemblages. The difficulty, however, is how to determine the intentions, behavioural or otherwise, that led to the creation of such facets and patterns besides technological factors.

(v) Retouch angle, area and intensity

These variables were applied to sampled tool categories to understand the nature and preference of retouch on tools. However, since the number of tools examined was small, behavioural and technological patterns were established from these variables alongside a combination of other variables. Angle measurements were also, at times, estimated and recorded as less than 50°, between 50° and 90° and greater than 90°.

Retouch area refers to the edge or area at which a tool was retouched. Such areas could be at the end (for example, end scrapers) or at the sides (side scrapers), and therefore located at the distal, proximal or either of the two lateral sides. Retouch intensity, on the other hand, refers to amount of retouch on a tool. This was qualitatively recorded as light – shallow and discontinuous retouch on a specific edge; normal– continuous and moderately invasive; heavy – steep and invasive; and lastly, stepped– heavy retouch with stacked retouch scars. Some of these kinds of retouch may indicate repeated re-sharpening of tools, and therefore reflect behavioural patterns such as curation of tools and recycling of used tools.

(vi) Blank form

Blank form refers to the basic shape of a flake. This variable was used to establish whether there were different kinds of reduction techniques. Apart from blank forms having the potential of indicating certain kinds of technologies, they also tend to be geographically and temporally specific; and may therefore reflect regional differences, interactions and changes over time. The categories used here were angular, flake-blade, blade, point and normal. Angular pieces are identified by their high exterior ridges. Flake-blades (a term commonly used in for sites like Klasies River in South Africa) have lengths more than twice their widths, while blades also fit this definition but are distinguished by their parallel flake-scars on the dorsal surface. Points have edges that converge into a point from a distinct butt end, a feature that helps distinguish them from convergent scrapers. All other pieces not falling into the above categories were coded as normal.

In summary, variables contained in 4.3.1, 4.3.2 and 4.3.3 above were used in appropriate combinations to obtain information on the following:

(i) Nature and condition of sites;

(ii) Stages of lithic reduction;

(iii) Movement of lithic materials;

(iv) Types of reduction strategies applied during the manufacture of the artefacts;

(v) Raw material procurement and the general environmental exploitation patterns.

This body of information contains behavioural activities useful in exploring the question of modern human behaviour during the MSA.

Chapter 5: Assemblage variability and technological patterns

> *In technology, the MSA saw significant advances. The basic stone tool making was no longer a matter of knocking flakes off a core... Instead, the more complex technique of preparing the core by precise flaking to a required shape and size, and then finally striking off the finished tool came increasingly into use. (Sutton 1981:473)*

5.1 Background

The earliest stone tools appear in the archaeological record about 2.6 to 2.4 million years ago (Harris 1983). These consist of simple modified stones that characterize the Oldowan (Plummer 2005). The Oldowan was a simple technology lasting to about 1.6 million years ago. Cores were struck to produce sharp cutting edges or sharp-edged flakes that were used in processing both plant and animal food resources. The industry is characterized by (i) a limited number of artefact types, consisting mainly of flaked pieces (spheroids, choppers, or chopping tools) and detached pieces (flakes and scrapers), and (ii) similarity of artefacts across sites. Developed Oldowan Industries A, B, and C; the Karari Industry, and then the Acheulian Industry (Harris and Isaac 1976; Isaac 1984; Leakey 1971) followed the Oldowan. The assemblages belonging to Developed Oldowan Industries are technologically similar to those of the earlier Oldowan; but add a few more types to the basic Oldowan, with emphasis on battered pieces, mainly the spheroids and other larger pieces such as proto-bifaces as defined by M.D. Leakey (1971:5).

> These tools are intermediate between a biface and a chopper. They are generally bifacially flaked along both lateral edges as well as at the tip. The butts are thick and are often formed by the cortex surface of the cobblestone. Some specimens are high backed with a flat under surface and others are biconvex or lenticular in cross-section. The edges are jagged as in choppers and are often utilised.

The Karari Industry, on the other hand, contains new artefact types (for example, Karari scrapers) made on large flakes, while the Acheulian Industry contains new forms such as the handaxes, which are large bifacial implements of either pointed or ovate planform, and cleavers defined as bifacially flaked artefacts with a straight, sharp-edged bit on one end (Harris and Isaac 1976; Isaac and Harris 1997; Schick and Toth 1988:241).

Even though there were technological improvements within the Acheulian period starting around 1.4 my ago (Asfaw *et al.* 1992), the trend of limited artefact types and similarity of artefacts in different sites continued. The Acheulian techno-complex lasted longer, with little innovation until towards the end, when some of the lithic reduction techniques such as Levallois methods used during the MSA seem to have been present. This scenario led to the lumping of the period since the first appearance of tools to the Acheulian period, generally known as the Early Stone Age, into one cultural or behavioural category. Technologically, tool production represented a least-effort method of producing flakes using hard hammer or bipolar techniques (Toth 1985) in a simple behavioural pattern.

As discussed in Section 3.4, the MSA that came after the Acheulian indicates technological advancement characterized by regionally restricted variability within Africa as well as differences between (inter-assemblage) and within (intra-assemblage) assemblages. While multiple factors may cause such variation across and within assemblages, hominid behaviour may have had a major role in order to create suitable adaptive strategies in different environments. The behavioural patterns developed from this period onwards, however, seem to go beyond the mere necessity of survival strategies, to include social identities and networks as well as attempts to adapt to all environments. Such patterns are lacking in the Early Stone Age but are clearly present in LSA assemblages (Klein 1992). This has been attributed to the absence and presence of modern human behaviour in the Early Stone Age and LSA respectively. The presence of such patterns in the MSA remains under investigation.

This chapter presents a description of assemblages analyzed from the five MSA sites described in Section 4.1. Some of the samples, especially from Muguruk, Cartwright's Farm, and Prolonged Drift, are small when broken down to artefact categories; and may provide unreliable statistical results in the comparisons presented below. While this is a problem that could be solved by collecting and analysing more samples from these sites, resources and time available for this study, unfortunately, could only allow the use of the material presented here. The technological patterns revealed in this study will therefore form the starting point for detailed future investigations in which larger samples would be examined. For now, however, the samples provide technological patterns and trends that reflect the general picture in the assemblages. Materials are presented to reveal the nature of variation in order to explore causes of such variation, and also to examine technological patterns present in the assemblages. To realize these objectives, the following steps were taken:

i) Examination of cores, flakes, and a limited number of tools to explore the range of variation in artefact morphology and technology;

ii) Description of these artefact categories in both quantitative and qualitative terms;

iii) A consideration of other factors such as the environmental conditions within which these assemblages were created, and an assessment of whether this played a role in variations between assemblages or in creating particular technological patterns.

The aim of the analysis was to compare the assemblages and to identify any existing behavioural and environmental factors leading to MSA variability. The specific aims of the artefact analyses were: (a) to reconstruct and describe the technological system within which the assemblages were created, identifying any distinct technological patterns; and (b) to use the identified patterns within the wider technological system to explore the question of hominid behaviour. The implications of such behaviour would then be used to assess the degree to which middle to late Pleistocene MSA cultures in East Africa fit the model of behavioural modernity.

5.2 Quantitative and Qualitative Analysis

5.2.1 Raw material analysis

Most of the artefacts in the study sample are made of obsidian, which is a volcanic glass abundant in the Central Rift Valley region, as indicated by the many sources identified by Merrick and Brown (1984:132-135 figure 1 and 2).). Sources correspond to specific petrological groups, which define classes of obsidian having similar mineralogical and chemical composition, mainly using Fe, Ca, and Ti. These are numbered as referenced in Tables 5.2 and 5.3, which refer to classes identified at sites in Kenya and northern Tanzania. Artefacts made on other materials such as quartz, quartzite, and other volcanics appear only in small traces within these assemblages.

A breakdown of raw materials in the sample is presented in Table 5.1. At Prospect Farm, 95.3% of the sample assemblage is obsidian, while only 4.4% is other kinds of volcanic rocks. Other materials account for less than 1%. Sources for the obsidian used are located at distances ranging between 15 km and over 75 km away (Table 5.2), implying use of exotic materials. Soffer (1988:201) defines exotic as any archaeological, especially lithic, materials originating at distances of more than 30 km from the site where they are found. Most researchers, who have examined the movement of raw materials, especially obsidian in the East African region (Merrick and Brown 1984; Ambrose 2001), however, have tended to use the 40 to 50 km mark to define what "exotic" means. At Enkapune Ya Muto, 97.3% of the sample assemblage is obsidian, about 2% is quartz, while the remainder (about 1%) are other materials. Obsidian used here comes from sources located between 15 km to 70 km, distributed within the Lake Naivasha basin (Ambrose 2001:24, figure 1). Quartz and chert found here are non-local, and may have come from 65 km away (Ambrose 2001:31). At Prolonged Drift, all of the artefacts in the sample assemblage are obsidian. These were obtained from Sonanchi, Njorowa Gorge, Upper Eburru, and Masai Gorge, some 40, 50, 33, and 30 km away respectively (Table 5.3). Other sources between the main ones may also have been utilised, but investigation into this possibility has not yet been done. The Cartwright's Farm sample assemblage is about 94% obsidian, 6% chert, and less than 1% quartz. Obsidian came from distances ranging from 5 km to 40 km away (Merrick and Brown 1994). Other materials such as quartz and quartzite may have come from equally distant places; and again, this possibility needs to be investigated. At Muguruk, 96% of the sample assemblage is ombo phonolite (a basalt) while 4% is quartz. Other materials used at the site, according to earlier researchers (Merrick and Brown 1984; McBrearty 1986), include obsidian from the Central Rift Valley sources of Sonanchi (190 km away) and

Mt. Eburru (185 km away); and quartz and Kisumu phonolite from the adjacent hilly areas (less than 10 km away).

These results show that over 92% of the artefacts in all assemblages are made of obsidian that may have been obtained from any of the obsidian source localities identified by Merrick and Brown (1984) within the Lake Nakuru-Elmenteita and Naivasha basins. Artefacts made of quartz, quartzite, and other volcanics comprise only a small percentage of these MSA assemblages. The disparity within the Central Rift in terms of the use of obsidian versus other raw material types implies hominid exploitation of the abundant raw material – obsidian – while at the same time expanding raw material base by exploiting or experimenting with other scarce raw materials. Obsidian may also have been preferred over the other materials, such as other volcanics, due to its superior qualities for producing sharp edges and fine retouch.

Only about 6% of the study sample consists of other volcanic artefacts. This represents materials from Muguruk within the Lake Victoria Basin. The Central Rift Valley sites (assemblages) contain mainly obsidian artefacts, while Lake Victoria Basin assemblages represented by Muguruk materials are mainly dominated by artefacts made of other volcanic rocks, especially ombo phonolite. This is the abundant raw material, and may have been selected by the hominids for this reason. Overall, the analysed artefacts are mostly made on obsidian, with other volcanics coming a distant second.

Dominance of obsidian in the Central Rift and lava in the Lake Victoria basin gives a picture of reliance on local raw materials for artefact manufacture. While most of the raw materials were local and came from distances less than 50 km away, earlier studies (Merrick *et al.* 1994) show that these assemblages also contain non-local or exotic materials. Tables 2.5, 5.2 and 5.3 indicate that hominids used both local and exotic raw materials at these sites and within the two regions. Most of the obsidian used at Prospect Farm, Enkapune Ya Muto, Prolonged Drift, and Cartwright's Farm come from an average distance of 50 to 60 km away (Merrick and Brown 1984). These distances can be considered greater than a day's walk, if a round trip was to be taken in the African tropical heat environment. But where direct sourcing was not done, there is a possibility of "down-the-line" trade or exchange patterns (Renfrew and Bahn 2000:368, 369) where raw materials such as obsidian moved between the sites by being passed along by middle men or groups. If this pattern existed, then we have indications of exchange and/or trade, and it may also reflect the presence of specific groups (ethnic?) that are characteristic of behavioural modernity.

Transport of raw materials from distant sources may indicate hominid intention to use high-quality materials for controlled artefact manufacture or for specialized artefact forms. Thus technological requirements and other factors may have led to the transportation of obsidian from the Central Rift to Muguruk, a distance of 190 km (McBrearty 1986), and to the northern Tanzanian sites over 200 km away. These could have been done through "down-the-line" exchange and/or trade discussed above, and represent a strong indication of group interaction that could be the beginnings of social relationships and/or trade networks during the MSA period.

Selection and importation of raw materials was important throughout the East African region. The distribution of local and exotic materials would reflect hominid preferences for either of these categories. Temporary (hunting) sites occupied for short duration would have more exotic materials brought in by residents to perform particular tasks or as part of curation of tools during mobility. The MSA assemblage at Prolonged Drift contains a significant amount of exotic material relative to local ones, and is thought to have been a temporary hunting camp. Prospect Farm and Muguruk, on the other hand, contain a higher proportion of local compared to exotic materials (Kelly 1996).

5.2.2 Typological Analysis

(i) Characteristics of the Assemblages

An examination of the study sample indicates that three classes of artefacts dominate the assemblages: cores, flakes (whole flakes, utilized flakes and flake fragments), and flake tools of various forms (both retouched and/or Levallois). Table 5.4 presents a comparison of these classes in frequency distributions by site. Prospect Farm provided the highest number of artefacts (n = 1,672, 52%) analysed. These included cores (n = 311), retouched pieces (n = 380), flakes and blades (n = 902) and general waste (n = 79). Enkapune Ya Muto (n = 783, 24.3%) is second, while Prolonged Drift (n = 404, 12.6%), Cartwright's Farm (n = 238, 7.4%) and Muguruk (n = 121, 3.8%) follow in a descending order of quantity per site. While this distribution may imply that test results could be influenced by the large number of artefacts from Prospect Farm, it should be noted that artefacts were examined not in terms of quantity but the technological attributes associated with the pieces available at each site.

On the basis of these distributions, which indicate the dominance of flakes across the assemblages, the five samples show the characteristics of a flake tradition comprised of flakes and flake tools. However, the dominance of flakes may also reflect a sampling bias, as the study concentrated on the technological features of whole flakes and flake fragments. Therefore, to ascertain the preponderance of flakes in these assemblages,

Raw Material	SITE															Total	
	Prospect Farm			Enkapune Ya Muto			Prolonged Drift			Cartwright's Farm			Muguruk				
	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %
Obsidian	1593	95.3	53.4	762	97.3	25.6	404	100.0	13.5	223	93.7	7.5	-	-	-	2982	92.7
Quartz	2	0.1	9.5	12	1.5	57.1	-	-	-	2	0.8	9.5	5	4.1	23.8	21	0.7
Quartzite	-	-	-	2	0.3	100.0	-	-	-	-	-	-	-	-	-	2	0.1
Chert/ Flint	-	-	-	6	0.8	31.6	-	-	-	13	5.5	68.4	-	-	-	19	0.6
Lava	74	4.4	38.9	-	-	-	-	-	-	-	-	-	116	95.9	61.1	190	5.6
OMR	1	0.1	50.0	1	0.1	50.0	-	-	-	-	-	-	-	-	-	2	0.1
OSR	2	0.1	100.0	-	-	-	-	-	-	-	-	-	-	-	-	2	0.1
Total	**1672**	**100.0**	**52.0**	**783**	**100.0**	**24.3**	**404**	**100.0**	**12.6**	**238**	**100.0**	**7.4**	**121**	**100.0**	**3.8**	**3218**	**100.0**

Table 5.1 Raw material of MSA sample assemblage as distributed across sites. OMR = other metamorphic rocks, OSR = other sedimentary rocks.

Source	**Petrologic Group♣**	**Prospect Farm**			
		Spit 22–23	Spit 16–18	Spit 9–10	
		n	**n**	**n**	**Distance (km)**
Kisanana	8	2	1	1	75
Sonanchi	19			56	30
Njorowa Gorge	20/25	2	25	1	40
Oserian 2	21	1			40
Kinangop	24	2	6	1	30
Cedar H. Opuru	27/35	10		1	10
Upper Eburru	29/31/40	5	24	9	15
Masai Gorge	30/32	10	49	24	15
Ololerai	38		14		30
Unknown		34	17	22	
Total		**116**	**136**	**115**	

Table 5.2 Source and distance of some obsidian used at Prospect Farm (Modified from Merrick and Brown 1994). ♣ = a class of rocks having similar mineralogical and chemical composition (as in petrology), column numbers refer to classes identified by Merrick and Brown (1994) at sites in Kenya and northern Tanzania.

Source	Petrologic Group♣	Muguruk		Songhor		Mumba Hôhle		Nasera		Lukenya Hill			Prolonged Drift		Cartwright's Farm		Wetherell's	
										X1*	X2*							
		n	km	*n*	km	*n*	km	*n*	km	*n*	*n*	km	*n*	km	*n*	km	*n*	km
Kisanana	8																	
Highlands	12									26	15	6					1	45
Kedong'	14									8	3	65						
Sonanchi	19	1	190					6	230	3	-	125	41	40			5	38
Njorowa Gorge	20/25			1	145	14	305			3	23	105	45	50	20	35	11	24
Oserian 2	21									1	1	115						
Kinangop	24									-	1	125			2	5	3	12
Cedar H/Opuru	27/35									-	1	135					1	35
Upper Eburru	29/31/40	1	185					1	240	3	1	130	+	33			5	34
Masai Gorge	30/32							2	240	5	2	135	4	30	28	16	16	25
Unknown													6					
Total		**2**		**1**		**14**		**9**		**49**	**47**		**96**		**50**		**47**	

Table 5.3 Raw material (Obsidian) sources and movement within the Central Rift Valley, Southern Kenya, Lake Victoria Basin and Northern Tanzania regions of East Africa. X1* = Lukenya Hill 98.10 – 97.90 and X2* = Lukenya Hill 98.50 – 98.45. ♣ = a class of rocks having similar mineralogical and chemical composition (as in petrology), column numbers refer to classes identified by Merrick and Brown (1994) at sites in Kenya and northern Tanzania.

information must be obtained from other pointers such as the tool categories to verify if these are made on flakes.

Table 5.4 indicates that frequency distribution of artefact classes varies from site to site or assemblage to assemblage. Prospect Farm contains the highest number in all the categories. This may be attributed to size of the site as well as a long period of occupation leading to accumulation of large quantities of artefacts that have also influenced the amount of artefacts sampled in this study. Lower artefact frequencies for Muguruk, on the other, hand are purely due to sampling and logistical problems faced during this study, as discussed in Section 4.2.

The high number of cores, flakes, and general debitage at Prospect Farm, Enkapune Ya Muto and Muguruk suggests that core reduction and artefact manufacture took place at the sites. The graded nature of flakes and flake debris, as discussed in Sections 5.2.4 and 6.3, shows that a significant amount of tool preparation and rejuvenation also occurred at these sites. Meanwhile, the conspicuous absence of cores in the Prolonged Drift sample in contrast to a relatively high numbers of flakes indicates a possible manufacture of artefacts elsewhere, with only stone blanks and tools being brought to this site, where secondary reduction was carried out. The Cartwright's Farm sample also contains only twelve cores. This low number could be attributed to sampling bias during material collection from the site; or these two sites may have been temporary camps where occupation was limited and periodic, with core reduction occurring elsewhere. Alternatively, since most of the obsidian raw materials used for artefact manufacture were imported or transported from long distances, reduction of cores was complete, with most of the cores being reduced to non-diagnostic fragments.

(ii) Artefact diversity

From the examination of artefact subtypes presented in Tables 5.5, 5.6 and 5.7, there appears to be a significant diversity in this group of assemblages. Diversity is used here loosely to refer to a collection in which the individual types represent many classes relative to one where individual types represent only a limited number or a few classes. The classification scheme used is that developed by Merrick (1975) previously used for the analysis of East African MSA and LSA assemblages. Each artefact type or subtype is both morphologically and technologically distinct, and defines a limited range of functions performed during its life-span. The number of types defining the richness of the assemblages, and their relative proportion, defining their evenness or how they are spread out mirrors the number of activities and their relative frequency during prehistoric time.

While it is beyond the scope of the current study to establish the function of tools (as this would involve a completely new set of analysis such as lithic microwear), the typological breakdown of the artefacts into more than 25 subtypes reflects assemblage diversity in terms of richness (the number of types present in the entire collection containing the 3218 individuals). A simple measure of richness based on a direct count of types (MacArthur 1965; Williamson 1973) as observed in the assemblage may be applied here. This approach ignores assemblage characteristics as well as varying sample sizes (Bobrowsky and Ball 1989), and may be a starting point in the investigation and comparison of assemblages with unequal sample sizes.

Assemblages with more tool types are usually considered to be more diverse than those with fewer tool types. Distribution of tool sub-types (Table 5.7) indicates that the highest frequency is 14.9%, while the lowest is less than 1%, with all the other distributions falling between the two. These kinds of distribution, where percentage values are shared amongst many types almost evenly, indicate the assemblages are more diverse than when one type accounts for a greater proportion of the percentage distribution (Ambrose 1984).

Based on general observation, however, diversity is more pronounced in the Prospect Farm sample than in other sites. The same is expected for Muguruk, which is larger than Enkapune Ya Muto, Prolonged Drift and Cartwright's Farm. Both Prospect Farm and Muguruk are large sites which had fairly high intensity occupation, while Enkapune Ya Muto, Prolonged Drift and Cartwright's Farm are small-restricted areas although they each had equally high intensity occupations. Hypothetically, small areas with high intensity occupations show low artefact diversity (Ambrose 1984), while the opposite is true for larger sites. The distribution of individual types across the five assemblages (sites) is also unequal, reflecting lack of evenness (equal distribution of individuals across all types or similarity in abundance) in the sample assemblage. These differences in distributional characteristics may be attributed to unequal sample size between the five MSA assemblages.

Overall, the higher number of artefact types (diversity) reflects an increased number of activities for which different tools were required. It may also reflect environmental challenges the hominids faced, requiring them to manufacture more artefacts in order to cope with or adapt to the conditions under which they lived. Such challenges could have been the need to exploit different environmental resources, and, therefore, the requirement for different types of artefacts, which in turn increased artefact diversity. Alternatively, diversity may reflect an established group of artisans whose duty

Artefact category	SITE															Total	
	Prospect Farm			Enkapune Ya Muto			Prolonged Drift			Cartwright's Farm			Muguruk				
	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %
Core	311	18.6	66.2	135	17.2	28.7	2	0.5	0.4	12	5.0	2.6	10	8.3	2.1	470	14.6
Tool	380	22.7	63.5	41	5.2	6.9	1	0.2	0.2	175	73.5	29.3	1	0.8	0.2	598	18.6
General debitage	79	4.7	80.6	4	0.5	4.1	2	0.5	2.0	13	5.5	13.3	-	-	-	98	3.0
Flake	886	53.0	43.7	601	76.8	29.7	399	98.8	19.7	30	12.6	1.5	110	90.9	5.4	2026	63.0
Blade	16	1.0	61.5	2	0.3	7.7	0	0	0	8	3.4	30.8	-	-	-	26	0.8
Total	**1672**	**100.0**	**52.0**	**783**	**100.0**	**24.3**	**404**	**100.0**	**12.6**	**238**	**100.0**	**7.4**	**121**	**100.0**	**3.8**	**3218**	**100.0**

Table 5.4 General artefact types by site for the entire MSA sample.

Core sub-types	SITE										Total	
	Prospect Farm		Enkapune Ya Muto		Prolonged Drift		Cartwright's Farm		Mugunruk			
	n	%	n	%	n	%	n	%	n	%	n	%
RDC	9	2.9	-	-	-	-	1	8.3	2	20.0	**12**	**2.6**
RCARD	45	14.5	6	4.4	-	-	1	8.3	3	30.0	**55**	**11.7**
RCAL	1	0.3	-	-	-	-	-	-	-	-	**1**	**0.2**
RSPPC[1]	17	5.5	5	3.7	0	0	2	16.7	-	-	**24**	**5.1**
RSPPC[2]	6	1.9	-	-	-	-	-	-	-	-	**6**	**1.3**
NRSPC	9	2.9	-	-	-	-	-	-	-	-	**9**	**1.9**
NRDPC	14	4.5	3	2.2	-	-	-	-	-	-	**17**	**3.6**
NRMPC	12	3.9	-	-	-	-	-	-	-	-	**12**	**2.6**
IC	95	30.5	20	14.8	2	100.0	4	33.3	4	40.0	**125**	**26.6**
CC	2	0.6	-	-	-	-	-	-	-	-	**2**	**0.4**
CF	101	32.5	101	74.8	-	-	4	33.3	1	10.0	**207**	**44.0**
Total	**311**	**100.0**	**135**	**100.0**	**2**	**100.0**	**12**	**100.0**	**10**	**100.0**	**470**	**100.0**

Table 5.5 Typological breakdown of core types in the sample assemblage. RDC = regular discoidal core, RCARD = regular core approaching radial discoidal core, RCAL = regular core approaching levallois core, RSPPC[1] = regular single platform prismatic core, RSPPC[2] = regular single platform pyramidal core, NRSPC = non regular single platform core, NRDPC = non regular double platform core, NRMPC = non regular multiple platform core, IC = irregular core, CC = casual core, CF = core fragments

Flake sub-types	SITE															Total	
	Prospect Farm			Enkapune Ya Muto			Prolonged Drift			Cartwright's Farm			Muguruk				
	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %
End-struck whole flake	325	36.7	71.7	39	6.5	8.6	21	5.3	4.6	14	46.7	3.1	54	49.1	11.9	453	22.4
Core-trimming whole flake	94	10.6	37.9	71	11.8	28.6	71	17.8	28.6	-	-	-	12	10.9	4.8	248	12.2
Trimming and re-sharpening whole flake	104	11.7	32.4	49	8.2	15.3	156	39.1	48.6	-	-	-	12	10.9	3.7	321	15.8
Flake fragments	114	12.9	51.6	70	11.6	31.7	24	6.0	10.9	11	36.7	5.0	2	1.8	0.9	221	10.9
Core-trimming flake fragments	113	12.8	26.2	244	40.6	56.6	56	14.0	13.0	-	-	-	18	16.4	4.2	431	21.3
Tool-trimming flake fragments	43	4.9	18.0	125	20.8	52.3	62	15.5	25.9	-	-	-	9	8.2	3.8	239	11.8
Side-struck whole flake	79	8.9	82.3	3	.5	3.1	8	2.0	8.3	3	10.0	3.1	3	2.7	3.1	96	4.7
Utilized flake	14	1.6	82.4	-	-	-	1	0.3	5.9	2	6.7	11.8	-	-	-	17	0.8
Total	**886**	**100.0**	**43.7**	**601**	**100.0**	**29.7**	**399**	**100.0**	**19.7**	**30**	**100.0**	**1.5**	**110**	**100.0**	**5.4**	**2026**	**100.0**

Table 5.6 Typological breakdown of whole flakes and flake fragments in the sample.

Tool sub-types	SITE															Total	
	Prospect Farm			Enkapune Ya Muto			Prolonged Drift			Cartwright's Farm			Muguruk				
	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %
Single-sided scraper	46	12.1	80.7	6	14.6	10.5	-	-	-	4	2.3	7.0	1	100.0	1.8	57	9.5
Double-sided scraper	17	4.5	70.8	2	4.9	8.3	-	-	-	5	2.9	20.8	-	-	-	24	4.0
Racloir transverse scraper	3	0.8	60.0	-	-	-	-	-	-	2	1.1	40.0	-	-	-	5	0.8
Single-sided end and side scraper	4	1.1	57.1	-	-	-	-	-	-	3	1.7	42.9	-	-	-	7	1.2
Double-sided end and side scraper	-	-	-	1	2.4	33.3	-	-	-	2	1.1	66.7	-	-	-	3	0.5
Convex end scraper	21	5.5	84.0	2	4.9	8.0	-	-	-	2	1.1	8.0	-	-	-	25	4.2
double convex end scraper	4	1.1	80.0	-	-	-	-	-	-	1	0.6	20.0	-	-	-	5	0.8
Carinated end scraper	1	.3	50.0	1	2.4	50.0	-	-	-	-	-	-	-	-	-	2	0.3
Oblique end scraper	3	0.8	75.0	-	-	-	-	-	-	1	0.6	25.0	-	-	-	4	0.7

Table 5.7 Distribution of tool types in the MSA sample assemblages.

Table 5.7 continued.

Tool sub-types	SITE															Total	
	Prospect Farm			Enkapune Ya Muto			Prolonged Drift			Cartwright's Farm			Muguruk				
	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %
Small convex scraper	1	0.3	100.0	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2
Circular scraper	1	0.3	11.1	1	2.4	11.1	-	-	-	7	4.0	77.8	-	-	-	9	1.5
Disc-like convex scraper	10	2.6	55.6	-	-	-	-	-	-	8	4.6	44.4	-	-	-	18	3.0
Convex scraper	8	2.1	57.1	-	-	-	-	-	-	6	3.4	42.9	-	-	-	14	2.3
Concave and notched scraper	12	3.2	66.7	1	2.4	5.6	-	-	-	5	2.9	27.8	-	-	-	18	3.0
Notched side scraper	5	1.3	83.3	1	2.4	16.7	-	-	-	-	-	-	-	-	-	6	1.0
Convergent scraper	25	6.6	30.5	6	14.6	7.3	-	-	-	51	29.1	62.2	-	-	-	82	13.7
Steep core scraper	1	.3	33.3	-	-	-	-	-	-	2	1.1	66.7	-	-	-	3	0.5
Composite scraper	4	1.1	50.0	1	2.4	12.5	-	-	-	3	1.7	37.5	-	-	-	8	1.3
General scraper	3	0.8	60.0	1	2.4	20.0	-	-	-	1	0.6	20.0	-	-	-	5	0.8
Crescents	3	0.8	60.0	2	4.9	40.0	-	-	-	-	-	-	-	-	-	5	0.8
Pseudo-crescent	2	0.5	100.0	-	-	-	-	-	-	-	-	-	-	-	-	2	0.3

Table 5.7 Distribution of tool types in the MSA sample assemblages.

Table 5.7 continued

Tool sub-types	SITE															Total	
	Prospect Farm			Enkapune Ya Muto			Prolonged Drift			Cartwright's Farm			Muguruk				
	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %
Straight backed blade	21	5.5	91.3	-	-	-	-	-	-	2	1.1	8.7	-	-	-	23	3.8
Curved backed blade	4	1.1	50.0	-	-	-	-	-	-	4	2.3	50.0	-	-	-	8	1.3
Ortho truncated blades	-	-	-	-	-	-	-	-	-	1	0.6	100.0	-	-	-	1	0.2
Side and oblique truncated blades	-	-	-	-	-	-	-	-	-	1	0.6	100.0	-	-	-	1	0.2
Utilized flake-blade	29	7.6	87.9	-	-	-	1	100.0	3.0	3	1.7	9.1	-	-	-	33	5.5
Triangle	1	0.3	25.0	-	-	-	-	-	-	3	1.7	75.0	-	-	-	4	0.7
Trapeze	2	0.5	33.3	-	-	-	-	-	-	4	2.3	66.7	-	-	-	6	1.0
Micro percoir	21	5.5	65.6	8	19.5	25.0	-	-	-	3	1.7	9.4	-	-	-	32	5.4
Miscellaneous (DBM)	87	22.9	97.8	2	4.9	2.2	-	-	-	-	-	-	-	-	-	89	14.9
Curved backed microliths	3	0.8	100.0	-	-	-	-	-	-	-	-	-	-	-	-	3	0.5
Other backed microliths	9	2.4	56.3	3	7.3	18.8	-	-	-	4	2.3	25.0	-	-	-	16	2.7
Unifacial point	22	5.8	31.9	3	7.3	4.3	-	-	-	44	25.1	63.8	-	-	-	69	11.5
Bifacial point	7	1.8	70.0	-	-	-	-	-	0	3	1.7	30.0	-	-	-	10	1.7
Total	**380**	**100.0**	**63.5**	**41**	**100.0**	**6.9**	**1**	**100.0**	**0.2**	**175**	**100.0**	**29.3**	**1**	**100.0**	**0.2**	**598**	**100.0**

Table 5.7 Distribution of tool types in the MSA sample assemblages.

and responsibility was to supply the society with the required tools. Using the analogy of a modern industrial set up, such specialised groups normally produce goods en-masse, with higher chances of innovation and diversification. The answers to some of these questions may only be known after future research in how artefacts were used at these sites.

5.2.3 Analysis of cores

A core is a mass of homogeneous lithic material that has had flakes removed from its surface (Andrefsky 1998:12). In archaeological assemblages, cores form the category of pieces with angular multifaceted surfaces indicating purposeful striking and removal of flakes. They generally form the nucleus of lithic materials remaining after the removal of flakes (Crabtree 1972); and come in a great variety of forms and sizes, which correspond to the varied nature of naturally occurring stones and also the extremely variable efforts in shaping them to obtain the desired detached pieces. A number of specimens in the assemblages have been classified as cores and core fragments.

Table 5.4 presents frequencies of cores per site relative to other artefact forms, and also shows that majority of the cores and core fragments come from the Prospect Farm assemblage (n = 311), with Enkapune Ya Muto (n = 135) coming second. Other assemblages, Prolonged Drift (n = 2), Cartwright's Farm (n = 12), and Muguruk (n = 10), register low counts of the total cores sampled and analysed. The distribution of core types per site is shown in Table 5.5. Pictorial examples are shown in Figures 5.6 to 5.9.

Core fragments dominate the core category with a frequency of 44%. These pieces represent the by-products of artificial fracture, and exhibit angular shapes often with two or three sharp fresh edges and flake-scar patterns on two or more surfaces. Flake scar patterns are multifaceted, and indicate removal of flakes prior to fragment removal from the objective piece. The presence of these pieces in a significant quantity, especially at Prospect Farm where the core category contains about 32.5% of core fragments, is a possible indication of either (i) initial stages of reduction, and/or (ii) complete reduction, or exhaustive use of raw materials at these sites. In most cases, for example, in Merrick's (Merrick 1975) typology, this category is merged with irregular cores, providing information on the nature of flake removal from cores. In this work, however, these large numbers of flaking products have been given their own classification.

Both formal and non-formal cores were exploited (Table 5.5). Most of the formal cores were prepared prior to the removal of flakes. These include radial discoidal cores, regular cores approaching discoidal and Levallois cores, single platform prismatic, and pyramidal cores. Most of these reflect the characteristics of the classical Mousterian disc cores and prepared core forms as described by Bordes (1961). Some of the discoidal cores are not flaked all round to form radial cores, and are therefore classified as approaching discoidal cores. Similarly, some of the cores do not exhibit complete preparation of the striking platform as is typical of Levallois cores, and are therefore classified as approaching Levallois cores. Both regular single-platform prismatic and pyramidal cores further underscore the use of formal core technology, either as a means of maximizing the cutting edge or controlling the size and shape of the detached pieces in these assemblages.

Non-regular cores in the assemblages exhibit no preparation characteristics, and indicate that flake removal was either unidirectional or multidirectional. The presence of irregular and casual cores further shows that opportunistic detachment of pieces was practiced alongside non-opportunistic practices that resulted in the use of Levallois core reduction technology. Non-regular double-platform cores, which comprise 3.6% of total cores, may also be interpreted as a means of maximizing raw material before being discarded. These cores are generally of different shapes, with some resembling angular shatter or core fragments discussed earlier.

The distribution of core types varies between sites. This distribution is partly due to sampling strategies applied in this work. Figures 5.1, 5.2 and 5.3 present results of quantitative data. Most of the cores are concentrated on the lower weight classes around 0-40 grams, while maximum dimensional measurements are concentrated between 20 and 60 mm with minimal spread on either side. Core size is mainly concentrated between 1,000 and 3,000 mm/g (measure of core maximum linear dimension in millimetres by core weight in grams = mm/g). This shows that most cores are generally small in size, and may be a reflection of the degree to which they were reduced before being discarded.

Figure 5.4 a-c is a comparison of mean values for core weight, maximum dimensions, and size respectively. Enkapune Ya Muto exhibits the smallest means of all the three measures, while Muguruk stands out with the largest means of the same measures. Prospect Farm, Prolonged Drift and Cartwright's Farm occupy the middle ground between the two extremes. The inter-site distributions may be attributed to site location and raw material for tool manufacture, or to sample bias. Enkapune Ya Muto, being a rockshelter, had most of the raw material brought in from elsewhere, especially in the form of flake blanks. Such valued materials were most likely used to the last possible piece, leading to the small nature of most of the core pieces recovered from this site. Table 5.5 indicates the presence of prepared cores in the form of regular cores approaching discoidal cores, and regular single-platform cores, as well as non-regular double-platform and irregular cores. These forms result from formal and informal core reduction techniques, which maximize the use of raw materials available, ensuring that they are exhausted before being discarded. Maximization was a priority at this site, given that raw material was transported from the Lake Naivasha Basin. The relatively high number of core fragments at this site may also have caused low mean values at Enkapune Ya Muto.

The moderate mean values for Prospect Farm and Cartwright's Farm are a result of the application of core reduction techniques, especially the Levallois core technology, relative to the abundant large objective pieces. Formal and informal technologies were carried out, as high-quality raw materials were found within the vicinity of these sites (Merrick *et al.* 1994; Andrefsky 1998; Waweru 2002). Obsidian nodules used as raw material objective pieces are abundant, even though exotic materials, similarly obsidian in nature, were also used at the sites as discussed earlier.

The high mean values for Muguruk reflects reduction preferences, abundant local raw material, and raw material type. While obsidian cores are common at Prospect Farm, Enkapune Ya Muto, Prolonged Drift and Cartwright's Farm sites, basalt of Ombo phonolite types is the major raw material at Muguruk. Obsidian has better flaking qualities that enabled cores to be reduced to the smallest possible pieces. Ombo phonolite, on the other hand, has relatively poor flaking qualities; and therefore could not be reduced to levels similar to obsidian pieces. This feature makes most cores at Muguruk relatively larger, and therefore results in larger mean values.

Apart from the examination and comparison of mean values, which show differences between the sites, analysis of variance was carried out to assess whether the differences between the sites, using core measurements, is significant. Table 5.8 shows the results of this analysis. F–values for core weight, core maximum dimensions, and core size are well above one (>1) at a significant level of less than .0005 ($p = .0005$), indicating a high degree of variation. This may be attributed to several factors including reduction procedures, size and quality of the objective pieces available as raw materials, raw material types, and whether such materials were local or exotic, as well as due to sample size differences between the sites.

Analysis of the combined group of all cores (including core fragments) and a separate group of core fragments alone, show that there is a significant variation between the sites when it comes to core weight, maximum dimension, and size. This is, however, not the case when individual assemblages are examined separately. Table 5.9 presents the results of analysis of variance for individual sites (assemblages) using the same variables. Only the Prospect Farm sample shows significant variation. The remaining sites indicate little variation of cores within the assemblages.

Core flake scar patterns were also examined for evidence of the ways in which flakes were removed. This exercise was carried out to obtain information on the techniques and strategies employed during the flake removal process, which in turn would allow for inferences on stone tool manufacture and possible uses to be made. The frequency distribution of the six patterns used in this exercise per site is presented in Table 5.10.

Two forms of Levallois reduction techniques were used to produce the assemblages. Lineal core reduction involved the preparation of a striking platform from which flakes were removed one at a time (Mellars 1996:64). This gave rise to simple and parallel flake removal patterns (scar patterns) observed on some cores. However, strict adherence to this technique seems not to have been observed. Flat surfaces on objective pieces were at times used as striking platforms without prior preparation, while adhering to the format of lineal reduction.

The recurrent core reduction technique (Mellars 1996:67) involved preparation of cores to remove several flakes before such cores were again shaped for further reduction. Strategies associated with this procedure gave rise to radial flake patterns observed on radial discoidal cores; and simple flake scar patterns on conical and prismatic cores, where removal was unidirectional. Strategies like direct freehand percussion were used to split objective pieces so that the split surface is used as a striking platform, with blows directed around the core margin, and flakes removed unidirectionally in the case of conical and prismatic cores. On the other hand, the cortex edge adjacent to the split surface was used to remove flakes while rotating around the cortex margin, with flakes being removed towards the center of the core. This perimeter to center (e.g., Figure 5.6) removal pattern was multidirectional, and is observable on radial discoidal cores.

Apart from these formal core reduction techniques and strategies, informal ones also seem to be present. Random, transverse and opposed platform patterns indicate that at times cores were reduced expediently without prior preparation. Variations in the application of expedient strategies exist, and seem to have been controlled largely by the shape and size of the nodules that were being reduced. At times a protruding end of a nodule or core was knocked off, or a single flake removed to produce a non-cortical surface from which other flakes were removed. This produced random and transverse scar patterns reflecting multidirectional reduction strategies common with most informal techniques. Even with formal techniques, strategies were sometimes abandoned and multidirectional strategies applied to get the last useable flakes before a core was discarded. Multidirectional strategy seems to have been common and useful in reducing blocky and angular chunks. Flat surfaces on such chunks formed ready striking platforms, from which several flakes were removed, leaving random or near random flake scars on the nucleus remaining (cores).

The presence of scar patterns indicating that flakes were removed from both or opposite ends of cores indicate the application of bipolar core reduction technique. The bipolar percussion strategy may have been used to reduce or maximize expended cores, flake-blanks and/or various forms of tools. Cores resulting from this strategy reflect opposing scar patterns due to use of the opposite ends of the core as striking platforms. Flakes from this strategy may show opposing platforms and/or crushed platforms and bulbs.

The reduction strategies discussed above appear to have led to the removal of a significant amount of cortical cover from most of the cores. Figure 5.5 shows that most of the cores, including core fragments, did not have cortex. The small number of cores with traces of cortex mainly comes from Prospect Farm. Levallois core reduction strategies applied at this site, in line with the larger raw material nodules, required less maximization of objective pieces, leading to more cortical cores in the assemblage.

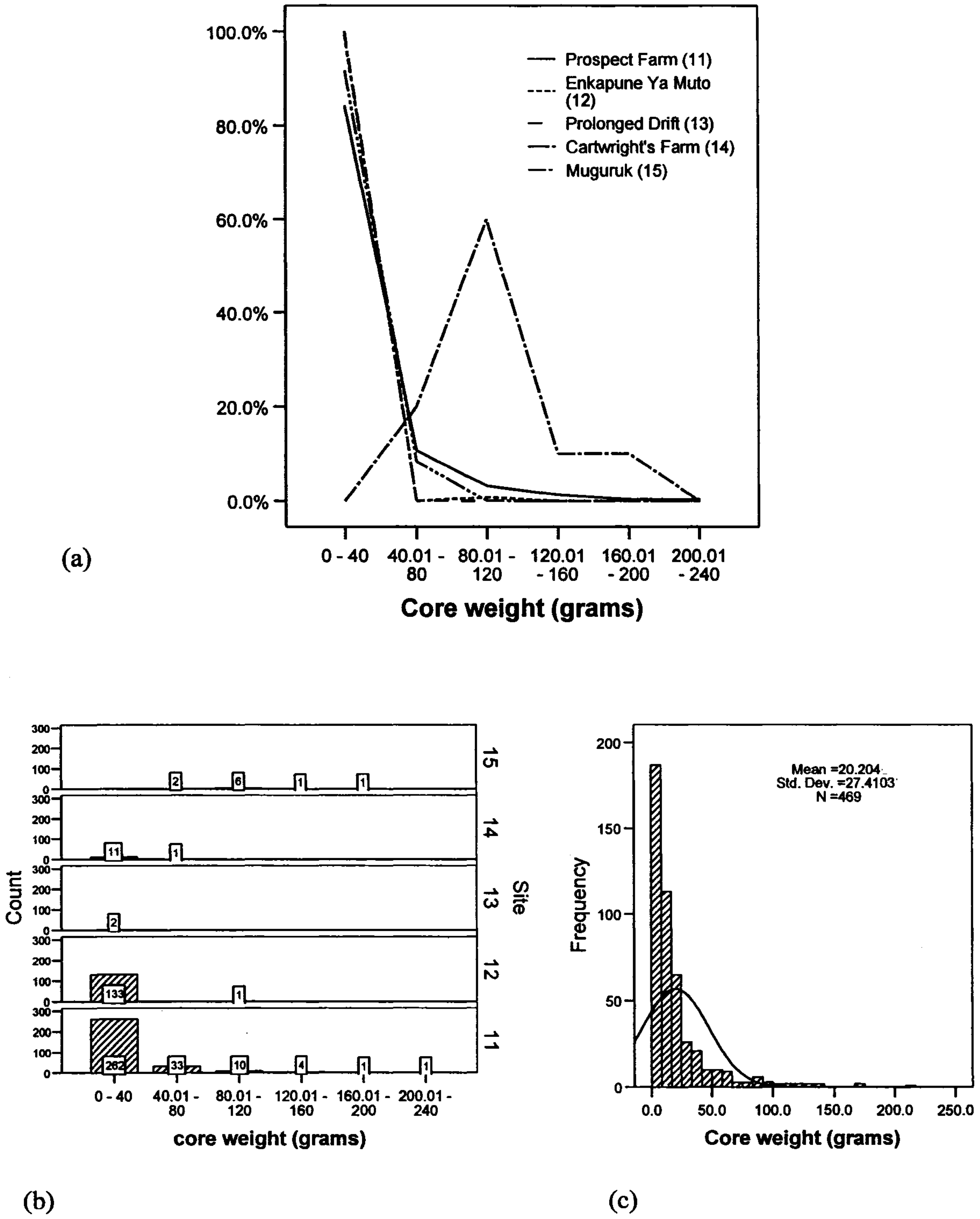


Figure 5.1 Core weight (a) Percentage frequency distribution, (b) distribution of counts within weight classes, and (c) nature of spread in the combined MSA sample assemblage.

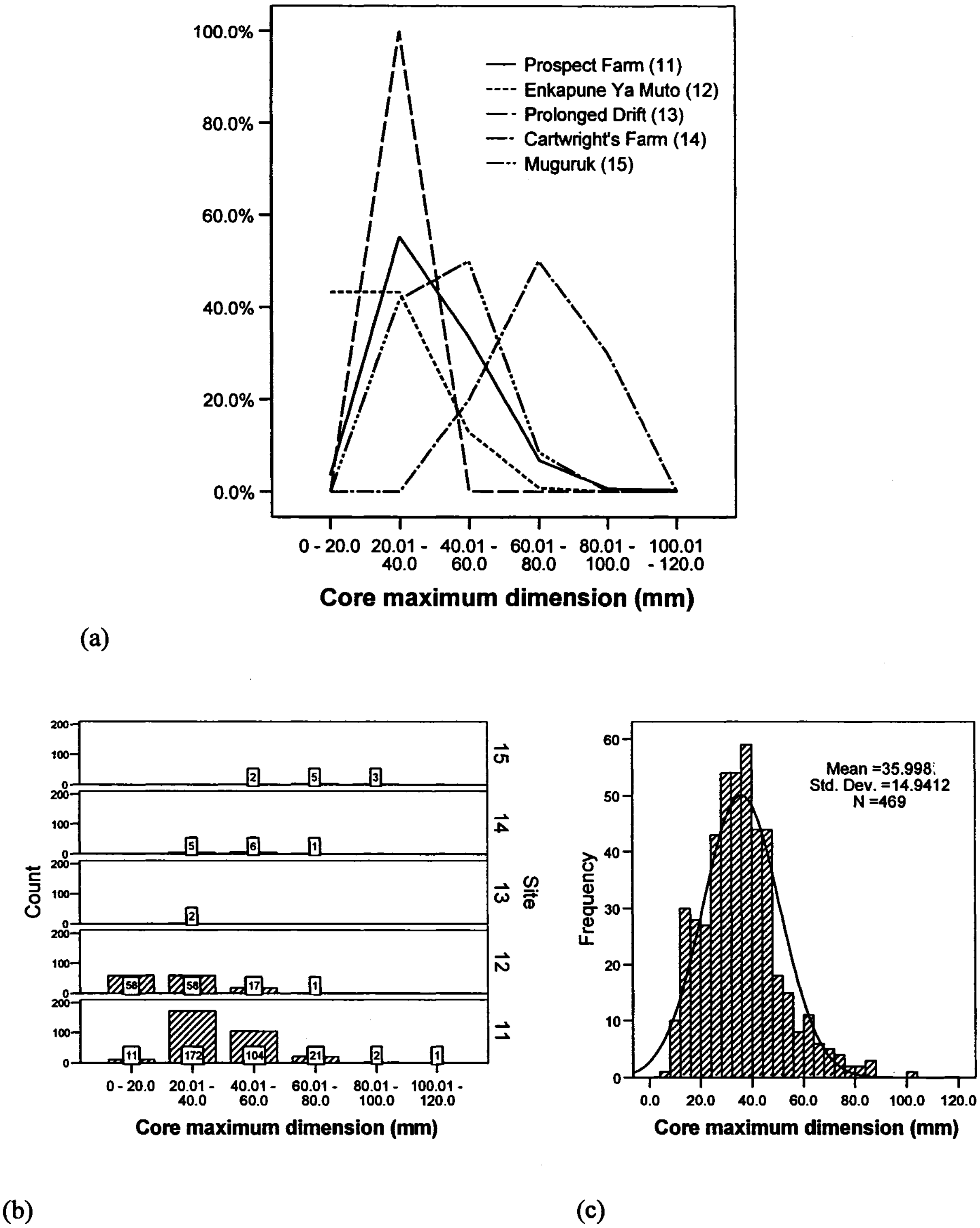
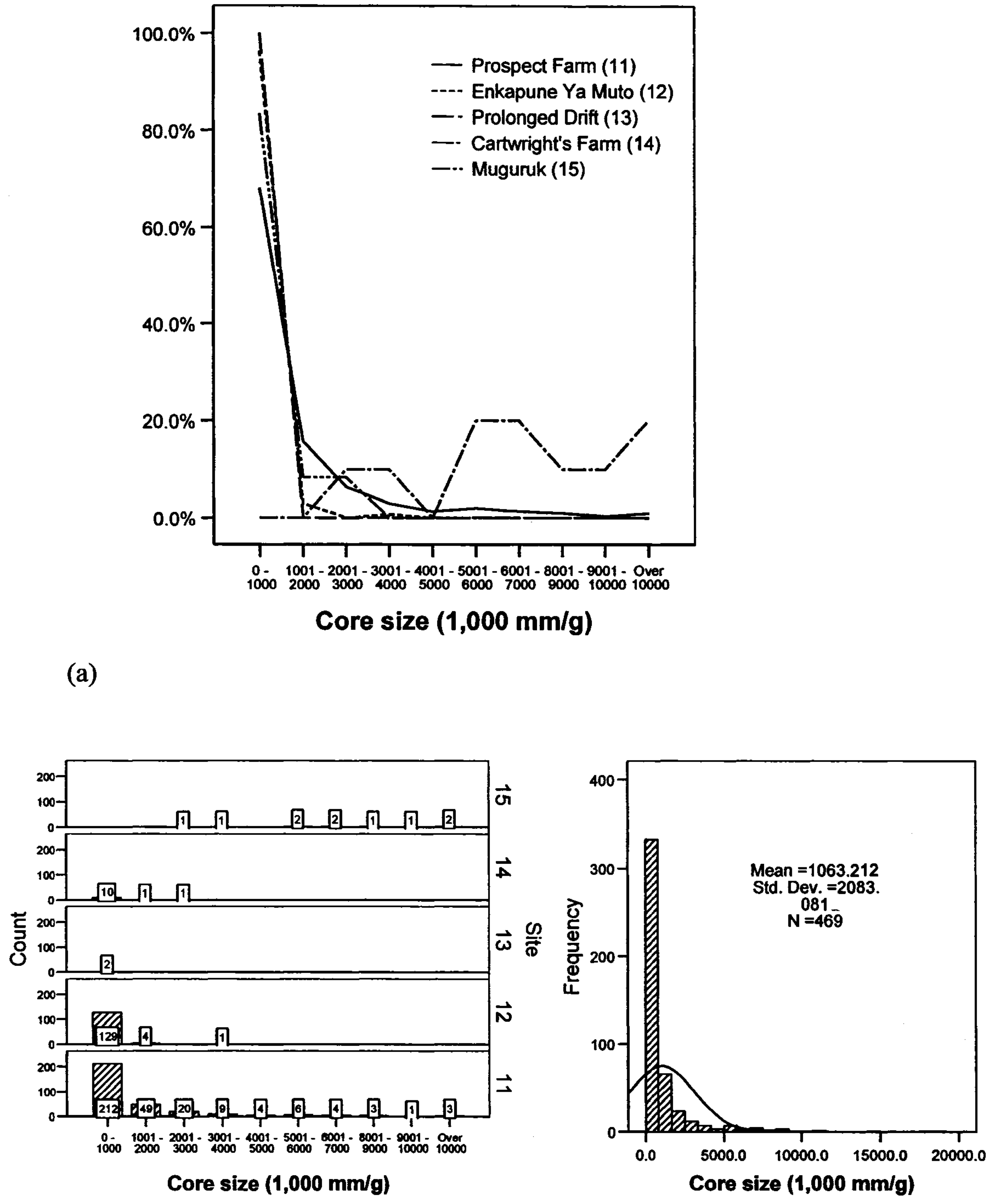


Figure 5.2 Core maximum dimension (a) Percentage frequency distribution, (b) distribution of counts within maximum dimension classes, and (c) nature of spread in the combined MSA sample assemblage.

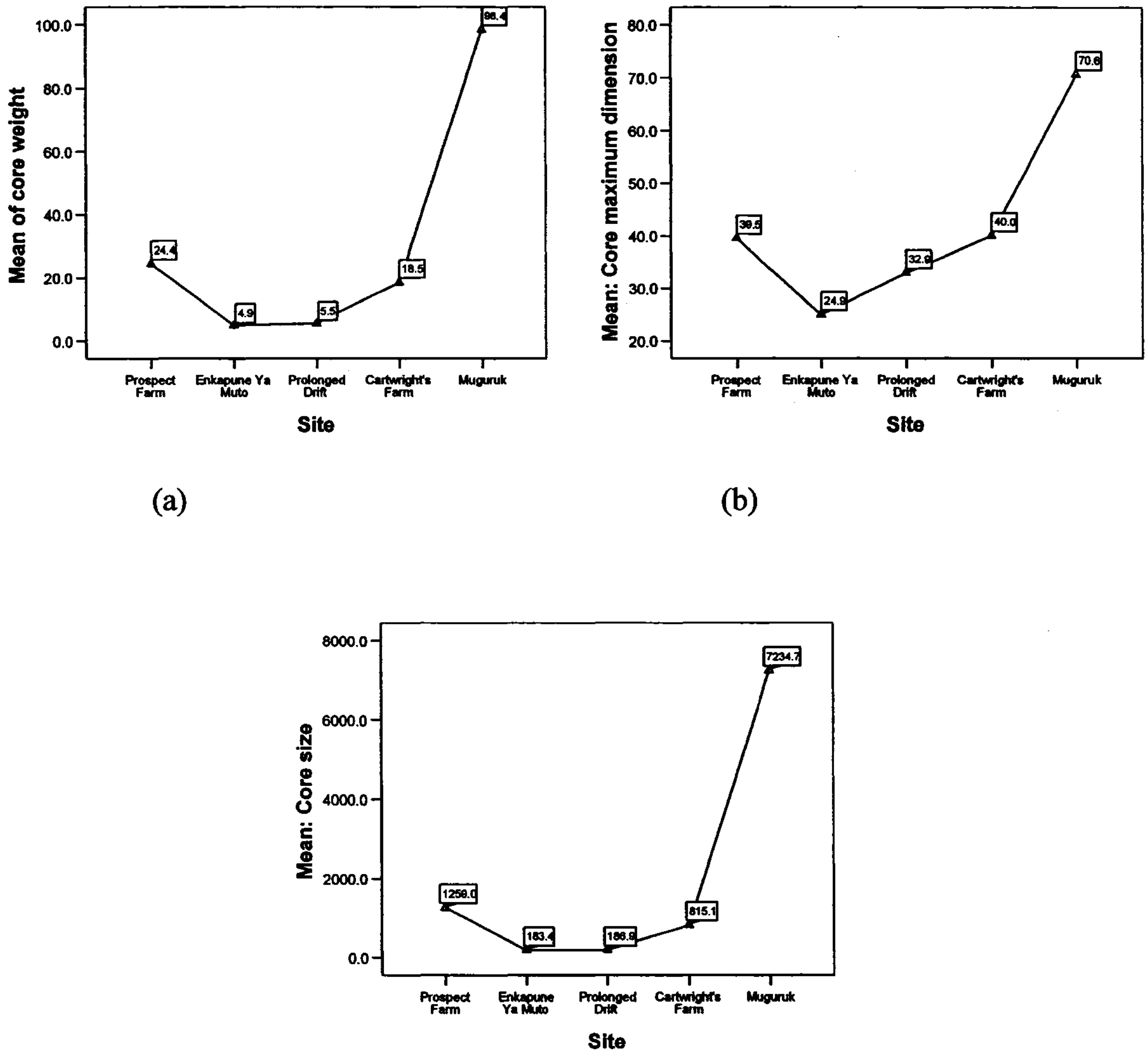


(a)

(b)

(c)

Figure 5.3 Core size: (a) Percentage frequency distribution, (b) distribution of counts within size classes, and (c) nature of spread in the combined MSA sample assemblage.



(a) (b)

(c)

Figure 5.4 Comparison of site mean measurements for (a) core weight, (b) core maximum dimension, and (c) core size.

Test variable	Cores and Core fragments			Core fragments		
	df	F	p	df	F	p
Core weight	4	45.165	.000	3	15.094	.000
Core maximum dimension	4	52.492	.000	3	20.388	.000
Core size	4	37.768	.000	3	12.447	.000

Table 5.8 Analysis of variance test results between sites for core measurements (cores and core fragments). DF = degree of freedom, F = statistical measure of similarity between and within population sets using observed and expected means and P = probability.

Test variable	Prospect Farm			Enkapune Ya Muto			Cartwright's Farm			Muguruk		
	df	F	p	df	F	p	df	F	p	df	F	p
Core weight	10	9.8	.000	4	0.9	.439	4	2.2	.168	3	1.2	.386
Core maximum dimension	10	5.2	.000	4	2.6	.041	4	0.6	.669	3	0.4	.769
Core size	10	8.7	.000	4	0.7	.619	4	1.2	.389	3	0.8	.537

Table 5.9 Analysis of variance test results within sites for cores and core fragments. df = degree of freedom, F = statistical measure (similarity between and within population sets using observed and expected means), and p = probability.

Core flake pattern	SITE															Total	
	Prospect Farm			Enkapune Ya Muto			Prolonged Drift			Cartwright's Farm			Mugurук				
	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %
Radial	76	24.4	84.4	7	5.2	7.8	-	-	-	2	16.7	2.2	5	50.0	5.6	90	19.1
Simple same pattern	64	20.6	56.6	44	32.6	38.9	-	-	-	3	25.0	2.7	2	20.0	1.8	113	24.0
Parallel same pattern	26	8.4	54.2	20	14.8	41.7	-	-	-	2	16.7	4.2	-	-	-	48	10.2
Opposed platform	1	0.3	33.3	2	1.5	66.7	-	-	-	-	-	-	-	-	-	3	0.6
Transverse	2	0.6	100.0	-	-	-	-	-	-	-	-	-	-	-	-	2	0.4
Random	142	45.7	66.4	62	45.9	29.0	2	100.0	0.9	5	41.7	2.3	3	30.0	1.4	214	45.5
Total	**311**	**100.0**	**66.2**	**135**	**100.0**	**28.7**	**2**	**100.0**	**0.4**	**12**	**100.0**	**2.6**	**10**	**100.0**	**2.1**	**470**	**100.0**

Table 5.10 Distribution of flake scar patterns on cores.

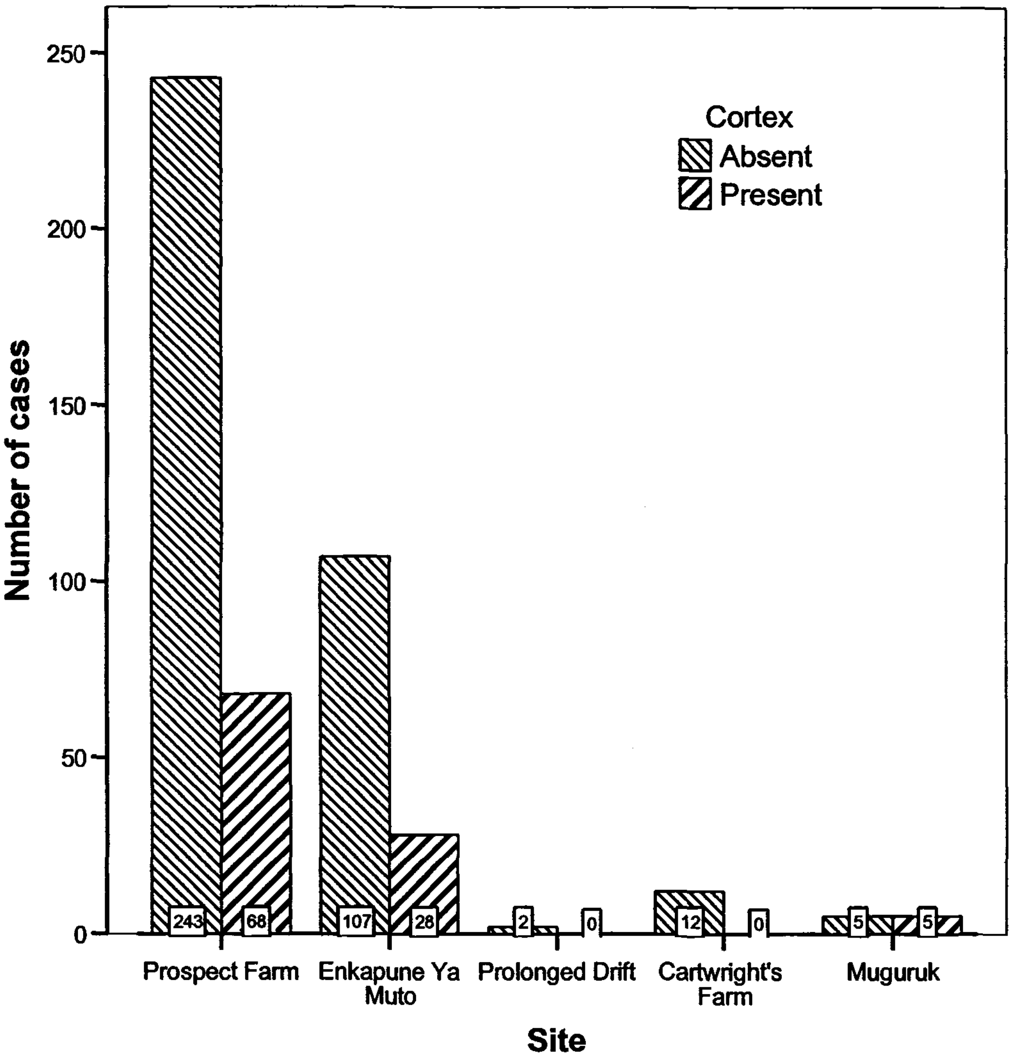


Figure 5.5 Distribution of cortical and non-cortical cores in the MSA sample assemblage.

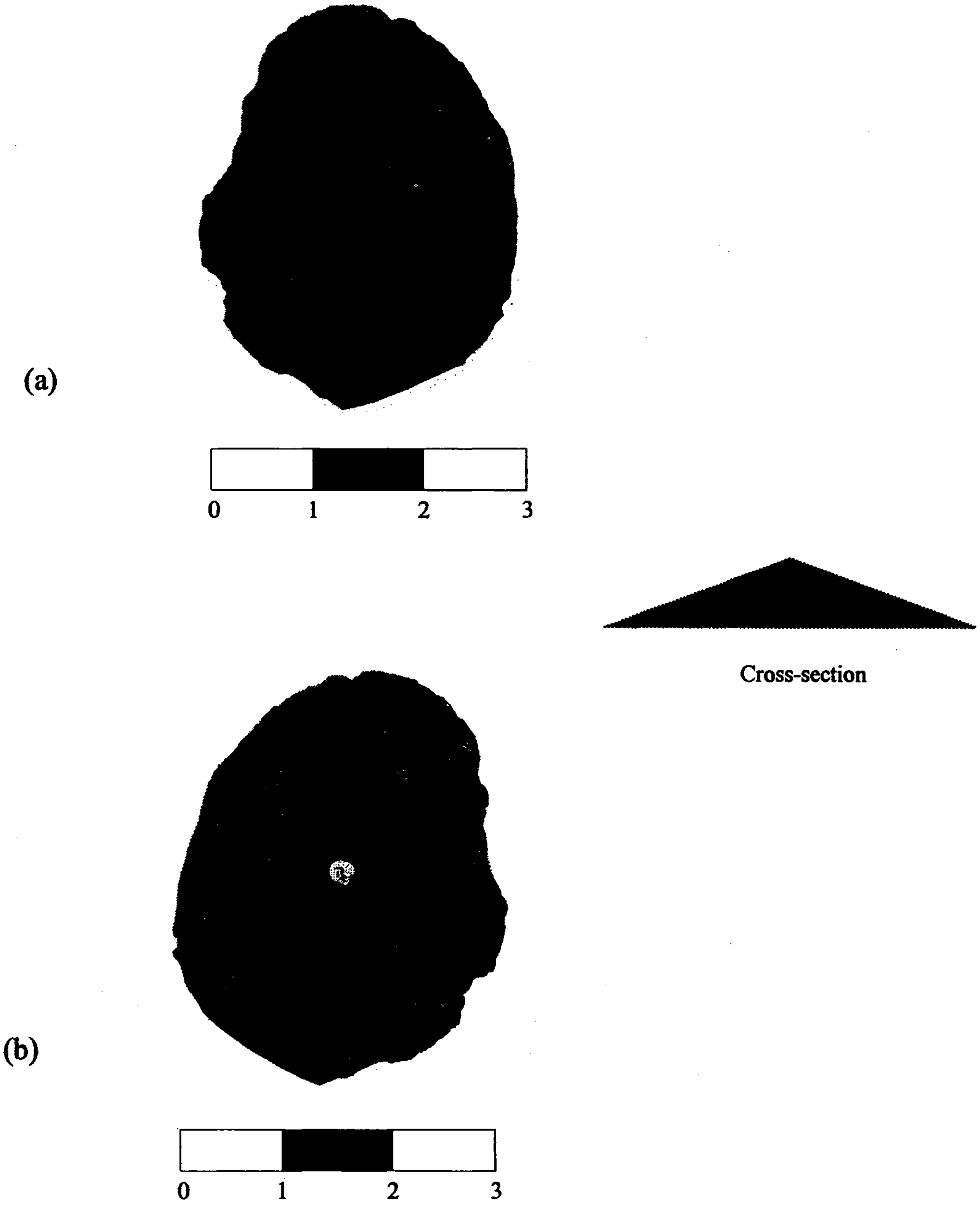


Figure 5.6 An obsidian radial discoidal core from Prospect Farm: (a) upper and (b) lower parts of the core.

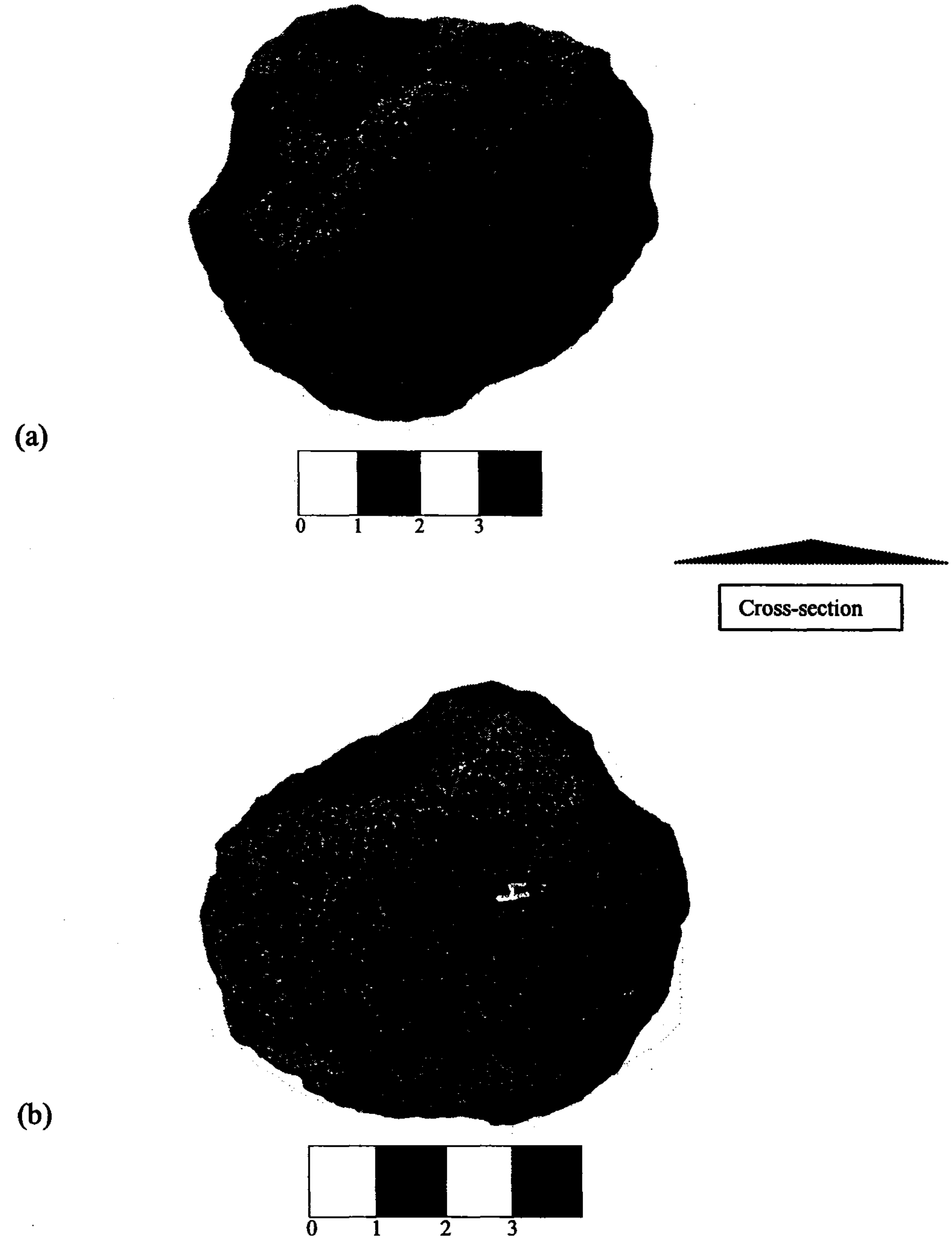


Figure 5.7 A basalt regular core approaching discoidal core from Prospect Farm: (a) upper and (b) lower parts of the core.

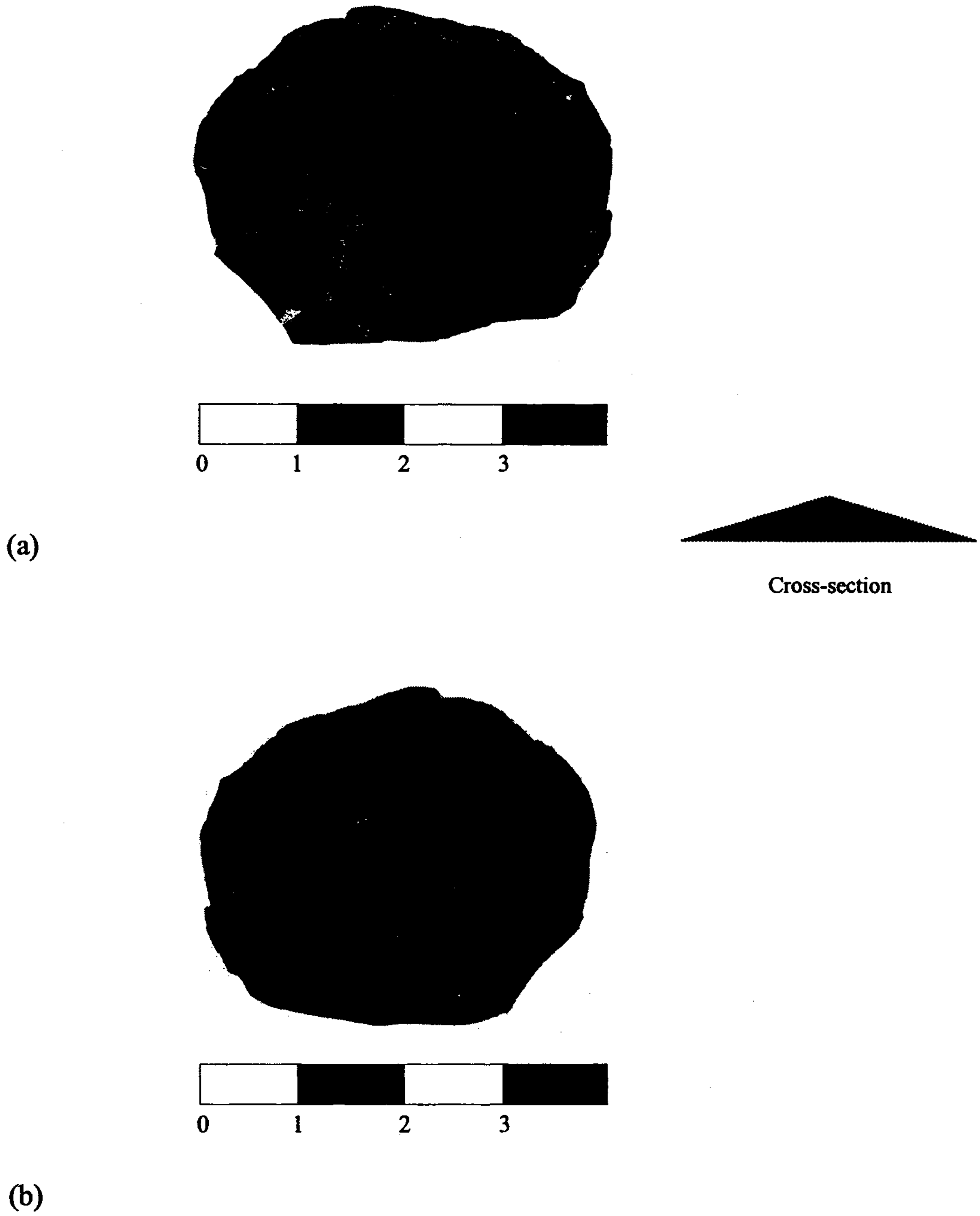


Figure 5.8 An obsidian regular core approaching discoidal core from Prospect Farm: (a) upper and (b) lower parts of the core.

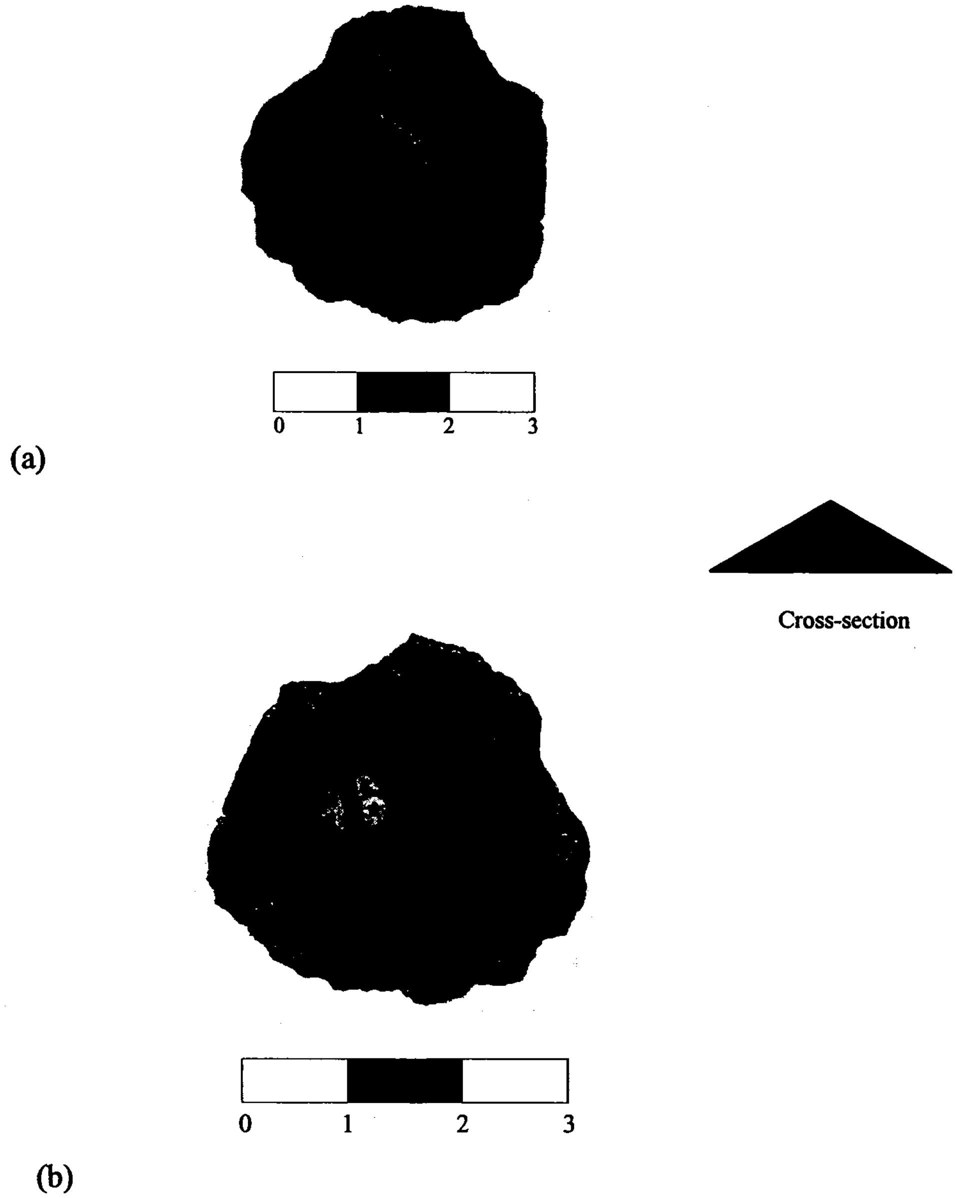


Figure 5.9 An obsidian regular core approaching discoidal core from Prospect Farm: (a) upper and (b) lower parts of the core.

5.2.4 Analysis of flakes

Flakes are characteristic spalls removed from a stone core during artefact manufacture. They are usually characterised by a striking platform or butt; a dorsal surface that may exhibit scars of previous flake removal from a core; a ventral surface with a bulb of percussion, bulbar scar, ripples or waves curving away from the point of percussion, and fissures or hackle marks radiating out from the point of percussion (Schick and Toth 1988:209). The term “flake” may also be used in a general sense to mean any fragment of stone detached by percussion or pressure, and exhibiting a bulbar surface. Various types found in the assemblages from the five sites are listed in Table 5.6. Whole flakes have recognisable striking platforms and bulbs of percussion, intact flake release surfaces, and no evidence of retouch or utilisation. This group is divided into end-struck and side-struck forms, defining the point at which flakes were hit in order to detach them from cores. The difference between the two is based on the ratio of breadth to length (B/L). End struck forms have a breadth to length ratio of less than 1.0, while side struck forms have ratios greater than 1.0.

A further division of whole flakes into core-trimming, and trimming and re-sharpening forms is based on dorsal scar observations. Core-trimming forms contain flake scars akin to those found on (portions of) core platforms, while trimming and re-sharpening scars are associated with the characteristics of the cutting edge of a tool. In the former, flakes are removed by a blow directed across the worked core surface, perpendicular to the direction of old flake scars, using the direct hammer technique. In the latter (trimming and re-sharpening flakes), flakes are removed using soft hammer direct percussion, with the ridge forming the intersection of the old worked surface and the former flake release surface falling closer to either of the lateral edges. These flakes and scars are generally smaller relative to, for example, core trimming ones. Flakes without all of these characteristics have been classified as flake fragments. They are also divided into core and tool trimming forms, based on similar factors as discussed for whole flakes.

The majority of flakes come from Prospect Farm and Enkapune Ya Muto (n = 886 and n = 601 respectively). All flake types seem to be present in high quantities at Prospect Farm, with end-struck whole flakes (n = 325) accounting for 36.7% of the total number of flakes and flake fragments sampled from the site. The least frequent here are utilised flakes (n = 14), representing about 1.6% of the total. The presence of all subtypes at this site is significant in understanding the technological activities carried out at the site. Whole flakes, resulting from direct reduction of cores (end-struck and side-struck whole flakes), core and tool trimming whole flakes, as well as flake fragments from both core and tool trimming, indicate that the site was a main manufacturing area. Most of the reduction activities as well as tool shaping after use seem to have been carried out.

The Enkapune Ya Muto assemblage also contains all flake sub-types except utilised flakes. However, there seems to be an unusually high number of core-trimming flake fragments (n = 244) and tool-trimming flake fragments (n = 125) that may be interpreted as representing a high degree of core preparation and production of well-trimmed and standardised tools, which is not necessarily the case given the sample characteristics. Prolonged Drift has a fair distribution of flake subtypes but with an unusual presence of core-trimming whole flakes and core-trimming flake fragments, given the limited number of cores documented at the site (my sample contains only two pieces). The high number of tool trimming and re-sharpening whole flakes (n = 156) is, however, in line with the explanation that the site may have served as a camp into which tools and flake blanks were brought to perform specific duties (Merrick 1975). Such tools may have been re-sharpened after use, resulting in the accumulation of this evidence.

The Cartwright's Farm sample contains a limited number of whole flakes (n = 17), while fragments are minimal (n = 11), while the Muguruk sample is small, but represents a fair distribution of all flake subtypes. The sites, like Prospect Farm, may have been centers of activity where all manufacturing and use of artefacts occurred.

The sample assemblages show substantial quantities of flake fragments. This distribution indicates the presence of initial stone manufacturing and tool rejuvenation activities at the sites. The majority of the flake fragments come from Enkapune Ya Muto; and may reflect the restricted nature of the site area, confining much of the chipping and discarding of waste within a limited area. It may also be due to trampling effects in a restricted area that the site occupies.

Utilised flakes form a small proportion (0.8%) of the total flake sample. These show evidence of utilisation on the edges in the form of breakage and dulling features, which indicate use for cutting or scraping of some sort. The nature of use, however, remains a subject of future research and is therefore only an observation.

The proportional representation of these flake types varies considerably between sites. A number of observations can be made. First, it is notable that Prospect Farm contains all the categories in significant proportions, with the highest being end-struck whole flakes. This is suggestive of all stages of core reduction, from the initial flaking activities to tool rejuvenation, taking place at the site. It indicates that cores were reduced into flakes which were then used to make tools for various functions, with such tools being re-sharpened or re-made into new usable forms after some time before being discarded. A similar trend is present at Enkapune Ya Muto, except that core trimming and tool re-sharpening seem to have been more common than elsewhere, indicating the practise of maximizing both number and size of flakes obtained from cores, as well as recycling of tools through rejuvenation.

Secondly, there is a high proportion of trimming and re-sharpening flakes, and a comparatively very low number of flake fragments at Prolonged Drift. This distribution suggests that tools may have been carried into this site from elsewhere, used, and then re-sharpened. Only minimal local reduction activities may have taken place at the site. Lastly, distributions at the Cartwright's Farm and Muguruk sites are attributable to the nature of the samples used. Both Cartwright's Farm and Muguruk, on the other hand, show low proportions due to small samples that were used, as discussed earlier in Section 4.2.

Table 5.6 also shows relative frequency distribution of flake categories in the sample assemblages as a whole. Results of analysis of variance between sites (combined assemblage) and within sites (individual sites) for whole flakes are presented in Table 5.11. Inter-site comparisons indicate that there is significant difference between the assemblages for all the measurements taken. Similarly, there are significant differences within the Prospect Farm, Enkapune Ya Muto and Prolonged Drift samples, where significance levels of less than .0005 indicate variation in flake morphology. However, samples from Cartwright's Farm and Muguruk show insignificant difference, which is attributed to small sample effect.

The least variation in the combined sample assemblage or inter-site comparisons is exhibited by the ratio of breadth-to-length (B/L), whose F-value is 11.6. The mean of breadth-to-length ratio approaches 1.0 mm in all the five sites (Prospect Farm = 0.817, Enkapune Ya Muto = 0.703, Prolonged Drift = 0.877, Cartwright's Farm = 0.491 and Muguruk = 0.748), as shown in Figure 5.11. The remaining attributes (length, width, and thickness; ratio of thickness-to-width, and ratio of thickness-to-length) show marked variation between the assemblages, as shown in Figure 5.10 and 5.11, where the various mean values are compared. Variation shown between and within assemblages may be attributed to different reduction techniques and strategies applied at the sites, types, availability/source and size of raw materials, as well as the location of the particular sites, which either restricted or promoted technological behaviours. This may also be due to the different types of flakes present in the assemblages.

Figure 5.12 shows (a) the percentage frequency distribution for length measurements of whole flakes, (b) the distribution of counts across the sites and (c) the range of measurements in the entire assemblage. Most artefacts fall within the 0 to 30 mm size range. Cartwright's Farm site has larger flakes, with the majority falling within the 30.0 to 40.0 mm size range. Muguruk, on the other hand, with many flakes within the 10.0 to 20.0 mm size range, has an almost uniform distribution within other size ranges up to the 60.0 to 70.0 mm size range.

These size clusters show a non–normal distribution (Figure 5.12 (b) and (c)), with most artefacts concentrated to the left, meaning a greater proportion of the length measurements are less than or equal to the mean. The presence of these small-sized flakes suggests little disturbance at the sites, especially by running water or erosion, which could have washed away lighter materials. The relatively larger flakes at Cartwright's Farm could be attributed to recovery methods where larger pieces may have been preferred over smaller ones; i.e., a sampling problem during surface collection of materials at the site. Larger sizes at Muguruk, on the other hand, may be a result of the use of ombo phonolite that has poor flaking qualities and could not be reduced to smaller pieces as obsidian within the Central Rift Valley and the adjacent areas.

Larger flakes, measuring over 80.0 mm, are scarce or completely absent in the assemblages, suggesting little preparation of flake blanks for the manufacture of other tools. Alternatively, if such blanks were prepared, then they were transported from these sites to other localities, where they were possibly made into other tool forms. Figures 5.13 and 5.14 show the frequency distributions of width and thickness and reveal the nature of skew and spread of these measurements. These measurements seem to be equal across the sites, with thickness almost approaching a normal distribution except for outliers found at Prospect Farm and Muguruk. This distribution can be explained by the high flaking quality of obsidian, used as a major raw material for over 98% of the flakes examined.

A definition of flake shape was attempted using the ratio of width to length. Figure 5.15 (a) to (c) shows percentage frequency distributions, and the nature of skew and spread of this attribute for the five sites. There is considerable variation between sites, with peaks at 0.40 to 0.60 and 0.60 to 0.80 suggesting that most of the ratio measures cluster around the overall mean of 1.0 (Figure 5.11a). Despite this clustering toward a unit, there is no indication that distinct shape patterns are present.

Test variable	**Combined assemblage (Inter-assemblage variance)**			**Prospect Farm**			**Enkapune Ya Muto**			**Prolonged Drift**			**Cartwright's Farm**			**Muguruk**		
	df	F	p	df	F	p	df	F	p	df	F	p	df	F	p	df	F	p
Length	4	70.5	.000	3	42.6	.000	3	19.4	.000	3	23.5	.000	1	.039	.847	3	5.1	.003
Width	4	48.7	.000	3	23.2	.000	3	18.9	.000	3	32.7	.000	1	3.9	.099	3	5.8	.001
Thickness	4	60.9	.000	3	17.9	.000	3	17.5	.000	3	35.8	.000	1	1.2	.288	3	3.3	.026
Ratio of width to length	4	11.6	.000	3	59.3	.000	3	6.3	.000	3	12.4	.000	1	4.2	.058	3	9.9	.000
Ratio of thickness to width	4	41.0	.000	3	3.4	.017	3	1.9	.138	3	11.5	.000	1	1.1	.315	3	1.1	.346
Ratio of thickness to length	4	28.3	.000	3	11.4	.000	3	2.8	.044	3	19.3	.000	1	1.7	.217	3	2.0	.116

Table 5.11 Analysis of variance results for whole flakes metrical measurements. df = degree of freedom, F = statistical measure (similarity between and within population sets using observed and expected means), and p = probability.

Figure 5.16 shows relative thickness, which is the ratio of flake thickness to flake width. The distribution is clustered around 0.21 to 0.40; and approaches a normal distribution (Figure 5.16 c), suggesting no significant difference in relative thickness across sites. As stated earlier for flake thickness, this may be attributed to the dominant use and quality of obsidian as raw material to produce thinner and almost transparent flakes. The ratio of flake thickness to length, and the nature of skew and spread is presented in Figure 5.17.

Technologically, the basic shapes of whole flakes suggest very minimal distinct shape patterns. Frequency distributions of whole flake forms are presented in Table 5.12. Forms include angular, flake-blade, blade, points and normal categories. Shaped forms like points, flake-blades and blades are rare, while angular and normal categories are common. These distributions suggest minimal predetermination of tool shapes prior to reduction activities. They also indicate that there were few standardised technological patterns that would have produced more shaped blanks for the manufacture of specific tool categories such as points. It is also important to note that most points in the five assemblages (as discussed in Section 5.2.5), come from Prospect Farm; Cartwright's Farm and Enkapune Ya Muto containing most of the angular and point blanks, which are probable candidates for the manufacture of point tools. The higher percentage of normal flake forms is also the result of the presence of core trimming and tool trimming whole flakes in a significant quantity. Such flakes do not have any specific shapes.

Weathering on whole flakes

A measure of the degree of weathering on artefacts at different sites was carried out using binomial codes: fresh or worn/weathered. Fresh flakes and tools generally have sharp edges and shiny surfaces, with any patination on the artefact surface being uniform. Weathered pieces, on the other hand, have dulled-edges and surfaces due to movement and contact with other objects before or after deposition. Weathering marks on artefacts indicate disturbance at sites, and may be studied independently to establish the nature and effects of factors causing them to appear on archaeological remains.

Table 5.13 shows the distribution of whole flakes in the various assemblages, based on their being fresh or weathered. Overall, most of the flakes (88.5%) show no signs of weathering, indicating little disturbance of materials at the various sites. Comparatively, there is less weathering at Prospect Farm, Enkapune Ya Muto and Prolonged Drift (n = 54, 9%; n = 20, 12.3% and n = 0, 0% respectively) than at Cartwright's Farm and Muguruk (n = 10, 58.8%; n = 45, 55.6% respectively). Prospect Farm materials are fresh but are heavily patinated in most cases, while those from Enkapune Ya Muto are also fresh but show signs of breakages (Figure 5.18 and 5.19), probably due to trampling.

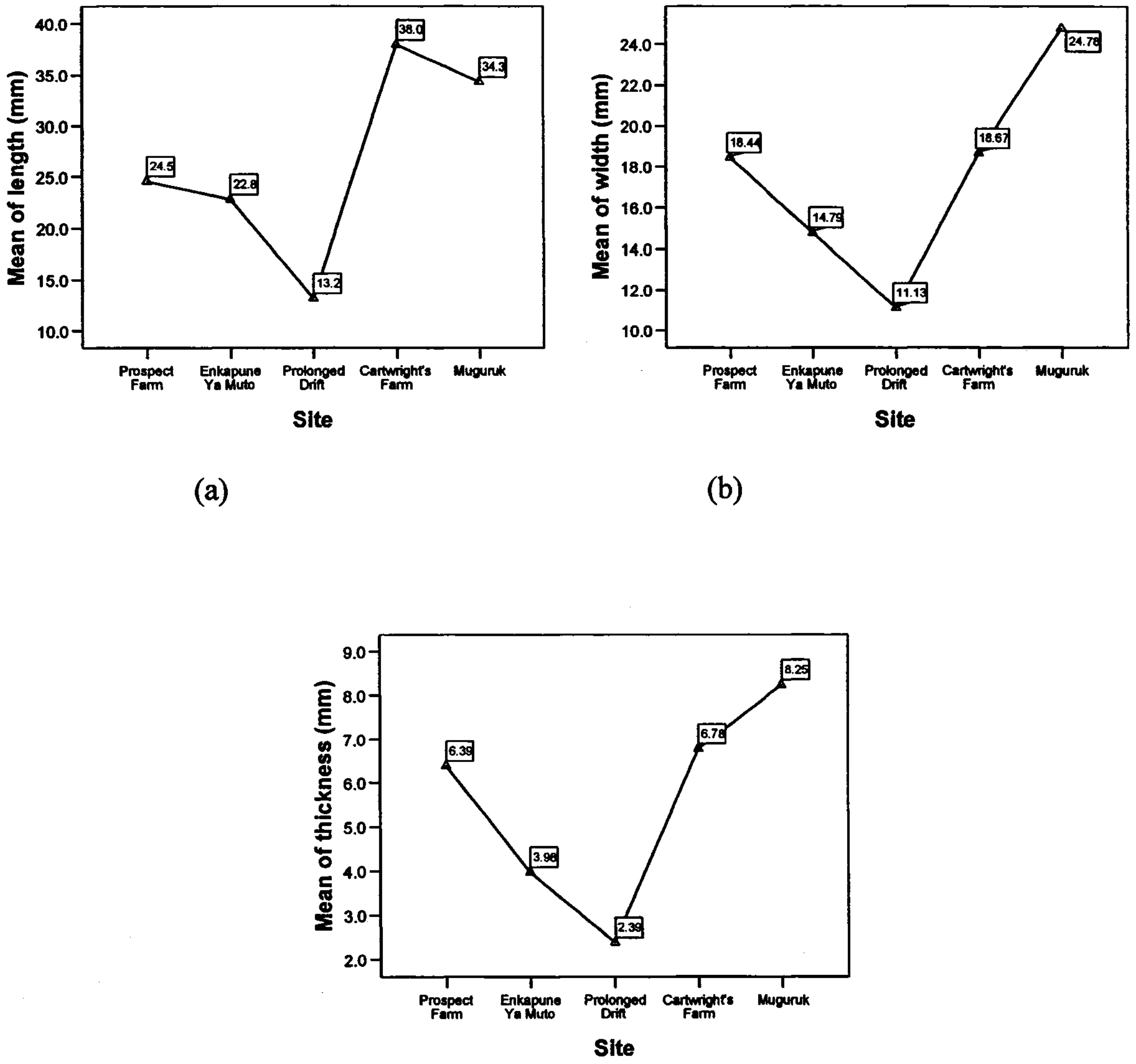
Apart from differential degrees of disturbance between the two groups, other factors seem to account for the observed differences. First, the differences may be attributed to raw material. Over 98% of whole flakes from Prospect Farm and Enkapune Ya Muto are made on obsidian, while about 99% of whole flakes at Muguruk are made on basalt (Ombo phonolite). Compared to obsidian, basalt weathers easily. Secondly, exposure of materials on the surface may account for the high weathering at Cartwright's

Flake form	SITE Prospect Farm		Enkapune Ya Muto		Prolonged Drift		Cartwright's Farm		Muguruk		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Angular	125	20.8	13	8.0	8	3.1	-	-	1	1.2	147	13.2
Flake blade	29	4.8	18	11.1	-	-	2	11.8	-	-	49	4.4
Blade	4	0.7	-	-	-	-	-	-	-	-	4	0.4
Point	3	0.5	3	1.9	-	-	-	-	-	-	6	0.5
Normal	439	73.2	128	79.0	249	96.9	15	88.2	80	98.8	911	81.6
Total	**600**	**100.0**	**162**	**100.0**	**257**	**100.0**	**17**	**100.0**	**81**	**100.0**	**1117**	**100.0**

Table 5.12 Blank form of flakes in the MSA sample assemblage by site

Abrasion	SITE Prospect Farm		Enkapune Ya Muto		Prolonged Drift		Cartwright's Farm		Muguruk		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Fresh	547	91.0	142	87.7	257	100.0	7	41.2	36	44.4	989	88.5
Worn	54	9.0	20	12.3	-	-	10	58.8	45	55.6	129	11.5
Total	**601**	**100.0**	**162**	**100.0**	**257**	**100.0**	**17**	**100.0**	**81**	**100.0**	**1118**	**100.0**

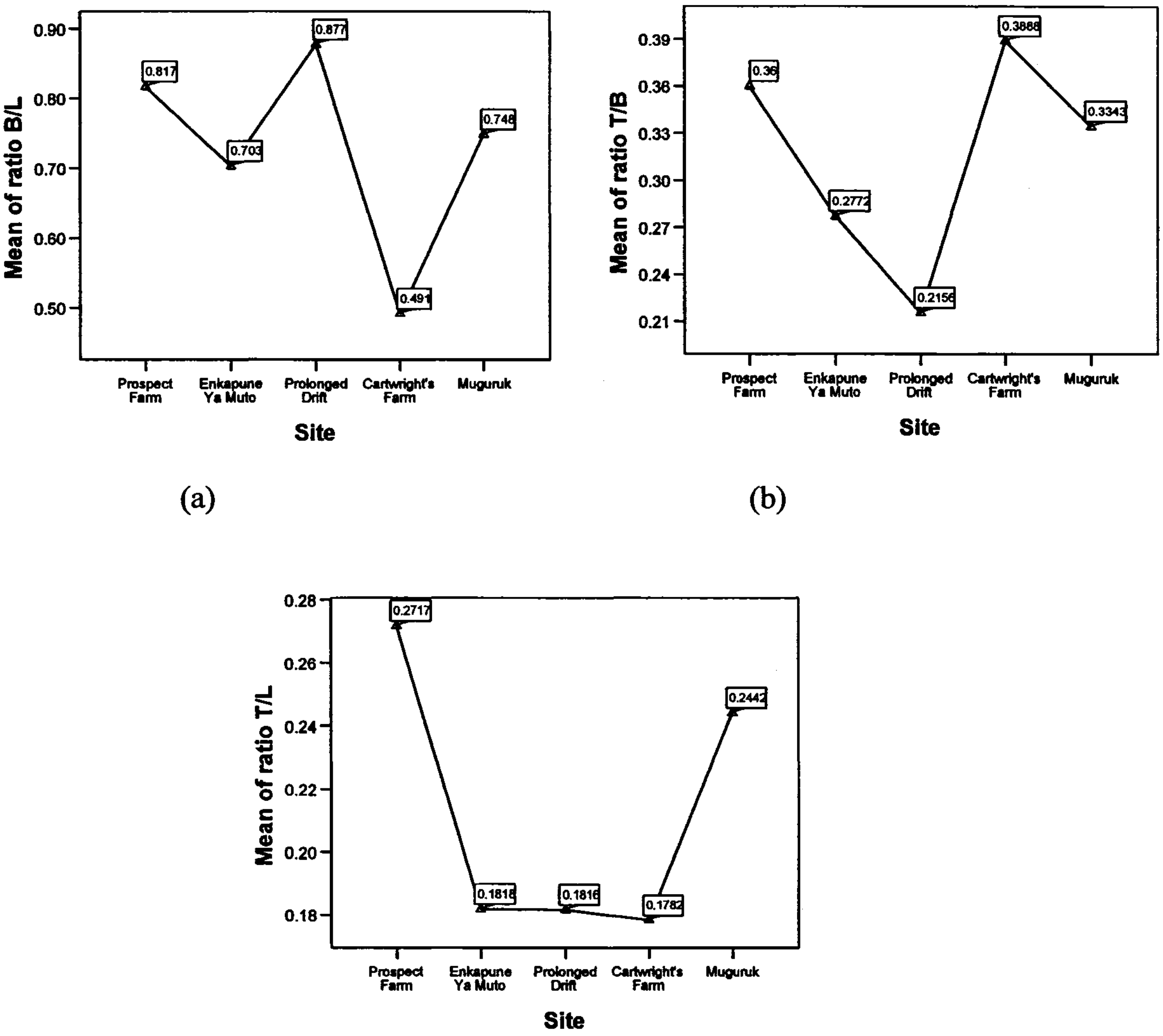
Table 5.13 Weathering on whole flakes in the MSA sample assemblages by site.



(a) (b)

(c)

Figure 5.10 Comparison of site mean measurements for whole flake (a) length, (b) width, and (c) thickness in the MSA sample assemblages.



(a) (b)

(c)

Figure 5.11: Comparison of site mean ratios for whole flakes: (a) breadth to length (b) thickness to breadth and (c) thickness to length.

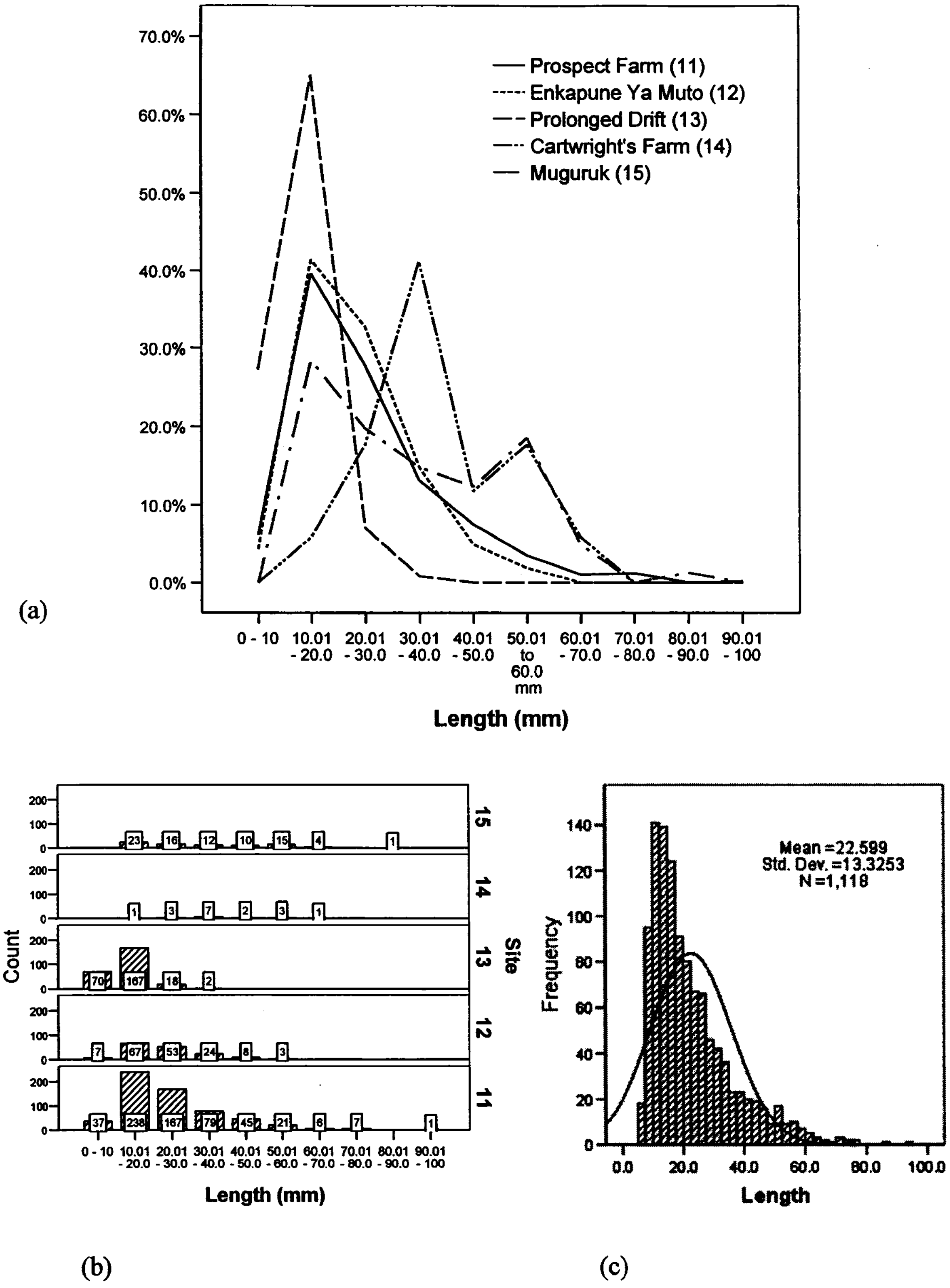


Figure 5.12 Whole flakes length (a) Percentage frequency distribution, (b) distribution of counts within length classes, and (c) nature of spread in the combined MSA sample assemblage.

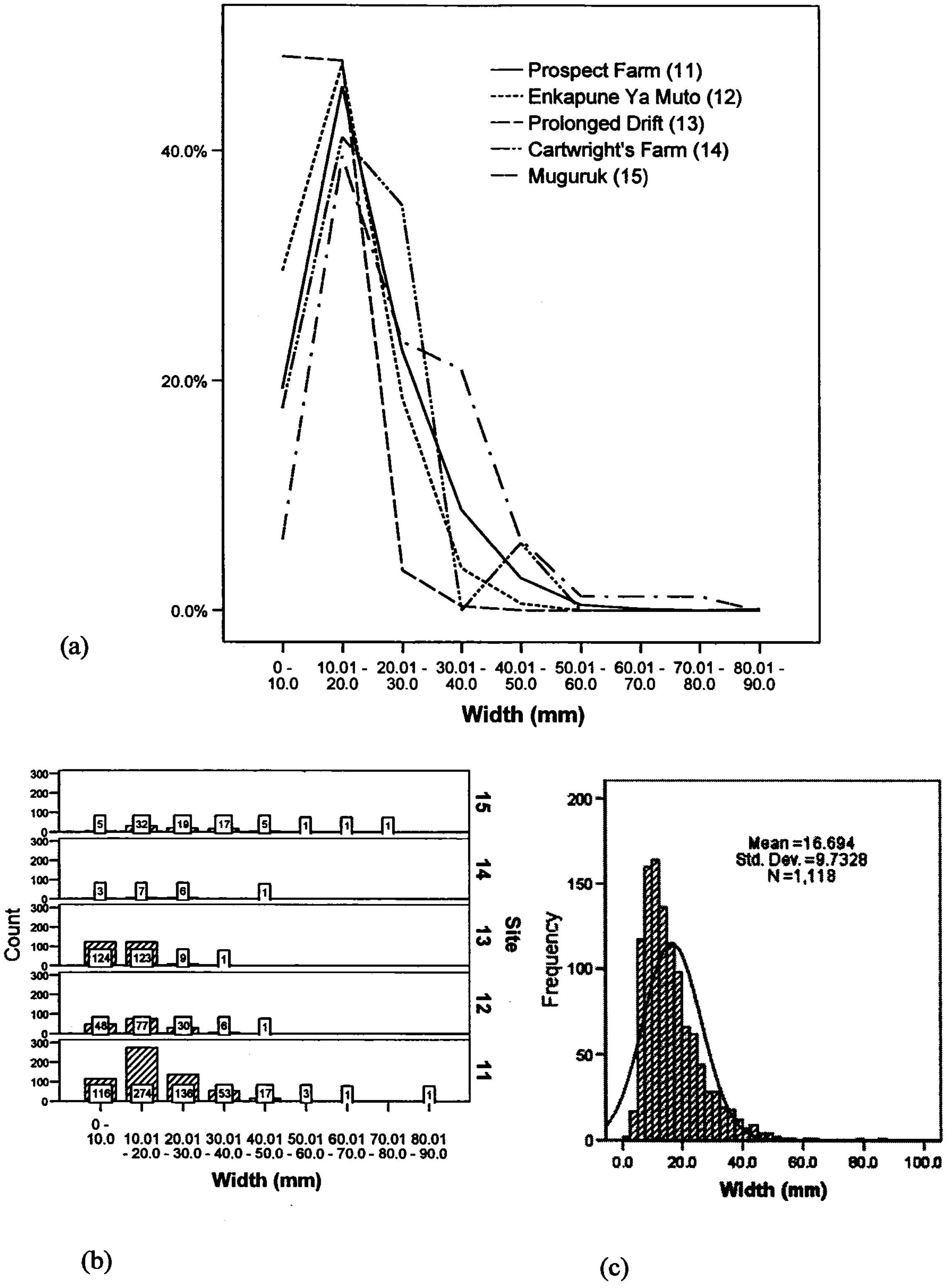


Figure 5.13 Whole flakes width (a) Percentage frequency distribution, (b) distribution of counts within width classes, and (c) nature of spread in the combined MSA sample assemblage.

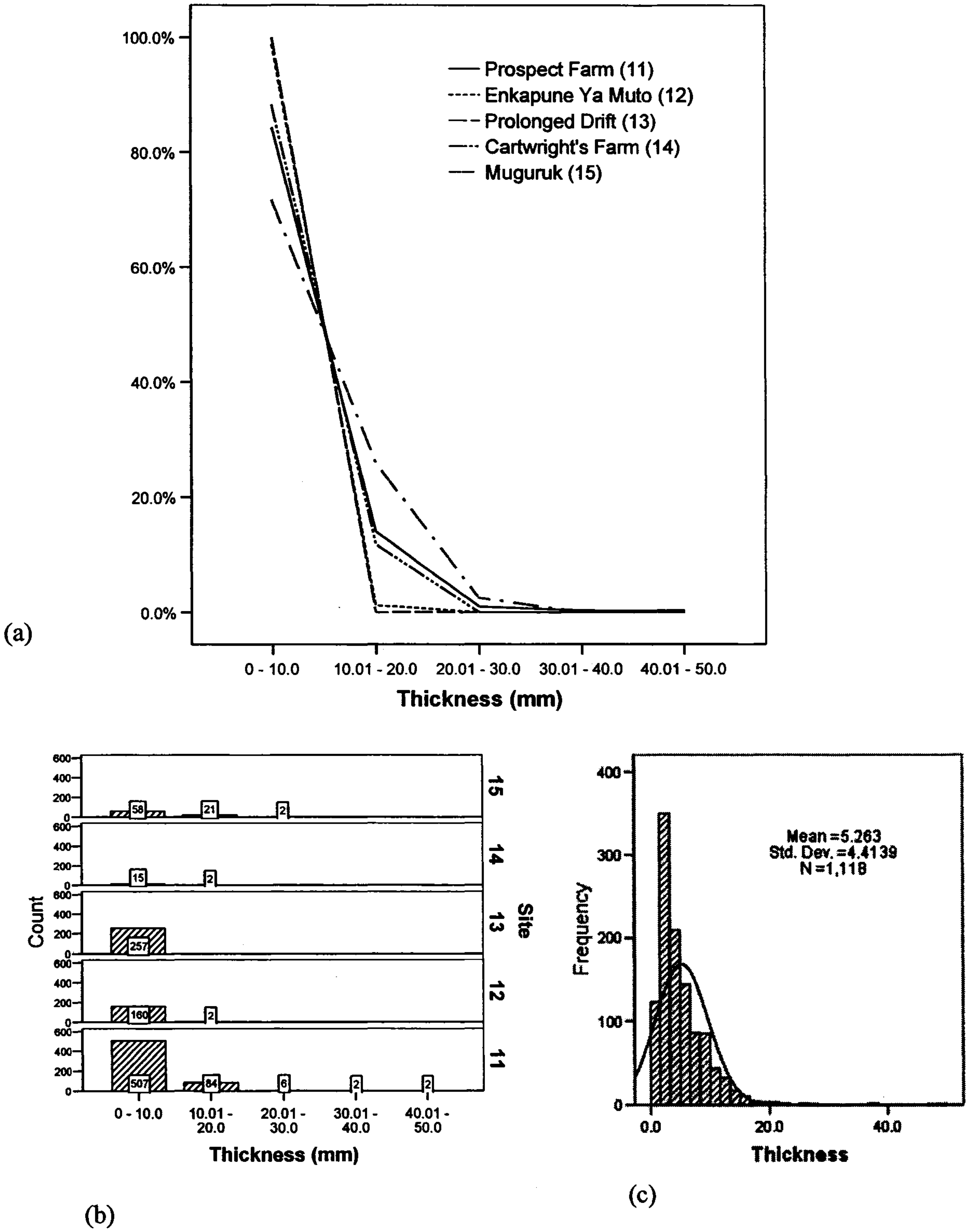


Figure 5.14 Whole flake thickness: (a) Percentage frequency distribution, (b) distribution of counts within thickness classes, and (c) nature of spread in the combined MSA sample assemblage.

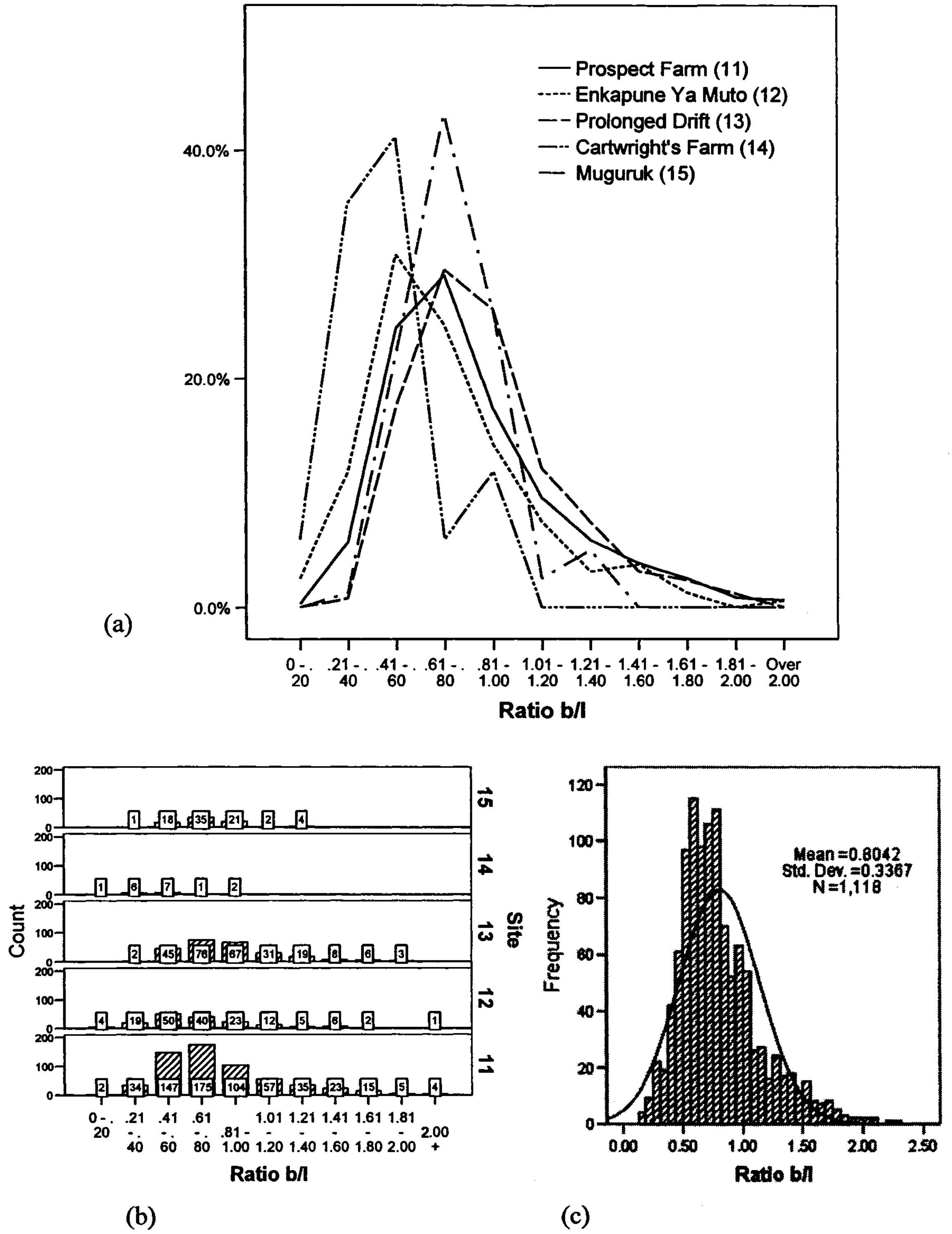


Figure 5.15 Whole flake breadth/length ratio: (a) Percentage frequency distribution, (b) distribution of counts within breadth/length ratio classes, and (c) nature of spread in the combined MSA sample assemblage.

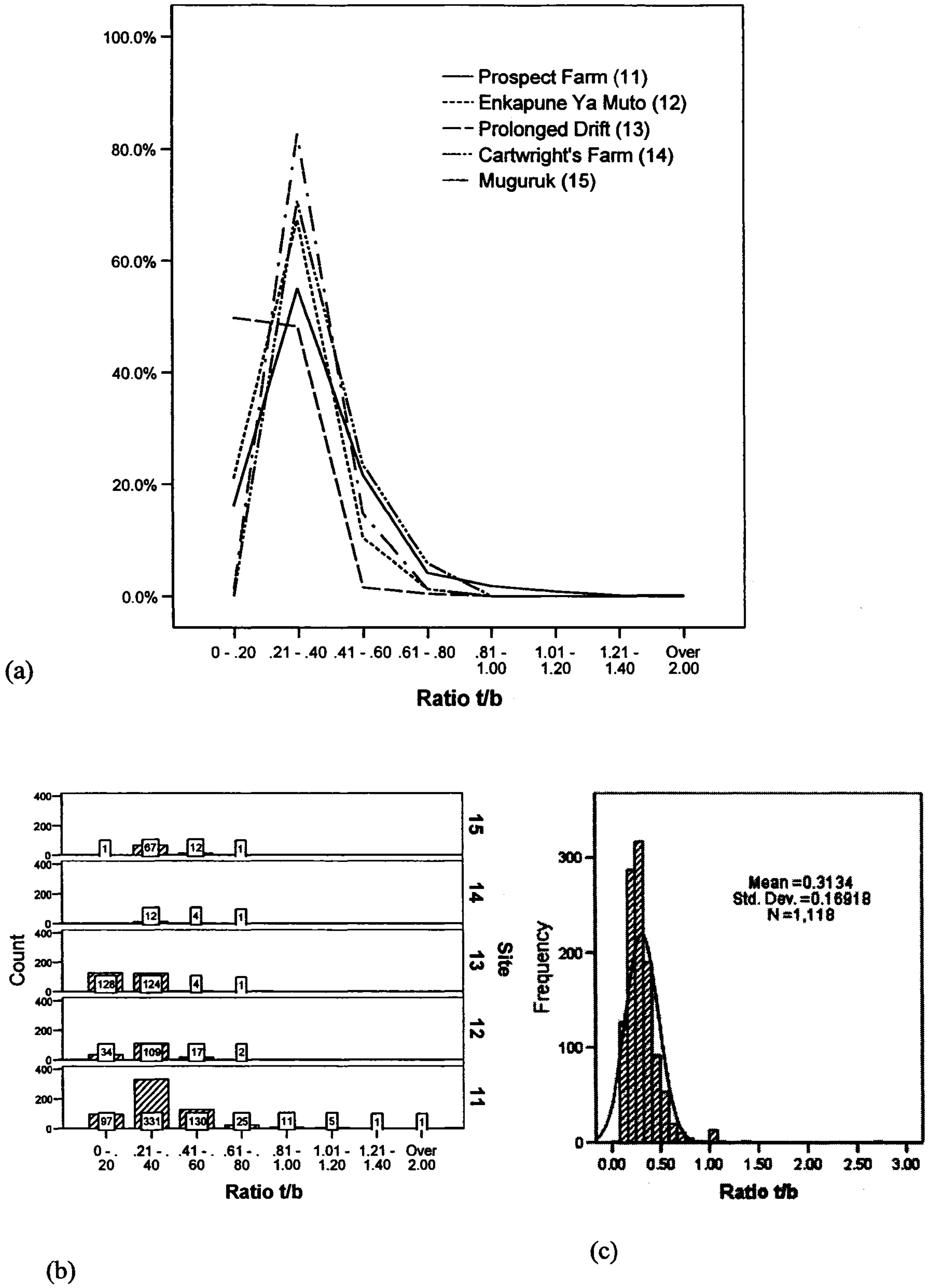
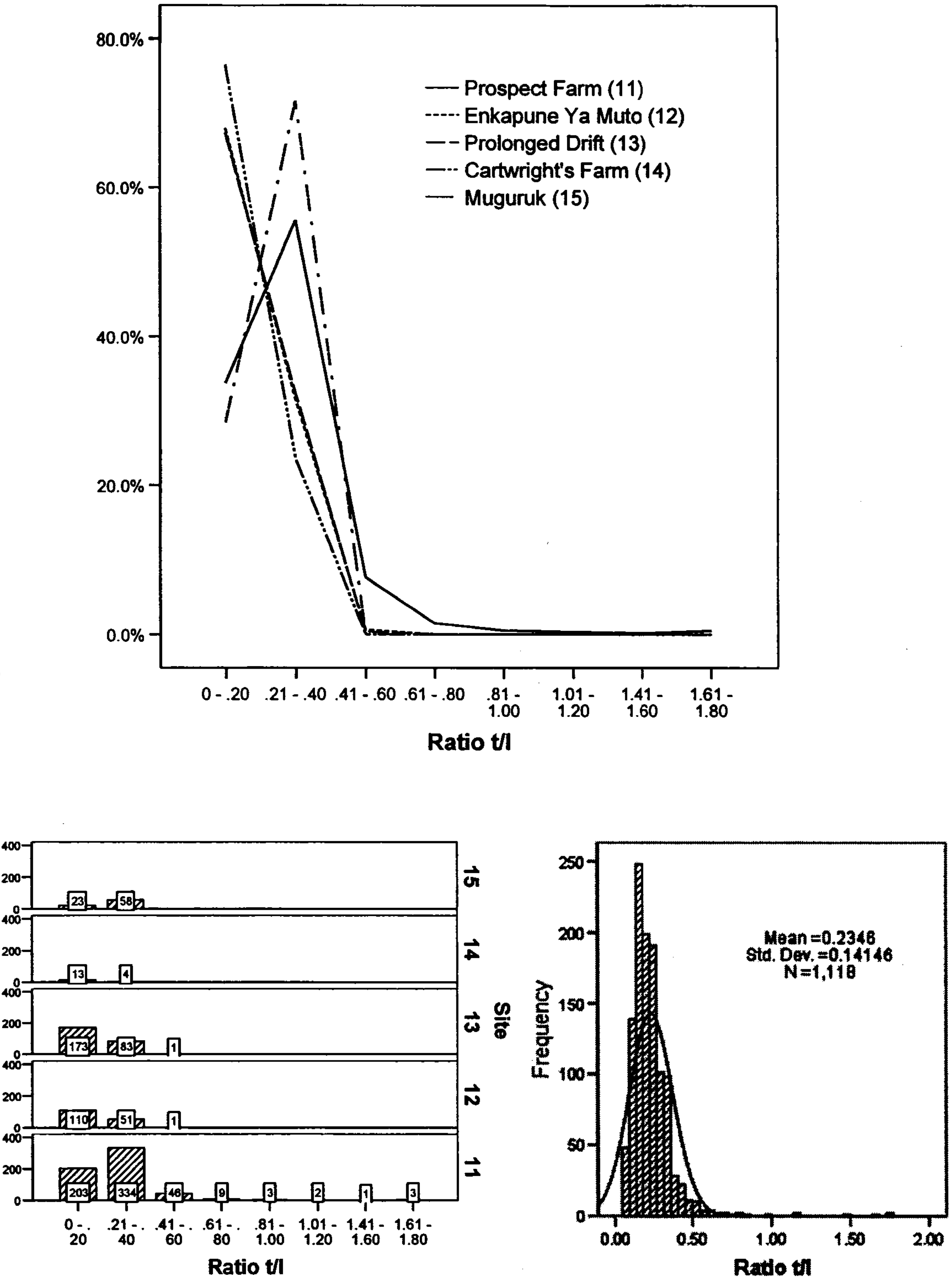


Figure 5.16 Whole flakes thickness to breadth ratio: (a) Percentage frequency distribution, (b) distribution of counts within t/b ratio classes, and (c) nature of spread in the combined MSA sample assemblage.



(a)

(b)

(c)

Figure 5.17 Whole flakes thickness/length ratio: (a) Percentage frequency distribution, (b) distribution of counts within thickness/length ratio classes, and (c) nature of spread in the combined MSA sample assemblage.

Farm compared to materials from other sites that were collected mainly through excavation. And lastly, site location seems to have played a role in protecting materials against both natural and anthropogenic forces at rock shelter sites like Enkapune Ya Muto. Prospect Farm and Prolonged Drift also enjoyed the high elevation location with minimal anthropogenic interferences. Modern settlements and other population activities, such as farming, do not extend to the high elevations occupied by these sites. Besides, the deep stratification (Figures 3.4 and 3.6) of these sites seems to have also protected the materials from any temporary running water.

Whole flake platform facets

As discussed previously, platform facets may indicate the stage at which a flake was removed from the core, as well as the reduction technique and strategy used to detach it. Table 5.14 shows the distribution of 366 flakes with distinct platforms observed for facets. Prospect Farm and Enkapune Ya Muto exhibit a spread out distribution of scar counts, with slightly higher percentages falling within the higher scar counts. This suggests that all stages of reduction may have been carried out at these sites. On the other hand, low numbers of flakes with either low or high scar counts at Prolonged Drift is suggestive of emphasis on secondary reduction, or the absence of initial reduction procedures. The number of flakes and scar counts at Cartwright's Farm and Muguruk may not be statistically significant; but could indicate that materials at the former resulted mainly from later stages of reduction, while those from the latter reflect all stages of reduction.

The presence of these faceted platforms is also indicative of the use of Levallois technology. Even though the faceting index, which is the percentage of faceted platforms

(Levallois technology) in an assemblage (Dibble *et al.* 2003:115), is only 26.4% as opposed to 45% on the total number of whole flakes, the trend is that of an emerging use of prepared platforms from which flakes were struck; and thus the application of Levallois technology and strategies.

Cortical cover on whole flakes

The presence or absence of cortex on a flake may indicate the stage of reduction, or whether the flake was the result of tool shaping. Detailed analysis of flake cortex cover helps in arranging flakes hierarchically along a reduction trajectory. In this work, however, a simple method was adapted to show presence or absence of cortex on artefacts (Table 5.15). Percentage distribution of the counts shown indicates that the number of whole flakes with cortex, with most having less than quarter of cortex cover on individual flakes, is lower at all the sites. The higher number of whole flakes with cortex at Prospect Farm and Muguruk suggest initial stages of reduction but also less intensive reduction, probably due to the availability or abundance of raw materials. However, given the large number of whole flakes at Prospect Farm, the percentage with cortex is lower. This observation and the fact that the site has the highest number of cores (Table 5.5) could imply that some of the cores were pre-shaped at quarry sites before being transported to the site for formal reduction procedures.

Another important observation is the very high percentage of non-cortical whole flakes (n = 248, 96.5%) and very low percentage of cores (n = 2, less than 1%) at Prolonged Drift (Tables 5.5 and 5.15). This suggests that reduction of cores may have been carried out elsewhere, and flakes and tools transported into the site. If this is true,

Platform facets	SITE Prospect Farm	 Enkapune Ya Muto	 Prolonged Drift	 Cartwright's Site	 Muguruk	Total
1	61	2	6	0	10	79
2	85	4	3	1	3	96
3	73	4	0	1	0	78
4	46	3	3	0	0	52
5	26	4	2	1	1	34
More than six	19	3	0	0	0	22
Total	**315**	**20**	**14**	**3**	**14**	**366**

Table 5.14 Distribution of platform facets among whole flakes in the MSA sample assemblages.

Cortex	SITE Prospect Farm		Enkapune Ya Muto		Prolonged Drift		Cartwright's Farm		Muguruk		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Absent	492	81.9	141	87.0	248	96.5	17	100.0	65	80.2	963	86.1
Present	109	18.1	21	13.0	9	3.5	-	-	16	19.8	155	13.9
Total	**601**	**100.0**	**162**	**100.0**	**257**	**100.0**	**17**	**100.0**	**81**	**100.0**	**1118**	**100.0**

Table 5.15 Presence and absence of cortex on whole flakes by site.

then Prolonged Drift would most likely have been a temporary camp site.

Overall, a higher percentage of whole flakes (*n* = 963, 86.1%) do not have cortex compared to those that do (*n* = 155, 13.9%). The percentage for individual site counts cluster around the overall percentage mean of 89%, indicating that there is little difference in the proportion of flakes without cortex between the sites. This may indicate the application of similar reduction strategies at all the sites. Initial core shaping may have been carried at quarry sites before such cores were taken to the various sites, especially Prospect Farm, Enkapune Ya Muto, and Prolonged Drift, for reduction procedures. Alternatively, higher percentages of non-cortical flakes may reflect high reduction intensity at the sites exhibiting such percentages.

Whole flake scar patterns

Six types of dorsal scar patterns listed in Table 5.16 have been used to establish which technological strategies were applied to produce flakes. The distribution of these various patterns per site reflect the application of both formal (prepared core reduction) and informal (opportunistic or expedient core reduction) strategies. Distributions vary from site to site. Prospect Farm, for example, exhibits a higher count of radial flake scar patterns, indicating that prepared core or formal reduction strategies were applied. Higher cases of same-pattern simple scars and same-pattern parallel scars also reflect formal core reduction strategies, even though the same pattern may at times be produced by expedient or opportunistic strategies depending on the shape and size of raw material nodules being reduced.

If radial, simple same pattern and simple parallel patterns are to be accepted wholly as signalling formal core reduction, then there is strong evidence of formal reduction strategies at Prospect Farm, Enkapune Ya Muto, and Prolonged Drift, while Cartwright's Farm and Muguruk exhibit mainly a mixture of both formal and informal strategies, probably due to sample size effect. The choice of which strategy to use probably depended on shape and size of the raw materials, as opposed to any fixed regulations or organised fixed patterns of core preparation and reduction which are present but minimal. Opposed platform and transverse scar patterns underscore the significance of nodule shape and size in controlling the choice of reduction strategies. Most of the flakes with these types of scars result from expedient reduction strategies.

Scar pattern	**SITE**										**Total**	
	Prospect Farm		**Enkapune Ya Muto**		**Prolonged Drift**		**Cartwright's Farm**		**Muguruk**			
	n	%	n	%	n	%	n	%	n	%	n	%
Radial	87	14.5	-	-	1	0.4	-	-	2	2.5	90	8.1
Same pattern simple	227	37.8	102	63.0	182	70.8	4	23.5	48	59.3	563	50.4
Same pattern parallel	139	23.1	32	19.8	15	5.8	5	29.4	8	9.9	199	17.8
Opposed platform	2	0.3	-	-	-	-	-	-	-	-	2	0.2
Transverse	83	13.8	3	1.9	13	5.1	8	47.1	5	6.2	112	10.0
Plain	63	10.5	25	15.4	46	17.9	-	-	18	22.2	152	13.6
Total	**601**	**100.0**	**162**	**100.0**	**257**	**100.0**	**17**	**100.0**	**81**	**100.0**	**1118**	**100.0**

Table 5.16 Comparison of dorsal scar pattern on whole flakes for individual MSA sample assemblages.

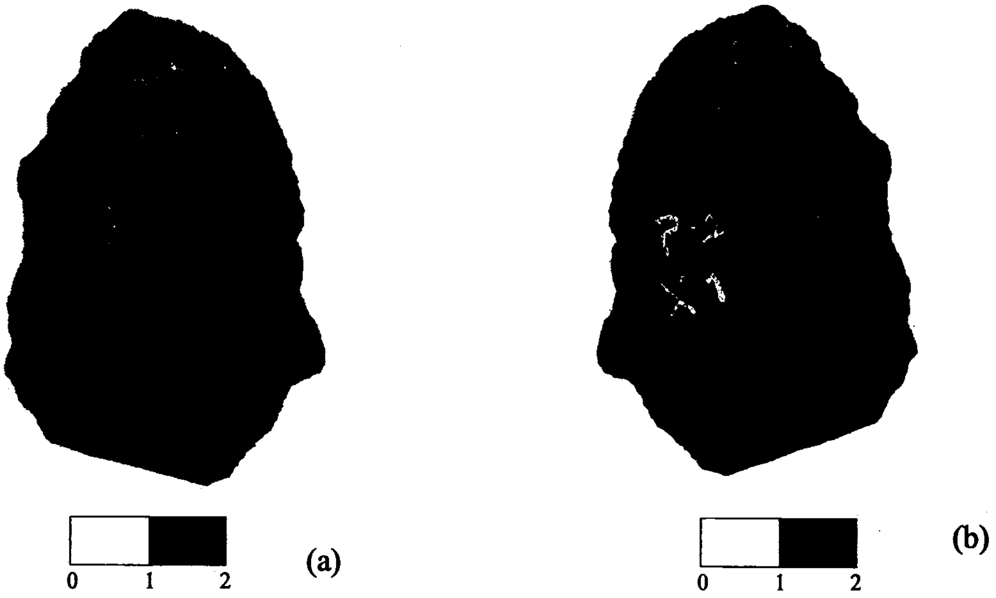


Figure 5.18 Heavily patinated basalt flake from Prospect Farm: (a) dorsal and (b) ventral surfaces.

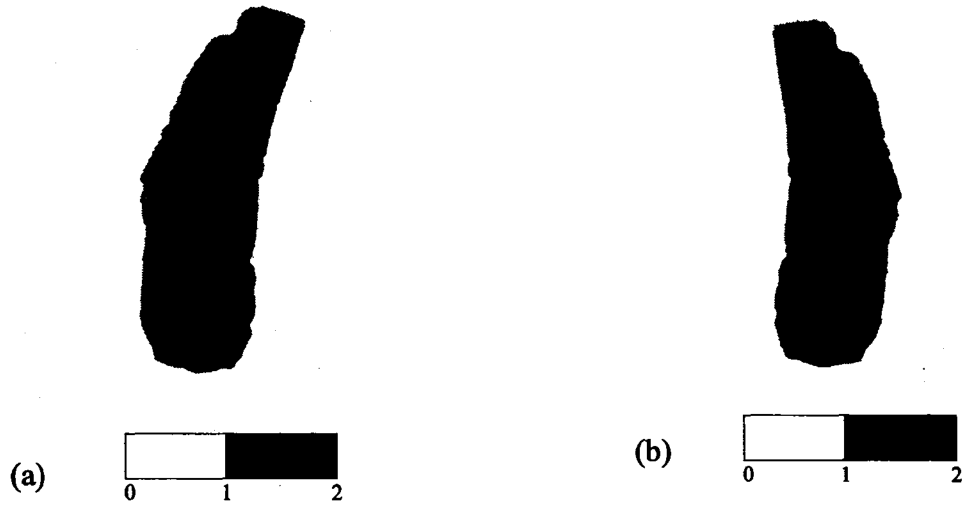


Table 5.19 Utilised end-struck whole blade with a broken tip from Enkapune Ya Muto: (a) dorsal and (b) ventral sides.

5.2.5 Analysis of scrapers and points

A wide range of tool types might be expected in MSA assemblages. However, the breakdown of tool subtypes presented in Table 5.7 shows that scrapers are the most abundant forms of shaped pieces. These are mainly light duty scrapers made on flakes and chipped fragments. They exhibit considerable variation in edge form or retouched edge(s), resulting in a great number of types.

Table 5.17 shows the various types represented. It is clear that the most numerous form in the combined assemblage is the convergent scraper (n = 82, 27.9%). These contain some retouch from the ventral side, even though dorsal retouch also occurs. Retouch occurs on two sides that converge into a pointed end. The next most numerous scraper form is the single-side scraper (n = 56, 19%), which exhibits trimming on one straight side, with flaking mostly from the ventral side. Others include convex end scrapers (n = 25, 8.5%), double-side scrapers (n = 24, 8.2%), disc-like convex scrapers and concave and notched scrapers (n = 18, 6.1% each), and convex scraper (n = 14, 4.8%). The remaining forms register low frequencies, and differ basically in shape and the location of trimming. Overall, the scrapers are thin except for the convergent pieces that exhibit thickness at the butt end.

The convergent scraper category forms part of Merrick's classificatory system (1975). This category reflects unique trimming and shape which approaches that of formal points. In this sense, most of the convergent scrapers differ only slightly from points, and may at times be confused with this category in MSA assemblages.

A wide variety of scraper forms in these assemblages reflects possible opportunistic practices in retouch patterns. Retouch is mostly on single edges, either lateral or transverse (perpendicular) relative to the long axis. Retouch is also mostly discontinuous along the retouched edges, with rare cases of invasive retouch that could be the result of re-sharpening practices. Table 5.18 shows frequency distribution of retouch intensity per site. It is clear that there is variation between the sites in the way retouch was applied. About 53.2% of the total scraper sample shows normal retouch, consisting of continuous and moderately invasive flaking along the edge(s). The majority of these come from Cartwright's Farm and Prospect Farm. Light retouch consisting of shallow and discontinuous retouch on specific edges counts for about 36.6%, and specimens are mainly found at Prospect Farm. Both heavy and stepped retouched forms account for 10.2% of the scraper sample.

Scraper retouch also shows that occasionally artefacts are retouched on certain edges; then flipped over and retouched on the opposite side in the manner bifaces would be worked. A number of scrapers also show fresher retouch on worn edges and may indicate tool recycling or rejuvenation by the makers, or attempts by later groups to re-use the same tools by re-sharpening them. Scraper edges are not as refined as those of blade tools and cutting-knife categories that provide sharper cutting edges.

Scraper size

Figures 5.20 to 5.22 and Table 5.19 show frequency distribution of scraper length, breadth and thickness; and the attributes reflecting mean standard deviation, standard error and range per site. A number of observations come from these distributions. First, there is a general similarity in length, breadth and thickness of scrapers at Prospect Farm and Cartwright's Farm. Most scrapers cluster at 30.01–40.0, 20.01–30.0 and 10.0–20.0 mm for length, breadth and thickness respectively. This similarity may be the result of a large number of convergent scrapers present at these two sites. Convergent scrapers are semi-shaped, being sub-triangular; and therefore may give the impression of a standardised group of implements. Secondly, scrapers from Enkapune Ya Muto are relatively smaller in size, and cluster at 20.01–30.0 and 10.01–20.0 for length and breadth respectively. These scrapers also show lower mean values compared to other sites (Table 5.20). This slight difference in size between the two open-air sites (Prospect Farm and Cartwright's Farm) and the rock shelter (Enkapune Ya Muto) site may be attributed to the degree of use and re-sharpening of scrapers before being discarded. Smaller scrapers at Enkapune Ya Muto also reflect the smaller size of flakes resulting from complete or exhaustive reduction of cores, as opposed to reduction patterns and strategies at the other sites, where opportunistic practices seem to have been carried out due to the abundance of raw materials.

Thirdly, although the sample from Muguruk is not statistically significant in this case, a single-sided scraper from the site measured 40.5 mm, 28.3 mm, and 13.0 mm in length, breadth and thickness respectively. These correspond to the 40.01–50.0, 20.01–30.0 and 10.01–20.0 mm classes for length, breadth and thickness respectively, within the total sample assemblage; and indicate that this implement is slightly larger than those from the other sites. As a representative of the site, this size difference may be due to differences in raw materials as well as flaking strategies at the site of Muguruk, where the main raw material is lava (Ombo phonolite) as opposed to obsidian at the other sites.

Scraper shape

The ratio of breadth to length (B/L), thickness to breadth (T/B) and thickness to length (T/L) are presented in Figures 5.23, 5.24 and 5.25 respectively. Both B/L and T/L ratios show that there is insignificant difference between scrapers from all the sites. This tendency toward similarity across sites is due to a large number of convergent scrapers that make up about 27.9% of the total sample assemblage. There is, however, a great deal of variation among scraper forms within individual assemblages containing different forms, including but not limited to irregular, circular, trapezoidal, triangular, rectangular, oval, convex and concave scrapers. Examples of some of these types are presented in Figures 5.26 to 5.31. Analysis of variance results (Table 5.21) using metrical measurements and ratios indicate that there are significant differences in length, breadth and thickness between the sites. The ratios for the same measurements are, however, not significantly different except for slightly higher mean values for Muguruk (Table 5.20).

Convergent Scrapers

Both convergent scrapers and points (unifacial and bifacial points) pose an interesting technological aspect within the tool categories of the samples under study. These are two different tools yet are almost similar in terms of size and shape parameters. This suggests that the technology which resulted in these categories forms the foundations upon which the manufacture of later projectile points is based. When convergent scrapers and points presented in Figures 5.28 to 5.31 are examined closely, there seems to be some similarity between convergent scrapers and points. Visually, both look similar; and may be likened to other "projectile points" such as symmetrical triangular flakes, foliate bifaces, bifacial points and tanged points found in various Middle Stone Age and Later Stone Age contexts in Africa; and examples would be classified as either a Mousterian point or a convergent scraper within European Middle Palaeolithic contexts in line with Bordes' (1961) typology.

Scraper sub-types	SITE												Total	
	Prospect Farm			Enkapune Ya Muto			Cartwright's Farm			Mugurok				
	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %
Single-sided scraper	45	26.9	80.4	6	26.1	10.7	4	3.9	7.1	1	100.0	1.8	56	19.0
Double-sided scraper	17	10.2	70.8	2	8.7	8.3	5	4.9	20.8	-	-	-	24	8.2
Racloir transverse scraper	3	1.8	60.0	-	-	-	2	1.9	40.0	-	-	-	5	1.7
Single-sided end and side scraper	4	2.4	57.1	-	-	-	3	2.9	42.9	-	-	-	7	2.4
Double-sided end and side scraper	-	-	-	1	4.3	33.3	2	1.9	66.7	-	-	-	3	1.0
Convex end scraper	21	12.6	84.0	2	8.7	8.0	2	1.9	8.0	-	-	-	25	8.5
double convex end scraper	4	2.4	80.0	-	-	-	1	1.0	20.0	-	-	-	5	1.7
Carinated end scraper	1	0.6	50.0	1	4.3	50.0	-	-	-	-	-	-	2	0.7
Oblique end scraper	3	1.8	75.0	-	-	-	1	1.0	25.0	-	-	-	4	1.4
Small convex scraper	1	0.6	100.0	-	-	-	-	-	-	-	-	-	1	.3
Circular scraper	1	0.6	11.1	1	4.3	11.1	7	6.8	77.8	-	-	-	9	3.1
Disc-like convex scraper	10	6.0	55.6	-	-	-	8	7.8	44.4	-	-	-	18	6.1
Convex scraper	8	4.8	57.1	-	-	-	6	5.8	42.9	-	-	-	14	4.8
Concave and notched scraper	12	7.2	66.7	1	4.3	5.6	5	4.9	27.8	-	-	-	18	6.1
Steep core scraper	1	0.6	33.3	-	-	-	2	1.9	66.7	-	-	-	3	1.0
Composite scraper	3	1.8	42.9	1	4.3	14.3	3	2.9	42.9	-	-	-	7	2.4
General scraper	3	1.8	60.0	1	4.3	20.0	1	1.0	20.0	-	-	-	5	1.7
Notched side scraper	5	3.0	83.3	1	4.3	16.7	0	0	0	-	-	-	6	2.0
Convergent scraper	25	15.0	30.5	6	26.1	7.3	51	49.5	62.2	-	-	-	82	27.9
Total	**167**	**100.0**	**56.8**	**23**	**100.0**	**7.8**	**103**	**100.0**	**35.0**	**1**	**100.0**	**0.3**	**294**	**100.0**

Table 5.17 Proportion of scraper sub-types in the MSA sample assemblages.

Retouch Intensity	SITE								Total	
	Prospect Farm		Enkapune Ya Muto		Cartwright's Farm		Muguruk			
	n	%	n	%	n	%	n	%	n	%
Light	84	56.0	12	70.6	0	0	1	100.0	97	36.6
Normal	51	34.0	5	29.4	85	87.6	-	-	141	53.2
Heavy	14	9.3	-	-	10	10.3	-	-	24	9.1
Stepped	1	0.7	-	-	2	2.1	-	-	3	1.1
Total	**150**	**100.0**	**17**	**100.0**	**97**	**100.0**	**1**	**100.0**	**265**	**100.0**

Table 5.18 Intensity of retouch on scrapers by site for the MSA sample assemblages.

	L	B	MB	T	B/L	T/B	T/L	PL	PB	PT
N	294	294	294	294	294	294	294	33	33	33
Range	51.9	54.8	107.8	19.0	1.3	0.6	0.6	37.6	13.6	13.8
Mean	33.8	25.0	26.3	9.4	0.8	0.4	0.3	19.5	7.2	8.9
S.E.	0.53	0.5	0.6	0.8	0.01	0.01	0.01	1.5	0.5	0.5
S.D.	9.1	7.8	9.8	3.0	0.2	0.00	0.09	8.8	2.6	2.7
Variance	82.6	61.4	95.3	9.2	0.1	0.010	0.01	77.8	6.7	7.2

Table 5.19 Metrical data for combined scraper forms from the MSA sample assemblages. L = length, B = breadth, MB = maximum breadth, T = thickness, PL = platform length, PB = platform breadth and PT = platform thickness.

		L	B	T	B/L	T/B	T/L
Prospect Farm	Mean	33.445	24.872	9.562	.7680	.3932	.2946
	n	167	167	167	167	167	167
	S.d.	9.2503	7.3599	3.0295	.21635	.10043	.08613
	Range	50.2	38.7	18.4	1.32	.55	.60
Enkapune Ya Muto	Mean	26.376	18.217	6.595	.7370	.3635	.2735
	n	23	23	23	23	23	23
	S.d.	7.7465	5.0707	2.6837	.26669	.11854	.14776
	Range	27.7	19.4	9.4	.99	.46	.55
Cartwright's Site	Mean	35.933	26.555	9.734	.7438	.3787	.2759
	n	103	103	103	103	103	103
	S.d.	8.2085	8.3431	2.7931	.16662	.09541	.06428
	Range	45.3	50.6	12.5	.73	.47	.32
Muguruk	Mean	40.500	28.310	12.950	.7000	.4600	.3200
	n	1	1	1	1	1	1
	S.d.	.	.	.	.	.	.
	Range	.0	.0	.0	.00	.00	.00
Total	Mean	33.787	24.953	9.402	.7568	.3860	.2865
	n	294	294	294	294	294	294
	S.d.	9.0881	7.8331	3.0284	.20419	.10022	.08587
	Range	51.9	54.8	19.0	1.32	.55	.62

Table 5.20: Metrical data for scraper forms by site for the MSA sample assemblages. L = length, B = breadth, T = thickness.

Test variable	Combined assemblage (Inter-assemblage variance)			Prospect Farm			Enkapune Ya Muto			Prolonged Drift			Cartwright's Farm			Muguruk		
	df	F	p	df	F	p	df	F	p	df	F	p	df	F	p	df	F	p
Length	3	7.8	.000	17	1.02	.439	10	1.52	.242	-	-	-	15	1.74	.057	-	-	-
Width	3	7.7	.000	17	2.48	.002	10	2.05	.120	-	-	-	15	4.32	.000	-	-	-
Thickness	3	8.2	.000	17	1.81	.031	10	.906	.556	-	-	-	15	2.37	.006	-	-	-
Ratio of width to length	3	0.4	.752	17	2.96	.000	10	1.16	.399	-	-	-	15	3.15	.000	-	-	-
Ratio of thickness to width	3	1.0	.378	17	1.89	.122	10	.632	.763	-	-	-	15	1.08	.388	-	-	-
Ratio of thickness to length	3	1.2	.296	17	2.59	.001	10	.601	.786	-	-	-	15	1.51	.118	-	-	-

Table 5.21 Analysis of variance results for combined and individual assemblage scraper measurements. df = degree of freedom, F = statistical measure (similarity between and within population sets using observed and expected means), and p = probability.

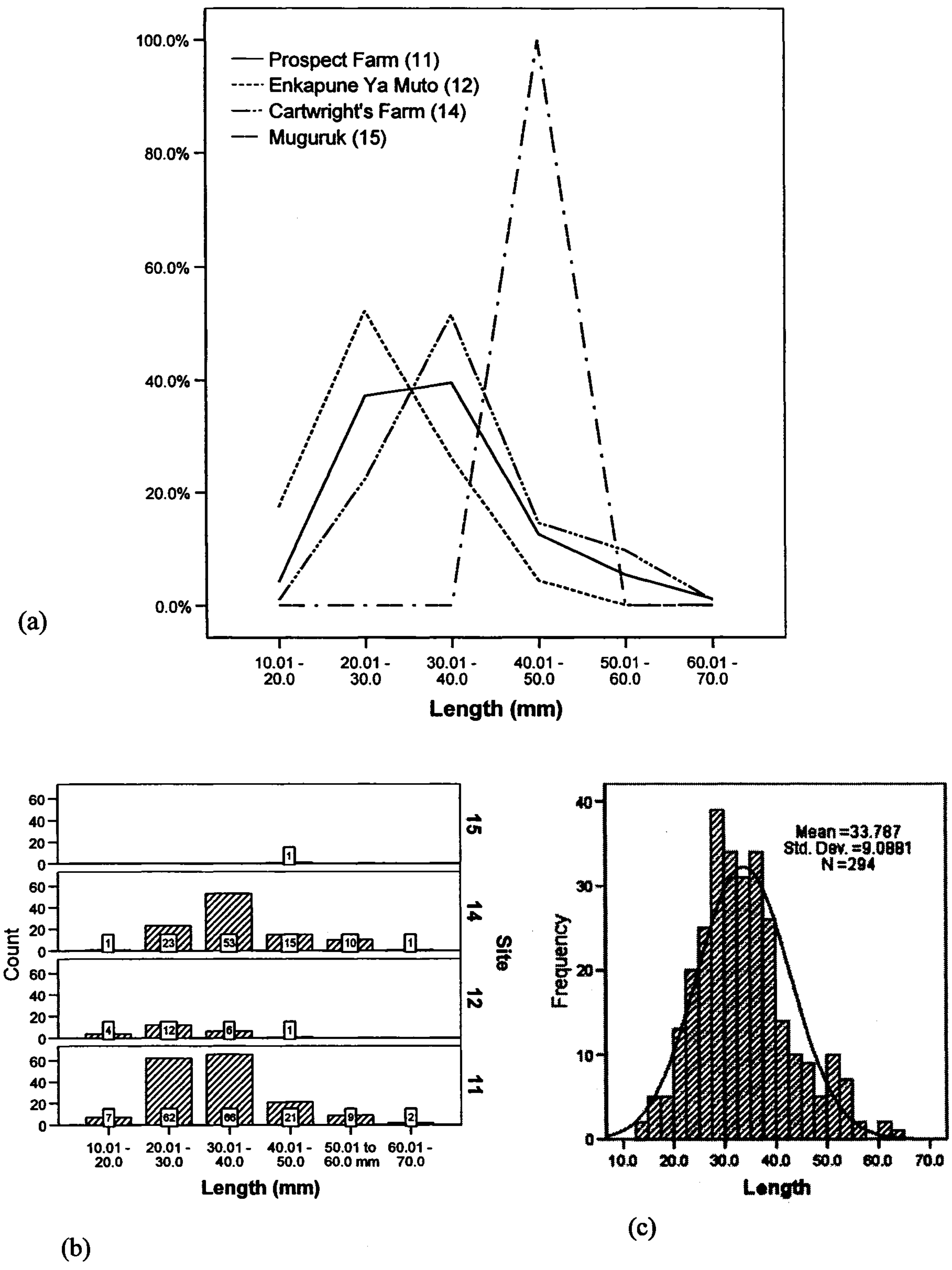


Figure 5.20 Scraper length: (a) percentage frequency distribution, (b) distribution of counts within length classes, and (c) nature of spread for the distribution in the combined MSA sample assemblage.

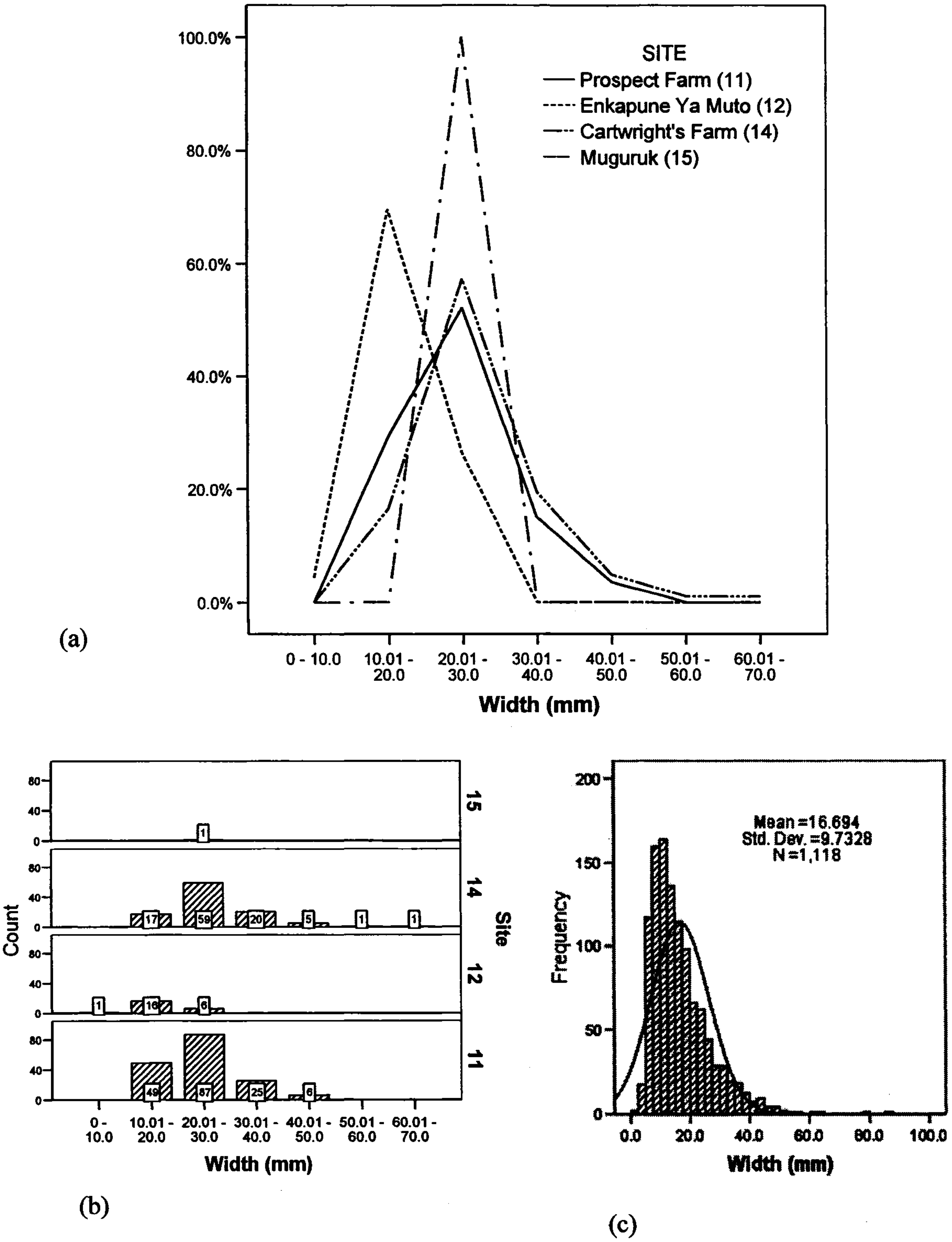


Figure 5.21 Scraper width: (a) percentage frequency distribution, (b) distribution of counts within width classes, and (c) nature of spread for the distribution in the combined MSA sample assemblage.

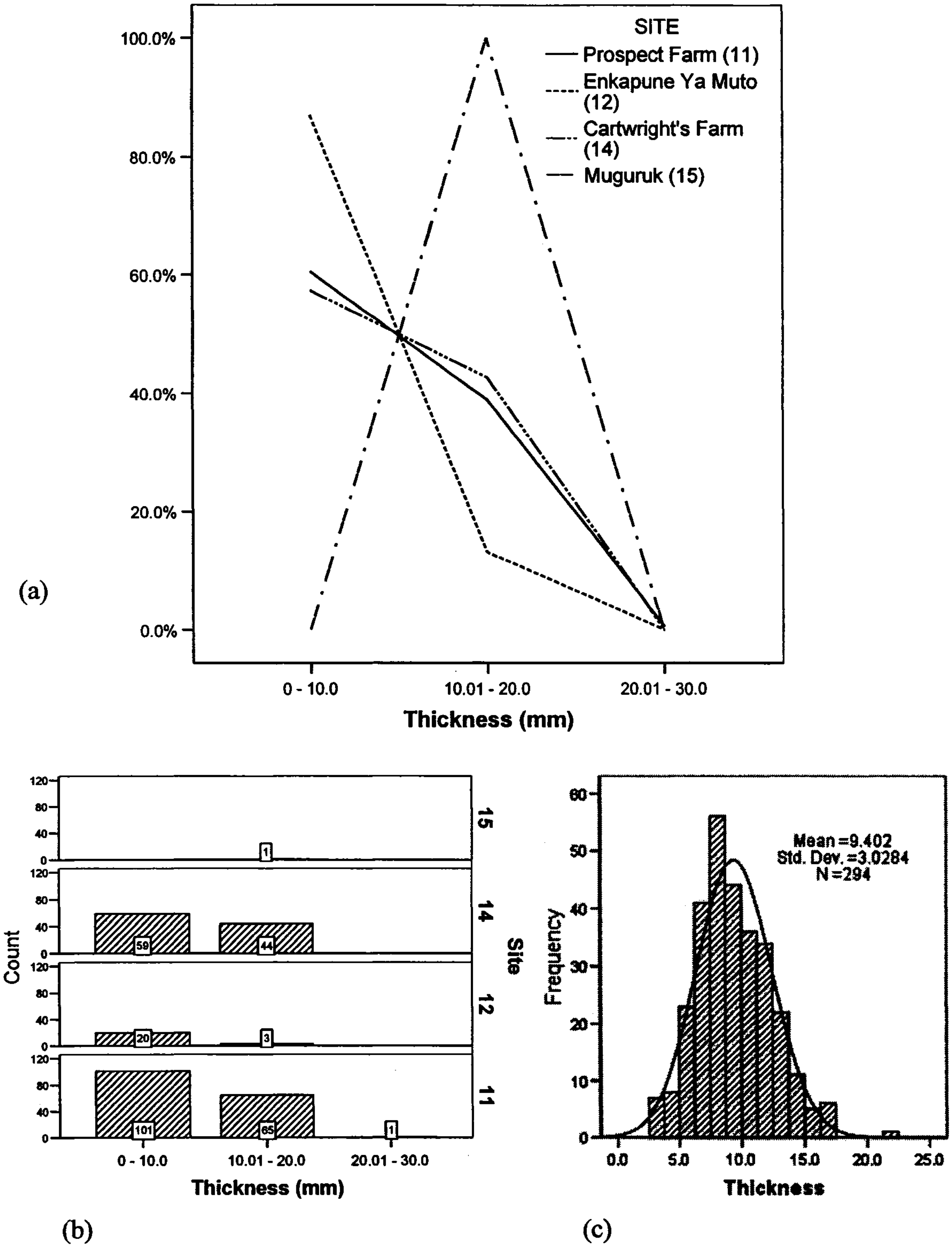


Figure 5.22 Scraper thickness: (a) percentage frequency distribution, (b) distribution of counts within thickness classes, and (c) nature of spread for the distribution in the combined MSA sample assemblage.

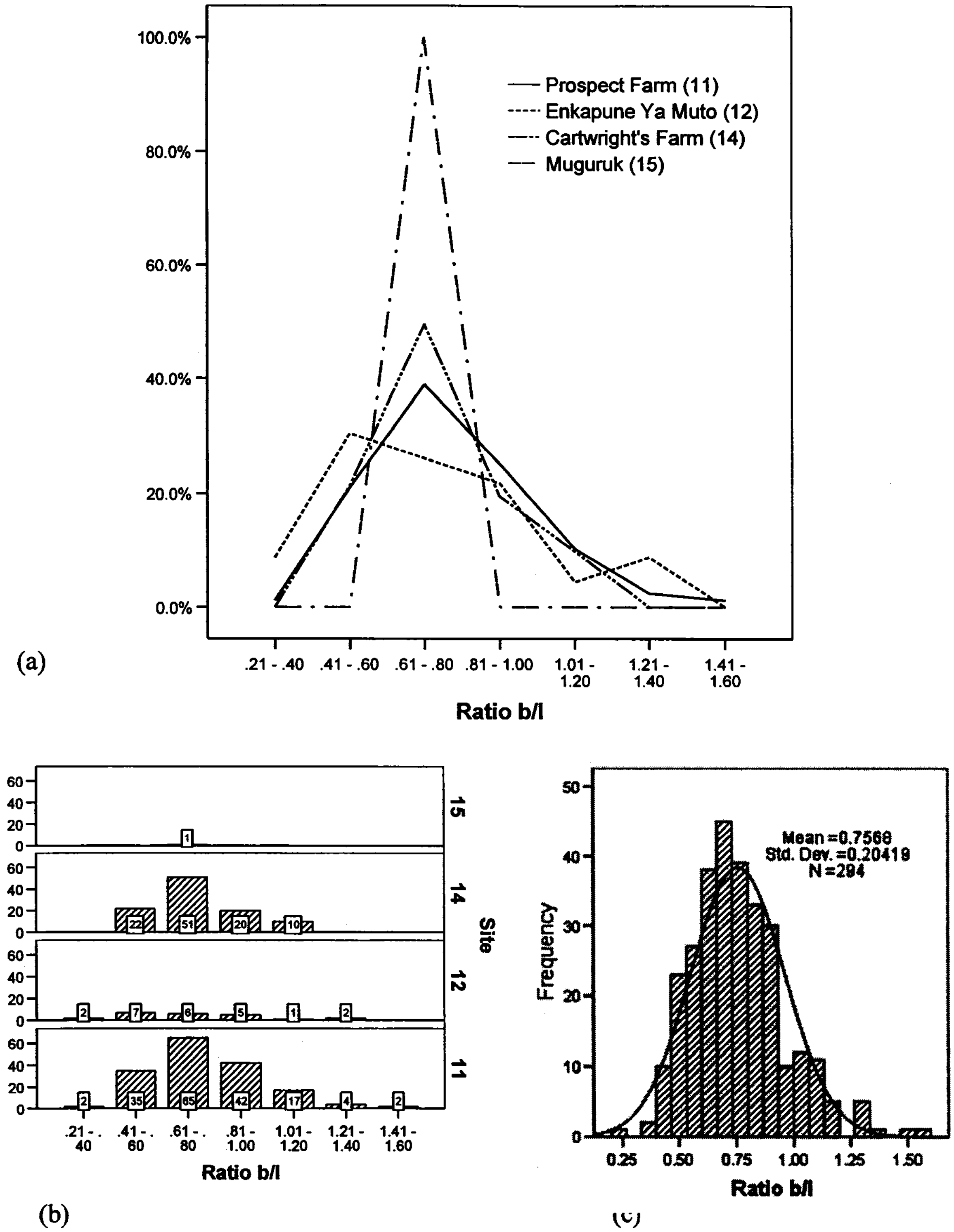


Figure 5.23 Scraper breadth/length ratio: (a) percentage frequency distribution, (b) distribution of counts within breadth/length ratio classes, and (c) nature of spread for the distribution in the combined MSA sample assemblage.

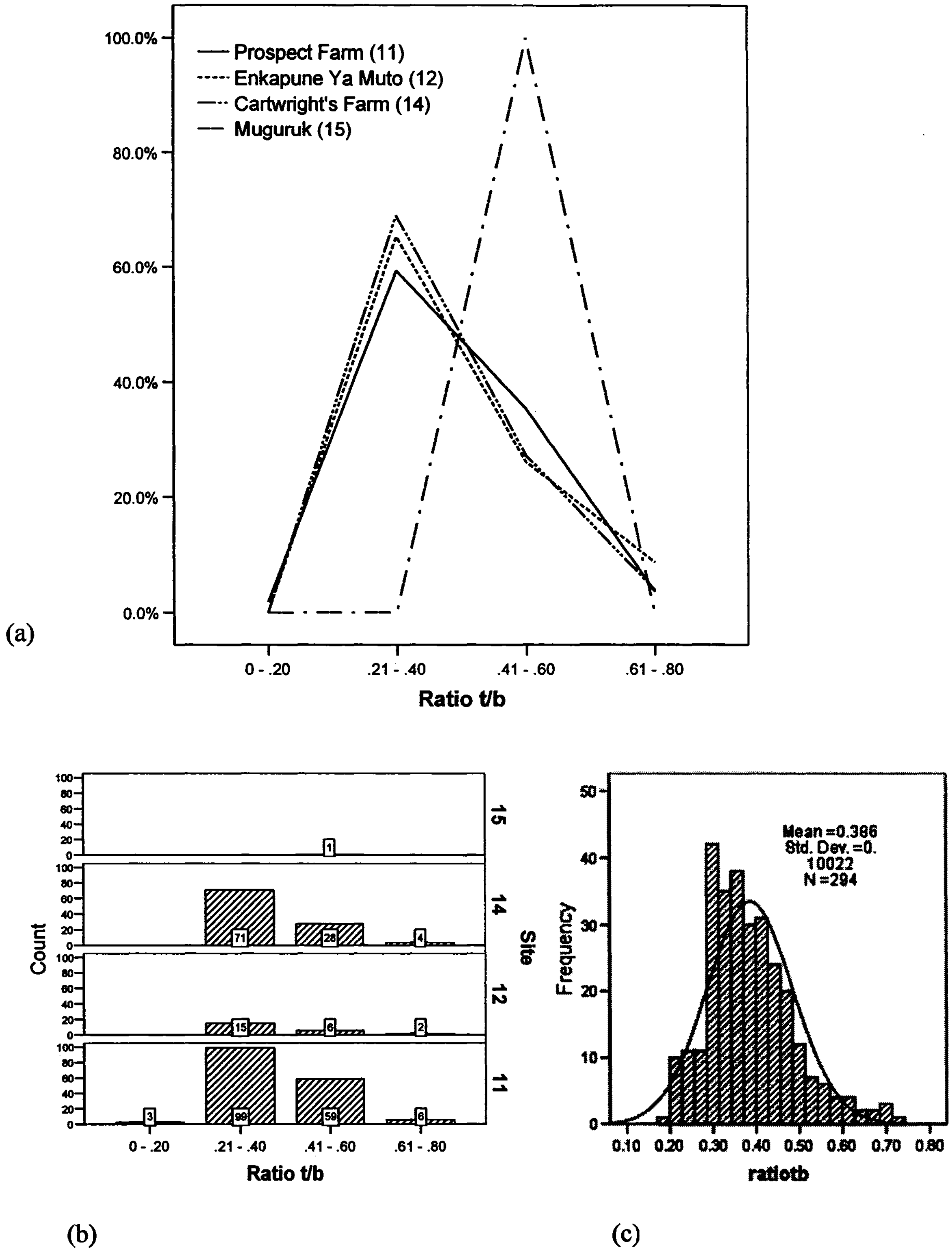


Figure 5.24 Scraper thickness/breadth ratio: (a) percentage frequency distribution, (b) distribution of counts within thickness/breadth ratio classes, and (c) nature of spread for the distribution in the combined MSA sample assemblage.

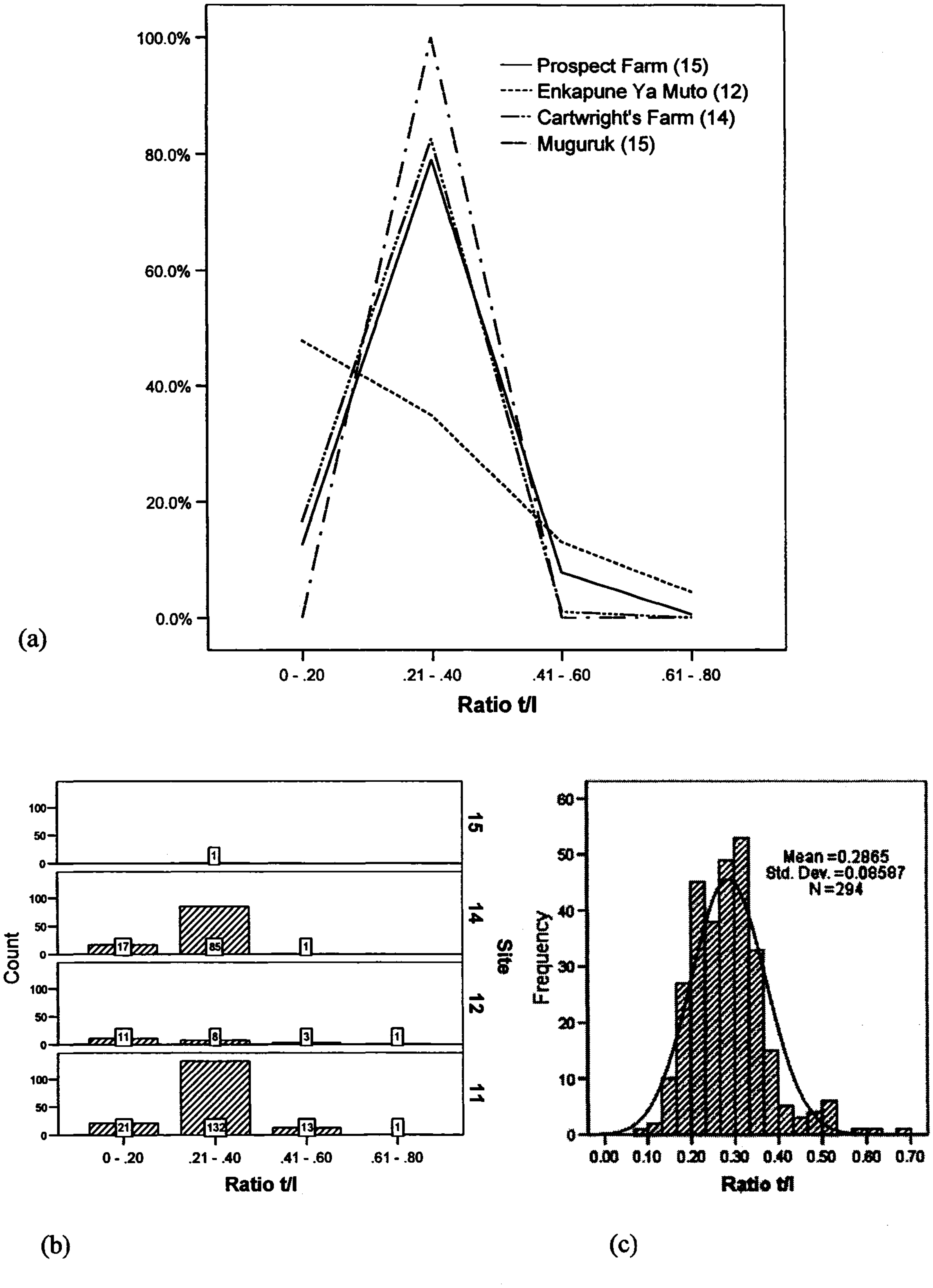


Figure 5.25 Scraper thickness/length ratio: (a) percentage frequency distribution, (b) distribution of counts within thickness/length ratio classes, and (c) nature of spread for the distribution in the combined MSA sample assemblage.

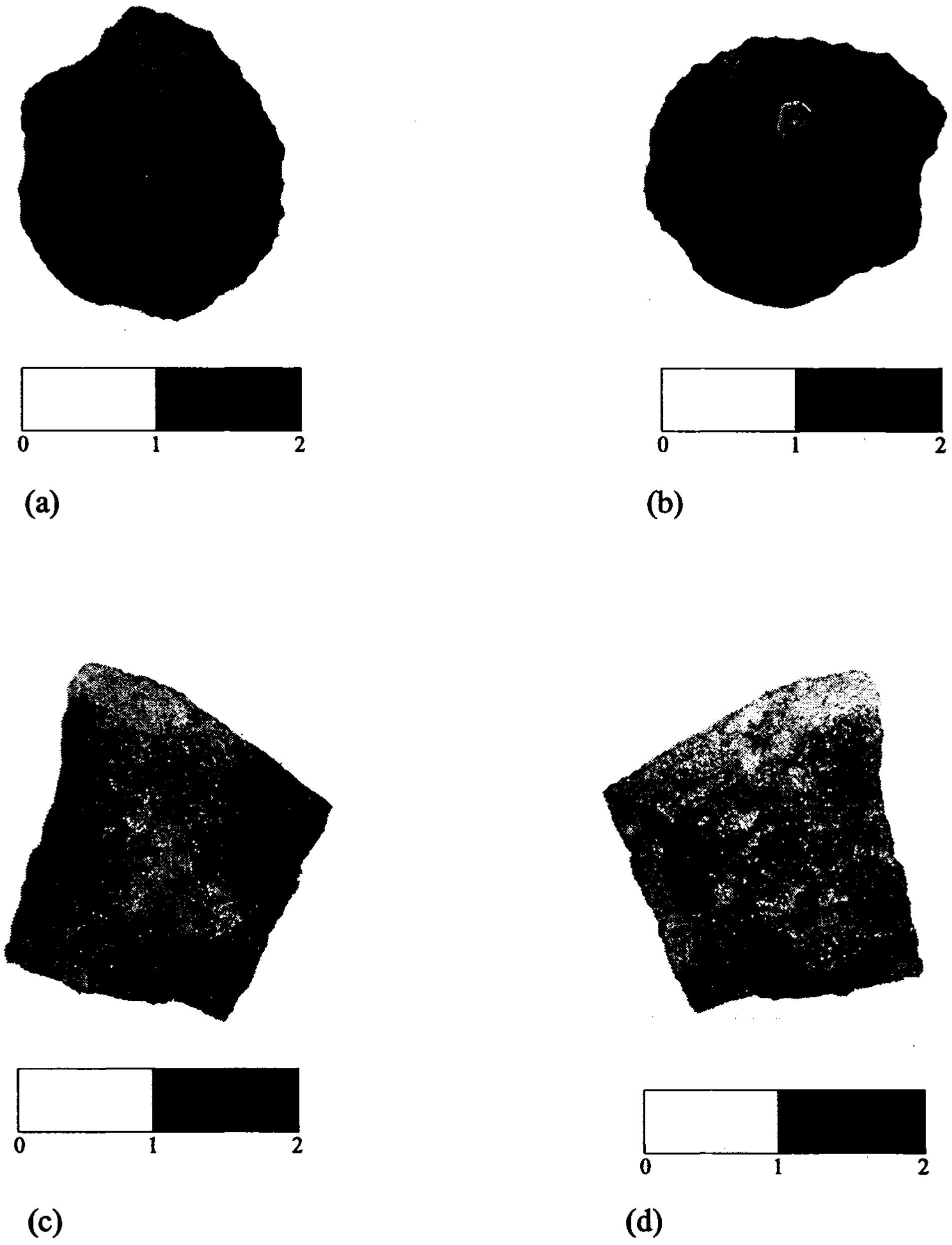


Figure 5.26 An obsidian circular scraper from Prospect Farm and quartz side-scraper from Enkapune Ya Muto: (a) and (c) show dorsal sides and (b) and (d) ventral sides.

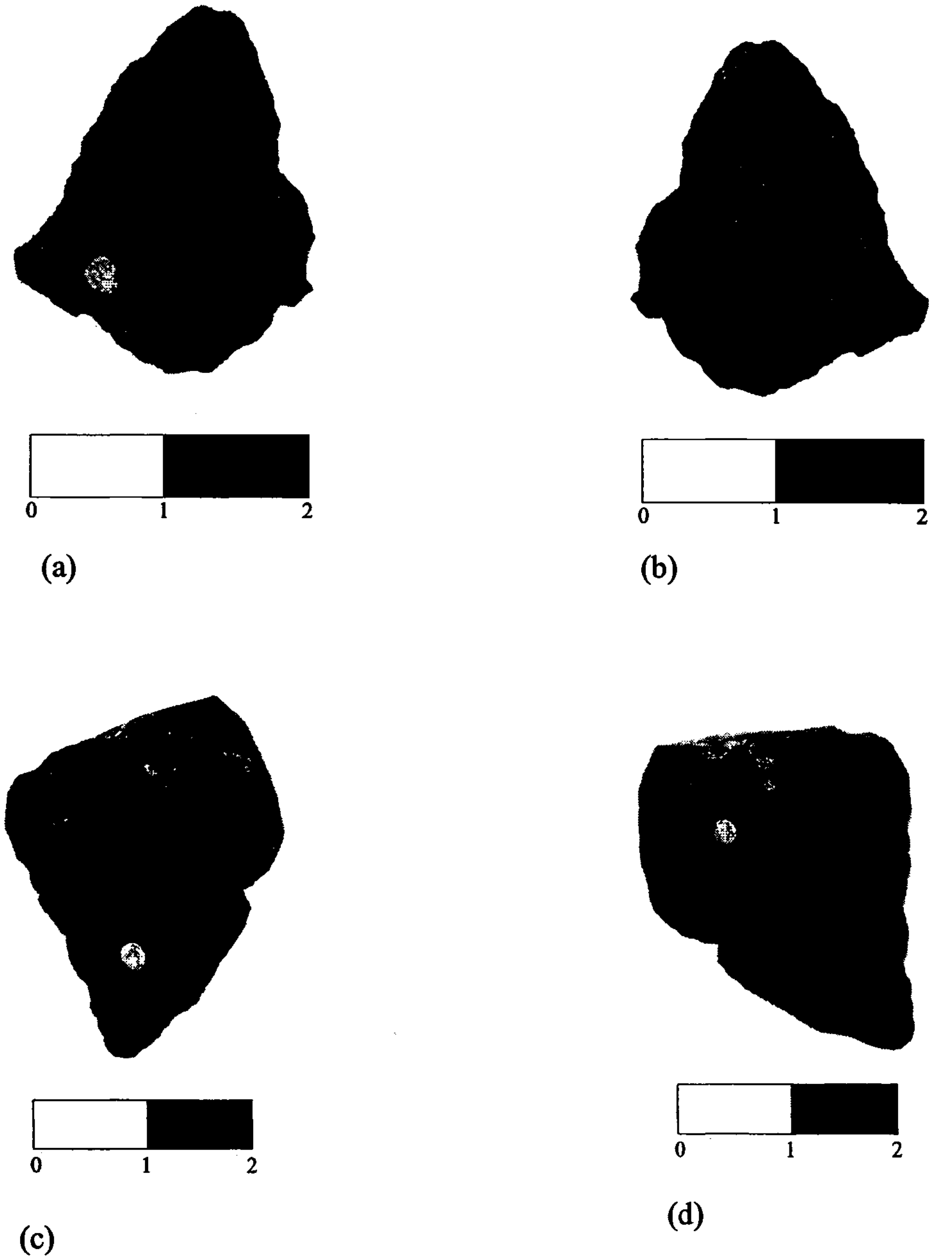
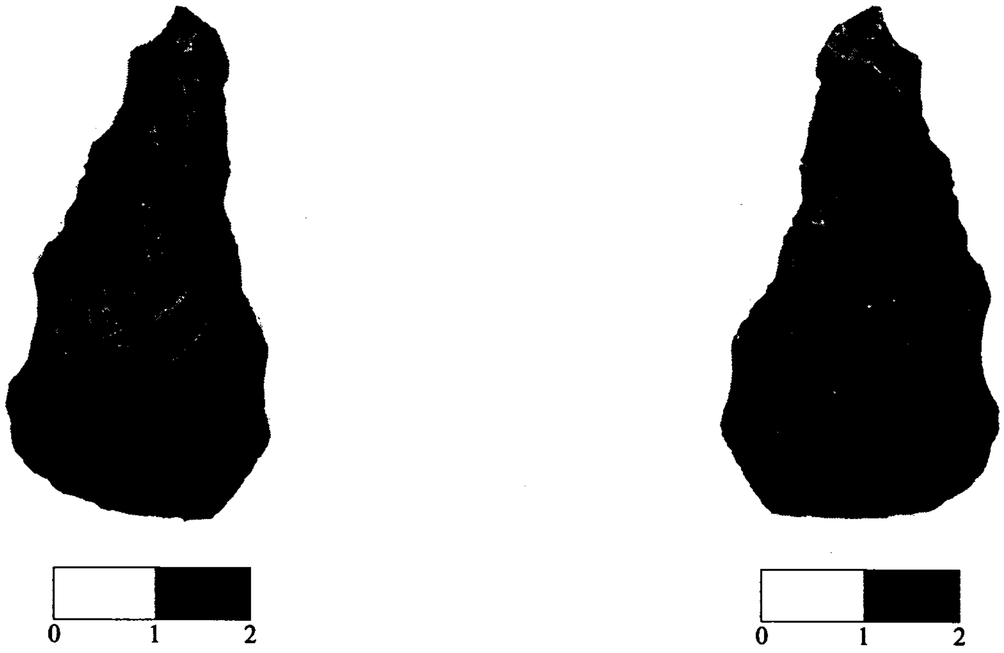


Figure 5.27 Obsidian side-scrapers made on triangular flake blanks from Prospect Farm: (a) and (c) show the dorsal side while (b) and (d) the ventral side.



(a) (b)

Figure 5.28 A convergent scraper from Prospect Farm: (a) dorsal side and (b) ventral side.

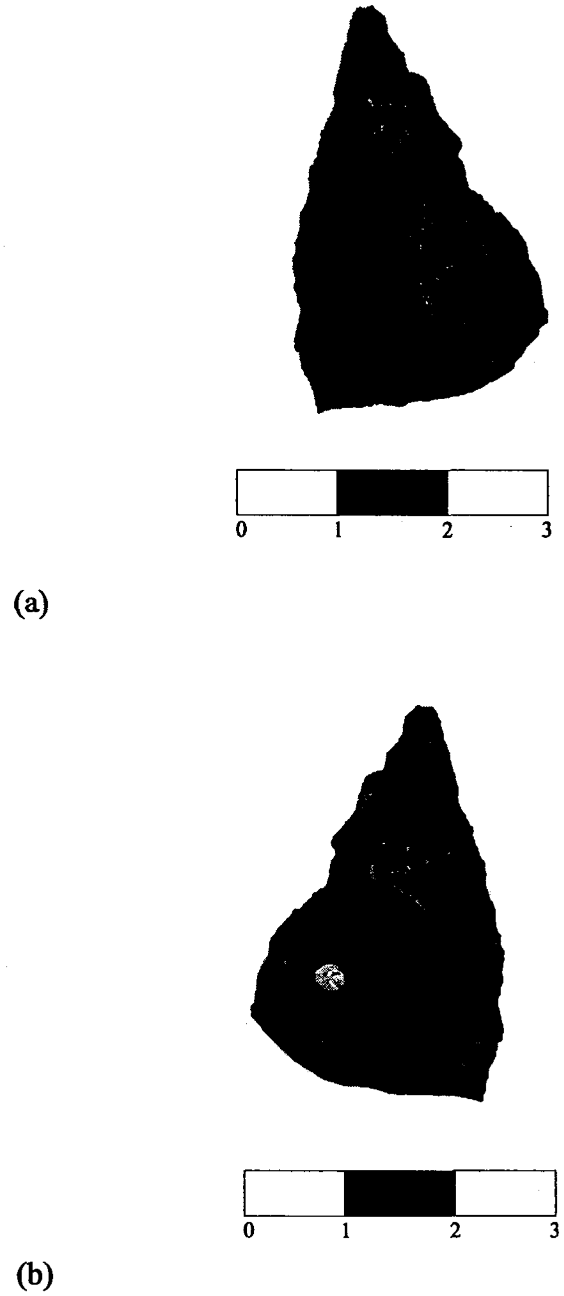


Figure 5.29 A unifacial point from Prospect Farm: (a) dorsal side and (b) ventral side.

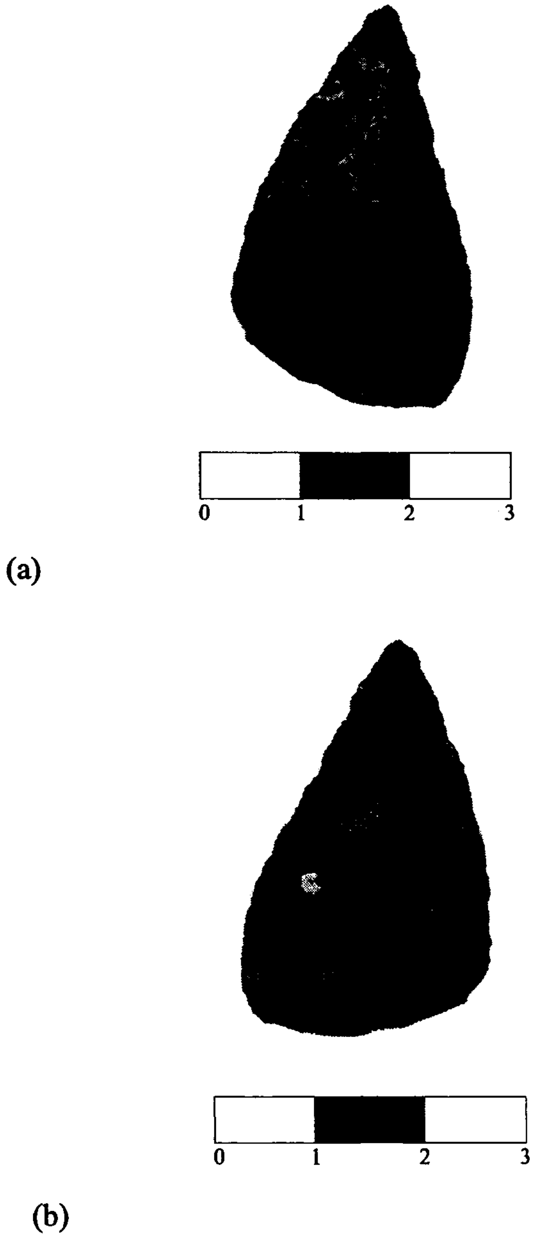


Figure 5.30 A bifacial point from Prospect Farm: (a) dorsal and (b) ventral sides.

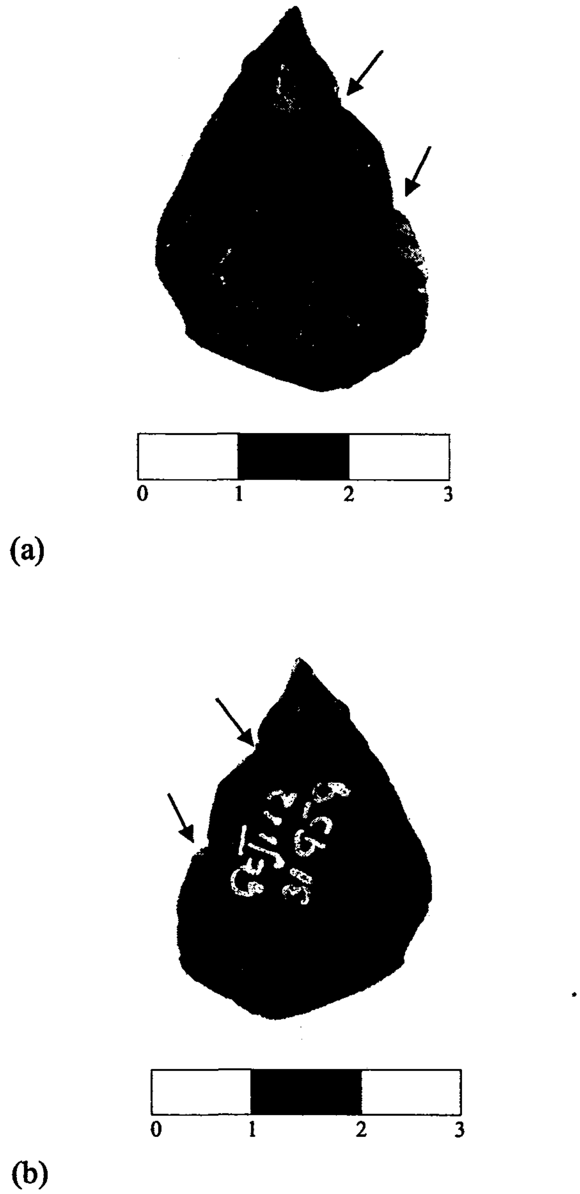


Figure 5.31 A unifacial point from Enkapune Ya Muto with dented edge indicating possible use shown by the arrows: (a) dorsal and (b) ventral side.

This means that there is only a thin technological line dividing these two forms of tools. This is significant in attempts to understand the decisions that governed the tool making process; and also the emergence of modern human behaviour. When does a tool become a point and not a convergent scraper? Such a decision must have involved a well thought out pattern of activities that is not far removed from that of modern thinkers.

Technologically, the analysed convergent scrapers had two retouched sides converging into a pointed end or tip. Most are made on triangular flakes or convergent flakes (Table 5.22) with wide unworked or minimally modified butt ends. A mixture of light and normal retouch, involving shallow and discontinuous and continuous and moderately invasive retouch (Table 5.23) on the edges, was applied to the dorsal surfaces, but not always. Such retouch was probably done using direct freehand soft hammer technique, involving holding a flake blank in one hand and using a flaking implement held in the other hand to remove tiny flakes from the edges as desired.

Most of the pieces have bulbs and striking platforms destroyed in the process of retouch or trimming of the pieces to attain desired shape forms. However, most of the convergent scrapers are also less refined compared to either unifacial or bifacial points. The degree of refinement allows for the overall symmetry, modification or working of the butt end, as well as thinness of pieces to be used as differentiating features between the two tool categories. The absence of cortex cover on most convergent scrapers, as shown in Table 5.24, indicates that their production comes later in the reduction trajectory. Also, in terms of artefact preservation, most are fresh (Table 5.25) except for the Cartwright's Farm sample, which shows a higher percentage of worn artefacts.

Analysis of variance using measured attributes and ratios (Table 5.26) indicates that there is little difference between convergent scrapers across the MSA assemblages. Equally, there are no significant differences between unifacial points from the three assemblages compared. This implies that similar technological approaches were applied at all the sites where these artefacts are found. The F-values are significantly similar for length, breadth and thickness as well as the ratios that incorporate these measurements. Mean values presented in Figures 5.32 and 5.33 further show a significant similarity in length, breadth, maximum breadth and thickness at Prospect Farm and Cartwright's Farm. At Enkapune Ya Muto, however, low values indicate that convergent scrapers are slightly smaller than those from the other sites. Such differences could be the result of reduction strategies at the different sites, with reduction at Enkapune Ya Muto aimed at maximisation of core and flake blanks as a result of scarcity or importation of raw materials.

Points

Points (both unifacial and bifacial) are technologically distinct from convergent scrapers in terms of refinement and overall shape. Most of the forms are unifacial, with only a few bifacial pieces in the sample (Table 5.27). While the overall shape of the pieces may vary, both are generally symmetrical relative to the lines of retouch; and have a thin cross-section. Most of the unifacial points are made on convergent flakes or flake fragments (Table 5.28), and have more refined butt ends compared to convergent scrapers.

Plan form	SITE										
	Prospect Farm			Enkapune Ya Muto			Cartwright's Farm			Total	
	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Col. %
Convergent	25	100.0	32.1	6	100.0	7.7	47	92.2	60.3	78	95.1
Intermediate	-	-	-	-	-	-	4	7.8	100.0	4	4.9
Total	**25**	**100.0**	**30.5**	**6**	**100.0**	**7.3**	**51**	**100.0**	**62.2**	**82**	**100.0**

Table 5.22 Plan form for convergent scrapers by site

Retouch intensity	SITE										
	Prospect Farm			Enkapune Ya Muto			Cartwright's Farm			Total	
	n	Column %	Row %	n	Column %	Row %	n	Column %	Row %	n	Column %
Light	17	70.8	81.0	4	80.0	19.0	-	-	-	21	26.6
Normal	5	20.8	10.2	1	20.0	2.0	43	86.0	87.8	49	62.0
Heavy	2	8.3	28.6	-	-	-	5	10.0	71.4	7	8.9
Stepped	-	-	-	-	-	-	2	4.0	100.0	2	2.5
Total	**24**	**100.0**	**30.4**	**5**	**100.0**	**6.3**	**50**	**100.0**	**63.3**	**79**	**100.0**

Table 5.23 Intensity of retouch by site on convergent scrapers.

Cortex	SITE						Total	
	Prospect Farm		Enkapune Ya Muto		Cartwright's Farm			
	n	%	n	%	n	%	n	%
Absent	24	96.0	5	83.3	49	96.1	78	95.1
Present	1	4.0	1	16.7	2	3.9	4	4.9
Total	**25**	**100.0**	**6**	**100.0**	**51**	**100.0**	**82**	**100.0**

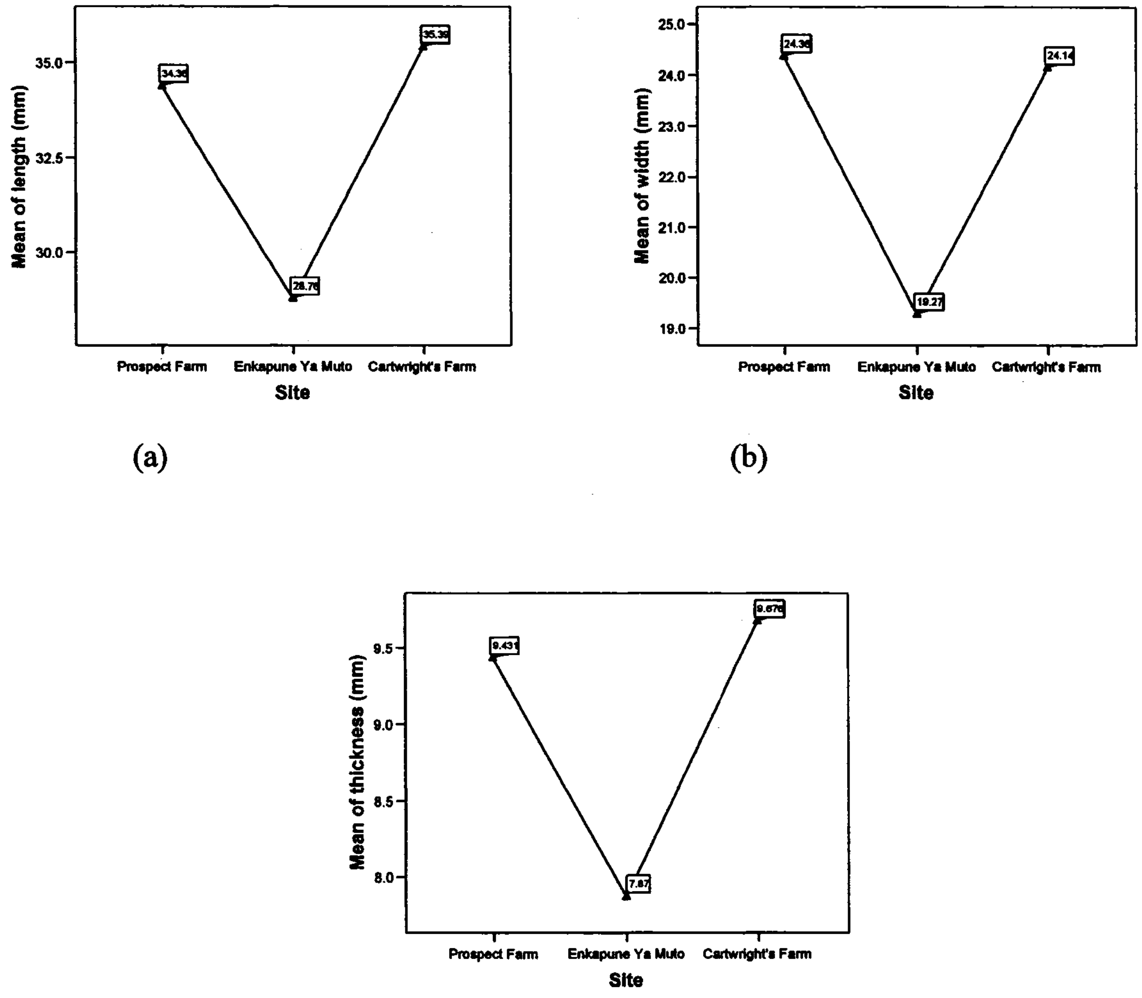
Table 5.24 Presence and absence of cortex by site for convergent scrapers in the MSA sample assemblages.

Abrasion	SITE						Total	
	Prospect Farm		Enkapune Ya Muto		Cartwright's Farm			
	n	%	n	%	n	%	n	%
Fresh	19	76.0	5	83.3	19	37.3	43	52.4
Worn	6	24.0	1	16.7	32	62.7	39	47.6
Total	**25**	**100.0**	**6**	**100.0**	**51**	**100.0**	**82**	**100.0**

Table 5.25 Weathering by site on convergent scrapers in the MSA sample assemblages.

Tested variables	Convergent scrapers				Unifacial points			
	n	df	F	p	n	df	F	p
Length	82	2	1.748	.181	66	2	1.441	.244
Width/Breadth	82	2	2.392	.098	66	2	3.825	.027
Thickness	82	2	1.404	.252	66	2	.967	.386
Ratio B/L	82	2	.789	.458	66	2	1.429	.247
Ratio T/B	82	2	.198	.821	66	2	4.620	.013
Ratio T/L	82	2	.198	.821	66	2	3.220	.046

Table 5.26 Analysis of variance results for convergent scrapers and unifacial points in the sample assemblage. df = degree of freedom, F = statistical measure (similarity between and within population sets using observed and expected means), and p = probability.

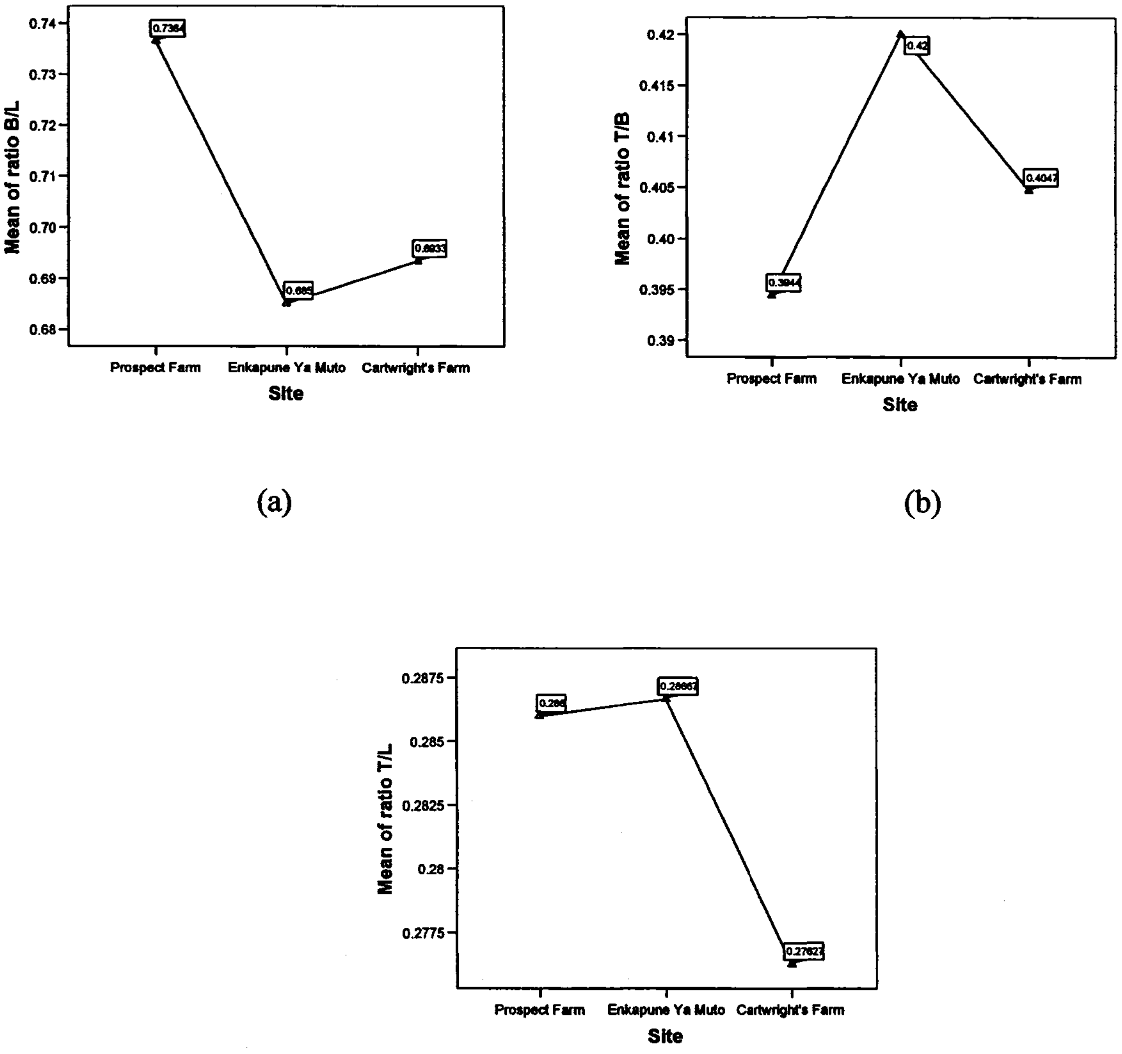


(a)

(b)

(c)

Figure 5.32 Comparison of site mean measurements for convergent scrapers: (a) length, (b) width, and (c) thickness.



(a)

(b)

(c)

Figure 5.33 Comparison of site mean ratios for convergent scrapers: (a) breadth/length ratio, (b) thickness/breadth ratio, and (c) thickness/length ratio.

Retouch intensity for this category is mainly normal (Table 5.29) along the convergent sides, and is marginally and/or sub-invasively (Table 5.30) applied on either the dorsal or ventral sides. Edges are distinct and sharper than those of convergent scrapers. Similar technology in retouching convergent scrapers may have been used in making points.

Striking platforms and bulbs are not easily identifiable on most points due to heavy trimming of pieces to shape them up. Equally lacking on most of the pieces is the cortex cover (Table 5.31), indicating their late production in the reduction trajectory, and heavy trimming to arrive at the desired size and shape.

Table 5.32 shows that about 42% of the total sample of points is weathered. Most of these come from Cartwright's Farm. Pieces from Prospect Farm, on the other hand, exhibit less weathering but heavy patination on artefacts due to the chemical content of the matrix from which the artefacts were extracted.

Analysis of variance using measured attributes and ratios provided in Table 5.26 indicates that F-values for length, thickness and ratio of breadth to length (B/L) are similar across the sites. This implies that the manufacture of points was controlled, leading to the production of standard sizes at all sites. Shape-defining measures, particularly length, the ratio of thickness to breadth (T/B) and thickness to length (T/L), however, indicate that there are slight differences in cross-section between sites. Some points are asymmetric relative to the longitudinal axis.

Comparison of mean values for measured attributes and corresponding ratios (Figures 5.34 and 5.35) reveal significant details for understanding technological features on points in relation to the assemblages. Points from Prospect Farm and Cartwright's

Farm are slightly longer and wider than those from Enkapune Ya Muto, which are slightly thinner. However, mean values for various ratios (breadth/length, thickness/breadth and thickness/length) indicate an insignificant difference; and therefore show that the points are similar in shape, or at least have a tendency toward shaped implements.

Sub-types	**SITE** **Prospect Farm**		**Enkapune Ya Muto**		**Cartwright's Farm**		**Total**	
	n	%	n	%	n	%	n	%
Unifacial point	22	75.9	3	100.0	44	93.6	69	87.3
Bifacial point	7	24.1	-	-	3	6.4	10	12.7
Total	**29**	**100.0**	**3**	**100.0**	**47**	**100.0**	**79**	**100.0**

Table 5.27 Proportion of point categories by site in the MSA sample assemblages.

Plan form	**SITE** **Prospect Farm**		**Enkapune Ya Muto**		**Cartwright's Farm**		**Total**	
	n	%	n	%	n	%	n	%
Convergent	20	90.9	2	66.7	42	95.5	64	92.8
Intermediate	2	9.1	1	33.3	2	4.5	5	7.2
Total	**22**	**100.0**	**3**	**100.0**	**44**	**100.0**	**69**	**100.0**

Table 5.28 Plan form by site for unifacial points category in the MSA sample assemblages

Retouch intensity	SITE Prospect Farm		Enkapune Ya Muto		Cartwright's Farm		Total	
	n	%	n	%	n	%	n	%
Light	7	43.8	1	100.0	-	-	8	13.1
Normal	6	37.5	-	-	39	88.6	45	73.8
Heavy	1	6.3	-	-	5	11.4	6	9.8
Stepped	2	12.5	-	-	-	-	2	3.3
Total	**16**	**100.0**	**1**	**100.0**	**44**	**100.0**	**61**	**100.0**

Table 5.29 Intensity of retouch by site for unifacial points category in the MSA sample assemblages.

Extent of retouch	SITE Prospect Farm		Enkapune Ya Muto		Cartwright's Farm		Total	
	n	%	n	%	n	%	n	%
Marginal	7	43.8	1	100.0	30	68.2	38	62.3
Sub-invasive	7	43.8	-	-	12	27.3	19	31.1
Invasive	2	12.5	-	-	2	4.5	4	6.6
Total	**16**	**100.0**	**1**	**100.0**	**44**	**100.0**	**61**	**100.0**

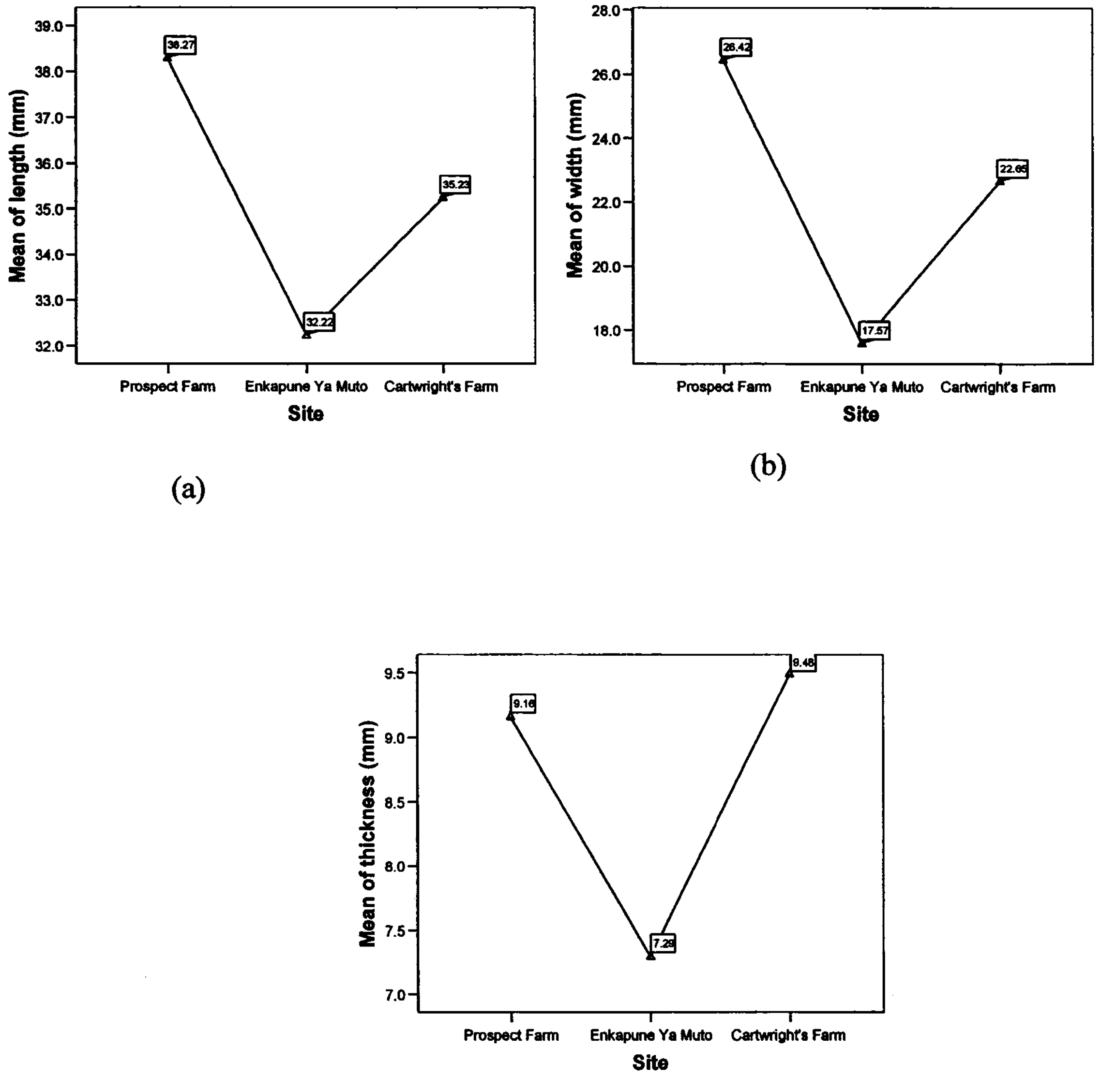
Table 5.30 Extent of retouch by site on unifacial points in the MSA sample assemblages.

Cortex	SITE Prospect Farm		Enkapune Ya Muto		Cartwright's Farm		Total	
	n	%	n	%	n	%	n	%
Absent	18	81.8	2	66.7	44	100.0	64	92.8
Present	4	18.2	1	33.3	-	-	5	7.2
Total	**22**	**100.0**	**3**	**100.0**	**44**	**100.0**	**69**	**100.0**

Table 5.31 Presence and absence of cortex on unifacial points by site in the MSA sample assemblages.

Abrasion	SITE Prospect Farm		Enkapune Ya Muto		Cartwright's Farm		Total	
	n	%	n	%	n	%	n	%
Fresh	17	77.3	2	66.7	21	47.7	40	58.0
Worn	5	22.7	1	33.3	23	52.3	29	42.0
Total	**22**	**100.0**	**3**	**100.0**	**44**	**100.0**	**69**	**100.0**

Table 5.32 Weathering by site on unifacial points in the MSA sample assemblages.



(a)

(b)

(c)

Figure 5.34 Comparison of site mean measurements for unifacial points: (a) length, (b) width, and (c) thickness.

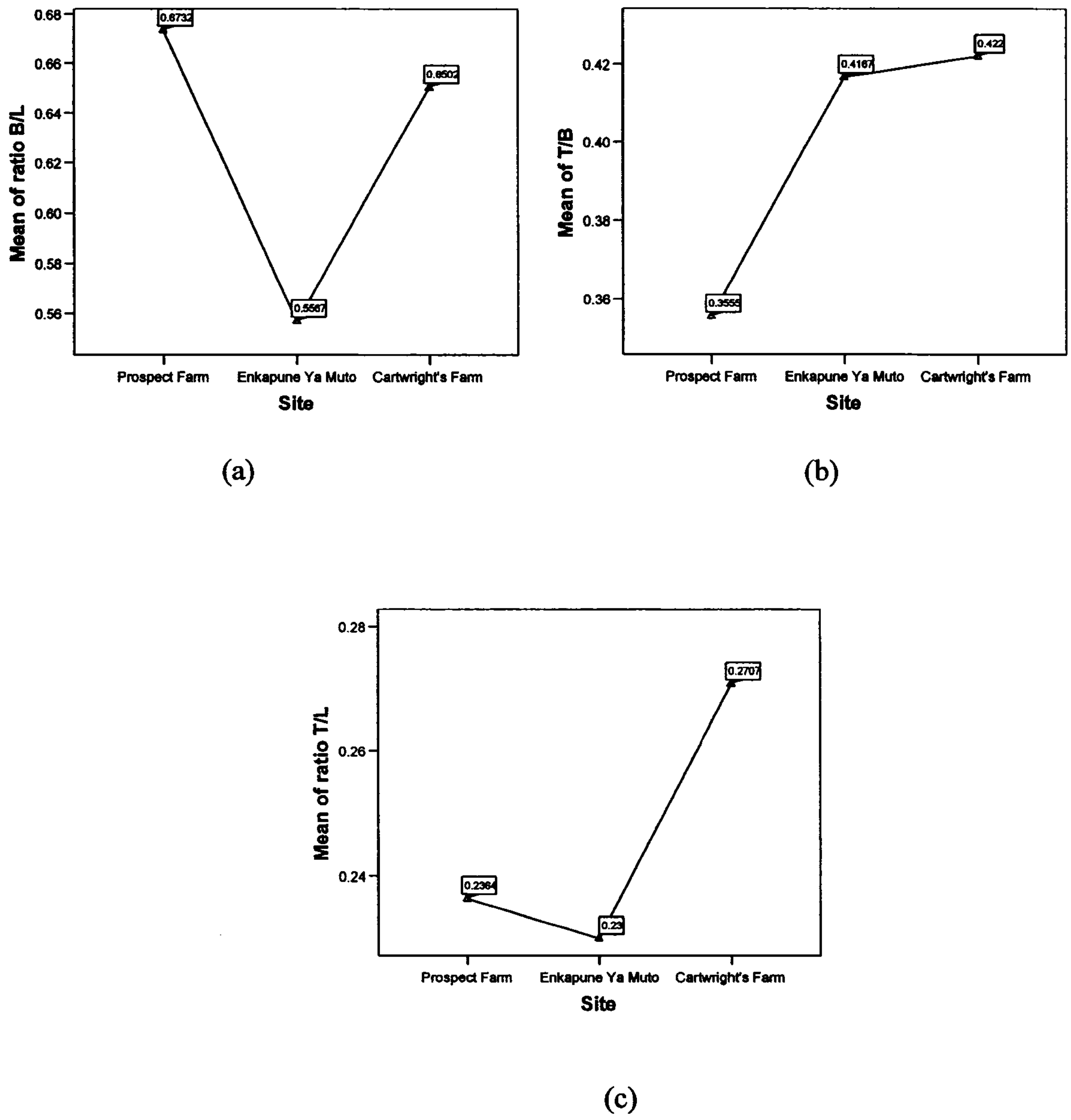


Figure 5.35 Comparison of site mean ratios for unifacial points: (a) breadth/length ratio, (b) thickness/breadth ratio, and (c) thickness/length ratio.

5.3 Summary

Raw material analysis

This analysis sampled 3,218 flaked stone artefacts. The most common raw material is obsidian (n = 2,982, 92.7%). Basalt is a distant second (n = 190, 5.6%). Twenty-one pieces (0.7%) are made of quartz, while nineteen (0.6%) are made of chert. The remaining six pieces (0.19%) are divided equally between quartzite, OMR, and OSR.

Materials from the Central Rift Valley sites (Prospect Farm, Enkapune Ya Muto, Prolonged Drift, and Cartwright's Farm) are almost exclusively made of obsidian, while those from the Lake Victoria Basin site (Muguruk) are made of basalt/other lava. Obsidian from the Central Rift Valley sites comes from different outcrops within the region, where extraction occurred before the raw material was shaped and transported to the different sites for stone tool manufacture. The presence of obsidian of different origins at the various sites implies that raw materials or artefacts were transported considerable distances before or after some kind of reduction. Such movements bring the acquisition of raw materials during this time in conformity with that of hunter-gatherer societies characterised by use of both local and exotic materials.

At Muguruk, lava, especially ombo phonolite, formed the main raw material; and was locally available. Exotic materials, especially obsidian from the Central Rift and quartz, were also sought. This underscores the emerging appreciation of the value of different rock types in stone tool manufacture, which paved the way for inter-regional exchange patterns.

The exclusive use or preference for obsidian at the Central Rift Valley sites may be due to superior flaking qualities over basalt, and also its abundance compared to other materials such as cryptocrystalline forms possessing similar superior qualities. Basalt was preferred at Muguruk because of its abundance. The long distance (more than 160 km) to obsidian sources at the Central Rift Valley sites may also have limited the use of this raw material at the site. At the same time other raw materials, such as quartz, quartzite, and chert, which could be used as alternatives, are generally scarce in the vicinity of the site. Overall, considering the distances raw materials were transported, as presented in Tables 5.2 and 5.3, the use of both local and exotic materials indicates an emerging pattern of long-distance or inter-regional interaction between the makers of MSA assemblages.

Typological analysis

All artefacts (n = 3,218) were sampled from previously excavated assemblages, and were analysed comparatively to understand MSA technology in relation to modern human behaviour. The most common artefact type is the flake (n = 2,026, 63%), which also includes flake fragments. Shaped artefacts (tools) are the second most common (n = 598, 18.6%), and contain a number of sub-divisions defining various tool categories. Next are cores and core fragments (n = 470, 14.6%), a category called general debitage (n = 98, 3%) that could not be assigned to any of the major categories; and blade and blade-like pieces (n = 26, 0.8%) that also include modified forms. Most materials come from Prospect Farm (n = 1,672, 52.0%), followed by Enkapune Ya Muto (n = 783, 24.3%), Prolonged Drift (n = 404, 12.6%), Cartwright's Farm (n = 238, 7.4%), and Muguruk (n = 121, 3.8%).

The presence of all artefact categories at Prospect Farm, Enkapune Ya Muto, and Muguruk implies that manufacturing occurred at these localities. While the same could be true for Prolonged Drift and Cartwright's Farm, the scarcity of cores indicates that artefact manufacture may have been done elsewhere and finished products were brought into these sites. Alternatively, initial core reduction occurred elsewhere, and blanks were brought to these sites for the remaining flaking stages.

Flake characteristics, such as the dorsal and ventral surfaces, striking platforms, bulb of percussion, and flake scars, are identifiable on most of the flakes and flake fragments as well as the various tool categories. The dominance of flake and flake-tools suggest that core reduction was aimed at producing pieces that could be further shaped through retouching or trimming into desired end products. In this process, both formal and informal (non-opportunistic and opportunistic) reduction strategies were applied. The appearance of a few blades may be a reflection of an emerging sophistication in stone tool manufacture. The relatively diverse nature of artefacts in the assemblages, as shown in Tables 5.4 and 5.7, and discussed in Section 5.2.2 (ii), also reflects an emerging pattern of diversification hitherto lacking in stone tool manufacture, which is mostly associated with later advanced technologies.

Core Analysis

Four hundred seventy (470) cores and core fragments were examined. The most common type in this category was core fragments (n = 207, 44%). Two pieces labelled as casual cores may belong to this group, even though they were placed in the general range of cores. The next common type is irregular core (n = 125, 26.6%), followed by regular core approaching radial discoidal core (n = 55, 11.7%), and regular single-platform prismatic core (n = 24, 5.1%). Others include non-regular double-platform core (n = 17, 3.6%), radial core (n = 12, 2.6%), non-regular multiple-platform core (n = 12, 2.6%), and non-regular single-platform core (n = 9, 1.9%). The remaining forms, regular core approaching Levallois, and regular single platform pyramidal cores, account for less than 2% of the total.

Core types represented in the samples (Table 5.5) resulted from a flexible reduction procedure that combined both unidirectional and multidirectional strategies involving use of formal and informal approaches to stone tool manufacture. A multidirectional reduction strategy was the most common; and involved the use of radial core reduction, Levallois core reduction, and bipolar core reduction techniques on a variety of different sizes of objective pieces. Simple radial cores together with regular cores approaching radial discoidal cores comprise about 14.3% of the total core sample. These reflect the traditional Levallois techniques in which flakes are removed from a prepared surface, usually in a centripetal pattern. Regular single-platform prismatic and pyramidal cores together with regular cores approaching Levallois cores make up about 6.6% of the total core sample. These further underscore the use of Levallois technique, in which specific parts of the core are prepared for piece by piece removal of flakes in the reduction process.

Single-platform cores also indicate the use of a unidirectional reduction strategy. Prismatic and pyramidal forms fall into this category; and reflect abundance of raw material where such strategies were applied, in this case at Prospect Farm. Unidirectional strategies are non-economical, and tend to be common at sites where there is high percentage of raw material availability.

Non-regular double-platform and multiple-platform cores together with irregular cores indicate that the artisans at these MSA sites had mixed preferences for reduction strategies. Irregular cores are of significant quantities throughout the assemblages, meaning an overwhelming use of multidirectional reduction strategy. Most of these pieces do not show their pre-core forms.

Core size (Figures 5.1, 5.2, 5.3) and mean scores (Figure 5.4) are generally low due to the use of exhaustive reduction strategies, raw material types, and transport of some materials from considerable distances, especially at Enkapune Ya Muto and Prolonged Drift. The percentage of cortex on cores is also low, indicating either a high degree of core reduction before discard, or some form of core trimming at quarry sites before cores were transported for stone tool manufacture at the sites and in preparation for flake removal.

Analysis of flakes

For the 2,026 pieces identified as flakes and flake fragments (Table 5.6), end-struck and side-struck whole flakes account for about 27.1%. Core trimming and re-sharpening whole flakes account for 12.2% and 15.8% respectively. Flake fragments from core trimming and tool re-sharpening, on the other hand, account for 21.3% and 11.8% respectively. About 10.9% of the pieces were diagnosed as flake fragments, while less than one percent was identified as utilised flakes.

Of the 1,118 whole flakes, the majority are described as normal (Table 5.12). This means they do not take any specific forms conforming to the general characteristics of angular, flake-blade, blade, or point forms as described in Section 3.2.3. No shape patterns are exhibited, and most are small-sized with no distinct platforms. Only about 366 pieces (Table 5.14) had distinct platforms with countable facets. Of these faceted platforms, a great majority are multifaceted, indicating preparation of cores before the removal of flakes.

Flakes were produced in a flexible pattern involving the use of radial core reduction and other Levallois techniques in which cores were prepared and reduced both unidirectionally and multidirectionally. Scar patterns on whole flakes indicate that these two strategies of core reduction gave rise to the archaeological specimens analysed.

Flakes appear to have been produced by percussion flaking in which both hard and soft hammer techniques may have been used. Crushed platforms and sheared bulbs, especially at Prospect Farm, may be a sign of excessive force exerted by a hard hammer, or the use of the bipolar technique. Thin cross-sectional dimensions of trimming flakes as well as indistinguishable striking platforms and bulb of percussions may further indicate the use of soft hammer in the later stages of reduction or tool rejuvenation.

The majority of the flakes are fresh (Table 5.13), indicating the reduction processes occurred where the materials were recovered. The percentage of cortical flakes is low (Table 5.15) despite a relatively higher percentage of core trimming whole flakes and flake fragments. This could mean most of the cores were pre-shaped prior to their use in formal or informal tool manufacture.

Sixteen flakes, 14 from Prospect Farm and two from Cartwright's Farm, had a series of chips on their edges characteristic of damage caused by pressing on hard surfaces. These have been classified as utilised flakes. The nature of use these pieces were put to, however, could not be ascertained.

Scrapers and points

There were 294 scrapers examined. The distribution of types (Table 5.17) shows a great variety of scraper forms within the assemblages. Convergent scrapers (n = 82, 27.9%) and single side scrapers (n = 56, 19.0%) are the most common categories. Other categories include convex end scrapers (n = 25, 8.5%), double side scraper (n = 24, 8.2%), disc-like convex scraper (n = 18, 6.1%), and concave and notched scraper (n = 18, 6.1%). A number of other forms exist in low frequencies of less than five percent of total.

Technologically, the varied nature of scraper forms indicates no diagnostic or consistent manufacturing processes in all the assemblages. However, the use of flakes for the manufacture of various types of scrapers and other tool forms is consistent throughout the assemblages. Similarly, there is a consistent use of triangular flake blanks for making pointed pieces such as convergent scrapers, and unifacial and bifacial points.

Retouch on scrapers, especially the convergent forms, is mostly either light or normal. These types are common at Prospect Farm and Cartwright's Farm, and consist of discontinuous and continuous sub-invasive scalar retouch at the affected edges. Due to their late manufacture along the reduction trajectory, as well as the amount of trimming on them, most scrapers have no cortex. For example, more than 95% of the convergent scrapers in the total sample contained no cortex.

In terms of size and shape, the combined sample of scrapers does not show any form of standardisation. Length measurements, for example, seem to be distributed across all length classes, with a slight peak at 30–40 mm. These measurements approach a normal distribution. Convergent scrapers, however, exhibit some form of standardisation in shape throughout the assemblages. The mean breadth to length ratio in all three assemblages is 0.7 (Prospect Farm = 0.73, Enkapune Ya Muto = 0.68, Cartwright's Farm = 0.69) while the mean thickness to breadth ratio is 0.4 (Prospect Farm = 0.39, Enkapune Ya Muto = 0.42, Cartwright's Farm = 0.40).

Due to the small nature of the sample in most of the scraper categories, and a combination of all types of raw materials, it is difficult to see distinct patterns and accurately assess standardisation from the total sample of scrapers. Certain categories such as convergent scrapers, however, begin to show signs of standardisation.

Seventy-nine specimens were classified as points. These included unifacial and bifacial forms (Table 5.27) exhibiting retouch that converges to form a symmetrical point. As is the case with convergent scraper forms, points were made from triangular flake blanks with convergent plan forms. Retouch intensity was equally light and normal, and formed marginal and sub-invasive retouch marks at the edges. In terms of size and shape, variation is evident in size; while shape tends to be rather consistent within and between assemblages, especially at Prospect Farm, where both points and convergent scrapers exhibit almost the same shape patterns. Despite such similarities, strict standardisation of these pieces (points) cannot be categorically stated, as there is still a significant degree of variation in size and shape-defining measurements.

Chapter 6: Behavioural implications of the technological system

Inferences about technological organisation require more than the assignment of an artefact class to an organisational strategy.
(Amick 1994:9)

6.1 Introduction

Middle Stone Age assemblages have been examined in order to discover existing patterns within the technological system. Cores, flakes, and tools were analysed to see how implements were produced at each technological stage. Technological attributes such as core preparation; dimensions and frequencies of cores, flakes, and tools; retouch; striking platform treatment; and frequency and nature of flake scars, have been considered in the light of behavioural processes within the assemblages. These processes form an interrelated body of decisions or choices that explain hominid adaptive patterns of behaviour.

Technological processes consist of stages within which specific activities are carried out. Each stage and its activities depend on hominid decisions governed by constraints within the environment and in the social and economic realms. Artefacts, which are markers of this complex interplay of events, display the choices made by early hominids in one way or another. They form an important window into the past. Comparing the choices which resulted in different assemblages may lead to the establishment of patterns of behaviour. However, in order to elucidate the relationship between the technological and behavioural patterns, a number of theoretical considerations must go hand in hand with the examination of material evidence.

Behavioural patterns mostly depend on the environment within which activities occur and which provide a distinct area as a point of reference (Struever 1971; Redman

1973; Plog and Hill 1971). With different environments or physiographic units, human actions will be influenced differently, creating different behavioural patterns. The creation of assemblages at various sites within the Central Rift Valley and the Lake Victoria Basin is considered in light of this hypothesis. Both areas provide distinct geographic units within East Africa (Chapter 3 and 4) where hominid adaptation processes could have been influenced heavily by local factors. Hominid behaviour that resulted in the assemblages in these areas should, therefore, be understood in the light of similar or different conditions available for hominid exploitation.

Equally important in understanding behaviour and related processes is the time frame and the palaeoenvironmental conditions (Harris 1978). Relying on secondary data from previous research, past environmental conditions within which MSA sample assemblages were created has been discussed (Chapter 3) along with more site-specific information (Ambrose 1984, 1989; McBrearty 1986; Merrick 1975; Barut 1996). These MSA assemblages were created during a period of unstable climate and changing environmental conditions of the middle to late Pleistocene period. The extent to which these conditions influenced behavioural patterns and archaeological material distribution remains a subject of investigation.

Behavioural patterns are also caused by corporate rather than individual actions. They are, therefore, best understood after a consideration of a number of variables that capture activities of a broader population size. Individual artisans leave marks of their behaviour as individual makers of artefacts. For a common behavioural pattern to be established and for this to reflect an acceptable technological patterning, sets of assemblages or a number of all possible variables should be considered to capture the activities of such individual artisans. An examination of such clustered activities at sites may unveil regular patterned relationships among archaeological variables, incorporating site characteristics and environmental conditions in understanding behaviour at each site and in the general assemblage.

6.2 The technological system

In prehistoric societies and others for which lithic technology was important, stone tool technologies formed part of a wider cultural system contributing toward the realisation of daily needs. In this way, stone tool technologies may have represented complex activities that embodied the creation of artefacts through the use of "technological subsystems". Through such subsystems, technologies evolved over considerable time; and became part and parcel of societies. The creation and use of stone tools was thus contained within cultural rules that are difficult to detect archaeologically, and in most cases are taken for granted. Technologies, therefore, exerted a significant influence in different contexts, choreographing human efforts in intricate patterns of standard operating procedures.

The study of such procedures within archaeological assemblages in order to understand past human behavioural patterns has gained currency in the past decades. This is manifested, among other things, in the growing desire to know how and at what stage each artefact was produced. The construction of a body of information, within and across archaeological assemblages, to inaugurate distinct stages and the nature of actions in the production of an artefact, remains significant in understanding technological subsystems. Information gathered from such subsystems give patterns that may be used to explain overall technological behaviour.

Figure 6.1 is a model of the overall picture of activities that are likely to take place at various stages of lithic reduction, and may be used to describe MSA technological system including all the subsystems. As activities differ from site to site, subsystems are likely to show adjustments created to maintain technological or societal equilibrium at different sites. The different activities, carried out in the process of adjustments, and which translate into different choices and behaviour, in turn, create different technological patterns.

Unfortunately, such a model of technological system, as illustrated in Figure 6.1, could not be exhaustively tested because of the specific nature of the question dealt with in this work. The diagram includes not just the implements manufactured (which are the actual objects of investigation in this work), but also the cultural knowledge or skill to make and use the manufactured implements. The diagram also includes the environment within which the system is created as well as the nature of links between subsystems that make technological systems integral aspects of the cultures they are part of (Lemonnier 1992). Information on some of the components, such as social and economic needs, and use and discard subsystems, could not be gathered as these fall outside the question being investigated in the current work. However, it can be argued that social and economic needs, and use and discard subsystems formed part of the technological system within which hominid behaviour acted as a linking web through which the whole system adjusted and was held together. Behaviour influenced activities in each subsystem creating desired outputs, but in turn, was influenced by the same outputs, as well as the constraints operating within the subsystems leading to an evolutionary development of behaviour to higher cognitive forms.

The environmental subsystem can be defined as the collective effects of both climatic and ecological factors, including the availability or lack of raw materials for stone tool manufacture. The main constraints within this subsystem, therefore, are: (i) climate that causes different ecological niches, creating the need for different technological interventions or adaptive behaviour; (ii) raw material availability and type, which dictates the methods of reduction applied to get the most desired pieces of artefacts; and (iii) nature of procurement, including the decision of whether local or exotic materials are used.

The (technological) knowledge subsystem consists of artisans' knowledge and skills, learning, or passage of knowledge procedures; and the manufacturing process, which included reduction techniques and strategies. The next subsystem (manufactured implements) refers to all manufactured implements resulting from the technological procedure. This is controlled by the need for artefacts to be able to carry out various activities to fulfil hominid needs, but also to participate in other activities such as trade or exchange as well as social requirements. The social and economic needs may also be treated as a separate subsystem which embodies all the needs a society may have that affects the technological process. Major constraints here include food acquisition, trade and exchange (if any), and any other needs. Lastly is the use and discard subsystem through which the expended artefacts are removed from active use and abandoned to form the archaeological record. Main constraints include the ability of the artefact to be used for specific duties, whether the artefact can re-enter the use system, and other discard factors such as breakages beyond repair. In all these, behaviour controls the

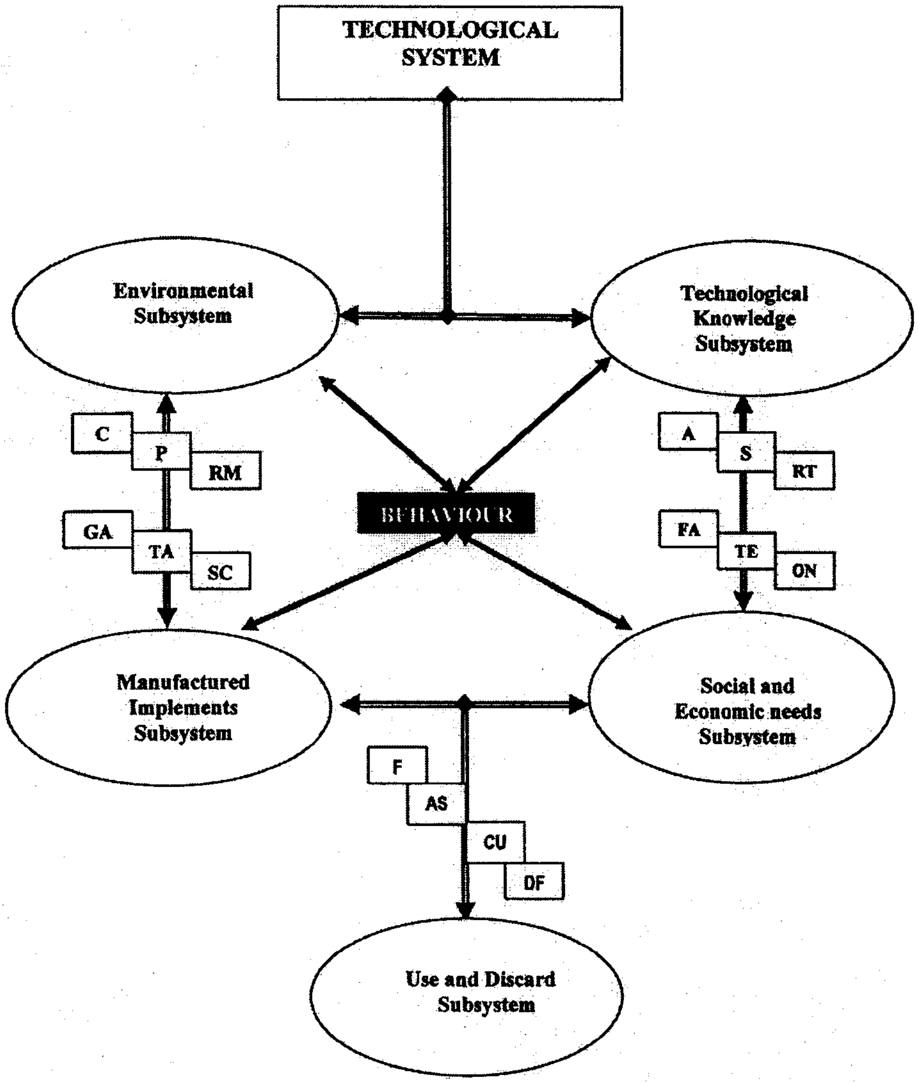


Figure 6.1 A model of a technological system showing subsystems and constraints causing patterns of behaviour. C-climate, P-procurement, RM-raw material, A-artisans, S-skills, RT-reduction techniques, GA-general artefacts, TA-trade artefacts, SC-socio-cultural artefacts, FA-food acquisition, TE-trade and exchange, ON-other needs, F-function, AS-artefact success or failure, CU-curation, and DF-discard factors.

decisions made within individual subsystems, as each constraint is tackled to create the most appropriate action in response to the needs faced by the technological system.

6.3 Technological procedure

The technological process included steps from core preparation to tool production and discard. Evidence present in the five MSA assemblages examined has failed to support the presence of a distinct and organised technological system. The assemblages contain evidence of mixed technological procedures. The observed procedures are also demonstrably less complex and organised compared to what may be found in LSA assemblages, where there are dominant distinct blade and microlithic technologies. However, there can be no doubt that MSA assemblages reveal a technological phenomenon distinguishable in form and intent, if not in complex style, from earlier assemblages. In selection of stone types and raw material form, the degree of care taken in core preparation, and other tangible elements within the process, MSA technological procedures can be seen as quite distinctive and a result of planning and forethought. While this is not unique to moderns in Africa, and can be found elsewhere in the Middle Palaeolithic, the degree to which this is done in the MSA time heralds what was to happen in the LSA/Upper Palaeolithic advance cultures. If these do not reflect modern human behaviour or traces of its roots in some of the simplest forms, then what behaviour do they represent? I would suggest that such distinct features within the technological system were developed and designed by people whose brains had started to work like our own. Such designs were aimed at maximising the use of available raw materials. The procedures may also have been carried out simultaneously with other complex technological procedures, the evidence for which has been lost.

The description of the MSA manufacturing procedures presented here is but a static one for a once-dynamic and reactive lithic reduction system. It is reactive in the sense that the entire process constantly adjusted and altered, depending on the stimulus from each of the subsystems of the technological system discussed previously. The actual reduction also adjusted depending on how raw materials passing through various stages responded to flaking techniques and strategies. While procedures were overwhelmingly similar at the different sites, a number of differences in treatment of raw material necessitated by raw material sizes and types resulted in varied responses and actions along the reduction trajectories. Some of these responses are mentioned below.

(i) Core selection and initial treatment

Rocks of different sizes, shapes, and types (but mainly obsidian and lava within the Central Rift Valley and Lake Victoria basin respectively) were obtained or quarried from open rock outcrops or easily accessible quarries. Shaping of cores may have occurred at the sources, such as Sonanchi quarry, Kedong quarry, and Upper Eburru (Merrick and Brown 1984:134) within the Central Rift Valley before the materials were transported to their respective sites for further reduction. Low frequencies of cortical flakes and other by-products of flaking at the sites suggest that this first step in which a considerable amount of cortex was removed from cores was common, and may have been carried out to prepare the pieces for transportation to the sites.

Apart from locally available raw materials, core pieces of exotic origin were imported to Prospect Farm, Enkapune Ya Muto, Prolonged Drift, and Cartwright's Farm.

To facilitate transportation, the materials were subjected to some trimming that removed a significant amount of cortex from cores. Unfortunately, there is no way of measuring the amount of cortex removal at this stage, as this occurred at a location other than the archaeological sites. This process may have varied from site to site, depending on location and raw material requirements. Most materials used at Enkapune Ya Muto seem to have gone through this process to facilitate transportation of materials from the Rift Valley floor sources to the rock shelter located on the Mau Escarpment at an elevation of 2,400 m. Due to the unique location of this site, it is most likely that even those materials obtained a few kilometres away had to undergo some form of shaping. This process also seems to have been carried out for materials used at Prospect Farm, based on the low frequency of cortical flakes from the large assemblage. The use of materials from different sources, some of which are at distances over 40 kilometres away, may have encouraged this initial trimming of cores for transport. But while the low frequencies of cortical pieces has been used to infer this activity, it may be possible that such low frequencies were also caused by reduction techniques such as bipolar reduction, which may also lead to a high percentage of non-cortical flakes in an assemblage. This technique was used at Prospect Farm. Nevertheless, assemblages at Prospect Farm, Enkapune Ya Muto, and Prolonged Drift show initial core trimming due to transport of materials from distant locations.

(ii) Core preparation and reduction

Reduction started once cores were brought to the sites. It involved further shaping of cores in order to create striking platforms for the removal of desired flakes. Core-trimming flakes show this activity. They are characterised by a central dorsal ridge running down the length of the flakes, indicating removal by a blow struck across the worked core surface. Elaborate trimming at the beginning of reduction involved formal core reduction techniques through direct hard hammer percussion. After the preparation of striking platforms in the formal cores, the pieces were reduced using free-hand, hard hammer percussion, resulting in Levallois flakes or triangular flakes from discoidal cores. Cores reduced in this way include regular discoidal cores, regular cores approaching Levallois cores, regular cores approaching discoidal cores, and other single-platform cores such as regular single-platform prismatic and pyramidal cores that were minimally prepared.

Informal reduction techniques were also used to reduce cores. Natural flat surfaces on cores were used as striking platforms for multidirectional core reduction. Oval and rounded cores were split using bipolar techniques, where the piece was placed on an anvil and a hard hammer used to strike a blow at a targeted point. Once the split was successfully achieved, reduction proceeded by a suitable method or strategy. For example, a split rounded piece presented a flat surface on one side that was to be used as a platform to remove flakes around the edge of the piece toward the centre, thereby creating Levallois disc cores and flakes. This was done using either direct hard or soft hammer percussion, as opposed to the bipolar technique used to split up the core in the first place. The bipolar technique may have been commonly used, as it is simple and quickly learned by observation. It is also suitable for working small pieces as well as rounded rocks. With skill, it can be efficiently used to get a good deal of useful flake blanks from any kind of core available.

Core preparation and reduction stage show the use of both formal and informal reduction involving unidirectional and multidirectional strategies. Discoidal and Levallois techniques, where platforms were prepared and used for striking off flakes from cores by use of direct hard or soft hammer percussion, were common with formal cores. On the other hand, the bipolar reduction technique was used to reduce most of the non-formal (irregular) cores. These were used side by side; and changes could occur at any time, depending on the reaction of the pieces being worked. There was, therefore, no strict adherence to prepared core technology in the procedures as observed in these MSA assemblages.

Core preparation and reduction stage resulted in the production of a number of artefacts. Levallois flakes with facetted platforms (e.g. Table 5.14) indicating preparation of striking platforms remain an important sign of prepared-core technology. Triangular or convergent flakes from discoidal cores also signify the Levallois technology, and point toward significant advances in technology. These formal flake forms are represented in different sizes, reflecting the size of cores they came from. Radial scar patterns (Table 5.16) on their dorsal sides reflect not only the flake removal pattern but also the preparation the cores went through. Other by-products of core preparation and reduction including core-trimming flakes, other normal flakes and flake blanks, flake fragments, and core fragments indicate the use of multiple reduction techniques and strategies.

(iii) Flake production and selection

Once the cores were selected, shaped, and prepared (not necessarily in this order), flakes were removed as desired, using the prepared or naturally occurring platforms. Because of initial preparation, the concept of predetermined by-products seems to have guided the removal of flakes from cores, especially the regular ones upon which formal reduction strategies were used. Blows using free-hand, direct hard-or soft-hammer percussion produced bulb-bearing flakes, some of which were used as flake blanks for the manufacture of tools at the sites or elsewhere. In general, flake production from cores as a procedure resulted in five different types of flaking products:

(a) Facetted platform flakes with visible bulbs mainly from prepared Levallois cores;

(b) Triangular flakes from controlled flaking using Levallois disc core reduction techniques, from which most of the pointed implements or tools found in the assemblages are made. These flakes also have distinct bulbs in most cases;

(c) Other regular flakes bearing the characteristics of flakes with visible bulbs;

(d) Flakes with crushed platforms and sheared bulbs that possibly resulted from the use of bipolar percussion techniques;

(e) Flake fragments resulting from all the activities of flaking procedure, and mostly from bipolar reduction techniques.

Selection of flakes as blanks for the manufacture of particular tool forms was based on size, shape, and the workability of its edge(s) for retouch. In terms of size, there is no significant quantity of larger flakes that could serve as flake blanks removed specifically for this purpose. If such intention was present, then most if not all of such larger blanks were used for tool manufacture. Flakes, however, seem to be larger at Prospect Farm, Cartwright's Farm, and Muguruk compared to those from Enkapune Ya Muto and Prolonged Drift, as shown in Figures 5.10a and 5.12. This may be due to abundant raw materials at Prospect Farm that may have encouraged the use of strategies that do not maximise raw material use. However, at Cartwright's Farm the production of larger flakes could have been due to a sampling problem during the collection of materials from the site. At Muguruk, larger flakes are likely due to the nature of ombo phonolite being used as raw material. This material does not allow reduction of much smaller cores, compared to obsidian used in the Central Rift Valley. Beyond a certain size, any further flaking on such volcanic rocks will produce useless debitage. The small sized flakes at the remaining sites may have been a result of attempts to use the imported raw materials as much as possible. Or at Enkapune Ya Muto, the small sized nature of flakes could be due to trampling, as the site is in a confined area where hominid activities took place. The intention was to produce as many flakes as possible from all sorts of cores including the very tiny ones.

In terms of shape, only the triangular or convergent pieces are obviously distinguishable. These triangular-shaped forms readily became suitable for shaping into either convergent scrapers, or unifacial and bifacial points. Overall, selection of whatever type of flake for the manufacture of particular tool forms depended on the edge or edges that could be retouched to form either a cutting, scraping, or piercing edge. The varied nature of flake forms and edges explains the varied number of tool forms, as artisans maximised the forms and edges that were available for modification in the manufacture of tools.

(iv) Tool manufacture

Once flakes were selected for the manufacture of particular tools, direct soft hammer percussion technique was used to shape and retouch them. Very thin, almost transparent flakes resulting from tool trimming have been interpreted as the by-product of this delicate removal of flakes, with blows being directed at the edge of tools, from which flakes were removed. Such retouch originated mostly from the dorsal surfaces.

Convergent scrapers exhibit marginal and sub-invasive retouch that could have occurred as a result of using controlled removal of the edges using wooden or bone implements.

Retouch on other tool forms, such as points, was more complex; and may have combined more techniques. Preparation of the edges and tool shaping as well as trimming of the butt required the use of direct soft-hammer and hard-hammer percussion, and/or punch techniques.

Tool shape was basically created by alteration of flake blank edge(s) by retouch. Such activities were complex, given the varied nature of retouched tools. Modification and tool types, however, depended on the size of the flake preform, as retouch relies on the thickness of the central mass of each piece being shaped.

Flake pieces seem to represent expedient tools, which were used until dulled or until the intended task was performed, and then discarded. Retouched pieces, regardless of shape and size, were treated in a limited number of ways. However, even without considering the variation in flake size and shape, there are numerous flake tools that represent an expanded toolkit when compared to the earlier periods, and appear almost similar to those tools used in later periods.

Recognised in the assemblage as belonging to this stage of production are tool-trimming flakes and a number of flake fragments. These sharpening flakes contain traces of the retouched working edges of the original pieces, with scars generally smaller than those found on similar flakes from cores. The ridge formed by the intersection of the old worked surface and flake release surface is not symmetrically positioned on the centre of the dorsal surface. Instead, the ridge is close to one of the lateral edges of the flake.

Different tool types as listed in Table 5.7 also indicate the possibility of the use of different methods of edge modification and tool shaping.

(v) Tool re-sharpening and edge rejuvenation

Once the edges of tools became too dull to be used effectively, steps were taken to sharpen and/or re-sharpen and even re-shape them. This process involved the repeated removal of tiny flakes from the edges by direct flaking using soft hammers. This created new edge angles documented as superimposed new scars on old ones at the edge of tools.

This feature is found mainly at Prospect Farm. These procedures may have been repeated, forming a cycle in which a particular tool could have changed its form completely during its life-history. Rejuvenation of tool forms into new forms is an old archaeological problem, especially when it comes to imposition of typologies on archaeological remains. In Bordes' typology, scraper types 6–29 may represent stages in the progressive use and re-sharpening of one or more basic tool types (Dibble 1987a, 1987b, 1988). A single side-scraper, for example, may be re-sharpened and re-shaped into a double-sided scraper and eventually a convergent scraper or even a transverse scraper.

Badly battered edges that could not be re-sharpened were rejuvenated by the removal of large flakes that covered a greater part of an entire edge area. A number of scrapers from the Prospect Farm assemblage exhibited such rejuvenation or later major retouch, where large flakes were removed longitudinally along the edge of tools to create new retouch surfaces. Such pieces re-entered the system as new tool forms or small-sized forms of their original state. These forms of technological measures reflect the practice of tool recycling within the technological system, and form one of the signs of curation of materials during the MSA.

(vi) Discard

Exhausted cores that could no longer be useful even by bipolar reduction were eventually discarded. Similarly, expended tool forms and/or broken pieces were discarded to form the archaeological record.

Materials from Prospect Farm, Enkapune Ya Muto, and Muguruk are representative of all the technological stages or processes described here. Materials at Prospect Farm and Muguruk are larger in size than those at Enkapune Ya Muto, implying use of smaller cores or exhaustive reduction techniques in flake and tool production at the latter site. At Prolonged Drift, evidence for initial core trimming, which takes place during core acquisition and preparation, is missing, indicating that most of the materials used and discarded here may have been brought from elsewhere. It may also indicate that the site was a temporary resource-gathering site where no major manufacturing occurred except for the reduction and shaping of the flake blanks brought in for the purpose of carrying out specific tasks. This implies that the MSA artisans were conversant with tool curation (Binford 1979), importing artefacts for events to take place at a future time; and should, therefore, be considered as possessing cognition within the range of modern human behaviour.

6.4 Assemblage variability

MSA artefacts have been argued to show a low degree of variability and a static technological development (Klein 1992, 1998; Thackeray 1992, 2000; Clark 1999; Noble and Davidson 1996; Mithen 1996). Poor dating of sites and materials of this time period has hampered the understanding of technological patterning that could reveal aspects of variability in much of sub-Saharan Africa. In Eastern Africa, dated stratified MSA sites are scarce. Nevertheless, individual assemblages at different sites offer sufficient data to address the question of MSA variability.

The principal artefact types characterising this period were assessed in the previous chapter. The paucity of formal tools or retouched forms in these assemblages compared to flake debitage does not restrict their value in exploring the question of variability. Analysis of variance for cores, flakes, and tool samples in Chapter 5 (Tables 5.8, 5.9, 5.11, 5.21 and 5.26) presents summaries of variations in artefact attributes.

Understanding the meaning or causes of stone artefact variation has been of great interest to archaeologists ever since the beginning of lithic analysis (Evans 1872; Holmes 1894; Lubbock 1972). Normative archaeologists thought variation was linked to style, and used various styles to demarcate ethnic regions (Bordes 1961, 1973; Deetz 1967: 44-63, 1968; Krieger 1944). Variation was later linked to iconic active style in artefacts meaning a display of internal ethnic signalling wherein the artisan intentionally or consciously adds stylistic elements on top of the artefact's utilitarian elements to identify the owner (Wissner 1983, 1985; Wobst 1977). Variation was also linked to passive isochrestic style, which means a display of inherent behaviour wherein artisans unconsciously make specific and consistent choices based on options dictated by their culture (Close 1977: 7-8, 1989; Sackett 1982, 1990). Others attributed variation to adaptive reactions to different environments (Binford 1986, 1989; Dunnell 1978; Mellars 1970). In all these, it becomes clear that variation in artefact assemblages cannot be explained using a single causal factor but a combination of many factors, including raw material type and size, intended artefact use, manufacturing techniques and strategies amongst others (Andrefsky 1994; Dibble 1984, 1987; Wilmsen 1968).

New approaches linking stone artefact variation to the role of human behaviour (choice and decision-making) have been developed in recent years. Two hypotheses namely, social agency and behavioural ecology, have been proposed (Schiffer and Skibo 1987; Kelley 1999; Shott 1997). The social agency hypothesis maintains that all human actions, including those involving technology, are learned and performed in social contexts (Dobres 2000). Variation starts in such social contexts with individual behaviour or actions that eventually add up to create what may be seen as corporate actions or patterning in assemblages. Behavioural ecology, on the other hand, holds that variation results from decisions of people as they react to local environmental conditions. Decisions and choices are made relative to environmental circumstances; and are governed by the need for highest benefits, efficiency, and effectiveness (Kelley 1999:69). Subsistence patterns and lithic technological patterns of prehistoric people often reflect aspects of behavioural ecology in activities aimed at obtaining food and raw material resources.

Another hypothesis that has been cited as causing similarities and differences in stone artefacts is the functional one based on reconstruction of the functions to which different implements were put (Binford 1986, 1989; Mellars 1973). Function refers to the role an object played as an instrument of activity. Using this alone to explain variation may be inaccurate, as objects were possibly used for different functions at different times, therefore becoming different things at particular stages along their life cycle. The different stages may have included procurement of raw materials, manufacture, use, and discard.

Raw material availability and quantity, and the applied reduction strategies (Andrefsky 1994; Ludetke 1976) are also known to affect variability in significant ways. Projects related to diversity in manufacturing techniques now focus on the analysis of flake debris for clues regarding type of manufacturing procedures, degree of standardisation, nature and frequency of activities, and the location of activities as well as discard (Alher 1989; Shott 1994) in order to isolate factors causing variation. This may be done by looking at the association of formal debris attributes, which are usually diagnostic of specific reduction practices. Dibble (1984, 1987) and Kuhn (1992) cite reduction stages as major sources of variation, while Schiffer (1982) points out that the use-life history of a tool may cause variation in several other stages such as recycling, curation, re-sharpening, secondary reuse, and even discard. At these stages, identification of variation is based on individual artefacts or groups/categories of artefacts that make causal factors scattered and difficult to assemble. Besides, focus on use must incorporate comprehensive micro-wear studies to ascertain specific characteristics such as crushing, tool ventral thinning, polish, lustre, and striations to link implements to specific activities (Deacon and Deacon 1980; Hayden 1979: 26–27; Shott 1995). However, in examining all these characteristics, care must always be taken, as some of the characteristics may be caused by environmental conditions such as rough soil particles or grit and high alkaline (pH) conditions (Burroni *et al.* 2002).

Arguments provided through hypotheses of style, function, social agency, and behavioural ecology in explaining variation in stone assemblages provide the best avenues to look at variation in the MSA sample assemblages presented in this work. This technological examination of artefacts provides an opportunity to explore how and what caused variation at different stages of stone artefact manufacture.

Variation between assemblages from the five sites has been presented using core attributes (weight, F-value = 45.2, maximum dimension, F-value = 52.5 and size, F-value = 37.8), flake attributes (length, width, thickness, breadth to length ratio, thickness to breadth ratio and thickness to length ratio with F-values of 70.5, 48.7, 60.9, 11.6, 41.0 and 28.3 respectively), and sampled tool attributes with varying F-values, which indicate lack of similarity of artefacts. Variation is concentrated mainly in artefact sizes, types forming different categories, and frequency distributions in the different assemblages. Retouched pieces count less in this investigation, as detailed tool morphological and functional analysis was not possible in this work.

The main observable variation between the assemblages occurs at procurement and reduction stages, where hominids had different choices and decisions to make. One major choice, and which is a causal factor for the variation between the assemblages, is raw material type selection at the procurement stage. While material type is highly influenced by what is available locally, procurement requirements and stimuli from relevant technological subsystems may have led to decisions to expand the procurement range to include exotic materials from distant localities as well as less abundant local raw materials. There is a significant presence of a mixture of local and exotic raw material types as well as abundant and scarce raw material types. In the Central Rift Valley sites, over 95% of the artefacts are made from obsidian, which is the locally available raw material type mostly preferred for stone artefact manufacture. Different grades of obsidian transported to the various sites from distant locations may indicate the choice to go for such materials instead of using what was available locally.

Prospect Farm is found in an area where obsidian is readily available in outcrops and exposed cliffs on the slopes of Mt. Eburru. Other grades of obsidian used at the site, as reported by Merrick (1975), would have been imported from more than 30 kilometres away (Table 5.2). The other raw materials represented but not used much include basalt, quartz, and quartzite. Over 95% of the sample assemblage is obsidian, while basalt makes up the remainder.

The other sites within the Central Rift Valley contain no on-site raw material outcrops. This lack of local lithic raw materials, and the need for transport from considerable distances, may have led MSA inhabitants of Enkapune Ya Muto, Prolonged Drift, and Cartwright's Farm to adopt a more economic way of using raw materials. While the dominant raw material type at these sites remained obsidian, as at Prospect Farm, source and size/quantity of available materials led to different treatment, causing variation in artefact size between the assemblages. Using size parameters, materials from Enkapune Ya Muto and Prolonged Drift are relatively smaller, even with the other types of raw materials such as quartz, quartzite, and chert. Materials from Cartwright's Farm are slightly larger due to sampling methods applied during the collection of materials at the site.

The sample from Muguruk is almost entirely made of ombo phonolite, a grade of lava locally available in the region. Local sourcing of raw materials, and the nature of lava as a flaking material, led to the difference in flaking strategies reflected in the comparatively larger flakes than those found at the Central Rift Valley sites.

Reduction procedures employed by the makers of the MSA assemblages were presented in Section 6.3. These procedures involved technological decisions that led to the production of implements as dictated by manufacturing constraints. A number of cores were pre-shaped and prepared before the flaking process, while others entered the flaking process without preparation. Some cores were exhaustively reduced while others were not, due to the choice of particular strategies and the variable availability of cores. Flakes on the other hand, were produced at different stages along the reduction process. There are core-trimming flakes, produced during the initial pre-shaping of cores, which are different from core-reduction flakes which form the main flake blanks used to make various tools. There are also tool-trimming or re-sharpening flakes produced later on, when tool forms had been shaped. These different stages of production create implements that differ mainly because of their stage of production and the fact that different methods of flaking had to be used to realise their production. Lastly, there are retouched pieces that were modified depending on the function or use such implements were intended. This created different morphological features, further increasing the nature of variability.

While much of the variation exhibited by the MSA assemblages may be attributed to raw material procurement and type, technological procedures, and functions, other factors seem to have contributed to the variation as well. One such factor is the environmental conditions at the time the assemblages were created. Harsh, cold, and dry environments of the Middle to Upper Pleistocene period may have encouraged experimentation with new tools for the exploitation of challenging environments. An increase in the number of tool types over time compared to earlier cultural periods (e.g., the Early Stone Age) is evidence of the widening technological base. Artefacts were manufactured to exploit resources in both new and old familiar environments. Others may have been manufactured for exchange purposes, to create links with other groups that supplied items required for survival in harsh environments. Yet others may have been simply for self-adornment or identification. These constraints created a varied body of artefacts, thereby increasing the variability in MSA assemblages.

MSA occurrences at the five sites have been treated as individual assemblages as opposed to separate levels, as explained in the sampling section. By using this lumping procedure and treating all the phases as similar, variability measures have been increased within the sites which have multiple levels. Technically, variation within and between the sample assemblages is caused by the way materials have been put together into single assemblages. Prospect Farm has four MSA phases, while Muguruk has two distinct MSA levels. These could form distinct units both technologically and temporally; yet are treated as single assemblages at the sites.

Three major factors as illustrated in Figure 6.2 are, therefore, the main causes of variation observed in the MSA sample assemblages. Other factors related to temporal changes and technological improvements have not been discussed, due to practical problems. Yet others, such as tool function and use, are present; but discussion of these is beyond the scope of the current work.

6.5 Patterns and behaviour

In this section, technological features of the MSA sample assemblages are considered in an attempt to discern significant patterns of adaptive behaviour, which may be used to address the issue of modern human behaviour. The main focus in this synthesis is on the following:

(i) Behavioural implications of interrelated variables within the MSA sample assemblages;

(ii) Some hypotheses on behavioural patterns of hunter-gatherer societies relating to modern human behaviour;

(iii) The relationship between the technological patterns of adaptive behaviour observed in the assemblages and modern behavioural patterns as contained in current debates on the emergence of modern human behaviour.

(i) Raw material acquisition and use

Table 5.1 shows the proportions of raw materials represented in the assemblages studied. Material from the four Central Rift Valley sites is overwhelmingly obsidian, while that from Muguruk within the Lake Victoria Basin is mainly lava (ombo phonolite). Both of these raw materials are mostly associated with local sources, mainly outcrops and quarry sites that hominids may have visited regularly to obtain pieces for stone tool manufacture. The few non-obsidian objects in the Central Rift Valley assemblages are basalt at Prospect Farm and chert, quartz, and quartzite at Cartwright's Farm and Enkapune Ya Muto.

Apart from reliance on local materials, exotic obsidian was used at various sites, as presented in Tables 5.2 and 5.3. The presence of such exotic materials within MSA assemblages may indicate connections between different social groups. While it is clear, based on available data on distances, that such connections existed, their nature and strength remains unclear. Quartz used at Enkapune Ya Muto during the MSA Endigi Industry occupation, for example, was obtained from some 65 km away (Ambrose 1989).

However, the nature of the connection between the site and the source of quartz (either through trade or other forms of exchange) remains unclear. Similarly, the nature of connection between Prospect Farm people and the occupants of areas from which exotic obsidian pieces were obtained (Table 5.2) remains unclear.

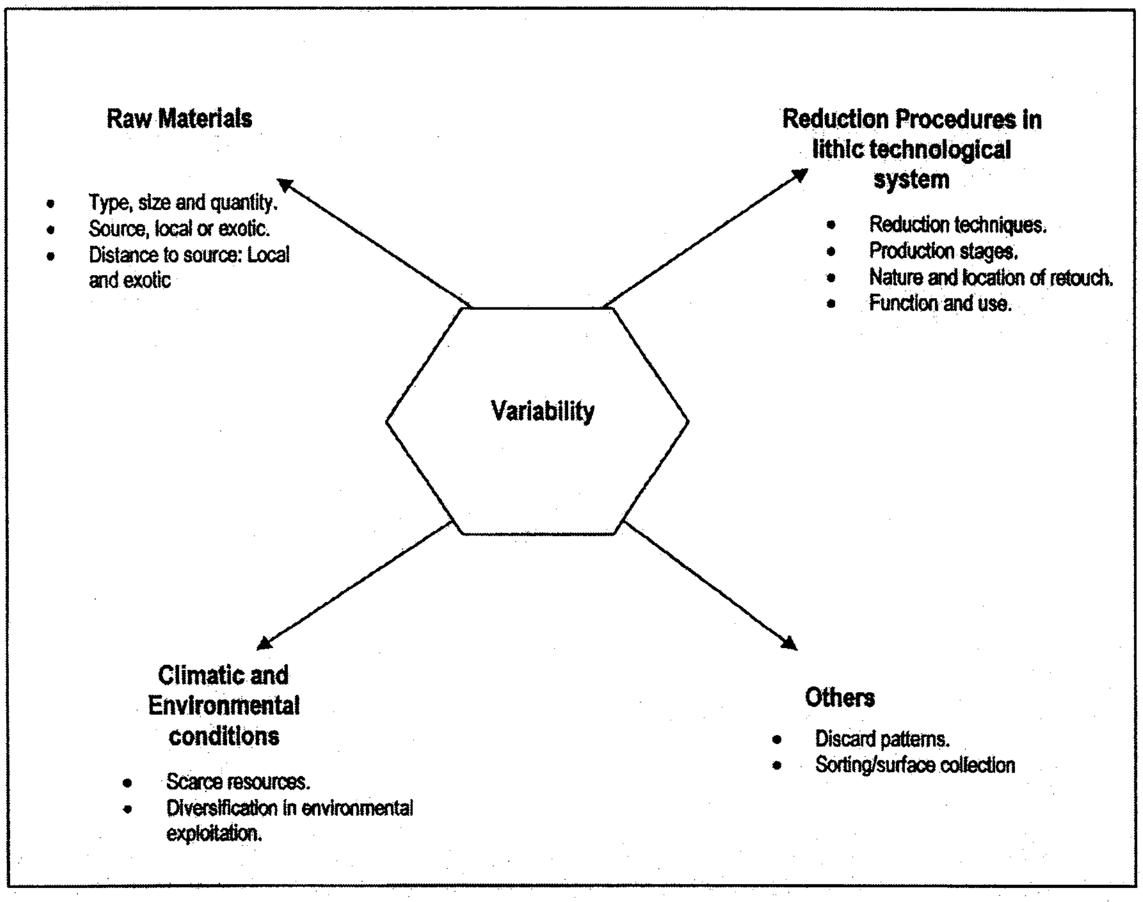


Figure 6.2: Factors responsible for the variation between and within MSA assemblages. Constraints are shown by bullets.

Despite lack of clarity on the nature of the connection between sites and raw material sources, the presence of both local and exotic (imported) materials at the sites confirms a major technological pattern of choosing between local and imported materials for stone tool manufacture. As opposed to the Acheulian period, when materials such as obsidian were rarely found more than 30 kilometres from any specific source, MSA raw materials were sourced from greater distances. Site-to-source distances increased dramatically, with materials such as obsidian being transported more than 300 kilometres from sources in the East African region (Merrick and Brown 1984). This entails major decision-making on the part of the hominids involved, and reflects a shift in behavioural patterns. The apparent choice to go for exotic materials at distant locations could reflect knowledge of the geological distribution of resources as well as the flaking quality of various rock types during the MSA period. Materials for stone tool manufacture may have, therefore, been selected based on this knowledge and not mere intuition. Planning may have formed part of raw material acquisition process from this time forward.

Both local and exotic raw materials were obtained through open quarrying. Obsidian in the Central Rift Valley, for example, comes from volcanic deposits in different areas, some of which are mountainous. Obsidian is also found in secondary geological contexts such as broken pieces in open fields and exfoliated pieces from slope and escarpment surfaces. Such nodules are usually small-sized; and even though they were used as sources of ready raw material, they were never the source of raw materials for elaborate stone tool manufacture. Much of the obsidian used at the sites was, therefore, obtained from specific quarry sites (for example, those mentioned in Table 5.3) where hominids cut or dug out objective pieces for stone tool manufacture and transported them to the sites where reduction processes occurred.

On the basis of raw material procurement methods, choice, and movement of objective pieces at the beginning of the technological process, it can be argued that hominids planned their activities during the MSA period in a fashion similar to later hunter-gatherer societies (Binford 1979). Such planned activities included obtaining cores from quarry sites, and choosing particular rock types and sizes as well as transporting the same to manufacturing sites. These resulted from decisions made within a variable environment, and reflect the use of economical strategies to realise technological adaptive needs. This may have included diversification of raw material use; for example, the use of varied rock types for tool manufacture, and social networks through which exchange between societies or bands may have been possible. These traits are amongst those given as defining modern human behaviour (Table 2.1).

It has further been argued that greater planning depth, amongst other things, in the use of environmental resources reflects higher cognitive abilities (Mellars and Stringer 1989; Nitecki and Nitecki 1989). Such planning characterises the life of Upper Palaeolithic/LSA hunter-gatherer societies in both the Old and New Worlds, and is a mark of modern human behaviour. Structured activities surrounding the procurement of raw materials used at the Central Rift Valley and Lake Victoria Basin sites should, therefore, be seen as reflecting modern human behavioural patterns.

(ii) Increased number of artefact types

Increased artefact diversity, as registered in the increased number of artefact types, has been used as a defining factor for modern human behaviour (McBrearty and

Brooks 2000). In this respect, the high number of artefact types within the MSA sample assemblages (Tables 5.4 and 5.7) reflects a richness that becomes an emerging technological pattern that may be linked to modern human behaviour. Larger sites like Prospect Farm and Muguruk, which had high-intensity occupation, show higher diversity of artefact types, while Enkapune Ya Muto, Prolonged Drift, and Cartwright's Farm, which are smaller sites with a high intensity of occupation, show lower diversity of artefact types.

The more diverse artefact base, as reflected in the increased number of artefact types within the MSA implement subsystems, also indicates a marked pattern of re-adjustment within the technological system. Various tool types imply varied use to which they were put. The various forms consisting of different sizes, some of which may have been used as composite tools, further imply an increase in technological demand in sustaining a viable technological system where specific tools were manufactured for specific activities. Such a demand may have been due to hominid adaptive requirements for acquiring either plant or animal resources within diverse or changing environments.

The patterns of artefact diversification and technological re-adjustment, as may be inferred from the MSA sample assemblages, also show that the technological system was responsive to environmental conditions. Location of MSA occupations at sites such as Prospect Farm, Prolonged Drift, and Enkapune Ya Muto, has been interpreted as being ecotonal (Ambrose 1998; Isaac 1979). Earlier (MSA) levels at Prospect Farm show low residential mobility in restricted areas, with little regional interaction during the last interglacial. During the last glacial, however, MSA levels at Prospect Farm, Prolonged Drift, and Enkapune Ya Muto show higher residential mobility within larger territories, which implies greater regional integration and possible exchange between bands (Ambrose 1998).

These changes in mobility patterns may be seen as responses to the conditions within the environments occupied by hominids, where they had to deal with resource predictability and unpredictability, distribution, size, and patchiness of resource areas as well as potential hazards in order to adapt effectively (Binford 1977, 1980). The ecotonal location of the sites was, therefore, a strategic measure to bring under control the acquisition of resources from both montane forest and savannah grassland.

The development of varied tool types within MSA toolkits became a necessary pattern to carry out activities within different ecotones. Planning formed the basis of diversification of the tool kit in the Central Rift Valley, Kenya, where montane forest plant and animal resources were exploited using one set of implements, and those of lowland savannah grassland by another (Figure 6.3). Ambrose (2001) uses evidence from the terminal MSA and early LSA to show that both environments were exploited by the makers of the Endigi Industry at Enkapune Ya Muto and Prospect Farm. Such exploitation may have taken place at different periods or seasons, and therefore reflect knowledge of resource periodicity and environmental predictability similar to what is expected in hunter-gatherer societies with modern human behavioural patterns (Binford 1977, 1980). Materials from Muguruk within the Lake Victoria Basin reflect a similar diversity, and the possibility of dependence on both forest resources where most of the larger implements were used, and the open grassland resources where smaller artefacts were used (Figure 6.4).

(iii) Technological change over time

High artefact turnover with industrial replacements in shorter intervals of time form part of increased artefact diversity that has been used as one of the defining traits for modern human behaviour (McBrearty and Brooks 2000). At Prospect Farm, Anthony (1978) identified four (technological) phases named I to IV. These contain technological differences noted by Merrick (1975), but which should be further investigated to understand such changes over time. In the meantime, such changes may be interpreted as adjustments within the technological system reflecting an early form of artefact turnover or replacements in shorter periods of time; characteristic of LSA increased artefact diversity and turnover, which is a mark of modern human behaviour. McBrearty (1986) documents similar changes at Muguruk Members 4 and 6.

(iv) Predetermination of artefact forms

Both formal and informal reduction strategies were used to produce MSA sample assemblages. The use of formal strategies such as Levallois and discoidal/radial core reduction techniques, where cores were prepared to create striking platforms from which flakes were removed, imply prior knowledge of the intended by-product of the flaking process. Such a mental template, as most researchers would argue, is the preserve of *Homo sapiens* endowed with higher cognition; and characterises the technological production of standardised blades and microblade artefacts of the LSA period.

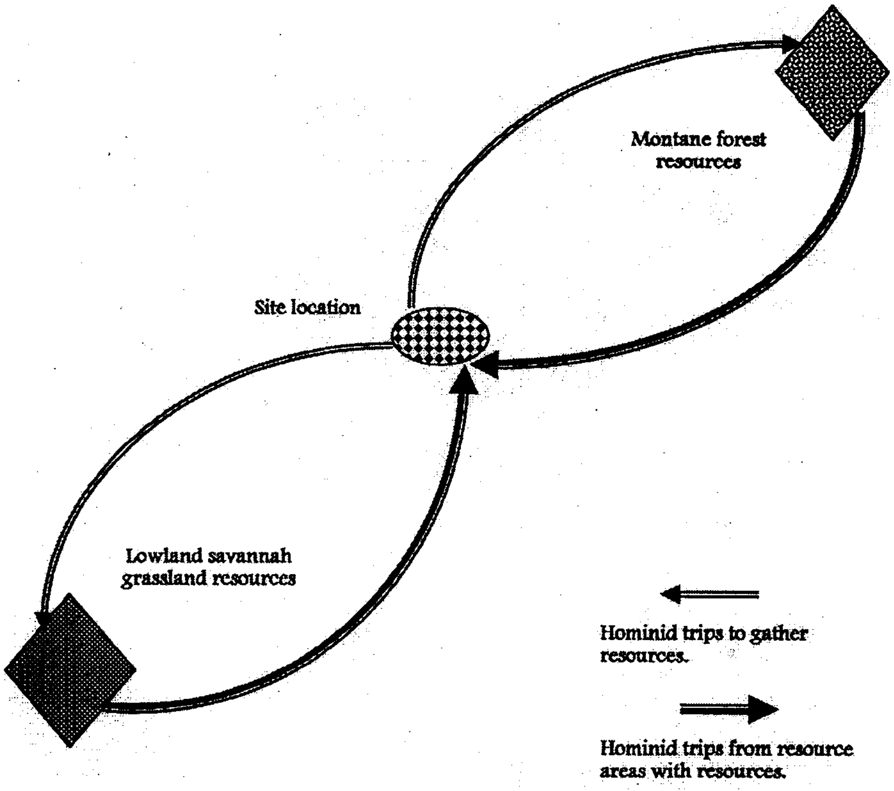


Figure 6.3: Hypothetical ecotonal site location (settlement) and resource acquisition patterns during MSA occupation at Prospect Farm, Enkapune Ya Muto, and Prolonged Drift based on Isaac's (1972) ecotonal settlement pattern model. Note that the patterns may have triggered stone tool diversification for the exploitation of both montane forest and lowland savannah grassland resources.

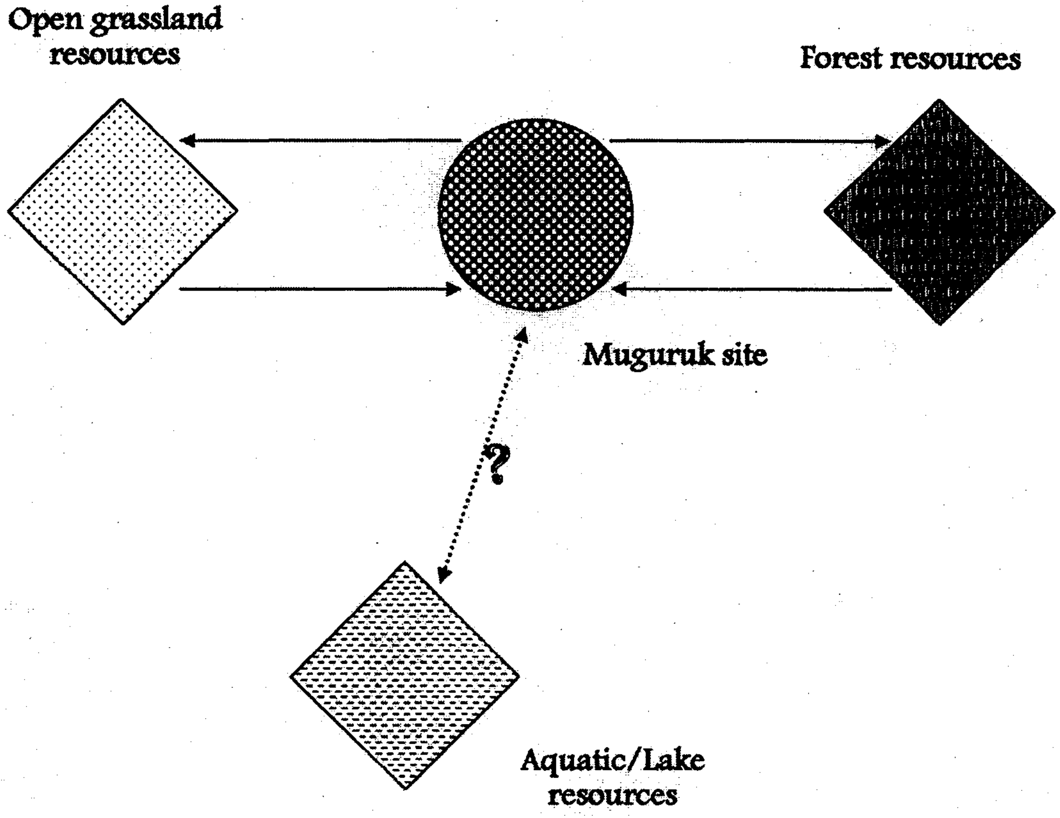


Figure 6.4: Hypothetical resource acquisition patterns at Muguruk during the MSA occupation. The pattern possibly contributed to the diversification of artefact forms at the site. Note that there is no technological evidence that the nearby aquatic resources were ever exploited.

The use of prepared core technology within the five sample assemblages is evidence that MSA artisans had in their minds a picture of the technological products before setting out to create them using selected methods. Such mental pictures may have included intended shape, size, and even quantity of the products to be obtained from the objective pieces. This pattern may be seen as a precursor to the LSA standardised technology, or even the development of mobile toolkits used as personal gear by hunter-gatherer societies (Binford 1979), where the total technological inventory to be used or transported is pre-arranged. The same idea of predetermined technological patterning may be traced from the earlier periods, but becomes clearer during the MSA, and more pronounced during later periods. This implies that behaviourally, the pattern developed gradually over time. To illustrate, take radial core reduction. This exists in Acheulian assemblages, with disc forms appearing even earlier within Oldowan industries (McBrearty 1986). As a reliable method of reduction, it was retained and improved by hominids in Africa and elsewhere through time; and became an overwhelmingly significant reduction method during the European Middle Palaeolithic and sub-Saharan MSA periods.

The recurrent presence of triangular or convergent artefact forms (flakes and tools) within the sample assemblages also supports the idea of predetermination of artefact forms, and may imply high cognition or modern human behaviour. Within the assemblages, unifacial and bifacial points as well as convergent scrapers are mostly made on triangular or convergent flakes. Materials put in the cutting edge category by Anthony (1978) also fall within this group of convergent forms, suggesting a desire or technological intention or plan to produce triangular-shaped implements. With this evidence, there is a possibility that there was control over shape and size, although these are only vaguely represented in the assemblages. Shape and size are important aspects of standardisation that have been used to define or trace the origins of modern human behaviour. A brief discussion on standardisation presented below suggests only limited traces of standardised technological behaviour within and between the assemblages. However, this topic requires further investigation, using new data, for the concept to be properly elucidated.

(v) Standardisation

Standardisation refers to the production of implements that exhibit common sets of characteristics. In stone tool technology, the assessment of standardisation becomes more complex and less straightforward (Arnold 1984), as it involves a consideration of a number of constraints that comprise the technological system. It can be assessed at the form or finished product level, or at the process level (Mellars 1989a). At these two levels, understanding standardisation is dependent on how best the constraints within the technological system are understood, and the setting of conditions governing the investigation. Mostly, however, standardisation is seen as relating to shape and size of artefacts within assemblages, and has been used to show thatthere is no significant difference between standardisation in the Middle and Upper Palaeolithic (Marks *et al.* 2001). Elsewhere, uniform artefact size and shape or patterns have been used as markers of standardisation associated with high cognition, hence indicating modern human behaviour (McBrearty and Brooks 2000; Mellars 1989a). Equally, technological similarities gained through the process of learning also may lead to standardisation across assemblages, reflecting high cognition characterised by comprehension and application of learned knowledge abilities.

Evidence from the MSA assemblages indicates an emerging pattern of standardisation in terms of technological process as well as the basic shapes of some finished products. At the process level, standardisation is dimly represented by (a) use of both local and exotic raw materials, (b) use of different rock types, and (c) use of Levallois and radial reduction techniques. It is possible that these behavioural patterns had become common (standard practice), leading to their presence at the Central Rift Valley and Lake Victoria Basin sites. At the implements level, evidence from points and convergent scrapers, as samples of tool forms, indicate that there is minimal standardisation. Most of these pointed pieces grade in shape from disc-like and elongate ovals through ovate and amygdaloidal shapes to triangular forms (Merrick 1975), without any distinct overall shapes. Points, most of which come from Prospect Farm, exhibit less variability even though they are less standardised compared to those that come from other East African sites such as Nasera rock shelter in Tanzania (Merrick 1975; Mehlman 1989). In terms of retouch, the two forms of points exhibit standardisation throughout the assemblages where they are found. The very small sample of points from the assemblages, however, made metrical examination of size and shape parameters to be considered only minimally. Size and shape defining measures indicate a close similarity of these artefact forms across the assemblages. This trend toward uniformity of artefact forms may be interpreted as patterning leading to standardisation, and therefore a behavioural shift setting the stage for the production of standardised implements.

6.6 Discussion and Summary

A number of points are clear from the investigation of the technological system and the subsequent patterns presented above. First, the emergence of modern human behaviour as defined by various traits such as (i) increased artefact diversity; (ii) artefact standardisation; (iii) complex blade and microlithic technologies, and curation of tools; (iv) diversification of raw material use, including bone, ivory, and other organic materials; (v) ornamentation and various forms of symbolism; (vi) structured living space, and economic intensification; (vii) occupation of wider geographic areas, and the establishment of social networks (Table 2.1), is not exclusively associated with the European Upper Palaeolithic cultures. Most of these traits are also found in Middle Palaeolithic contexts in Eurasian and North African sites (Table 2.4) dating to as early as 250,000 years BP. These early assemblages contain abundant evidence for complex technology in which blade production was a common feature (Conard 1990; Revillion 1995; Revillion and Tuffreau 1994; McBurney 1967; Chazan 1994).

Secondly, modern human behaviour-defining traits are found earlier in archaeological contexts in many parts of sub-Saharan Africa. Even though evidence is at times limited and of questionable dates, various traits are now known to have been present during the MSA in East, Central, and Southern Africa. Blade technology, for example, which is a hallmark of Upper Palaeolithic/LSA complex technology, indicating modern human behaviour, is found in the Kapthurin Formation in Kenya by 280,000 years BP, Gademotta and Aduma in Ethiopia by 235,000 years BP, and at Klasies River in South Africa by 120,000 years BP (Wendorf and Schild 1974; Brooks 1996, 1999; Tallon 19978). Other traits also appear during earlier dates in the archaeological record.

Structuring of living spaces has been dated to about 90,000 years BP (Table 2.2). Exploitation of various environmental resources, such as land and aquatic resources, date to about 80,000 years BP, as presented in Table 2.3. Diversification of raw material use including use of exotic lithics involving transportation over long distances dates about 130,000 years BP in East Africa (Mehlman 1989; Michels *et al.* 1983; Merrick and Brown 1994; Table 2.5). These appearances contradict the revolutionary link between modern human behaviour and the emergence of advanced cultures during the European Upper Palaeolithic.

Finally, given the evidence for the so-called modern human behaviour traits in various parts of the Old World, there is no point in saying that cultural modernity appeared abruptly or was triggered by a single event in any particular part of the world. The most likely explanation is that it developed gradually with archaic *Homo sapiens,* followed by anatomically modern *Homo sapiens* in Africa working toward the higher standards of behaviour witnessed when the immigrant species arrived in Europe at the start of the Upper Palaeolithic period. This might explain some of the early dates for sub-Saharan Africa, especially Eastern and Southern Africa where important biological evolutionary changes also took place (Table 2.6).

Many of the traits used in defining modern human behaviour are now known to be older than the 40,000 years BP boundary initially thought to mark the start of cultural modernity. Still, initially-held assumptions about the link between modern human behaviour and the emergence of advanced technologies during the European Upper Palaeolithic are remarkably tenacious. Some researchers still think that the early dates in various parts of the Old World, especially during the MSA in sub-Saharan Africa, do not compare with cultural transformations in Europe around 40,000 years BP (Klein 1992; Mellars 1989). Emphasis has been put on the volume of evidence gathered in Europe, and the rapidity with which cultural transformation took place. No other part of the world has ever registered such a rapid transformation or amount of evidence. Clearly, the European evidence shows an almost revolution-like change. However, this evidence is voluminous only when compared to other less-researched parts of the world. It may be possible that the volume of evidence for modern human behaviour from other parts of the world, especially sub-Saharan Africa, would provide equally large volumes of data. This possibility has contributed to a shift in research focus, where more East African sites are targeted for intensive research to explore the topic of the emergence of modern human behaviour. This study sought evidence from lithic technological systems, including artefact forms, distributions, and patterns as presented above. These give rise to a number of ways in which modern human behaviour is represented in the five MSA assemblages studied. These are summarised below.

Planning: Planning depth, which refers to the ability to establish strategies based on day-to-day experiences and carries them out in a group context, has been given as one of the traits signalling modern human behaviour (McBrearty and Brooks 2000). Direct evidence for this kind of activity is not available in the archaeological record, and is only inferred by looking at other forms of evidence. Indirect evidence from the five MSA assemblages examined argues strongly for the presence of planning and forethought within the technological systems. First, the acquisition of raw materials for artefact manufacture at the five sites indicates a planning process involving group activities. As shown in Tables 5.2 and 5.3, most sites depended on known quarry sites as sources of raw material. These sources were purposely visited by hominids from the various sites to obtain cores for stone tool manufacture. The cores may have been mined or cut and prepared before being transported to the manufacturing sites. This process may have been repeated several times as long as there was need for raw materials, and is a clear indication of planning by MSA hominids. Merrick and Brown (1984:134) provide evidence of flaking debris and cut sections from which quality obsidian was removed, attesting to the use of the locations as quarry and workshop sites.

Secondly, the distances involved in transporting raw materials from some of the quarry sites to the manufacturing sites are long, at times in excess of 60 km. According to the 30 km mark defining when raw materials become exotic (Soffer 1988), all the five assemblages seem to have been created using both local and imported raw materials. This process of choosing between either local or exotic materials, with the latter being obtained from distant locations while by-passing nearby sources, implies deliberate planned activities reflecting modern human behaviour. Where direct procurement was involved, group mobility took effect with journeys to and from raw material sources. But acquisition of exotic materials may also have been realised via exchange networks in which hominids did not have to travel to far quarry sites but obtained what they needed through down-the-line exchange networks (Renfrew and Bahn 2000). Such exchange patterns also reflected social relationships, and would indicate that MSA populations had cognitive capacity for modern human behaviour.

Lastly, the presence of exotic materials obtained from long distances, for example, the obsidian at Muguruk which comes from the Central Rift Valley, some 190 km away, underscores long-distance procurement strategy, which is another indicator of modern human behaviour. In the case of obsidian at Muguruk, direct procurement may not have been possible; and down-the-line exchange or other forms, such as gift exchange between individuals or groups, seem to be likely explanations. Such forms of exchange were possibly common in the East African region, where obsidian has been documented to have moved to different sites, including those in the Northern Tanzania region during the late MSA and the whole of the LSA. These are forms of evidence for cultural modernity.

Increased artefact diversity: Increased artefact diversity or number of tool categories has also been used as an archaeological indicator of modern human behaviour (McBrearty and Brooks 2000). Evidence from the sample assemblage, through a simple method of artefact category counts, indicates that there is a high number of artefact categories compared to earlier periods, e.g., the Acheulian; and the variety almost matches LSA cultures. Table 5.7 does not only contain various types of scrapers but also a number of backed pieces, including crescents and blade forms that would be expected in LSA contexts. The diversity is explicit at Prospect Farm, but is also present at the other sites; and indicates the presence of cultural modernity.

Increased artefact diversity is also related to other indicators of modern human behaviour, such as the exploitation of diverse environments, scheduling, and seasonality in resource exploitation. Evidence from other parts of sub-Saharan Africa provided in Table 2.3 indicates that MSA populations carried out deliberate hunting as early as 80,000 years BP. This included selective hunting, and hunting of dangerous animals. They also exploited aquatic resources such as fish, marine molluscs, and other forms including snails, angulate tortoises, and plant foods (Marean 1998; Klein 1994, 1989;

Milo 1998; Robbins *et al.* 1994; McBurney 1967). At the same time, they occupied various environments (Marks 1975; Mercader and Marti 2000). According to these indicators, there is clear presence of modern human behaviour.

Evidence from the studied assemblages indicates that during the MSA period, these sites were located in ecotones and hominids exploited both montane forest and savannah grassland resources, as illustrated in Figure 6.3. Populations at Muguruk may also have exploited tropical forest and open grassland resources, as presented in Figure 6.4. Exploitation of these environments may be linked to artefact diversity, with specific tools used to exploit specific environments or particular resources. This may also reflect the rise of special purpose tools, such as projectiles and geometric forms which dominate LSA cultures and are a hallmark of modern human behaviour. Ecotonal settlements, as presented by the location of Prospect Farm, Enkapune Ya Muto, and Prolonged Drift in the Central Rift Valley, further indicate a working knowledge of resource seasonality. Exploitation required appropriate adjustments in terms of coordinating mobility, and developing necessary tool kits. Based on this evidence, it can be argued that MSA populations had become logistically organized (Binford 1980) by their own standards, and show behaviour similar to most hunter-gatherer populations.

Diversification of material use: Making of tools using diverse materials such as bones, antler, wood, and other forms of organic nature constitutes modern human behaviour. Diversification of lithic raw materials used for tool manufacture, which goes back as early as 130,000 years BP (Clark 1959; Marks 1968), also signals cultural modernity. Evidence presented in the assemblage indicates the use of different rock types, including obsidian, basalt, quartz, quartzite, and chert. There is no evidence for the use of bones and wood, although these may have been used but have long been destroyed by the acidic soil conditions at most MSA sites. Other materials that are evidence for diversification in material use include the use of ostrich eggshell during a late MSA occupation at Enkapune Ya Muto (Ambrose 1998). Table 2.4, however, indicates that the use of bone tools elsewhere in sub-Saharan Africa was going on at least by about 90,000 BP at the South African sites of Border Cave and Klasies River, and the Katanda site in the Democratic Republic of the Congo (Beamont 1978; Volman 1984; Bada and Deems 1975; Brooks *et al.* 1995).

Blade technology: Grouped as new lithic technologies, blade technology, microblades, and backed pieces have been used as indicators of cultural modernity. Evidence from sub-Saharan Africa indicate that blade technology is found in the archaeological record by around 280,000 years BP (Tallon 1978), and is present at several Eastern and Southern African sites (Table 2.4). Evidence from the Central Rift Valley MSA assemblages indicates the presence of blades but in small quantities (Table 5.4). There are also backed pieces which include backed blades and crescents, and therefore indicate cultural modernity. The low frequencies of these backed pieces (Table 5.7) are partly a result of sampling bias; but indicate that the technology was in a developmental stage, and therefore imply the gradual development of modern behavioural traits.

Standardisation: Standardisation within formal tool categories or artefact types is another trait that has been used as indicating modern human behaviour. Evidence for standardisation in the MSA has been obtained for blades and microlithic pieces from

Klasies River in South Africa and Mumba rock shelter in Tanzania (Keller 1973; Volman 1984; Deacon 1984; Rust 1943; Rozy 1985; Mehlman 1989, 1991; Brooks et al. 1990). Evidence from the Central Rift Valley and Lake Victoria Basin assemblages, however, shows only a limited nature of standardisation in artefact production. Levallois reduction to produce flakes was standardised. The production of triangular flakes also seems to have had a standard procedure. The same type of flakes were also selected for the manufacture of convergent scrapers and the two forms of points (unifacial and bifacial). Convergent scrapers, even though different in refinement due to differential trimming of the butt area, approach a similar shape across sites. Similarly, the production of points, which was more elaborate than that of convergent scrapers, exhibits control of both shape and the general size of the implements. Breadth to length ratios, which define shape, indicate that there is very little difference between points from Prospect Farm, Enkapune Ya Muto, and Cartwright's Farm (Figure 5.35). This indicates that standardisation procedures were developing during the MSA period, and therefore mark the beginnings of cultural modernity.

These signs of standardisation, reflected in the production of similar convergent scrapers, and unifacial and bifacial points may also be linked to another aspect of cultural modernity where artefact makers posses a mental template of the by-product of stone manufacture. The assemblages contain evidence of the use of prepared core technologies such as the Levallois and radial reduction techniques. These formal strategies involved a calculation or having in mind what artefacts are to be produced. The production of triangular flakes on which convergent scrapers and points were made seem to have been a stage-managed process, with the end products already set out from the beginning. Such behaviour is the preserve of those with modern behavioural repertoire, and therefore argues strongly for the presence of cultural modernity in these assemblages.

Curation: McBrearty and Brooks (2000) list curation as an archaeological indicator for modern human behaviour. As introduced by Binford (1973:76), curation is a strategy for caring for tools and tool kits; and includes advance manufacture, transport, reshaping, and caching or storage of tools. Preparation and transportation of cores from quarry to manufacturing sites, or tools to work places, is therefore evidence of curation. Equally, reshaping of tools for use in new errands, or storage and maintenance of others for use in times of scarcity of resources are all forms of curation.

There is indirect evidence for this activity in the assemblages studied. There are no larger flake blanks at the sites, especially at Prospect Farm and Enkapune Ya Muto (Figure 5.20). This may indicate either the use of such larger flakes to manufacture tools at these sites, or transportation of the same to other localities for tool manufacture. If such transportation was done, then curation procedures were carried out.

Another possible evidence for curation is the large number of flakes and fragments as opposed to fewer cores at Prolonged Drift. This situation may have been created by transporting flake blanks to the site after core reduction was carried out elsewhere. This indicator that materials were imported from elsewhere may also imply that Prolonged Drift served a specific function, being visited only for the purposes of carrying out planned activities, in which case curated tool kits would be put to use.

At Enkapune Ya Muto, larger flakes relative to smaller cores with tiny scars are also indicative of transport of materials from elsewhere to this site. The same observation is true for Cartwright's Farm, whose implements, including tool forms made on flakes, are relatively larger compared to the nature of cores in terms of size and scar patterns. These anomalies may imply movement of things between sites.

Re-sharpening and rejuvenation of tools also provides evidence for curation. Tool-trimming and re-sharpening whole flakes and fragments (Table 5.6) is evidence for this activity. Rejuvenation of tools has been inferred from the presence of large fresh flake scars on the edge or surface of old tool surfaces containing old flake scars. The removal of such flakes was probably aimed at creating new surfaces for retouch, or changing the form of a particular tool into a new form.

Lastly, the most conspicuous evidence for curation within the Central Rift Valley is the transportation of cores from quarry sites to various sites. As discussed earlier, cores were cut, prepared, and transported to manufacturing sites. The use of materials from different sources in different sites as shown in Tables 2.5, 5.2, and 5.3 is therefore the clearest indication of curation activities during the MSA, indicating the presence of modern human behaviour.

Social and exchange networks: The ability to construct formalised relationships among individuals and groups is a mark of modern human behaviour. Evidence for this kind of behaviour usually comes in the form of goods or materials from one group being found in another group. As mentioned above in the discussion of raw material procurement, transportation of particular commodities from one group to another or a region to the next may be realised either through direct contact between the groups concerned, or through distance exchange networks such as down-the-line trade networks. These procedures involved a chain of bargains and interactions between groups and/or middlemen that brokered deals along the passage line.

The nature of 'obsidian networks' within the East African region is such that most likely than not, quantities of this stone found at the various sites may have been passed down-the-line from source to destination. Take, for example, the few pieces found at Muguruk whose origin was the Central Rift Valley some 190 km away. It is unlikely that the person who carried the pieces to the site conducted direct procurement. Similarly, obsidian from the Central Rift Valley sources used at sites in Northern Tanzania may not have been obtained through direct procurement, but through exchange networks. The distributions of obsidian within the Central Rift Valley and the entire East African region, therefore, underscores the likely presence of social interactions and exchange networks; and imply patterns of cultural modernity during the MSA.

What, then, of modern human behaviour in the MSA? In technological terms, the different technological subsystems provide test implications that correspond positively with the traits mentioned as defining modern human behaviour. The test implications for the various traits are at times not in themselves sufficient evidence to argue for the presence of cultural modernity during the MSA. Most importantly, however, a number of traits used in defining modern human behaviour feature prominently in the data used in the current study. Some, such as symbolism, including artefact styles, image representations, burials, and body adornments are absent from the data used. Prospect Farm, which contains multi-level occupations, remains a potential area to test other forms of variables not necessarily those related to modern human behaviour; but even other topics, such as the investigation of temporal variation in formal tool categories which was not possible in the current work. Explanations of the current indicators of modern human behaviour have been structured in terms of the patterns identified within the technological systems and their subsystems. These have been centred around raw material procurement and use, artefact technological features, environmental conditions, and the debate on the emergence of modern human behaviour.

Chapter 7: Summary and conclusions

> *Is there anything of which one can say, "Look! This is something new"? It was there already, long ago; it was here before our time. (Ecclesiastes 1:10 [Barker et al. 1995])*

7.1 Research purpose

Around 40,000 years ago in Europe, prepared-core technologies used during the Middle Palaeolithic cultures were replaced by blade and eventually microlithic technologies of the Upper Palaeolithic. At the same time, major behavioural changes characterised by symbolism, planned use of the environment, burials with grave goods, and high artefact turnover, amongst others, started to appear. These technological and behavioural changes coincided with the arrival of *Homo sapiens* in Europe around 30,000 to 40,000 BP. The changes were consequently attributed to the newcomers' modern behavioural repertoire, leading to the development of a trait list for defining modern human behaviour and the setting of its antiquity at 40,000 BP (Klein 1992; Mellars *et al.* 1989).

Heightened research in the European Middle and Upper Palaeolithic cultures revealed marked behavioural differences between the two cultures, leading to what has been termed the "human revolution" (Mellars and Stringer 1989), in which advanced technological and other behavioural activities appear suddenly in Europe by 40,000 BP. Evidence from Africa, however, indicates that some of the behavioural traits observed in Europe during the Middle to Upper Palaeolithic transition, and attributed to modern human behaviour, occurred gradually and earlier during the MSA which corresponds to the European Middle Palaeolithic. Researchers in sub-Saharan Africa (McBrearty and Brooks 2000), therefore, disagree with the notion of a 'revolution' in explaining the emergence and antiquity of modern human behaviour. Instead they focus attention on recovering more information from the vast uninvestigated African resources (Klein *et al.* 2002; Onjala 2004) to pursue the hypothesis of gradual development, and for a better understanding of this important subject.

The main question, therefore, is whether modern human behaviour emerged earlier than 40,000 BP during the MSA/Middle Palaeolithic, or during the transition to LSA/Upper Palaeolithic about 30,000 to 40,000 BP. Differing technological approaches and other behavioural patterns between the two periods have been interpreted as illustrating the presence or absence of modern human behaviour during the MSA/Middle Palaeolithic and LSA/Upper Palaeolithic respectively. The MSA/Middle Palaeolithic is seen as consisting of: (a) simple material culture lacking bone implements, fishing and fowling gear, variation in lithic technology, and use of exotic raw materials; (b) basic subsistence with no fishing, capture of flying birds, hunting of prime adult or dangerous animals, and emphasis on scavenging; and (c) absence of symbolic behaviour such as the use of art, personal ornaments, ochre use for other than utilitarian purposes (Klein 1995, Gamble 1994, Henshilwood and Marean 2003: 629). The period is, therefore, seen as lacking modern human behaviour as opposed to the LSA, which portrays the opposite picture. However, there is difficulty in assessing modern human behaviour during the MSA. In the absence of an acceptable body of theory defining its characteristics, it is difficult to know what actually constitutes "modern human behaviour" in the prehistoric record. Examples like those found in LSA/Upper Palaeolithic period appear from different parts of sub-Saharan Africa during the MSA, suggesting a considerable presence of evidence that has eroded over the years. The behavioural reflections of soft technology for the MSA are unavailable, while that of hard technology remains the only focus of attention that should be fully investigated in regions such as southern and eastern Africa.

Technological implements of the MSA are directly related to hominid behavioural patterns which indicate hominid skills, survival strategies within occupied environments, social structures, relationships between groups, and the abilities of the prehistoric societies, all of which are useful in the assessment of modern human behaviour. While the East African MSA lithic assemblages have been the subject of several years of investigation, the relationship between the technological systems and behaviour that produced such systems in understanding the emergence of modern human behaviour has not been undertaken. Most assemblages are small, and have attracted less attention (Onjala 2004) compared to assemblages from southern Africa that have featured prominently in the current debate on the emergence of modern human behaviour. Details of the technological system at several sites are not known, despite their potential in unlocking some of the behavioural aspects present during the MSA period.

The potential of East African MSA sites to provide evidence for modern human behaviour has also remained less attractive because of lack of preserved organic materials such as bone, and the absence of stratified sites with long periods of occupation. Prospect Farm, which is one of the largest sites in the region, has four short MSA horizons called phases (Anthony 1978), with the oldest dating to the last interglacial (OIS 5e, around 135,000 BP) and the youngest dating to 50,000 BP (Mitchels *et al.* 1983). The Endigi Industry at Enkapune Ya Muto, which is the only MSA horizon at the site, is equally short; and dates to OIS 3, (about 50,000 to 59,000 BP). Other sites of the same time period continue to be discovered in the region, and give promise of finding richer and well stratified occurrences.

MSA materials from Central and Western Kenya have been used in a number of projects touching on technology. Materials from Muguruk have been used to describe the Sangoan Industry and its technological features compared to those of the MSA (McBrearty 1986), while those from Prospect Farm have been used to define the Prospect Industry (Anthony 1978). Merrick and Brown (1984) examined raw material movement and use within the region, providing evidence for use of exotic materials at various sites. Merrick (1975) also considered the aspect of technological standardisation and artefact turnover at Prospect Farm, an idea that was also mentioned by Anthony (1978). These aspects are useful in examining the presence of modern human behaviour during the MSA; but are, unfortunately, only mentioned and therefore need further detailed investigation.

The goal of my research is to identify evidence for the presence of modern human behaviour in the MSA technological system as a contribution to the debate over the emergence of modern human behaviour. Reconstruction and description of the technological system were aimed at identifying technological patterns that translate into behavioural patterns useful in exploring questions on modern human behaviour within the studied assemblages. Working with the hypotheses that variation occurs within and between MSA assemblages, and that MSA artisans were behaviourally modern, the following research questions were raised:

(i) What was the structure of the technological process? Does this reflect aspects of modern human behaviour?

(ii) What are the main technological patterns represented in the assemblages? Do these reflect aspects of modern human behaviour?

(iii) Is there variation between the assemblages? What are the main causes of such variation, and do these reflect modern human behaviour?

(iv) Which aspects of the technological procedure reflect standardisation, if any?

(v) Is modern human behaviour represented in the MSA assemblages?

7.2 The evidence

The MSA sample assemblages were produced through a six-step technological procedure, with each step varying in intensity and appearance from site to site. I have discussed the order in which the steps occurred; but later steps, from the selection of flakes for tool manufacture, could have occurred in any order depending on the need and use to which implements were put. I have also indicated which implements were most likely produced at each stage, and at which sites. Amongst the implements are included the various core types including Levallois and radial discoidal forms, and the flake categories which detail the stages of the reduction process. Using the composition of different assemblages, Prospect Farm, Enkapune Ya Muto, Cartwright's Farm, and Muguruk seem to contain all stages of the manufacturing process except for evidence for core trimming at quarry sites. These sites were, therefore, most likely residential sites where manufacturing, use, and discard of exhausted tool forms occurred. At Prolonged Drift, however, the absence of cores indicates stages I and II occurred elsewhere, with only later stages taking place at the site. The site may have been a temporary campsite into which implements were transported and used to perform specific tasks, the nature of which is not known yet. This may imply curation of tools, which is a significant technological behaviour characteristic of modern human behaviour.

Two forms of raw materials are represented at the sites. Local and exotic materials were used at all the sites. Obsidian used at Prospect Farm came from local sources as well as from distant sources exceeding 50 km. Similarly obsidian used at the other Central Rift Valley sites is both local and exotic in origin. Chert used at Enkapune Ya Muto came from sources 65 km away, while obsidian pieces observed at Muguruk (McBreaty 1986) were transported some 190 km from the Central Rift Valley source. These distances, and the increased use of a combination of local and exotic raw materials, underscores the emergence of behavioural patterns pointing toward modern human behaviour, where hominids established links amongst groups in order to acquire necessary resources not immediately found within their territories.

Apart from combining local and exotic raw materials in their technological pursuits, MSA artisans used varied rock types for stone tool manufacture. While obsidian was preferred at the Central Rift Valley sites because of its high flaking quality and availability, Ombo phonolite, which is a grade of lava, was preferred at Muguruk within the Lake Victoria Basin because of its availability. Besides these rock types, other less preferred types including basalt, chert, quartz, and quartzite were used, demonstrating the diversification of raw material use.

Raw materials were obtained from their primary geological context such as outcrops and quarries in the Central Rift Valley. Hominids took time to visit such localities whenever they required material for stone tool manufacture. They also picked scattered pieces in secondary geological context to meet opportunistic technological demands. At Muguruk, ombo phonolite was quarried from outcrops adjacent to the site, with other rock types including quartz being transported from the nearby hills containing Precambrian rock formations. Acquisition of materials was a planned activity in most cases.

The assemblages resulted from both formal and informal technological strategies implying the presence of expedient/opportunistic and non-opportunistic technological behaviour. Reduction techniques included Levallois, radial, and bipolar techniques in which cores were either prepared to produce platforms from which flakes were struck, or reduced using naturally occurring platforms. No single assemblage shows preference for a particular technique. Instead, all the assemblages portray a mixture of strategies and techniques, making it impossible to discern any one reduction technique that was preferred over others. From the acquisition of cores to the manufacture of tools, flaking techniques included direct freehand percussion using either hard or soft hammer, radial break percussion, bipolar percussion, and pressure flaking.

Both reduction and flaking techniques varied from site to site. Prospect Farm and Muguruk, with all stages of manufacturing, showed all reduction and flaking techniques mentioned above. Bipolar reduction was used more at Enkapune Ya Muto, with all the flaking techniques except for radial break percussion, which was only common at Prospect Farm. At Prolonged Drift and Cartwright's Farm, bipolar reduction was more common, even though the use of only a small number of cores at these sites makes any conclusions doubtful.

Direct percussion using either hard or soft hammer was used to prepare Levallois and other cores; and to produce flakes from prepared and non-prepared cores, larger flakes, and to a lesser extent larger scrapers and other tool forms. Bipolar percussion was used to produce flakes from naturally shaped and irregular cores as well as expended pieces, which included larger tools from which flakes could be obtained. This technique was common at Enkapune Ya Muto and Prolonged Drift. Pressure flaking was used to prepare or sharpen tool edges, and also to rejuvenate tools such as convergent scrapers and points. Radial break percussion was minimally used, and the only tangible evidence is the radial retouch scars on some of the tools from Prospect Farm.

Cores, flakes, and finished tools were made and discarded at the sites. The Prospect Farm assemblage contains a high percentage of debitage and an assortment of tool forms, indicating the site was a focal point for the manufacturing process. Some of the tool forms discarded at the various sites, however, may not all have been made at those sites. Such finished products may have been manufactured elsewhere and moved upon completion to the sites where they are found. The composition of the Prolonged Drift assemblage, with no significant cores, indicates that materials were moved to this site from elsewhere. Larger flakes were also removed from sites for use and modification elsewhere, as all the assemblages show that a higher percentage of whole flakes are less than 80 mm in length.

Variation occurs in the assemblages in the form of artefact size, types forming different categories, and frequency distributions. Main causes of variation are from the different hominid choices and decisions at procurement and reduction stages of the technological process. These choices and decisions, made in accordance with the assessment of environmental conditions and hominid adaptive requirements, led to the production of a high number of artefact types, and smaller or larger forms, as dictated by circumstances. Variation is also due to the use of different raw materials, and the treatment of all MSA levels at sites like Prospect Farm and Muguruk as single assemblages. Also, the hierarchical nature of flakes (core-reduction whole flakes, core-trimming whole flakes, tool-trimming whole flakes, and varied flake fragments) used here contributes to the statistical variation observed between and within the assemblages. Much of the variation, however, is behavioural and in line with activities aimed at maximising the use of resources.

At all the sites, procurement involved use of local and imported raw materials. Different rock types were also used at all the sites, while Levallois and radial core reduction can also be traced in all the sites. These technological aspects had become standard, and were not affected by regional differences. They form standardised technological procedures that sustained viable technological systems at the different MSA sites.

The production of triangular flakes, from which semi-standardised convergent scrapers, and unifacial and bifacial points were made, indicates an emerging standardisation of artefact forms. These artefact forms exhibit signs of standardisation in size and shapes. Unifacial points, in particular, are well shaped, with similar retouch patterns across the sites.

7.3 Conclusions

That East African MSA technological systems represent dynamic and behaviour-controlled procedures cannot be doubted. The organisation and procedures within lithic technology reflect a broad spectrum technological set-up that served a wide range of purposes. The availability and use of local and exotic materials allowed for the production of various flaked implements that were used on-site and elsewhere. Carrying of implements, such as finished tools and flake blanks, from site to site, represents curation or "gearing up" that reflects modern human behavioural patterns. The presence of only a small percentage (less than 2%) of flakes measuring more than 80 mm in length at all the sites has been interpreted as indicating removal of such larger flakes for use elsewhere.

The range of approaches to manufacturing flakes for use reflects a flexible and co-ordinated stone industry. Collection of objective pieces and the decision to use particular reduction strategies and techniques involved use of the knowledge of geological distribution of rock types, flaking quality of different rock types, and the expected or desired flaking products. Use of the same knowledge resulted in the variation and diversification of artefact forms observed in this study. There is increased diversification of not only artefact types but also of raw materials used for stone tool manufacture at the different sites.

It appears that standard technological procedures were applied to produce artefacts that conformed to the cultural requirements of the period with a minimum of energy expenditure. The use of Levallois and radial core reduction across the five assemblages to produce almost similar artefact forms from different rock types, reflects the presence of knowledge and skills for tool manufacturing process that goes beyond intuitive behaviour, and which could have been learnt and passed on. It is my opinion that the technological system and the patterns that emerge can best be understood as a mixture of well-patterned and planned activities signifying modern human behaviour, and intuitive technological behaviour making use of available resources to remain viable in extremely unpredictable environments of the MSA period. The high number of tool forms in the various assemblages may reflect the fact that not only was the technological system dynamic and viable, it was complex enough to allow for the exploitation of resources from different niches such as montane forests and savannah grasslands in the Central Rift Valley, and forest and open grassland in the Lake Victoria region.

The system presents an incomplete package of modern human behavioural patterns compared to traits that are used to define modern human behaviour, as discussed in Chapter 2. However, a number of patterns show the presence of modern human behaviour. The presence of exotic materials and the use of a variety of rock types, at various sites suggest that the various groups had social links within the wider environment, upon which they controlled particular territories. Given that the nature of the links between groups is currently unknown, it can be assumed that acquisition of resources from distant localities occurred in the spirit of friendship, trade, or other forms of exchange. Such kind of behaviour constitutes modern behaviour similar to what may be observed ethnographically with modern hunter-gatherer societies.

Acquisition of raw materials from quarries and outcrops involved planning. This behavioural pattern suggests modern human behaviour even though there is lack of hard evidence on where and how materials were obtained for each site. The use of prepared core techniques, that is common at all the sites, suggests a mental template wherein artisans planned what their technological products would look like. This inference supports the presence of modern human behaviour, even though the percentage of products resulting from such planned procedures is small.

Production of semi-standardised artefacts such as triangular flakes, convergent scrapers, and unifacial and bifacial points, as well as the movement of artefacts either as tools or flake-blanks, shows an emerging trend toward modern behaviour. Standardisation and curation are clear markers of modern human behaviour. Their appearance within the sample assemblages, even though only in a limited way, is indicative of patterns that point toward modern human behaviour. Aspects of standardisation can also be seen in procurement procedures and the production of uniform Levallois flakes across the assemblages.

The cooler arid conditions of the middle to late Pleistocene period may have forced the hominids to adopt ecotonal settlement patterns within the Central Rift Valley. Such patterns are evident in the location of sites such as Prospect Farm and Enkapune Ya Muto, whose material remains reflect exploitation of both montane and savannah grassland resources (Ambrose 2001). These contributed to the diversification of artefact types for effective exploitation of varied environments and resources. The patterns also suggest hominid understanding of resource availability and seasonality, as different niches were exploited at different times. This marks the start of complex behavioural patterns that later developed into deliberate and planned management of the environment through activities such as controlled collection of resources, and burning among hunter-gatherer societies, such as the Dorobo and Okiek in the Central Rift Valley (Ambrose 1986).

7.4 Modern human behaviour in the MSA?

The technological patterns and their implications as presented here carry a mixture of archaic and modern behaviour. While there was tremendous improvement and innovation in various aspects of stone tool manufacture, such as wider sourcing of raw materials, and production of implements with controlled sizes and shapes, some aspects such as the use of radial core-reduction techniques continued with little improvement from the Acheulian period. This mixture of behavioural patterns implies that modern human behaviour existed in its early developmental stages. The artisans responsible for the sample assemblages, whether they were archaic or modern *Homo sapiens* possessed modern human behaviour abilities that were being developed gradually. Innovation, creativity, and complex understanding and use of the environment are testimony to this.

No bone implements or fishing and fowling gear have been recovered from any of these East African sites. However, implements such bone points, incised bones, shell beads, and ostrich eggshell beads have been found in southern Africa in MSA context (Henshilwood and Sealy 1997; Henshilwood *et al.* 2004). At the site of Enkapune Ya Muto in East Africa, Ambrose (1998) documents the presence of ostrich eggshell beads during the later parts of the MSA. There is also evidence for artefact variation and use of exotic raw materials in the Central Rift Valley and western Kenya. These indicate modern human behaviour, as they conform to Mellars' (1989) list of traits defining modern human behaviour.

Technological gear indicating exploitation of aquatic resources and flying birds are missing, but the presence of points that could have been hafted indicates deliberate hunting that could have included dangerous species. John Shea (1988) has argued that Middle Palaeolithic points in the Levant were hafted and used as spear points, therefore establishing technologically-assisted hunting as an important subsistence strategy during this period. If points recovered from the MSA sites in this study were used in a similar manner, then the behavioural aspect represented by the tools indicates modernity.

Symbolic behaviour such as the use of art, personal ornaments, and use of ochre is also missing; but the beginning of imposed artefact shapes and forms as seen in the manufacture of points may carry symbolic meaning and therefore reflect emerging modern behavioural patterns. It can therefore be argued that modern human behaviour was present during the MSA period and may have existed even earlier. The challenging cold and arid environments of the Middle to Late Pleistocene, which sparked innovation, may have presented such a catalyst leading to diversification expressed in the MSA assemblages in central and western Kenya, East Africa. More work in the region will produce finer details that have not been covered in this work to explain more aspects of modern human behaviour during the MSA period.

7.5 Research limitations and future research opportunities

This dissertation has attempted to trace signs of modern human behaviour in MSA lithic assemblages at five East African sites, based on archaeologically identifiable traits and arguments provided previously by other researchers. Such traits are discussed in details in Chapter 2, and applied to the findings of this research in Chapter 6. The findings and conclusions presented here, are, therefore, heavily reliant on the use of traits as a means of identifying cultural modernity, and may carry inherent limitations and errors contained in arguments associated with such list of traits. Some notable examples include the use of blade technology, standardisation of tools, and planning of activities, given as signalling modern behaviour, but which can be traced to earlier periods, and are associated with archaic *Homo sapiens* and/or Neanderthals. In the face of such uncertainties as to what should actually define modern behaviour, I cannot help but doubt the suitability of using the traits method as a means of tracing signs of modern behaviour. Furthermore, I cannot state authoritatively that I examined all aspects of the technological features pointing toward some of the traits discussed. My concern is that some of the traits would have been investigated further, although this would have only provided a better explanation rather than different results from the ones obtained.

The archaeological materials examined in this work were a product of sampling of artefacts from previous excavations. This presented serious challenges to this work, whereby issues of controls during excavation, catalogue, and the general state of artefacts in storage had to be dealt with. Differing sample sizes, for artefact categories at different sites, either amplified or deemed some of the expected results. Such anomalies may cause readers to doubt some of the results presented, as some samples are quite small, relative to larger ones they are compared with or against. Despite these sample and data problems, the dissertation makes a case for the emergence of modern behaviour, as signs for this are reflected even in the smallest of samples that reveal the choice of different raw materials, use of specific reduction techniques, and artefact shapes and sizes.

These problems, and others mentioned earlier in the dissertation, have at times caused me to doubt the results of my research, while at the same time given me impetus to pursue some of the issues and limitation raised in future research. The issues raised about the nature of obsidian movement; manufacture, use, and discard of artefacts; technological changes over time and how this links with behavioural shifts; environmental exploitation patterns; and tool curation processes all need examination using materials from a well-controlled excavation and recovery process. The current work has relied on some previous conclusions and inferences, some of which may not be clear. New research agenda in the Central Rift Valley, as well as the Lake Victoria basin, may offer better results to explain the development of human behaviour during the mid to late Pleistocene period.

My aim is to push the current research agenda in understanding the development of modern behaviour in the Central Rift Valley a step further, by delimiting research area to Prospect Farm, before expanding to other areas in East Africa. Prospect Farm is suitable, as it promises opportunities for chronological control over a large section of the Quaternary time, and will be useful in tracing technological changes and the factors that drove such changes. A well-organised excavation, and analysis of recovered materials from the site, will make clearer some of the issues and inferences made in this initial research on the emergence of modern human behaviour in East Africa. *Thutinda!*

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Appendix A: Artefact definitions

The typology used in analysing lithic artefacts in this work is that developed by Merrick (1975) in his analysis of Middle and Later Stone Age assemblages in East Africa. Most of the definitions presented below also follow closely his definition of the various artefact types. A few additions, such as core fragments and utilised flakes, are of my own; and are fitted here to capture those artefacts that could not fit within the typology as presented by Merrick. Only materials examined have been included in the definitions that follow. For a complete list of Merrick's typology, reference should be made to his Ph.D. dissertation, pages 442–478.

General definitions

Core

A core is a mass of homogeneous lithic material that has had flakes removed from its surface (Andrefsky 1998:12). Cores generally form the nucleus of lithic materials remaining after the removal of flakes (Crabtree 1972); and come in a great variety of forms and sizes, which correspond to the varied nature of naturally occurring stones, and also the extremely variable efforts in shaping them to obtain the desired detached pieces.

Flake

A flake is a chipped stone artefact removed from a core. A whole flake has recognisable striking platform and bulb of percussion, intact flake-release surface, and no evidence of retouch or utilisation.

Trimmed Piece (Tool)

A trimmed piece is any piece that is deliberately modified through retouch, backing, or trimming.

Regular Core

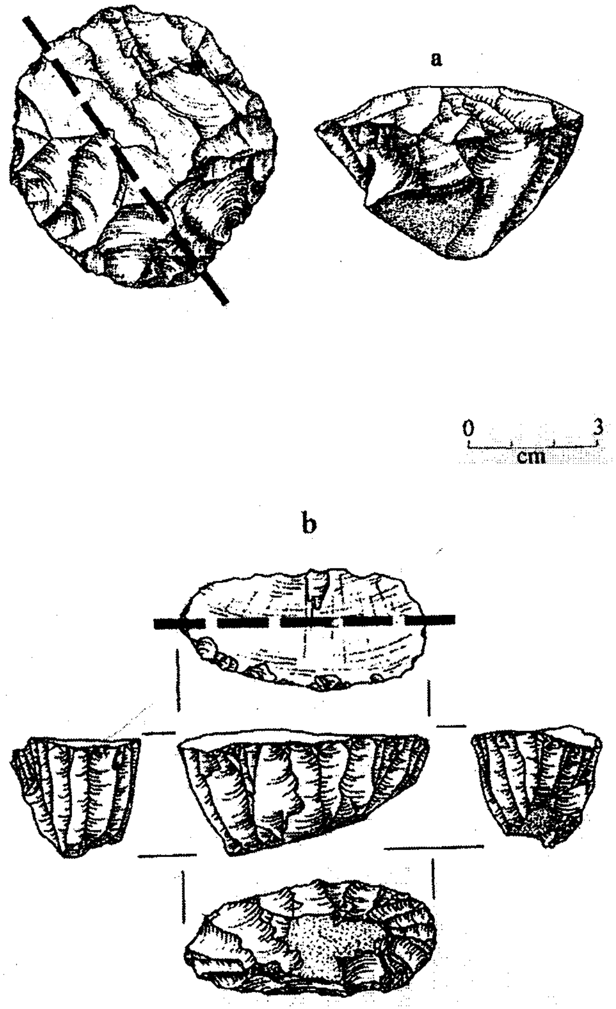
A regular core is a piece that has regular standardised morphology or regular standardised pattern of preparation. Examples are the Levallois cores, prismatic and pyramidal cores.

Non-regular core

A non-regular core is a piece that has no highly standardised shape.

Core maximum dimension

Core maximum dimension is the longest straight-line measurement on a core. A combination of this measurement taken in millimetres and core weight taken in grams gives an estimate of core size. Multiplication of the two provides a means of ranking the cores in terms of sizes.



Core maximum linear dimension is shown by the dashed lines (From Andrefsky, 2002:140, figure 7.2).

Definition of core types

Radial discoidal core

This core is circular in plan shape, with flaking originating on the equator extending around the conference of the core. It resembles classical Mousterian disc core (Bordes 1961, plate 106 (1); Merrick 1975, figure 4(1–3).

Regular core approaching radial discoidal core

This type approaches circular plan shape, but has incomplete flaking around the equator of the core.

Regular core approaching Levallois core

This type has the characteristics of radial preparation on the dorsal surface, with faceted platform from which single large flakes were removed. It compares with Bordes' (1961) plate 98 and Merrick's figure 4 (5 and 6).

Regular single-platform prismatic core

This is a core with a single platform and shape approaching a solid cylinder, flaked from around the edge of the platform as in Merrick's figure 4 (7).

Regular single-platform pyramidal core

This is a core with a single platform and shape approaching a solid cone flaked from around the edge of the platform forming the base of the cone, as illustrated in Merrick's figure 4 (8).

Non-regular single-platform core

This type exhibits no standardised shape, with a single platform from which flakes were removed using either one or more edges.

Non-regular double-platform core

The type exhibits no standardised shape, with double platforms at alternate ends from which flakes were removed using either one or more planes.

Non-regular multiple-platform core

This type exhibits no standardised shape, with multiple platforms from which flakes were removed.

Irregular core

This type exhibits scars showing the removal of multiple flakes using several platforms in no consistent manner, but opportunistically using natural platforms.

Casual core

This type of core exhibits the removal of three or less flakes, with the remaining part of the core covered by cortex.

Core fragment
This is a chunk or piece with evidence of flake removal. May be general waste, but large enough for close association with cores. Formed when cores break in undesired manner, either due to flaking technique used or flaking quality of the raw material used.

Definition of flake types

Whole flake
This is a complete piece struck from a core containing all flake features: striking platform, bulb of percussion, striations caused by force of impact, ventral and dorsal surfaces.

End-struck whole flake
This is a flake with a breadth to length ratio of less than 1.0, which is not a blade or bladelet.

Side-struck whole flake
This is a flake with a breadth to length ratio greater than 1.0, and is generally wider from side to side.

Core-trimming whole flake
This is a flake containing portions of a core's platform and scars of flakes removed from that platform on its dorsal surface. The former flaking edge of the core forms a central dorsal ridge running down the length of the flake, as the trimming flake is removed by a blow struck across the worked core face, perpendicular to the primary direction of the old flake scars.

Tool-trimming whole flake
This is a flake containing small scars on the dorsal surface which form traces of the retouch edge of a tool. The intersection of the old worked surface and the former flake release surface is asymmetrically positioned on the dorsal surface closer to one of the lateral edges.

Core-trimming flake fragment
This is a broken piece exhibiting some characteristics of core-trimming whole flakes.

Tool-trimming flake fragment
This is a broken piece exhibiting characteristics of tool trimming or re-sharpening whole flake.

Flake fragment
This is a piece that exhibits some characteristics of a whole flake, such as portions of platform or bulb of percussion.

Utilised flake

This is a piece that exhibits breakages, dulling, or grinding on the edge(s), possibly caused by usage.

General waste

This defines a piece that may be considered a flake fragment but shows no traces of the characteristics of flakes such as bulb of percussion or platform. Most pieces assigned to this type are angular in shape, with fractures mainly caused by the nature of the raw material. This type corresponds to Merrick's angular waste.

Whole blade

This is a flake with a breadth to length ratio of 0.5 or less. In other words, it has a length twice or more than the width. These are mostly end-struck.

Definition of trimmed pieces

Convergent scraper

This is a marginally or sub-invasively retouched piece having two lines of retouch converging and intersecting to form a point. It resembles points, but is less refined and modified at the butt end in overall. It compares with Bordes' (1961) plate 19, 20, 21 and Merrick's (1975) figure 1 (15).

Unifacial point

This is a relatively thin symmetrical piece with two lines of unifacial retouch that converge into a point. The types in this category are made generally on triangular flakes, unifacial; and may exhibit less or complex butt modification, invasive or sub-invasive retouch, and moderate to high refinement in terms of shape. It compares with types defined by Sampson (1972: 71).

Bifacial point

This is a relatively thin symmetrical piece with two lines of bifacial retouch that converge into a point. It is similar to a unifacial point except for the bifacial retouch.

Single-sided scraper

This is a piece with a single modified edge parallel to the long axis of the piece.

Double-sided scraper

This is a piece with two modified edges opposite each other and parallel to the long axis.

Racloir transverse scraper

This is a piece with a single modified edge similar to a single-sided scraper, but the modified edge is perpendicular to the flake axis. This type is mostly produced on side-struck flakes.

Single-sided end and side scraper
This is a piece with two or more contiguous modified edges, with at least one being parallel and the other perpendicular to the long axis. The two lines of retouch may meet abruptly or smoothly.

Double-sided side and end scraper
This is a piece with two modified edges parallel to the long axis of the piece and one modified edge perpendicular to the long axis.

Convex end scraper
This is a piece with a single smoothly arching convex-modified edge that runs perpendicular to the long axis. Modification is mostly at the distal and only occasionally at the proximal end. Retouch is also usually marginal or sub-invasive.

Double convex end scraper
This is a piece with double modification on opposing ends that results into either double convex end scraper (when the piece is long) or double convex side scraper (when the piece is short).

Carinated end scraper
This is a piece that exhibits steep and invasive retouch on single convex edge perpendicular to the long axis, with the modified end appearing to be triangular.

Oblique end scraper
This is a piece with a straight line of marginal or sub-invasive retouch perpendicular to and also oblique to the long axis.

Small convex scraper
This is a piece with a single convex modified edge extending around $^1/_3$ to $^2/_3$ of the perimeter of the piece. Length and breadth are equidimensional; and retouch is mainly marginal to sub-invasive, creating medium to steep edge angles (Sampson 1972: 185; Merrick 1975, figure 1(12).

Circular scraper
This is a piece with a single modified edge extending around the entire perimeter of the piece usually exhibiting marginal retouch with medium to steep edge angles. Types within this category are generally circular, as in Merrick's figure 1(13).

Disc-like convex scraper
This is a piece with a single convex modified edge extending around the entire perimeter of the piece, exhibiting invasive retouch and shallow edge angles. Types in this category may be either circular or oval in shape.

Convex scraper
This is a piece with a smoothly arching convex modified edge perpendicular to the long axis, but extending slightly on to the sides. Modification occurs either at the distal or proximal end, and is mainly marginal.

Concave and notched scraper
This is a piece that exhibits a single line of marginal or sub-invasive retouch forming a broad concavity or a more tightly flexed notch. Multiple concavities may be found on a single piece, in which case such a piece becomes a different tool form, as explained by Merrick 1975:454).

Steep (core) scraper
This is a piece which shows a measure of thickness with one or more lines of steep retouch; and is made on either general waste, pebbles, or natural rock fragments. Pieces in this category are usually larger or thicker than other scraper forms.

Composite scraper
This defines a piece bearing characteristics of more than one scraper type; for example, having a notch and a single scraping edge.

General scraper
This defines a piece that does not fit in the other categories as defined Merrick's (1975) typology.

Crescent
This is an artefact that has a continuous convex backed edge intersecting the opposite lateral edge at a point at each end of its arc. It may be semi-circular or oval, but the line of backing is always continuous throughout the arc.

Pseudo-crescent
This is similar to a crescent, but the backing is not continuous throughout the arc, leaving the basal end where portions of the platform and bulb of percussion remain.

Straight backed blade
This is a piece exhibiting a clear platform and distal end, with a single straight line of backing along the lateral edge.

Curved backed blade
This is a piece with a platform and a single completely backed straight lateral edge that becomes increasingly more convex toward the distal end, where it meets the unretouched lateral edge to form a point. It compares with Tixier's (1963) types 37 and 56, and Merrick's (1975) figure 2 (6, 7).

Triangle
This is a piece that is backed along all or part of two straight edges, with the third left unmodified. Angles of intersection of the sides are usually very distinct.

Trapeze
This is a piece exhibiting a symmetrical trapezoid shape with obliquely truncated backing at both the proximal and distal ends. Both the longer and shorter lateral edges may or may not be modified. It compares with Tixier's (1963) type 83 or 87, and Merrick's (1975) figure 2(11).

Micropercoir
This is a piece with two lines of backing on opposite lateral edges, converging into a refined elongate point.

Miscellaneous double-backed microlith (DBM)
This is a piece exhibiting backing on both lateral edges that cannot be assigned to other categories of backed pieces. Examples include double-backed crescents and double-backed blades and blade fragments.

Ortho-truncated blade
This is defined as a piece with a line of backing that is straight and oriented perpendicular to the parallel lateral edge.

Side and oblique truncated blade
This is a piece with a straight line of backing along one lateral edge that intersects a straight line of backing truncating the distal end. Distal truncation may be ortho or oblique in nature.

Curved backed microlith
Defined as a piece that does not fit into the major categories of curved backed pieces, but has a distinct curved line of retouch. Backing may truncate the proximal end, and includes Merrick's (1975) "eared crescents" and asymmetrical crescents. Pieces in this category may be similar to Tixier's (1963) type 60, and look like Merrick's (1975) figure 2(20, 21).

Other backed microlith
This term was used to define pieces not included in Merrick's (1975) typology.

Notched side scraper
This is a piece exhibiting retouch and a notch on a single lateral side. Usually the notch occurs toward the proximal end.