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UNIVERSITY OF ALBERTA

Middle Stone Age Occurrences in Southwestern Tanzania: an assessment of technology and adaptation in the Songwe River Region

BY

Gregory Harvey Miller ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Masters of Arts.

DEPARTMENT OF ANTHROPOLOGY

Edmonton, Alberta
Spring 1993

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ISBN 0-315-88417-7

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DEGREE: Masters of Arts

YEAR THIS DEGREE GRANTED: 1993

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UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled Middle Stone Age occurrences in Southwestern Tanzania: an assessment of technology and adaptation in the Songwe River Region submitted by Gregory Harvey Miller in partial fulfillment of the requirements for the degree of Master of Arts.

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Dr. Mary M. A. McDonald

April 23, 1993

Dedication

This thesis is dedicated to the memory of my brother Trevor Scott Miller.

Abstract

This thesis presents a typological and technological assessment of stone age lithic assemblages collected from six open air localities surveyed in the Lake Rukwa region of southwestern Tanzania. In all, 2616 artifacts are analyzed and these are classified as Middle Stone Age (MSA) in character on the basis of a lithic typology devised by Michael Mehlman (1989). Further study of artifact attributes helped to identify patterns of flake production and raw material use. In addition, an analysis of Toth flake types (Toth, 1982) helped to identify possible stages of on-site core reduction. A greater than expected frequency of late stage core reduction flakes (those with little to no cortical material) suggests that cores were initially flaked off-site, with flakes brought on-site, perhaps as blanks or preforms. As well, data indicate that reduction methods varied in direct response to raw material type and form, perhaps as a means to maximize the use-life of specific raw materials, and these observations are presented within a core reduction model.

The interpretations presented here are tentative pending the location and analysis of stratified MSA sites, and the development of a Songwe River culture-history. It is hoped that these data will be of use as an initial base for future study of MSA lithic technology for this region of Tanzania.

Acknowledgement

I wish to thank my advisors, Dr. Pamela R. Willoughby, and Dr. David Lubell for their assistance. I wish to also thank the other members of my committee, Dr. Raymond J. LeBlanc and Dr. Mary M.A. McDonald. I would like to thank Diane Cockle for her help with artifact diagrams. Any omissions or errors that are contained within the text are solely the responsibility of the author.

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Chapter One

Controversy: from stone tools to genetics

1.1. Introduction and general background

The Middle Stone Age (MSA) of sub-Saharan Africa, dates from 200,000 to 30,000 years BP (before present). It is recognized by a flake tool assemblage made from disc cores or, alternatively by the Levallois technique (Goodwin, 1928; Clark, 1988:237). The MSA marks a transition in lithic technology from preceding Early Stone Age (ESA) industries by the disappearance of Acheulean hand-axes and cleavers. Lewis Binford (1987) and Richard Klein (1989a; 1992) contend that MSA assemblages represent the end of nearly 1.6 million years of technological stagnation that is associated with *Homo erectus* and Archaic *Homo sapiens* populations. They believe that technological innovation only flourished with the emergence of anatomically modern humans, *Homo sapiens sapiens*, some 40,000 years ago in Western Europe. Desmond Clark (1988; 1989), believes that MSA lithic technology represents an important development in hominid social behaviour. Clark infers that the formal variation between MSA assemblages from different regions, demonstrates the first ever evidence for culturally-determined behavioural patterning.

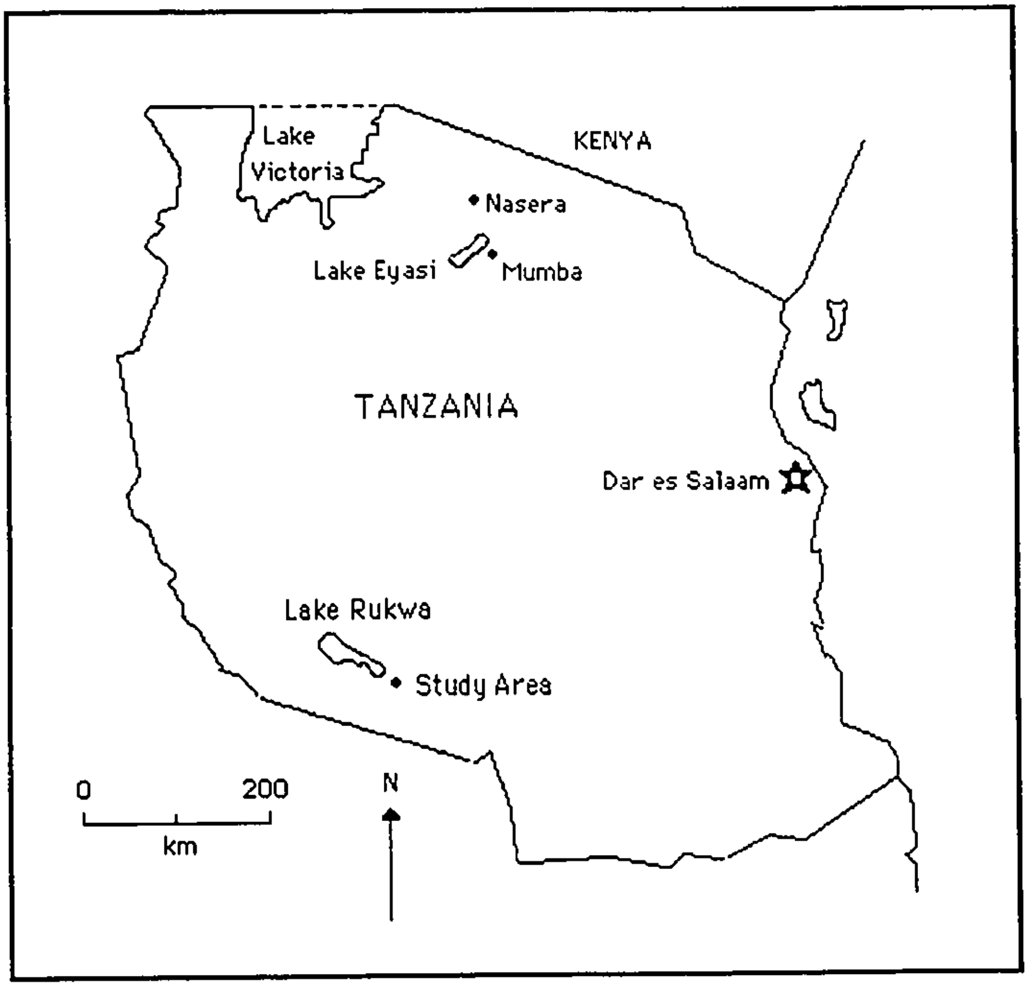
The preceding debate has grown over the last decade as part of a resurgent interest in the MSA. Adding to it is a controversial model that proposes an African origin for anatomically modern humans. The controversy lies mainly with the derivation of this model from genetic evidence (Cann *et al.*, 1987). Analyses of variation in gene frequencies found within the DNA of cellular organelles have led some researchers to postulate a common ancestral population for all living humans as originating in East Africa about 200,000 years ago (Cann *et al.*, 1987; Vigilant *et al.*, 1991). If this was the case, then the appearance of MSA industries at the very same time indicates a major shift in the human capacity for technological innovation and a MSA tool kit may well be the first used by anatomically modern humans.

This thesis presents data on MSA assemblages collected during a 1990 survey of the Songwe River region in southwestern Tanzania (FIG. 1.1.). Analysis and discussion will be based upon the application of a generalized stone age lithic typology that was devised by Michael Mehlman (1989), and will include a technological assessment of assemblages in an effort to demonstrate aspects of lithic production and raw material use. Comparisons will be made with MSA assemblages from Mumba and Nasera (Mehlman, 1989) located in northwestern Tanzania to help contrast rockshelter and open-air localities. Comparison of the distribution and use of raw materials across the Songwe River region will be presented as well as an analysis of Toth flake types (Toth, 1982) to infer on-site core reduction and flake manufacturing stages. A core reduction model that is based on raw material type and nodule form is used to demonstrate reduction methods that may have been applied to specific categories of peripherally worked cores. Analysis will conclude that specific decision making processes occurred during the production of Songwe River assemblages in support of Clark (1988).

1.2. A background to the MSA of East Africa

A review of the pertinent literature reveals a limited body of knowledge that has remained so for many years, perhaps due to four primary conditions. First, the archaeology and anthropology that was, and still is, carried out in East Africa remains divided between two topically diverse and temporally distant areas of interest. On the one hand, there is the study of Pliocene and Pleistocene hominid origins and, on the other hand, there is the study of techno-cultural developments of more recent Holocene peoples (Robertshaw, 1990:78, 1984; Bower *et al.*, 1980:41).

FIG. 1.1. Map of Tanzania showing study area and sites of Mumba and Nasera.



Second, the classification system that describes Stone Age culture history suffers from an inconsistency of application to such a degree that the term "Middle Stone Age", in operation since the 1920s, remains open to general interpretation and debate over its use as a chronological, technological, or cultural designator (Leakey, 1935:138; Malan, 1955:224; Kleindienst, 1967:831; Merrick, 1975:3; Mehlman, 1989:7).

Third, a small but growing body of information on the behaviour of early modern humans forces researchers to speculate upon such matters as social and technological capabilities. Some issues in need of further examination include social organization, subsistence and settlement strategies, and diet (Binford, 1987, 1990; Bishop and Clark, 1967; Butzer, 1975; Deacon, 1989; Merrick, 1975; Klein, 1989a, 1989b, 1992; Clark, 1970a, 1970b, 1988, 1989, 1990; Ambrose and Lorenz, 1990; Parkington, 1990; Rightmire, 1989).

Fourth, the MSA time frame had remained poorly known for several decades due to the limitations of available dating techniques (Bradley, 1985; Aitken, 1990). The lack of dating control, however, did not deter the use of available C14 dates to support the belief that the MSA was a relatively recent and brief episode of transition in lithic technology between the Acheulean Industry and subsequent microlithic industries of the Late Stone Age (LSA) (Leakey, 1936:75; Clark, 1970a:19; Clark and Kleindienst, 1974:78; Merrick, 1975:10).

1.2.1. Dating

Until the early 1970s, all available C14 dates indicated that the time span of a post-ESA East Africa was about 50,000 years. Almost half of this period, from 40,000 to 20,000 years ago, was thought to represent the MSA (Howell and Clark, 1963:487; Clark, 1970a:19). However, as many dates pushed the range limit of C14's reliability at just over 40,000 years BP, speculation arose that the MSA was a much older event than previously thought (Beaumont and Vogel, 1972:87). With the assistance of other radiometric and chemical dating methods, such as potassium/argon, uranium disequalibrium series, thermoluminescence, fission track, and amino acid racemization (Howell *et al.*, 1972; Szabo and Butzer, 1979; Bradley, 1985; Aitken, 1990), substantially large temporal gaps were revealed in the prehistory of East Africa that led to major shifts in the perception of hominid antiquity (Isaac, 1977, 1984; Butzer and Isaac, 1975; Binford, 1981; Clark, 1982a, 1982b, 1988). Reliable dating techniques that can close the time gap still remaining between 400,000 and 40,000 years ago are few in number and of questionable accuracy (Aitken, 1990). The uranium disequalibrium series, however, does provide dates indicating that the MSA encompasses a span of some 170,000 years, from roughly 200,000 BP to 30,000 BP (Szabo and Butzer, 1979; Clark, 1988:239; van der Merwe and Vogel, 1983).

1.2.2. Revision of the Pliocene and Pleistocene time frame

A revision of African prehistory serves to accommodate a growing number of lower Pleistocene hominid remains and artifact localities more so than it has to assess MSA material culture. This is a pattern that was originally established by the two-fold nature of East African archaeology and anthropology carried out since Louis Leakey brought this region of the world to the attention of the general public in the 1930s (L. S. B. Leakey, 1936, 1959; M. D. Leakey, 1971, 1979; R. Leakey, 1983; Lewin, 1987). The most popular work, in terms of press coverage, remains fossil human origins, and, to a lesser degree, the development of lithic technology. The evidence suggests that a direct hominid ancestor diverged from the African Pongidae during early Pliocene times around five million years ago (Sarich and Wilson, 1967). Further research has traced the development of the hominid lineage from an early ancestor, *Australopithecus afarensis*, through to the earliest member of the *Homo* lineage (*Homo habilis*), emerging about two million years ago (Klein, 1989a:121).

The earliest evidence of stone tool use is from the Hadar region, Ethiopia (Merrick and Merrick, 1976; Harris, 1983), dating from 2.4 to 2.7 million years BP. This material predates the Bed I lithics from Olduvai Gorge, dating to 1.8 million years BP (Hay, 1976; M. D. Leakey, 1971, 1976), and the site of Fejej, Ethiopia, at 1.9 million years BP (Asfaw *et al.*, 1991), as well as Senga 5 from the Semliki Valley, Zaire, that dates to about 2.3 million years BP (Harris *et al.*, 1987). The Senga 5 locality is significant because it represents the first hominid occupation of the Western Rift Valley.

Archaeology of the Holocene Epoch (from 10,000 BP to the present) attracts research directed more toward art, architecture, technological innovation and trade. Interpretation of Holocene prehistory seems less subjective than interpretation of Pleistocene prehistory because of the tangible nature of cultural material other than stone tools. Topics of research include demographics, linguistics, the development of pastoralism, horticulture and iron smelting, as well as Arab coastal trade and a growing interest in pre-colonialist and colonialist Africa from both historical and archaeological perspectives (Robertshaw and Collett, 1983; Robertshaw, 1984, 1990; Sutton, 1990). Consequently, the MSA has remained a topic of minor research significance, undoubtedly overlooked by the attention given to adjacent cultural periods. Only within the last decade has the MSA emerged as an integral period in the biological and socio-cultural evolution of *Homo sapiens sapiens*.

1.2.3. A history of incongruities and misinterpretation

The term Middle Stone Age was first defined by Goodwin (1928; Goodwin and Van Riet Lowe, 1929:95-145) to identify South African flake-tool assemblages that lacked the large tool component of the Acheulean Industry. Since 1928, the MSA has come to represent similar assemblages found scattered throughout most of sub-Saharan Africa (L. S. B. Leakey, 1936; Clark, 1970). It was not until 1947, however, that a Consultative Committee on African Terminology was formed during the First Pan African Congress on Prehistory, and presented formal guidelines for the development of an African system of nomenclature (Kleindienst, 1967; Cooke *et al.*, 1987; Robertshaw, 1990). During this time the MSA was officially accepted as part of a larger three-age culture history composed of the Early, Middle, and Later Stone Ages.

The apparent purpose of this three-age system was to structure a coherent framework that could cope with an increasing amount of palaeoanthropological and archaeological information coming out of eastern and southern Africa. This system was also an attempt to foster a distinctively sub-Saharan nomenclature that would be free of borrowed European labels and a comparative approach to culture-history that was based on a European world view (Kleindienst, 1967). The proposed guidelines were a positive step to establish a comprehensive African nomenclature, however, a small but solid body of accumulating research by scholars such as Leakey, Burkitt, Goodwin, Van Riet Lowe, Wayland and Jones (Leakey, 1936; Malan, 1955; Robertshaw, 1990), would persist to become an almost impenetrable fortress of biased interpretation. Their publications would remain the literature upon which all subsequent work would be compared. What was to follow was to some extent a marginal restructuring of sub-Saharan culture history by the addition of indigenous terms to name archaeological cultures (Kleindienst, 1967).

In retrospect this outcome is no surprise, since African archaeology as a discipline was very new and was pursued by European trained researchers (Robertshaw, 1990). For archaeologists like Louis Leakey, who were schooled during the 1910s and 1920s in an atmosphere generated by competing paradigms of cultural development (Harris, 1968; Shaw, 1989; Trigger, 1989), all interpretation of African Stone Age prehistory involved a dialectic between diffusionism and evolution. On the one hand, the diffusionist perspective saw culture in both material and ideological forms as having disseminated from major epicenters of civilization, such as ancient Egypt. On the other hand, evolutionists saw culture as developing through migration, invasion, and the assimilation of weaker cultures by those more advanced and that the interaction of competing cultural systems would at times lead to the development of vigorous hybrids that would exhibit the successful characteristics of both parent systems.

Louis Leakey, once thought that East African Mousterian-like assemblages (now understood to be part of the MSA) were a sub-Saharan variant of a European and North African Mousterian culture. Labeled the "Kenya Mousterian", he describes it as a Pan-African techno-cultural hybrid that had incorporated both Levalloisian and Acheulean technological characteristics (L. S. B. Leakey, 1936:48). Leakey (1936) postulates that successive migrations from Europe into north Africa by Mousterian peoples was the consequence of periodic glacial advance during the Pleistocene that resulted in social interaction and the dissemination of lithic technological skills to indigenous populations of north and east Africa. A second origin scenario sees an *in situ* development of a Mousterian culture in East Africa that was carried to southern Africa through successive, albeit unexplained migrations, that resulted in the Still Bay Complex, a South African Mousterian variant (L. S. B. Leakey, 1936:77). The broad pattern of movement of peoples and their technology from north Africa to south Africa is thought to have occurred many times and implies that African Early and Middle Stone Age periods are equitable with the European Lower and Middle Palaeolithic, to the extent that they share the material possessions and heritage of a similar cultural group.

One issue that arose during the Fourth Pan-African Congress on Prehistory in 1959, concerned the relationship that exists between a "Stone Age" and the culture or cultures it allegedly represents. The First Congress of 1947 had intended the three-age system of Early, Middle and Later Stone Ages to be used for the description of contemporaneous cultures with a similar assemblage composition (Kleindienst, 1967:831). However, this generic definition would remain open to interpretation and the MSA became known as a period when a specific Pan-African culture of European or North African heritage produced a diagnostic lithic assemblage. What was to be an essentially culture-free descriptive term, the MSA label took on larger cultural significance.

Also addressed by the Fourth Congress was the merit of a culture history that was still constructed on the basis of European criteria for analyses (Kleindienst, 1967). Since the First Congress convened, the path of least resistance for reconstructing sub-Saharan culture history appears to have been a continued embrace of European data for comparative purposes. Subsequently, the handful of analysed MSA assemblages were becoming much too broadly compared across space (Kleindienst, 1967:823). To put this into perspective, Mehlman (1989:1) states that East Africa has nearly 1.6 million square kilometres of land surface, but with less than a dozen excavated MSA localities. This figure is small by comparison with the more than one hundred investigated Mousterian localities from just 21,000 square kilometres in southwest France. These figures demonstrate the limited extent of MSA research for East Africa.

In response to growing academic concern over the ambiguous nature of the nomenclature, a Wenner-Gren Symposium on African Prehistory in 1965 recommended the replacement or outright abandonment of descriptive terms that were not chrono-stratigraphically or culturally and geographically relevant (Bishop and Clark, 1967:896). This decision was directed at cultural and technological labels borrowed from European sequences and went so far as to include the three-age system of Early, Middle, and Later Stone Ages. The symposium committee concluded that the future of sub-Saharan research would be better served if culture histories were clearly established at a local level before data is compared on a broader scale (Kleindienst, 1967:833). However, the "Middle Stone Age" persists in the dominant vocabulary of African prehistory, although it still lacks a clear definition (Cooke *et al.*, 1987; Clark, 1988; 1989; McBrearty, 1988; Mehlman, 1989).

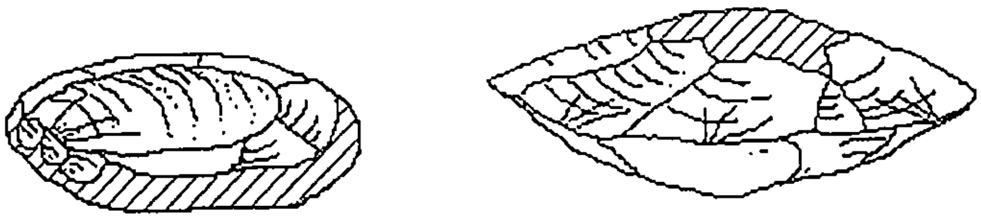
1.2.4. Typology, technology and the MSA

One aspect of the MSA that identifies it as a unique technological event is the predominance of flake tools produced by the Levallois and disc-core techniques. Levallois technique describes a method of core preparation for the removal of flakes with a predetermined planform. Cores are recognized by a radial scar pattern about their periphery with a large flake removal scar running the greater length of the a prepared flake release surface (FIG. 1.2.). Often it is only this final flake scar that distinguishes a Levallois core from other types of radially prepared cores (Clark and Kleindienst, 1974:91). As well, detached flakes exhibit some degree of platform faceting and a lack of edge modification or retouch. Disc-cores exhibit a pattern of peripheral flaking, from partial to complete (FIG. 1.2.); combinations include unifacial, parti-bifacial and bifacial flake removal. The technique is described as proto-Levallois, because of apparent core preparation before flake removal, however the result is of casual or expedient manufacture.

MSA assemblages include a range of flake tools that are the byproducts of the Levallois and disc-core techniques. These include a predominance of scraper forms and Levallois points. MSA tools are notably smaller than those associated with the Acheulean Industry, but are larger than the microlithic and blade tool elements diagnostic of LSA industries.

FIG. 1.2. Levallois and disc cores

//////// = cortex



Levallois core: with Levallois flake scar

Disc core

Until recently, the majority of MSA research was geared towards typological classification to help place assemblages within space and time. Unfortunately, the standard typology that is used is difficult to augment, refine, or replace due perhaps to an early establishment in the archaeological literature and there is little flexibility to accommodate any deviation from an expected range of tool types. Following guidelines proposed by the Wenner-Gren Symposium of 1965, archaeologists have begun to re-investigate some of the first researched MSA localities. In doing so, Harry Merrick (1975) and Michael Mehlman (1989) have challenged conventional nomenclature and taxonomy as part of an initial step to redress the criterion used to identify and describe Stone Age prehistory. Both authors seek to uncover transformation over time in lithic technology and, as importantly, attempt to do so within a delimited geographic region. In order to accomplish this, they found it necessary to construct a basic taxonomic framework that would encompass the technological forms of both MSA and LSA materials, using as their guidelines descriptive works by Clark and Kleindienst (1974), and Nelson (1973). As well, Mehlman (1989) incorporated Merrick (1975).

Merrick and Mehlman state that the methodology they have developed keeps tool type variation to a minimum number of categories in order to view the changes that occur between successive assemblages. Upon reconstructing a regional culture history, the authors believe that they are able to infer the local behavioural processes that may underlie the changes observed in technology, be it through manufacturing technique or raw material use, and that this ability is unattainable if the limited classification system that has presided over earlier analyses is used.

1.3. Classification and the Howieson's Poort Industry: a case in point for MSA assemblage variation

Conventional archaeological wisdom often views the development of material culture as a linear process of increasing technical complexity, efficiency and aesthetic appeal. Accordingly, blade-tool industries are the natural successor to flake-tool industries and become the technological index of the Upper Palaeolithic of Europe, and the LSA of Africa (Gamble, 1986; Binford, 1987; Klein, 1989a, 1989b). This view is tested by a MSA industry from South Africa known as the Howieson's Poort .

The Howieson's Poort (HP) is found at several South African coastal localities, the most notable being Klasies River Mouth (KRM) (Singer and Wymer, 1982; Binford, 1984). From KRM the HP levels are dated from 50,000 BP to 70,000 BP on the basis of C14 and uranium disequalibrium series (U/S) dates (Singer and Wymer, 1982:191). The tool kit is made from fine grained siliceous materials, such as chalcedony and indurated shale, which are non-local raw materials. Apparently they were selected over local quartz and quartzite for their finer flaking quality that allowed for the production of flake-blades. They are called this, perhaps to avoid controversy as true blade technology is supposed to appear 20,000 years later during the Upper Palaeolithic. The HP also contains a range of backed microlithic tool forms, such as crescents and trapezes, that are tool types associated with European Mesolithic industries.

Several models attempt to account for this apparently anomalous occurrence of an Upper Palaeolithic-looking tool kit appearing so early in the cultural sequence. Clark (1988:296), describes the HP as a break from the traditional mold of an expected MSA typology, and this is in keeping with his position on the regional variability of MSA assemblages. Supporting Clark, Singer and Wymer (1982:107) contend that the HP was produced by an intrusive MSA population with a distinctive cultural heritage. Ambrose and Lorenz (1990) surmise that the HP came about as an indirect consequence of a cultural adaptation made by an indigenous MSA population.

Briefly, Ambrose and Lorenz (1990:18) propose that an abundance of exotic lithic raw materials will correlate inversely with local food abundance and predictability. They believe that the requirements of technology would alone not be enough of an impetus to force the modification of hominid foraging behaviour. On this assumption then, the HP was the outcome of a brief period of increased residential and logistical mobility for the purpose of improving resource predictability at a time of extreme aridity. Such a system would provide hominids an opportunity to encounter new raw material sources (embedded procurement) and lead to an inevitable shift in the character of the stone tool assemblage.

Oxygen isotopic data indicate that a cooler and drier climatic period did occur at the end of the last interglacial approximately 95,000 years BP (oxygen isotope stage 5b). Ambrose and Lorenz (1990:25) believe that a shift in climate forced indigenous peoples to expand their foraging range that lead to their development of inter-group exchange networks. This pattern represents the first evidence of change in hominid territorial organization unseen during the previous two million years.

Concurring to some degree with Ambrose and Lorenz is Hilary Deacon (1989:560), who sees the HP as introducing a stylistic shift in artifact type for the marking of territorial boundaries. Deacon surmises that this indicates a period of intensified social networking that occurred during a period of high stress of the kind associated with a shift to drier weather. Following climatic amelioration the period of foraging territory expansion was reversed with a return to local food and lithic resources. Subsequent MSA levels at Klasies River Mouth reflect a pattern of artifact form similar to that observed for MSA assemblages that precede the Howieson's Poort.

The controversy created by the HP appearance is a clear example of how an established MSA typology lacks the flexibility to accommodate the variety and complexity of lithics described for recently analyzed South African sites. Consequently, a whole assemblage may fall outside the range of a standard taxonomy and rather than accommodate the assemblage it must be explained away by complex adaptation theories. The only positive outcome of the speculation that has arisen over the HP assemblage is that in an effort to place it within an acceptable culture historic framework, researchers are forcing themselves to look beyond the limitations imposed by classification systems and are able to introduce models that deal with behavioural aspects of hominid adaptation.

So why did subsequent MSA stone knappers return to producing previous lithic forms? The answer lies perhaps in the MSA hominids' ability to maximize specific raw materials. For example, Thackeray and Kelly (1988) and Thackeray (1989:51) have determined that production of the Howieson's Poort Industry did not involve a change in the techniques of core reduction that were already identified as in place with earlier MSA levels. This indicates that an ability to produce Upper Palaeolithic looking tools may have always been option, but was constrained, perhaps, by an availability of appropriate raw materials to facilitate their manufacture. A return to using locally available quartz and quartzite material by MSA populations indicates that whatever were the tasks that flake-blades and microliths made from chalcedony and indurated shale were used for, they were easily substituted with tools made from these other raw materials. Interchangeability of raw material type and a resulting tool morphology may indicate that the lithic component of the MSA tool kit used at KRM was incidental to other means of interacting with the local environment for subsistence and social pursuits. Use-wear analyses of MSA lithics from the Klasies River Mouth site would offer an opportunity to perhaps determine a functional equivalency between tool forms from the HP levels and those preceding and subsequent typical MSA levels. The Klasies River Mouth site may well prove to be a typologist's "Rosetta Stone" for the MSA of South Africa.

1.4. Behavioural continuity, technological continuity and the MSA

Throughout much of sub-Saharan Africa there is little evidence to suggest that a cultural hiatus occurred between the ESA and the MSA. According to Klein (1989a:261) this implies behavioural and technological continuity between the two Stone Ages. The MSA flake-tool component is referred to as a refinement of a light-duty tool component recognized with preceding Acheulean assemblages. Clark (1988) states that this apparent continuity of form is perhaps an outcome of the limitations placed by raw materials on viable methods of flake manufacture (as is perhaps the case for the Howieson's Poort assemblage). Similar reduction patterns observed between ESA and MSA assemblages suggests a similarity in successful functional responses to the constraints imposed by raw materials and need not imply the continuation of culturally determined patterns of behaviour between the two periods.

Isaac (1986) and Clark (1980:54; 1988:295; 1989) have observed that the clast size of raw materials (i.e., pebble, cobble, or boulder), as well as the distance from a site to a source, flaking quality, specific needs of the maker, and the method of core reduction all combine to influence the final shape of the artifact produced. For example, from the Porc Epic cave site, in Ethiopia (Clark *et al.*, 1984), data indicate that fine grained materials obtained from distant sources were more frequently selected for artifact manufacture over local quartz and quartzite. Although this pattern mimics that observed with the Howieson's Poort, it is not accompanied by an appearance of new tool forms (e.g., flake-blades or geometrics). Perhaps differential availability of fine grained materials and the means by which these are collected and reduced may well be a factor affecting the various regional facies of the MSA. Obsidian artifacts recovered from many MSA sites in southern Kenya and northern Tanzania have been traced by Merrick and Brown (1984) to sources ranging from 50 km to 100 km away. With X-ray fluorescence, the distribution of the chemical elements found within obsidian can be determined and 35 individual sources have been "fingerprinted" for Kenya and northern Tanzania. Mehlman (1989:179) reports that MSA assemblages from both Mumba and Nasera sites contain obsidian sourced from 320 km, to the Lake Naivasha region of Kenya. These data indicate that MSA peoples were aware of the flaking properties of this raw material and were willing to obtain it from great distances, either through transhumance or social networking.

1.5. Current status of the MSA for East Africa

Clark (1988:237) describes variation in the composition of MSA assemblages as the result of regionally specialized socio-economic behavioural patterning. He believes that this patterning demonstrates the first evidence for typological and technological variation across space and time. After nearly 1.4 million years of stasis in technological development MSA tool kits demonstrate qualitative and innovative change in both tool morphology and assemblage organization.

Several researchers disagree with Clark. Richard Klein (1989a, 1989b) argues that the MSA differs little from the Acheulean. He argues that a generalized Acheulean/MSA tool kit maintains typological and technological continuity over a vast period of time and across several environmental regimes (Klein, 1989a:262; 1989b: 539). As well, he points out that the disc-core and Levallois techniques used to help define the MSA, are known to have appeared during the Acheulean and upon these grounds the MSA should not be regarded as a separate technological event or cultural event, but rather it should be thought of as a final variant of the Acheulean Industry (Klein, 1989a:254). The absence of an Acheulean large core-tool component does not bother Klein for he believes that this is attributable to post-depositional processes, or the vagaries of excavation procedures, more so than to a change in lithic technology.

1.5.1. Some current models of MSA hominid capabilities

Klein (1989b) notes that a comparison of MSA and LSA faunal assemblages from South African localities indicates that MSA hunters were opportunistic, culling the weak and defenseless members of an animal species. This is based on the MSA faunal assemblage exhibiting an attritional mortality profile in which the majority of skeletal remains are from very young and very old individuals. By comparison, LSA faunal assemblages reflect a catastrophic mortality profile in which every age group is represented indicating an efficient level of hunting. Species identified from LSA faunal assemblages were large and/or dangerous: e.g., Cape buffalo (*Syncerus caffer*) and bush pig (*Potamochoerus porcus*) leading Klein to conclude that MSA hunters were not as efficient as LSA hunters as they lacked the technology and bravado necessary to hunt healthy and mature individuals of aggressive species.

In defense of MSA hunters, the fact that their faunal assemblage exhibits an attritional mortality profile might well be the result of acute risk management awareness (Sept, 1984; Foley, 1989). Klein could as easily ask why a hunter should risk personal injury or death confronting healthy adult individuals of aggressive species when a safer and perhaps simpler solution to obtaining meat resources was to selectively cull weaker individuals, i.e., the old and very young.

On the basis of comparative MSA and LSA lithic remains from South African localities, Ambrose and Lorenz (1990) conclude that MSA peoples failed to respond in ways analogous to LSA peoples when dealing with a similar resource structure. For example, they point out that subsequent to the Howieson's Poort levels at Klasies River Mouth, data indicate that MSA populations failed to seize on an opportunity to build upon the strengths of the HP industry's modern looking tool kit, and instead returned to the production of former tool types using former raw materials. This missed opportunity is in fact a rather ethnocentric bias perpetrated by the authors. Progress in lithic technology is perhaps not as linear a process as previously understood. For example, an expectation that stone tools should develop over time from large to small, simple to complex, core based to flake based and flake based to blade based can not always be expected to hold true, as demonstrated by the Howieson's Poort industry. Undoubtedly, there are several mitigating factors that may come into play during the process of tool production and in this particular case it appears to involve access to fine grained raw materials and the limitations imposed by other raw material types.

Lewis Binford (1973; 1981; 1987; 1989) presents a critique of the technological and the behavioural capabilities of Lower and Middle Palaeolithic hominids of both Africa and Western Europe. His argument reads that the differential distribution of resources across a landscape will result in areas of repeated use that will accumulate artifacts due to discard and loss during episodes of resource gathering. Patterns of redundancy in the covariation of tool types that are found at these locations suggests an extractive behaviour that is based on an expedient tool technology, where tools are manufactured on-the-spot for immediate use and discard. According to Binford expedient tools involve little forethought and require little effort to manufacture and consequently express little ethnic identity in the form of individualized or group conscious stylistic characteristics (Binford, 1973:243). Peoples solely dependent upon an expedient-based lithic technology demonstrate an inability to formulate efficient strategies of resource extraction and these patterns characterize French Mousterian assemblages studied by Binford.

What characterizes Upper Palaeolithic assemblages that are produced by modern humans is the curation of tools in anticipation of future food collecting events (Binford, 1973; 1976; 1980; 1987). Peoples will move collected food resources to a base camp by task groups that are organized specifically for the collection of these resources with a specialized tool kit. For example, the collection and processing of certain flora and fauna are tasks that may require identifiably distinct tool kits and these would be manufactured and maintained in advance for such purposes prior to their actual need (Binford, 1973; 1980; 1987). On a broad scale, assemblages that exhibit a redundancy in the covariation of an expedient tool kit are thought to be produced by hominids reacting solely by conditioned responses to environmental stimuli (Binford, 1973). According to Binford, MSA peoples are thought to have moved about the landscape between sources of food, water and shelter in a pattern devoid of behaviour that could be construed as being culturally determined.

Binford (1980:9) states that archaeologists should expect to see an increase over time in the general efficiency of resource procurement skills as early humans developed a greater capacity for problem solving. An increase in efficiency would be reflected by an increase in the internal spatial segregation of sites and by the recognition of task-specific tool kits. Behaviour thought to be culturally influenced should then be identified by a decrease in assemblage variability at an intra-regional level as local groups would have interacted to share their knowledge of local resources and their technological skills. As well, there should be a corresponding increase in assemblage variability at an inter-regional level as regional populations become distinct from their neighbours through differences in the stylistic and functional elements of their respective task-specific tool kits. Sites are expected to have little redundancy in the covariation of tool types to the extent that specialized activity areas may be recognized (Binford, 1987) and specific site types, such as home bases, hunting camps, or butchery sites may then be classified according to their distinctive artifact content.

According to these criterion, MSA assemblages do not exhibit an increase over time in their technological complexity, nor as yet have they yielded evidence for inter-regional variation that might indicate ethnicity. The variation that the MSA does demonstrate is thought to be the result of functional responses to environmental stimuli.

Deacon (1989:557) contends that MSA and LSA populations differed little with respect to settlement pattern behaviour. A comparison of site location in South Africa revealed that both MSA and the LSA peoples occupied sites ranging from the coastal plain to high in the Cape mountains. However, both MSA and LSA sites differ in location from South African ESA sites. Deacon believes that differences in site location between the ESA and the MSA relates to two conditions. First, MSA hominids must have had a knowledge of water containers that allowed them to move away from permanent water sources to exploit new habitats. Second, MSA hominids must have had a knowledge of below-ground plant-food resources because hearths from Klasies River Mouth contain their carbonized residues. These patterns indicate important changes in the use of resources since ESA times and suggest a modern level of subsistence behaviour.

According to Robert Foley (1989), the changing ecological conditions over the last 200,000 years in sub-Saharan Africa may have forced a hominid speciation event that saw the transition from *Homo erectus* to *Homo sapiens*. Several points presented by Foley will be used to support and criticize current models of MSA hominid capability. Foley (1989:301) reiterates Klein (1989) by observing that the transition from *Homo erectus* to Archaic *Homo sapiens* was not accompanied by any major change in lithic technology (the Acheulean is associated with *Homo erectus* and the MSA is associated with both archaic and modern forms of *Homo sapiens*). If a major technological change had occurred (and according to Foley this would have had to have been something more substantial than the disappearance of large bifacial core-tools), it would indicate the sudden appearance of an intrusive hominid population, one that was perhaps already adapted to an open woodland savanna thought to have been expanding in East Africa by this time.

Foley compared the rapid successions of glacial and interglacial fauna from Europe with a relatively stable faunal succession recorded for sub-Saharan Africa. Based on the principle of competitive exclusion, rapid faunal successions are thought to occur only when better adapted species wholly replace those that are not able to adapt quickly enough to changing environmental conditions. The time of transition between the extremes of glacial and interglacial conditions in Europe would have been too rapid for *in situ* adaptation by local fauna (Foley, 1989). By comparison, the shifting environmental dynamics experienced in sub-Saharan Africa during the same glacial and interglacial cycles are believed to have been less severe resulting in the isolation of some hominid populations as a consequence of a changing distribution pattern of suitable habitat. Over a period of several generations isolated hominid groups would experience *in situ* genetic drift resulting in morphological changes, as well as, regional variation in their adaptive behaviours (perhaps in evidence by the regional variation Clark has observed between MSA lithic assemblages?). Over a period of several cycles in habitat isolation at least one hominid population is believed to have evolved into anatomically modern *Homo sapiens sapiens.*

Foley (1989:313) also reiterates Ambrose and Lorenz (1990) by suggesting that during periods of habitat restriction an increasingly patchy resource base would have made the prediction of food location difficult. The severe nature of this problem could have been reduced by an increase in risk management. Foley believes that this type of increase would result in the exploitation of less dangerous fauna, a finding which Klein has observed from his South African MSA faunal assemblage data. Foley adds, however, that an increase in risk management would have involved a corresponding increase in the depth of resource planning, technological efficiency, and improved organizational skills; all are practical strategies to reduce resource unpredictability. Over time this form of strategic problem solving would have functioned to increase hominid intellectual behaviour and social behaviour and argues against Binford's position on the poor capabilities of MSA hominids. For Foley it was a combination of genetic drift and the mental processes involved with risk management that forced the speciation event that ultimately lead to the appearance of anatomically modern humans in East Africa during the last 200,000 years.

1.6. The fossil evidence

Binford (1980, 1987, 1989) and Klein (1989; 1992) contend that only with the appearance of anatomically modern humans by 40,000 BP is there indisputable archaeological evidence for culturally determined patterns of behaviour, as well as inter-regional variation of lithic assemblages. A direct association of complex technology with the presence of anatomically modern humans does not, however, hold true for all areas outside of Europe. From the Near East, for example, contemporaneous populations of *Homo sapiens sapiens* and *Homo sapiens neanderthalensis* are found with a Mousterian Industry and date back to 115,000 BP (Bar-Yosef, 1989:165). The fossil evidence from East Africa indicates that the appearance of *Homo sapiens sapiens* between 190,000 BP and 130,000 BP is associated with a MSA tool kit (Clark, 1988:289; Rightmire, 1989:109;

Klein, 1992:11). This is also the case from South Africa where modern humans appear by 100,000 BP (Klein, 1989a:534; 1992:11; Rightmire, 1989:109).

The fragmentary nature and poor archaeological context of many of the archaic and modern human specimens leaves few examples without some suspicion as to their stratigraphic and material association (Rightmire, 1989). The East African examples are primarily from northern Tanzania and southern Ethiopia and are summarized by Clark (1988), Rightmire (1989), Stringer (1989) and Day (1977). From Omo, several hominid specimens were recovered by L. S. B. Leakey in 1967. Those identified as modern included a partial skeleton of one individual (Omo 1) and cranial fragments of a second (Omo 3). Reconstruction of Omo 1 cranial and facial features suggests a robust, but modern morphology. A date of 130,000 years for this specimen was obtained by uranium series from shell samples found with associated sediments. The Omo 1 specimen is one of the earliest known examples with a modern cranial morphology. The Omo 3 specimen is estimated to be greater than 37,000 years old and is essentially modern.

At Laetoli, an almost complete modern cranium (LH 18) is dated to 120,000 BP. From the Mumba rock shelter site, north of Laetoli, three modern molar teeth are dated to be between 109,000 and 130,000 years old and are in association with an early MSA industry (Mehlman, 1989). From Porc Epic cave, a mandible fragment, including premolars and molars, is association with a MSA assemblage that is dated by obsidian hydration to be 70,000 years old. The mandible is robust, but falls within an acceptable range of variation for modern humans. On the basis of these few early specimens the speciation event that Foley (1989) describes must have occurred by at least 130,000 BP in East Africa.

1.7. Mitochondrial DNA and the single origin model

As mentioned above, renewed interest in the MSA is the result of genetic research that attempts to determine the time and place of modern human origins. A calibrated rate of gene mutation for mitochondrial DNA (mtDNA) indicates that modern humans may have originated in East Africa between 200,000 BP and 140,000 BP (Cann, *et al.*, 1987; Cann, 1988; Stoneking and Cann, 1989; Wilson and Cann, 1992; Vigilant *et al.*, 1991). This time frame supports the fossil record. Cann *et al.* (1987) chose to use mtDNA over nuclear DNA for two reasons: preliminary studies had shown that mtDNA accumulates mutations at a more rapid and steady rate than does DNA contained within the cell nucleus and it seemed logical that because mtDNA is passed down only through the female line, a lineage should be traceable back to a single female ancestor. Cann *et al.* (1987) used mtDNA samples from 135 individuals who represented populations from Africa, Asia, North America (African Americans), Europe and Southeast Asia. As a comparative test case, mtDNA was also obtained from a chimpanzee (*Pan troglodytes*).

Through the technique of restriction analysis, a process that measures the minimum number of mutations necessary to relate the mtDNA of two individuals, Vigilant *et al.* (1991:1504) were able to generate dendrograms of genetic relatedness. The greatest accumulation of mutations are identified by the deepest branches of the dendrogram which are associated with the East African samples. To derive a relative age for these deep branches, the differences observed between human and chimpanzee mtDNA were compared with an accepted date of divergence of the genus Homo and Pan, some five million years ago. The rate of accumulation of mutations is estimated to be 2% to 4% per one million years, and an age of 200,000 years is estimated for the deepest branch of the mtDNA dendrogram. This date is thought to represent the earliest time for a common female ancestor for all existing mtDNA types.

On the basis of these findings, Cann *et al.* (1987) theorize that an initial migration out of Africa by *Homo erectus* occurred about one million years ago that reached Southeast Asia by 700,000 BP and China by 500,000 BP. A second migration out of Africa by modern *Homo sapiens* occurred at 200,000 years BP, resulting in the complete replacement of all previous mtDNA types.

Those opposed to this "out of Africa" model are divided into two camps. One camp challenges the statistical methodology (Maddison, 1991; Templeton, 1991), and the second challenges the hypothesis of a single origin for the world's existing mtDNA types (Wolpoff, 1989). Maddison (1991:358) ran statistical trials with the mtDNA data and found 10,000 branches that were more parsimonious by five steps than those observed by *Cann et al.*, and concludes that the deepest branches equally favor both an Asian and African origin for the earliest modern mtDNA type. Templeton (1991:737) states that Cann *et al.*'s original analysis, as well as the reassessment by Vigilant *et al.* (1991), are both flawed because the addition of the data into the computer in a sequential rather than random manner produced dendrogram branching of false association. With random addition, Templeton was able to produce 100 branches that are more parsimonious by two steps and he concludes a non-African origin for modern mtDNA.

According to Wolpoff (1989), the single origin model proposed by Cann *et al.* (1987) goes against all current fossil evidence. A comparison of cranial material of both African and Asian archaic and modern *Homo sapiens* demonstrates that neither share the distinctive morphological features that are characteristic of each region. Wolpoff contends that the fossil data support a model of *in situ* multi-regional evolution from *Homo erectus* to archaic *Homo sapiens* ; to anatomically modern *Homo sapiens sapiens*. He also states that their model is too dependent upon an assumed rate of accumulation of genetic mutations that is still to be determined. Wolpoff (1989) concludes that the fossil evidence does support the idea of a common mtDNA ancestor at one million years BP, (coinciding with the first hominid migration out of Africa by *Homo erectus*), but does not support a more recent migration of *Homo sapiens sapiens* at 200,000 BP and the complete replacement of all mtDNA types.

As mentioned, the current evidence for the earliest occurrences outside of Africa for anatomically modern humans is about 115,000 years ago from the Near East sites of Jebel Qafzeh and Mugharet-es-Skhul (Bar-Yosef, 1989:165). As well, these modern humans are coeval with the *Homo sapiens neanderthalensis* remains from Shanidar, Tabun, Amud, and Kebera. This evidence suggests a persistence of archaic *Homo sapiens* during a time of expanding populations of anatomically modern forms with the possible admixture of mtDNA from both populations. The use of a similar Mousterian tool kit indicates that a one-to-one correlation between the appearance of modern humans and the introduction of an Upper Paleolithic technology is not supported, and there is no evidence for a swift replacement of archaic humans by modern forms.

Klein (1992), has recently shifted his opinion by acknowledging a growing body of data which indicates that modern human morphology preceded the development of more complex technologies in some parts of the Old World and current analyses are directed towards addressing the process of "sapienization" and the behavioural differences between Middle Stone Age /Middle Palaeolithic populations and those from the Upper Palaeolithic.

1.8. Summary

The status of the MSA is certainly much more complex now than it ever was when nomenclature was the single issue in need of resolution. Contention appears to loom over the larger issues of where the line should be drawn between archaic and modern human forms, and the need to clearly identify cultural versus non-cultural behaviour in the archaeological record. The difficulty with these issues is that there is so little hard evidence available from both the fossil and archaeological records. For East Africa, research continues to deal with classification and the structuring of culture history. However, with so few sites and dates, charting the time span of the MSA will remain a formidable task. However, there are two lines of thought that are generally agreed upon. First, the MSA spans the time of transition in the hominid lineage from archaic to modern forms of *Homo sapiens*. Second, the MSA involves change in lithic technology from industries based on a large core-tool component to industries based on the predominance of smaller flake-tools.

The fossil record indicates that anatomically modern humans first appeared in East Africa by 130,000 BP. Considering the fortuitous nature of fossil formation and discovery, this date may be a minimum. Relative ages provided by mtDNA studies place the common ancestor of all modern mtDNA types as having appeared by 200,000 BP to 140,000 BP. Although the authors have come under attack for their methods, the age estimate for modern human origins roughly coincides with those of the fossil record. It would appear that regardless of the model favoured, the time frame for the appearance of modern humans is encapsulated by the MSA period.

On the basis of assemblage composition, it is generally accepted that a transition occurred between the MSA and the ESA, but beyond a basic knowledge of classification there is very little known about MSA industries. No doubt some MSA assemblages were manufactured by anatomically modern humans, but whether these tool kits began with the appearance of modern humans is still unproved. The transition to a modern morphology did not necessarily coincide with the introduction of more complex technologies, or mobilary and parietal art, as is the case for the first appearance of modern humans in Europe. These findings have led to studies concerned with the identification and differentiation of "modern" behaviour (Klein, 1992).

For Klein (1989; 1992), Binford (1987) and Foley (1989), MSA assemblages are the tool kit of a hominid with a low level of technological capability. Klein (1989) and Binford (1987) add that MSA hominids also lacked in efficient strategies of resource procurement. Deacon (1989) and Foley (1989) state that the behavioural capacity of MSA hominids was essentially similar to that postulated for LSA modern human populations, whereas Ambrose and Lorenz (1989) observe that MSA hominids had the capacity to develop innovative tool forms, but only as an indirect byproduct of adaptation to environmental stress.

In light of the issues, Clark's (1988) proposition, that regional variability indicates an incipient form of cultural behaviour, is little further ahead. For East Africa, there remains too many unexplored areas of space and time to offer a conclusion one way or the other, and moreover, the small number of known MSA localities should not be so quickly used by some researchers to preclude the possibility of cultural behaviour.

There remain several questions that must be dealt with over the next few years. First, can we accept a humble beginning for modern human origins without evidence of complex technologies, without evidence of mobilary or parietal art, and without clear evidence of culturally determined patterns of behaviour ? From some of the preceding research and discussion, there appears to be some difficulty in directly conceding that our most recent hominid ancestry may have been unspectacular, and perhaps "primitive" in the same pejorative sense that prehistorians have applied this term to archaic *Homo sapiens* populations (Trinkaus and Shipman, 1993). Perhaps a growing academic and public interest in modern human origins is an indication of the need to address these issues.

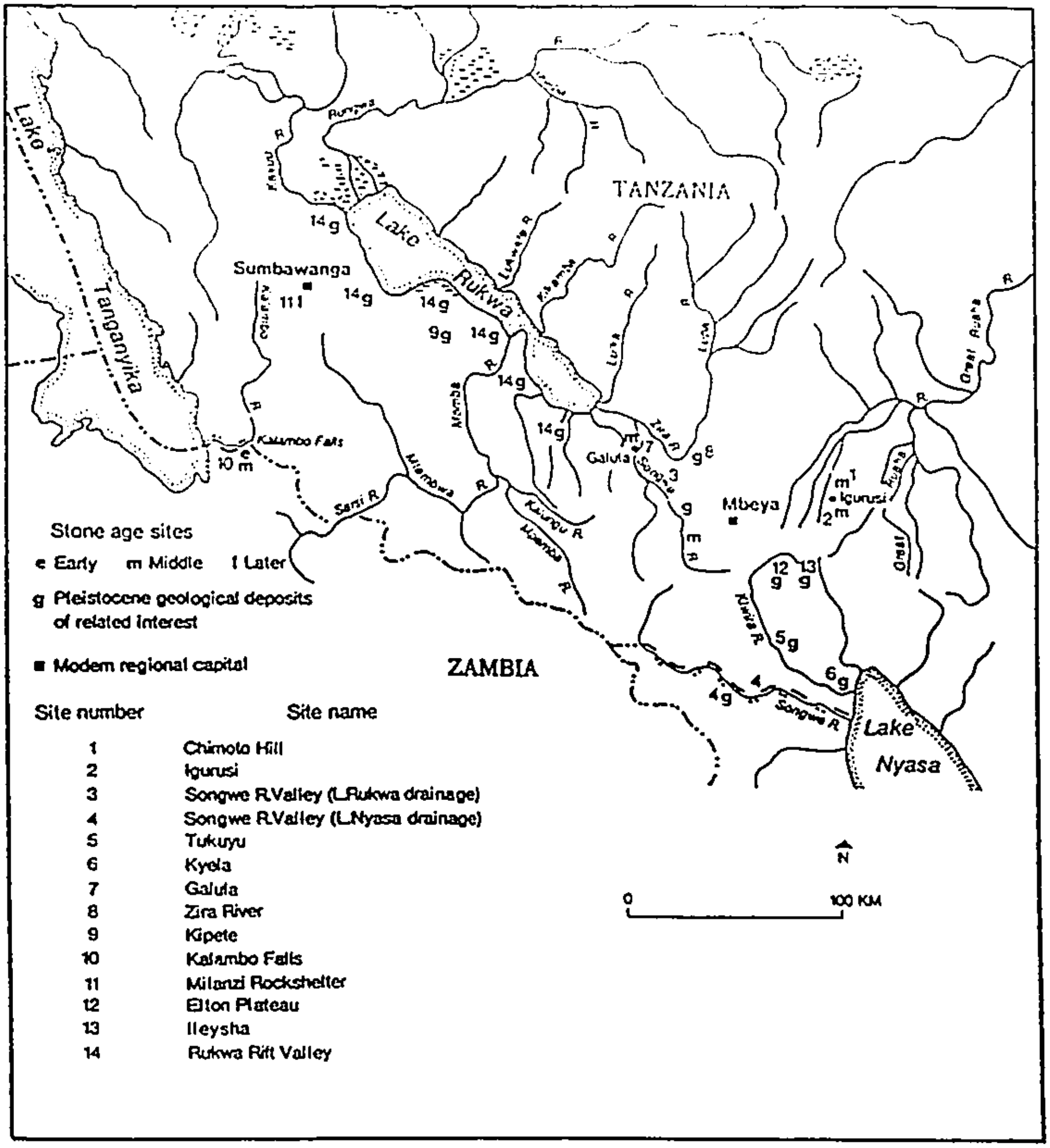
In the process of determining and, perhaps, redefining the limits by which the MSA is to be recognized and measured regarding a technological and/or cultural status, it is necessary to accept the possibility that assemblage variability may be more than the product of stimulus response to different environmental conditions, or the consequence of the properties of lithic raw materials. The MSA is an extensive period in the prehistory of sub-Saharan Africa and may well represent a more dynamic cultural and technological event than was once understood by previous observation. A combination of lithic attributes, fossil evidence, and claims by geneticists, should place the MSA at the forefront of African archaeology and palaeoanthropology for many years to come. If anatomically modern humans made their appearance in East Africa during this time frame, then it is imperative that MSA cultural attributes be pursued through the study of the most visible means that researchers have available; and that is lithic technology.

1.9. Previous research in the Songwe River region

Of the few areas of East Africa surveyed for evidence of MSA material, southwestern Tanzania, specifically the Songwe River region, remains almost completely unknown (FIG. 1.3). Research is limited to a few preliminary surveys carried out during the mid 1960s by Clark *et al.*(1970), Haynes (1970), and the 1970s by McBrearty *et al.* (1976). More recent survey was carried out by McBrearty *et al.* (1982, 1984), and Willoughby (1990, 1992). Clark *et al.* (1970) and McBrearty *et al.* (1982, 1984) both state that the Songwe River region is perhaps invaluable for the archaeological and palaeoanthropological information that it may contain. Their conclusion suggests that this area may once have supported a large MSA population, or had experienced regular reoccupation over extensive periods of time during the MSA period.

Clark *et al.* (1970) traversed the Songwe River region immediately south of Lake Rukwa. They report a MSA cultural deposit from the lower sediments exposed along the Nyara River, where it joins the Songwe near the main highway west of the Mbeya. Six metres above the river they describe a MSA deposit. A radiocarbon date of 29,000 to 32,000 years BC was obtained from immediately above this deposit and is believed to date a high lake stand (Haynes, 1970:315-316, and Haynes, n.d.). Further north near the village of Galula, Clark describes a 30 m series of lake sediments. Located 10 m below the top of this series is a layer of beach gravel containing a small number of MSA artifacts. These are described as a single high-backed disc core and a few Levallois flakes (Clark *et al.*, 1970:350).

FIG. 1.3. General overview of Stone Age localities surveyed in the Lake Rukwa region (adapted from Willoughby, 1989)



Stone age sites

e Early m Middle l Later

g Pleistocene geological deposits of related interest

■ Modern regional capital

Site number	Site name
1	Chimoto Hill
2	Igurusi
3	Songwe R.Valley (L.Rukwa drainage)
4	Songwe R.Valley (L.Nyasa drainage)
5	Tukuyu
6	Kyela
7	Galula
8	Zira River
9	Kipete
10	Kalambo Falls
11	Milanzi Rockshelter
12	Elton Plateau
13	Ileysha
14	Rukwa Rift Valley

A second survey of the region by S. McBrearty, T. Wynn and S. A. C. Waane (1982, 1984), located MSA materials in stratigraphic context at four localities (IdIu-1, IdIu-2, IdIu-3, IdIu-4) on what they describe as an ancient flood plain. Artifacts include Levallois flakes, disc cores, trimmed cobbles, burins and bifacially trimmed flakes. The occurrence of these materials on or near the surface of the flood plain suggests that local topography may have existed since MSA times.

Chapter Two

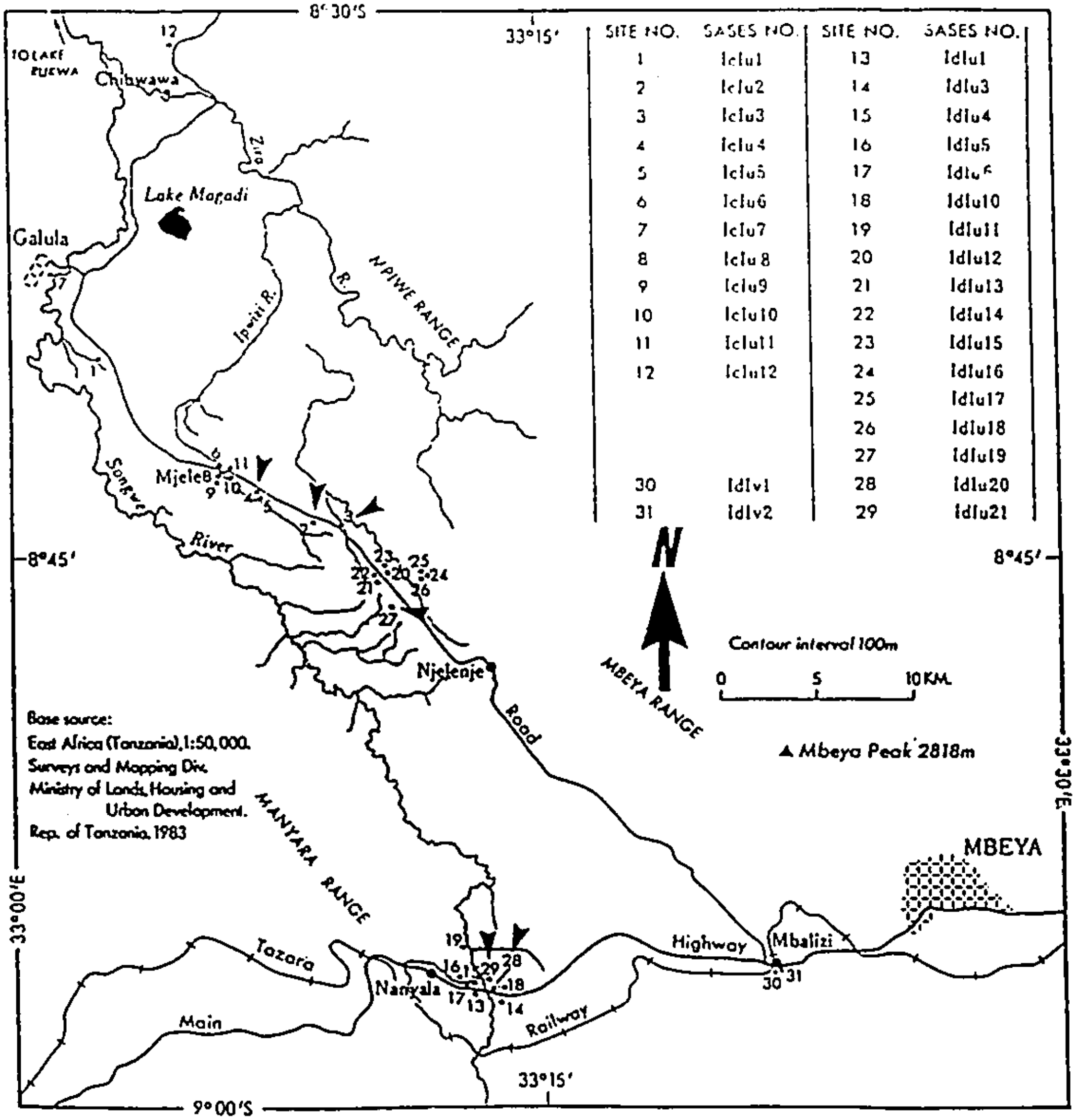
Environment, Physical Setting and Site Description

2.1. Environmental background

The study area comprises a short segment of the Songwe River located in southwestern Tanzania from 8° 30' S to 9° 00' S by 33° 00' E to 33° 30' E (FIG. 2.1.). The Songwe River flows north into Lake Rukwa ,and both river and lake are contained within a section of the Western or Albertine Rift Valley, known as the Rukwa Trough. This flat bottom trough begins southeast of Lake Tanganyika and continues south until it is transected by the Poroto Ridge that divides it from the Nyasa Trough and Lake Nyasa (also known as Lake Malawi). The Poroto Ridge is a volcanic feature composed of a chain of cinder cones and Mount Rungwe, a large volcano that rises to an altitude of 3238 m. The Songwe River originates from the northern slopes of the Poroto Ridge and drains adjacent fault scarps of the Rukwa Trough. To the east is the Mbeya Range, dominated by Mount Mbeya (3900 m) and to the west are located the more gradual slopes of the Chumwa and Manyara ranges.

Currently, Lake Rukwa is in an enclosed basin with no drainage outlet. During Late Pliocene to Early Pleistocene times, the tectonic and volcanic activity and uplift that resulted in the formation of the Poroto Ridge, changed the southerly flow of the Songwe River, and prevented it from draining Lake Rukwa into Lake Nyasa (Lake Nyasa currently lies some 330 m lower in mean elevation) (Spurr, 1953:10; Harkin, 1960). Harkin (1960) also reports that high Pleistocene beach stands, located to the north and south of Lake Rukwa, indicate that lake shores were at one time 200 m higher than they are at present and

FIG. 2.1. Map of Songwe River region showing the six study sites (Adapted from Willoughby, 1992)



SITE NO.	SASES NO.	SITE NO.	SASES NO.
1	Iclu1	13	Idlu1
2	Iclu2	14	Idlu3
3	Iclu3	15	Idlu4
4	Iclu4	16	Idlu5
5	Iclu5	17	Idlu6
6	Iclu6	18	Idlu10
7	Iclu7	19	Idlu11
8	Iclu8	20	Idlu12
9	Iclu9	21	Idlu13
10	Iclu10	22	Idlu14
11	Iclu11	23	Idlu15
12	Iclu12	24	Idlu16
		25	Idlu17
		26	Idlu18
		27	Idlu19
30	Idlv1	28	Idlu20
31	Idlv2	29	Idlu21

Base source:
East Africa (Tanzania), 1:50,000.
Surveys and Mapping Div.
Ministry of Lands, Housing and Urban Development.
Rep. of Tanzania, 1983

Spurr (1953) reports that the valley experienced at least two periods of relatively high lake stands during the Pleistocene.

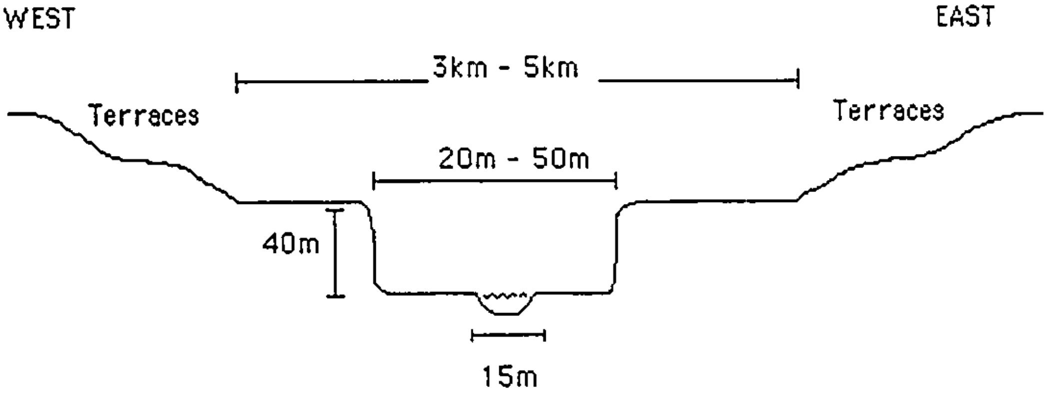
Adjacent to the Mbeya Lime Works, located 25 km to the west of Mbeya, and 75 km south/southwest of Lake Rukwa, are river cut exposures of fluvial and lacustrine sediments (Clark *et al.*, 1970). This area is presently some 250 m higher in mean elevation than the modern level of Lake Rukwa, and may represent one of a series of smaller lakes that formed when local drainage was reversed. The river is fed by many small, seasonal tributaries, that drain the surrounding escarpments, and break up local topography with the cutting of extensive networks of shallow and invasive erosional gullies. The river's present course deeply cuts into the lacustrine sediments that have developed on the floor of the trough which measures from 3 km to 15 km wide in the study area. Down cutting has etched 40 m into these sediments of reworked ash, sand, silt and intermittent lenses of pumice that form a soft, calcified matrix overlying Cretaceous sandstones and Tertiary volcanics. The upper 1 m to 2 m of the sequence is composed of very fine aeolian deposits of silts of primarily lacustrine origin, and the *in situ* weathering of local soils. During the dry season, from May to October, severe winds move across the 25 km of exposed lake bed, lifting and transporting silts throughout the river valley.

The Songwe river bed is composed of well rounded cobbles and boulders of basalt and granite. These materials are the weathered remnants of recent Tertiary and Quaternary volcanics, as well as of Pre-Cambrian and Paleozoic formations that underlie the region. The river's recent flood plain is a rather narrow shelf of organic rich silts that extend from 20 m to 250 m away from each bank edge. This small plain is abruptly walled in by cliffs cut during the Late Pleistocene (Spurr, 1953:11-15) (FIG. 2.2.).

A large percentage of the study area is comprised by the Songwe River between the villages of Njelenje and Mjele. This area is paralleled by a series of river terraces that have formed upon the lower scarps of the Mbeya and Manyara ranges of the Rukwa Trough.

These terraces are most prominent on the eastern scarp and dip under what appear to be relatively recent deltaic and lacustrine deposits to the south of Mjele village and some

FIG. 2.2. Present river bed and flood plain of the Songwe River in the study area between the villages of Njelenje and Mjele



30 km southeast of Lake Rukwa. These terraces are composed of silts, small gravels and cemented and weathered ash with broad, but intermittent gravel bars of quartz, quartzite, granite and basalt pebbles and cobbles. The only access road to the villages that are located south of the lake is built upon the uppermost terrace and this is also where two of the study sites (IcIu-2, IcIu-3) are located.

2.2. Local geology

Intensive geological survey of the Songwe River region began during the 1930s, and continued until the 1960s. The majority of the data is regionally focused with only a minimum of information on the Later Pleistocene, and more recent geologic prehistory (Stockley, 1938; Spurr, 1953; Harkin, 1960). As a consequence, it is difficult to directly associate geologic events that may have occurred during MSA occupation of the region.

The basement complex of the southern Lake Rukwa region was formed during the Pre-Cambrian and Paleozoic eras. It is composed of granite, quartzite, gneiss and schist, with extensive quartz veining (Spurr, 1953:5; Harkin, 1960:6). On top of this basement complex is deposited a series of Mesozoic sediments identified as the Karroo Formation, of Triassic and Jurassic age, and an extensive Cretaceous formation. Of interest to this study is the K3 Bed of the Karroo Formation, because it contains isolated and aggregated bands of nodular chert that Stockley (1938:24) describes as ranging from pebble to cobble in size. The K3 Bed may be a source for the chert found in the lacustrine deposits south of Mjele, near the site of IdIu-19, and may be the source for all chert used by the prehistoric occupants of the region. Outcroppings of the Karroo K3 bed are identified to the east of the Mbeya region, near Igarusi, and to the northwest of Lake Rukwa, however these deposits were not visited in 1990.

Spurr (1953:8) and Harkin (1960:7) describe the Cretaceous formation as dominated by a current-bedded red sandstone and siltstone, overlain by coarse-grained, gray, pebbly, feldspathic grits. These sediments are believed to have developed within an estuary environment. During archaeological survey, Haynes (1970) describes similar sediments exposed along the Nanyala stream near the Mbeya Lime Works. Located well above these deposits were Pleistocene age lake sediments (Clark *et al.*, 1970). According to Harkin (1960), the top of this Cretaceous formation is a weathered unconformity that was subsequently buried by Tertiary and Quaternary sediments of lacustrine and volcanic origin. These latter sediments are represented by an extensive series of fluvial deposits derived from volcanic ash and tuffs that originated during the formation of the Poroto Ridge, as well as from Mount Rungwe eruptions. These materials are identified by white to pale-green clays that overlie reworked silts and sands and containing lag deposits of pebble to cobble size clasts of quartz, quartzite and basalt (Harkin, 1960). Spurr (1953:10) also describes an extensive period of thermal hot spring activity in the region due to faulting. These springs form calcareous tufa cones and terraces throughout the region. During the Cretaceous the first in a series of many lakes was formed, with extensive deltaic deposits giving way to pebble beds and coarse white sands.

The depositional history of the Quaternary Period is complex. Sediments vary in appearance and texture from well sorted to poorly sorted indicating periodic transition between steep and gentle river gradients, corresponding with high and low discharge velocities (Boggs, 1987:354). The extreme range of variation observed is perhaps due to tectonic uplift followed by rapid downward cutting by the river. For example, east of the village of Nanyala, the Nanyala River bisects a series of ancient river channels that show signs of being choked with poorly sorted gravels, cobbles, and volcanic ashes. As well there is evidence nearby for reduced gradients as ancient river beds demonstrate well sorted sediments. Volcanic activity is also indicated by the beds and lenses of pumice and ash found throughout the valley. Intermittent intrusions of basalt lava flows are confined to the southeast section of the Rukwa Trough. Spurr (1953:13) reports that during a second period of thermal activity, small spring fed lakes appeared between previous limestone deposits and recent volcanic extrusives. Extensive deposits of travertine and porcellanous limestone are found further to the east of the Mbeya Lime Works where a karst topography is identified.

2.3. Local environment and vegetation

The Songwe River region is dominated by a *Brachystegia-Julbernardia* woodland, also described as "Miombo" forest (Lind and Morrison, 1974:81-86), that thrives on the well-drained, upper and middle slopes of the ridges and high terraces of the eastern and western scarps. Further downslope and continuing across the floor of the Rukwa Trough is a combination of dry bushland and thinly wooded grassland. Dry bushland is apparently a recent phenomenon, the result of rapid evaporation of soil moisture that is augmented by overgrazing and intensive deforestation. These denuding processes have allowed the invasion of drier habitat vegetation types, such as thorny bushes (Lind and Morrison, 1974). Stands of yellow acacia are observed along the present floodplain and baobab trees are scattered throughout the region on prominent knolls overlooking the river.

Crops grown in the immediate vicinity of the river include, sorghum, cotton, corn, cabbage, tomato, onion, coffee, and ground nuts. Plantain, bananas, papaya, and mango are grown on the river bank. Further south of the Songwe River region and including the cooler foothills of the Poroto Ridge are extensive tea plantations. Domestic fauna include, cattle, goat, sheep, pig, chicken and duck. Wild fauna in the area appears to be limited to small antelope, yellow baboon (*Papio*), and leopard.

2.4. Field work, site description, site context and excavation

Archaeological field survey was conducted from September 16, 1990 to November 12, 1990. The project was directed by Dr. P. Willoughby, of the University of Alberta, with permission from the Tanzania Commission on Science and Technology and the Tanzanian Department of Antiquities, both located in Dar es Salaam. The region traversed included localities identified by Clark *et al.* (1970), and McBrearty *et al.* (1982; 1984), as well as those areas previously unsurveyed. The total surface area covered was approximately 40 km^2, parceled out between the eastern edge of the Songwe River, north from Mbalizi village to Galula village, and east of Nanyala village, near the main highway to Zambia.

Survey was done on foot by a crew of five, including Dr. Willoughby, myself and three officers from the Department of Antiquities. The terrain was traversed by systematically walking over selected localities, with team members spread several metres apart to obtain maximum visual coverage of the ground surface. Survey was done during the end of the dry season (July to September) in order to facilitate access by unpaved road and foot path. The terrain was often difficult to traverse due to steep slopes cut by erosional gullies. Tall dry grass and deciduous leaf debris often made surface visibility of artifacts and poisonous snakes no small concern. Burning of this undermat is carried out by local villagers who use these forested areas for the gathering of firewood, the grazing of livestock and the cutting of wood to make charcoal, a dry season commodity that is sold to the larger population centres. Foot travel was of necessity limited to naturally open areas and those recently burned and consequently, field methodology was selective and systematic due to constraints of accessibility and time as the rains begin in November.

Where possible, survey was carried out to the east and west of the roadway for up to several kilometers. A primary objective of study for the northern extent of the region was to walk along the ancient river terraces that are located on the western slope of the Mbeya Range, and to descend across these terraces to the floor of the Rukwa Trough, and continue, where possible, to the Songwe River. When dense clusters of artifacts were encountered, (approximately a dozen or more items per square metre) that belonged to any period, they were given a Standardized African Site Enumeration System (SASES) designation (Nelson, 1971). The immediate surface area was then carefully walked and a selected sample of artifacts was collected for analysis. Samples were collected in such a manner so as to represent the general range of artifact type, raw material and artifact size distribution observed on the surface. No specified percentage of material was collected from a locality. Large, or more dense sites would have a greater number of artifacts collected. Other, less dense localities were also surveyed, but these were recorded by their geographical relationship to SASES designated sites.

Seventeen of 33 sites were found to contain assemblages of MSA type. Some localities were multi-component, containing MSA, LSA and/or Iron Age materials. For the purpose of this thesis six single component MSA sites were considered for further analysis. These were chosen to represent the three main survey areas within the total survey region. Sites, IcIu-2, IcIu-3 and IcIu-4, were selected to represent the northern end of the survey area. These sites were located adjacent to, and immediately south of Mjele village where the terrace system of the Mbeya scarp dips beneath what appear to be more recent lacustrine sediments. A fourth site, IdIu-19, is located east of the Songwe River between the villages of Mjele and Njelenje. The remaining two sites, IdIu-20 and IdIu-21, are located to the south of the survey area near the Catholic Mission Church, east of Nanyala village. These latter two sites are located on the surface of an ancient flood plain.

2.5. Some factors affecting the artifact sample

The surface context of artifacts makes it extremely difficult to determine the exact nature of their accumulation or the extent to which assemblages may have suffered post-depositional disturbances. All that can be said is that, since Pleistocene times, the study region was exposed to a complex series of erosional and depositional events that have left site integrity and site resolution poor (Binford, 1981). Surface accumulations do not appear to be an obvious consequence of recent redeposition by water, such as might occur at the bottom of a gully, and sites may be deflated.

To the south end of the survey region, near Nanyala village, extensive damage to local topography, due to erosional gullies that have cut deeply into the banks of the Songwe River and its smaller tributaries, has occurred. This region also suffers extensive soil erosion, due to local mining of travertine, and the removal of ancient fluvial gravels for highway construction and maintenance. Several sites described for this region by Clark and Howell (1970), and McBrearty *et al.* (1982; 1984), were never relocated and may have been destroyed by these activities.

2.6. Site description

IcIu-2 is located at 33° 8' E, 8° 44' S, and represents a dense surface scatter of MSA materials on the highest river terrace of the western Mbeya Range. The site is located 4 km southeast of the village of Mjele at a mean elevation of 1050 m. The area was recently burned making surface visibility of artifacts good. The soil is a gray to beige sandy silt with well rounded gravels and some small cobbles. The site slopes very gradually from east to west with 3° to 5° of inclination that increases to 30° on its western extremity. To the east the site is abruptly cut by an ephemeral stream gully that exposes about 8 m of sandstone of Cretaceous age.

IcIu-3 is located at 33° 9' E, 8° 44' S at an elevation of 1090 m. This site is 2 km southeast of IcIu-2 and forty metres higher in mean elevation, but also on the highest river terrace. It is bounded to the east by the ephemeral stream gully described for IcIu-2, however, near the top of this gully, above the sandstone deposits, but beneath the artifact bearing sediments, there is a 40 cm thick band of welded pumaceous tuff that has weathered black. Blocks of this material are protruding through the surface of the site indicating that deflation of the overlying artifact bearing sediments has occurred.

IcIu-4 is located at 33° 7' E, 8° 43' S at the south end of Mjele village. It is situated at a mean elevation of 1000 m. Site surface exhibits a mixture of weathered volcanic ashes with fluvial gravels and dips gradually to the west. Portions of the site have been hand-tilled for agricultural purposes. MSA artifacts were densely scattered around two mud brick homes.

IdIu-19 is located at 33° 11' E, 8° 46' S at a mean elevation of 1200 m. It is approximately 7 km north of the village of Njelenje. IdIu-19 is situated on small knoll to the west side of an ephemeral stream channel that feeds the Songwe River. This knoll, and those adjacent to it, stand out in stark contrast to the surrounding terrain by being covered in white quartz pebbles and small cobbles. These give the knolls an appearance of being snow capped. The surface of IdIu-19 is composed of ash-like sediments and beneath this is a deposit of large grained quartz sands. This sand may represent Cretaceous age lake shore sediments that are described by Spurr (1953). Local sediments also contain large blocky nodules of chert.

IdIu-20 or the Songwe Brickwork site is located at 33° 13' E, 8° 57' S, at an elevation of 1220 m. The site is situated 5 Km east of Nanyala village on a mesa on the east side of the Songwe River and just north of the highway to Zambia. The site area has recently been used for brick making. MSA artifacts were densely scattered over a confined area.

IdIu-21 is located at 33° 13' E, 8° 57' S and is situated several hundred metres northwest of IdIu-20 on the same mesa feature at a mean elevation of 1220 m. To the east of this site were found Iron Age artifacts including pottery and iron furnace remains.

Chapter Three

Methods and Objectives

3.1. Introduction

During survey, very few materials that could be dated were recovered and, therefore, it was not possible to date the six artifact localities or determine their relationship to one another upon the landscape. However, to orient the artifacts within a relative frame of reference, each was categorized by their general morphological features, using a typological approach devised by Mehlman (1989). Mehlman constructed this typology following study of *in situ* assemblages from the Mumba and Nasera rock shelter sites, located in the Olduvai Gorge/Lake Eyasi region of northern Tanzania (FIG. 1.1.). Mehlman is able to distinguish several industrial entities and establishes a culture-history for the Upper Pleistocene and Holocene occupations of the rock shelters, as well as a detailed account of the nature of change in assemblage composition from the MSA period through to the Pastoral Neolithic.

Mehlman's methodology emphasizes change in the general patterning of artifacts in regards to the location and degree of retouch. Although data are derived from sites that represent perhaps a small portion of the possible site types that were used by MSA hominids in the Olduvai Gorge/Lake Eyasi region, this typology is a good place to begin an analysis of Songwe River assemblages. Mehlman's typology is recent and essentially complete, because it is entirely based on the description of *in situ* materials obtained from nearby localities that have good chronological control. By using this typology it is hoped that some aspect of technological adaptation used by Songwe River MSA inhabitants can be brought to light. This typology is not expected to be wholly representative of the Songwe

River region, but only to be a guide and an approximation of the potential variation of MSA artifact types.

A small part of this analysis will look at site complexity between the two regions of the Songwe River and Olduvai Gorge/Lake Eyasi. As the artifact material from the Songwe River region is derived from open-air sites, there is an interest ,on the part of the author, in the range of variability that may exist between localities of this type and those of more enclosed environs, as represented by the Mumba and Nasera rockshelters.

3.2. Mumba and Nasera MSA assemblages

Mehlman (1989:207) distinguishes two MSA industries from the Mumba and Nasera assemblages. The earliest, is the Sanzako Industry, from Mumba Bed VI-B, dated between 130,000 and 70,000 years BP. The second, is the Kisele Industry, from Mumba Bed VI-A, dated from 70,000 to 45,000 years BP, and Nasera, levels 12 to 25, dated from 56,000 to >60,000 years BP (Mehlman, 1989:207).

The Sanzako Industry differs from the more recent Kisele Industry by having a lower ratio of Levallois technique, points/perçoirs, endscrapers and convex edged scrapers, as well as having an increase in the frequency of side scrapers and notched/concave scrapers, and an increase in the frequency of bifacially modified pieces and heavy duty tools (including a series of small bifaces or choppers). Mehlman (1989:183) describes Sanzako bifaces as point-like in planform, but too "chunky" in cross section to be considered points/perçoirs and their low frequency precludes their interpretation as point rough-outs.

Mehlman states that the Sanzako Industry is less diverse and more "primitive" than the subsequent Kisele Industry. Obsidian artifacts from Bed VI-B were chemically fingerprinted by X-Ray florescence and were found to have originated from the Lake Naivasha region of Kenya, more than 320 Km to the northeast of Lake Eyasi. This may indicate that MSA hominids were highly mobile, or that trade between these regions had developed at a very early date.

From Mumba VI-A, and Nasera levels 12-25, the Kisele Industry is distinguished from the Sanzako Industry by having smaller artifacts with specific categories of scraper forms well represented (e.g. end scrapers are more typically represented). As well, a higher frequency of bifacially modified pieces and retouched points is observed, and retouched points were found to consistently represent over 10% of trimmed pieces recovered by level. These points are distinguished as unifacial types are made primarily on quartz, and bifacial types are made from chert; the latter exhibiting bulbar thinning.

Levallois cores are rare in the Kisele assemblages, although large flakes made from both quartz and chert have platform faceting described as consistent with Levallois preparation. Mehlman (1989:201) also notes that bipolar reduction of quartz is infrequent by comparison with subsequent LSA assemblages, and tools such as blades, backed pieces, burins and heavy duty tools are rare as well. Core types are comparable with those of the Sanzako Industry from Mumba VI-B, although core subtypes are more variable with radially prepared cores being the most frequent type.

During the 1930s, Louis Leakey distinguished two industries from Nasera (Mehlman, 1989:201). From the lower levels (21 to 23) he described a "Developed Levalloisian" industry, while from the upper levels (12 to 17), he identified a "Proto-Stillbay" industry. After analyzing these assemblages at Nasera, Mehlman could find no basis to support Leakey's interpretation. Even as dates for the layers in question gave a time range of 110,000 to 70,000 years BP, for levels 21 to 23, and a date of 70,000 to 45,000 years BP for levels 12 to 17, the assemblages maintain a consistent form and type and, subsequently, were identified as belonging to a single technological entity.

Obsidian used at Nasera was also chemically fingerprinted and was found to have originated from three Kenyan localities: the Masai Gorge, Sonanchi Crater, and Mount Eburru, some 240 km away (Mehlman, 1989:206).

The Kisele Industry from Bed VI-A, at Mumba, is indistinguishable from the Kisele assemblage from Nasera. Mehlman found that Mumba Lower Bed VI-A equates with the earlier Nasera levels of 18 to 25, and that Mumba Upper Bed VI-A equates with Nasera levels 12 to 17. Levallois cores remain minimally represented, whereas radial, disc, and part-peripheral cores dominate the core assemblage, although to a lesser degree than seen at Nasera. There is, as well, an increase in the frequency of patterned platform core types, a greater frequency of heavy duty tools and unifacial and bifacial points are similarly represented at Mumba VI-A, as they are at Nasera (Mehlman, 1989:207).

Of the scraper subtypes, convex end scrapers are dominant and Mehlman (1989:207) notes an apparent trend between Nasera and Mumba assemblages in a shift, over time, from convex side scrapers to convex end scrapers. As well, points shift in predominance from sub-triangular to a more leaf, or ovate, planform; although, from Mumba VI-A, sub-triangular forms continued to prevail . Backed tool forms are noted to be quite rare. Obsidian from Mumba VI-A, is identified from the same Lake Naivasha source exploited by earlier Sanzako Industry tool makers.

From these assemblages, Mehlman constructed a local culture-history for the Olduvai Gorge/Lake Eyasi region and a typology that is applied to the Songwe River data. The typology consists of 105 artifact subtypes distributed between four general categories; trimmed pieces (T/P as abbreviated in Tables), cores, debitage, and non-flaked (e.g., ground or pecked) stone implements (Mehlman, 1989:127-154) (Table 3.1.). Each of these is further divided into specific tool type categories. For example, under trimmed pieces there are listed ten tool types: scrapers, backed pieces, points/perçoirs, burins, bifacially modified, becs, composite tools, outils écaillés, heavy duty tools and other modified pieces. Each class of tool type contains a number of subtypes. For example, there are 22 scraper subtypes. Trimmed pieces are identified by the location, type and extent of retouch, or backing, that is observed relative to platform end, and cores are

Table 3.1. Lithic Artifact Typology (Adapted from Mehlman, 1989).
(numbers in parentheses refer to artifact subtype)

I. Trimmed Pieces
A. Scraper
1. Small convex (1)
2. Convex
a. End and double end (2-3)
b. End and side (4)
c. Circular (5)
d. Nosed end (6)
e. Side and double side (7-8)
f. Nosed side (9)
3. Sundry
a. End and double end (10-11)
b. End and side (12)
c. Side and double side (13-14)
4. Concave
a. Concave (15)
b. Concavity (16)
c. Notch (17)
5. Combination (18-20)
6. Divers scraper (21)
7. Convergent (22)
8. Scraper fragment (23)
B. Backed Pieces
1. Geometric
a. Crescent (24)
b. Triangle (25)
c. Trapeze (26)
2. Curve-backed (27)
3. Straight-backed (28)
4. Truncation
a. Orthagonal (29)
b. Oblique (30)
c. Angle-backed (31)
5. Divers backed (32)
6. Borer/drill/perçoir (33)
7. Backed fragment (34)
C. Points/Perçoirs
1. Unifacial (35)
2. Alternate face/edge (36)
3. Bifacial (37)
D. Burins
1. Dihedral (38)
2. Angle (39)
3. Mixed/other (40)
E. Bifacially Modified Pieces
1. Discoid (41)
2. Point blank (42)
3. Sundry and fragment (43)
F. Becs (44)
G. Composite Tools (45-48)
H. Outils écaillés (49)
I. Heavy Duty Tools
1. Core scraper (50)
2. Coreaxe/Pick (51)
3. Core chopper (52)
J. Other Modified Pieces
1. Sundry modified (53)
2. Cutting edge (54)
3. Bulbar thin/Talon reduced (55)
4. Tool fragment (56)
II. Cores
A. Peripherally Worked
1. Part-peripheral (57)
2. Radial/biconic (58)
3. Disc (59)
4. Levallois (60)
B. Patterned Platform
1. Prismatic/pyramidal (61)
2. Divers single platform (62-63)
3. Double-opposed (64-65)
4. Double-adjacent (66-67)
5. Multiple platform (68)
C. Intermediate
1. Platform/peripheral (69-70)
2. Platform/bipolar (71-72)
3. Bipolar/peripheral (73)
D. Bipolar
1. Simple opposed (74)
2. Three-sided (74)
3. Double-opposed (74)
4. Fragment (75)
E. Amorphous/Casual (76)
III. Debitage
A. Angular Fragments
1. Core edges/splinters (77)
2. Chips/chunks (78-79)
3. Blade segment/distal (80-81)
B. Specialized Flakes
1. plain burin spall (82)
2. Tool resharpening (83)
C. Flakes
1. Whole (84-85)
2. Talon fragments (86-87)
D. Blades
1. Whole (88-89)
2. Talon fragments (90-91)
E. Levallois Flakes (92-93)
IV. Non-Flaked Stone Implements
A. Hammer stones (94)
B. Anvil Stones (95-97)
C. Pestle Rubbers (98-99)
D. Polished Axes (100-101)
E. Stone Disc (102-103)
F. Sundry Ground/Polished(104)
G. Manuports (105)

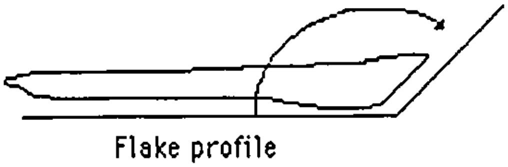
classified by the location and direction of flake scars (e.g., peripherally worked, patterned platform, intermediate, bipolar, and amorphous).

Debitage is composed of angular fragments, core trimming pieces, whole and unretouched flakes, blades and specialized types such as Levallois flakes. The category of non-flaked stone implements includes items that are ground or pecked, such as hammer stones and pestles. Few of these artifacts were recovered from the Songwe River region with none found at the six study sites.

3.3. Variables measured

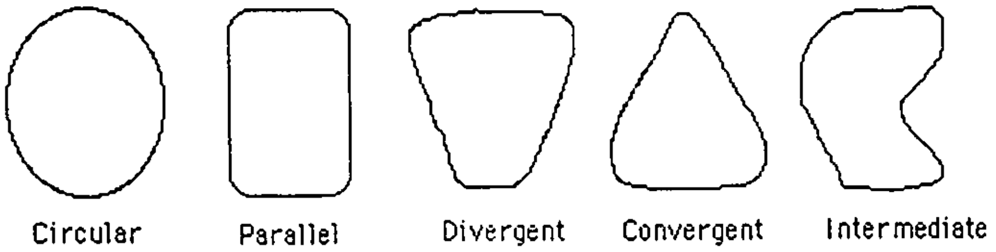
Other variables measured for artifacts include, raw material, length, breadth, thickness, weight, and the presence or absence of abrasion. Trimmed pieces and whole flakes are measured for platform faceting, and platform angle (the angle described by the intersection of a line parallel with the platform surface and a line parallel with the ventral or flake release surface) (FIG. 3.1.).

FIG. 3.1. Measure of platform angle with contact goniometer



Trimmed pieces are also measured for the number of dorsal flake scars and dorsal scar patterning, e.g., radial, transverse, opposed, same platform parallel, same platform simple, and plain, where the direction of previous flake removal is uncertain (McBrearty, 1986:183). Flake planform is determined by the visual distinction of general flake outline, with the flake oriented so that its platform serves as the base. Planforms are either circular, parallel sided, divergent, convergent, intermediate (a combination of the previous forms), and unknown, a category to distinguish broken flake and blade talon fragments when not enough of the medial portion of the flake remains to allow an estimation of original shape (McBrearty, 1986:198) (FIG. 3.2.).

FIG. 3.2. Flake planform (adapted from McBrearty, 1986)



Trimmed pieces are measured for angle of retouch, which is the angle described by the intersection of a line parallel with the ventral face and a line parallel to the slope of retouch along the flake margin (FIG. 3.3.). This measure is used by Mehlman to distinguish between a cutting edge (≤35°), a scraper edge (>35° to <90°); although scrapers generally fall within the range of 45° to 70°); and a backed edge (>80°). As well, trimmed pieces are measured for degree of retouch which is described as marginal, semi-invasive or invasive (Clark and Kleindienst, 1974:85) (FIG. 3.4.).

Trimmed pieces, whole flakes, specialized flakes and flake/blade talon fragments are measured for their Toth flake type based on a classification scheme devised by Nick Toth (1982:73-75) for measuring the general stage of core reduction as initial or latter stage depending on the extent of cortex material that remains on dorsal and platform surfaces.

There are seven Toth types (FIG. 3.5.): types I, II and III, are recognized by exhibiting cortex on their platform surface. Respective dorsal surfaces are distinguished by exhibiting either total cortex coverage (type I), partial cortex coverage (type II), or no cortex coverage (type III). Toth type I-III flakes represent an initial stage of core flaking because of the high profile of cortex material that they exhibit. Flakes struck from cores that have a majority of their cortex removed comprise Toth types IV, V and VI. These are recognized by the lack of cortex material on their platforms. Respective dorsal surfaces are distinguished by having total cortex coverage (type IV), partial cortex coverage (type V), and no cortex coverage (type VI). In general, flake types IV-VI are thought to represent a

FIG. 3.3. Angle of retouch and types of edge retouch.

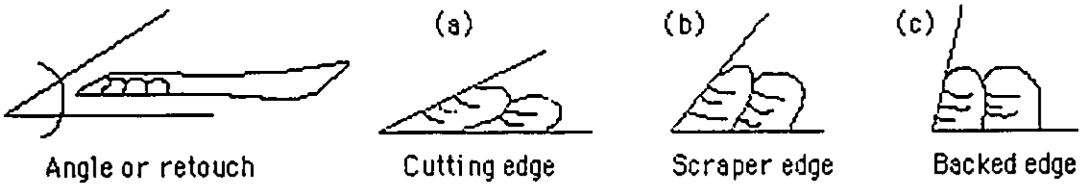


FIG. 3.4. Intensity of retouch

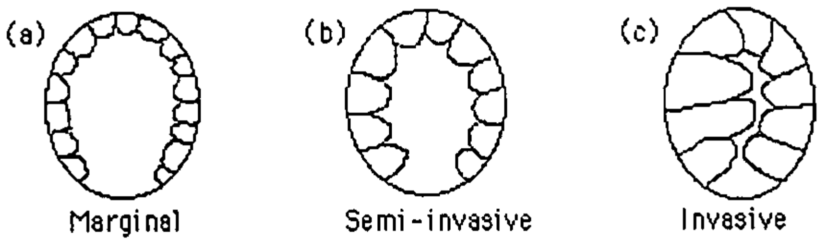
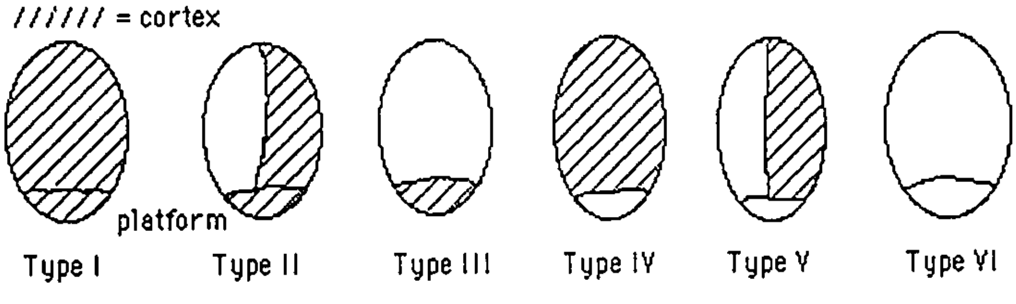


FIG. 3.5. Toth Type (adapted from Toth, 1982)



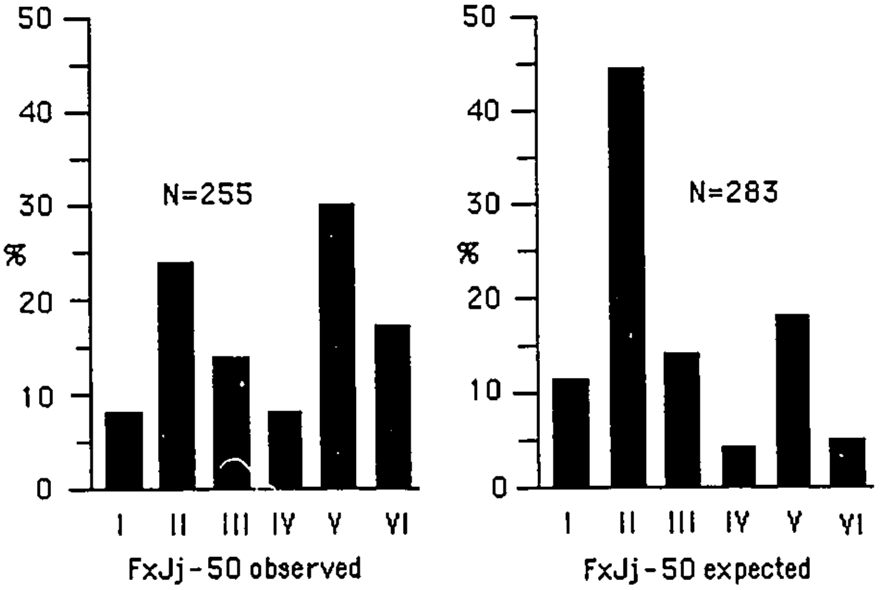
latter stage of core reduction, with type VI flakes produced during what is believed to be a final reduction stage. Toth type VII flakes, are those with collapsed or missing platforms making their general technological characteristic ambiguous (Toth, 1982:75). This category includes trimmed pieces that have platforms removed by retouch or extensive platform thinning.

Toth used his flake types to describe a core reduction sequence for several Koobi Fora, ESA assemblages (1982:216). To recognize patterns of reduction intensity, specific core types, core-tools and flake-tools from the FxJj-50 site were replicated. Toth (1982: 277) chose this assemblage, because he believed that it represented a single occupational event of short duration with minimal disturbance by depositional and post-depositional processes. Based on the observed flake assemblage, Toth felt that the combination of the above factors meant that the FxJj-50 assemblage would provide a more representative sample of the initial and final stage of core reduction. His goal was to produce a sample flake assemblage for comparison with the frequency of flake types observed from FxJj-50 (1982:282). An expected correlation between these two assemblages, however, was not observed, as the replicated assemblage produced a histogram dominated by Toth type I-III flakes, forming 70.0% of the total flake assemblage, and Toth type IV-VI flakes, combining for 29.0% of the flake assemblage (FIG. 3.6.).

According to Toth (1982:282), this distribution indicates that the flakes produced by the initial stages of core reduction should numerically predominate over those of latter stage reduction. However, the observed flake assemblage from FxJj-50 is quite different, as type I-III flakes combined for 45% of the total flake assemblage, and type IV-VI flakes combined for 54% . This latter group is dominated by Toth type V and VI flakes belonging to the latter, and more intensive stage, of core reduction.

Toth (1982:330) offers four scenarios to account for the lower than expected frequency of type I-III flakes and the greater than expected frequency of Toth type IV-VI flakes from FxJj-50. These are summarized as follows: (1) raw materials selected for their use as cores, may have been initially flaked at their source in order to test for fracturing quality. Those found with internal flaws would be discarded. Selected cores are expected then to have from one to several type I flakes removed before they were transported back to a site for further flaking. (2) Non-cortical flakes of type V and VI, may have been produced off-site for transport to sites. (3) Hominids may have been selectively removing from their sites type I-III flakes, thus diminishing their on-site frequency; and (4) depositional processes may have preferentially accumulated non-cortical flakes.

FIG. 3.6. Observed and expected distribution of Toth type for FxJj-50



According to Toth (1982:264), the last scenario is plausible, but only if type V and type VI flakes (those generally smaller and lighter than other flake types), were deposited by water, from an upstream locality. However, this is difficult to substantiate, because the data indicate that it is the larger and heavier type I-III cortical flakes that were removed from the site. If the removal of these flakes was perhaps due to water activity, then lighter flakes should be expected to have been removed also.

Toth's thoroughness of method warranted the use of his replicated data as a comparative sample for measuring the frequencies of Toth flake types from the Songwe River assemblages. Toth's (1982:330) interpretation of specific flake frequencies, and the implication that they have for discerning the stages of core reduction are also applied. However, one aspect of Toth's analysis is altered for this study, in order to accommodate the potential for variation of core reduction techniques. Toth's analysis is based on a study of Oldowan and Acheulean ESA industries, both of which are typified by core-tool and large flake-tool components. Toth (1982:75) incorporates only those flakes that are ≥2 cm in length because flakes of equal or greater dimension were noted to have been selected as tools by the Koobi Fora hominids. As this thesis involves the analysis of a more recent technology, and one that lacks a large core-tool component and, to some degree, a large flake-tool component so typical of ESA industries, flakes of ≥ 1 cm are included for Toth type. Flakes of these proportions should be addressed because they may be important byproducts of the disc core and Levallois techniques that typify MSA industries.

Songwe River core types are measured for their general frequency. The distribution of dominant core types is also compared between selected assemblages and a model of core reduction is presented in Chapter 5.

Based on observation of the Songwe River data there are patterns that lend support to an argument that MSA populations may have operated under culturally determined behaviour patterns. Final summary and discussion will lend support to Clark's (1988; 1989) proposition on the behavioural and cultural potential of MSA hominids.

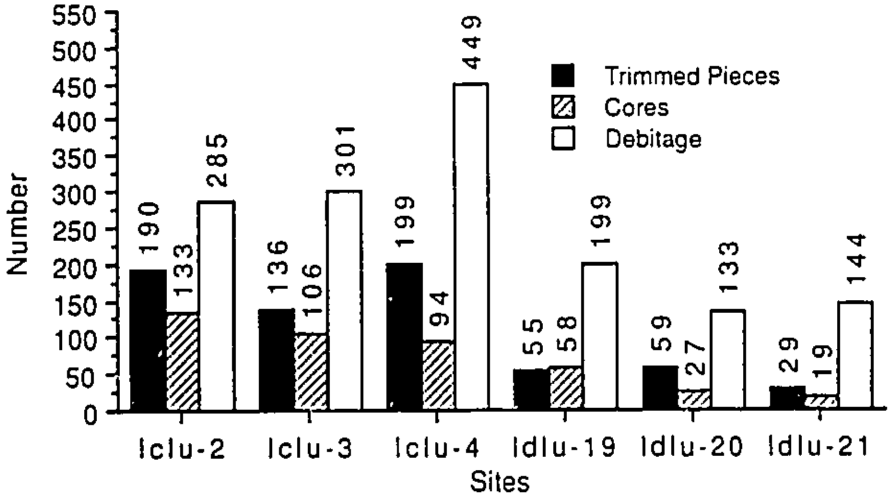
Chapter Four

Metrical Data, Assemblage Description and Comparison of Songwe River Assemblages

4.1. Artifact distribution

A total of 2616 artifacts were obtained from the six localities: Iclu-2 (n=608), Iclu-3 (n=543), Iclu-4 (n=742), Idlu-19 (n=312), Idlu-20 (n=219) and Idlu-21 (n=192). Numerical distribution of general artifact categories, including trimmed pieces (listed as T/P in tables), cores, and debitage are presented with FIG. 4.1.

FIG. 4.1. Distribution of general artifact categories (N=2616)



A comparison of Songwe River materials with those excavated from Mumba and Nasera rockshelters (Mehlman, 1989) revealed little discrepancy in the representation of artifact types. Only debitage is found in greater numerical abundance from an excavated context. In a study of Eastern North American sites, Baker (1978) sought to explain variability in the surface distribution of specific classes of artifact types through an analysis of the "size effect" (see also Schiffer, 1987:267-269). Items such as cores, large flakes and large pieces of debitage were found consistently over-represented on site surfaces in comparison with smaller flakes and flake debitage. Subsequent excavation of these sites revealed a consistent pattern of high numbers of smaller items found below the surface than was the case for larger items, such as cores.

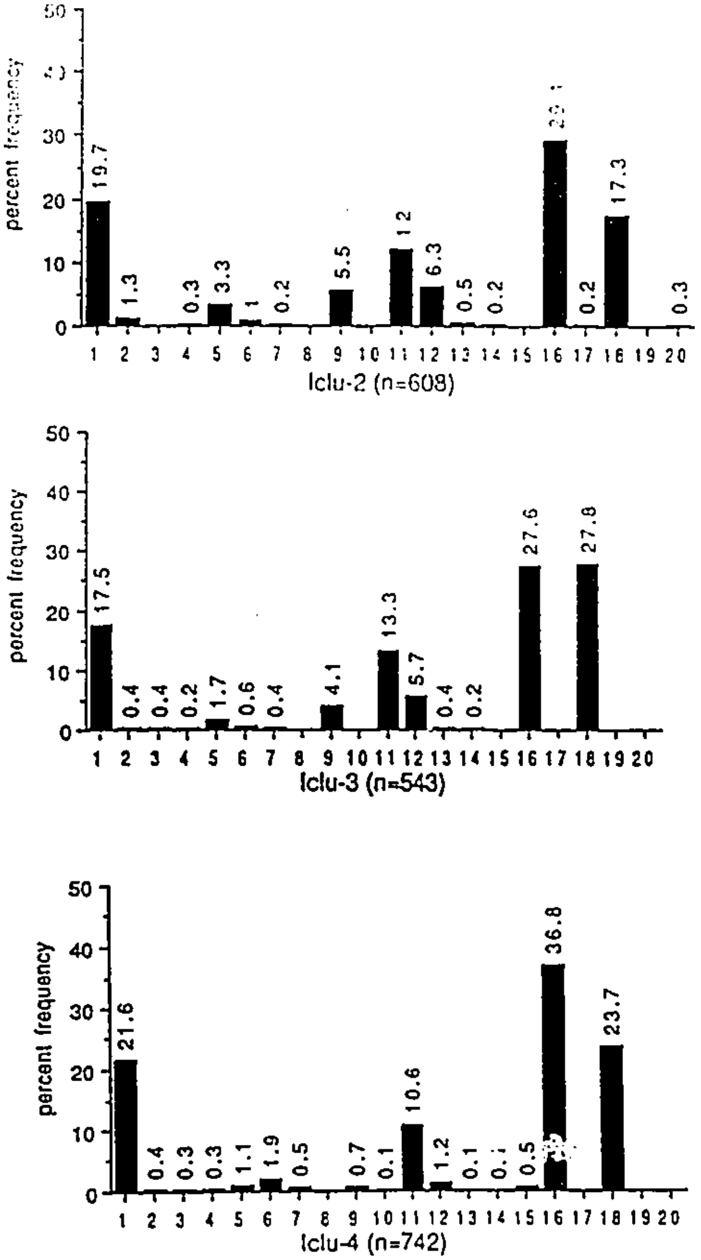
Baker (1978) surmises that larger items are more likely to be picked up and reused by subsequent site occupants and are less easily covered by soils or detritus during site use. As well, smaller artifacts have a greater tendency to become quickly buried once lost or discarded and are re-buried sooner than larger items if exposed at the surface. On the basis of results from test units at IcIu-4, size effect plays a role in the surface distribution of Songwe River artifacts and to such an extent that trimmed pieces and cores are over-represented on site surfaces.

Figure 4.2.a., and FIG 4.2.b., demonstrate the tool type distribution for all Songwe River assemblages. The horizontal axes list all major tool type categories as per Mehlman (1989:117) (see also Table 3.1.). Figures indicate a similar distribution pattern across all six sites, however, differences between southern and northern localities, with regard to the appearance of Levallois flakes, is noted.

4.2. Artifact weathering and abrasion

Analysis revealed that 94% of all artifacts are neither weathered, nor abraded. Of those that are weathered, over half (53%) are from Iciu-4, with 2% from IdIu-19. These figures may indicate two distinct depositional regimes. IcIu-4 is associated with well-sorted deposits of deltaic origin, and IdIu-19 is associated with fine silts and reworked ash and sand, indicating a lacustrine origin. As well, the surface of IdIu-19 has a high density of well rounded quartz pebbles. Many flakes retain the integrity of their edges and those

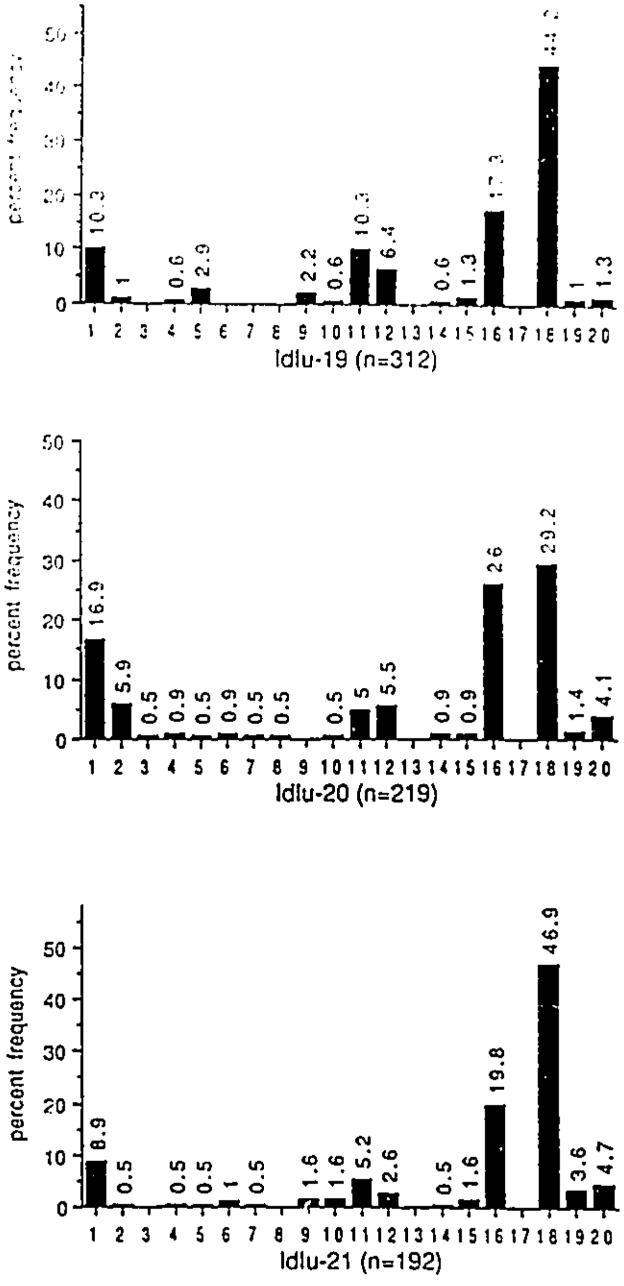
FIG. 4.2.a. Tool type distribution: Iclu-2, Iclu-3, Iclu-4



1 = scrapers
2 = backed pieces
3 = points/perçoirs
4 = burins
5 = bifacially modified
6 = becs
7 = composite tools
8 = outils ecailles
9 = heavy duty tools
10 = other retouched pieces

11 = peripherally worked cores
12 = patterned platform cores
13 = intermediate cores
14 = bipolar cores
15 = amorphous cores
16 = angular debitage
17 = specialized flakes
18 = whole flakes
19 = blades
20 = Levallois flakes

FIG. 4.2.b. Tool type distribution: Idlu-19, Idlu-20, Idlu-21



1 = scrapers
2 = backed pieces
3 = points/perçoirs
4 = burins
5 = bifacially modified
6 = becs
7 = composite tools
8 = outils ecailles
9 = heavy duty tools
10 = other retouched pieces
11 = peripherally worked cores
12 = patterned platform cores
13 = intermediate cores
14 = bipolar cores
15 = amorphous cores
16 = angular debitage
17 = specialized flakes
18 = whole flakes
19 = blades
20 = Levallois flakes

that show abrasion are extensively rolled. Data suggest that artifacts may have been accumulated through loss or discard, at or near to the location where they are found, as there is little evidence to indicate accumulation through extensive processes of water transport. Under low magnification, a number of trimmed pieces exhibit pitting and polish along portions of retouched margins that suggests use-wear (Keeley and Toth, 1981). A better grasp of the depositional history of the Songwe River sediments is required before any statement about use-wear can be made. With regards to future endeavors with Songwe River assemblages, the abundance of chert in this region offers good potential for use-wear analysis.

4.3. Raw materials

Distribution of raw materials is given by Table 4.1, and clearly indicates that quartz is the predominant form, comprising almost half of the total artifact assemblage. Volcanics comprise less than 9% of raw materials, even though the region has an extensive history of volcanic activity (Spurr, 1953; Harkin, 1960). Examples of volcanic materials found were welded tuffs that were extensively weathered. When tested for flaking quality, these materials fractured conchoidally, but flakes were unable to retain an edge due to the softness of the material. Clasts of other metamorphic and other sedimentary materials are only minimally represented, with each comprising less than 3% of the assemblage. One piece of obsidian was found at IcIu-4, however its association is unclear. Geologic reports of the Poroto Ridge and Rungwe volcanics mention no surface occurrences of obsidian

Table 4.1. Raw material distribution for Songwe River region

	Quartz	Quartzite	Chert	Volcanic	Obsidian	Oth.Met	Oth.Sed	Total
N	1209	404	663	223	1	55	61	2616
%	46.2	15.4	25.3	8.5	0.04	2.1	2.3	100%

(Spurr, 1953; Harkin, 1960). Obsidian was not found among the LSA or Iron Age assemblages that were observed, and it appears to be a rarely used raw material. The nearest known source of obsidian is from the Mt. Kilimanjaro region to the north east (Merrick and Brown, 1974).

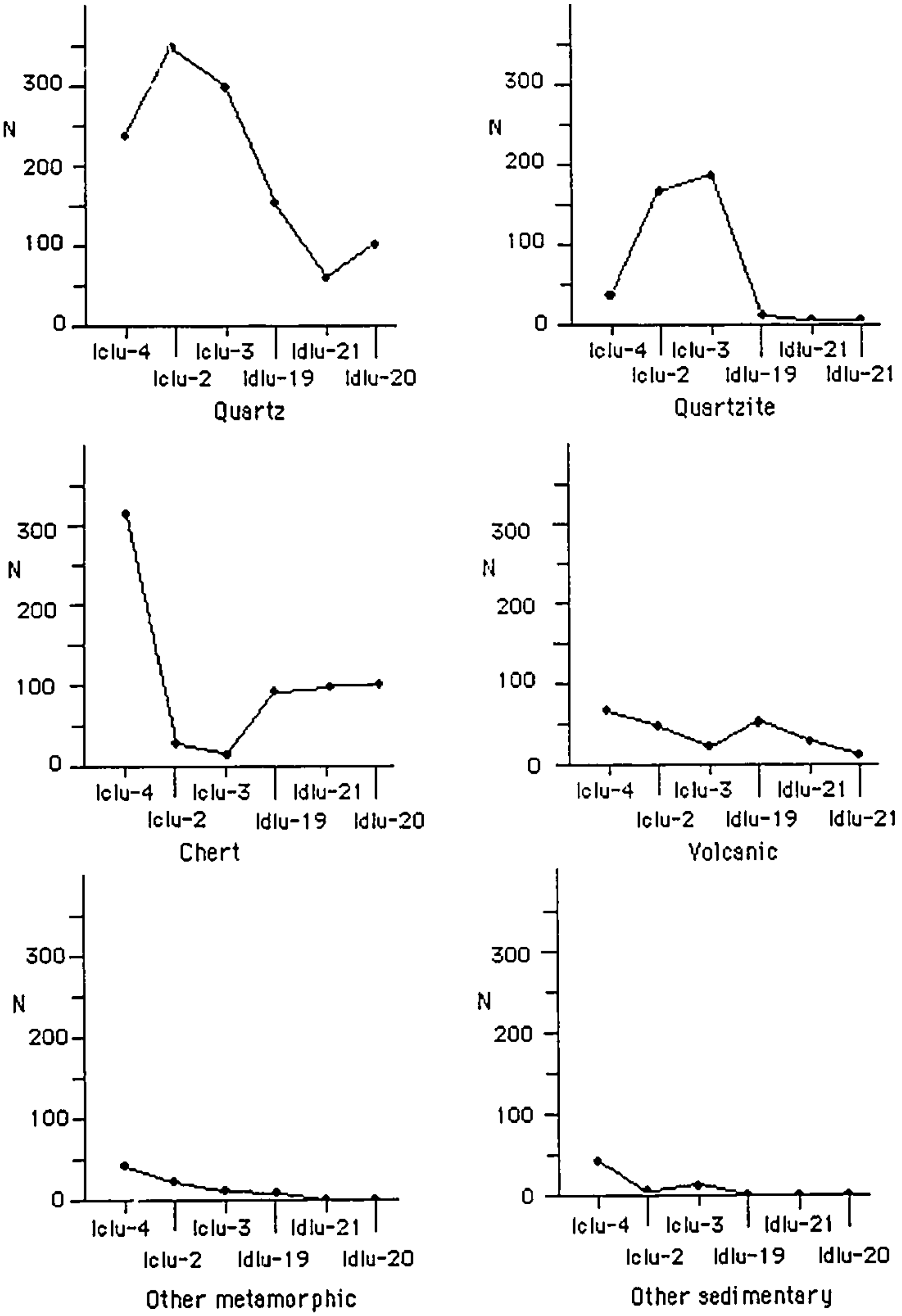
A comparative distribution of raw materials by site is presented by FIG. 4.3. Sites are listed according to their location within the study area from north to south. IcIu-2, IcIu-3 and IcIu-4 are from the north, IdIu-19 is central, and IdIu-20 and IdIu-21 represent the south extension. On the basis of the data, quartz remains high across the three sub-areas, averaging 30% to 60% of the raw material. The general distribution for quartzite is skewed in favor of the northern area, and chert maintains a high frequency within the central and southern extent, although its greatest numerical occurrence is at IcIu-4. Volcanics predominate within the central and southern areas, whereas other metamorphic and other sedimentary materials are evenly distributed between all three areas.

4.4. Raw material distribution by site

4.4.1. Northern assemblages: IcIu-2, IcIu-3, IcIu-4

At IcIu-2, a total of six hundred and eight artifacts were collected (see Table 4.2; 4.3; and 4.4. for a breakdown of categories by raw material). Of this total, 58% (n=352) are quartz, 27% (n=165) are quartzite, 6.7% (n=41) are volcanic and 5.8% (n=35) are chert. Other metamorphic and other sedimentary materials comprise 1.5% (n=9) and 1.0% (n=6), respectively. The frequency of raw material type from IcIu-3 is similar to IcIu-2: quartz comprises 55% (n=300), quartzite 35% (n=184), chert 5% (n=29) and volcanic materials, 3% (n=15). Other metamorphic and other sedimentary materials comprise 1.1% (n=6) and 1.7% (n=9), respectively.

FIG. 4.3. Numerical frequency of raw materials: sites are listed from north to south



The pattern of raw material distribution for IcIu-4 is unique in comparison to IcIu-2 and IcIu-3. Chert predominates and is found to increase in frequency from less than 6% at IcIu-2 and IcIu-3, to 43% at IcIu-4. Quartz remains dominant, although it drops in frequency from a high of 58% at IcIu-2, and 55% at IcIu-3, down to 32% for IcIu-4. The occurrence of quartzite is minimal at IcIu-4, dropping from 30% of the raw material at IcIu-2 and IcIu-3, to just over 5%. For materials such as volcanic (9%), other metamorphic (5%), and other sedimentary (6%), these demonstrate a slight increase in frequency.

4.4.2. Central and southern assemblages: IdIu-19, IdIu-20, IdIu-21

The distribution of raw material types among artifact categories for IdIu-19, IdIu-20 and IdIu-21 are also shown by Tables 4.2, 4.3 and 4.4. From IdIu-19, three hundred and twelve artifacts were recovered. Trimmed pieces represent 18% (n=55) of the assemblage, cores 19% (n=58), and debitage representing 64% (n=199). Of a total of two hundred and nineteen artifacts were recovered from IdIu-20: trimmed pieces comprise 27% of the assemblage, cores 12%, and debitage, 61%. At IdIu-21, one hundred and ninety two artifacts were recovered. Trimmed pieces comprise 15% of this assemblage, cores 10%, and debitage 75%. From IdIu-19, and the southern sites of IdIu-20 and IdIu-21, figures indicate that a greater use of specific raw material types occurred with the exclusion of others. For example, from IdIu-19 and IdIu-20, quartz remains consistent in preference with 50% and 46%, of the raw material assemblage, respectively. Whereas, at IdIu-21 quartz represents just 31% of raw material, which is a significant drop in frequency when compared with an overall predominance of this raw material type within the Songwe River region Quartzite is minimally represented from both central and southern areas and comprises just 3% of the raw material at IdIu-19, 2% at IdIu-21, and less than one percent at IdIu-20. This pattern is similar to that observed for quartzite from IcIu-4, and may

Table 4.2. Trimmed pieces by raw material for all sites

	1. Quartz	2. Quartzite	3. Chert	4. Volcanic	5. Obsidian	6. Other Met.	7. Other Sed.
Iclu-2 N=190	n=93 R=48.9 T=15.3	n=63 R=33.2 T=10.4	n=10 R=5.3 T=1.6	n=16 R=8.4 T=2.6	n=0	n=4 R=2.1 T=0.7	n=4 R=2.1 T=0.7
Iclu-3 N=133	n=69 R=50.7 T=12.7	n=47 R=34.6 T=8.7	n=2 R=10.3 T=2.6	n=2 R=1.5 T=0.4	n=0	n=2 R=1.5 T=0.4	n=2 R=1.5 T=0.4
Iclu-4 N=199	n=36 R=18.1 T=4.9	n=15 R=7.5 T=2.0	n=79 R=39.7 T=10.6	n=39 R=19.6 T=5.3	n=0	n=8 R=4.0 T=1.1	n=22 R=11.1 T=3.0
Idlu-19 N=55	n=31 R=56.4 T=9.9	n=3 R=3.5 T=1.0	n=13 R=23.6 T=4.2	n=8 R=14.5 T=2.6	n=0	n=0	n=0
Idlu-20 N=59	n=23 R=39.0 T=10.5	n=0	n=32 R=54.2 T=14.6	n=4 R=6.8 T=1.8	n=0	n=0	n=0
Idlu-21 N=29	n=11 R=37.9 T=5.7	n=1 R=3.4 T=0.5	n=14 R=48.3 T=7.3	n=3 R=10.3 T=1.6	n=0	n=0	n=0

R=row frequency; T=total frequency of artifact category for site

Table 4.3. Cores by raw material for all sites

	1. Quartz	2. Quartzite	3. Chert	4. Volcanic	5. Obsidian	6. Other Met.	7. Other Sed.
Iclu-2 N=133	n=82 R=61.7 T=13.5	n=40 R=30.1 T=6.6	n=4 R=3.0 T=0.7	n=6 R=4.5 T=1.0	n=0	n=0	n=1 R=0.8 T=0.2
Iclu-3 N=106	n=56 R=52.8 T=10.3	n=38 R=35.8 T=7.0	n=5 R=4.7 T=0.9	n=3 R=2.8 T=0.6	n=0	n=1 R=0.9 T=0.2	n=3 R=2.8 T=0.6
Iclu-4 N=94	n=37 R=39.4 T=5.0	n=5 R=5.3 T=0.7	n=38 R=40.4 T=5.1	n=1 R=1.1 T=0.1	n=0	n=11 R=11.7 T=1.5	n=2 R=2.1 T=0.3
Idlu-19 N=58	n=31 R=53.4 T=9.9	n=0	n=23 R=39.7 T=7.4	n=4 R=6.9 T=1.3	n=0	n=0	n=0
Idlu-20 N=27	n=14 R=51.9 T=6.4	n=0	n=11 R=40.7 T=5.0	n=2 R=7.4 T=0.9	n=0	n=0	n=0
Idlu-21 N=19	n=5 R=26.3 T=2.6	n=1 R=5.3 T=0.5	n=9 R=47.4 T=4.7	n=4 R=21.1 T=2.1	n=0	n=0	n=0

R=row frequency; T=total frequency of artifact category for site

Table 4.4. Debitage by raw material for all sites

	1. Quartz	2. Quartzite	3. Chert	4. Volcanic	5. Obsidian	6.Other Met.	7. Other Sed.
Iclu-2 N=285	n=177 R=62.1 T=29.1	n=62 R=21.8 T=10.2	n=21 R=7.4 T=3.5	n=19 R=6.7 T=3.1	n=0	n=5 R=1.8 T=0.8	n=1 R=0.4 T=0.2
Iclu-3 N=301	n=175 R=58.1 T=32.2	n=99 R=32.9 T=18.2	n=10 R=3.3 T=1.8	n=10 R=3.3 T=1.8	n=0	n=3 R=1.0 T=0.6	n=4 R=1.3 T=0.7
Iclu-4 N=449	n=166 R=37.0 T=22.4	n=20 R=4.5 T=2.7	n=200 R=44.5 T=27.0	n=24 R=5.3 T=3.2	n=1 R=0.2 T=0.1	n=19 R=4.2 T=2.6	n=19 R=4.2 T=2.6
Idlu-19 N=199	n=95 R=47.7 T=30.4	n=7 R=3.5 T=2.2	n=56 R=28.1 T=17.9	n=38 R=19.1 T=12.2	n=0	n=2 R=1.0 T=0.6	n=1 R=0.5 T=0.3
Idlu-20 N=133	n=64 R=48.1 T=29.2	n=2 R=1.5 T=0.9	n=54 R=40.6 T=24.7	n=12 R=9.0 T=5.5	n=0	n=0	n=1 R=0.8 T=0.5
Idlu-21 N=144	n=44 R=30.6 T=22.9	n=1 R=0.7 T=0.5	n=70 R=48.6 T=36.5	n=28 R=19.4 T=14.6	n=0	n=0	n=1 R=0.7 T=0.5

R=row frequency; T=total frequency of artifact category for site

indicate that when siliceous materials, such as chert, became available, the use of quartzite was remarkably reduced.

Chert increases in frequency and comprises 30% of the raw material assemblage from IdIu-19, 44% from IdIu-20 and 48% from IdIu-21. Volcanic materials also demonstrate a somewhat similar trend. For example, at IdIu-19 volcanics comprise 16% of the assemblage; 18% at IdIu-21, and 8% for IdIu-20. Other sedimentary materials are infrequent and provide less than one percent of the raw material assemblage at all three sites. Other metamorphic materials are completely absent from IdIu-20 and IdIu-21, and comprise just 0.6% of the raw material at IdIu-19.

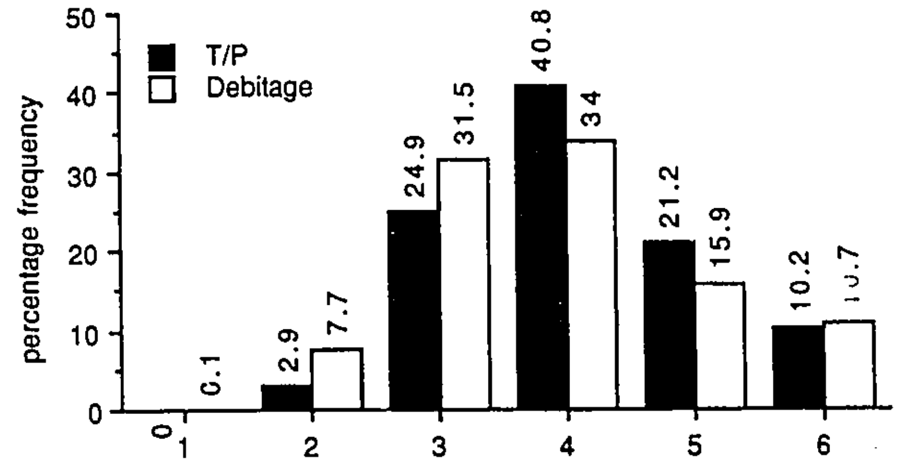
4.5. General figures for Songwe River artifacts

4.5.1. Artifact size

Figures 4.4.a., 4.4.b., 4.4.c., and 4.4.d., present the metrical data on trimmed pieces and flake debitage. All dimensions are in millimeters and weight is given in grams. Histograms for flake length, breadth and thickness describe a relatively normal dispersion curve, with length and breadth data indicating a slight skew towards the larger size categories. This pattern may be due to the fact that smaller sized flakes were more likely to remain invisible to survey team members against the background of vegetal detritus. A comparison with test pit data from IcIu-4 [illegible]ealed that this is indeed the case (FIG. 4.5.).

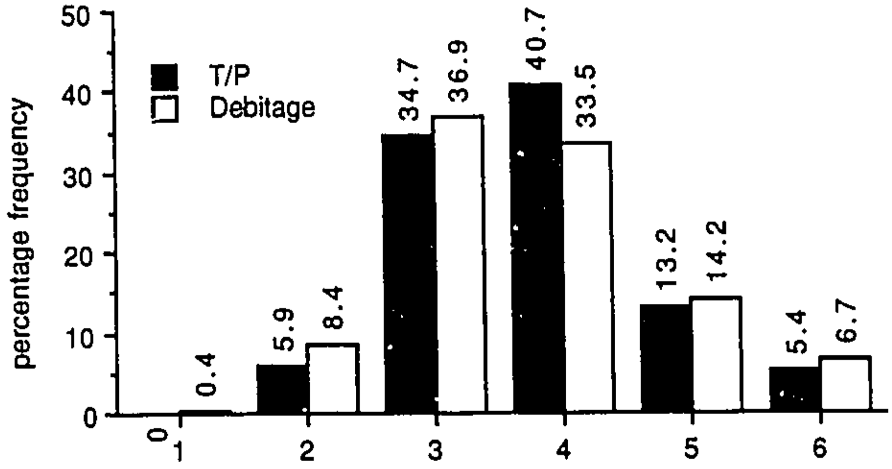
Using a 4 mm mesh screen, over eleven hundred artifacts were recovered from three test units, taken to a depth of 40 cm. These included fifty-seven trimmed pieces and two hundred and five pieces of flake debitage. As indicated, the highest frequencies for sub-surface flake length are categories 2 and 3 (measuring from 10.1 mm to 30.0 mm) that represent over 86% of recovered material. By comparing test-pit data with surface collected materials, the 10.1 mm to 20.0 mm range is under -represented on site surfaces as it comprises just 11% of surface material, whereas it comprises 54% of subsurface material. None of the smaller sized (<20.0 mm) artifacts represent trimmed pieces, although many were identified as trimmed and utilized angular fragments.

FIG. 4.4.a. Flake length: trimmed pieces (T/P) (n=596) and flake debitage (n=762)



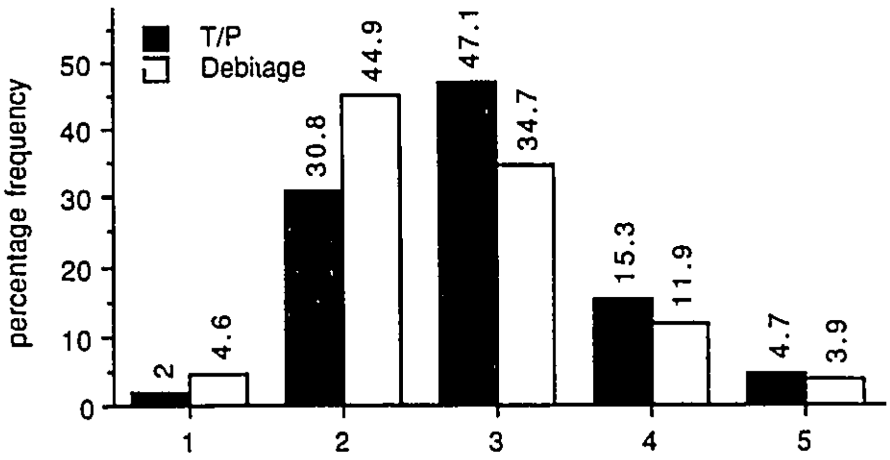
1.0 mm-10.0 mm=1; 10.1 mm-20.0 mm=2; 20.1 mm-30.0 mm=3; 30.1 mm-40.0 mm=4; 40.1 mm-50.0 mm=5; 50.1 mm through highest=6.

FIG. 4.4.b. Flake breadth: trimmed pieces (n=596) and flake debitage (n=762)



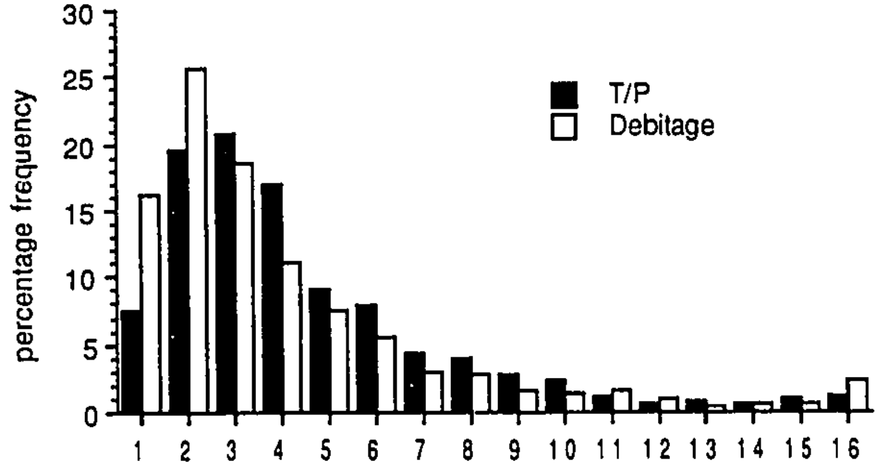
1.0 mm-10.0 mm=1; 10.1 mm-20.0 mm=2; 20.1 mm-30.0 mm=3; 30.1 mm-40.0 mm=4; 40.1 mm-50.0 mm=5; 50.1 mm through highest=6.

FIG. 4.4.c. Flake thickness: trimmed pieces (n= 596) and flake debitage (n=762)



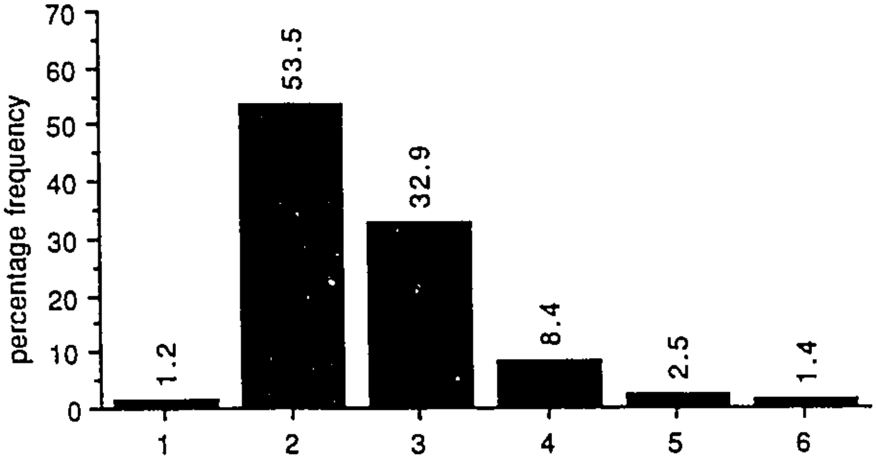
1.0-5.0 mm=1; 5.1-10.0 mm=2; 10.1-15.0 mm=3; 15.1-20.0 mm=4; 20.1 mm through highest=5.

FIG. 4.4.d. Flake weight in grams: trimmed pieces (n=596) and flake debitage (n=762)



0.1-5.0 gm=1; 5.1-10.0 gm=2; 10.1-15.0 gm=3; 15.1-20.0 gm=4; 20.1-25.0 gm=5; 25.1-30.0 gm=6; 30.1-35.0 gm=7; 35.1-40.0 gm=8; 40.1-45.0 gm=9; 45.1-50.0 gm=10; 50.1-55.0gm=11; 55.1-60.0 gm=12; 60.1-65.0 gm=13; 65.1-70.0 gm=14; 70.1-75.0 gm=15; 75.1 gm through highest=16.

FIG. 4.5. IcIu-4: comparative flake lengths from excavated test case data. Combined for trimmed pieces and flake debitage (n=262).

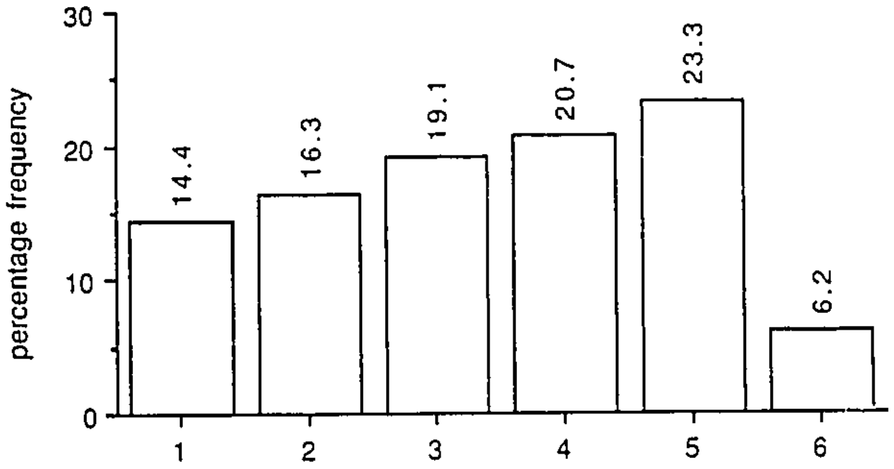


1.0 mm-10.0 mm=1; 10.1 mm-20.0 mm=2; 20.1 mm-30.0 mm=3; 30.1 mm-40.0 mm=4; 40.1 mm-50.0 mm=5; 50.1 mm through highest=6.

4.5.1.a. Planform

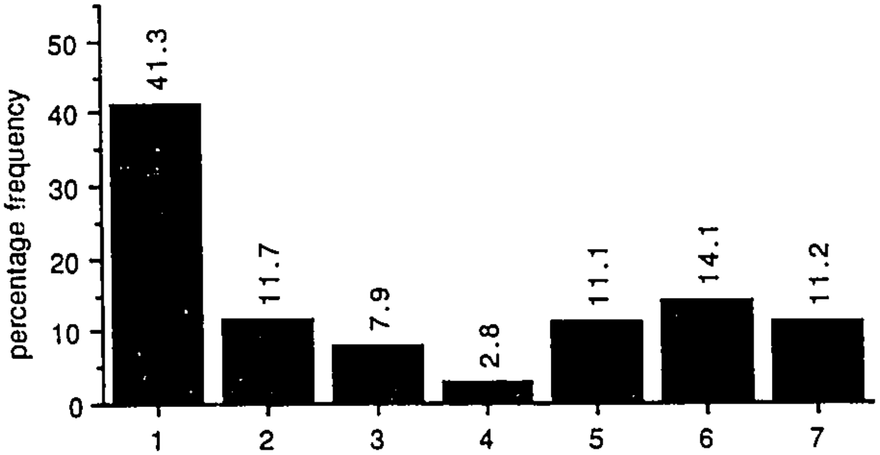
The following figures represent flake planform (FIG. 4.6.), and dorsal scar patterning (FIG. 4.7.). Flake planform is quite evenly distributed between the categories of convergent (14%), parallel (16%), divergent (19%) and intermediate (21%) categories (see FIG. 3.2 for planform outlines). Flakes of unknown planform (category 6) (6%), represent flakes that have distal ends broken or missing. Flakes with a circular planform (23%) are the most abundant, which is a pattern consistent with radial removal from disc cores. A ratio of flake breadth to length produced a range of 0.61 to 1.20 with a modal frequency of 0.81 to 1.00 (1.00 indicates that breadth and length are equal).

FIG. 4.6. Flake planform for Songwe River assemblages (n=1358)



1 = convergent; 2 = parallel; 3 = divergent; 4 = intermediate; 5 = circular;
6 = unknown (see also FIG.3.2).

FIG. 4.7. Dorsal scar patterning for Songwe River assemblages (n=1358)



1 = radial; 2 = same platform simple; 3 = same platform parallel; 4 = opposed platform; 5 = transverse; 6 = plain; 7 = none or cortex.

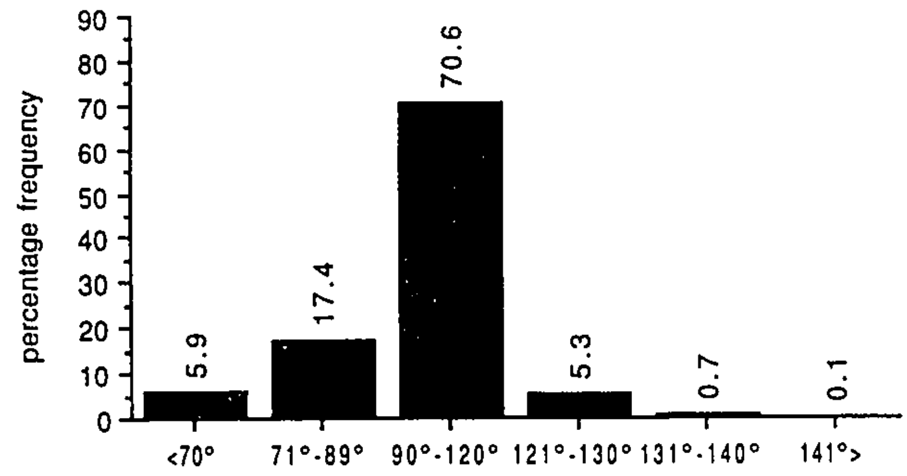
4.5.1.b. Dorsal scar patterning

Dorsal scar pattern distribution demonstrates a predilection for radial scarring, which is consistent with a radial disc core preparation technique. Perhaps the low frequency of flakes with an opposed platform scar pattern (category 4) indicates the limited use of a patterned platform core reduction technique. Mehlman (1989: 311; 368) found that patterned platform core reduction is more readily apparent with transitional MSA/LSA, and LSA industries than with the MSA assemblages that he recovered from Mumba and Nasera.

4.5.1.c. Platform angle and modal values

Analysis of flake platform angle is presented by FIG. 4.8. Data indicates that a modal range for platform angles is from 90° to 120°. Mean values also suggest that there was a modal size range for flakes struck during core reduction. For example, modal flake length is 20.1 mm to 50.0 mm, modal flake breadth is 20.1 mm to 40.0 mm, and modal flake thickness is 5.1 mm to 15.0 mm. An overall impression is one of flakes of a rather short, broad and thick nature were selected for. The weight distribution curve for flakes is skewed indicating that a modal weight range was 5.1 gm to 20.0 gm, although heavier categories, associated with thicker and larger flakes and perhaps specific raw material density, were utilized.

FIG. 4.8. Flake platform angle (n=1224)



4.5.1.d. Artifact retouch

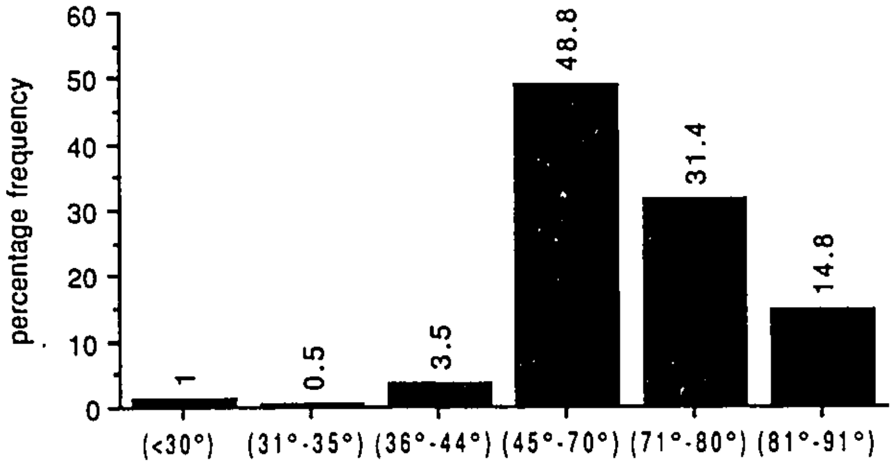
Of the total assemblage, 26% (n=668) were classified as trimmed pieces or tools. Of these, five hundred and ninety-six were examined for their level of retouch as being either marginal, semi-invasive, or invasive (see FIG. 3.4 for an illustration of these categories). The remaining seventy-two pieces are classified as per Mehlman (1989: 139) as heavy duty tools and "other" tools, where a measure of retouch intensity is not required. Of the trimmed pieces assessed, 94% were found to have marginal retouch, 5.7% were found with semi-invasive retouch and 0.2% (1 item) had invasive retouch.

Due to the "casual" nature of retouch implied by the high frequency of marginally retouched pieces, many are classifiable as trimmed/utilized debitage according to Mehlman's (1989: 127) typology (t/u in tables). However, Mehlman does distinguish some marginally retouched pieces from trimmed/utilized flake debitage by a method that is based on a measure of "boldness of modification" and "distinct retouch scarring". Mehlman states that, due to the relatively steep edges that are often produced by intentional modification and distinctive retouch, flakes with marginal retouch may be subjectively classified as tools (Mehlman, 1989:127). A boldness of modification was assessed for all retouched pieces, as well as what appears to be, in many instances, distinctive scarring, e.g., concave or notched edged pieces with a steep scraper retouch.

4.5.1.e. Angle of retouch

The angle of retouch for trimmed pieces is given by FIG. 4.9. The angle of retouch for the majority of artifacts approximate Mehlman's category for scrapers (45° to 80° with 80%), and backed pieces (81° to 91° with 15%). Artifacts with a cutting edge are represented by a retouch angle of <35°, but these are very rare, comprising just 1.5% of the total artifact assemblage.

FIG. 4.9. Angle of retouch for all trimmed pieces (n=596)



4.6. Analyses of trimmed pieces and flake debitage

This section presents data on the general artifact categories of trimmed pieces and flake debitage; included are the categories of whole and specialized flakes. Focus will be on describing any relationship that may be seen to exist between these artifact categories with regards to their preparation and removal from cores. In order to do so, an analysis of Toth flake type (Toth, 1982) and flake platform preparation is incorporated. As well, a comparison of flake debitage and trimmed pieces, between Songwe River assemblages and those from Mumba and Nasera rockshelters (Mehlman, 1989), will be done, with a look at frequencies of specific tool types.

Initially, there was an interest to observe the variation of tool types between surface assemblages and those collected through excavation in order to assess surface sampling procedures. As well, there was concern over the relative numbers of specific artifact types and sub-types that are represented by the Mumba and Nasera assemblages, as compared with those from the Songwe River region. From Table 4.5, the distribution of trimmed

Table 4.5. Distribution of tool types and whole and specialized flakes

Sites: Tooltypes:	Iclu-2	Iclu-3	Iclu-4	Idlu-19	Idlu-20	Idlu-21	MumbaVIB (Sanzako)	MumbaVIA (Kisele)	Nasera (Kisele)
1.scrapers (1-23)	n=120 f1=76.4 f2=19.7	n=95 f1=83.3 f2=17.5	n=160 f1=82.5 f2=21.6	n=32 f1=66.7 f2=10.3	n=37 f1=62.7 f2=16.9	n=17 f1=65.4 f2=8.9	n=91 f1=38.2 f2=4.0	n=257 f1=42.8 f2=5.9	n=91 f1=36.5 f2=2.0
2.backed pce (24-34)	n=8 f1=5.1 f2=1.3	n=2 f1=1.8 f2=0.4	n=3 f1=1.5 f2=0.4	n=3 f1=6.3 f2=1.0	n=13 f1=22.0 f2=5.9	n=1 f1=3.8 f2=0.5	n=0	n=5 f1=0.9 f2=0.1	n=2 f1=0.8 f2=0.04
3.points/ perçoirs (35-37)	n=0	n=2 f1=1.8 f2=0.4	n=2 f1=1.0 f2=0.3	n=0	n=1 f1=1.7 f2=0.5	n=0	n=4 f1=3.3 f2=0.3	n=68 f1=11.3 f2=1.5	n=36 f1=14.5 f2=0.8
4.burins (38-40)	n=2 f1=1.3 f2=0.3	n=1 f1=0.9 f2=0.2	n=2 f1=1.0 f2=0.3	n=2 f1=4.2 f2=0.6	n=2 f1=3.4 f2=0.9	n=1 f1=3.8 f2=0.5	n=0	n=0	n=1 f1=0.4 f2=0.02
5.bifacially modified (41-43)	n=20 f1=12.7 f2=3.3	n=9 f1=7.9 f2=1.7	n=8 f1=4.1 f2=1.1	n=9 f1=18.8 f2=2.9	n=1 f1=1.7 f2=0.5	n=1 f1=3.8 f2=0.5	n=24 f1=19.5 f2=2.1	n=58 f1=9.7 f2=1.3	n=23 f1=9.2 f2=0.5
6.becs (44)	n=6 f1=3.8 f2=1.0	n=3 f1=2.6 f2=0.6	n=14 f1=7.2 f2=1.9	n=0	n=2 f1=3.4 f2=0.9	n=2 f1=7.7 f2=1.0	n=6 f1=4.9 f2=0.5	n=49 f1=8.2 f2=1.1	n=7 f1=2.8 f2=0.2
7.composite tools (45-48)	n=1 f1=0.6 f2=0.2	n=2 f1=1.8 f2=0.4	n=4 f1=2.1 f2=0.5	n=0	n=1 f1=1.7 f2=0.5	n=1 f1=3.8 f2=0.5	n=9 f1=7.3 f2=0.8	n=36 f1=6.0 f2=0.8	n=15 f1=6.0 f2=0.3
8.outils écaillés (49)	n=0	n=0	n=0	n=0	n=1 f1=1.7 f2=0.5	n=0	n=0	n=0	n=1 f1=0.4 f2=0.02
10.other (53-56)	n=0	n=0	n=1 f1=0.5 f2=0.1	n=2 f1=4.2 f2=0.6	n=1 f1=1.7 f2=0.5	n=3 f1=11.5 f2=1.6	n=20 f1=16.3 f2=1.7	n=107 f1=17.8 f2=2.4	n=70 f1=28.1 f2=1.6
<u>Debitage</u>									
17.special flakes (82-83)	n=1 f1=0.9 f2=0.2	n=0	n=0	n=0	n=0	n=0	data not given	data not given	n=1 f1=0.02 f2=0.02
18.flakes (84-87)	n=105 f1=97.2 f2=17.3	n=151 f1=100 f2=27.8	n=176 f1=100 f2=23.7	n=138 f1=95.2 f2=44.2	n=64 f1=84.2 f2=29.2	n=90 f1=84.9 f2=46.9	n=425 f1=51.5 f2=36.4	n=1558 f1=59.9 f2=35.9	n=995 f1=24.5 f2=22.3
19.blades (88-91)	n=0	n=0	n=0	n=3 f1=2.1 f2=1.0	n=3 f1=3.9 f2=1.4	n=7 f1=6.6 f2=3.6	n=1 f1=0.1 f2=0.1	n=45 f1=1.7 f2=1.0	n=9 f1=0.2 f2=0.2
20.Levallois flakes (92-93)	n=2 f1=1.9 f2=0.3	n=0	n=0	n=4 f1=2.7 f2=1.3	n=9 f1=11.8 f2=4.1	n=9 f1=8.5 f2=4.7	n=12 f1=1.5 f2=1.0	n=51 f1=2.0 f2=1.2	n=8 f1=0.2 f2=0.2
N =	265	265	370	193	135	132	548	2234	1259

f1=freq within general category;f2=freq of tool type amongst all tool types from site pieces are noted to be quite comparable between the two regions on the basis of a presence or absence count. The greater numbers of whole flake debitage (tool type 18), from Mumba and Nasera, indicate that a substantial amount of on-site core reduction had taken place. The figures also indicate that there is a greater opportunity for the recovery of flake debris through excavation and screening procedures than is possible with surface recovery. However, the depositional and erosional histories of each locality must be considered, as these play an important role in the frequency of visible material (Bower, 1986:23). By their physical nature, rockshelters are locations of refuge from the elements and the chances of smaller debitage and trimmed pieces being removed by more active natural forces, such as rain, is perhaps, reduced.

The frequency of general artifact categories and specific tool type categories indicate that the method of surface collection used during survey of the Songwe River region was successful, as it provided a wide sample of surface materials. There are, however, specific tool type categories that are not well represented. For example, points/perçoirs are rare, although these are highly visible elements among the Mumba and Nasera assemblages. The tool types not found between the two regions (not listed in Table 4.5.) are non-flaked stone (General category 4, in Mehlman, 1989). These are represented by hammer stones and anvils from Kisele Industry assemblages at Mumba and Nasera. There may be some indication here that rockshelters differed in use from open-air localities.

A rockshelter is an area of human activity and/or habitation foci of perhaps a more permanent duration (Mehlman, 1989; Villa, 1982). The larger and heavier hammer stones and anvils may have been left behind as site furniture (Schiffer, 1987:93) and used when the site was next occupied. Over time, these items can accumulate. The absence of these items from the Songwe River assemblages is perhaps related to portability, or to specific site function. For example, if open-air sites represent transient camps or task specific localities, hammer stones and anvils may not have been part of the required tool kit, or they were of too much value to be left behind and were transported out.

Table 4.5 also demonstrates that scrapers are the predominate class of trimmed pieces for all nine assemblages, and comprise on average 16% of all artifacts recovered at each site (see f2 figures in Table 4.5.), and about 73% of all selected trimmed pieces (see f1 figures in Table 4.5.). From Mumba levels VI-B (Mehlman, 1989:669), Sanzako Industry scrapers comprise 38% of trimmed pieces. From Mumba levels VI-A (1989:675), Kisele Industry scrapers comprise 43% of trimmed pieces. At Nasera, MSA levels 12-25 (Mehlman, 1989:700-702), scrapers comprise 37% of all trimmed pieces recovered. The overall frequency of scraper forms (4%) from among all artifact categories identified at Mumba and Nasara are of several magnitudes less than scraper frequencies observed from the Songwe River sites, as the latter average 16% of all artifacts recovered. This discrepancy is perhaps related to differences in the procedure of artifact recovery. For example, high numbers of flake debitage are recovered through excavation and their large numbers serve to mathematically reduce the representative frequency of all other artifact types.

Of Mehlman's 23 scraper forms (22 subtypes and one category for scraper fragments), only small convex scrapers (subtype 1) are distinguished by size (≤ 25 mm). All remaining subtypes are identified by location of retouch and planform. The distribution of scraper subtypes for the Songwe River sites and for Mumba and Nasera are presented by Table 4.6. As the data indicate, there are distinct differences in the distribution of subtypes between the two regions. A high number of sundry side scrapers (n=73) and notched pieces (n=32) from Mumba VI-A, perhaps indicate wood working or maintenance activities. These particular items may be associated with the frequent occurrence of Levallois flakes, blades and points/perçoirs as part of a tool kit for the production and maintenance of hafted tools. An independent use-wear study would be necessary, however, before any association of scraper forms with specific tasks could be suggested.

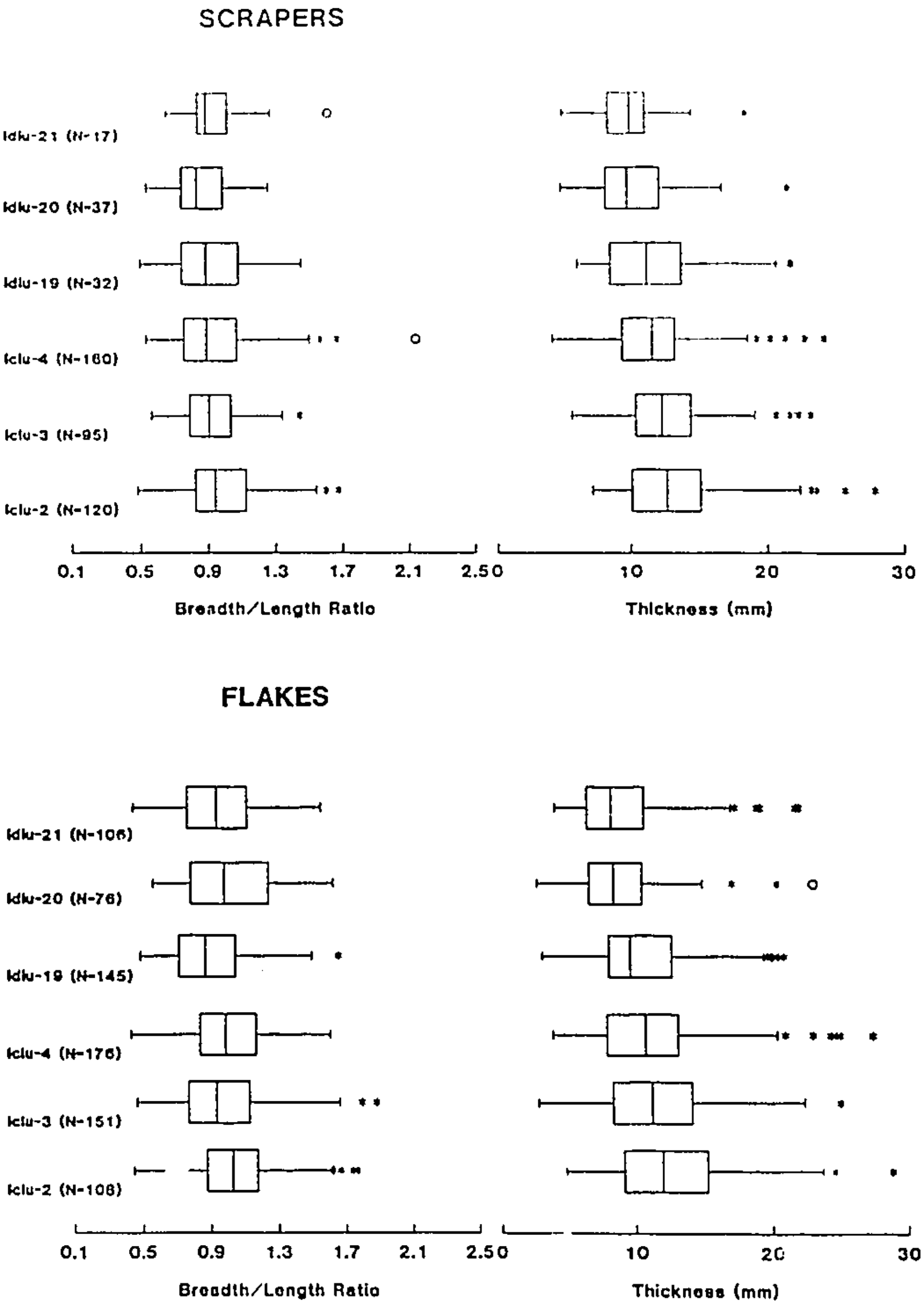
Figure 4.10 presents a summary comparison of mean length to breadth ratio and thickness for scrapers and whole flake debitage. The box and whisker plots indicate that scrapers are made from a fairly consistent size range of flakes, as seen for the pattern of whole flake debitage. Data on scraper and flake thicknesses, indicate the same trend. Complete metrical data listing standard deviation and maximum and minimum ranges for all tool types, including cores, are listed by Appendix 1.a., Appendix 1.b., and Appendix 1.c. Next to core-tools, scrapers are the largest trimmed pieces found at all sites and are rivaled only by bifacially modified pieces. At no site are trimmed pieces made on flakes that are longer than the maximum length exhibited by whole flake debitage. A higher standard deviation for debitage length and breadth is a pattern that would be consistent with flakes of a specific size range being selected for retouch from among larger flake blanks and demonstrates that MSA hominids were selective in their choices of flake removal from cores.

Table 4.6. Distribution of scraper forms

subtypes	Iclu-2	Iclu-3	Iclu-4	Idlu-19	Idlu-20	Idlu-21	MumbaVIB	Nasera	MumbaVIA
1.small convex	1	5	4	0	1	0	0	3	1
2.convex end	16	8	14	2	8	3	0	4	8
3.cvx double end	0	0	0	0	0	0	0	1	0
4.cvx end/side	14	13	12	1	3	0	1	4	2
5.circular	28	19	44	4	1	5	0	1	2
6.nosed end	0	0	3	0	2	0	0	3	18
7.convex side	3	5	19	1	4	2	0	11	2
8.cvx dbl side	3	4	5	2	1	0	0	2	1
9.nosed side	0	0	0	1	0	0	1	0	8
10.sundry end	4	4	4	3	1	0	0	1	10
11.sund dble end	0	0	0	0	0	0	0	0	3
12.sund end/side	4	7	2	5	2	0	3	6	19
13.sundry side	6	6	9	2	2	2	19	13	73
14.sund dble side	12	6	5	0	1	2	4	0	7
15.concave	1	2	5	1	4	0	2	0	2
16.concavity	4	1	0	4	0	0	0	2	0
17.notch	0	1	0	0	0	2	6	0	32
18.sundry combin	1	1	1	0	1	0	1	0	8
19.cvx end+ccv	0	4	3	0	1	0	0	0	3
20.cvx side+ccv	5	4	8	1	3	1	1	1	0
21.divers	0	0	1	1	1	0	2	1	1
22.convergent	9	3	8	3	0	1	0	1	5
23.scraper frag.	9	2	13	1	1	0	7	37	52
Totals:	120	95	160	32	37	17	47	91	257

combin = combination, ccv = concave, cvx = convex, dble = double

FIG. 4.10. Summary comparison of breadth/length ratios for scrapers and whole flakes



After assessing the mean lengths of all selected trimmed pieces, flakes of 20 mm to 50 mm in length are found to be those most abundantly produced (see also FIG. 4.4.a.). A few flakes that fell outside of the larger end of this size range were selected for retouch, but not on a frequent basis, even though core size allowed for their manufacture. For example, IdIu-19 has the largest cores in terms of their length, breadth and thickness, however, the selection of flake size from this site remains consistent with the general pattern of flakes having a greatest dimension of 50 mm. This modal size range was, perhaps, most appropriate, or durable, for hand held manipulation ,or hafting. However, flakes are rather small and this may indicate some aspect of the motor skills of MSA hominids for this region.

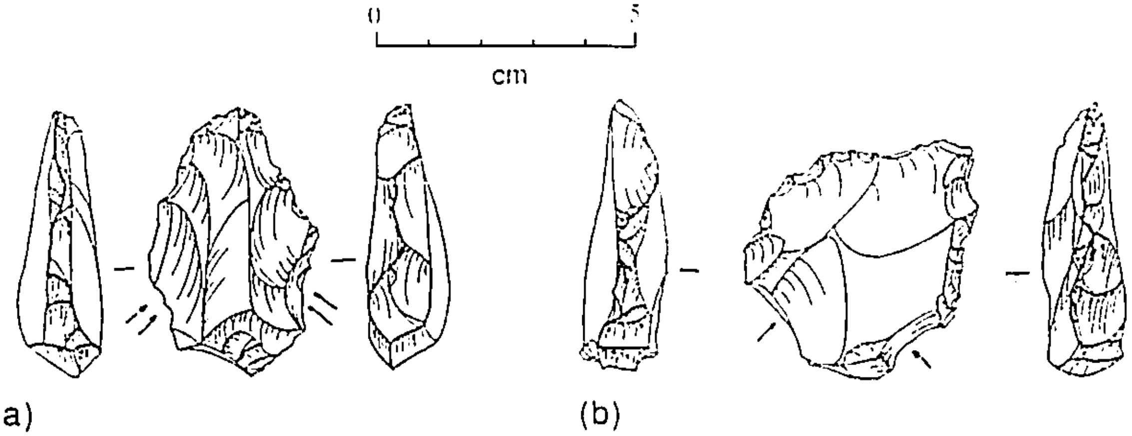
Clark (1988:298) states that MSA assemblages provides the first evidence of compound tool use, in the form of hafted points. The evidence, however, is circumstantial and is based on a preponderance of unifacial and bifacial points recovered from several East African assemblages. From Klasies River Mouth, shouldered points suggest hafting (Singer and Wymer, 1982), however, there seem to be few if any East African forms that exhibit unmistakable proximal notching or shouldering. Only from North African Aterian assemblages is there evidence for hafting as many artifacts exhibit a proximal tang (Clark, 1970:128).

The presence of unifacial and bifacial points among MSA assemblages does suggest hafting, perhaps as a means to maximize the functional efficiency of tool design. However, from the Songwe River assemblages, points and perçoirs are quite rare with only four recorded: 2 unifacial points and 2 backed perçoirs, one of each from IcIu-3 and IcIu-4. Points and perçoirs are a dominant tool type with the Mumba and Nasera assemblages (Mehlman, 1989:544), comprising 15% of trimmed pieces at Nasera (second only to scraper forms), and 11% of trimmed pieces for Mumba VI-B, as well as just over 3% for Mumba VI-A.

Mehlman (1989:135) distinguishes points from convergent scrapers by their respective angles of retouch (points have a cutting edge of ≤30°), and by the angle of intersection that is formed by the lines of retouch. Convergent scrapers exhibit a more obtuse angle of intersection (>45° to <70°), whereas points are more acute. Perçoirs are distinguished from points and convergent scrapers by having visibly concave edges due to intentional modification. Convergent scrapers are few in number from Mumba VI-A (n=5), and from Nasera (n=1). From the Songwe River assemblages, 24 convergent scrapers were recovered (just over 5% of all scrapers found); the highest occurrence was from IcIu-2 with nine.

Of related interest are artifacts that Mehlman (1989:137) describes as "point rough-outs". These come under the category of bifacially modified pieces and are thought to be point preforms because they approach the morphology of bifacial points. Four artifacts fitting this description are recognized among the Songwe River assemblages, 3 from IcIu-4 and 1 from IdIu-19. One of these, from IcIu-4, is unique (FIG. 4.11.a., artifact #646) because it exhibits shouldering. Semi-invasive trimming scars were removed from the flake's ventral surface immediately adjacent to either side of the platform. This trimming did not appear to be an attempt to remove, or thin the bulb of percussion; nor did the shouldering appear to be designed as a working edge for scraping (retouch approximated 90°, consistent with backing). A similar pattern is observed on a backed awl/drill/perçoir from IcIu-4 (FIG. 4.11.b., artifact #635.) with trimming on the dorsal surface adjacent to the platform. Being so near to the platform, this type of modification may have offered better purchase for a hand held use, or facilitated some form of hafting. However, artifact platforms are very thick, approximating 1.5 cm in diameter, and if hafted this way would have required a shaft of broad diameter.

FIG. 4.11. Evidence of shouldering or notching.
Artifacts are from IcIu-4: (a) #646 point roughout (chert) (b) #635 backed awl/drill/perçoir (chert)



(small arrows indicate areas of shouldering or notching retouch)

Clark's (1988:237) overview of the MSA, describes unifacial and bifacial points as two elements that distinguish MSA assemblages from those of the preceding ESA . The near absence of points from the Songwe River assemblages is perplexing. At the Mumba and Nasera rockshelters, the greater occurrence of points is perhaps indicative of these sites as areas of stone tool production and maintenance. A high frequency of flake talon fragments of both untrimmed and trimmed varieties from the Nasera Kisele Industry assemblage (totaling 670, or 17% of all debitage material) may indicate the repair and replacement of broken or damaged flakes and points at this site (Table 4.7.).

Counts for whole flake and flake talon fragments from Mumba VI-A and VI-B were not compiled in a manner conducive to their individual comparison. Flake talon fragments of both untrimmed and trimmed and utilized varieties are common within the Songwe River. Their occurrence is perhaps indicative of site-use inferred for Nasera rockshelter. Flakes of Levallois type are not found in great numbers in the Songwe River assemblages, and only at IdIu-20 and IdIu-21, do they occur with any degree of consequence. Levallois flakes are not found at IcIu-3 and IcIu-4, and their presence at IcIu-2 and IdIu-19 is minimal, comprising less than 3% of the flake assemblage.

Table 4.7. General distribution of subtypes for flake debitage from the Songwe River and Olduvai Gorge/Lake Eyasi region (adapted from Mehlman, 1989)

	Iclu2	Iclu3	Iclu4	Idlu19	Idlu20	Idlu21	Nasera	MumbaVIB	MumbaVIA
82.spall-burin	1	0	0	0	0	0	0	-	-
83.spall-tool	0	0	0	0	0	0	1	-	-
84.flake,whole	32	60	71	85	33	56	254	-	-
85.flake,t/u	51	70	76	41	20	10	61	-	-
86.flk talon	5	9	11	11	9	17	602	-	-
87.talon t/u	17	12	18	1	2	7	78	-	-
								425	1558
88.blade,whole	0	0	0	1	1	5	4	1	26
89.blade,t/u	0	0	0	0	2	2	3	0	1
90.bld talon	0	0	0	2	0	0	2	0	18
91.bld talont/u	0	0	0	0	0	0	0	0	0
92.Levallois flk	0	0	0	4	8	5	4	10	46
93.Levallois t/u	2	0	0	0	1	4	4	2	5
Totals:	108	151	176	145	76	106	1012	438	1654

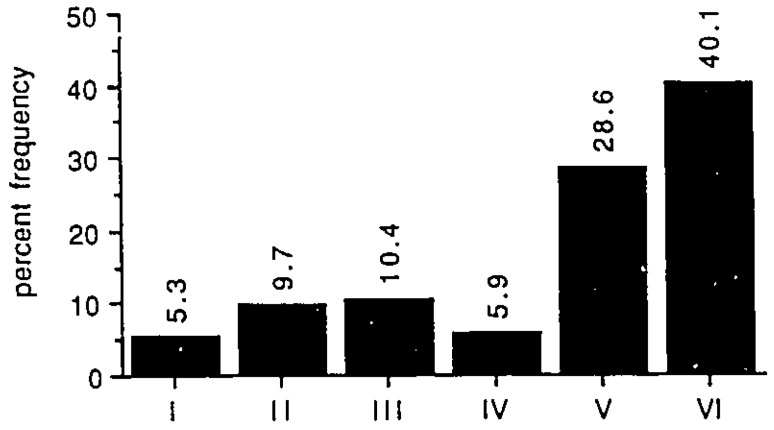
bld = blade, flk = flake, t/u = trimmed and/or utilized

4.7. Description of Toth type

Through replicative studies, Toth (1982:73) found that type I, type II, and type III flakes (those with cortex covered platforms: see also FIG. 3.5.), represent what he describes as an initial stage of core flaking, i.e., the initial removal of cortex from a core during unifacial reduction. Toth also found that type IV flakes indicate an initial stage of bifacial core flaking. Toth defines the later stages of core reduction with type V and type VI flakes, that are removed once cortex material is removed from virtually every flake release surface.

Of the total number of flakes that were measured, roughly 10% were type VII. These flakes are indeterminant because their platforms have collapsed or are removed, precluding their use in a discussion of core reduction. The general distribution of Toth types I-VI from the Songwe River region is presented by FIG. 4.12. Data reveals that of those measured, Toth type V, and type VI flakes are the most common. This pattern suggests that there may have a demand for flakes with little cortex coverage.

FIG. 4.12. Combined distribution of Toth types for Songwe River sites (n=1224)



The combined Toth distribution for trimmed pieces and flake debitage from test excavation units at Iclu-4 is presented by FIG. 4.13., and the observed and expected frequencies of Toth type from the ESA Koobi Fora site of FxJj-50 are given by FIG. 4.14.a. Figure 4.14.b. demonstrates the Toth assemblages for all six Songwe River sites.

The general distribution of Toth type by site is quite variable, with no distribution matching that expected by Toth for FxJj-50. The Songwe River data is not expected to completely correlate with either an expected or observed frequency as given by Toth, because his data are derived from a core tool based industry where flakes are struck as part of the process of core shaping. However, a high expected frequency of type I-III flakes would be consistent with an initial process of cortex removal. Higher than expected frequencies of type V and type VI flakes are perhaps related to the shaping and retouch of core tools, whereas from the Songwe River region, assemblages demonstrate a more intensive production of flakes once an initial process of cortex removal of cores had occurred. Core tools, or heavy duty tools, are a minor component of Sengwe River assemblages, and their production is not indicated by the Toth type distribution.

FIG. 4.13. Toth type distribution for trimmed pieces and flake debitage from test excavation units at Iclu-4 (n=262)

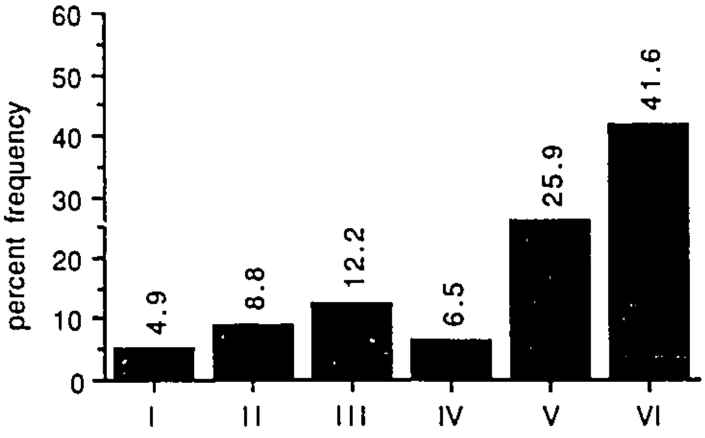
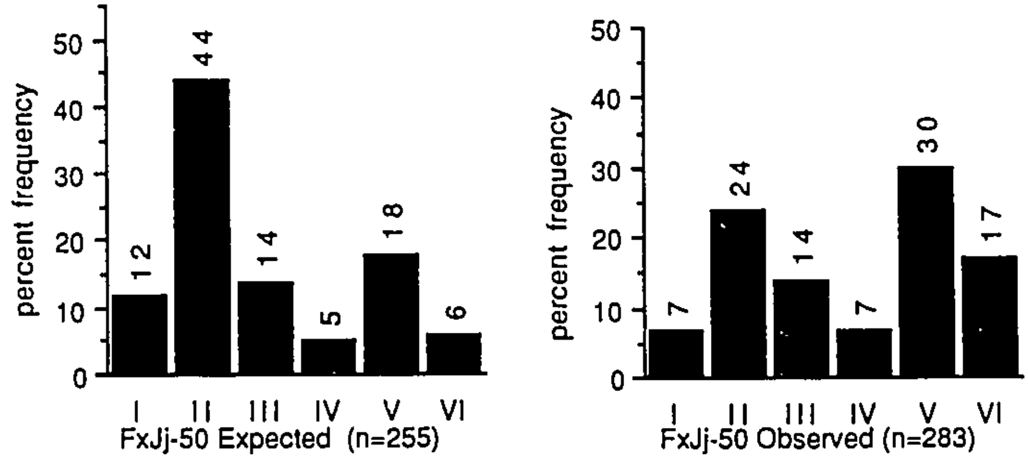


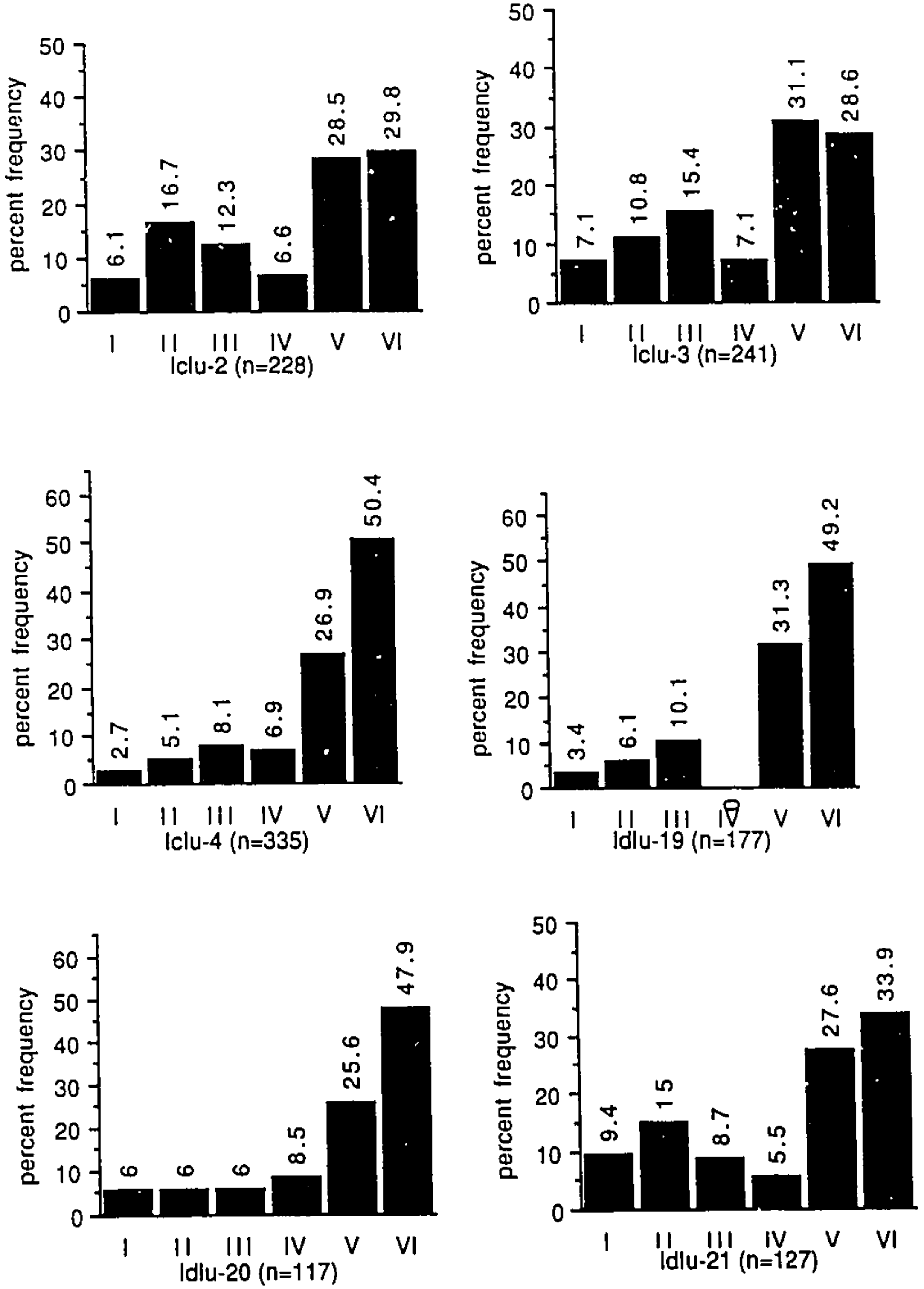
FIG. 4.14.a. Toth type distribution of FxJj-50 (adapted from Toth, 1982).



FxJj-50 Expected (n=255)

FxJj-50 Observed (n=283)

FIG. 4.14.b. Toth type distribution for Songwe River sites.



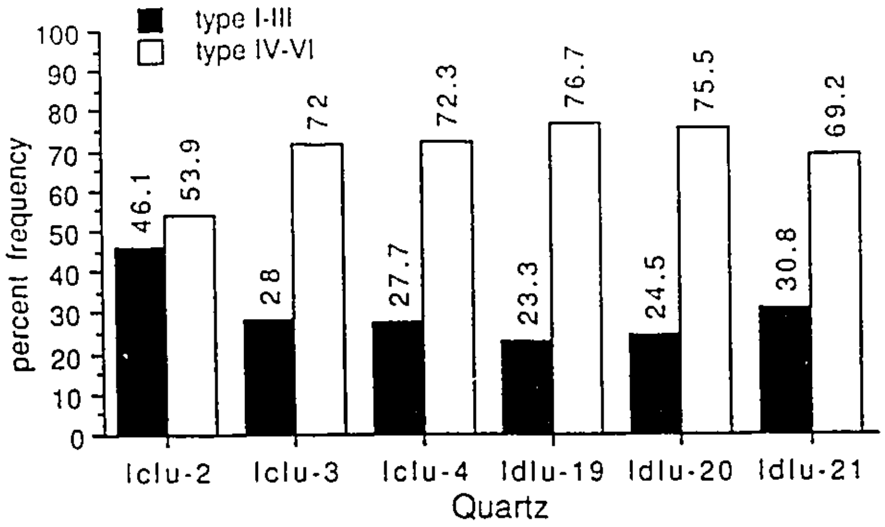
4.7.1. Raw material and Toth type distribution

The distribution of Toth type by raw material is given by FIG. 4.15.a, and b. Iclu-2: quartz, comprises 46% of type I-III flakes and 54% of type IV-VI flakes. This distribution indicates that a full range of quartz flake production occurred. Quartzite, comprising 27% of the raw material at Iclu-2, appears to have been initially flaked off-site, judging by a 2:1 ratio of type IV-VI flakes (67.6%) to type I-III flakes (32.4%). Flakes made from chert, volcanic, other metamorphic, and other sedimentary materials combine for a very low frequency of the total flake assemblage at Iclu-2. The majority of flakes that are made from these latter materials are identified as Toth type IV-VI: 85.7% for chert, 91.3% for volcanic, 100% for other metamorphic, and 66.7% for other sedimentary. An infrequent occurrence of debitage for these raw materials, as well as a single core of other sedimentary material, indicate that they were not selected as often for flake manufacture.

Iclu-3: The distribution of Toth type at Iclu-3 is similar to Iclu-2. Toth type IV-VI flakes are found to predominate across all raw material categories with only quartzite showing some small evidence for an initial stage of core reduction as having occurred on-site, with type I-III flakes representing over 46% of the quartzite assemblage.

Iclu-4: The observed distribution of Toth flake types from Iclu-4 is unique. When type I-III flakes are combined for all raw materials they comprise just 15.8% of the total Toth assemblage, whereas type IV-VI flakes combine for 84.2% . This pattern is the reverse of an expected frequency of flake types, as recorded by Toth (1982). A full 87% of chert flakes are of Toth type IV-VI, as well as 72% of quartz flakes, 89% of volcanic flakes, and 79% of quartzite flakes, respectively. The minimal representation of other metamorphic and other sedimentary materials at Iclu-4, suggests that these may have been reduced off-site. A similar pattern seems evident for volcanic material, as 41 trimmed pieces are identified (38 scraper forms, 2 points/perçoirs and 1 heavy duty tool), but with

FIG. 4.15.a. Toth type distribution by raw material: quartz, quartzite.



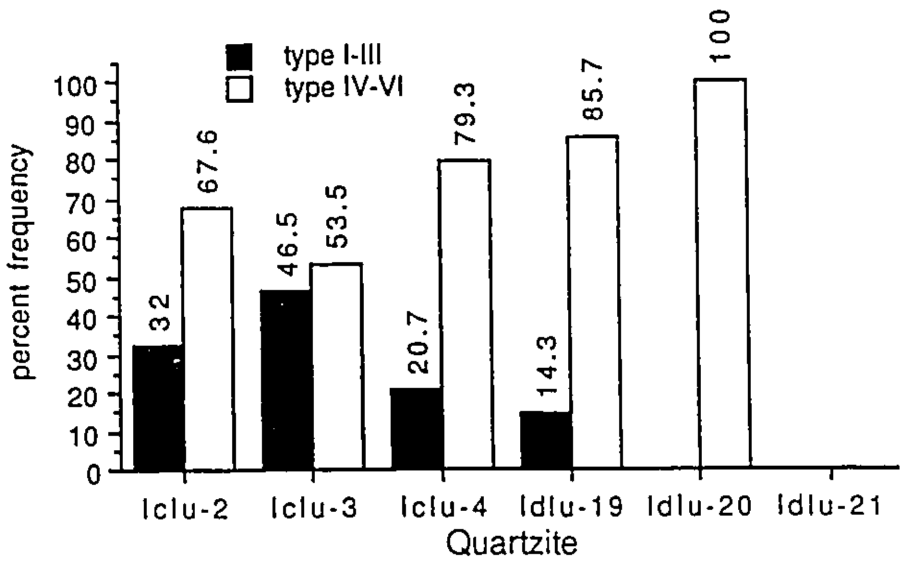
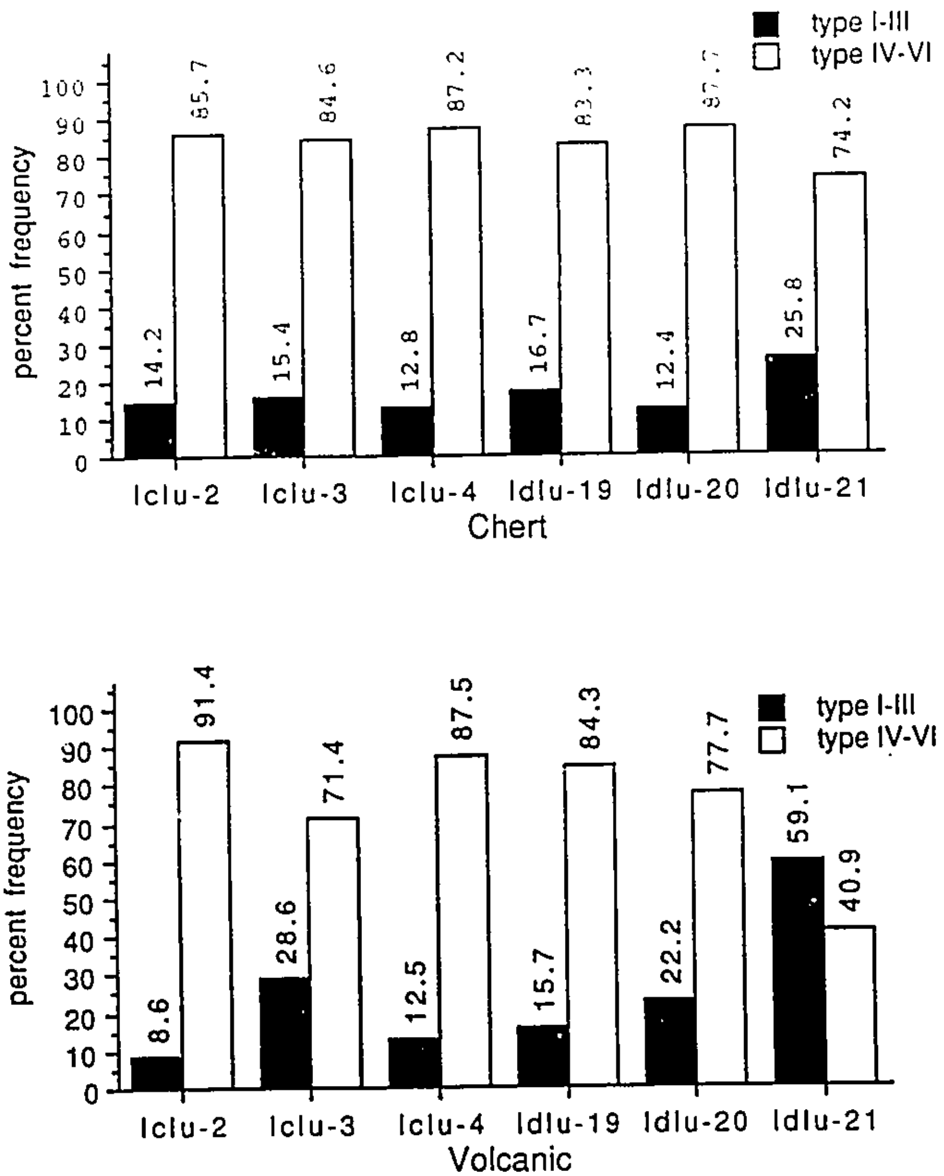


FIG. 4.15.b. Toth type distribution by raw material: chert, volcanic.



only one peripherally worked core. It would appear that volcanic materials may not have been readily accessible and when they were obtained, were intensively reduced off-site.

Exotic lithics such as volcanic, other metamorphic and other sedimentary raw materials may have been collected and flaked enroute, between areas of subsistence activity and habitation. Pre-struck flake blanks and preforms may have been carried onto a site where they eventually became worked out, lost, broken, or discarded. It is of particular interest to note that although volcanic materials are infrequently represented as a raw material from IcIu-4, scrapers made from volcanics comprise 24% (n=38) of the 160 scrapers found at this site. This demonstrates that volcanic flakes were selected for scraper retouch, second only to chert.

<u>IdIu-19</u>: Cores of quartzite are absent from IdIu-19. The low frequency of type I-III flakes (0.6% of flakes analyzed), and type IV-VI flakes (3.4% of the flakes analyzed), suggests that quartzite was rarely selected for flake use. Toth type IV flakes are not represented by any of the raw materials at IdIu-19. This pattern was not expected, since an initial stage of bifacial flaking of peripherally worked cores should have produced at least a small percentage of type IV flakes (Toth, 1982) as peripherally worked cores are common at IdIu-19 (55.2%). No flakes made of other metamorphic material are found, and only one flake (type VI) is made of other sedimentary material. Volcanic materials are more prevalent at IdIu-19 and comprise 16% of the flake assemblage. Their Toth type distribution suggests that only the later stages of core reduction had been carried out on-site as over 84% of volcanic flakes are of types IV-VI. As well, the difference in the Toth type frequency for quartz flakes suggests that an initial stage of core reduction occurred only minimally on-site.

<u>IdIu-20</u>: The Toth distribution for IdIu-20 reveals a pattern similar to IdIu-19. Chert is the predominant raw material comprising about 49% of the flake assemblage. Of this figure 88% of chert are type IV-VI, as well 75.5% of quartz flakes, 78% of volcanic flakes and all quartzite flakes are of type IV-VI. A high frequency of these flake types for

these materials indicates a low occurrence of initial on-site core reduction. Of note, there are no flakes recorded for other metamorphic and other sedimentary materials at this site.

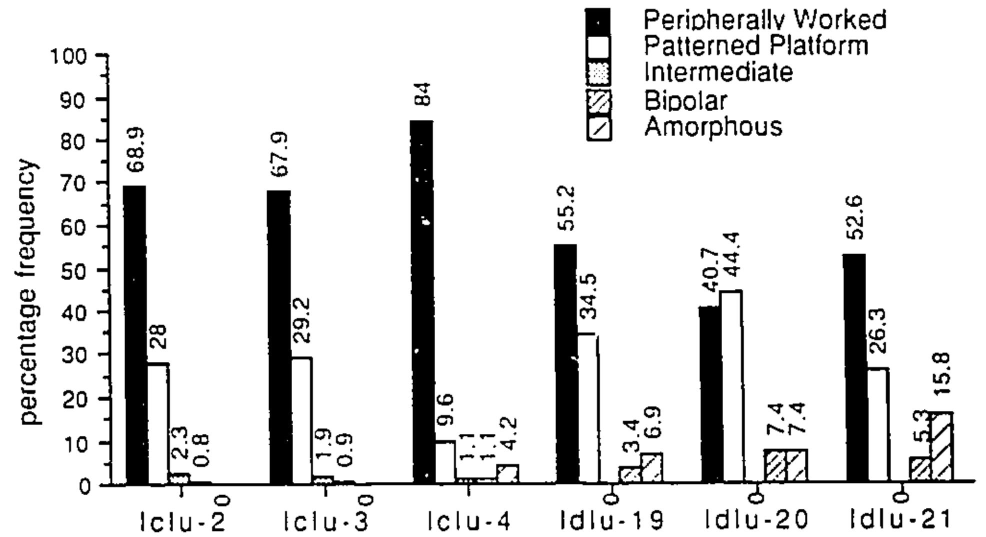
IdIu-21: The distribution of Toth types for IdIu-21 is almost identical to IdIu-20. Chert predominates, comprising 52% of the assemblage. The majority of chert flakes (75%) are of type IV-VI, and so are the majority of quartz flakes (69%). Only for volcanic material is the trend somewhat reversed, as 59% of volcanic flakes are of type I-III. Granting that volcanic materials make up just 17% of the total flake assemblage, their Toth type distribution is comparable with that observed for quartz from IcIu-2, and for quartzite from IcIu-3. With the more southern sites being located much closer to the Poroto Ridge, the appearance of volcanics at IdIu-21, in a form indicating a greater occurrence of initial core reduction, implies that these materials were anything but exotic.

4.8. Distribution of selected core types and raw material types

Respective frequencies for the distribution of peripherally worked and patterned platform cores of chert for two reasons. First, chert was observed to be minimally represented among general artifact categories at both IcIu-2, and IcIu-3, whereas, it was found common for artifact categories at IcIu-4 (see Tables 4.2, 4.3 and 4.4). This difference may indicate change over time and space in raw material preference between these localities. Second, the distribution of chert core types, between IcIu-2 and IcIu-3 on the one hand, and IcIu-4 on the other hand, suggests that clast form may have been quite different and may have originated from two separate depositional regimes.

At an elevation of 1000 m above mean sea level, IcIu-4 is 50 m lower than IcIu-2 (1050 m), and 90 m lower than IcIu-3 (1090 m). These latter two sites, however, are located on the same upper terrace that dips to the north. Data indicate that IcIu-4 may be of a somewhat more recent age, formed at a time when a higher lake level (not necessarily

FIG. 4.16. Distribution of core types for the Songwe River region



Lake Rukwa) was fed by a river system that laid deposits of ash, silts and gravels over a tilting and apparently subsiding Mbeya escarpment, burying the north extension of the eastern terrace system .

Peripherally worked chert cores are not found at Iclu-2, and they represent under 2% of the total core assemblage from Iclu-3. At Iclu-4, however, peripherally worked cores represent one-third of the core assemblage and 82% of all core types made of chert. By comparison, the data for patterned platform cores reveals that although these cores were rather equally distributed between the sites of Iclu-2, Iclu-3 and Iclu-4 (representing roughly 3% of respective core assemblages), 60% of chert cores from Iclu-2, and 100% of chert cores from Iclu-3 are of the patterned platform type, whereas less than 8% of chert cores from Iclu-4 are of this type.

The predominance of patterned platform cores from Iclu-2 and Iclu-3 suggest that a different mode of core reduction may have occurred. To further address this issue the available core data from Idlu-19 was assessed. At Idlu-19 chert is locally available as large blocky nodules. Of the 23 chert cores from Idlu-19, 61% are of the patterned platform variety, with 22% peripherally worked. It would appear that a more successful reduction method of blockier clasts is obtained with a patterned platform technique. By comparison clasts of quartz from IdIu-19 are smaller, and clast form approximates a flattened ovoid. Reduction of these clasts is by peripheral flaking (84%), with 13% reduced by a patterned platform technique.

Further investigation reveals that the extensive production of peripherally worked cores is perhaps a response to a generally smaller and rounder clast of chert nodule available, as these are smaller and more spherical than the nodules found at IdIu-19. The lower frequency of chert found at IcIu-2, and IcIu-3, and the greater percentage of patterned platform cores made of chert at these sites, suggests that original clast form may have been large and blocky (perhaps approximating those found at IdIu-19) more so than those clasts found at IcIu-4. Perhaps there was a different source of chert exploited at IcIu-4 than was unavailable for use at IcIu-2 and IcIu-3. If future attempts to date local sediments reveals IcIu-4 as a more recent depositional event, then perhaps a different chert source had become available since the time that IcIu-2 and IcIu-3 were formed.

At IcIu-4, evidence indicates that chert was selected over other raw materials for specific tool types. For example, circular scrapers are the most common of trimmed pieces from the three northern assemblages. At IcIu-2 and IcIu-3 they are made mainly from flakes of locally available quartz and quartzite, whereas at IcIu-4 they are manufactured from chert and volcanic materials, even though quartz and quartzite are locally abundant.

All observations indicate a similarity of reduction technique and range of tool size, regardless of raw material, and it would appear safe to conclude that access to finer cryptocrystalline material did not directly affect either the type of flake produced, or the general technique of flake manufacture. Thackeray (1989) observes that whereas the Howieson's Poort Industry appears to foreshadows Upper Palaeolithic tool forms, the technique of manufacture was no different than the technique used to produce MSA 1 and MSA 2 assemblages, as well as assemblages of MSA 3, and MSA 4. For the Songwe

River assemblages, raw material type and original clast form appear to have influenced the particular method of core reduction, for example, by the use of a patterned platform versus a peripherally worked technique. However, raw materialk and clast form did not influence the particular type of flakes produced. Chert may have been an exotic raw material at IcIu-2 and IcIu-3, but at IcIu-4 chert was selected over other locally available materials in what would appear to be a selective manner. However, sourcing of chert is needed for this region.

4.9. Flake preparation

In addition to a measure of core reduction intensity, platform faceting was assessed for all trimmed pieces and flakes, in order to observe to what extent, if any, cores were prepared before flake removal. As the majority of cores appear to be heavily reduced (based on observations of minimal remaining cortex coverage), the removal of cortex for the purposes of platform preparation had perhaps taken place with some regularity. The low frequency of trimmed pieces and flake debitage, having cortex covered platforms and/or partial to complete cortex covered dorsal surfaces, i.e., Toth type I, type II, type III and type IV, indicate that many flakes represent the byproducts of core testing (Toth, 1982) and the preparation of platform surfaces.

A characteristic of the disc core and Levallois techniques is the degree of platform preparation and flakes produced by these methods are expected to have a greater propensity for a higher number of platform facets, i.e., more than one or two facets. However, Clark and Kleindienst (1974:91) point out that a wide range of platform faceting: from plain to multi-faceted, is observed for the Kalambo Falls assemblage, to such a degree that little correlation exists between the level of platform faceting and a disc core or Levallois technique being preferred over any other technique of core reduction. Toth (1982:271) notes that even with a very simple process of flake removal, the undulations and ridges that are created by adjacent and overlapping negative flake scars will give a somewhat false indication of intentional platform preparation if these surfaces are used as platforms because the flakes that are removed will exhibit at least two platform facets. Mehlman's (1989) system of classification does not distinguish specific techniques used in the preparation and trimming of tools and whole flakes and so, consequently, no guidelines are provided to help measure this variable, or its value, for Stone Age flake production. Identification of Levallois flakes by Mehlman (1989:151) is minimal, based on a short list of traits: end-struck, oval-shaped, with radial dorsal scarring and little to no retouch.

Clark and Kleindienst (1974) suggest that a more appropriate measure of platform faceting might include a count of the number of platform facets relative to platform length. This was not attempted because the results may be difficult to interpret. For example, a count of four platform facets would certainly imply a more intensive level of platform preparation. However, there are no guidelines to indicate how to interpret a measure of four facets on a platform of 15 mm in length, versus four facets on a platform of 30 mm in length. The two are perhaps indicative of completely different methods of platform preparation and/or core reduction procedures. An arbitrary metrical relationship indicating at what point platform length and the number of platform facets supports either a simple or intensive level of platform preparation is difficult to determine.

Flakes with one or two platform facets are "plain faceted", indicating little to no purposive platform preparation. This category includes flakes produced by the initial stages of core reduction (e.g., Toth type I-III) that have cortex covered platforms. Flakes of type I-III are counted as having a single facet to distinguish them from flakes lacking complete platforms, i.e., Toth type VII. Flakes with three platform facets are "simple faceted", indicating that some intentional platform faceting had perhaps occurred. Flakes having four or more platform facets are categorized as "complex faceted", because platform preparation appears to be an intentional process.

Table 4.8 presents the extent of platform faceting observed for the Songwe River assemblages. Plain platform faceting clearly predominates. The general trend for the Songwe River assemblages is therefore one of casual preparation of cores through a technique of plain platform faceting. Only IcIu-4 differs from this trend with a 3:1 ratio of plain faceting to simple and complex faceting, as compared with an almost 9:1 ratio for the same variables from the other five assemblages and may relate to raw material use.

A measure of platform faceting by raw material demonstrated patterns of flake preparation that may be associated with specific raw materials. Observations indicate a trend for increased platform faceting for materials such as chert and volcanics. Only at IcIu-3 did quartzite outnumber chert for complex faceted flakes. Quartz predominates across all faceting categories, which may be a tribute to its difficult flaking qualities. Faceting of quartz may aid in the control of flake removal, as well as serve to reduce platform collapse, or shatter. By comparison, quartzite is noted to be rarely prepared before flaking and quartzite appears to have been overlooked when very siliceous materials were available.

Observations indicate that for all three sub-regions of the Songwe River area, IcIu-4 dominates with 45.7% of the total sample of simple faceted flakes and 71.4% of the total sample of complex faceted flakes. These figures indicate that a high degree of platform preparation had occurred at this site. IcIu-2, IcIu-3 and IdIu-19 dominate the plain faceted

Table 4.8. Platform faceting by site

Faceting	Iclu-2	Iclu-3	Iclu-4	Idlu-19	Idlu-20	Idlu-21	Totals	%
Plain (1-2)	n=206 R=21.0 C=90.4	n=222 R=22.3 C=92.1	n=205 R=20.6 C=61.6	n=158 R=15.9 C=89.3	n=95 R=9.5 C=81.2	n=109 R=11.0 C=85.8	n=995	81.4%
Simple (3)	n=21 R=16.1 C=9.2	n=14 R=10.8 C=5.8	n=58 R=44.6 C=17.6	n=12 R=9.2 C=6.8	n=12 R=9.2 C=10.3	n=13 R=10.0 C=10.2	n=130	10.6%
Complex (≥4)	n=1 R=1.0 C=0.4	n=5 R=5.1 C=2.1	n=70 R=72.4 C=21.0	n=7 R=7.1 C=4.0	n=10 R=10.2 C=8.5	n=5 R=5.1 C=4.0	n=98	8.0%
	n=228	n=241	n=335	n=177	n=117	n=127	N=1223	100%

R = Row frequency; C = Column frequency

category for quartz and quartzite, and this may relate to the type of peripheral core reduction that these materials have undergone.

On the basis of the data presented by Table 4.8, the majority of flakes exhibit plain platform faceting. The high occurrence of this pattern is perhaps due to the removal of large preparatory flakes from core surfaces that gives an appearance of plain faceting, suggested by Toth (1982). Perhaps the ridge created by adjacent flake scar margins was intentional, as well as the production of a clean and flatter striking surface. Flake scar ridges serve to channel the energy from a percussion impact and provide some control over flake removal (Hellweg, 1984:34) by reducing the potential for flake shatter, or hinge and step fracturing.

The impression given by these data, is one of cores having been carefully prepared for both immediate, extended and, perhaps, future flaking events. In effect, this pattern demonstrates what may be a level of planning for flake removal. Perhaps preferred raw material types, such as chert, were not readily available in the Songwe River region in easy to manipulate forms (i.e., appropriate clast size or shape for hand held percussion). Other materials, such as quartz and quartzite, seemingly so abundant in the region, were not selected, hence the high frequency of chert used at IcIu-4. When chert was available, in an in easy to manipulate form, it appears to have been carefully prepared in order to obtain the maximum number of flakes from a core.

An overall appearance of casual core reduction is perhaps the byproduct of a unique method of flake preparation where facet ridges may have been intentionally produced to provide a flatter area for the impact of flake removal blows. Simple faceted, or complex faceted, platform preparation is perhaps one outcome of hard hammer percussion technique. All evidence from the Songwe River area suggests that hand held hard hammer percussion was the predominant method of flake removal from cores as indicated by broader flake platforms and thick flakes (Clark and Kleindienst, 1974:86).

The preceding observations led to the development of a core reduction model that is presented in Chapter 5. The model documents the hypothetical life history of a specific class of peripherally worked cores and suggests that these were influenced by raw material type and clast shape.

Chapter Five

A Hypothetical Core Reduction Model for MSA Assemblages of the Songwe River Region

5.1. Introduction

This chapter presents a hypothetical core reduction model based on the Songwe River data. For the two most frequently observed core types, peripherally worked and patterned platform, the evidence indicates that final core forms are the consequence of initial nodule shape as this shape influences or determines the reduction process of flake manufacture. The data also indicates that within the category of peripherally worked cores, specific types of raw material were differentially reduced.

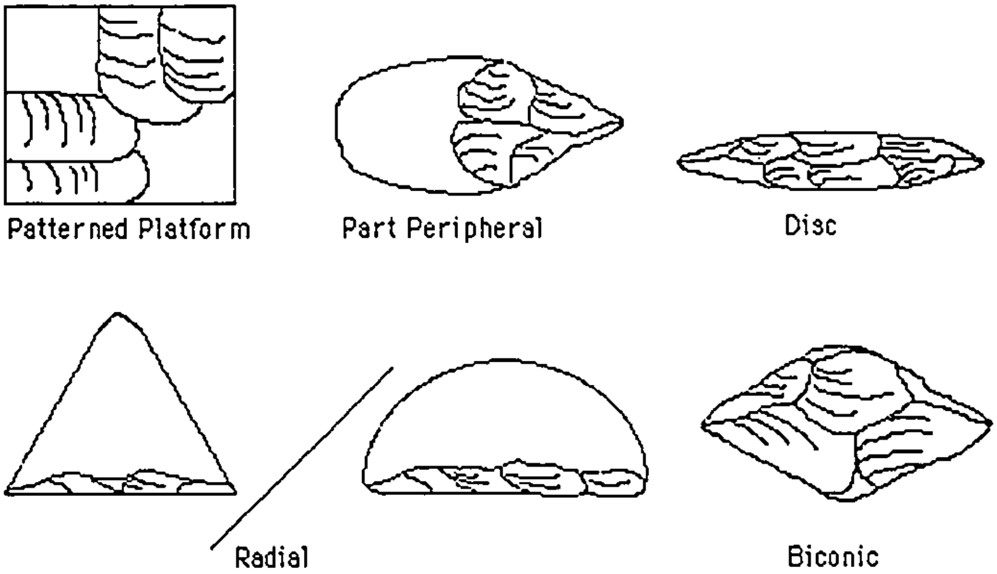
An understanding that raw material form may influence the process of core reduction is not new (see Goodwin, 1928:45; Van Riet Lowe, 1945:56). Early analyses present this topic as of marginal interest to typological classification (Clark *et al.*, 1970; Clark and Kleindienst, 1974; Merrick, 1975; Mehlman, 1989). For example, Clark and Kleindienst (1974:92) suggest that Levallois cores are part of a broad continuum of peripherally worked cores that grade into radial and discoidal core types upon becoming too small for the removal of Levallois flakes. More recently, Clark (1988) describes nodule form as placing limitations on basic core reduction procedures, and that these procedures may account for the many similarities seen between the flake tool component of both ESA and MSA industries. Variation of core morphology is undoubtedly the consequence of decision making processes and that these are dictated, perhaps, by situational needs and the flexibility to accomodate available raw materials. An analysis of core variability with respect to initial nodule form and raw material type has yet to be applied to East African MSA assemblages.

5.2. Working definitions of core types

The following working definitions of core types are from Mehlman (1989) (FIG. 5.1.). For clarification, terms used by Clark and Kleindienst (1974) are also given. Patterned platform cores range in planform from sub-rectangular to sub-cuboid with platform surfaces and adjacent flake release surfaces approximating a 90° angle. Further subtyping of this core type is based on the number and direction of flake removal scars (Mehlman, 1989:142). Peripherally worked cores are identified by a pattern of bifacial flake removal from a natural perimeter or equator. There are four types (i) Levallois, (ii) part-peripheral, (iii) disc core, and (iv) radial/biconic, identified by the degree of peripheral flaking and general cross section (Mehlman, 1989:141-142). Part-peripheral cores exhibit a similar morphology as core choppers, but without evidence of edge battering or crushing. These particular cores are unifacially or bifacially flaked along one-third to one-half of their circumference. Clark and Kleindienst (1974) describe part-peripheral cores as "proto-biconical" because they believe that they may represent incomplete disc or biconical cores. Disc cores have a thin lenticular cross-section and are bifacially reduced about their entire circumference. If extremely thin, disc cores are classified as "bifacially modified discoids" under the category of trimmed pieces (Mehlman, 1989: 142).

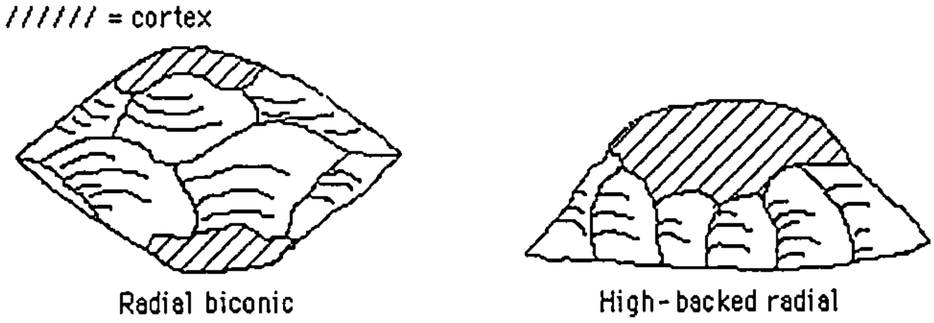
Radial/biconic cores are flaked about their entire circumference and there is a clear distinction between "radial" and "biconic" types. Radial cores are triangular to "dome-shaped" with one distinctively flat flake release surface. They are called "high-backed radial cores" by Clark and Kleindienst (1974:92). Larger examples are thought to be "un-struck" Levallois cores, whereas smaller examples are thought to be exhausted Levallois cores. Biconic cores are diamond shaped in cross-section with a bifacially flaked circumference.

FIG. 5.1. General side view of patterned platform and peripherally worked cores



For clarification, radial/biconic cores will be listed here as representing two distinct core types because of their apparently unique life-histories. From this point on radial cores will be referred to as "high-backed radial" cores and biconic cores will be referred to as "radial biconic" cores as per Clark and Kleindienst (1974) (FIG. 5.2.).

FIG. 5.2. Side view of radial biconic and high-backed radial cores



5.3. Observations

An analysis of Songwe River patterned platform cores reveals that adjacent flake release surfaces approximate an intersecting angle of >70° to <120°, 97.5% of the time. Flakes removed have a corresponding range of platform angles of >60° to <110° with a modal value of 90°. Logically then, trimmed pieces and flake debitage with a platform angle of greater than 110° may not have been struck from patterned platform cores. An analysis of peripherally worked cores indicates, however, that the angle formed by adjacent flake release surfaces approximates 70° or less, 84.2% of the time; meaning that trimmed pieces and flake debitage with a platform angle of 110° or greater were probably removed from peripherally worked cores (FIG. 5.3.). On the basis of these observations, a point of core discard can be postulated for peripherally worked cores. With just one flake observed with a platform angle of greater than 130°, the discard of peripherally worked cores may have occurred as flakes began exhibiting a platform angle approaching 130° (corresponding with an adjacent flake release surface angle of 50° to <70°). For radial biconic cores, the number of flakes potentially removeable is limited by three important factors, (i) core thickness, (ii) core circumference, and (iii) how quickly adjacent platform surfaces begin to intersect at an angle of 50° to 70°. In other words, how long the core can maintain the production of flakes with a platform angle of less than 120°.

Toth type frequencies indicate that flake types I-III are somewhat under-represented for the Songwe River assemblages. As discussed earlier, flake types I and II are believed to indicate an initial stage of cortex removal and unifacial core reduction. Unifacially flaked cores can be expected to produce at least one type I flake and perhaps several type II flakes in an overlapping fashion (FIG. 5.4.), hence, the high expected frequency of type II flakes from Nick Toth's replicated assemblage. During the initial process of bifacial core reduction the first flake struck would be of type IV, followed in overlapping fashion by several type V flakes (FIG. 5.5.), accounting perhaps, for the low

FIG. 5.3. A comparison of adjacent flake release angles for core types

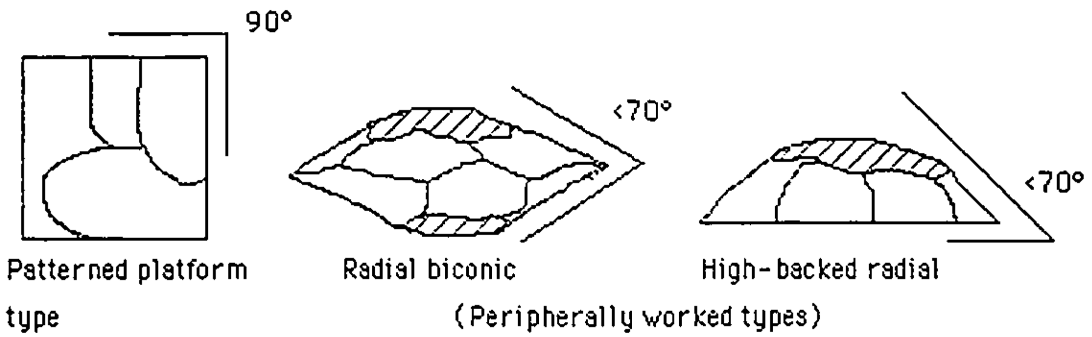


FIG. 5.4. Production of Toth type I and type II flakes

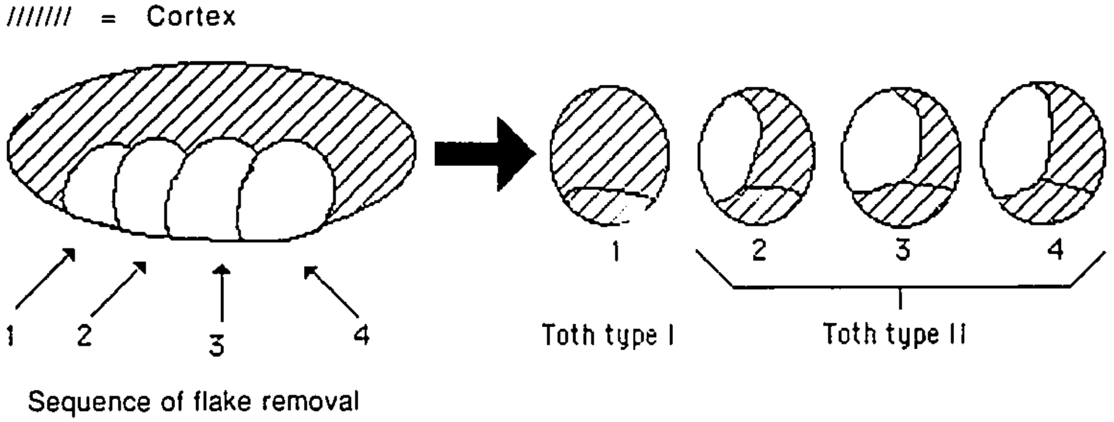
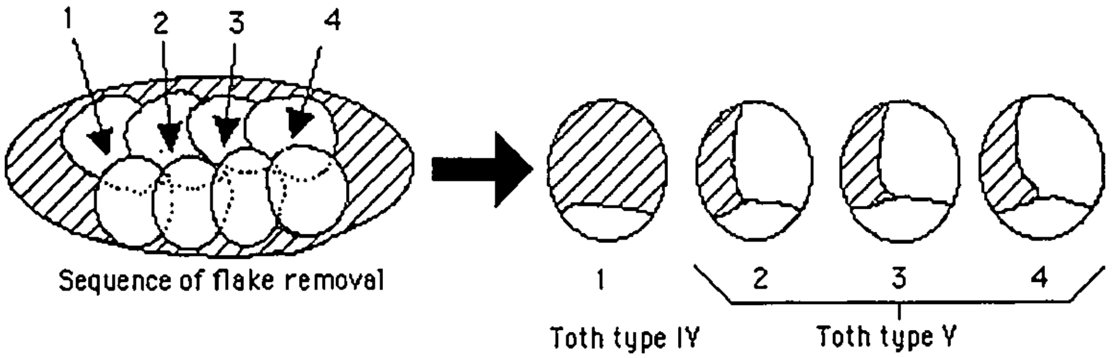


FIG. 5.5. Production of Toth type IV and type V flakes

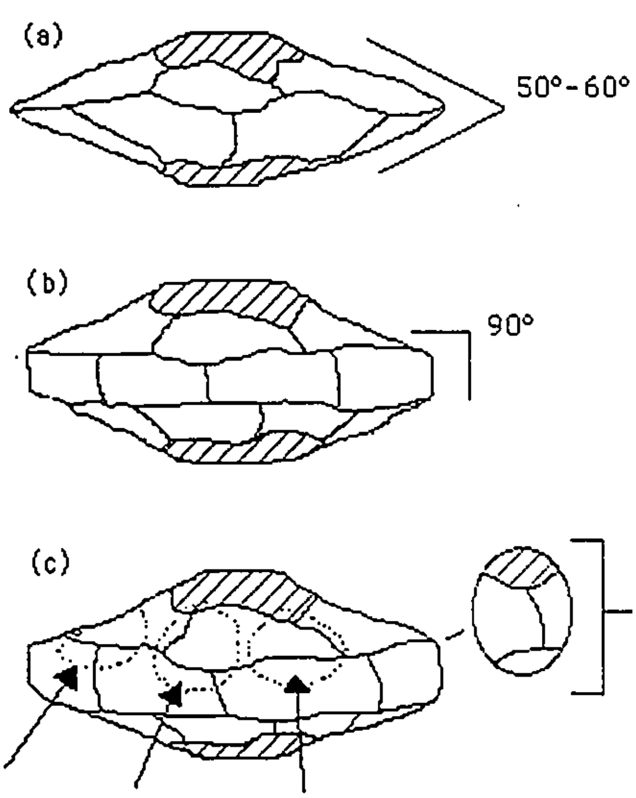


expected frequency of type IV flakes and the high expected frequency of type V flakes observed. Data indicate that it is type V and type VI flakes that are the most abundant, with type V flakes comprising 28.6%, and type VI flakes comprising 40.1% of all trimmed pieces. As type VI flakes do not exhibit cortex material they are struck after cortex is removed and as well, after the core has been bifacially reduced. This means that a peripherally worked core will only be able to produce a limited quantity of type VI flakes before exhaustion and discard (bearing in mind attributes such as core thickness, core circumference and propensity to produce flakes with a platform angle of less than 120°). On this basis, the use-life of a radial biconic core is inferred to be rather short.

To re-prepare the platform surfaces of a radial biconic core, preparatory flaking would have had to have been done in such a manner that the core edge was obliquely sheared off to achieve a 90° angle (FIG. 5.6.). This is a difficult procedure since a misplaced blow will only remove a flake with an extreme platform angle of greater than 120°. If the edges are successfully sheared off, then the core's circumference will be greatly reduced resulting in the removal of flakes that fall short of the modal length range of 20 mm to 50 mm (see FIG. 4.4.a.). As well, these shorter flakes will have a greater chance of including cortex on their distal dorsal surface due to the cortex that remains on the polar surfaces of the radial biconic core.

The majority of peripherally worked cores from Iciu-2, IcIu-3 and IdIu-19 are made from quartz and quartzite pebbles and small cobbles, however, many exhibit only partial bifacial flaking (parti-bifacial) and are classified as "part-peripheral" cores. Of those analyzed, several exhibit extensive battering and crushing on their flaked margins and these are listed as choppers under the category of heavy duty tools (Mehlman, 1989:139). Either these were intentionally produced as choppers or they became choppers subsequent to a limited use-life as cores. Interestingly, the majority of these choppers are oblong in planform, and it appears that the knapper had taken advantage of the nodule's thinner edge

FIG. 5.6. Possible pattern of radial biconic core re-preparation



(a) Core unsuitable for further flake removal due to flake platform angles approaching 130°.

(b) Hypothetical procedure for re-preparation of platform to approximate 90°. Circumference of the core is reduced.

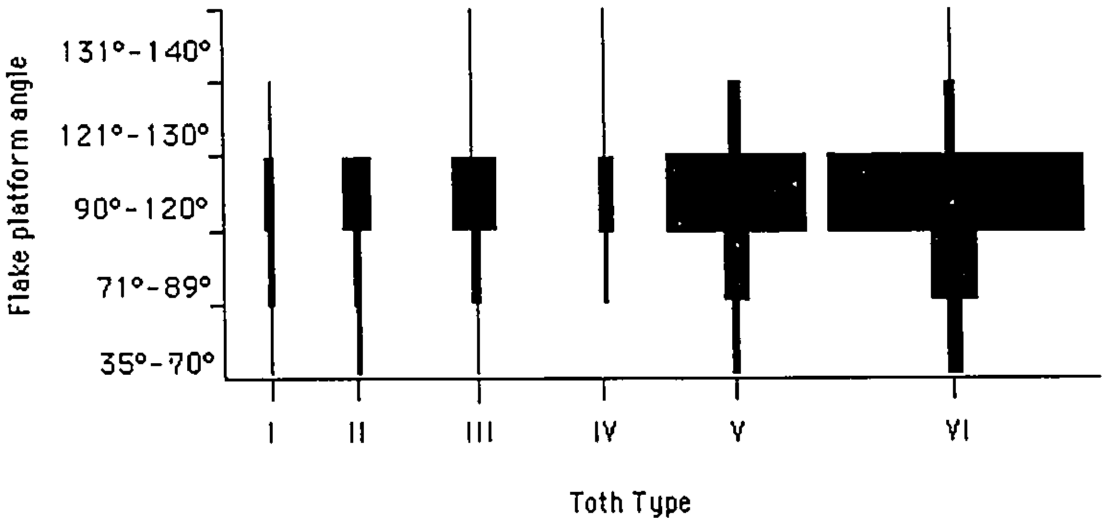
(c) Flakes removed will be shorter than a modal length of 20 - 50mm, and will have cortex on their dorsal distal end.

to achieve part-peripheral and parti-bifacial flaking, thus leaving the more spherical portion unstruck to serve as a handle.

Based on observation, the use-life of part-peripheral and radial biconic cores is short because once cortex bearing flakes (Toth types I, II, IV and V) are struck, there appears to be little opportunity for the knapper to remove many type VI flakes before adjacent flake release surfaces intersect at roughly 60° to produce flakes with a platform angle of about 120°. The rare occurrence of type VI flakes with a platform angle of greater than 120° (seven from Iclu-4 and one from Idlu-19) indicates that some knappers may have attempted to maximize flake removal before core discard.

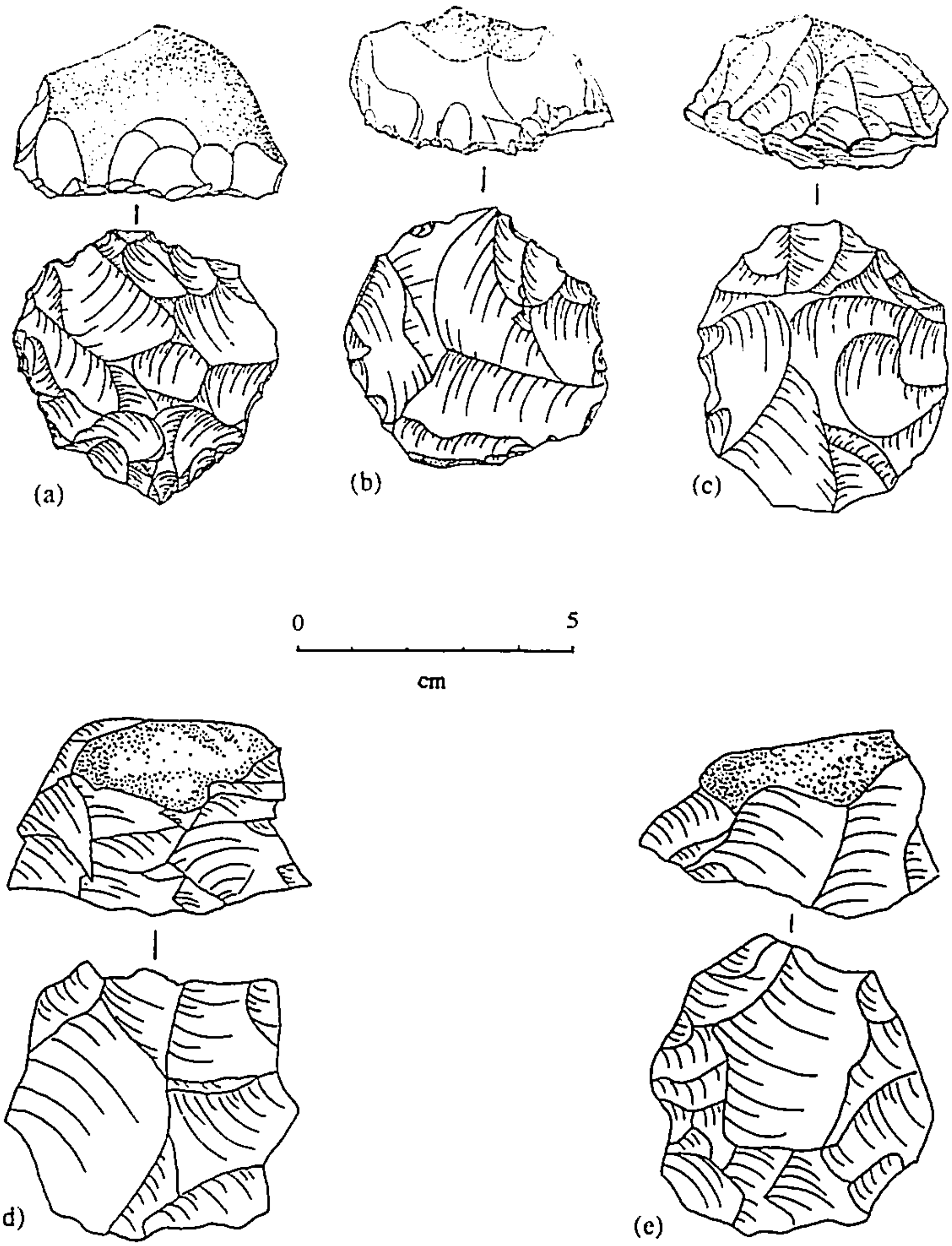
Figure 5.7 represents the combined distribution of Toth type by flake platform angle for the sites of Iclu-4 and Idlu-19. The pattern indicates that there are more type VI flakes than can be adequately accounted for by the reduction of part-peripheral and radial biconic cores, and perhaps it is high-backed radial cores that account for their abundance.

FIG. 5.7. Combined distribution of Toth type by flake platform angle for IcIu-4 and IdIu-19 (line width equals two cases with uneven figures rounded up)



High-backed radial cores are the next most frequent ly observed type of peripherally worked core in the Songwe River region. They differ from part-peripheral and radial biconic cores by having one shallow-convex, flat, or shallow-concave flake removal surface and an opposed cortex bearing surface that is high-backed or domed (FIG. 5.8.). Data show that high-backed radial cores are made from chert moreso than they are made from quartz or quartzite and that original nodule shape appears to have determined the reduction process. For example, chert from IdIu-19 is reduced by a patterned platform method due to the nodules being large and blocky that does not lend itself to peripheral flaking. At IcIu-4, chert is not reduced by the patterned platform method, nor is it reduced in the same manner as quartz and quartzite. As well, there is no evidence from any of the Songwe River assemblages to indicate that chert was reduced by the part-peripheral or

FIG. 5.8. High-backed radial cores: all examples are from IcIu-4



All examples are made of chert, except (c) which is made of quartz.

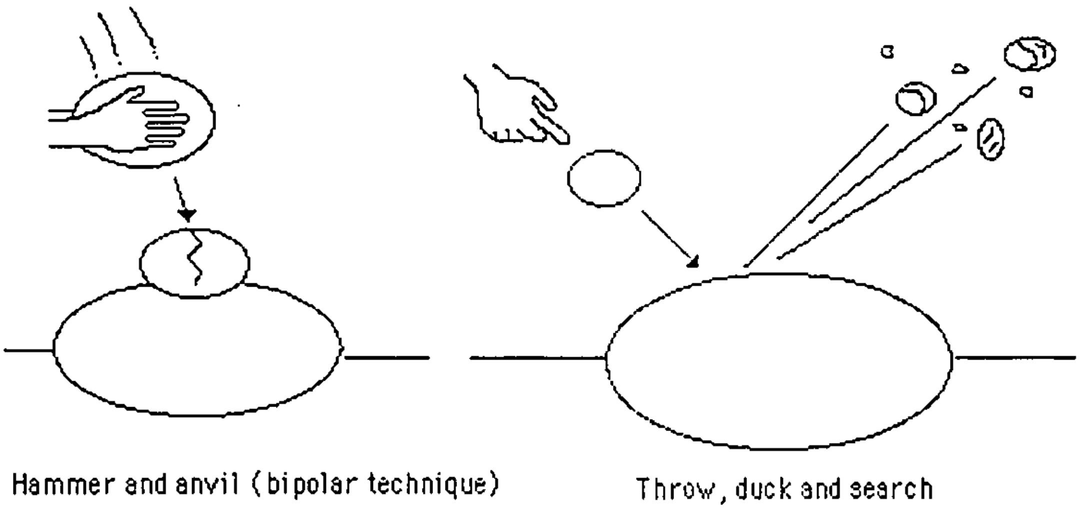
radial biconic method and for all sites but IdIu-19, chert is reduced by the high-backed radial method.

Further assessment of high-backed radial cores reveals a pattern similar to the one seen for part-peripheral and radial biconic cores; that is that discard may have occurred when adjacent platform surfaces and flake release surfaces intersect at an angle of 60° to 70°. It would seem that although a different process of core reduction (high-backed radial versus radial biconic) was used to reduce raw materials of a specific nodule shape, a consistent pattern of flake platform angle and core exhaustion was maintained. If a behavioural inference can be drawn from this data it is that raw material type and raw material form are influencial on core reduction procedures. High-backed radial cores also show evidence for platform preparation, which is a characteristic not easily recognized for part-peripheral and radial biconic cores. Platform preparation apparently serves to remove the outer cortex while providing an oblique striking platform. Facet ridges may have served to channel the energy of percussive blows thus making flake removal a more predictable venture (Hellweg, 1984).

Observations indicate that clast form is a determinant of core reduction patterns; i.e., peripherally worked cores versus patterned platform cores. Pebbles and cobbles with a natural perimeter appear amenable to peripheral flaking, whereas blockier examples are amenable to reduction by a patterned platform technique. With this information, three questions are generated: first, what is the reduction process of peripherally worked cores? Second, how does this process differ for high-backed radial and radial biconic core types, bearing in mind that the point of core exhaustion appears quite consistent? Third, is there a visible pattern that will offer information as to why cores may have been reduced in the ways that they were?

Since chert is not found as whole nodules, except from IdIu-19, it is impossible to directly determine its form at IcIu-4. However, on the basis of the curvature of the cortex bearing dome on high-backed radial cores found at IcIu-4, an original form may have been spherical. To determine an initial flaking procedure that will reduce a spherical nodule into a high-backed radial core an analysis of general morphology indicates that spherical nodules may have been split in half. This procedure would require some form of bipolar reduction, either by using a hammer and anvil technique or by the throwing of nodules against a larger anvil stone (FIG. 5.9.). Analysis of flakes and cores revealed little evidence suggesting that bipolar reduction was a preferred method, even though it would appear to be the most efficient.

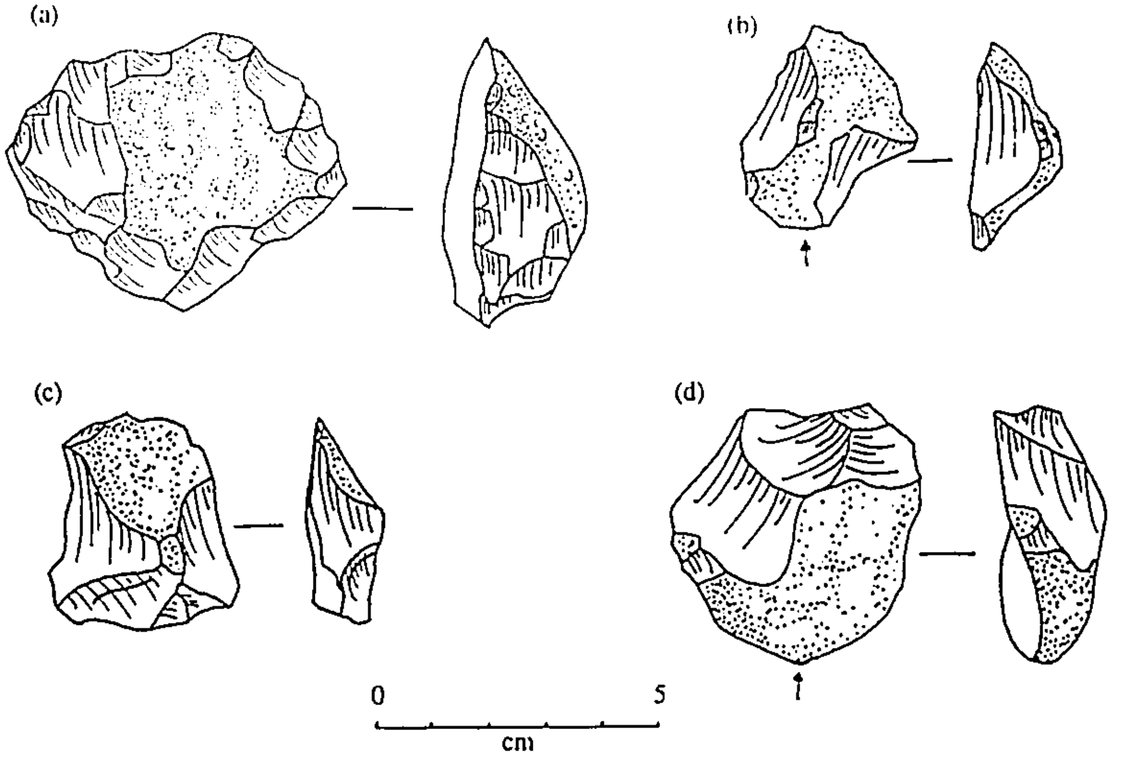
FIG. 5.9. Potential technique for the initial shaping of spherical clasts



Several chert flakes are noted to have similar longitudinal and lateral cross-sections. These flakes are quite thick across their medial portion and approximate a high-backed or domed appearance. Dorsal surfaces have cortex and the remnants of negative flake removal scars (FIG. 5.10.). The data suggests, that these flakes were removed from a spherical clast (FIG. 5.11.). During field sorting of artifacts, Mehlman (1989:149) classified flakes of this variety as "core fragments" because of their retaining cortex material and negative flake removal scars. He later suggests that they are "core rejuvenation" or "core redirection" flakes and deserve their own sub-typing under "specialized flakes", because they appear to have been struck from radially prepared cores to establish a clean and flat flake release surface (perhaps by the removal of a high-backed end). If flake production is to ensue about the core's periphery, then the flakes removed would be of Toth type IV and, as indicated earlier, these flakes are one of the rarest observed.

FIG. 5.10. Alternative evidence for initial high-backed radial core reduction.

Artifacts (a), (b), (c) are from IcIu-4 and are made of chert. Artifact (d) is from IdIu-19 and is made of quartz



Apparently, the removal of flakes from a radial high-backed core did not occur until a striking platform was prepared transverse to the flake release surface (FIG. 5.12.) that may have served three purposes. First, platform preparation will remove cortex. Second, platform preparation will alter the core's arc of circumference so that flatter striking platforms are produced. As well, flake scar ridges will provide purchase for percussive flake removal blows (FIG. 5.13). Third, platform preparation will provide a striking

FIG. 5.11. Proposed initial reduction of spherical clasts, based on observed evidence for high-backed, cortex bearing flakes (c), and lack of evidence for bi-polar technique.

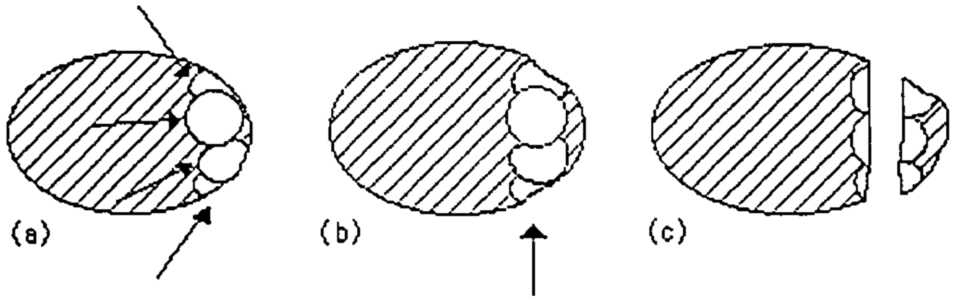


FIG. 5.12. Proposed preparation of platform transverse to flake release surface

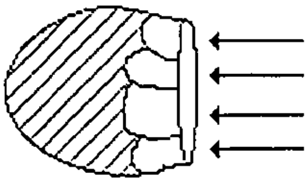
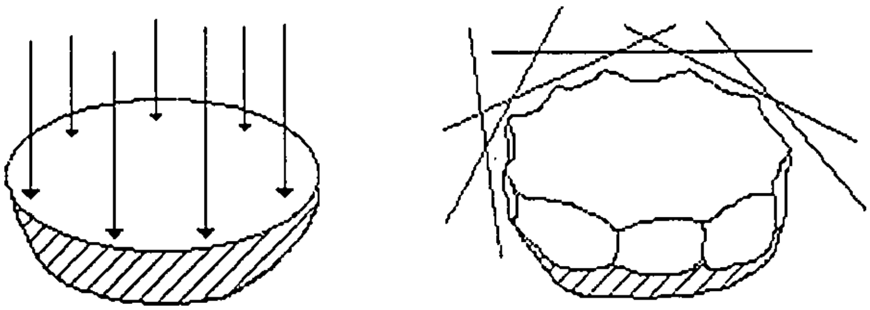
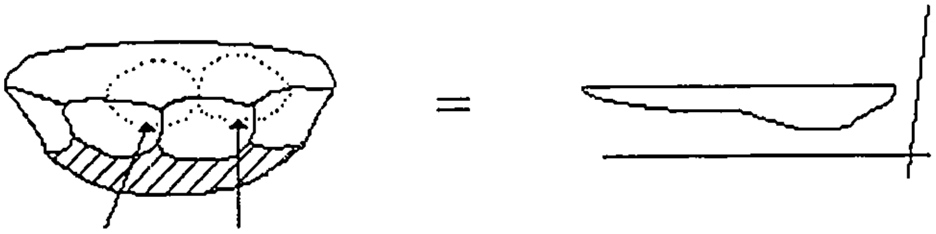


FIG. 5.13. Proposed reduction of core circumference in order to provide a flatter striking surface for flake removal



(a) Before flake removal showing impact points

(b) After flake removal



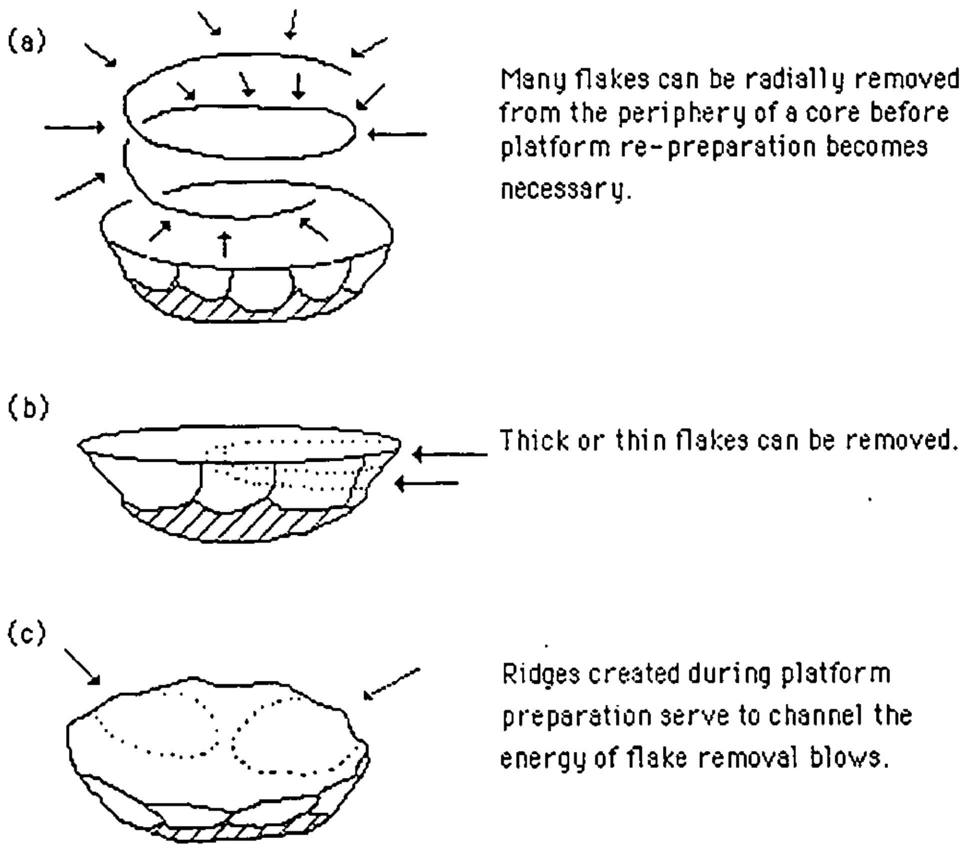
(c) Flake removal blows directed along flake scar ridges

Flake platform angle approximates 90° (flake profile) surface for the removal of flakes with a modal platform angle range of 90° to 120°.

During analysis of platform faceting, a majority of trimmed pieces and flake debitage are plain faceted and exhibit one or two platform facets. However, there are flakes with simple faceting (3 facets) and complex faceting (4 or more facets) that suggest that some form of intentional platform preparation had been occurring. Perhaps, platform preparatory flaking was done to maximize the removal of cortex transverse to the flake release surface. If so, then this procedure would have augmented the three conditions of platform preparation that are listed above by introducing the element of time as a variable. For example, the removal of cortex transverse to the flake release surface will reduce the need for re-preparation of the striking platform, perhaps after the removal of several flakes. A larger platform surface would have offered the knapper the freedom to remove thick or thin flakes as required (FIG. 5.14.).

If high-backed radial cores are the consequence of the reduction procedure that is proposed then perhaps the number of type VI flakes that could have been produced with a platform angle range of 90° to 120° was greater than if a radial biconic core reduction technique was applied. In effect, the production of high-backed radial cores may have served to maximize the number of flaking events, and increased core use-life of selected raw materials. Naturally, as flakes are repeatedly removed from about a high-backed radial core it will become thinner. If there is a second or third sequence of platform preparation then cores may have become too thin for hand-held percussion. Data indicate, however, that it is the angle formed between an adjacent flake release surface and platform surface that determines high-backed radial core discard and for radial biconic cores, discard is determined by adjacent flake release angles as well as core thickness and core circumference. Platform preparation of high-backed radial cores must affect the adjacent angle. For thin examples, the angle formed by adjacent flake release surfaces approaches 50° to 70°. Discard may follow since flakes will have a non-modal platform angle of greater than 120° (FIG. 5.15.). Discard of both radial biconic cores (part-peripheral and peripheral types) and high-backed radial cores occurred at the same point.

FIG. 5.14. Proposed value of a larger platform surface

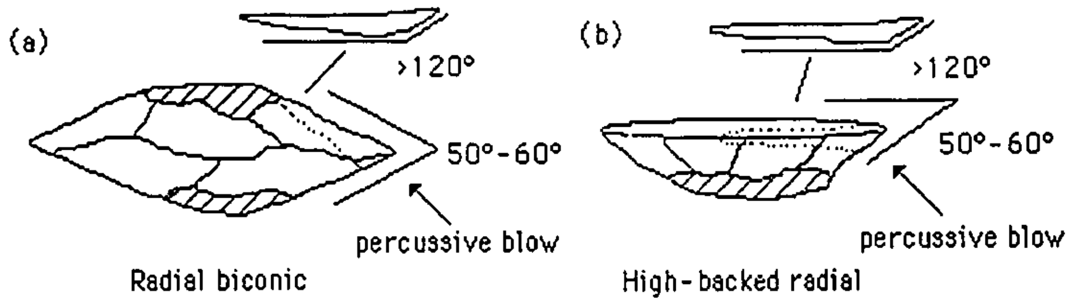


Many flakes can be radially removed from the periphery of a core before platform re-preparation becomes necessary.

Thick or thin flakes can be removed.

Ridges created during platform preparation serve to channel the energy of flake removal blows.

FIG. 5.15. Proposed point of core discard as angle between adjacent surfaces decreases to produce flakes with a non-modal platform angle



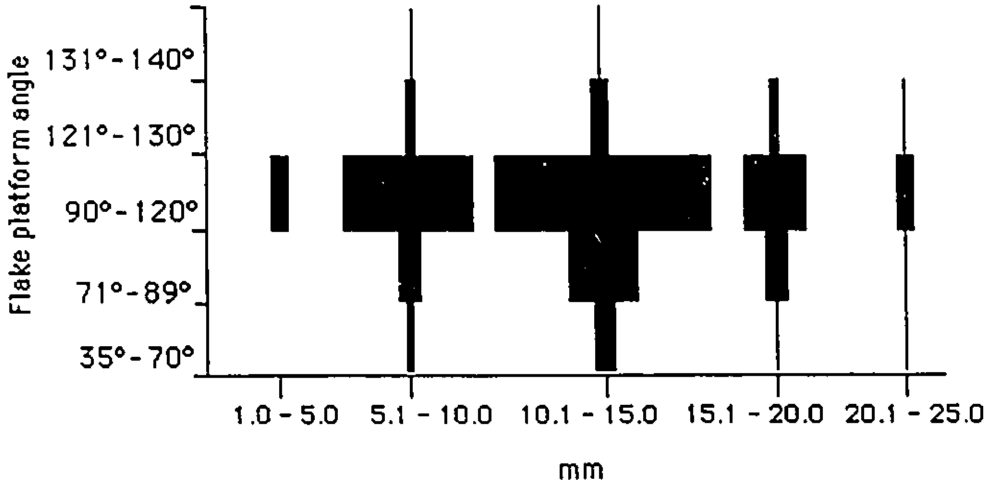
Radial biconic

High-backed radial

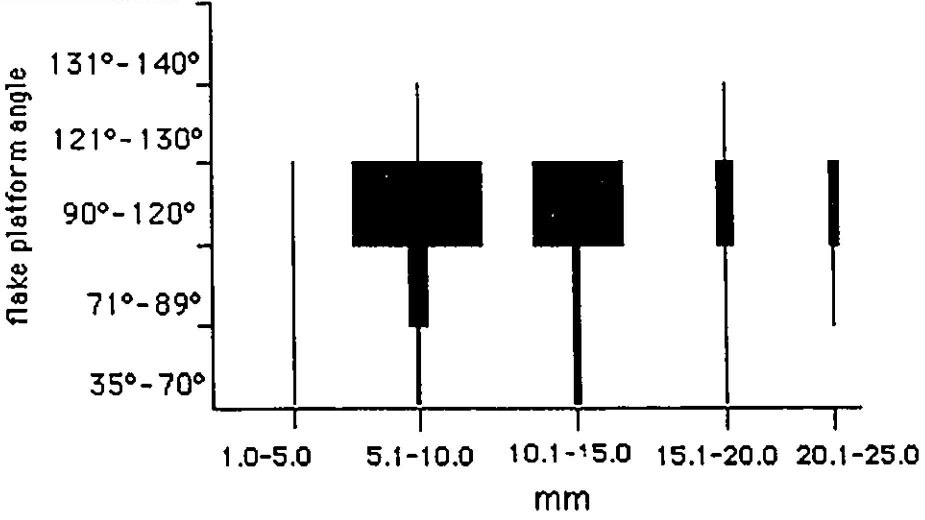
Figures 5.16.a and b, demonstrate the comparative distribution of flake platform angle and flake thickness for trimmed pieces and flake debitage from IcIu-4 and IdIu-19. The figures indicate that flake thickness can not be completely ruled out as having some influence on the point of core discard. At IcIu-4, the majority of flakes fall within the category of 10.1 mm to 15.0 mm in thickness, indicating the importance of this size range.

FIG.5.16 a and b. Generalized distribution of flake platform angles and flake thickness in mm for IcIu-4 and IdIu-19 (single line weight represents two cases and uneven values are rounded up).

(a) **IcIu-4**



(b) **IdIu-19**



Numbers fall of rapidly for both thinner and thicker categories of flakes, although the data does suggest that thinner flakes (1.0 mm to 10.0 mm) were struck with greater frequency for the 90° to 120° platform angle category. This pattern indicates that during the process of flake removal, gradually thinning cores may have forced knappers to adjust by striking correspondingly thinner flakes until flake removal by hand-held hard hammer percussion became too difficult. For IcIu-4, it would appear that the 5.0 mm to 10.0 mm range was an acceptable limit for flake thickness. As there are no flakes from IcIu-4 and IdIu-19 with a platform angle of greater than 120° representing the thinnest flake category (1.0 mm to 5.0 mm), core discard may have occurred just after flake thickness fell below 5.1 mm. A similar pattern is observed for IdIu-19.

5.4. Further observation and inferrence of the use-life of peripherally worked cores

Comparative analysis of peripherally worked cores and platform angles of trimmed pieces and flaked debitage from IcIu-4 and IdIu-19, suggests an extended use-life for some radial biconic and high-backed radial cores. First, the range and distribution frequencies for flake platform angles are contrasted (FIG. 5.17.). According to the distribution, the majority of platform angles fall within an expected range of 90° to 120°, 73.7% of the time, at IcIu-4, and 77.3% of the time, at IdIu-19. The next most frequent category is 71° to 89° with 17.0% at IcIu-4, and 12.5% at IdIu-19. At IcIu-4, 6.6% of the flakes measured had a platform angle greater than 121° (5.7% for the 121° to 130° range and 0.9% for the 131° to 140° range). A similar pattern was not observed at IdIu-19, where less than 2% of flakes had a platform angle of greater than 121°, falling within the 121° to 130° range.

As expected, the majority of adjacent flake release surface angles on peripherally worked cores would demonstrate an angle of 60° to 110° (with a maximum outside range of 50° to 59°). This corresponds with flakes having a platform angle of between 70° and 120°, with a maximum of 121° to 130° (Table 5.1. a and b). Indeed, this is the case for 74.5% of the cores from Iclu-4, and 71.2% of the cores from Idlu-19. What is curious, is the fact that 25.5% of cores from Iclu-4, and 28.8% of cores from Idlu-19, have adjacent platform angles of 30° to 60°, translating into flakes with a platform angle of 131° to 150° (FIG. 5.18.). As stated previously, less than one percent of the flakes from Iclu-4 fall within this range, and none were observed from Idlu-19. Clearly, there is some discrepancy as there appears to be fewer flakes with a platform angle of 120° to 150° than is indicated by the high frequency of cores with adjacent flake release angles of 30° to 60°. On the basis of an earlier analysis of flake platform angle, the maximum range selected for was 120° to 130°.

FIG. 5.17. Frequency distribution for platform angles on trimmed pieces and flake debitage from Iclu-4 and Idlu-19. (values indicate percent frequency).

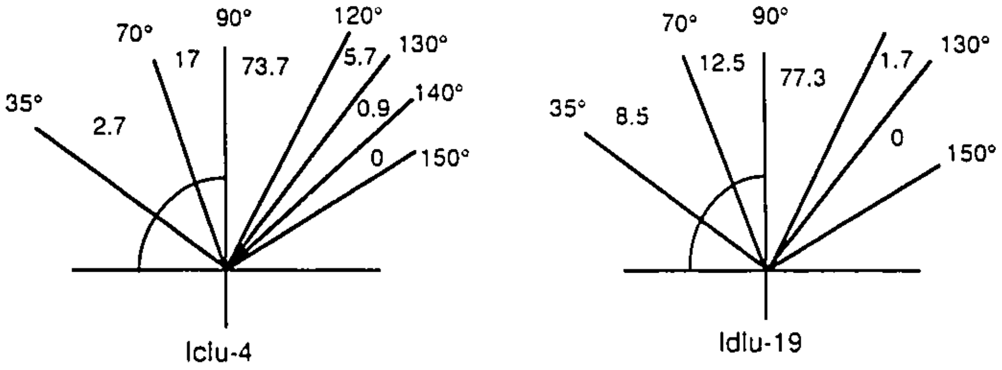


Table 5.1.a. Iclu-4: Mean adjacent platform angle by raw material for peripherally worked cores

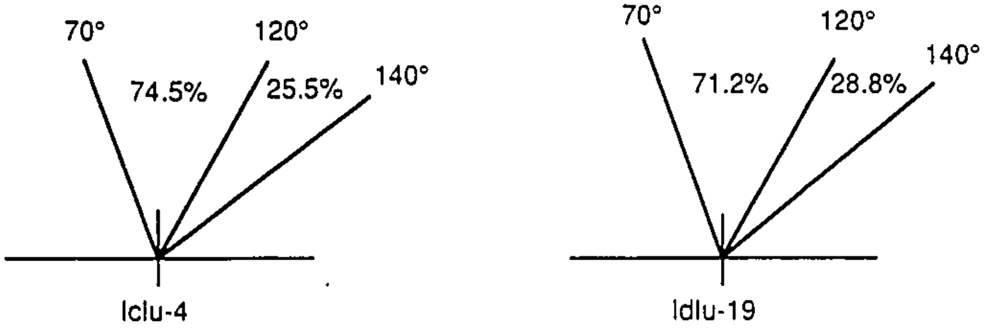
Raw Material								
adjpltang	Quartz	Quartzite	Chert	Volcanic	Oth Met.	Oth Sed.	Total	
60°-110°	27	1	24	0	5	2	59	74.5%
50°-59°	5	1	4	1	2	0	13	16.5%
40°-49°	2	0	2	0	1	0	5	6.3%
<39°	0	1	1	0	0	0	2	2.5%
Total	34	3	31	1	8	2	79	
	43.0%	3.8%	39.2%	1.2%	10.1%	2.5%		100%

Table 5.1.b. IdIu-19: Mean adjacent platform angle by raw material for peripherally worked cores

	Raw material				
adjpltang	Quartz	Chert	Volcanic	n	
60°-110°	22	1	0	23	71.3%
50°-59°	2	2	1	5	15.6%
40°-49°	2	2	0	4	13.2%
<39°	0	0	0	0	
Total	26	5	1	N= 32	
	81.3%	15.6%	3.1%		100%

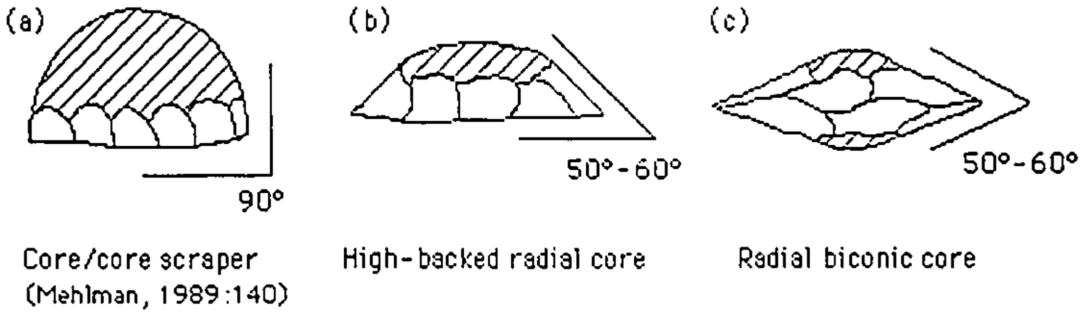
The question, then is, why is there such a discrepancy between the core and flake data and where did the majority of flakes with platform angles of greater than 120° go, since they were not found among the categories of trimmed pieces or flake debitage collected from site surfaces? The sampling process should have aquired some of these flakes if their on-site occurrence was as high as the core data suggest. Frequencies of 6.6% for IcIu-4, and 1.7% for IdIu-19, appear to under-represent these flakes (FIG. 5.17.) and their low occurrence within the assemblages is perhaps a consequence of sampling vagaries or, perhaps, exhausted cores had been further reduced at a location not in direct association with where cores or flakes were recovered.

FIG. 5.18. Adjacent platform core angles translated into corresponding flake platform angles



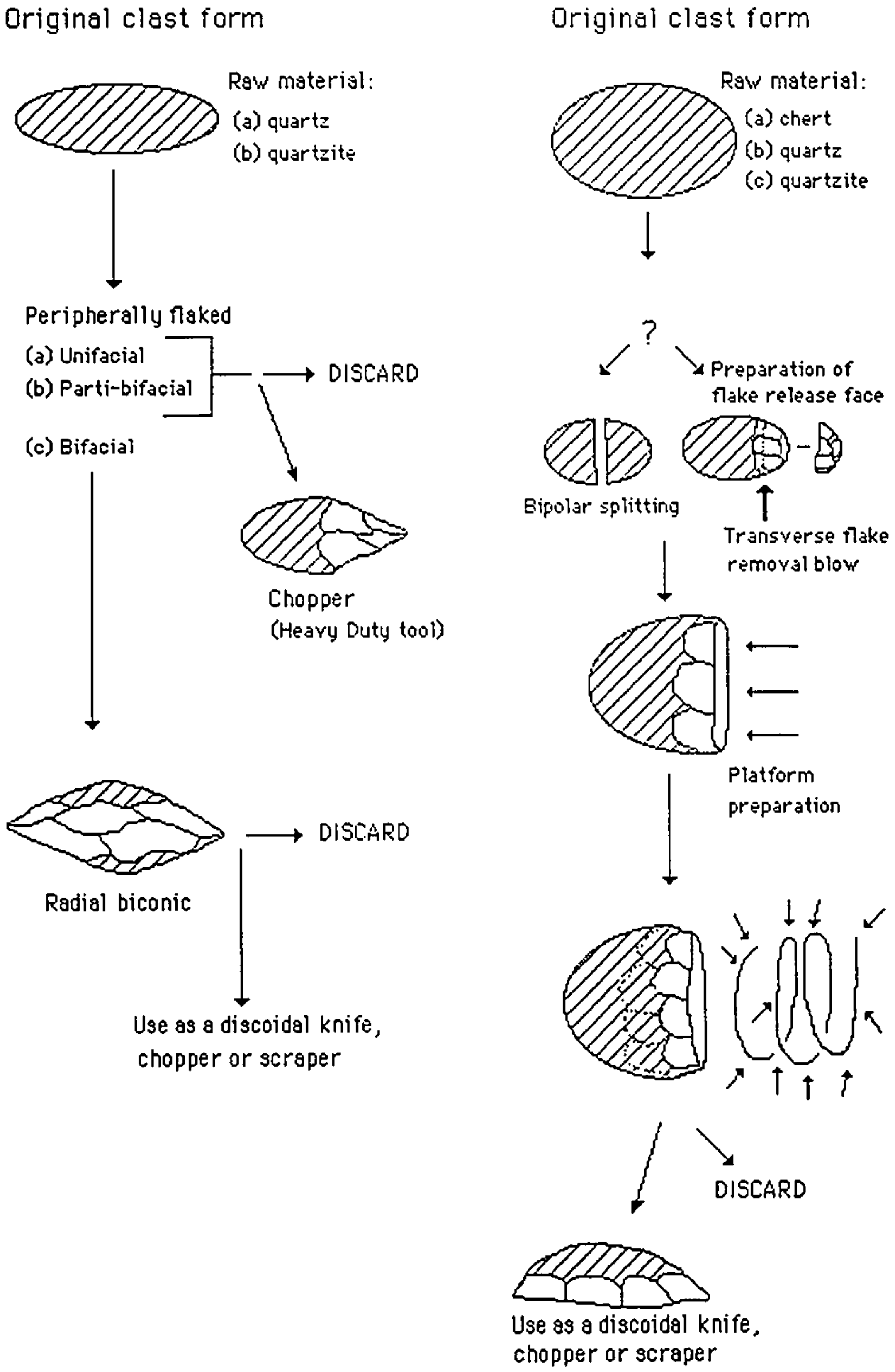
Examination of core edges under low power magnification revealed edge polish and micro-chipping that may be due to use-wear. Perhaps, when some of these cores were no longer useful for flake removal they were used as tools for cutting, chopping, or scraping. Their acute edges do not allow for classification as "core/core scraper" under Mehlman's (1989) taxonomy, since these core tool types are identified by having obtuse edges (FIG. 5.19.). The edge morphology of radial biconic and high-backed radial cores approaches that of discoids, and discoidal knives, with a diagnostic edge angle of less than 35°. However, these particular tool types are defined as very thin radial biconic cores with no cortex remaining on either surface, and this is hardly the pattern observed for the radial biconic cores measured. Perhaps after use-life as a core, platform surfaces were retouched

FIG. 5.19. Core/core scraper edge versus high-backed radial and radial biconic core types (adapted from Mehlman, 1989)



in a manner to produce a more acute edge. Figure 5.20 summarizes the core reduction model and presents recognized, as well as, hypothetical tool types.

FIG. 5.20. Hypothetical life-history of high-backed radial and radial biconic cores



5.5. Conclusion

The evidence indicates that specific decisions had been made concerning how cores were reduced. Data show that high-backed radial cores may have been produced in order to maximize the number of flaking events from a single core, as well as to maximize the number of Toth type VI flakes with a modal platform angle of 70° to 120° (to a maximum range of 130°). It would appear that raw material type and original clast form played an important role in the methods of core reduction. The majority of high-backed radial cores are made from chert, although quartz and quartzite were also reduced in this fashion. The majority of quartz and quantzite pebbles and cobbles reduced in a part-peripheral and radial biconic fashion were done so apparently to take advantage of their original clast form. Patterned platform core reduction appears limited to large clasts, as is the case for quartz and quartzite nodules from IcIu-2, IcIu-3, IdIu-20, IdIu-21, and for chert nodules from IdIu-19. It would appear that due to an apparent infrequent occurrence in local sediments at IcIu-4 of fine cryptocrystalline raw materials chert nodules were reduced as high-backed radial cores to maximize the material's use-life. Exhausted cores may have been further flaked or retouched for use as scrapers, knives or choppers.

Chapter Six

Summary and Conclusion

6.1. Discussion

Within this study several objectives were accomplished; the first of which was to apply Mehlman's (1989) classification system to the Songwe River assemblages. Problems that were encountered while using this system made it necessary to make modifications and these are given below. Other objectives achieved included: a test for variation of raw material use between the three subregions comprised by the six sites; an analysis of Toth flake types that helped to identify patterns of on-site core reduction; as well as, analyses of metrical data that demonstrated attribute distribution patterns specifically in the form of a modal size range for trimmed pieces. As an outcome, a core reduction model is derived that looks at the reduction patterns of a particular class of peripherally worked cores, leading to inferences regarding specific decisions made by MSA hominids that determined the method and extent of core preparation, flake manufacture, and core discard. Data indicates that patterns of core reduction were contingent upon, or certainly influenced by, specific raw material type, and that this may point to a pattern of hominid decision making processes in support of Clark (1988) regarding regional variability of lithic assemblages.

Throughout this work the difficult nature of dealing with surface assemblages was made all too apparent. The six localities appear deflated and assemblages may well represent a palimpsest of overlapping, and perhaps unrelated, occupation events or episodes of activity. As well, this situation is complicated by a lack of temporal control for this region, leaving the duration of hominid occupation of the Songe River valley unknown, although it may well represent several tens of thousands of years. For example, Clark and Howell (1970) have described Sangoan Industry artifacts from the Songwe

River region. Further evidence was not recovered in 1990, however, although similar materials, from the Lake Victoria region, are dated to about 200,000 years BP (McBrearty, 1988). If a similar date can be assumed for the Songwe River region, then the area may have had continuous, or intermittent, occupation since the late Middle Pleistocene, and MSA assemblages may have been deposited any time between 200,000 and 30,000 BP. For analytical purposes, it became necessary to assume the contents of each site as representing a single MSA assemblage.

Morphologically, the six sites represent at least four distinct riverine or lacustrine landscapes: (1) river terraces (IcIu-2, IcIu-3), (2) delta or river mouth (IcIu-4), (3) lake shore (IdIu-19), and (4) river floodplain (IdIu-20, IdIu-21), that implies the use of a variety of habitats. However, the association of these localities and their specific value as areas for subsistence or living activities is difficult to determine. Faunal remains have yet to be located in this region, although some bone fragments have come from nearby matrices. Only future study will be able to test for bone material in context with stone tools.

The conclusions that are drawn from this study are tentative, pending the discovery and excavation of stratified MSA sites. However, it is hoped that the data will provide an initial starting point for the development of a Songwe River culture-history.

6.1.a. Problems encountered during lithic classification

The most significant problem encountered with the application of Mehlman's classification scheme is the use and interpretation of edge retouch. As Mehlman (1989:127) indicates, edge retouch is an important variable for distinguishing trimmed pieces, or tools, from "trimmed and utilized" flake debitage. Artifacts with semi-invasive, or invasive, retouch are classified as tools, whereas those exhibiting marginal retouch are classified as trimmed and utilized debitage. If this guideline was wholly complied with, then virtually every retouched Songwe River artifact would be regarded as flake debitage, since only a small percentage (5.9%) possess the characteristics that would allow them to be described as tools.

Of the trimmed pieces, just over 94% exhibit marginal retouch and the majority of these have an edge angle of between 45° to 80° (FIG 3.3.). According to Mehlman (1989:129) this range in edge angle describes scraper retouch. Several other categories of tool types were identified by what appears to be an intentional modification of flake planform. On the one hand then, are artifacts that are typologically classifiable as tools, whereas, on the other hand, and according to their high frequency of marginal retouch, these same artifacts could be considered trimmed and utilized flake debitage!

Mehlman offers a solution, albeit subjective, to this quandary. Flakes can have "purposive retouch" and/or "intentional modification" as both are dependent on the location of retouch, angle of retouch and the modifications to flake planform. Artifacts then, can be classified as formal tools regardless then of the extent of their retouch scarring, whether it is marginal, semi-invasive or invasive. On the basis of this contingency, a majority of marginally retouched pieces from the Songwe River assemblages are considered formal tools. However, since marginal, semi-invasive, and invasive retouch appear to be a measure of time invested in the preparation of a working edge, it is difficult to interprete the intrinsic value of these measurements as they pertain to an identification of artifact type.

Clearly, a working definition of these variables is required, and an alternative approach is, perhaps, one that sees an introduction of both "flake blank" and "flake preform" to Mehlman's classification scheme. The closest that Mehlman (1989:137) comes to describing anything like these types is with his category of "point roughouts". Perhaps a majority of Songwe River artifacts are neither formal tools, nor flake debitage, but are trimmed flakes in the process of becoming tools. Data indicates that an initial stage of on-site core reduction, in the form of Toth type I-III flakes, was infrequent. This is especially true for volcanic, other metamorphic and other sedimentary materials, as cores are rare by comparison to raw materials, such as quartz or quartzite. According to Toth (1982), this pattern suggests that latter stage core reduction flakes (Toth type IV-VI), made from these rarer raw materials, were brought on-site in significantly greater than expected numbers. Perhaps these flakes were brought in as blanks or preforms and were modified into tools as needed during the course of on-site activities. Many were apparently left unfinished as whole flakes and marginally retouched pieces, as part of a cache; or they were lost or discarded. At this point in time, all that can be said for the Songwe River sites is that they were areas where a range of activities had occurred; the predominant activity requiring tools with marginal retouch and a hypothetical scraper edge.

For the Songwe River region, there may be a fine line between what archaeologists describe as formal tools, blanks, and preforms. It is apparent, however, that little effort was invested in, or perhaps wasted on, the production of "classic" MSA tool types as described by Goodwin (1928), van Riet Lowe (1945) and Bordes (1950; 1979). Perhaps the modal range of edge retouch of 45° to 80° was to facilitate flake manipulation for immediate hand held or hafted use and may also have facilitated further modification with a minimal compromise to a modal range of flake length, width and thickness. Flakes with an angle of retouch of less than 45° (approaching that of cutting tools) are few in number. They may have been salvaged, or curated, for modification into scraping implements, thus removing any evidence of their having once been whole flakes, perhaps of Levallois origin (Binford and Binford, 1966). With so very few Levallois flakes found in the Songwe River assemblages, they may have succumed to this fate or they were simply not an important part of the tool kit . What may be the case for this region is that Levallois flakes were either not produced in very large quantities, or they were carefully controlled once struck from a core. The low frequency of Levallois cores is also noteworthy, although as Clark and Kleindienst (1974) have suggested, these cores may be part of a larger continuum of peripherally worked cores that have become radial cores once removed from the production of Levallois flakes.

If large numbers of flakes were produced as blanks and preforms, perhaps a different approach to an expedient, versus curated, form of flake production is required for the Songwe River region. For example, expedient tool production is indicated by a majority of trimmed pieces having marginal retouch. Curation, may also be interpreted by the production of many flakes with what is a generalized pattern of preform flaking in the form of marginal retouch. In this way blanks and preforms, of predominantly Toth type V and type VI, may have been mobilary items transported from site to site to be used as needed.

On the basis of the core data, Mehlman's typology was refined to further differentiate the type categories of peripherally worked cores. It was necessary to do this in order to distinguish between high-backed radial cores and radial biconic cores, presently combined under the single rubric of radial/biconic (subtype 58) (Mehlman, 1989:141). These two types are distinguished in this thesis as per Clark and Kleindienst (1974), because their production appears to involve a separate and unique reduction process. On the basis of their shared planform, radial biconic cores appear to be associated with part-peripheral cores (subtype 57), more so than they are associated with high-backed radial cores. A radial biconic core appears to be the result of an extensive reduction of a peripherally worked core, whereas the life-history of a high-backed radial core is different. High-backed radial cores warrant receiving their own distinctive core sub-typing and this concern is discussed in Chapter 5, through a core reduction model.

To summarize, the core reduction model presents the hypothetical use-life of both radial biconic and high-backed radial cores. Data from IcIu-2, IcIu-3, IcIu-4, and IdIu-19, indicate that these cores were reduced in ways unique to raw material type and clast form; blocky nodules of chert are reduced by a patterned platform method, whereas spherical nodules of chert, quartz, and quartzite are peripherally flaked. Furthermore, the type of peripheral reduction that chert received is unique. All chert cores are reduced in a high-backed radial fashion only, whereas quartz and quartzite are reduced by both a part-peripheral, and radial biconic fashion, with only a few examples reduced as high-backed radial cores.

In conjunction with these observations, subsequent analyses revealed that a relationship exists between flake platform angle, flake release angle, the point of apparent core discard, and original clast form. For example, quartz is primarily bifacially reduced in a radial fashion. However, the use-life of a quartz core that is reduced this way is short; limited by four interrelated factors: (1) core edge approximating an equator, to facilitate bifacial reduction, (2) core circumference, as a measure of the potential number of flakes that may be struck from the core's periphery, (3) core thickness, and (4) the core's potential to maintain flakes with a modal platform angle of between 90° and 120° (with an outside range of 130°).

Once an initial stage of core reduction is completed by the removal of the cortex, there is limited opportunity for the radial and bifacial removal of more than a few flakes of Toth type VI, before flake platform angles approached 120°. Beyond this point cores appear to have been rarely used for the further production of flakes. Quartz cores appear to have been discarded, at this point, rather than re-prepared, as efforts to prepare new platforms may not have been well rewarded, as on average, flakes are shorter than a modal flake length of 20 mm to 50 mm, and exhibit remnant cortex on their dorsal distal surface.

Spherical nodules of chert are not reduced in a part-peripheral or radial biconic fashion, but instead are reduced as high-backed radial cores in such a way that flakes are removed in a radial fashion about a single flake release perimeter that has an oblique and continuous striking platform prepared transverse to the flake release surface. Cores prepared in this manner will provide a greater number of Toth type VI flakes (the most abundant Toth type), before striking platforms can no longer be rejuvinated, or maintain flakes with a platform angle of 90° to 120°. At this critical juncture, the core was apparently discarded. Further observation, however, indicates that some high-backed radial cores may have been recycled into scrapers, disc knives and/or choppers, as suggested by edge wear and polish observed under low power magnification.

The variation observed in peripherally worked cores is perhaps opportunistic, guided by raw material form for the production of flake blanks. However, it would appear that knappers sought out raw materials in shapes that were easy to manipulate for flake manufacture. The processes behind this method of flake manufacture, and the transmission of these processes within a localized region, must have involved some form of shared objective, especially with regard to how raw materials were to be used. These shared objectives may represent a small glimpse at just one form of technological adaptation seen for MSA hominids of the Songwe River region. Comparative data from other regions would be of value toward assessing whether an observed pattern of raw material use and flake manufacture, as described here, are solely unique to the Songwe River region. Future study will incorporate these data from other East African and south African MSA assemblages.

6.1.b. Discussion of regional differences

A comparison of Songwe River and Mumba and Nasera assemblages was done to provide information on potential differences between rockshelter and open-air localities. A comparison of site complexity, that focused on the occurrence of specific tool type categories of trimmed pieces and flake debitage revealed a shared occurrence of artifact types, but with a variation of artifact frequency. This discrepancy is attributable to at least two factors, (1) variation in the techniques used in artifact recovery, and (2) some aspect of site function. Through the processes of excavation and screening, a more representative sampling of on-site density of artifacts, if not complexity, is expected to occur, as smaller items have a greater chance of being recovered. By contrast, surface sampling is influenced by a wide range of taphonomical and post depositional processes, including the size effect (Baker, 1978; Schiffer, 1978), surface vegetation, weathering of sediments, trampling and collector bias.

Through surface sampling, a high frequency (37%) of trimmed pieces and flake debitage, having a range in length of 30.1 mm to 40.0 mm (FIG. 4.4.a.), was recorded, whereas sub-surface testing produced an assemblage with just over 8% of flakes of this size range. Sub-surface tests also recorded a majority of trimmed pieces and flake debitage with a length of 10.1 mm to 20.0 mm (54% of the combined assemblage) (FIG. 4.5.), whereas surface samples produced just 5.3% of flakes of this smaller size range; clearlydemonstrating the discrepancy between the two techniques.

Site function is suggested by a variation in the occurrence and frequency of specific artifact types. As is the case for the Songwe River assemblages, scrapers are the predominant type of trimmed pieces found at Mumba and Nasera rockshelters, for both the Sanzako Industry (38%), and the Kisele Industry (43% for level VI-A, and 37% for Nasera lower levels). Of the scraper forms, the variation between the two regions is indicated by the predominant types represented (Table 4.6). For example, at IcIu-2, IcIu-3 and IcIu-4, convex end, convex end and side, and circular scrapers are the most predominant types, whereas at Mumba VI-A, there is a moderate occurrence of nosed end, sundry end, and sundry end and side scrapers with sundry side scrapers predominating. Notched pieces comprise a large percentage of trimmed pieces from Mumba VI-A, and these may be related to woodworking activities. A high frequency of flake debitage, blades and points/perçoirs from Kisele Industry assemblages, at Mumba and Nasera, may be related to the occurrence of notched pieces, and the manufacture and/or maintenance of hafted hunting weapons. In the Songwe River region, notched and concave pieces are rare, as is the case for points/perçoirs. On the basis of frequencies of artifact types, the Mumba and Nasera assemblages would appear to represent areas where a greater variety of specific processing and maintenance activities occurred, whereas, the Songwe River assemblages indicate areas where activities took place that required tools with a scraper edge morphology.

From IdIu-19, IdIu-20 and IdIu-21 scraper use is reduced with an increase in blades and Levallois flakes, perhaps indicative of extractive and processing tasks. As well, flake debitage levels are very high at IdIu-19 (44.2%), and IdIu-21 (46.9%), although a corresponding increase in core frequency is not observed, suggesting that flakes may have been brought on to the site.

The major difference between assemblages from the Songwe River region and those of the Olduvai Gorge/Lake Eyasi region is the occurrence of a non-flaked stone category in the form of hammers and anvils. As site furniture, these items may indicate home bases (Baker, 1978). Their non-occurrence in the Songwe River region suggests that these sites may not have been localities of repetitive, or lengthy occupation, to the extent that is implied by the many occupation layers described for the Mumba and Nasera rockshelters.

Tool type distribution between Songwe River sites is consistent with each site exhibiting a similar variation in range of artifact forms (FIG 4.2.a., and FIG. 4.2.b.). Scrapers are the predominant tool type, indicating a general similarity of on-site activities. IcIu-2, and IcIu-3, exhibit the greatest frequency of heavy duty tools, a category that was not a focal point of interest in this thesis since they appear to be a cross-over from the part-peripheral reduction of quartz and quartzite pebbles and cobbles. Edge battering is the only feature that distinguishes these items from cores, and as presented by the core reduction model, heavy duty tools are the result of opportunistic use of discarded peripherally worked cores. A high incidence of flake debitage is common for all sites, and indicates extensive on-site core reduction. However, a low on-site frequency of cores, and a high overall frequency of Toth type V and type VI flakes, suggests that cores were reduced off-site and latter stage core reduction flakes were carried on-site as blanks and preforms.

IdIu-20 stands out from among the other sites for its high frequency of backed tools, and IdIu-19, IdIu-20 and IdIu-21 are identified as having a greater occurrence of blades and Levallois flakes. If these particular tool types represent cutting implements, then these three sites may represent localities where some degree of resource extraction and processing occurred. However, on the basis of the general distribution of tool types the six Songwe River sites appear to share greater similarities than differences.

6.1.c. Raw material distribution

The six localities are roughly located on a north to south line within the river valley. IcIu-2, IcIu-3, and IcIu-4, are located within the northern extent of thestudy area, and IcIu-4 remains distinct from the other two in terms of raw material occurrence. All three of these sites have an abundance of quartz and quartzite. Minimal occurrences of volcanic and other sedimentary materials suggests that these materials may have been uncommon in the immediate vicinity. Volcanic material is more prevalent in the southern assemblages, and it may well have been from this region that the volcanics found throughout the river valley originated: a distance of at least 30 km.

IcIu-4 is also unique because it exhibits a very high frequency of chert, whereas at the nearby localities of IcIu-2 and IcIu-3, very little chert was found. No evidence of a chert source was found locally and erosional gullies in the immediate vicinity of IcIu-4 revealed only gravels composed of quartz, quartzite, granite and basalt. The frequency of chert at IcIu-4 is approximated at IdIu-19, IdIu-20 and IdIu-21, and, like volcanic material, the frequency chert use increases the further south sites are located in the Rukwa Trough. This may indicate a source local to the southern region. IcIu-4 appears to be a focal point for the accumulation of chert and, as pointed out, this material was reduced in a fashion unique from quartz and quartzite.

IdIu-19 is situated on an exposure of well-rounded quartz pebbles and small cobbles. Below this surface there is a 10 m exposure of loosely compacted, coarse grained quartz sand that extends from 300 m south of the site. To the southeast of the site this sand is overlain by very fine sediments of reworked volcanic ash and silt. These latter sediments are related to Pleistocene lacustrine silts as described by Spurr (1953). Large nodules of chert (15-30 cm in length, by 8-10 cm in width, by 3-7 cm thick) are found on the surface just to the southeast of the site. Although a source for these nodules was not located, their occurrence in the area does suggest that one may be nearby. As well, the size difference between these nodules and those believed used at IcIu-4 indicates that there may be two sources for chert. The source used for the artifacts at IcIu-4 is perhaps a fluvial lag deposit as cortex bearing flakes indicate extensive rolling and battering.

By proportion, quartz and quartzite predominate the raw materials observed at IdIu-19, however, there is an increase in the use of volcanic material over that seen for IcIu-2 and IcIu-3. A similar pattern of increased volcanic use is observed for IdIu-20 and IdIu-21. These two sites are much closer to the eastern slopes of the Manyara Range, as well as the volcanic uplands of the Poroto Ridge, and this may be reflected by a higher on-site occurrence of volcanic material.

The number of volcanic cores identified from all assemblages is 20: 4 from IdIu-21, 2 from IdIu-20, 4 from IdIu-19, 1 from IcIu-4, 3 from IcIu-3 and 6 from IcIu-2. For the southern region, a majority of volcanic pieces belong to the categories of flake debitage and angular waste, and this pattern is the same for IdIu-19. However, the occurrence of 39 trimmed pieces and a single volcanic core at IcIu-4, as compared with 79 trimmed pieces of chert and 38 chert cores, indicates a completely different pattern of use for these two raw materials. Volcanic material was apparently transported from greater distances (from the south?), in the form of flake blanks, whereas chert was brought onto the site in nodular or prepared core form.

The majority of surface occurrences of volcanics were found to be of poor flaking quality, however basalt, which is very common in lag deposits and river bed exposures, was completely over-looked as a source for flaking by Songwe River inhabitants. The volcanic material that was used is of a more vitreous composition and resembles a welded tuff.

Overall, there is a trend for a decrease in the use of quartz and quartzite the further south sites are located in the valley. As well, there is a corresponding increase in the use of chert. Volcanics also appear to have been more in use the further south assemblages were recovered. Other metamorphic and other sedimentary materials are infrequently represented and comprise a very small percentage of the total raw materials recorded at each site. On the basis of a spatial distribution of raw materials, it appears that local sources were exploited, as is the case for quartz use throughout the valley, and quartzite use in the northern region. Variation in raw material use is perhaps a reflection of local availability, although the data indicate that chert and volcanics were preferentially selected over quartz and quartzite when available, even though sources for these materials may have been distant. For other metamorphic and other sedimentary raw materials, these appear to have been opportunistically retrieved, as their occurrence in local sediments is rare. As well, the evidence does not suggest that these materials were actively sought out for flake production.

6.1.d. Discussion of Toth type distribution

The general pattern for all three northern assemblages is one indicating that the initial stages of core reduction had occurred off-site. The low on-site occurrence of type I-III flakes suggests that partly or fully cortical flakes were not preferentially sought after as blanks for tool production. Toth type I flakes are underrepresented, as expected, and indicate that cores may have been tested for flaking quality perhaps at their point of origin.

Final stage core reduction flaking predominated for virtually all raw material types, as is indicated by a predominance of Toth type IV-VI flakes for all raw material categories. A greater frequency of initial stage flaking of cores (type I-III) occurred with raw materials that appeared to be locally available, such as quartz and quartzite at IcIu-2, and IcIu-3. A low frequency of Toth type I-III flakes of chert at IcIu-4, suggests that cores may have been initially prepared off-site.

At IdIu-19, focus again was on the later stages of core reduction, as Toth type V and type VI flakes predominate. Type IV flakes were not found and this is perhaps an anomaly of surface survey since these flakes represent an initial stage of bifacial core reduction which is a common reduction method observed for quartz at this site. The Toth type distribution for IdIu-20 maintains an emphasis on later stage reduction flakes, although there is minimm of initial on-site reduction of quartz and chert. IdIu-21 appears to be a location of volcanic core reduction as Toth types I and II flakes occur in greater frequency than latter stage reduction flakes. However, a low occurrence of volcanic cores at this site was not observed.

Sub-surface tests at IcIu-4 revealed a remarkable difference in the size range of artifacts observed and indicates an influence of size effect (Baker, 1978). However, the Toth type distribution of this sub-surface assemblage (FIG. 4.13.) revealed a pattern similar to that seen for Toth types on the surface, with a greater frequency of Toth type V and VI flakes. This information is of value as it confirms that whereas the size effect influences surface representation of artifacts, it does not appear to affect the pattern of distribution for Toth flake types, nor alter an interpretation of the stages of on-site core reduction.

6.1.e. Discussion of platform preparation

An analysis of platform preparation indicated that Toth type V and type VI flakes exhibit the greatest frequency of simple and complex faceting. This pattern was found especially so at IcIu-4, where purposive and extensive platform preparation had occurred, perhaps as method to maximize the use-life of chert cores. On the basis of platform preparation data, faceting is perhaps one method of flake preparation dependent more so on immediate flaking requirements than it is for following any formal Levallois style. The predominance of peripherally worked cores suggests that the Levallois technique was not a technique of core reduction strictly adhered to by Songwe River inhabitants. Data indicate that a range of flake types were produced through available methods of peripheral and patterned platform core reduction techniques, constrained perhaps by raw material type and clast form.

A predominance of plain faceting in conjunction with a high frequency of marginal retouch on flakes suggests an expedient based technology. However, observation of specific patterns of core reduction, as demonstrated by the core reduction model, led to the conclusion that cores were carefully and selectively reduced. The abundance of quartz and quartzite nodules used as cores is perhaps indicative of the availability of these raw materials, and may have influenced their reduction and discard with little evidence of platform re-preparation. However, for raw materials, such as chert, that appear to be quite rare by comparison, careful preparation before flake removal occurred, indicating that a method for maximizing the flaking potential of these materials may have been practiced.

6.2. Conclusion

The interpretations presented here, based as they are on surface collections, are tentative, pending the location and analysis of stratified sites and the development of a local culture-history. However, the region has proven itself to be a rich and valuable resource of Pleistocene cultural material, and although it is difficult to offer solid support for Clark (1988), from the limited perspective allowed by surface collections, the patterns that are visible do suggest that the MSA inhabitants of the Songwe River region selectively utilized specific raw materials from among an available range of types. The degree of variation of flake manufacturing processes observed for specific raw material type and raw material shape indicates that these hominids must have had a shared objective as to what constituted an appropriate flake with regard to its length, breadth, thickness, and platform angle, as well as an appropriate method of core reduction. The distinctive pattern of reduction of chert, as compared to quartz and quartzite, indicates that this material may have been reduced in a manner that would allow for the maximum number of flakes to be removed before core exhaustion. This pattern indicates that chert was conserved through high-backed radial core preparation.

A more thorough study of the techniques of core preparation and flake manufacture is required for this region and time frame, in order to help those who study early modern human behaviour and material culture to appreciate some of the logistics and decision making processes that are undoubtedly involved. As well, these data can be compared with other MSA assemblages to see how patterns and techniques of raw material use vary across both space and time. It is hoped that the data presented in this thesis will be of some use as an initial data base for future research on Middle Stone Age lithic technology for the Songwe River region.

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Appendix 1.a. Mean dimensions, standard deviation and range in mm for selected tool types and debitage.

Sites:	Iclu-2		Iclu-3		Iclu-4		Idlu-19		Idlu-20		Idlu-21	
Tooltypes												
1.scrapers	n=120	Range	n=95	Range	n=160	Range	n=32	Range	n=37	Range	n=17	Range
Length	35.4±9.7	64.1-19.6	36.5±9.4	73.1-19.0	36.8±9.6	71.7-14.8	40.6±11.6	70.3-25.4	36.2±10.3	59.5-19.5	36.9+10.2	55.4-22.
Breadth	33.7±8.3	57.9-14.5	33.0±8.9	69.0-17.3	33.6±9.4	69.8-16.0	35.7±9.5	57.1-17.2	30.3±7.2	50.5-18.1	34.3+8.5	50.0-19.
Thickness	13.3±4.1	27.9-7.2	12.7±3.3	23.2-5.7	11.8±3.4	24.2-4.2	12.1±4.4	21.8-6.1	10.4±3.6	21.6-[illegible]9	10.3+3.2	18.5-5.0
2.backed	n=8	Range	n=2	Range	n=3	Range	n=3	Range	n=13	Range	n=1	Range
Length	38.9±15.4	59.5-21.8	24.2±3.2	26.4-21.9	18.5±1.9	19.7-16.4	36.0±12.6	45.3-21.7	20.0±3.7	25.7-14.7	32.6	-----
Breadth	29.7±14.4	55.1-15.4	20.4±6.6	25.0-15.7	23.0±17.1	42.7-11.3	29.3±11.0	40.8-18.8	17.1±3.5	22.3-11.6	35.5	
Thickness	11.9±4.7	27.9-7.2	7.8±1.6	8.9-6.6	7.3±4.3	12.2-4.1	8.7±4.3	11.3-3.8	5.2±1.2	3.8-1.1	12.6	
3.points	n=0	Range	n=2	Range	n=2	Range	n=0	Range	n=0	Range	n=0	Range
Length		-----	29.8±4.2	32.8-26.8	28.8±8.7	34.9-22.6		-----		-----		-----
Breadth			31.3±3.3	33.5-29.1	35.8±8.6	41.8-29.7						
Thickness			11.7±1.4	12.7-10.7	9.0±1.1	9.7-8.2						
4.burins	n=2	Range	n=1	Range	n=2	Range	n=2	Range	n=2	Range	n=1	Range
Length	23.3±3.5	25.7-20.8	31.0	-----	24.4±2.5	26.2-22.6	30.0±0.1	30.1-29.9	30.7±6.7	35.4-25.9	27.1	-----
Breadth	26.8±3.2	29.0-24.5	25.2		18.7±2.3	20.3-17.0	26.3±2.5	28.1-24.5	25.0±2.1	26.4-23.5	25.3	
Thickness	7.6±0.7	8.1-7.1	13.4		8.8±1.6	9.9-7.6	7.6±2.2	9.1-6.0	10.2±3.7	12.8-7.5	3.0	
5.bifacial	n=20	Range	n=9	Range	n=8	Range	n=9	Range	n=1	Range	n=1	Range
Length	39.1±10.2	62.4-23.6	36.9±5.4	43.9-30.2	43.5±8.5	58.3-31.7	49.6±12.3	74.0-37.5	28.9	-----	42.2	-----
Breadth	36.4±10.5	60.1-18.1	37.3±11.5	66.2-27.0	35.4±7.0	44.8-27.4	44.5±11.2	26.6-66.8	17.8		43.9	
Thickness	28.1±3.6	23.8-10.1	14.6±3.7	21.5-9.4	12.6±1.7	14.3-8.8	16.6±3.0	21.3-12.7	5.7		16.9	
6.becs	n=6	Range	n=3	Range	n=14	Range	n=0	Range	n=2	Range	n=2	Range
Length	33.5±7.6	45.0-23.5	27.6±8.6	37.5-21.6	34.0±7.9	47.7-21.6		-----	29.1±2.8	31.0-27.1	22.5±1.8	23.7-21.
Breadth	33.4±6.3	40.4-23.5	28.2±10.4	38.6-17.8	31.3±6.8	42.1-21.6			31.3±11.7	39.5-23.0	26.1±1.1	26.8-25.
Thickness	11.6±1.3	13.4-9.9	10.2±2.1	12.5-8.3	10.8±3.1	18.3-6.8			12.7±6.7	15.8-7.1	6.1±0.0	--------

Appendix 1.b. Selected tool types and debitage.

Tooltypes	Iclu-2		Iclu-3		Iclu-4		Idlu-19		Idlu-20		Idlu-21	
7.composite	n=1	Range	n=2	Range	n=4	Range	n=0	Range	n=1	Range	n=1	Range
Length	65.9	-----	46.2±11.6	54.4-38.0	46.0±11.2	59.0-31.8		-----	75.2	-----	62.0	-----
Breadth	35.8		28.9±6.2	33.2-24.5	44.9±14.8	55.4-23.8			50.0		49.2	
Thickness	12.9		12.2+1.8	13.4-10.9	14.7+3.5	16.8-9.5			20.5		11.8	
10.other	n=0	Range	n=0	Range	n=1	Range	n=2	Range	n=1	Range	n=3	Range
Length		-----		-----	39.7	-----	33.6±1.5	34.6-32.5	34.0	-----	36.8±14.6	46.2-19.
Breadth					23.1		30.1±4.9	33.5-26.6	41.4		41.5±18.8	62.5-26.
Thickness					8.5		10.3±2.4	12.0-8.6	10.5		8.1±3.1	10.7-4.7
Flake Debitage												
18.flakes	n=105	Range	n=151	Range	n=176	Range	n=138	Range	n=64	Range	n=90	Range
Length	34.4±13.5	72.6-11.2	34.0±13.1	102.0-13.3	33.7±11.8	93.3-12.0	39.1±12.6	89.3-15.3	31.4±10.6	64.6-13.6	34.5±14.0	86.0-15.
Breadth	34.4±11.8	81.6-15.7	31.2±10.8	65.7-9.5	33.1±10.6	77.8-10.0	35.5±14.3	132.8-16.4	30.8±9.1	55.9-13.7	32.4±11.8	78.7-16.
Thickness	12.7±4.8	28.8-4.9	11.6±4.4	25.0-2.8	11.1±4.2	27.4-3.9	10.7±3.8	20.9-3.1	9.3±3.8	23.0-2.7	9.3±3.9	22.0-4.1
19.blades	n=0	Range	n=0	Range	n=0	Range	n=3	Range	n=3	Range	n=7	Range
Length		-----		-----		-----	36.9±11.0	49.4-28.9	32.7±9.3	41.4-22.9	35.7±7.6	48.6-27.
Breadth							23.6±1.3	24.8-22.3	20.4±6.6	24.5-12.8	20.3±4.1	26.8-15.
Thickness							6.8±1.2	7.8-5.4	6.4±2.1	8.8-5.0	8.7±3.3	14.3-6.0
20.Levallois	n=2	Range	n=0	Range	n=0	Range	n=4	Range	n=9	Range	n=9	Range
Length	40.1±2.7	42.0-38.2		-----		-----	45.8±10.3	57.4-35.7	31.6±8.6	51.2-24.2	37.8±12.1	64.4-22.
Breadth	43.1±6.6	47.7-38.4					36.7±4.1	40.9-31.1	32.7±6.9	42.0-22.7	34.9±6.4	42.5-21.
Thickness	11.2±3.0	13.3-9.0					9.8±2.8	12.2-6.4	8.1±2.4	13.4-6.1	9.0±3.1	13.9-4.7

8.outils ecailles	Idlu-20		
	n=1		Range
	Length	25.2	-----
	Breadth	17.9	
	Thickness	9.8	

17.Specialized flakes	Iclu-2		
	n=1		Range
	Length	20.4	-----
	Breadth	9.1	
	Thickness	7.2	

Appendix 1.c. Cores: mean Length, Breadth, Thickness, standard deviation and Range in mm.

Sites:	Iclu-2		Iclu-3		Iclu-4		Idlu-19		Idlu-20		Idlu-21	
Tooltypes												
11.Periph	n=91	Range	n=72	Range	n=79	Range	n=32	Range	n=11	Range	n=10	Range
Length	42.2±10.3	88.2-23.6	44.3±9.9	73.0-21.2	44.7±9.6	72.2-25.7	50.5±10.6	69.9-31.8	39.4±8.4	55.0-31.7	48.1±16.2	73.2-30.
Breadth	35.4±8.4	74.4-20.2	37.8±8.7	60.3-19.8	38.2±8.5	70.0-20.1	42.0±9.6	63.4-26.0	33.8±6.6	44.0-25.1	40.6±15.2	65.8-27.
Thickness	21.0±5.8	39.0-12.1	22.4±7.8	44.2-8.6	20.5±7.9	49.0-8.7	21.0±6.2	39.1-11.0	17.0±6.2	24.7-4.5	23.0±8.9	38.3-12.
12.Pattern	n=37	Range	n=31	Range	n=9	Range	n=20	Range	n=12	Range	n=5	Range
Length	50.9±14.5	89.5-24.6	58.4±15.8	93.6-28.8	50.4±16.3	83.4-30.7	51.8±17.0	109.8-25.4	49.2±9.8	69.8-30.3	48.5±5.6	53.4-41.
Breadth	38.7±8.5	60.0-20.8	48.3±14.8	83.1-21.6	45.6±14.2	76.6-28.6	43.3±14.0	89.7-24.3	42.7±10.8	63.7-23.0	39.6±5.0	46.9-33.
Thickness	27.3±9.7	58.8-11.3	33.0±11.4	55.3-16.5	36.2±12.2	54.3-14.1	30.8±16.2	83.9-12.6	30.5±6.5	39.9-18.5	27.9±7.7	35.5-19.
13.Intermed	n = 3	Range	n=2	Range	n=1	Range	n=0	Range	n=0	Range	n=0	Range
Length	45.3±13.7	61.1-37.1	40.2±2.1	41.7-38.7	59.0	-----		-----		-----		-----
Breadth	38.4±9.9	49.4-30.3	37.7±2.4	39.4-36.0	51.0							
Thickness	21.5±2.0	23.8-20.0	18.3±2.1	19.7-16.8	32.4							
14.Bipolar	n=1	Range	n=1	Range	n=1	Range	n=2	Range	n=2	Range	n=1	Range
Length	25.8	-----	42.0	-----	24.2	-----	34.2±4.2	37.1-31.2	31.7±7.2	36.8-26.6	30.3	-----
Breadth	16.8		33.4		27.3		21.0±0.4	20.7-21.2	24.9±2.4	26.6-23.2	28.0	
Thickness	8.3		10.5		10.2		9.3±1.1	10.0-8.5	13.9±1.6	15.0-12.7	13.2	
15.Amorph	n=0	Range	n=0	Range	n=4	Range	n=4	Range	n=2	Range	n=3	Range
Length		-----		-----	50.2±5.5	58.1-45.4	46.4±12.8	62.7-33.9	42.6±1.1	43.3-41.8	43.8±7.9	52.8-38.
Breadth					36.4±6.3	45.0-30.1	31.1±7.4	39.7-22.4	32.0±1.6	33.1-30.9	36.5±11.7	49.9-28.
Thickness					24.6±4.5	29.1-19.1	18.1±8.2	29.0-11.6	19.8±6.8	24.6-15.0	16.5±3.5	20.5-13.